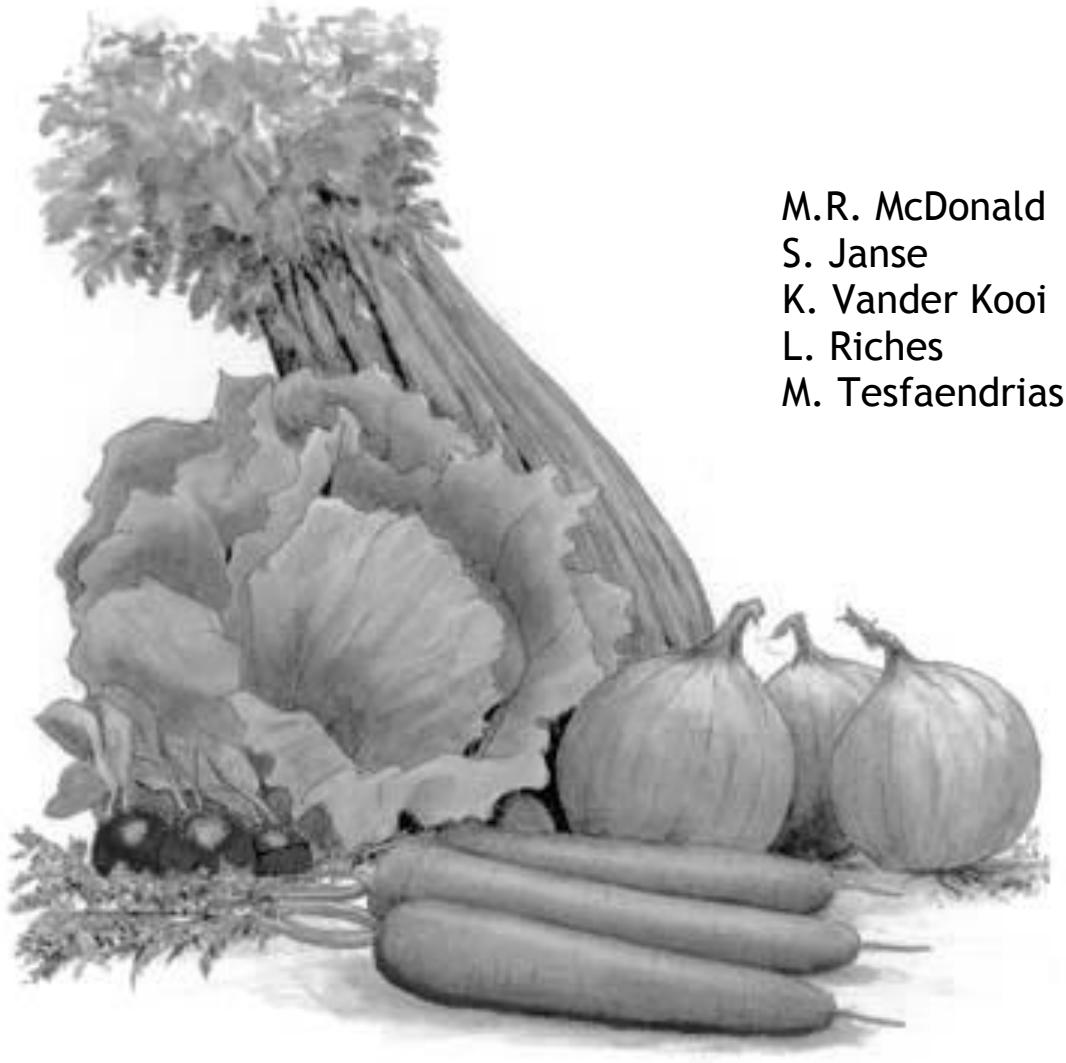
Muck Vegetable Cultivar Trial & Research Report 2012



M.R. McDonald
S. Janse
K. Vander Kooi
L. Riches
M. Tesfaendrias

UNIVERSITY of GUELPH

Office of Research &
Dept. of Plant Agriculture
Report No. 62

Muck Crops
Research Station
Kettleby, Ontario

Research and Cultivar Trial Report for 2012

University of Guelph
Office of Research &
Department of Plant Agriculture
Muck Crops Research Station

1125 Woodchoppers Lane
Kettleby, Ontario L7B 0E9
Phone (905) 775-3783 Fax: (905) 775-4546

www.uoguelph.ca/muckcrop/

INDEX

Page

RESEARCH PROJECTS

Carrots

…/continued

RESEARCH PROJECTS – continued **Page**

Brassia Crops

Onion

Lettuce

Miscellaneous

…/continued

RESEARCH PROJECTS – continued **Page**

Miscellaneous continued

Integrated Pest Management

CULTIVAR TRIALS

STAFF - 2012

UNIVERSITY OF GUELPH
Office of Research and
Department of Plant Agriculture

MUCK CROPS RESEARCH STATION

Shawn Janse	Research Station Manager
Mary Ruth McDonald, Ph.D., P.Ag.	Research Scientist
Kevin Vander Kooi	Agricultural Technician
Laura Riches	Agricultural Technician
Michael Tesfaendrias	Research Associate/IPM Coordinator
Hunter Roberts	Research Assistant
Miško Mitrović	Agricultural Worker
Abhinanden Deora	Post Doctoral Fellow
Kalpana Sharma	Post Doctoral Fellow

Seasonal Contracts:

Gerry Drouillard	Summer Assistant
Allison Grant	Summer Assistant
Carrie McKinnon	Summer Assistant
Andrea Smith	Summer Assistant
Hunter Roberts	Summer Assistant
Sarah Ellens	Summer Experience

Graduate Students:

Laura Barbison	School of Environmental Science
Brian Colins	Department of Plant Agriculture
Thomas Gludovacz	Department of Plant Agriculture
Dennis Van Dyk	Department of Plant Agriculture

IPM Supervisor:	**Scouts:**
Michael Tesfaendrias	Kayla Maier
	Zach McLarens

CO-OPERATING COMPANIES

Special thanks for supplying seed used in many of the research projects at the Muck Crops Research Station.

Stokes Seed Ltd	Jim Robinson
Bejo	Jan Van Der Heide

CO-OPERATING RESEARCH STAFF - EDUCATION/RESEARCH/GOVERNMENT

Clarence Swanton	Dept. of Plant Agriculture, University of Guelph, Ontario, Canada
Kevin Chandler	Dept. of Plant Agriculture, University of Guelph, Ontario, Canada
Greg Boland	School of Environmental Sciences, University of Guelph, Ontario, Canada
Ivan O'Halloran	Ridgetown Collage, University of Guelph, Ridgetown, Ontario, Canada
Deanna Nemeth	Ontario Ministry of Agriculture, Food & Rural Affairs, Guelph, Ontario, Canada
Christoph Kessel	Ontario Ministry of Agriculture, Food & Rural Affairs, Guelph, Ontario, Canada
Bruce Gossen	Agriculture & Agri-Food Canada, Saskatoon, Canada
Gary Peng	Agriculture & Agri-Food Canada, Saskatoon, Canada
Alan Taylor	Dept. Horticultural Science, Cornell University, New York, U.S.A.
Phil Simon	University of Wisconsin, Madison, Wisconsin, U.S.A.

CO-OPERATING RESEARCH STAFF - INDUSTRY/PRIVATE SECTOR

Kevin Brink	Ocean Mist Farms, Castroville, California, U.S.A.
Rod McLeod	Chemtura Inc, Lethbridge, Alberta, Canada
Kathleen Kauth	Blackstone Agriculture Inc., Kincardine, Ontario, Canada
Lauren Strachen	Neudorff North America, Victoria, British Columba, Canada
Neil Carter	Engage Agro, Guelph, Ontario, Canada
Ahmed Bilal	Vineland Research and Innovation Centre, Vineland, Ontario, Canada
Sid Hovius	Nunhems (Bayer Crop Science), Newmarket, Ontario, Canada
Dale Nash	Cavendish Farms, Wheatley, Ontario, Canada

SEED SOURCES - 2012 - CULTIVAR TRIALS

Bejo **Bejo Seeds Inc.**, 1088 Healey Road, Geneva, New York, 14456, U.S.A.
Tel: (308) 789-4155

Cro **Crookham Company,** P O Box 520, Caldwell, Indiana, 83606, U.S.A.
Tel: (208) 459-7451

Nun **Nunhems**, 8850 59th Avenue N.E., Brooks, Oregon, 97305, U.S.A.
Tel: (503) 393-3243

RZ **Rijk Zwaan Export B.V.**, P.O. Box 40, 2678, 2G Delier, Holland
Tel: 0174-532300

Sem **Seminis Vegetable Seeds,** 2700 Camino Del Sol, Oxnard, California, 93030, U.S.A.
Tel: (866) 334-1056

Sol **Solar Seeds Inc.,** Box 1158, Bradford, Ontario, L3Z 2B5, Canada
Tel: (800) 227-7687

Sto **Stokes Seed Ltd.**, 296 Collier Rd, Box 10, Thorold, Ontario, L2V 5E9, Canada
Tel: (800) 396-9238

Tak **American Takii Inc.**, 301 Natividad Rd., Salinas, California, 93906, U.S.A.
Tel: (408) 443-4901

UNF **Coop Uniforce**, 291 rue Cooperative, Sherrington, Quebec, J0L 2N0, Canada
Tel: (450) 454-3986

Vil **Vilmorin Inc.**, 2551 N Dragoon Street # 131, Tucson, Arizona, 85745, U.S.A.
Tel: (520) 884-0011

We would like to thank our seed suppliers for the various cultivar trial submissions in 2012.

LEGEND OF SEED SOURCES

A&C	Abbott & Cobb Inc.
Aris	Aristogenes Inc.
Asg	Asgrow Seed Co.
BBI	Bakker Brothers of Idaho, Inc.
Bejo	Bejo Seeds Inc.
BO	Brinker-Orsetti Seed Co.
Car	Cardinal Seed Co. Inc.
Chr	Chriseed
Cro	Crookham Company
CS	Campbell Soup Co.
CU	Cornell University
DF	Daehnfeldt
EJ	Erie James Ltd.
FAIR	Fairbanks Selected Seed Co.
FM	Ferry-Morse Seed Co.
FFS	Fred Fuller Seeds
HM	Harris Moran Seeds
Nor	Norseco Inc.
Nun	Nunhems USA Inc
NZ	Nickerson-Zwaan B.V.
Pal	D. Palmer Seed Co. Inc.
PETO	Petoseed Co.
Pol	Polonica International
Rio	Rio Colorado Seeds Inc.
Rog	Rogers Seed
RS	Royal Sluis Inc.
RZ	Rijk Zwaan Export B.V.
Sak	Sakata Seed America Inc.
SC	Seed Science Inc.
Sham	Shamrock Seed Co.
Sem	Seminis Vegetable Seeds
Sieg	Siegers Seed Co.
Sol	Solar Seed Co.
Sto	Stokes Seeds Ltd.
Sun	Sun Seeds
SN	Seminova
Swy	Seedway Inc.
Tak	American Takii Inc.
Toz	A. L. Tozer Ltd.
Wis	University of Wisconsin
VDH	Vanderhave
UNF	Co-op Uniforce
Vil	Vilmorin Inc.
ZW	Zwaan Seeds, Inc

INTRODUCTION AND ACKNOWLEDGMENTS

The Muck Crops Research Station, as part of the Department of Plant Agriculture and the Office of Research, University of Guelph, is responsible for conducting and coordinating research projects to solve problems in the production of vegetables grown in organic soils.

In 2012, Muck Crops Research Station staff conducted, and/or co-operated on research projects with researchers from the Department of Plant Agriculture and School of Environmental Sciences at the University of Guelph; researchers from OMAFRA, Agriculture and Agri-Food Canada, and Cornell and Wisconsin Universities; research departments of the Crop Production Chemical Industry, numerous seed companies, and growers.

This report consists of two sections: the first contains highlights of research projects which were conducted in 2012 under the supervision of Professor Mary Ruth McDonald and other researchers at the University of Guelph. The second section contains highlights of various muck crops cultivar evaluations in 2012 in-field and storage trials, under the supervision of the Research Station Manager, Shawn Janse. The results published in this report should be treated as a progress report. Some of the chemicals used in the trials are not registered for use on the crops they were applied to. Additional trials may be necessary before firm conclusions and recommendations can be made.

The Muck Crops Research Station is an active participant in the training of new researchers on muck vegetables through the Graduate Student Program of the University of Guelph. Presently the Muck Crops Research Station has four M.Sc. graduate students, two Post Doctoral fellows, and one Research Associate working on muck vegetables.

The Muck Crops Research Station continues to conduct research to assist in the future registration of chemicals for muck vegetables. Recently, research programs have aided in the registration of Chateau herbicide for onions (Dr. Clarence Swanton) and the emergency use label for Delegate for thrips on onions (Dr. Mary Ruth McDonald).

We would like to take this opportunity to express our sincere appreciation to the staff for their efforts in conducting these research projects, cultivar evaluation trials and producing this report. Many thanks also to all the co-operating researchers, technicians, industry personnel, and growers for their continued support and interest in muck crops.

Mary Ruth McDonald, Ph.D., P.Ag.
Professor
Department of Plant Agriculture

Shawn Janse
Research Station Manager
Office of Research

Weather Data 2012

PRECIPITATION

Month	2002		2003		2004		2005		2006		2007	
	Rain mm	Snow cm	Rain mm	Snow cm	Rain mm	Snow cm	Rain mm	Snow cm	Rain mm	Snow cm	Rain mm	Snow cm
January	10	17	0	22	4	53	20	20	32	17	21	29
February	27	12	0	36	5	9	17	34	25	21	6	33
March	43	0	0	37	65	6	13	0	15	3	24	10
April	77	0	20	7	56	0	74	0	44	2	54	0
May	113	0	105	0	108	0	14	0	65	0	43	0
June	106	0	75	0	50	0	63	0	64	0	29	0
July	76	0	29	0	102	0	33	0	72	0	27	0
August	18	0	81	0	104	0	56	0	41	0	33	0
September	40	0	111	0	25	0	53	0	174	0	40	0
October	49	0	78	0	26	0	41	0	102	0	32	0
November	43	30	91	15	54	4	87	14	67	0	54	20
December	12	22	36	11	43	36	38	34	25	9	22	77
Annual	**614**	**81**	**626**	**128**	**642**	**108**	**509**	**102**	**726**	**52**	**385**	**169**
Total Precip.	**695**		**754**		**750**		**611**		**778**		**554**	

LTA = Long Term Average for U of Guelph, Dept. of Plant Agriculture - Kettleby
1125 Woodchoppers Lane, R.R. #1, Kettleby, ON, L7B 0E9. 38 Years (1975-2012)

PRECIPITATION

Month	2008		2009		2010		2011		2012		LTA	
	Rain mm	Snow cm	Rain mm	Snow cm	Rain mm	Snow cm	Rain mm	Snow cm	Rain mm	Snow cm	Rain mm	Snow cm
January	27	22	0*	44	9*	21	15	38	39	13	19	29
February	31	56	48*	26	189*	33	17	40	15	19	20	24
March	19	47	56*	5	36*	0	56	21	30	2	31	14
April	44	0	105	0	12	0	75	0	51	0	54	4
May	56	0	117	0	52	0	92	0	49	0	73	0
June	68	0	49	0	170	0	68	0	55	0	76	0
July	137	0	135	0	146	0	56	0	140	0	86	0
August	62	0	89	0	74	0	113	0	69	0	80	0
September	81	0	51	0	95	0	67	0	94	0	83	0
October	54	0	62	0	60	0	83	0	123	0	69	1
November	30*	13	31	2	41	0	85	1	32	0	55	9
December	13*	63	46	9	61	72	49	4	35	14	26	28
Annual	**622**	**201**	**789**	**86**	**789**	**126**	**776**	**104**	**732**	**48**	**671**	**109**
Total Precip.	**823**		**875**		**901**		**880**		**780**		**780**	

LTA = Long Term Average for U of Guelph, Dept. of Plant Agriculture - Kettleby
1125 Woodchoppers Lane, R.R. #1, Kettleby, ON, L7B 0E9. 38 Years (1975-2012)

* Data collected from Egbert, ON

MEAN TEMPERATURE (°C)

	2002		2003		2004		2005		2006		2007	
Month	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**
January	1.6	-5.1	-5.0	-15.1	-6.6	-17.1	-3.4	-13.7	2.9	-4.0	-0.4	-9.3
February	2.0	-7.6	-3.5	-15.2	0.0	-12.2	1.8	-9.1	-1.8	-10.5	-5.2	-14.2
March	4.0	-4.9	3.9	-8.9	5.2	-11.7	2.8	-5.9	4.2	-4.5	4.4	-5.2
April	10.9	1.8	10.2	-1.3	10.6	0.7	12.5	0.7	13.2	1.4	10.1	0.5
May	16.0	3.8	17.1	5.9	18.6	6.3	17.8	3.7	19.9	7.6	20.7	4.5
June	24.2	12.2	23.9	10.6	22.9	9.6	27.7	14.7	24.5	12.3	26.3	11.3
July	28.8	14.6	26.4	13.5	25.3	13.2	28.8	14.7	28.2	15.5	26.0	12.4
August	26.9	12.3	26.9	14.0	23.9	11.8	26.8	13.0	25.8	12.5	26.7	12.8
September	25.0	10.0	21.6	8.4	23.7	9.6	24.1	9.4	19.3	9.3	23.8	8.7
October	12.2	2.3	13.5	2.4	14.7	3.5	14.8	5.2	12.8	3.0	18.5	6.5
November	5.4	-1.6	7.7	0.1	8.5	-0.3	9.0	-0.6	8.6	1.3	5.5	-3.4
December	0.8	-7.7	1.9	-5.4	8.5	-0.3	-1.7	-8.1	4.6	-1.8	-1.0	-8.6
Mean	**13.1**	**2.5**	**12.1**	**0.7**	**12.9**	**1.1**	**13.4**	**2.0**	**13.5**	**3.5**	**13.0**	**1.3**

LTA = Long Term Average for U of Guelph, Dept. of Plant Agriculture - Kettleby
1125 Woodchoppers Lane, R.R. #1, Kettleby, ON, L7B 0E9. 38 Years (1975-2012)

MEAN TEMPERATURE (°C)

	2008		2009		2010		2011		2012		LTA	
Month	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**
January	0.2	-7.4	-6.2*	-16.2*	-3.8*	-11.6*	-3.0	-14.2	1.3	-6.9	-2.6	-11.2
February	-2.1	-10.7	-0.8*	-10.5*	-2.4*	-8.9*	-0.8	-11.3	2.7	-5.6	-1.3	-10.4
March	-0.8	-9.0	4.5*	-6.3*	7.4*	-2.9*	3.7	-5.6	12.7	-0.1	3.3	-5.4
April	14.4	2.7	12.7	0.8	16.2	3.4	12.7	1.2	12.5	0.0	11.4	1.2
May	17.0	4.4	18.7	5.5	22.6	7.6	19.8	8.4	23.4	8.4	19.0	6.8
June	24.8	13.6	22.3	10.2	23.9	12.9	24.8	12.0	26.9	13.2	24.0	11.5
July	26.6	14.1	23.6	11.7	29	15.6	30.1	15.5	29.7	14.7	26.6	14.0
August	25.1	11.0	25.2	13.0	27.8	14.4	26.9	13.4	27.0	13.1	25.4	12.9
September	21.7	8.2	21.9	7.5	21.1	9.8	22.6	10.6	21.7	8.0	20.9	9.0
October	13.2	1.5	11.9	2.8	15.2	3.5	15.4	4.7	14.6	4.8	13.6	3.6
November	5.3*	-3.4 *	9.7	-0.4	7.9	-1	11.1	1.1	7.3	-1.4	6.7	-0.9
December	-1.7*	-9.9 *	0.3	-6.0	-4.6	-6.7	3.7	-3.9	3.8	-3.4	0.2	-6.8
Mean	**12.0**	**1.3**	**12.0**	**1.0**	**13.4**	**3.0**	**13.9**	**2.7**	**15.3**	**3.7**	**12.3**	**2.0**

LTA = Long Term Average for U of Guelph, Dept. of Plant Agriculture - Kettleby
1125 Woodchoppers Lane, R.R. #1, Kettleby, ON, L7B 0E9. 38 Years (1975-2012)

* Data collected from Egbert, ON

EXTREME TEMPERATURE (°C)

Month	2002		2003		2004		2005		2006		2007	
	H	L	H	L	H	L	H	L	H	L	H	L
January	10.4	-16.4	4.3	-28.8	12.4	-31.7	15.8	-30.2	11.4	-13.1	11.1	-25.5
February	12.9	-20.7	6.2	-29.3	7.9	-25.2	6.5	-17.4	6.6	-22.3	3.2	-23.4
March	17.3	-12.5	16.9	-27.7	16.8	-11.7	16.0	-14.2	18.9	-14.1	20.8	-24.5
April	29.2	-9.7	26.9	-12.8	23.7	-8.1	27.4	-3.3	22.6	-5.7	24.3	-8.0
May	28.1	-1.5	23.7	-1.4	29.3	-1.4	26.2	-1.6	34.6	-2.8	32.6	-2.6
June	31.9	2.7	34.6	3.2	32.4	2.4	35.0	6.1	33.2	6.3	33.4	3.7
July	34.4	6.9	33.4	7.4	30.1	5.2	35.0	7.1	33.3	9.2	32.9	5.1
August	33.4	5.0	33.0	5.9	28.8	3.4	32.8	7.0	36.0	4.9	34.7	4.2
September	34.4	0.5	28.5	1.3	29.0	1.7	31.9	1.6	27.1	0.7	33.5	0.9
October	29.0	-5.4	26.6	-2.0	26.5	-2.9	28.8	-2.7	25.5	-1.4	30.0	-1.4
November	16.1	-8.4	17.7	-8.1	13.6	-6.5	18.8	-14.4	15.4	-3.4	14.3	-16.2
December	7.7	-20.0	8.8	-17.2	10.1	-28.4	4.2	-22.1	10.9	-13.2	6.5	-23.0
Annual High & Low	**34.4**	**-20.7**	**34.6**	**-29.3**	**32.4**	**-31.7**	**35.0**	**-30.2**	**36.0**	**-22.3**	**34.7**	**-25.5**

Extreme Temperatures for U of Guelph, Dept. of Plant Agriculture - Kettleby

1125 Woodchoppers Lane, R.R. #1, Kettleby, ON, L7B 0E9. 38 Years (1975-2012)

EXTREME TEMPERATURE (°C)

	2008		2009		2010		2011		2012		EXTREME TEMPERATURES			
Month	**H**	**L**	**H**	**L**	**H**	**L**	**H**	**L**	**H**	**L**	**H**	**Year**	**L**	**Year**
January	13.8	-26.7	1.9 *	-30.3 *	4.3*	-25.8*	11.7	-28.7	7.9	-20.3	15.8	2005	-36.0	1977
February	6.6	-20.9	8.9 *	-2.7 *	2.5*	-16.1*	9.7	-24.8	9.2	-17.3	14.5	1984	-33.0	1979
March	8.1	-25.5	15.3 *	-18.9 *	18.7*	-10.7*	14.8	-14.8	26.4	-15.6	26.4	2012	-29.0	1984
April	25.7	-2.6	27.3	-5.3	26.2	-2.7	23.5	-3.0	25.7	-5.9	30.0	1990	-14.0	1983
May	27.4	-2.6	29.9	-1.8	32.3	-0.5	28.3	-0.2	34.9	1.1	34.6	2006	-4.0	1983
June	33.6	8.1	32.2	1.7	31.1	5.2	33.4	5.2	35.5	7.6	35.5	1988	-2.0	1977
July	31.6	6.4	27.6	4.9	35.4	7.4	36.3	6.8	35.3	9.7	36.3	2011	2.5	1984
August	33.8	3.7	31.3	4.5	35.1	7.0	31.5	8.5	32.6	6.4	36.3	2001	0.5	1982
September	31.1	1.8	26.6	-0.7	33.2	4.0	30.8	5.4	29.9	1.7	34.4	2002	-6.5	1991
October	27.3	-4.9	18.2	-6.1	24.4	-2.4	29.2	-3.6	23.5	-4.7	30.0	89 & 07	-9.0	1975
November	20.2 *	17.5 *	18.8	-7.2	14.5	-5.4	19.2	-6.6	18.5	-5.8	24.0	1990	-22.0	1977
December	8.2 *	-20.5 *	9.8	-15.7	11.1	-5.4	14.3	-19.6	15.1	-12.7	20.0	1982	-31.5	1980
Annual High & Low	**33.6**	**-26.7**	**32.2**	**-30.3**	**35.4**	**-25.8**	**36.3**	**-28.7**	**35.5**	**-20.3**	**36.3**		**-36.0**	

Extreme Temperatures for U of Guelph, Dept. of Plant Agriculture - Kettleby
1125 Woodchoppers Lane, R.R. #1, Kettleby, ON, L7B 0E9. 38 Years (1975-2012)

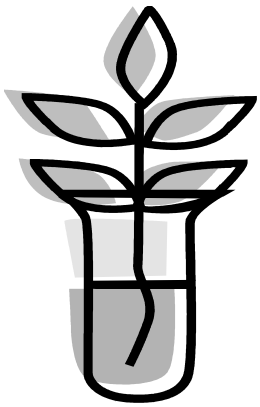
* Data collected from Egbert, ON

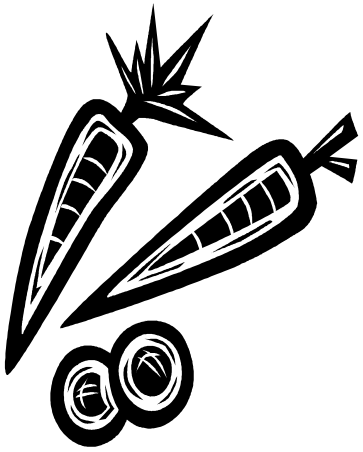
GROWING DEGREE DAYS (5°C Base)

Month	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	LTA
January	1	0	3	3	4	6	13	0*	0*	1	0	**1**
February	2	0	0	0	0	0	0	1*	0*	0	0	**1**
March	7	17	19	8	14	23	0	7*	15*	5	123	**16**
April	99	67	57	58	98	73	147	84	147	74	54	**78**
May	156	202	233	182	226	205	178	220	312	282	338	**237**
June	396	368	318	487	401	405	427	338	395	403	450	**382**
July	518	463	442	519	523	439	477	391	536	552	533	**472**
August	452	477	397	462	439	457	404	436	499	472	467	**436**
September	375	300	349	352	279	337	299	291	314	348	295	**296**
October	106	100	126	154	101	233	95	72	139	163	145	**125**
November	27	29	25	59	42	11	37*	29	14	69	15	**31**
December	0	2	0	0	6	0	0*	0	2	6	11	**3**
Annual	**2139**	**2025**	**1969**	**2284**	**2133**	**2189**	**2077***	**1869***	**2373***	**2375**	**2431**	**2077**

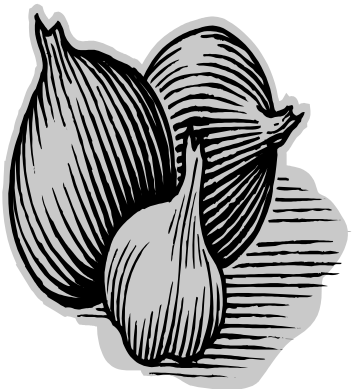
LTA = Long Term Average for U of Guelph, Dept. of Plant Agriculture - Kettleby
1125 Woodchoppers Lane, R.R. #1, Kettleby, ON, L7B 0E9 38 Years (1975-2012)

* Data collected from Egbert, ON





Research Reports 2012



CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang), cv. Uppercut 25
PESTS: Carrot rust fly (*Psila rosae* (Fabricius))
Carrot weevil (*Listronotus oregonensis* (LeConte))

AUTHORS: MCDONALD MR[1], RICHES L[1], VANDER KOOI K[1] & TAYLOR AG[2]
[1] University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station
[2] Cornell University, Dept. of Horticultural Science, New York State Agricultural Experiment Station

TITLE: COMPARISON OF INSECTICIDE SEED TREATMENTS AND FOLIAR SPRAYS FOR CONTROL OF DAMAGE BY CARROT RUST FLY AND CARROT WEEVIL IN CARROTS, 2012

MATERIAL: ENTRUST (spinosad 80%), CRUISER 5 FS (thiamethoxam 47.6%), SEPRESTO 75 WS (clothianidin 56.25%, imidacloprid 18.75%), MOVENTO 240 SC (spirotetramat 240 g/L), RIPCORD 400 EC (cypermethrin 407 g/L), HGW 86 (cyantraniliprole 47 %), DERMACOR X-100 (chlorantraniliprole 50%), SURROUND WP (kaolin clay 95%), THIRAM 50 WP (thiram 50%)

METHODS: The trial was conducted at the Muck Crops Research Station, Holland Marsh, Ontario, in organic soil (pH ≈ 6.8, organic matter ≈ 64.8). Carrots were direct seeded (60-65 seeds/m) onto raised beds using a push V-belt seeder on 31 May. A randomized complete block arrangement with five replicates per treatment was used. Each experimental unit consisted of two rows, 86 cm apart and 5 m in length. Treatments were seed film coatings at 5.13 g ai/100 g seed of SEPRESTO 75 WS, ENTRUST + CRUISER 70 WS, HGW 86 and DERMACOR X-100, and foliar applications of MOVENTO at 375 mL/ha, RIPCORD at 175 mL/ha and SURROUND at 25 kg/ha. An untreated check was also included. Seeds were treated at Cornell University by Alan Taylor. Foliar treatments were applied on 30 July, 8, 17 and 23 August using a CO_2 backpack sprayer equipped with a single TeeJet 8004 fan nozzle calibrated to deliver 500 L/ha L at 250 kPa. On 14 August, at the start of the 2nd generation of carrot rust fly (CRF), 25 carrots per replicate were pulled to determine the maximum damage from 1st generation CRF. On 25 October, carrots in two 1.16 m sections from each row were pulled for a harvest damage assessment. On 29 August and 3 December, respective samples were washed in a small drum washer, visually examined for CRF and weevil damage. Carrots were visually examined for insect damage and numbers and weights of damaged and marketable carrots recorded. Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1ºC), September (14.8ºC) and October (9.7ºC), and above average for June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: June 18.2ºC, July 20.7ºC, August 19.5ºC, September 15.8ºC and October 8.9ºC. Monthly rainfall was below the previous long term 10 year average for June (55 mm), average for August (69 mm), and above average for July (140 mm), September (94 mm) and October (124 mm). The long term previous 10 year rainfall averages were: June 74 mm, July 81 mm, August 67 mm, September 74 mm and October 59 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained using Fisher's Protected LSD Test at $P = 0.05$ level of significance.

RESULTS & DISCUSSION: Significant differences in carrot weevil damage were found among the treatments at both assessment dates (Table 1). At the early assessment, carrots grown from seeds treated with HGW 86 had significantly lower percentage of weevil damage than the ENTRUST + CRUISER and SURROUND treatments and the untreated check. The SEPRESTO and HGW 86 seed treatments had significantly less weevil damage than the check.
At harvest, carrots treated with HGW 86 had a significantly less weevil damage than carrots treated with MOVENTO and the untreated check. However, MOVENTO was applied too late in the season to be effective against carrot weevil. There were no significant differences in incidence of weevil damage

among seed treatments DERMACOR, SEPRESTO, ENTRUST + CRUISER, the SURROUND foliar treatment and the untreated check at harvest. Carrot rust fly (CRF) pressure was low in 2012. No significant differences were found in CRF among the treatments (Table 2).

CONCLUSIONS: HGW 86 used as a seed treatment appears to control carrot weevil damage. SEPRESTO seed treatment reduced carrot weevil damage in one of two assessment dates. These treatments warrant further study, since firm conclusions cannot be made from a single year of trials. Low levels of carrot rust fly damage made assessing products for effectiveness against this insect inconclusive.

Table 1. Evaluation of carrot weevil damage on carrots treated with insecticide seed treatments and foliar sprays, grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Appl'n Method	Rate (gai/100g seed)	Weevil Damage (%)	
			14 Aug	25 Oct
HGW 86	seed	5.13	4.8 a[1]	8.8 a
DERMACOR	seed	5.13	10.9 ab	13.9 ab
SURROUND	foliar	25 kg/ha	24.8 d	13.2 ab
SEPRESTO	seed	5.13	11.5 ab	16.5 ab
ENTRUST + CRUISER	seed	5.13 + 5.13	16.0 bcd	17.4 abc
MOVENTO	foliar	375 mL/ha	13.6 abc	27.0 c
Check	--	--	23.2 cd	21.2 bc

[1] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher's Protected LSD test.

Table 2. Evaluation of carrot rust fly (CRF) damage on carrots treated with insecticide seed treatments and foliar sprays, grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Appl'n Method	Rate (gai/100g seed)	Rust Fly Damage (%)	Rust Fly Damage (%)	Mkb Yield (t/ha)
SEPRESTO	seed	5.13	1.4 ns	1.4 ns[1]	71.0 ns
ENTRUST + CRUISER	seed	5.13 + 5.13	1.7	1.7	69.5
MOVENTO	foliar	375 mL/ha	2.1	2.1	61.7
RIPCORD	foliar	175 mL/ha	2.5	2.5	61.3
SURROUND	foliar	25 kg/ha	2.6	2.6	63.6
HGW 86	seed	5.13	3.0	3.0	60.5
DERMACOR	seed	5.13	3.4	3.4	53.1
Check	--	--	0.2	0.2	57.5

[1] ns=not significantly different at $P = 0.05$, Fisher's Protected LSD test

Funding for this project was provided by Bradford Cooperative and Storage Ltd. through the Holland Marsh Growers' Association, the OMAFRA/University of Guelph Plant Production Systems Program and the New York State Agricultural Experiment Station. Cornell University provided support for seed treatment application of new chemistry seed treatments. Any opinions, findings, conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of Cornell University or those of Rutgers State University of New Jersey.

CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang.), cv. Cellobunch
PESTS: Carrot rust fly (*Psila rosae* (Fabricius))
Carrot weevil (*Listronotus oregonensis* (LeConte))

AUTHORS: MCDONALD MR & RICHES L
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: EVALUATION OF SPINOSAD BAIT FOR CONTROL OF CARROT RUST FLY AND CARROT WEEVIL IN CARROTS, 2012

MATERIALS: SPINOSAD BAIT (spinosad 0.07%)

METHODS: The trial was conducted on organic soil (pH ≈ 7.0, organic matter ≈ 57.2%) at the Muck Crops Research Station, Holland Marsh, Ontario. Carrots, cv. Cellobunch, were direct seeded (82 seeds/m) on raised beds using a Stanhay Precision Seeder on 24 May. Each experimental unit consisted of eight rows, 8 m long, 86 cm apart, with the outside two rows on either side used as guard rows. A randomized complete block arrangement with four replicates per treatment was used. Treatments were: SPINOSAD bait and an untreated check. SPINOSAD BAIT was applied at 49.3 kg/ha on 6 June, 25 July and 7 August. On 30 August, 25 carrots per replicate were pulled to determine the maximum damage from 1st generation CRF. On 18 October, 50 carrots from the middle four rows per replicate were pulled for a harvest damage sample. On 30 August for the first sample and 18 December for the second sample, carrot samples were washed in a small drum washer, visually examined for CRF damage, and sorted into classes based on a scale of 0 to 3 where 0 = no damage, 1 = one superficial feeding track (light damage), 3 = ≥1 deep feeding track(s) (heavy damage). The weight of undamaged (marketable) carrots was used to determine yield. Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1ºC), September (14.8ºC) and October (9.7ºC), and above average for May (15.9ºC), June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: May 12.3ºC, June 18.2ºC, July 20.7ºC, August 19.5ºC, September 15.8ºC and October 8.9ºC. Monthly rainfall was below the previous long term 10 year average for May (49 mm) and June (55 mm), average for August (69 mm), and above average for July (140 mm), September (94 mm) and October (124 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm, July 81 mm, August 67 mm, September 74 mm and October 59 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained using Fisher's Protected LSD Test at $P = 0.05$ level of significance.

RESULTS: as presented in Table 1

CONCLUSIONS: No differences in percent rust fly damage, percent weevil damage or total insect damage were observed among the treatments (Table 1). In future trials, adjusting the timing of applications may improve efficacy.

Table 1. Evaluation of SPINOSAD BAIT for control of carrot rust fly and carrot weevil damage in carrots, cv. Cellobunch, grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	30 August			18 October		
	% Rust Fly	% Weevil	% Total Insect Damage	% Rust Fly	% Weevil	% Total Insect Damage
SPINOSAD BAIT [2]	3.5 ns[1]	11.5 ns	12.8 ns	0.0 ns	8.9 ns	8.9 ns
Check	4.7	8.2	11.7	1.5	9.0	10.5

[1] ns = not significantly different, $P = 0.05$ Fisher's Protected LSD Test
[2] SPINOSAD BAIT was applied 3 times at 49.3 kg/ha on 6 June, 25 July and 7 August.

Funding for this project was provided by Neudorff North America.

CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang.) cvs. Envy, Olympus
PESTS: Northern root-knot nematode (*Meloidogyne hapla*) and violet root-rot (*Rhizoctonia* spp.)

AUTHORS: VAN DYK D, MCDONALD MR & JORDAN K
Dept. of Plant Agriculture, University of Guelph

TITLE: EVALUATION OF FUMIGANTS FOR CONTROL OF SOIL-BORNE NEMATODE PESTS IN CARROTS, 2012

MATERIALS: PIC-PLUS (chloropicrin 86%), VYDATE (oxamyl 24%)

METHODS: The trial was conducted on muck soil (pH~7.5, organic matter ~49.9%) naturally infested with northern root-knot nematode and violet root-rot near Grand Bend, Ontario. On 13 May, plots were treated in 400 m strips with three rows spaced 60 cm apart. Two carrot cultivars, Envy and Olympus were direct seeded (80 seeds/m) on raised beds on 14 May. The treatments were: PIC PLUS at 67.2, 78.4, and 112 kg/ha, VYDATE at 2 L/ha, and an untreated check. Four 25 carrot subsamples, representing four replications, were taken every 100 m in both cultivars and assessed mid-season (23 August) and at final harvest (23 October) by rating damage by nematode and violet root-rot incidence. Nematode damage was rated on a 0 to 5 gall index where 0= no galling or forking, 1= 1-10 galls on secondary roots, 2= 10-50 galls with light forking, 3= 50-100 galls with forking, 4= >100 galls with severe forking, 5= >100 galls with severe forking and severe stunting. Disease severity index (DSI) was calculated using the following formula:

$$DSI = \frac{\sum [(\text{class no.})(\text{no. of plants in each class})]}{(\text{total no. plants per sample})(\text{no. classes-1})} \times 100$$

Data were analyzed using Statistix V.9.using Tukey's HSD test at P = 0.05 level of significance. As there was no significant interaction between the cultivars, cultivars were combined for statistical analysis.

RESULTS & DISCUSSION: At the mid-season assessment, carrots treated with PIC-PLUS at 112 kg/ha had more marketable carrots compared to carrots treated with VYDATE at 2 L/ha, or the untreated check (Table 1).
At harvest, carrots treated with PIC-PLUS at all three rates had a higher percentage of marketable carrots and lower disease severity than carrots treated with VYDATE at 2L/ha (Table 1). Carrots treated with PIC-PLUS at 112 kg/ha had a higher percentage of marketable carrots and lower disease severity than the untreated check (Table 1).

CONCLUSIONS: PIC-PLUS provided acceptable control of northern root-knot nematode damage on carrots. VYDATE did not reduce nematode damage or violet root-rot incidence compared to untreated carrots.

Table 1. Percent marketable carrots and root-knot nematode severity for carrots (cv. Envy, Olympus), treated with VYDATE and three rates of PIC-PLUS grown on muck soil in Grand Bend Ontario, 2012.

Treatment	Rate	Marketable Carrots (%)[1]		Nematode Damage (DSI)[1, 2]	
		Mid-Season	Harvest	Mid-Season	Harvest
Check	--	60.8 bc[3]	63.6 bc	4.8 ns[4]	4.4 bc
VYDATE	2 L/ha	60.0 c	48.0 c	4.9	5.9 c
PIC PLUS	67 kg/ha	70.8 abc	82.4 ab	3.8	1.3 ab
PIC PLUS	78 kg/ha	79.6 ab	86.0 a	2.2	1.1 a
PIC PLUS	112 kg/ha	81.2 a	75.6 ab	2.1	2.1 ab

[1] Cultivars were combined for statistical analysis.

[2] $\text{DSI} = \dfrac{\sum [(\text{class no.})(\text{no. of plants in each class})]}{(\text{total no. plants per sample})(\text{no. classes}-1)} \times 100$

[3] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Tukeys test.

[4] ns indicates that no significant differences were found among the treatments

Funding for this project was provided by the Canadian Agricultural Adaptation Program, the Bradford Cooperative and Storage Ltd, and the Grand Bend Growers Association.

CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang.) cv. Cellobunch
PEST: Northern root-knot nematode (*Meloidogyne hapla*)

AUTHORS: VAN DYK D, MCDONALD MR & JORDAN K
University of Guelph, Dept. of Plant Agriculture

TITLE: SMALL SCALE EVALUATION OF FUMIGANTS FOR CONTROL OF SOIL-BORNE NEMATODE PESTS IN CARROTS, 2012

MATERIALS: MUST GRO (allylisothiocyanate), MCW-2 GR (fluensulfone)

METHODS: The trial was conducted on muck soil (pH~7.0, organic matter ~69.4%) inoculated with root-knot nematode in the Holland Marsh, Ontario. Soil was contained in 1 m x 2 m plots by sheets of tin buried 0.5 m into the ground. Plots were treated on 29 August with MUST GRO at 1120 and 840 kg/ha, MCW-2 at 31 kg/ha, and an untreated check. Carrots cv. Cellobunch, were direct seeded (80 seeds/m) on 5 September using an Earthway push seeder fitted with an Earthway 1002-5 disc into formed beds. A final assessment was conducted on 13 November by rating galls caused by root-knot nematode. Nematode damage was rated on a 0 to 5 gall index where 0= no galling or forking, 1= 1-10 galls on secondary roots, 2= 10-50 galls with light forking, 3= 50-100 galls with forking, 4= >100 galls with severe forking, 5= >100 galls with severe forking and severe stunting. Disease severity index (DSI) was calculated using the following formula:

$$DSI = \frac{\sum [(\text{class no.})(\text{no. of plants in each class})]}{(\text{total no. plants per sample})(\text{no. classes-1})} \times 100$$

Data were analyzed using Statistix V.9.using Tukey's HSD test at P = 0.05 level of significance.

RESULTS AND DISCUSSION: Carrots treated with MCW-2 had lower percent disease, and lower disease severity then carrots treated with MUST GRO at both rates and the untreated check (Table 1).

CONCLUSIONS: MCW-2 provided a reduction in root knot nematode damage. Possible phytotoxicity was observed in carrots treated with MUST GRO so rate or pre-plant intervals may need to be altered for future study.

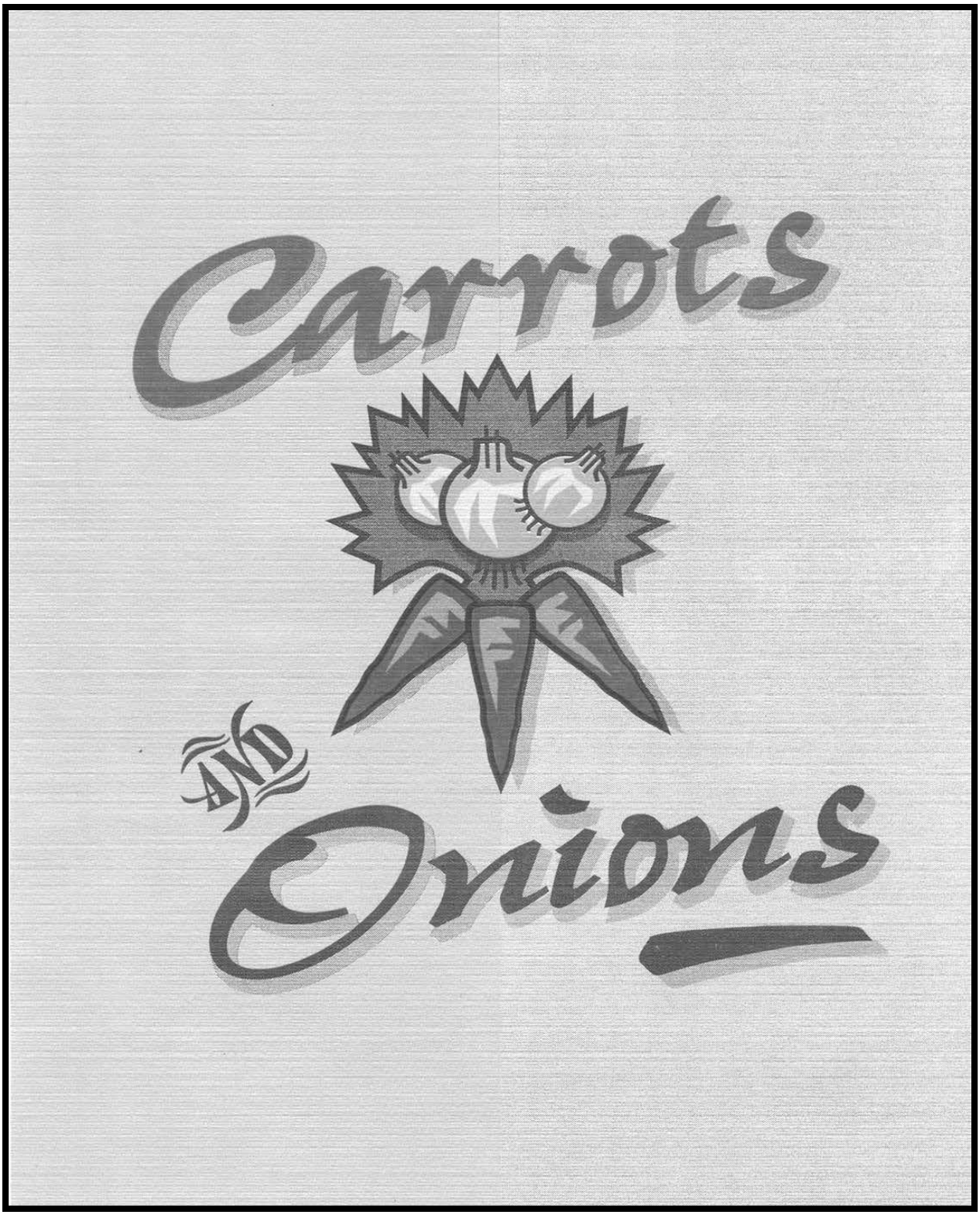
Table 1. Percent diseased and root-knot nematode damage for carrots, cv. Cellobunch, treated with MCW-2 and two rates of MUST GRO grown on muck soil in Holland Marsh, Ontario, 2012.

Treatment	Rate (kg/ha)	Percent Unmarketable	Nematode Damage (DSI)[1]
Check	--	32.0 ab[2]	7.6 ab
MCW-2	31	15.6 a	3.2 a
MUST GRO	840	39.0 b	11.0 b
MUST GRO	1120	43.8 b	11.9 b

[1] $DSI = \frac{\sum [(\text{class no.})(\text{no. of plants in each class})]}{(\text{total no. plants per sample})(\text{no. classes-1})} \times 100$

[2] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Tukeys test.

Funding for this project was provided by the Canadian Agricultural Adaptation Program and the Bradford Cooperative and Storage Ltd.


Carrots
AND
Onions

CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang.) cv. Cellobunch
PEST: Cavity spot (*Pythium intermedium* de Bary, *Pythium irregulare* Buisman, *Pythium sulcatum* Pratt & Mitchell, *Pythium sylvaticum* W.A. Campbell & J.W. Hendrix, *Pythium ultimum* Trow and *Pythium violae* Chesters & C.J. Hickman)

AUTHORS: MCDONALD MR & VANDER KOOI K
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: EVALUATION OF FUNGICIDES FOR CONTROL OF CAVITY SPOT ON CARROTS, 2012

MATERIALS: RANMAN 400 SC (cyazofamid 34.5%), REASON 500 SC (fenamidone 50%) RIDOMIL GOLD 1 G (metalaxyl-M and S-isomer 1.0%), SYLGARD 309 (siloxylated polyether 76%)

METHODS: The trial was conducted on organic soil (pH ≈ 5.8, organic matter ≈ 78.6%) naturally infested with *Pythium* spp. at the Muck Crops Research Station, Holland Marsh, Ontario. A randomized complete block design with four replicates per treatment was used. Carrots, cv. Cellobunch, were direct seeded (≈67 seeds/m) on raised beds using a V-belt push seeder 24 May. Each experimental unit consisted of two rows, 86 cm apart, 6 m in length (≈ 11700 linear m/ha). Treatments were: RANMAN at 440 mL/ha + SYLGARD at 150 mL/ha applied 5 days after seeding (DAS) (29 May), REASON at 600 mL/ha, applied 8 DAS (2 June) and RIDOMIL GOLD 1 G at 25 kg/ha applied with the carrot seed. Following treatment applications 25 mm of rain fell, this rain helped to move the product into the root zone. An untreated check was also included. On 25 October, a carrot sample from two 1.16 m of row were harvested from each treatment and placed into cold storage. On 18 December, carrots were washed in a small drum washer, assessed and weighed for forking, stunting and cavity spot lesions. Carrots were sorted into classes based on the size of the largest cavity spot lesion (measured as horizontal length). The six classes were: no disease, very light (< 1 mm), light (1-2 mm), medium (3-5 mm), heavy (6-10 mm), and very heavy (> 10 mm). The disease severity index (DSI) was determined using the following equation:

$$\text{DSI} = \frac{\sum [(\text{class no.})(\text{no. of carrots in each class})]}{(\text{total no. carrots per sample})(\text{no. classes } -1)} \times 100$$

Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1 ºC), September (14.8ºC) and October (9.7ºC), and above average for May (15.9ºC), June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: May 12.3ºC, June 18.2ºC, July 20.7ºC, August 19.5ºC, September 15.8ºC and October 8.9ºC. Monthly rainfall was below the previous long term 10 year average for May (49 mm) and June (55 mm), average for August (69 mm), and above average for July (140 mm), September (94 mm) and October (124 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm, July 81 mm, August 67 mm, September 74 mm and October 59 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained using Fisher's Protected LSD Test at $P = 0.05$ level of significance.

RESULTS: as presented in Table 1

CONCLUSIONS: No significant differences were found among the treatments in cavity spot incidence or severity. No differences were found in marketable yield.

Table 1. Disease incidence and severity (DSI) of cavity spot for carrots, cv. Cellobunch, treated with various fungicides, grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Rate (mL/ha)	Application Timing (DAS)	% Marketable	% Cavity Spot	DSI[1]	t/ha
RANMAN + SYLGARD	440 + 150	5	81.1 ns[2]	60.9 ns[2]	22.8 ns	74.7 ns
RIDOMIL GOLD	25 (kg/ha)		86.7	50.2	17.6	85.2
Check	--	--	77.6	45.6	16.9	77.0
REASON	600	8	85.4	43.9	15.7	85.9

[1]Disease severity index (DSI) was determined using the following equation:

$$\text{DSI} = \frac{\sum [(\text{class no.})(\text{no. of carrots in each class})]}{(\text{total no. carrots per sample})(\text{no. classes } -1)} \times 100$$

[2]ns = not significantly different, $P = 0.05$ Fisher's Protected LSD Test

Funding for this project was supplied by the OMAFRA/University of Guelph Sustainable Production Systems Program.

CROP: Carrot (*Daucus carota* subsp. s*ativus* (Hoffm.) Arcang.), cv. Cellobunch
PEST: Sclerotinia rot of carrot (*Sclerotinia sclerotiorum* (Lib.) de Bary)

AUTHORS: MCDONALD MR[1], RICHES L[1] & GOSSEN BD[2]
[1]University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station
[2]Agriculture and Agri-Food, Saskatoon

TITLE: EVALUATION OF FUNGICIDES ON CARROTS INOCULATED WITH *SCLEROTINIA SCLEROTIORUM* FOR SCLEROTINIA ROT OF CARROT, 2011-2012

MATERIALS: PRISTINE (pyraclostrobin 25.2%, boscalid 12.8%), LANCE WDG (boscalid 70%)

METHODS: Carrots, cv. Cellobunch, were direct seeded (82 seeds/m) on raised hills, into organic soil (pH ≈ 6.3, organic matter ≈ 73.3%) on 31 May 2011 using a Stanhay Precision Seeder at the Muck Crops Research Station, Holland Marsh Ontario. A randomized complete block arrangement with four replicates per treatment was used. Each experimental unit consisted of four hills, 5 m in length, 86 cm apart. Treatments were: PRISTINE at 737 g/ha and LANCE at 630 g/ha on carrots inoculated and not inoculated with sclerotinia. Untreated checks, both inoculated and non-inoculated, were also included. Treatments were applied on 29 August and 6, 16, and 30 September using a pull-type plot sprayer with TeeJet D-3 hollow cone nozzles at 690 kPa (boom) in 500 L/ha of water. On 31 August 2011 treatments were inoculated by evenly spreading paper strip inoculum, 1.5 g/m, on the soil in the 2 intercrop rows per experimental unit. Inoculum was provided by Dr. B. Gossen, AAFC. At harvest on 28 October 2011, one ≈ 25 kg bin was harvested from each replicate and was placed in a Filacell storage. On 13 January, 19 March, and 25 May, 2012, the storage samples were removed, assessed for disease, healthy and diseased carrots were counted and weighed. Healthy carrots were returned to the storage until the next assessment. Compared to the averaged previous 10 years, the air temperatures in 2011 were average for May (14.1°C), June (18.4°C), August (20.2°C) and September (16.6°C), above average for July (22.8°C) and October (10.1°C). The long term previous 10 year average temperatures were: May 13.3°C, June 18.5°C, July 20.4°C, August 19.6°C, September 15.7°C and October 8.9°C. Monthly rainfall was below the previous long term 10 year average for June (67 mm) and July (56 mm), average for September (67 mm), and above average for May (92 mm), August (113 mm) and October (83 mm). The long term previous 10 year rainfall averages were: May 76 mm, June 74 mm, July 82 mm, August 59 mm, September 72 mm and October 62 mm. Data was analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained using Fisher's Protected LSD Test at $P = 0.05$ level of significance.

RESULTS: as presented in Tables 1 and 2

CONCLUSIONS: Significant differences in the number sclerotinia foci were observed throughout the growing season (Table 1). On the 22 September assessment date the non-inoculated check had significantly higher foci/meter than all other treatments except the inoculated check. All fungicide treatments had significantly fewer numbers of foci observed over the season than the non-inoculated check. Inoculation did not significantly increase disease development in the field or disease incidence in storage. No significant differences were found in disease incidence in storage on any assessment dates (Table 2).

Table 1. In-field white rot evaluations of carrots, cv. Cellobunch, treated with LANCE and PRISTINE and inoculated with *Sclerotinia sclerotiorum*, grown at Holland Marsh, Ontario, 2011.

Treatment	Inoculation	Rate (g/ha)	# Sclerotinia foci/m			
			22 Sept	5 Oct	27 Oct	Season Total
PRISTINE	Non-Inoculated	737	0.25 a[1]	0.12 a	0.00 ns[2]	0.31 a
LANCE	Inoculated	630	0.62 ab	0.12 a	0.00	0.69 a
LANCE	Non-Inoculated	630	0.62 ab	0.12 a	0.00	0.69 a
PRISTINE	Inoculated	737	0.75 ab	0.62 b	0.00	1.06 ab
Check	Inoculated	---	2.00 bc	0.75 b	0.25	2.62 bc
Check	Non-Inoculated	---	2.62 c	0.37 ab	0.25	3.06 c

[1] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher's protected LSD test.
[2] ns = not significantly different at $P = 0.05$, Fisher's Protected LSD test

Table 2. Evaluation of LANCE and PRISTINE for control of sclerotinia rot in carrots, cv. Cellobunch, non-inoculated and inoculated with *Sclerotinia sclerotiorum*, grown and stored at Muck Crops Research Station, Holland Marsh, Ontario, 2011-2012.

Treatment	Inoculation	Rate (g/ha)	% Sclerotinia After Storage			
			13 Jan	19 Mar	25 May	Total
PRISTINE	Non-Inoculated	737	0.3ns[1]	0.1 ns	0.6	1.0 ns
LANCE	Inoculated	630	0.0	0.2	1.7	2.0
LANCE	Non-Inoculated	630	0.0	0.2	1.9	2.1
PRISTINE	Inoculated	737	0.0	0.4	3.0	3.4
Check	Inoculated	---	0.0	0.5	0.8	1.3
Check	Non-Inoculated	---	1.1	0.7	2.1	3.9

[1]ns = not significantly different at $P = 0.05$, Fisher's Protected LSD Test

Funding for this project was supplied by the OMAFRA/University of Guelph Sustainable Production Systems Program.

CROP: Carrot (*Daucus carrota* sub sp. *Sativus* (Hoffm.) Arcang.), cv. Cellobunch
PEST: *Sclerotinia sclerotiorum* (Lib.) de Bary

AUTHORS: TESFAENDRIAS MT & MCDONALD MR
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: EFFECT OF BIOCONTROL PRODUCTS ON GERMINATION AND SURVIVAL OF SCLEROTIA OF *SCLEROTINIA SCLEROTIORUM*, 2012

OBJECTIVE: to evaluate the efficacy of biocontrol products on carpogenic (apotecia formation) and myceliogenic germination of *Sclerotinia sclerotiorum*, the cause of sclerotinia rot (white mold) of carrots

MATERIALS: CONTANS (*Coniothyrium minitans* W.A. Campbell, strain CON/M/91-08), *Trichoderma atroviride* Karsten A, *Trichoderma atroviride* Karsten B, *Microsphaeropsis ochracea* Carisse and Bernier

METHODS: The trial was conducted in organic soil (pH ≈ 6.8, organic matter ≈ 64.8%) at the Muck Crops Research Station (MCRS) in carrot plots and *in vitro* in the laboratory. A *Sclerotinia sclerotiorum* isolate obtained from an infected carrot from the MCRS was used in the trial. The culture was initiated by placing a dry sclerotium on potato dextrose agar supplemented with streptomycin sulfate (PDA) plates incubated at 18-21ºC for 7 days. On 19 March, 5 mm diameter agar plugs from actively growing mycelia were sub cultured onto fresh Petri plates of PDA for production of sclerotia. Plates were incubated in the dark in plastic packaging sleeves for 4 weeks at room temperature (18-21ºC). To dry and separate the sclerotia from the media, plates were left open weekly for few minutes. After four weeks of incubation, mature sclerotia (black with no visible surface exudates) were harvested using sterile tweezers. For conditioning, sclerotia were incubated on moistened filter paper in beakers and kept at 4ºC for 8 weeks before the trial. Following conditioning, sclerotia were treated with the biofungicide solutions. Treatments were: CONTANS (1 x 10^6 spores/mL), *Trichoderma atroviridae* A (1 x 10^8 spores/mL), *T. atroviridae* B (1 x 10^8 spores/mL), *Microsphaeropsis ochracea* (1 x 10^8 spores/mL). A sterile water check was also included. Ten mL of the biofungicide was applied to each beaker, to cover the sclerotia with the suspension, and kept overnight at 4ºC.

On 12 June, treated sclerotia were transferred into carrot field plots, cv. Cellobunch, seeded on 25 May at a rate of 85 seeds/m of row and a row spacing of 86 cm. Each experimental unit consisted of 25 sclerotia placed individually in an open 1 cm^2 plastc grid, 172 cm apart, set on top of the soil in carrot rows with 1 m in-row spacing and covered with 0.5 cm soil. A randomized complete block design with six replications per treatment was used. To determine total percent cumulative carpogenic germination, grids were monitored weekly for apothecia production from individual sclerotium until end of October and numbers recorded.

For comparison, on 12 June each treatment was plated onto 1% water agar at room temperature with a 12 h photoperiod under fluorescent light. Each treatment was replicated five times with 20 sclerotia/replicate. Apothecia formation was monitored weekly until end of October and numbers recorded.

To evaluate recovery and mycelial germination, sclerotia were recovered from the field on 24 October. Sclerotia and soil from each grid was sieved to recover the sclerotia. Sclerotia were surface-sterilized for 1 min in 70% alcohol, 3 min in 5% sodium hypochlorite and rinsed 3 times in sterilized water, blotted dry and plated onto droplets of PDA. The plates were kept at room temperature prior to evaluation. Plates were evaluated for mycelial germination on 12 November. A sclerotium was considered viable when it germinated and produced sclerotia.

Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1 ºC), September (14.8ºC) and October (9.7ºC), and above average for June (20.1ºC) and July (22.2ºC). The

long term previous 10 year average temperatures were: June 18.2ºC, July 20.7ºC, August 19.5ºC, September 15.8ºC and October 8.9ºC. Monthly rainfall was below the previous long term 10 year average for June (55 mm), average for August (69 mm), and above average for July (140 mm), September (94 mm) and October (124 mm). The long term previous 10 year rainfall averages were: June 74 mm, July 81 mm, August 67 mm, September 74 mm and October 59 mm. Data were analysed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained using Fisher's Protected LSD test with $P = 0.05$ level of significance.

RESULTS: as presented in Table 1

CONCLUSIONS: There were significant differences among the treatments for apothecial germination, recovery and mycelial germination of the sclerotia placed in the carrot plots. In the field trial, apothecial germination of sclerotia treated with CONTANS was lower than for sclerotia treated with *T. atroviride* A and B, and the untreated check. In the *in vitro* trial, there were no significant differences among the treatments in apothecial formation. The percent sclerotia recovered and mycilial germination of the recovered sclerotia were also different among the treatments. The fewest sclerotia were recovered from grids containing sclerotia treated with CONTANS (13.3%) compared to all the other treatments (52-68%). Of the recovered sclerotia, 71.9 and 87.9% of the sclerotia treated with *M. ochracea* and the untreated check had mycelial germination respectively. *Trichoderma atroviride* B reduced mycelial germination by 70%, while *T. atroviride* A and CONTANS reduced mycelial germination of the recovered sclerotia by 50% (Table 1).

Table 1. Apothecial and mycelial germination, and recovery of *Sclerotinia sclerotiorum* sclerotia treated with biofungicides, in carrot plots and *in vitro* at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Apothecial production (%)		% Recovered sclerotia	% Mycelial germination
	Field	*In vitro*		
CONTANS	2.0 a[1]	1.0 ns[2]	13.3 a	51.1 b
Trichoderma atroviride A	8.0 b	6.0	52.7 b	50.1 b
Trichoderma atroviride B	12.7 b	1.2	58.7 b	29.3 a
Microsphaeropsis ochracea	7.3 ab	6.0	66.0 b	71.9 c
Check	12.0 b	3.0	68.0 b	87.9 c

[1] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher's Protected LSD test.
[2] ns = not significantly different at $P = 0.05$, Fisher's Protected LSD test

Funding for this project was provided by the Plant Production Systems of the OMAFRA/University of Guelph Partnership.

CROP: Carrot (*Daucus carota s*ub sp. *Sativus* (Hoffm.) Arcang.)
PEST: *Fusarium* spp.

AUTHORS: TESFAENDRIAS MT & MCDONALD MR
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: COMPARISON OF CARROT CULTIVARS FOR RESISTANCE AND SUSCEPTIBILITY TO CARROT ROOT ROT CAUSED BY *FUSARIUM*, 2012

MATERIALS: carrot cultivars Cellobunch and Envy (Stokes Seeds), Fontana (Bejo Seed Co.), Olympus (Sakata Seed America Inc.), 2384 and 2289 (Seminis Vegetable Seeds), CX 480 (Vilmorin Inc.)

METHODS: The trial was conducted at a commercial carrot field in the Holland Marsh, Ontario, with a history of root rot of carrots caused by *Fusarium*. Carrot seeds were direct seeded (70-80 seeds/m) on raised beds using a push V-belt seeder on 7 June. A randomized complete block arrangement with four replicates per treatment was used. Each experimental unit consisted of a 5 m long row. On 22 August and 19 October, a random sample of 25 and 100 carrots respectively was removed from each replicate and placed in cold storage. On 29 August and 20 December, carrots were washed in a small drum washer and visually assessed for fusarium root rot lesions and sorted into classes based on number of lesions per carrot. Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1 ºC), September (14.8ºC) and October (9.7ºC), and above average for June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: June 18.2ºC, July 20.7ºC, August 19.5ºC, September 15.8ºC and October 8.9ºC. Monthly rainfall was below the previous long term 10 year average for June (55 mm), average for August (69 mm), and above average for July (140 mm), September (94 mm) and October (124 mm). The long term previous 10 year rainfall averages were: June 74 mm, July 81 mm, August 67 mm, September 74 mm and October 59 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained using Fisher's Protected LSD test with $P = 0.05$ level of significance.

RESULTS: as presented in Tables 1 and 2

CONCLUSIONS: There were no significant differences in disease incidence or severity among the carrot cultivars at either assessment period (Tables 1 & 2). Of all the carrots assessed during the August evaluation, only three were infected with *Fusarium*. At the second assessment (collected on 19 October), 24-41% of the carrots were infected with *Fusarium* and had developed the characteristic symptoms of carrot root rot. Although not statistically significant, the percentage of healthy carrots was 70% or more for carrot cultivars Fontana, Cellobunch and Olympus (Table 2).

Table 1. Incidence and severity of carrot root rot caused by *Fusarium* on various carrot cultivars grown in muck soil in a commercial carrot field in the Holland Marsh, Ontario, 2012. (First assessment)[1]

Treatment	% Healthy carrots	# Carrots with lesions				Mean # carrots with lesion
		1 lesion	2 lesions	3 lesions	4 lesions	
Envy	25.0 ns[2]	0.0 ns	0.0 ns	0.0 ns	0.0 ns	0.0 ns
Olympus	25.0	0.0	0.0	0.0	0.0	0.0
CX 480	25.0	0.0	0.0	0.0	0.0	0.0
2289	25.0	0.0	0.0	0.0	0.0	0.0
Fontana	24.8	0.3	0.0	0.0	0.0	0.3
2384	24.5	0.3	0.3	0.0	0.0	0.5
Cellobunch	24.3	0.8	0.0	0.0	0.0	0.8

[1]Carrot roots were collected on 22 August for the first assessment.
[2]ns = not significantly different at $P = 0.05$, Fisher's Protected LSD test

Table 2. Incidence and severity of fusarium carrot root rot on various carrot cultivars grown in muck soil in a commercial carrot field in the Holland Marsh, Ontario, 2012. (Second assessment)[1]

Treatment	% Healthy carrots	# Carrots with lesions				Mean # carrots with lesion
		1 lesion	2 lesions	3 lesions	4 lesions	
Fontana	75.5 ns[2]	18.0 ns	5.3 ns	1.0 ns	0.3 ns	24.5 ns
Cellobunch	71.8	19.8	7.3	1.0	0.3	28.3
Olympus	70.3	21.3	5.0	3.3	0.3	29.8
Envy	68.8	21.8	8.3	1.3	0.0	31.3
CX 480	68.5	25.3	4.0	2.0	0.3	31.5
2289	64.0	25.0	8.3	2.3	0.5	36.0
2384	58.8	28.5	8.5	2.5	1.8	41.3

[1]Carrot roots were collected on 19 October for the second assessment.
[2]ns = not significantly different at $P = 0.05$, Fisher's Protected LSD test

Funding for this project was provided by the Holland Marsh Growers' Association through the support of the Bradford Co-operative Storage Ltd.

CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang.)
PEST: Cavity spot (*Pythium intermedium* de Bary, *Pythium irregulare* Buisman, *Pythium sulcatum* Pratt & Mitchell, *Pythium sylvaticum* W.A. Campbell & J.W. Hendrix, *Pythium ultimum* Trow and *Pythium violae* Chesters & C.J. Hickman)

AUTHORS: MCDONALD MR & RICHES L
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: EVALUATION OF COLOURED CARROTS FOR SUSCEPTIBILITY TO CAVITY SPOT, 2012

MATERIALS: carrot breeding lines from the University of Wisconsin; Deep Purple from Bejo Seeds Inc.; White Satin, Yellowstone and Purple Haze from Seedway; PS 2384, CR2289, Cellobunch, Envy and Santa Crus from Seminis Vegetable Seeds; Atomic Red from Johnny's Selected Seeds

METHODS: The trial was conducted on organic soil (pH ≈ 6.8, organic matter ≈ 64.8%) naturally infested with *Pythium* spp. at the Muck Crops Research Station, Holland Marsh, Ontario. A randomized complete block design with four replicates per treatment was used. Carrots were direct seeded (≈67 seeds/m) on raised beds using a push V-belt seeder on 31 May. Each experimental unit consisted a twin row (1 hill), 6 m in length, spaced 86 cm apart. On 14 August, where plant stand numbers permitted 25 carrots was removed, placed in storage and assessed for cavity spot on 27 to 29 August. On 22 and 24 October, 50 carrots in each replicate were harvested, placed into cold storage, and assessed for cavity spot on 11 and 12 December. At both assessments carrots were washed in a small drum washer, visually examined for cavity spot lesions, and sorted into classes based on the size of the largest lesion (measured as horizontal length). The six classes were: no disease, very light (< 1 mm), light (1-2 mm), medium (3-5 mm), heavy (6-10 mm), and very heavy (> 10 mm). The disease severity index (DSI) was determined using the following equation:

$$\text{DSI} = \frac{\sum [(\text{class no.})(\text{no. of carrots in each class})]}{(\text{total no. carrots per sample})(\text{no. classes } -1)} \times 100$$

Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1ºC), September (14.8ºC) and October (9.7ºC), and above average for May (15.9ºC), June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: May 12.3ºC, June 18.2ºC, July 20.7ºC, August 19.5ºC, September 15.8ºC and October 8.9ºC. Monthly rainfall was below the previous long term 10 year average for May (49 mm) and June (55 mm), average for August (69 mm), and above average for July (140 mm), September (94 mm) and October (124 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm, July 81 mm, August 67 mm, September 74 mm and October 59 mm. All data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistics V.9. Means separation was obtained using Fisher's Protected LSD test with P =0.05 level of significance.

RESULTS: as presented in Table 1

CONCLUSIONS: On both assessment dates, sample size varied among cultivars. Due to low sample numbers, breeding lines Purple 7262B, 70458, Yellow 032-1, Purple CS Susceptible 665-1, White 029-1 and Red 0148B were not pulled for assessment on 14 August. Significant differences in disease incidence and DSI were found among cultivars in carrots pulled on 14 August and 24 October (Table 1).
In August, Deep Purple and Purple Haze had significantly lower cavity spot incidence than all other cultivars except breeding line 70460 and Red 914-1. Deep Purple had a significantly lower DSI than all other cultivars except Purple Haze and breeding lines 70460, Red 9141-1 and Yellow 8519YB.
Deep Purple, Purple Haze and breeding lines Purple 7262B, 70460 and 70458 had significantly lower cavity spot incidence than all other cultivars except breeding line Yellow 032-1. Deep Purple and

breeding lines Purple 7262B, 70460, 70458 and Yellow 032-1 had a lower DSI than all other cultivars except breeding lines Purple Haze and Yellowstone. As is consistent with 2011, purple cavity spot susceptible breeding line 665-1 had a much higher incidence of cavity spot (90.5%) than other purple carrots.

Funding was provided by the OMAFRA/University of Guelph Plant Production Systems Program.

Table 1. Disease severity index (DSI) and incidence of cavity spot in coloured carrots grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Cultivar	Source[1]	Colour	Disease Incidence (%)		DSI[2]	
			14 Aug	24 Oct	14 Aug	24 Oct
Purple 7262B	UW	Purple	---[4]	2.3 a	---	0.9 a
Deep Purple	Bejo	Purple	4.0 a[3]	6.7 a	1.4 a	2.4 ab
70460 Purple with orange core	UW	Purple	11.9 ab	13.9 ab	3.9 abc	4.4 abc
70458 Purple with orange core	UW	Purple	---	16.8 abc	---	7.1 a-d
Purple Haze	Seedway	Purple	9.0 a	36.7 bc	3.4 ab	16.4 cde
Yellow 032-1	UW	Yellow	---	39.8 cd	---	14.9 bcd
Yellowstone	Seedway	Yellow	34.3 cde	61.6 de	9.6 b-f	18.9 de
Dark Orange 034-1	UW	Orange	36.9 c-f	69.3 ef	11.2 c-g	34.7 fgh
PS 2384	Sem	Orange	31.0 b-e	76.7 efg	8.8 b-f	28.1 ef
Cellobunch	Sem	Orange	39.9 def	81.7 efg	11.5 d-g	34.9 fgh
Envy	Sem	Orange	32.0 b-e	86.9 fg	8.8 b-f	33.5 fg
Santa Crus	Sem	Orange	41.3 def	87.9 fg	12.1 d-g	37.6 fgh
Yellow 8519YB	UW	Yellow	28.4 bcd	88.4 fg	8.2 a-e	35.6 fgh
Purple CS Susceptible 665-1	UW	Purple	---	90.5 fg	---	61.3 j
Red 914-1	UW	Red	19.3 abc	90.9 fg	5.9 a-d	51.1 ij
White 029-1	UW	White	---	91.0 fg	---	44.0 ghi
Atomic Red	JSS	Red	36.0 cde	94.3 fg	13.2 efg	51.7 ij
CR2289	Sem	Orange	55.6 f	95.2 g	17.4 g	46.1 ghi
White Satin	Seedway	White	49.4 ef	99.0 g	15.8 fg	40.7 f-i
Red 0148B	UW	Red	---	100.0 g	---	49.7 hij

[1] Bejo = Bejo Seeds Inc.; JSS = Johnny's Selected Seeds; Sem = Seminis Vegetable Seed; UW = University of Wisconsin

[2] Disease Severity Index (DSI) was determined using the following equation:

$$DSI = \frac{\sum [(\text{class no.})(\text{no. of carrots in each class})]}{(\text{total no. carrots per sample})(\text{no. classes } -1)} \times 100$$

[3] Numbers in a column followed by the same letter were not significantly different at $P=0.05$, Fisher's Protected LSD Test.

[4] --- indicates plant stand insufficient for sampling


HOLLAND MARSH
Growers'
Association

CROP: Carrot (*Daucus carota*.), cv. Cellobunch
PEST: Weeds

AUTHORS: SWANTON C J, JANSE S & CHANDLER K
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: TOLERANCE OF CARROTS TO POSTEMERGENCE HERBICIDES, 2012

MATERIALS: GOAL 2XL (oxyfluorfen 24%), REFLEX (fomesafen 24%), BLAZER (acifluorfen 24%), fluthiacet-methyl (10.9%).

OBJECTIVE: To evaluate the tolerance of carrots to postemergence herbicides applied at twice the rate required for the control of redroot pigweed.

METHODS: The trial was conducted at a site with organic soil (organic matter 75%, pH 6.5) on the Muck Crops Research Station, Holland Marsh. Plots consisted of 2 hills, 86 cm apart and 4m long. Carrots were seeded on May 25 at a density of ~80/m of row. The trial consisted of 6 treatments, including an untreated control, arranged in a randomized complete block design with four replications. Treatments consisted GOAL 2XL, REFLEX, BLAZER, and fluthiacet-methyl. Treatments were applied postemergence at twice (2X) the rate required to provide ~80% control of redroot pigweed (determined in previous experiments). Also included was a 1X dose tank-mixture of BLAZER plus GOAL 2XL. Treatments were applied on 24 June when carrots were at the 2 leaf stage and again on 8 July when carrots were at the 4 leaf stage. Treatments were applied in 200 L/ha of water. All plots were maintained weed-free for the duration of the experiment by periodic hand-weeding. Visual assessments crop tolerance evaluations were at weekly intervals up to mid-August, and carrots were harvested on 28 September. Total, marketable and non-marketable (split, forked, and <0.75" diameter carrots) carrot yields were determined. Recommended management practices for soil fertility and pest control were followed. Data was analyzed by ANOVA and means separated using Fisher's Protected LSD test (P=0.05).

RESULTS: as presented in Table 1

CONCLUSIONS: Injury at 5 DAT (days after treatment), following herbicide application when carrots were at the 2 leaf stage, was greater with GOAL 2XL and REFLEX than with BLAZER and fluthiacet-methyl. Following sequential application of herbicides when carrots were at the 4 leaf stage, injury at 4 DAT was greater with GOAL 2XL than with REFLEX, BLAZER, and fluthiacet-methyl. At 18 DAT at the 4 leaf stage, injury was minimal with all treatments. Total and marketable carrot yields with all herbicide treatments were similar to the untreated check.

Table 1. Tolerance of carrots to postemergence herbicides applied twice, when carrots were at the 2 and 4 leaf stage at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Dose	Injury (%) DAT[1]			Yield (t/ha)	
	gai/ha	5/-	18/4	32/18	Total	Marketable[2]
Untreated		0	0	0	83	75
GOAL 2XL	120	26	20	3	68	63
REFLEX + Turbocharge	10 + 1% v/v	20	6	0	82	68
Fluthiacet-methyl + Agral 90	3.75 + 0.5% v/v	10	8	1	78	69
BLAZER + Assist	37.5 + 1% v/v	11	9	4	73	63
BLAZER + GOAL 2XL + Assist	18.75 + 60 + 0.5%	25	23	4	73	65
LSD (P=0.05)		*4*	*5*	*NS*	*NS*	*NS*

[1]Days after treatment (2 leaf/4 leaf stage at application)
[2] excluding forks, splits, <0.75" diameter

Funding for this project was supplied by the OMAFRA/University of Guelph (Maintaining Plant Health with Effective Integrated Weed Management) and by Agriculture and Agri-food Canada.

CROP: Carrot (*Daucus carota*.), cv. Cellobunch
PEST: Weeds

AUTHORS: SWANTON C J, JANSE S & CHANDLER K
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: TOLERANCE OF CARROTS TO PRE AND POST APPLIED RESIDUAL HERBICIDES, 2012

MATERIALS: PROWL H2O (pendimethalin 45.5%), DUAL II MAGNUM (s-metolachlor/benoxacor 91.5%), pyroxasulfone (85%), flufenacet (60%), NORTRON SC (ethofumesate 48%).

OBJECTIVE: to evaluate the tolerance of carrots grown on muck soils to selected residual herbicides applied preemergence and postemergence

METHODS: The trial was conducted at a site with organic soil (organic matter 75%, pH 6.5) on the Muck Crops Research Station, Holland Marsh. Plots consisted of 2 hills, 86 cm apart and 4m long arranged in a randomized complete block design with four replications. Carrots were seeded on May 25 at a density of ~80/m of row. The trial consisted of 10 treatments with residual herbicides applied preemergence and postemergence at 2X the proposed use rate. Preemergence treatments were applied on 28 May and postemergence treatments applied on 29 June when carrots were at the 3 leaf stage. All treatments were applied in 200 L/ha of water. All plots were maintained weed-free with periodic hand-weeding. Visual assessments for crop tolerance were made bi-weekly up to mid-July, and carrots were harvested on 28 September. Recommended management practices for soil fertility and pest control were followed. Data was analyzed by ANOVA and means separated using Fisher's Protected LSD test (P=0.05). Maximum crop injury was observed at 21 and 5 days after application of preemergence and postemergence treatments, respectively, and results are presented below.

RESULTS: as presented in Table 1

CONCLUSIONS: Carrot had excellent tolerance to 2X the proposed use rates of PROWL H2O, DUAL II MAGNUM, pyroxasulfone, and flufenacet applied preemergence and when carrots were at the 3 leaf stage. Carrots also had excellent tolerance to NORTRON SC applied preemergence. No significant injury was observed and yields with all herbicide treatments were similar to the untreated check.

Table 1. Tolerance of carrots to residual herbicides applied preemergence and at the 3 leaf stage of carrot development at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Dose gai/ha	Timing	Injury[1] (%)	Injury[2] (%)	Yield (t/ha)
Untreated			0	0	67
Pyroxasulfone	178	PRE	10	1	54
Flufenacet	900	PRE	6	4	62
DUAL II MAGNUM	2746	PRE	11	5	62
NORTRON SC	7920	PRE	6	1	61
PROWL H2O	6000	PRE	0	3	68
Pyroxasulfone	178	3 leaf	-	8	55
Flufenacet	900	3 leaf	-	5	62
DUAL II MAGNUM	2746	3 leaf	-	9	62
PROWL H2O	6000	3 leaf	-	0	67
LSD (P=0.05)			*NS*	*NS*	*NS*

[1,2] Injury on 18 June and 4 July, 21 and 5 days after preemergence and 3 leaf treatments applied, respectively.

Funding for this project was supplied by the OMAFRA/University of Guelph (Maintaining Plant Health with Effective Integrated Weed Management) and by Agriculture and Agri-food Canada.

CROP: Carrot (*Daucus carota*.), cv. Cellobunch
PEST: Red Root Pigweed

AUTHORS: SWANTON C J, JANSE S & CHANDLER K
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: EFFICACY OF POST APPLIED HERBICIDES FOR CONTROL OF REDROOT PIGWEED IN CARROTS, 2012

MATERIALS: GOAL 2XL (oxyfluorfen 24%), REFLEX (fomesafen 24%), BLAZER (acifluorfen 24%), fluthiacet-methyl (10.9%).

OBJECTIVE: to evaluate the tolerance of carrots to postemergence herbicides applied at twice the rate required for the control of redroot pigweed

METHODS: The trial was conducted at a site with organic soil (organic matter 75%, pH 6.5) on the Muck Crops Research Station, Holland Marsh. Plots consisted of flat beds with carrot rows 43 cm apart and 4m long. Carrots were seeded on 12 June at a density of ~80/m of row. The trial consisted of 13 treatments, including a weedy control, arranged in a randomized complete block design with four replications. Treatments consisted GOAL 2XL, REFLEX, BLAZER, and fluthiacet-methyl applied at 1X rates of 60, 5, 18.75, and 1.875 gai/ha, respectively, additional rates of each herbicide that were +/- 20% of the 1X rate were included. Appropriate adjuvants were used for each herbicide as required (see below for details). Treatments were applied on 24 June when redroot pigweed was at the 2-4 leaf stage. Treatments were applied in 200 L/ha of water. Visual assessments for efficacy were made up to 18 DAT (days after treatment), at which time the trial was discontinued. Recommended management practices for soil fertility and pest control were followed. Data was analyzed by ANOVA and means separated using Fisher's Protected LSD test (P=0.05).

RESULTS: as presented in Table 1

CONCLUSIONS: Selected postemergence herbicides were evaluated at below label rates for the control of redroot pigweed in carrots grown on muck soil. All treatments gave >90% control at 5 DAT (days after treatment). At 10 DAT control was >90% with all doses of GOAL 2XL (48-72 gai/ha) and BLAZER (15-22.5 gai/ha) but <90% with all doses of REFLEX (4-6 gai/ha), and fluthiacet-methyl (1.5-2.25 gai/ha).

Table 1. Efficacy of postemergence herbicides for the control of redroot pigweed in carrot, at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Dose	Control (%) DAT[1]		
	gai/ha	5	10	18
Weedy control		0	0	0
GOAL 2XL	48	100	94	88
GOAL 2XL	60	100	96	86
GOAL 2XL	72	100	98	94
REFLEX + Turbocharge	4 + 0.5% v/v	96	84	78
REFLEX + Turbocharge	5 + 0.5% v/v	98	86	71
REFLEX + Turbocharge	6 + 0.5% v/v	96	79	71
Fluthiacet-methyl + Agral 90	1.5 + 0.5% v/v	95	85	74
Fluthiacet-methyl + Agral 90	1.875 + 0.5% v/v	100	79	75
Fluthiacet-methyl + Agral 90	2.25 + 0.5% v/v	98	83	74
BLAZER + Assist	15 + 0.5% v/v	100	91	88
BLAZER + Assist	18.75 + 0.5% v/v	100	93	85
BLAZER + Assist	22.5 + 0.5% v/v	100	90	85
LSD (P=0.05)		*4*	*8*	*11*

[1]Days after treatment at 2-4 leaf stage.

Funding for this project was supplied by the OMAFRA/University of Guelph (Maintaining Plant Health with Effective Integrated Weed Management) and by Agriculture and Agri-food Canada.

CROP: Carrot (*Daucus carota*.), cv. Cellobunch

AUTHORS: SWANTON C J, JANSE S & CHANDLER K
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: TOLERANCE OF CARROTS TO PRE AND POST APPLIED RESIDUAL HERBICIDE TANK-MIXTURES, 2012

MATERIALS: LOROX (Linuron 48%), GESAGARD (prometryne 48%), DUAL II MAGNUM (s-metolachlor/benoxacor 91.5%), NORTRON SC (ethofumesate 48%), BLAZER (acifluorfen 24%), GOAL 2XL (oxyfluorfen 24%).

OBJECTIVE: to evaluate the tolerance of carrots grown on muck soils to selected residual herbicide tank-mixtures applied preemergence and postemergence

METHODS: The trial was conducted at a site with organic soil (organic matter 75%, pH 6.5) on the Muck Crops Research Station, Holland Marsh. Plots consisted of 2 hills, 86 cm apart and 4m long arranged in a randomized complete block design with four replications. Carrots were seeded on May 24 at a density of ~80/m of row. The trial consisted of 12 treatments, with tank-mixtures of residual herbicides applied at 1X the proposed use rate. Also included, were postemergence tank-mixtures of LOROX plus BLAZER and GOAL 2XL. Preemergence herbicide treatments were applied on 28 May and postemergence treatments applied on 29 June when carrots were at the 3 leaf stage. All treatments were applied in 200 L/ha of water. All plots were maintained weed-free with periodic hand-weeding. Visual assessments for crop tolerance were made bi-weekly up to mid-July, and carrots were harvested on 28 September. Recommended management practices for soil fertility and pest control were followed. Data was analyzed by ANOVA and means separated using Fisher's Protected LSD test (P=0.05). Maximum crop injury was observed at 21 and 5 days after application of preemergence and postemergence treatments, respectively, and results are presented below.

RESULTS: as presented in Table 1

CONCLUSIONS: Carrots had excellent tolerance to preemergence LOROX or GESAGARD tank-mixed with NORTRON SC or DUAL II MAGNUM. Carrot tolerance was also excellent with LOROX, GESAGARD, and LOROX plus GOAL 2XL applied when carrots were at the 3 leaf stage. Postemergence tank-mixtures of LOROX plus DUAL II MAGNUM and LOROX plus BLAZER plus ASSIST caused slight and temporary injury. Carrot yields with all herbicide treatments were similar to the untreated check.

Table 1. Tolerance of carrots to tank-mixtures of residual herbicides applied preemergence and at the 3 leaf stage of carrot development at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Dose gai/ha	Timing	Injury[1] (%)	Injury[2] (%)	Yield (t/ha)
Untreated			0	0	75
LOROX	2250	PRE	0	0	76
LOROX + NORTRON SC	2250 + 3960	PRE	0	0	71
LOROX + DUAL II MAGNUM	2250 + 1373	PRE	1	0	77
GESAGARD	3400	PRE	1	0	66
GESAGARD + NORTRON SC	3400 + 3960	PRE	0	0	85
GESAGARD + DUAL II MAGNUM	3400 + 1373	PRE	3	0	72
LOROX	2250	3 leaf	-	0	71
LOROX + DUAL II MAGNUM	2250 + 1373	3 leaf	-	9	67
LOROX + BLAZER + ASSIST	2250 + 18.75 + 0.5%	3 leaf	-	10	63
LOROX + GOAL 2XL	2250 + 60	3 leaf	-	4	77
GESAGARD	3400	3 leaf	-	3	67
LSD (P=0.05)			*NS*	*2*	*NS*

[1,2] Injury on 18 June and 4 July, 21 and 5 days after preemergence and 3 leaf treatments applied, respectively.

Funding for this project was supplied by the OMAFRA/University of Guelph (Maintaining Plant Health with Effective Integrated Weed Management) and by Agriculture and Agri-food Canada.

CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang.) cvs. Nutri-red, Atomic Red, Red Canyon and T-29

AUTHORS: MCDONALD MR[1] & BILAL A[2]
[1]University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station
[2]Vineland Research and Innovation Centre, Vineland Station

TITLE: EVALUATION OF VARIOUS RED CARROT CULTIVARS GROWN ON ORGANIC SOIL, 2012

INTRODUCTION: There is a growing interest in non-traditional vegetables including coloured carrots in Ontario. In co-operation with the Vineland Research and Innovation Centre, an evaluation of four red carrot cultivars was conducted to identify cultivars suitable for commercial production on organic soil in the Holland Marsh.

MATERIALS: red carrot cultivars Nutri-red, Atomic Red, Red Canyon and T-29

METHODS: The trial was conducted at the Muck Crops Research Station, Holland Marsh, Ontario, in organic soil (pH ≈ 6.6, organic matter ≈ 72.3%). Carrots cultivars Red Canyon (Norseco Inc.), Atomic Red (Genetic Seed & Chemical), Nutri-red (William Dam Seeds Ltd.) and T-29 (Vegetable Research Institute, Faisalabad, Punjab, Pakistan) were direct seeded at ≈ 66 seeds/m, onto raised carrot hills using a push V-belt seeder on 30 May. Each experimental unit consisted of three hills, 86 cm apart, and 6 meters long. A randomized complete block experiment design was used. On 16 July, plants in two, 1 m sections of row were counted to establish stand density. On 29 August, seed stalks were counted and numbers recorded. On 18 October carrots in a 1.16 m section of row were pulled from each replicate and placed in storage, then removed on 18 December, sorted into marketable and culls (split and forked), weighed and counted to determine yield. Carrots were assessed for the following qualities: width of crown, external colour (0 to 5 where 0 = light pink and 5 = dark red), uniformity of colour (0 to 10 where 0 = least uniform and 10 = most uniform), skin smoothness (0 to 10 where 0 = roughest and 10 = smoothest) and prominence of lateral root bases (see Fig. 1) (0 to 3 where 0 = not raised, 3 = most prominent). Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1°C), September (14.8°C) and October (9.7°C), and above average for May (15.9°C), June (20.1°C) and July (22.2°C). The long term previous 10 year average temperatures were: May 12.3°C, June 18.2°C, July 20.7°C, August 19.5°C, September 15.8°C and October 8.9°C. Monthly rainfall was below the previous long term 10 year average for May (49 mm) and June (55 mm), average for September (75 mm), and above average for July (140 mm), August (79 mm) and October (113 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm, July 81 mm, August 67 mm, September 74 mm and October 59 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained using Fisher's Protected LSD test at P = 0.05 level of significance.

RESULTS & DISCUSSION: Significant differences in external colour, smoothness, lateral root base prominence and crown width were found among the cultivars (Table 1). Cultivars Nutri-red and Atomic Red had smoother skin, less prominent lateral root bases and narrower crown widths than Red Canyon and T-29. Nutri-red and Atomic Red had a darker external colour than T-29 and Nutri-red had a darker external colour than Red Canyon and T-29.

Significant differences in percent marketable, marketable yield, plant stand and the number of seed stalks in late August where found among the cultivars (Table 2). Red Canyon had a higher yield and percent marketable carrots than Nutri-red and T-29.

In the trial, plant stands ranged from 20 to 40 plants/m. Atomic Red and Nutri-red than had significantly more carrots per meter than Red Canyon and T-29. Cultivars Atomic Red and Nutri-red had significantly

fewer seed stalks per plot than T-29 and Red Canyon. T-29 had significantly fewer seed stalks than Red Canyon.

CONCLUSIONS: Generally, yield and quality of all cultivars was poor. The percentage of marketable carrots ranged from 62 to 33% and culls were the result of splitting and forking. Thin plant stands may have contributed to splitting. Experimenting with higher seeding rates in future trials may improve quality. Nutri-red and Atomic Red had better overall appearance and seemed better suited to this area compared to Red Canyon and T-29.

Investment in this project has been provided by Agriculture and Agri-Food Canada through the Canadian Agricultural Adaptation Program (CAAP). In Ontario, this program is delivered by the Agricultural Adaptation Council.

Vineland Research and Innovation Centre is funded in part by Growing Forward, a federal-provincial-territorial initiative.

Table 1. Quality assessments for red carrots, cvs. Atomic Red, Nutri-Red, Red Canyon and T-29, grown at Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Cultivar	Supplier	Colour Rating[1]	Uniformity of Colour[2]	Smoothness Rating[3]	Lateral Root Base Prominence[4]	Crown Width (cm)
Nutri-red	William Dam Seeds Ltd	4.4 a	7.1 ns	7.4 a	1.0 a	3.0 a
Atomic Red	Genetic Seed & Chemical	4.0 ab	5.8	8.6 a	1.1 a	3.6 a
Red Canyon	Norseco Inc	3.9 b	6.2	5.2 b	2.0 b	4.7 b
T-29	VRIF, Pakistan[5]	1.6 c	5.6	1.6 c	2.8 c	6.8 c

[1] Rated on a scale of 5 to 0 where 5=dk red, 4=red, 3=lt red/pink, 2=dk pink, 1=pink, 0=very lt pink
[2] Rated on a scale of 0 to 10 where 0 = poor uniformity and 10 = most uniform
[3] Rated on a scale of 0 to 10 where 0 = very rough and 10 = perfectly smooth
[4] Rated on a scale of 0-3 where 0 = not raised, 1 = slightly raised, 2 = medium bumps, 3 = very large bumps
[5] Vegetable Research Institute Faisalabad, Punjab, Pakistan.

Table 2. Yield for red carrots, cvs. Atomic Red, Nutri-Red, Red Canyon and T-29, grown at Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Cultivar	Supplier	% Mkb	t/ha	Stand (plants/m)[1]	# carrot/m^2[2]	Seed stalks/plot[3]
Red Canyon	Norseco Inc	62.2 a	30.4 a	33.0 a	22.1 b	46.5 c
Atomic Red	Genetic Seed & Chemical	50.2 ab	23.6 ab	35.5 a	34.1 a	1.8 a
Nutri-red	William Dam Seeds Ltd	34.7 b	15.1 b	39.0 a	35.2 a	2.5 a
T-29	VRIF, Pakistan[4]	32.6 b	15.9 b	19.8 b	10.2 c	24.0 b

[1] Plants emerged on 16 July (47 DAS)
[2] Number of carrot per meter at harvest, 18 October
[3] Seed stalks counted on 29 August (91 DAS)
[4] Vegetable Research Institute Faisalabad, Punjab, Pakistan.

CROPS: Cabbage (*Brassica oleracea*), cv. Golden Acres
Cauliflower (*Brassica, oleracea*), cv. Freedom CMS

PESTS: Downy mildew (*Peronospora parasitica* (Per.:Fr.) Fr.)
Alternaria leaf blight (*Alternaria brassicola* (Schwein.) Wiltshire)

AUTHORS: MCDONALD MR & RICHES L
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: EVALUATION OF PHOSTROL FOR CONTROL OF DOWNY MILDEW AND *ALTERNARIA* LEAF BLIGHT ON CABBAGE AND CAULIFLOWER, 2012

MATERIALS: PHOSTROL (mono- and dibasic sodium, potassium and ammonium phosphites 53.6%), BRAVO (chlorothalonil 500 g/L)

METHODS: Trials were conducted at sites near the Muck Crop Research Station, Holland Marsh, Ontario, in organic soil (pH ≈ 7.4, organic matter ≈ 47.6%). On 25 and 28 May cabbage, cv. Golden Acres and cauliflower, cv. Freedom CMS, were seeded into 128 cell plug trays, grown in the greenhouse and hand transplanted on 19 June. A randomized complete block arrangement with four replicates per treatment was used. Each experimental unit consisted of two 7.5 m long rows, 2.8 m apart with 45 cm in-row spacing. Treatments were: BRAVO at 4.8 L/ha and PHOSTROL at 2.9 and 5.8 L/ha. Untreated checks were also included. Treatments were applied as foliar sprays on 27 July and 6, 13 and 23 August using a CO_2 backpack sprayer equipped with four TeeJet 8002 VS fan nozzles spaced 40 cm apart and calibrated to deliver 300 L/ha at 240 kPa (boom). Plots were monitored for the presence of downy mildew on a weekly basis. On 30 August, 20 bottom leaves per replicate were removed and the numbers of *Alternaria* leaf blight lesions were counted and recorded. Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1ºC) and September (14.8ºC) and above average for June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: June 18.2ºC, July 20.7ºC, August 19.5ºC and September 15.8ºC. Monthly rainfall was below the previous long term 10 year average for June (55 mm), average for August (69 mm), and above average for July (140 mm) and September (94 mm). The long term previous 10 year rainfall averages were: June 74 mm, July 81 mm, August 67 mm and September 74 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistics V.9. Means separation was obtained using Fisher's Protected LSD test with P =0.05 level of significance.

RESULTS: as presented in Table 1

CONCLUSIONS: Weather conditions were not conducive for downy mildew infection in 2012 and no downy mildew was found in either trial. In both trials low incidence of *Alternaria* leaf blight was observed, but no significant differences were found among the treatments (Table 1).

Table 1. Alternaria and downy mildew (DM) incidence for cabbage, cv. Golden Acres, and cauliflower, cv. Freedom CMS , treated with fungicides and grown near the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Rate/ha	Avg # Alternaria Lesions/leaf		Total # DM Lesions/leaf	
		Cabbage Trial	Cauliflower Trial	Cabbage Trial	Cauliflower Trial
BRAVO	4.8 L	0.5 ns [1]	1.6 ns	0.0 ns	0.0 ns
PHOSTROL	5.8 L	1.2	2.2	0.0	0.0
PHOSTROL	2.9 L	1.5	3.3	0.0	0.0
Check	--	0.9	3.1	0.0	0.0

[1]ns = no significant differences were found among treatments

Funding for this project was provided by Engage Agro, Guelph, Ontario.

Since joining the Department of Plant Agriculture, University of Guelph in 1997, Dr. Mary Ruth McDonald has been active in supervising new researchers in the agricultural field. There have been a total of 15 graduate students who have conducted various research projects for their Master Degrees or Ph.D. at the Muck Crops Research Station. We are all proud to be a part of the education and training of future agricultural professionals.

CROP: Napa cabbage (*Brassica rapa* ssp. Pekinensis), cv. Mirako
PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

AUTHORS: MCDONALD MR[1], PENG G[2], RICHES L[1]
[1]University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station
[2]Agriculture and Agri-Food Canada, Saskatoon

TITLE: EFFICACY OF THE ENDOPHYTIC BIOLOGICAL CONTROL AGENT *HETEROCONIUM* FOR THE MANAGEMENT OF CLUBROOT IN NAPA CABBAGE, 2012

MATERIALS: *HETEROCONIUM CHAETOSPRIRA* (isolate code: B2-HB1), RANMAN 400 SC (cyazofamid 34.5%), SERENADE ASO (1.34% *Bacillus subtilis* QST 713)

OBJECTIVE: to evaluate the efficacy of *Heteroconium chaetosprira* in inducing plant resistance to clubroot

METHODS: The trial was conducted at the Muck Crops Research Station, Holland Marsh, Ontario, in organic soil (pH ≈ 6.6, organic matter ≈ 66.2%) naturally infested with *Plasmodiophora brassicae* pathotype 6. Napa cabbage, cv. Mirako, was seeded on 29 May into 128-cell plastomer plug trays, and hand-transplanted on 26 June. A complete block design with four replicates per treatment was used. Each experimental unit consisted of three rows, 5 m long, and 30 cm apart, with in-row spacing of 30 cm. Treatments were SERENADE at 5% v/v applied as a plug tray drench on 19 June (7 days before transplant), RANMAN at 1.85 L/ha applied as a post-transplant drench on 26 June, and *Heteroconium chaetospira* (Hc) isolate code: B2-HB1 at 2.0% v/v mixed into the soilless potting mix of equal parts ASB and Promix used to fill the 128-cell plug transplant trays. An untreated check was also included. On 14 August, 10 plants from each replicate plot were removed from the soil, each top and root pair individually weighed and roots examined for clubroot. On 15 August, 10 napa heads were cut from each replicate and weighed for yield and roots examined for clubroot incidence and severity. For both assessments clubroot was classified by severity using a scale of 0 to 3: 0 = no clubbing, 1 = < 1/3 of root clubbed, 2 = 1/3 – 2/3 of roots clubbed, and 3 = > 2/3 of roots clubbed. Disease severity index (DSI) was determined using the following equation:

$$\text{DSI} = \frac{\sum [(\text{class no.})(\text{no. of roots in each class})]}{(\text{total no. roots per sample})(\text{no. classes } -1)} \times 100$$

Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1ºC) and above average for June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: June 18.2ºC, July 20.7ºC and August 19. Monthly rainfall was below the previous long term 10 year average for June (55 mm), average for August (69 mm), and above average for July (140 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm and July 81 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained by using Fisher's Protected LSD Test at $P = 0.05$ level of significance.

RESULTS & DISCUSSION: Significant differences in clubroot severity were found among the treatments (Table 1). However, no significant difference in clubroot severity was found between Napa cabbage treated with a RANMAN transplant drench at 1.85 L/ha and napa cabbage grown in soilless mix with Hc included at the rate of 2.0% v/v. Napa cabbage treated with the RANMAN drench had a significantly lower clubroot severity rating than napa cabbage treated with SERENADE and the untreated check. No significant differences in clubroot incidence and weight per head were found among the treatments (Table 1).

CONCLUSIONS: *Heteroconium chaetosprira* may induce resistance to clubroot resulting in a disease severity similar to a RANMAN drench treatment applied at transplant.

Table 1. Disease incidence and severity for napa cabbage transplants seeded into a soilless mix inoculated with *Heteroconium chaetospira* (Hc), grown in soil naturally infested with the clubroot pathogen at Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatments	Clubroot Incidence (%)	DSI[1]	Weight/head (g)
RANMAN	72.5 ns[2]	34.6 a[3]	565.8 ns
Hc	83.8	58.8 ab	669.0
SERENADE	97.5	83.8 b	433.3
Check	98.8	84.2 b	462.0

[1] Disease Severity Index (DSI) was calculated with the equation:

$$DSI = \frac{\sum [(\text{class no.})(\text{no. of roots in each class})]}{(\text{total no. roots per sample})(\text{no. classes} - 1)} \times 100$$

[2] ns = no significant differences at $P = 0.05$, Fisher's Protected LSD test

[3] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher's Protected LSD test.

Funding for this project was provided by Clubroot Mitigation Project of Agriculture and Agri-Food Canada, the Plant Production Systems Program of the Ontario Ministry of Agriculture, Food and Rural Affairs and the University of Guelph.

CROPS: Canola (*Brassica napus* L.), cvs. 34-65RR, Invigor 5030LL
Pak choi (Brassica rapa), cv. Mei Qing

PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

AUTHORS: MCDONALD MR[1], RICHES L[1], GOSSEN BD[2] & STRELKOV S[3]
[1]University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station
[2] Agriculture and Agri-Food Canada, Saskatoon
[3] University of Alberta, Dept. of Agricultural, Food & Nutritional Science

TITLE: POTENTIAL FOR SEED TRANSMISSION OF *PLASMODIOPHORA BRASSICAE* INOCULUM ON CANOLA SEEDS, THIRD YEAR PHASE, 2012

METHODS: On 15 June, 2010, Canola seed, line 34-65RR (Dekalb), inoculated with various concentrations of spores of *Plasmodiophora brassicae* (pathotype 3) at the University of Alberta, was direct seeded at ≈ 40 seeds/m using an Earthway push seeder into soil free of *Plasmodiophora brassicae* (organic matter ≈ 42.4%, pH ≈ 7.7) near the Muck Crops Research Station, Holland Marsh, Ontario. Levels of inoculum were: 10^6, 10^5, 10^4, 10^3, 10^2, 10^1, 10^0 spores. In the 2nd-year phase of the trial, conducted in 2011, non-inoculated susceptible canola seed, cv. Invigor line 5030 LL, was seeded at ≈ 36 seeds/m using an Earthway push seeder on 16 June, 2011, into the exact location of the plot used in 2010 for the 1st-year phase of the trial. For both trials a randomized complete block design with four replicates was used. Each experimental unit consisted of four 5 m long rows, 40 cm apart. On 4 October (1st year) and 2 September (2nd year), 50 plants per replicate were harvested, and roots washed and examined for clubroot incidence. As well, all four replications of canola roots grown from seeds inoculated with 10^6 spore concentration from the 2010 1st year phase trial, and the single clubbed root from the 2011 2nd -year phase trial were shipped to the Dr. Strelkov for further examination of roots for very small clubs and clubroot confirmation. On 18 June 2012, in the 3rd year of the trial, pak choi susceptible to clubroot, cv. Mei Qing, was seeded using an Earthway push seeder (plate 1002-10) in a plot 8.5 m by 12.5 m on the SW corner of the original 2010 plot. The center of the 2012 seeding was the location of the suspected club found in 2011. On 29 and 30 August, all pak choi plants were pulled, and roots washed and examined for clubroot incidence. Clubroot was classified by severity using a scale of 0 to 3: 0 = no clubbing, 1 = < 1/3 of root clubbed, 2 = 1/3 – 2/3 of roots clubbed and 3 = > 2/3 of roots clubbed. Disease severity index (DSI) was determined using the following equation:

$$\text{DSI} = \frac{\sum [(\text{class no.})(\text{no. of roots in each class})]}{(\text{total no. roots per sample})(\text{no. classes} - 1)} \text{ x100}$$

Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1ºC), and above average for June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: June 18.2ºC, July 20.7ºC and August 19.5ºC. Monthly rainfall was below the previous long term 10 year average for June (55 mm), average for August (69 mm), and above average for July (140 mm). The long term previous 10 year rainfall averages were: June 74 mm, July 81 mm and August 67 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained by using Fisher's Protected LSD Test at $P = 0.05$ level of significance.

RESULTS & DISCUSSION: Clubroot symptoms were found at the rate of 0.1% of canola plants (1 plant in 235) grown from non-inoculated seeds in soil used previously to grow canola inoculated with 10^2 spores of *Plasmodiophora brassicae*; however, no significant differences were found in clubroot incidence or severity in canola plants grown directly from seeds inoculated with any concentration of *Plasmodiophora brassicae* (1^{st}- year phase), or in plants grown from non-inoculated seed in soil used previously to grow canola inoculated with any concentration of *Plasmodiophora brassicae* (2^{nd} and 3^{rd} year phases) (Table 1).

CONCLUSIONS: It is unknown whether the single club resulted from infection from *Plasmodiophora brassicae* (pathotype 3) on infected seeds, or from *Plasmodiophora brassicae* (pathotype 6) caused by contamination. We could not demonstrate infection of canola from *P. brassicae* resting spores on seed. We could not demonstrate infection of canola (2011) or pak choi (2012) from *P. brassicae* (pathotype 3) resting spores potentially carried over in the soil from infected seeds seeded in 2010.

Table 1. Clubroot incidence and disease severity index (DSI) for canola, cv. 34-65RR, grown from seeds inoculated with various rates of clubroot spores (1^{st} Year); non-inoculated canola, cv. Invigor line 5030 LL (2^{nd} Year), or pak choi, cv Mei Qing (3^{rd} Year), seeded in 3 consecutive years (2010 – 12) in the same plot, near the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Rate of Inoculum	Clubroot Incidence (%)			DSI		
	1^{st} Year Phase[1]	2^{nd} Year Phase[2]	**3^{rd} Year Phase[3]**	1^{st} Year Phase	2^{nd} Year Phase	**3^{rd} Year Phase**
10^2	0.0 ns[4]	0.1 ns	**0.0**	0.0 ns	0.04 ns	**0.0**
Check	0.0	0.0	**0.0**	0.0	0.0	**0.0**
10^0	0.0	0.0	**0.0**	0.0	0.0	**0.0**
10^1	0.0	0.0	**0.0**	0.0	0.0	**0.0**
10^3	0.0	0.0	**0.0**	0.0	0.0	**0.0**
10^4	0.0	0.0	**0.0**	0.0	0.0	**0.0**
10^5	0.0	0.0	**0.0**	0.0	0.0	**0.0**
10^6	0.0	0.0	**0.0**	0.0	0.0	**0.0**

[1] Canola grown from seeds inoculated with various rates of *Plasmodiophora brassicae* (pathotype 3).
[2] Canola grown in soil which was used to grow canola from seeds inoculated with various rates of *Plasmodiophora brassicae* (pathotype 3) in the previous year.
[3] Pak Choi grown in soil which was used to grow canola from seeds inoculated with various rates of *Plasmodiophora brassicae* (pathotype 3) two years previous.
[4] ns = no significant differences were found among the treatments

Funding for this project was provided by the Clubroot Mitigation Project of Agriculture and Agri-Food Canada, and the Plant Production Systems Program of the Ontario Ministry of Agriculture, Food and Rural Affairs and University of Guelph.

CROP: Canola (*Brassica napus* L.) cvs. 45H21, 7367, 7377, Invigor 5030, ACS-N39, 46A76, Westar, Exceed
Broccoli (*B. oleracea* L. var. *botrytis*) cvs. BC 7540, Diplomat
Brussels sprouts (*B. oleracea* L. var. *gemmifera*) cvs. Crispus , Jade Cross E
Cabbage (*B. oleracea* L. var. *capitata*) cv. B 2819, Klimaro (red), Kilaherb, Bronco (green)
Napa cabbage (*B. rapa* L. spp. *pekinensis*) cvs. Bilko, Mirako
Shanghai pak choy (*B. rapa* L. spp. *Chinensis* var. *communis*) cvs. Bejo 2834, Mei Qing Choy

PESTS: *Plasmodiophora brassicae* Wor. pathotype 6

AUTHORS: SHARMA K[1], GOSSEN BD[2], GLUDOVACZ T[1] & MCDONALD MR[1]
[1]University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station
[2]Agriculture and Agri-Food Canada Research Centre, Saskatoon

TITLE: DETERMINE THE RELATIONSHIP BETWEEN ROOT AND SHOOT WEIGHT OF CANOLA INFECTED WITH THE CLUB ROOT PATHOGEN, IN COMPARISON TO OTHER BRASSICA SPECIES

METHODS: Field trials were conducted at the Muck Crops Research Station, Holland Marsh, Ontario, in organic soil (pH ≈ 6.3, organic matter ≈ 74.7 %) naturally infested with *Plasmodiophora brassicae*, pathotype 6 at two sites, one at a site with high disease pressure (site 1) and the second at a site with low disease pressure (site 2). Eight canola cultivars, 45H21, 7367, 7377, Invigor 5030, ACS-N39, 46A76, Westar, and Exceed were seeded on 3 August at site 1 and 2. In a separate trial, eight different *Brassica* sp., Broccoli cvs. BC 7540 and Diplomat, Brussels sprouts cvs. Crispus and Jade Cross E, Cabbage cv. B 2819, and Klimaro (red), Kilaherb, and Bronco (green), napa cabbage cvs. Bilko, and Mirako, Shanghai pak choy cvs. Bejo 2834 and Mei Qing Choy were seeded into 128-cell plug trays containing soilless mix on 4 May and grown in a greenhouse. On 6 June, Plants were hand-transplanted into three 7.5 m rows, 55 cm apart with 30 cm in-row spacing (pak choy, broccoli and napa cabbage), or two 7.5 m rows 86 cm apart with 45 cm in-row spacing (cabbage and Brussels sprouts). Canola plants were uprooted and assessed for clubroot severity and incidence, and top and root weight at 13 weeks after seeding on 6 November. The other *Brassica* sp. were uprooted and assessed on 10 July (pak choy), 20 July (napa cabbage), 8 August cabbage (B 2819 and Kilaherb), 20 August (broccoli), 23 August cabbage (Klimaro and Bronco), and 20 September (Brussels sprouts) when they reached the marketable maturity and assessed for clubroot severity, top and root weight. There were 10 plants per experimental unit for all assessments. After collection, the roots were washed and assessed for clubroot incidence and severity using a 0 to 3 scale, where: 0 = no symptoms; 1 = clubbing on < 1/3 of the tap root; 2 = < 2/3 of root with clubbing; 3 = clubbing on > 2/3 of tap root. A disease severity index was calculated for each plot from the individual plant ratings using the following formula:

$$\text{DSI} = \frac{\sum [(\text{class no.})(\text{no. of leaves in each class})]}{(\text{total no. plants per sample})(\text{no. classes} - 1)} \times 100$$

Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1 ºC), September (14.8ºC) and October (9.7ºC), and above average for May (15.9ºC), June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: May 12.3ºC, June 18.2ºC, July 20.7ºC, August 19.5ºC, September 15.8ºC and October 8.9ºC. Monthly rainfall was below the previous long term 10 year average for May (49 mm) and June (55 mm), average for August (69 mm), and above average for July (140 mm), September (94 mm) and October (124 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm, July 81 mm, August 67 mm, September 74 mm and October 59 mm. Data analyses were conducted using SAS statistical software (v 9.2, SAS Institute, Inc.,

2010, Cary, NC, USA). Correlation analysis was used to quantify the relationships between shoot weight and root weight among various *Brassica* species, varieties and cultivars infected with *P. brassicae* at site 1 and 2.

RESULTS: as presented in Tables 1 and 2

CONCLUSIONS: There was considerable variation among the Brassica crops evaluated, and among different cultivars of the same crop, for all of the variables that were assessed at different sites (Table 1 and 2). Among the tested Brassica crops, the highest root weight was produced by cabbage cv. Bronco (120 - 550g) and the lowest root weight was produced by Brussels sprouts cv. Jade Cross (0.07 - 0.53g) under high disease pressure, and the highest root weight was produced by Brussels sprouts cv. Crispus (140 - 490 g) and the lowest root weight was produced by canola cv. Invigor 5030 (9 – 18 g) under low disease pressure. Similarly, cabbage cv. Kilaherb had the largest shoot weight (3400 - 7350g) and canola cv. Exceed had the lowest shoot weight (0.10 – 45 g) under high disease pressure, and cabbage cv. Bronco (3860 - 9760g) had the highest shoot weight under low disease pressure and the lowest shoot weight was produced by canola cv. Invigor 5030 (9 – 18 g). Under high disease pressure, the highest root/shoot ratio was found on canola cv. Exceed (0.1 – 7.5) and the lowest root/shoot ratio was found in Brussels sprouts cv. Jade Cross (0.00 – 0.002), and under low disease pressure, the highest root/shoot ratio was found on canola cv. Exceed (0.09 – 0.22) and the lowest root/shoot ratio was found in napa cabbage cv. Mirako (0.00 – 0.02).

Under high disease pressure, root weight increased with shoot weight for all of the resistant Brassica species except for the resistant cabbage cv. B 2819 and napa cabbage cv. Bilko, and also for the susceptible broccoli cv. BC 7540, cabbage cv. Klimaro, canola cvs. Invigor 5030, ACS-N39 and Westar, and pak choy cv. Mei Qing Choy (Table 1). There was no relationship between root and shoot weights for the susceptible canola cvs. 46A76 and Exceed. Shoot weight decreased with increasing severity class of the roots for the susceptible cabbage cvs. Klimaro and Bronco, canola cvs. ACS-N39, 46A76 and Exceed. Root weight increased with increasing severity class for the susceptible broccoli cv. Diplomat, cabbage cv. Klimaro, pak choy cv. Mei Qing Choy, and moderately susceptible canola cv. Invigor 5030. In some cases the relationship between severity class and shoot and root weight could not be assessed because the roots were all in a single class, 0 or 3.

Under low disease pressure, root weight increased with shoot weight for all of the resistant and susceptible cultivars of canola, napa cabbage and pak choy, and also for the resistant broccoli cv. BC 7540 and susceptible Brussels sprouts cv. Jade Cross (Table 2). There was no relationship between root and shoot weights for cabbage cultivars, and also for the susceptible broccoli cv. Diplomat and resistant Brussels sprouts cv. Crispus. Only in susceptible cabbage cv. Bronco', shoot weight decreased with increasing severity class of the roots, the rest of the Brassica species showed no relationship between the shoot weight and severity class of the roots. Root weight increased with increasing severity class for the susceptible broccoli cv. Diplomat, Brussels sprouts cv. Jade Cross, and cabbage cvs. Klimaro and Bronco. In some cases the relationship between severity class and shoot and root weight could not be assessed because the roots were all in a single class, 0 or 3.

These data suggest that root weight that increases with shoot weight is normal for most Brassica crops, when there is little or no infection by *P. brassicae*. These results show the extent that vegetative top growth is reduced in relation to increasing severity of clubroot and under high disease pressure.

Funding for this project was provided by the Clubroot Mitigation Project of Agriculture and Agri Food Canada, and the Plant Production Systems Program of the Ontario Ministry of Agriculture, Food and Rural Affairs and University of Guelph.

Table 1. List of Brassica crops assessed for root weight range, shoot weight range, root/shoot ratio, disease severity, R^2: Root to shoot, R^2: Shoot to Severity class and R^2: Root to Severity class after infection with *P. brassicae* under high disease pressure (at site 1) at Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Crop	Cultivar	Clubroot reaction	Root weight range (g)	Shoot weight range (g)	Root to shoot ratio	Severity class range	R2: Root to shoot (*P*)	R2: Shoot to severity class (*P*)	R2: Root to severity class (*P*)
Broccoli	BC 7540	R	65-290	920-3590	0.02-0.33	0-2	**0.36 (0.02)**	0.02 (ns)	0.05 (ns)
	Diplomat	S	11-430	450-3920	0.02-0.33	1-3	**0.55 (0.00)**	0.16 (ns)	**0.40 (0.01)**
Brussels sprouts	Crispus	R	11-41	1050-4430	0.001-0.04	0	**0.38 (0.01)**	-	-
	Jade Cross	S	0.07-0.53	126-1630	0.001-0.002	3	0.10 (ns)	-	-
Cabbage	B 2819	R	100-230	1170-6040	0.03-0.15	0-2	0.01 (ns)	**-0.37(0.02)**	0.23(ns)
	Klimaro	S	60-660	90-3760	0.11-1	2-3	**0.86 (0.00)**	**-0.50 (0.00)**	**0.86 (0.00)**
	Kilaherb	R	80-160	3400-7350	0.02-0.03	0	**0.31 (0.05)**	-	-
	Bronco	S	120-550	200-4530	0.03-1.1	2-3	0.13(ns)	**-0.46 (0.00)**	0.13(ns)
Canola	45H21	R	0.30-28	4.9-210	0.05-0.18	0-2	**0.97 (0.00)**	0.13(ns)	0.14 (ns)
	7367	R	0.20-20	4-133	0.03-1.3	0	**0.75 (0.00)**	-	-
	7377	R	0.20-17	5-109	0.04-0.44	0	**0.70 (0.00)**	-	-
	5030	MS	0.08-13	3-52	0.00-1.2	0-3	**0.59 (0.00)**	0.24 (ns)	**0.84 (0.00)**
	ACS-N39	S	0.60-27	0.90-56	0.06-1.9	0-3	**0.59 (0.00)**	**-0.42 (0.00)**	0.27(ns)
	46A76	S	0.30-24	0.20-47.2	0.04-10	0-3	0.11 (ns)	**-0.40 (0.00)**	0.11 (ns)
	Westar	S	0.20-12	2.6-89	0.03-0.19	0-2	**0.92 (0.00)**	0.29 (ns)	0.17 (ns)
	Exceed	S	0.30-5.8	0.10-45	0.02-7.5	0-3	0.04 (ns)	**-0.51 (0.00)**	0.14 (ns)
Napa cabbage	Bilko	R	14-44	790-2820	0.00-0.03	0	0.08 (ns)	-	-
	Mirako	S	18-235	360-2160	0.03-2.6	3	0.30 (ns)	-	-
Pak choy	Bejo 2834	R	8-38	324-1773	0.02-0.06	0	**0.37 (0.01)**	-	-
	Mei Qing	S	15-89	117-1069	0.02-0.33	0-3	**0.33 (0.03)**	0.21 (ns)	**0.52 (0.00)**

[1] Bold letter in a column indicates significant relationship between the tested parameters.
[2] ns = no significant relationship between the tested parameters

Table 2. List of Brassica crops assessed for root weight range, shoot weight range, root/shoot ratio, disease severity, R^2: Root to shoot, R^2: Shoot to Severity class and R^2: Root to Severity class after infection with *P. brassicae* under low disease pressure (site 2) at Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Crop	Cultivar	Clubroot reaction	Root weight range (g)	Shoot weight range (g)	Root to shoot ratio	Severity class range	R2: Root to shoot (*P*)	R2: Shoot to Severity class (*P*)	R2: Root To Severity class (*P*)
Broccoli	BC 7540	R	60-200	1100-3100	0.02-0.17	0-1	**0.59 (0.00)**	0.18 (ns)	0.01 (ns)
	Diplomat	S	50-430	1110-3860	0.02-0.17	0-3	0.19 (ns)	0.12 (ns)	**0.66 (0.00)**
Brussels sprouts	Crispus	R	140-490	1300-4840	0.16-0.17	0-1	0.28 (ns)	0.03 (ns)	0.23 (ns)
	Jade Cross	S	80-650	1820-5790	0.16-0.13	0-3	**0.33 (0.04)**	0.023 (ns)	**0.35 (0.03)**
Cabbage	B 2819	MR	100-300	2000-5280	0.03-0.10	0-1	0.26 (ns)	0.15 (ns)	0.15 (ns)
	Klimaro	S	120-340	2250-6000	0.03-0.08	0-2	0.02 (ns)	0.13 (ns)	**0.56 (0.00)**
	Bronco	S	80-290	3860-9760	0.01-0.05	0-2	0.09 (ns)	**-0.40 (0.01)**	**0.42 (0.00)**
	Kilaherb	R	80-190	4120-7880	0.01-0.04	0	0.24 (ns)	-	-
Canola	45H21	R	8-47	75-460	0.06-0.21	0-2	**0.93 (0.00)**	0.00 (ns)	0.05 (ns)
	7367	R	3-27	80-310	0.04-0.10	0	**0.90 (0.00)**	-	-
	7377	R	3-47	80-460	0.04-0.10	0	**0.95 (0.00)**	-	-
	5030	MS	9-18	60-200	0.09-0.18	0	**0.85 (0.00)**	-	-
	ACS-N39	S	8-30	80-340	0.07-0.12	0	**0.88 (0.00)**	-	
	46A76	S	15-24	34-250	0.09-0.44	0	**0.74 (0.00)**	-	-
	Westar	S	6-23	90-260	0.05-0.13	0	**0.89 (0.00)**	-	-
	Exceed	S	11-23	65-230	0.09-0.22	0	**0.58 (0.00)**	-	-
Napa cabbage	Bilko	R	11-32	1170-3700	0.00-0.02	0	**0.34 (0.03)**	-	-
	Mirako	S	12-32	1300-3680	0.00-0.02	0-3	**0.38 (0.01)**	0.08 (ns)	0.10 (ns)
Pak choy	Bejo 2834	R	11-40	401-1447	0.02-0.03	0	**0.48 (0.00)**	-	-
	Mei Qing	S	9-31	521-1450	0.01-0.04	0	**0.53 (0.00)**	-	-

[1] Bold letter in a column indicates significant relationship between the tested parameters.
[2] ns = no significant relationship between the tested parameters

CROPS: Bok/Pak choi (*Brassica rapa* L. var. *communis*), cvs. Bejo 2834, Mei Qing
Broccoli (*B. oleracae* L. var. *Italia*), cvs. Emerald Jewel & Diplomat
Brussels sprouts (*B. oleracea* L. var. *gemmifera* DC.), cvs. Crispus, Jade Cross E
Napa cabbage (*B. rapa* L. spp. *pekinensis*) cvs. Bilko, Mirako
Cabbage (*B. oleracea* L. var. *capitata*) cvs. Kilaherb, Bronco, B-2819, Klimaro

PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

AUTHORS: SHARMA K[1], GOSSEN BD[2], GLUDOVACZ T[1], RICHES L[1] & MCDONALD MR[1]
[1]University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station
[2]Agriculture and Agri-Food Canada Research Centre, Saskatoon

TITLE: COMPARISON OF VARIOUS BRASSICA VEGETABLES FOR RESISTANCE AND SUSCEPTIBILITY TO CLUBROOT, 2012

MATERIALS: two pak choi cvs.: Bejo 2834 (Sakata Seed America) and Mei Qing (Stokes Seeds), two broccoli cvs.: Emerald Jewel (Sakata Seed America) and Diplomat (Stokes Seeds), two Brussels sprouts cvs.: Crispus (Syngenta) and Jade Cross E (Stokes Seeds), two napa cabbage cvs.: Bilko (Stokes Seeds) and Mirako (Bejo Seeds) , four cabbage cvs.: Kilaherb, Kilaton, Kilaxy, Tekila (Syngenta Seeds), B-2819, and Klimaro (Bejo Seeds)

METHODS: The trial was conducted at the Muck Crops Research Station, Holland Marsh, Ontario, in organic soil (pH≈6.3, organic matter≈74.7%) naturally infested with *Plasmodiophora brassicae* at high (site 1) and low (site 2) levels of inoculum. On 9 May, all cultivars were seeded into 128-cell plug trays and grown in the greenhouse. On 8 June plants were hand-transplanted into three 7.5 m rows, 55 cm apart with 30 cm in-row spacing (pak choi, broccoli and napa cabbage), or two 7.5 m rows 86 cm apart with 45 cm in-row spacing (cabbage, Brussels sprouts). A randomized complete block arrangement with four replicates per treatment was used. On 19 July (pak choi, napa cabbage), 11 (broccoli), 28 (cabbage) and 31 (Brussels sprouts) August, 20 plants from each replicate were harvested, roots were cut from the tops trimmed and weighed for marketable yield, and the roots were rated for clubroot on a scale of 0 to 3: 0 = no clubbing, 1 = <1/3 of root clubbed, 2 = 1/3 – 2/3 of roots clubbed and 3 = > 2/3 of roots clubbed. Disease severity index (DSI) was determined using the following equation:

$$DSI = \frac{\sum [(\text{class no.})(\text{no. of roots in each class})]}{(\text{total no. roots per sample})(\text{no. classes} - 1)} \times 100$$

Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1 ºC), September (14.8ºC) and October (9.7ºC), and above average for May (15.9ºC), June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: May 12.3ºC, June 18.2ºC, July 20.7ºC, August 19.5ºC, September 15.8ºC and October 8.9ºC. Monthly rainfall was below the previous long term 10 year average for May (49 mm) and June (55 mm), average for August (69 mm), and above average for July (140 mm), September (94 mm) and October (124 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm, July 81 mm, August 67 mm, September 74 mm and October 59 mm. Treatment effects were assessed using analysis of variance (PROC GLM, SAS software version 9.2, SAS Institute Inc., 2010). Means were separated using Tukey's test.

RESULTS: as presented in Table 1

CONCLUSIONS: Clubroot incidence and severity was high at site 1 (high inoculum) as compared to site 2 (low inoculum) and the yield was higher in site 2 as compared to site 1 (Table 1). Both clubroot incidence and severity was high in the susceptible cultivars in site 1. Mei Qing Choy, Diplomat, Jade Cross E, Klimaro, Bronco and Mirako had 80-100% clubroot incidence and severity. Whereas, the resistant cultivars, Bejo 2834, Crispus and Kilaherb had 0% clubroot incidence and severity, however resistant napa cabbage Bilko developed very few clubroot symptoms (DSI=30%), and BC 7540, B-2819 had intermediate resistance (DSI=30% and 43%, respectively). Significant differences in clubroot incidence and severity were found between broccoli, cabbage and napa cabbage cultivars. Weight per head was significantly higher for resistant Bejo 2834, BC 7540, Crispus, Kilaherb and Bilko cultivars compared to susceptible Mei Qing Choy, Diplomat, Jade Cross, Bronco and Mirako, respectively. With the disease reduction in site 2, marketable yield of the susceptible Mei Qing Choy, Diplomat, Jade Cross, Bronco and Mirako has substantially increased. Similarly, resistant Bejo 2834 and Kilaherb had higher marketable yield in site 2 as compared to site 1 (Table 1).

Table 1. Comparison of various Brassica cultivars for susceptibility to clubroot, grown in soil naturally infested with the clubroot pathogen under different disease pressure (site 1 and 2) at Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Crop	Cultivar	Site 1			Site 2		
		Clubroot incidence	Disease severity index	Yield (g) [2]	Clubroot incidence	Disease severity index	Yield (g)
Bok/Pak choy	Bejo 2834	0 c[1]	0 d	1506 a	0 e	0 c	1827 a
	Mei Qing	100 a	80 b	852 b	13 e	4 c	1244 b
Broccoli	BC 7540	78 b	30 c	661 a	25 d	8 c	834 a
	Diplomat	100 a	100 a	243 b	88 a	50 a	831 a
Brussels sprouts	Crispus	0 c	0 d	313 a	0 e	0 c	317 b
	Jade Cross	100 a	100 a	0 b	53 c	24 b	553 a
Cabbage	Kilaherb	0 c	0 d	3400 a	0 e	0 c	4075 a
	Klimaro	100 a	99 a	600 b	65 b	28 b	1600 b
	B-2819	98 a	43 c	600 b	15 e	5 c	1100 bc
	Bronco	100 a	98 a	676 b	65 b	26 b	4388 a
Napa Cabbage	Bilko	8 c	3 d	2101 a	3 e	2 c	2373 a
	Mirako	100 a	100 a	1439 b	24 d	10 c	2411 a

[1]Means followed by the same letter do not differ at $P < 0.05$ based on Tukey's test. For yield, mean separation was done within crop, but for CI and DSI it was run among cultivars.
[2]Yield based on sample of 20 heads.

Funding was provided by The Fresh Vegetable Growers of Ontario through the Farm Innovation Program (FIP) that is part of Growing Forward, a federal-provincial-territorial initiative. The FIP program is administered by the Agricultural Adaptation Council, and the OMAFRA University of Guelph Plant Production Systems Program.

CROP: Canola (*Brassica napus* L.), Canola (*B. rapa* L.), Ethiopian mustard (*B. carinata* L.)
PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

AUTHORS: DEORA A[1, 2], GOSSEN BD[1], MCDONALD MR[2]
[1]Agriculture and Agri Food Canada, Saskatoon,
[2]University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: COMPARISON OF CANOLA SPECIES AND CULTIVARS FOR SUSCEPTIBILITY TO *PLASMODIOPHORA BRASSICAE* PATHOTYPE 6, 2012

METHODS: The trial was conducted at the Muck Crops Research Station, Holland Marsh, Ontario, in organic soil (pH ≈ 6.7, organic matter ≈ 70%) naturally infested with *Plasmodiophora brassicae*. Twenty different Brassica lines, from three species were tested for susceptibility to clubroot. The trial was seeded on June 14, 2012 using an earth way (plate number 1002-9). There were four replications per treatment. Each replication consisted of two 3 m long rows with row-to-row distance of 40 cm, and 25 seeds/m. Treatments were arranged in a randomized complete block design. At least 25 plants from each replicate were uprooted on July, 25 2012 and clubroot severity assessed using a 0–3 scale where plants were divided into classes according to the extent of clubbing; 0 = no clubbing, 1 < 1/3 of root clubbed, 2 = 1/3 to 2/3 of roots clubbed, and 3 > 2/3 of roots clubbed. Clubroot incidence (CI) was calculated as the proportion (%) of plants showing clubroot symptoms. A disease severity index (DSI) was calculated using the following equation

$$\text{DSI} = \frac{\sum [(\text{class no.})(\text{no. plants in each class})]}{(\text{total no. plants per sample})\ (\text{no. classes} - 1)} \times 100$$

The average air temperature, soil temperature at 5cm depth and rainfall for the planted period were 22.4°C, 20.8°C and 2.0 mm, respectively for the growing period. The data were analyzed using an analysis of variance with MIXED procedure using SAS software (version 9.1). Means separation were obtained using Tukey test with $P = 0.05$ level of significance.

RESULTS: Significant differences in clubroot incidence and DSI were found among different Brassica crops (Table 1). Both of the *B. carinata* (Ethiopian mustard) lines were highly susceptible and showed 100% incidence and DSI. All of the five *B. rapa* canola lines tested were moderately to highly susceptible. Among the 13 *B. napus* canola lines, ACS-N39 was the highly susceptible line with almost 100 % incidence and DSI, three commercial lines, 45H29, 73-67 and 73-77 were highly resistant and rest of others were either moderately to highly resistant.

CONCLUSIONS: Out of 20 lines tested, 17 were identified with more than 60% DSI, which reflects that most of these lines were susceptible to pathotype 6 under high disease pressure conditions (high inoculum coupled with disease favouring weather conditions). The lines that were highly resistant to pathotype 6 were all *B. napus*.

Table 1. Clubroot incidence and severity on different Brassica crops in soil naturally infested with clubroot pathogen at the Muck Crops Research Station, Holland, Marsh, 2012.

Cultivar	Species	Source[1]	CI (%)	DSI
090863 EM	*B. carinata*, Ethiopian mustard	AAFC	100 a[2]	100 a
080816 EM	*B. carinata*, Ethiopian mustard	AAFC	100 a	100 a
ACS-N39	*B. napus*, canola	AAFC	100 a	99 a
AC Sunbeam 09-10496	*B. rapa*, canola	AAFC	100 a	92 abc
ACS-N46	*B. napus*, canola	AAFC	100 a	93 ab
TR 8 (ACS-C16)	*B. rapa*, canola	AAFC	100 a	81 a-e
AC Excel	*B. napus*, canola	AAFC	100 a	87 a-d
ACS-C29	*B. rapa*, canola	AAFC	95 ab	68 d-g
Westar	*B. napus*, canola	AAFC	94 ab	72 b-f
45H21	*B. napus*, canola	PHB	90 ab	64 d-g
Golden	*B. napus*, canola	AAFC	89 ab	48 g
11-11095 (Synergy)	*B. rapa*, canola	AAFC	90 ab	65 d-g
11-11094 (Early One)	*B. rapa*, canola	AAFC	92 ab	61 efg
RSYN1-43	*B. napus*, canola	AAFC	92 b	70 c-g
N06-937	*B. napus*, canola	AAFC	84 ab	58 fg
AC Elect	*B. napus*, canola	AAFC	93 ab	72 b-f
InVigor 5030	*B. napus*, canola	BCS	89 ab	63 efg
45H29	*B. napus*, canola	PHB	14 c	5 h
73-77	*B. napus*, canola	Monsanto	6 c	2 h
73-67	*B. napus*, canola	Monsanto	10 c	4 h

[1] AAFC-Agriculture and Agri-Food Canada, BCS- Bayer Crop Science, PHB- Pioneer Hi-Bred

[2] Values followed by the same letter under each column do not differ at $P = 0.05$ based on Tukey's Multiple Mean Comparison Test.

Funding for this project was provided by the Clubroot Mitigation Initiative of Agriculture and Agri-Food Canada.

CROP: Cabbage (*Brassica oleracea* L. var. *capitata*) cv. Golden Acres

AUTHORS: MCDONALD MR & RICHES L
Muck Crops Research Station, Dept. of Plant Agriculture, University of Guelph

TITLE: EVALUATION OF PLANT SUPPLEMENTS ON CABBAGE YIELD AND QUALITY, 2012

MATERIALS: EARTH BOOST, BLACKSTONE 20-20-20, BIOCAL, BIOFRUIT, BIOSTIX

METHODS: The trial was conducted in mineral soil near the Muck Crops Research Station, Holland Marsh, Ontario. Green cabbage cultivar Golden Acres was seeded on 7 June into 128-cell plug trays. Plants were grown in soilless mix + Earth Boost at 600 g/107 L bale of soilless mix or a standard soilless mix, plants were placed on ebb and flow benches and grown in a greenhouse. At the 3-leaf stage (29 June) foliar applications of BioFruit at 1:200 + BioStix at 1:1 followed four days later (3 July) by BioCal at 1:200 + BioStix 1:1,000 were applied to the plants grown in the Earth Boost soil. Foliar applications were applied at 125 mL/tray (to run-off) using a hand-held pump sprayer. On 26 June and 3 July a standard fertilizer treatment of 20-20-20 was applied to all treatments using a watering can. Pre-plant fertilizer treatments were: nitrogen (N), phosphorus (P) and potassium (K) at 130, 20 and 150 kg/ha respectively + N side dress at 40 kg/ha (full rate), and N-P-K at 65, 10 and 75 kg/ha + N side dress at 20 kg/ha (half rate). Fertilizer was broadcast by hand and cultivated into plots and side dress was applied on 31 July. Plants grown with EarthBoost were transplanted into plots treated with the full and half rates of N-P-K and plants grown without EarthBoost were transplanted into plots treated with the full rate of N-P-K. An unfertilized check using plants without EarthBoost was also included. Earth Boost treatments received applications of Bio-Fruit at 5 L/ha + Blackstone 20-20-20 at 2.5 kg/ha + 1:1000 BioStix on 17 July, 3 and 17 August and BioCal at 5 L/ha + 1:1000 BioStix on 30 July, 7, and 21 August. On 6 September 24 heads per replicate were harvested and assessed for yield. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained by using Fisher's Protected LSD Test at $P = 0.05$ level of significance.

RESULTS & DISCUSSION: There were no significant differences in weight per head or percent of marketable heads among the treatments, however, numerical differences suggest trends. For all of the variables measured, there were no differences between cabbage grown with the standard fertilizer and cabbage grown with the Blackstone treatment and half the rate of the standard fertilizer. Blackstone plus the full rate of granular fertilizer had the numerically highest average weight per head, while Blackstone plus the half rate or granular fertilizer had the numerically highest weight per head of the marketable heads. Cabbage grown without preplant fertilizer had numerically smaller head weights but a numerically higher percentage of marketable heads compared to the other treatments (Table 3). Split heads was the main cause of unmarketablity. Splitting in cabbage is a physiological disorder caused by rapid growth usually when there is a sudden increase in soil moisture. Cabbages grown without preplant nitrogen were slower growing and did not split as a result of extra soil moisture. They were lighter but had less splitting resulting in a higher percentage of marketable heads.

Cabbage grown with commercial standard treatments or half the rate of recommended fertilizer had more surviving plants than cabbage grown with the full rate of granular fertilizer (Table 3). Growing conditions after transplanting were not favourable; air and soil temperatures were high during the initial trial period and hand watering was required. The differences observed in plant survival may be a random occurrence.

The nitrogen (N) recommendations for cabbage are 130 (preplant) and 40 (side-dress) kg of actual N (Vegetable Production Recommendations, 2010-2011, OMAFRA Publication 363). The trial was based on two different rates of nitrogen plus Blackstone product treatments, however, nitrogen is not provided by BioFruit or BioCal treatments and therefore the trial may not have been designed to prove the benefits of these products.

CONCLUSIONS: No significant differences were found in yield or percent marketable heads among the treatments.

Table 1. Greenhouse treatment protocol for cabbage transplants grown in the greenhouse from 7 June to 3 July at Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Plug Tray Soil	Plug Tray Treatment	Foliar application[1]	
			Comb'n A[4]	Comb'n B[5]
Commercial Std	soilless mix	20-20-20 soluble fertilizer[3]	None	None
Earth Boost	soilless mix + Earth Boost at 600 g/bale	20-20-20 soluble fertilizer[3]	29 June	3 July

[1] Sprayed to run-off (125 mL/plug tray)
[2] BM1 All-purpose professional growing mix
[3] Plant Products 20-20-20 at 20 g/10 L applied with watering can 26 June and 3 July
[4] Combination A: BioFruit at 1:200 + BioStix1:1,000 at 3 leaf stage.
[5] Combination B: BioCal at 1:200 + BioStix 1:1,000 4 days after Combination A.

Table 2. Field treatment protocol for cabbage grown at Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Pre-Plant Broadcast Granular	Side Dress	Foliar applications	
			Comb'n C[1]	Comb'n D[2]
Check	none	none	none	none
Commercial Std	N-P-K pre-plant[3]	40 kg/ha N	none	none
Earth Boost	N-P-K pre-plant	40 kg/ha N	17 July, 3, 17 Aug	30 July, 7, 21 Aug
Earth Boost	½ N-P-K pre-plant[4]	20 kg/ha N	17 July, 3, 17 Aug	30 July, 7, 21 Aug

[1] BioFruit at 2 L/A + Blackstone 20-20-20 at 1 kg/A + 1:1,000 BioStix starting 2 weeks after transplant
[2] BioCal at 2 L/acre + 1:1,000 BioStix 4 days after Combination C
[3] ammonium nitrate at 130 kg N/ha, mono ammonium phosphate (MAP) at 20 kg P/ha, potassium sulphate at 150 kg K/ha
[4] ammonium nitrate at 65 kg N/ha, mono ammonium phosphate at 10 kg P/ha, potassium sulphate at 75 kg K/ha

Table 3. Yield data for cabbage, cv. Golden Acres, treated with Blackstone fertilizer combinations grown near Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment[1]	Average Wgt/Head[2] (g)	% Marketable[3]	Weight/Head of Mkb (g)	Plants/Replicate at Harvest
Blackstone + full granular	1792 ns[4]	79.9 ns	1704 ns	31.3 b[5]
Blackstone + half granular	1710	86.7	1766	34.8 a
Commercial Std	1594	87.7	1717	35.5 a
Check	1338	94.3	1434	33.3 ab

[1] Refer to Tables 2 & 3 for greenhouse and field treatment protocols.
[2] Average weight of 24 heads, untrimmed, both marketable and unmarketable
[3] Heads were unmarketable mainly due to splitting with some rot.
[4] Not significantly different at $P = 0.05$, Fisher's Protected LSD test
[5] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher's Protected LSD test.

Funding for this project was provided by Blackstone Agricultural Inc., Toronto, Ontario.

CROP: Canola (*Brassica napus* L.), cv. In Vigor 5030
PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

AUTHORS: DEORA AD[1, 2], GOSSEN BD[1], MCDONALD MR[2]
[1]Agriculture and Agri Food Canada, Saskatoon,
[2]University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: EVALUATION OF BORON FOR THE CONTROL OF CLUBROOT IN CANOLA, 2012

MATERIALS: SOLUBOR (20.5% B, $Na_2B_8O_{13} \cdot 4H_20$)

METHODS: Field trials were conducted at the Muck Crop Research Station in muck soil (pH ≈ 6.3, organic matter ≈ 70%) at sites naturally infested with *P. brassicae* pathotype 6. Canola, cv. 5030, was sown on June 05, 2012 in the first trial and September 11, 2012 in the second trial using an earth way (plate number 1002-9). Boron (SOLUBOR, 20.5% B as $Na_2B_8O_{13}4H_20$, powder, Borax Inc., Valencia, CA) was applied as a pre-emergence broadcast using a 8002 TeeJet nozzles on CO_2 operated knapsack sprayer. The rate of application was 400 mL in 10 sec or 40 mL/sec. Subsequently, B was incorporated in soil by raking. In first trial, rates of 0, 4, 8, 16 and 32 kg B/ha were assessed, while rates of 0, 16, 32, 48 and 64 kg/ha were examined in a second trial. There were four replications per treatment. Each replication consisted of four 3 m long rows with row-to-row distance of 40 cm, and 25 seeds/m. Treatments were arranged in a randomized complete block design. For first trial, 50 plants from each replicate were uprooted for clubroot severity assessment for 6 and 11 weeks on July 17, 2012 and August 21, 2012, respectively. For second trial, assessment for the disease was conducted 6 wk after sowing on October 13, 2012. Due to low temperature conditions, no disease symptoms appeared on plants in second trial, so no rating could have done. A rating scale of 0–3 was used, where plants were divided into classes according to the extent of clubbing; 0 = no clubbing, 1 < 1/3 of root clubbed, 2 = 1/3 to 2/3 of roots clubbed, and 3 > 2/3 of roots clubbed. Clubroot incidence (CI) was calculated as the proportion (%) of plants showing clubroot symptoms. A disease severity index (DSI) was calculated using the following equation

$$\text{DSI} = \frac{\sum [(\text{class no.})(\text{no. plants in each class})]}{(\text{total no. plants per sample})\ (\text{no. classes} - 1)} \times 100$$

For the first trial, phytotoxicity of B was assessed based on seedling establishment count from a 2-m length of row at 3 wk after sowing in first trial and calculated on seedling estabilishment/m^2 basis. In addition, the growth stage of 10 plants per plot was assessed at 9 wk after sowing (% plants at vegetative, flowering, or podding stage). These plants were then destructively sampled to measure plant height, and root and shoot dry weight. Pod weight and yield data was obtained at final assessment at 11 wk after sowing. For the second trial, phytotoxicity symptoms were assessed 6 wk after sowing. Fifty plants were assessed for plants with toxic symptoms (%) and weight (g). The data obtained from all the trials were analyzed using an analysis of variance with MIXED procedure using SAS software (version 9.1). Means separation were obtained using Tukey test with P= 0.05 level of significance.

The average air temperature, soil temperature at 5cm depth and rainfall for the planted period for 6 and 11 wk after sowing were 22.0°C, 20.3°C and 1.5 mm, and 21.4 °C, 20.5°C and 2.9 mm, respectively for the growing period.

RESULTS: No significant differences for seedling establishment were found among the boron rates in the first trial; however, the differences were found when higher rates were tested in second trial (Table 1).

Percent plants showing disease symptom increased and their weight decreased with increase in boron rate in second trial. Significant reduction in clubroot severity was noted by 6 wk after sowing but no suppression was noted by 11 wk after sowing in first trial (Table 2). Even at 9 weeks after sowing, clubroot levels were very high (100% incidence and severity). Plants were generally at the podding stage in all treatments, except for a few plants in the control and at the low rate of B (4 kg ha^{-1}) that were so affected by clubroot that they had not advanced beyond the vegetative stage (Table 2). In contrast, the plants in B treatments were still flowering; all of the plants in 32 kg B/ha had flowers along with pods. The height and shoot weight of canola increased as B rate increased (Table 3). However, root weight was not affected by B application (Table 3), so the root to shoot weight ratio decreased with an increase in boron rate. There was an increase in pod weight and yield of canola with increase in boron rate (Table 3).

CONCLUSIONS: Broadcast application of B above 32 kg ha^{-1} is phytotoxic to canola; however it reduced *P. brassicae*-induced prematurity of canola and the impact of the pathogen on shoot growth and yield in organic soil.

Table 1. Effect of rates of pre-plant B applied as broadcast and incorporated on seedling establishment and phytotoxicity of canola in *P. brassicae*-infested muck soil Muck Crops Research Station, Holland Marsh, Ontario, 2012.

B rate (kg/ha)	Trial 1	Trial 2		
	Seedling establishment (m^2)		Plants with toxic symptoms (%)[1]	Plant weight (g)[2]
0	24 ns[3]	33 a[4]	0 a	233 a
4	24	-	-	-
8	26	-	-	-
16	24	33 a	3 a	210 a
32	26	28 a	13 a	176 ab
48	-	28 a	40 b	138 b
64	-	23 b	94 c	68 c

[1] Assessment of 50 plants per plot. Symptoms consisted of leaf cupping and burning of edges of older leaves.
[2] Mean weight of 10 plants per plot.
[3] ns = non-significant
[4] Values followed by the same letter under each column do not differ at $P = 0.05$ based on Tukey's Multiple Mean Comparison Test.

Table 2. Effect of rates of pre-plant B applied as broadcast and incorporated on clubroot disease severity, development and yield of canola in *P. brassicae*-infested muck soil in Trial 1 Muck Crops Research Station, Holland Marsh, Ontario, 2012.

B rate (kg/ha)	DSI		Developmental stage[1]		
	6 wk	11 wk	Vegetative	Flowering	Podding
0	100 ns[2]	100 ns	11 ns	0 a[3]	88 ns
4	100	100	8	10 ab	88
8	98	100	1	30 bc	97
16	98	100	0	40 c	98
32	76	100	0	100 d	100

[1]Each value represents percent plants possessing a trait based on assessment of 10 plants per plot at 9 weeks after sowing (n = 6).
[2] ns = non-significant
[3]Values followed by the same letter under each column do not differ at P = 0.05 based on Tukey's Multiple Mean Comparison Test.

Table 3. Effect of rates of pre-plant B on root and shoot weight of canola grown in a *P. brassicae*-infested muck soil in Trial 1 Muck Crops Research Station, Holland Marsh, Ontario, 2012.

B rate (kg/ha)	Height (cm)	Root weight (g) [1]	Shoot weight (g) [1]	Root/shoot weight ratio	Pod weight (g) [2]	Yield (t/ha) [3]
0	59 a[4]	64 ab	56 a	1.17 a	211 a	0.27 a
4	52 a	61 b	61 a	1.02 ab	273 a	0.31 a
8	64 a	72 ab	80 a	0.9 b	405 a	0.56 ab
16	64 a	64 ab	77 a	0.84 bc	571 a	0.81 b
32	98 b	85 a	131 b	0.65 c	1451 b	1.88 c

[1] The values under root and shoot weight represent mean weight of 10 plants per plot at 9 weeks after sowing.
[2] Pod weight reflects weight of pods of plants harvested from 2 m row per plot.
[3] The values under yield are calculated from the seeds obtained from 2 m row per plot.
[4] Values followed by the same letter under each column do not differ at P = 0.05 based on Tukey's Multiple Mean Comparison Test.

Funding for this project was provided by the Clubroot Mitigation Initiative of Agriculture and Agri-food Canada.

CROP: Yellow cooking onions (*Allium cepa* L.) cv. LaSalle
PEST: Onion thrips, (*Thrips tabaci* Lindeman)

AUTHORS: MCDONALD M R and RICHES L
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: EVALUATION OF FOLIAR INSECTICIDES TO CONTROL ONION THRIPS ON ONIONS, 2012

MATERIALS: CONCEPT (imidacloprid 75 g/L, deltamethrin 10 g/L), DELEGATE WG 400 (spinetoram 25%), MOVENTO 240 SC (spirotetramat 240 g/L), MATADOR 120 EC (lambda-cyhalothrin 120 g/L) AGRI-MEK (abamectin 1.9%), DIBROM (naled 864 g/L), SYLGARD 309 (siloxylated polyether 76%), GOWAN 10021 (experimental)

METHODS: Onions, cv. LaSalle, were direct seeded (34 seeds/m) in muck soil (pH ≈ 7.0, organic matter ≈ 57%) using a Stanhay Precision Seeder near the Muck Crops Research Station, Holland Marsh, Ontario on 7 May. A randomized complete block arrangement with four replicates per treatment was used. Each replicate consisted of two beds each with four twin rows (40 cm apart), 10 m in length. Two 2.32 m sections of row were marked for yield samples. The first application of insecticide was applied on 20 July when thrips counts reached the threshold of one thrips per leaf. Subsequent applications were applied 30 July, 8 and 15 August. A tractor-mounted sprayer fitted with AI TeeJet® Air Induction Even Flat spray tips (AI9503 EVS) at 120 psi, delivering 500 L water/ha was used. Products, rates and abbreviations and the dates of spray applications were as shown in Tables 1 & 2 respectively. Adult and larval thrips were counted on the inside leaves of 20 randomly pulled onions per replicate on 18 and 24 July, 2 and 13 August and on 10 onions per replicate on 20 August. On the last assessment date onions were 50% lodged. On 28 September, when onions tops were dry, all onions in the two 2.33 m sections rows designated for yield were pulled and placed in storage. On 30 October onion samples were removed from storage and sorted by size to determine total and marketable yield. Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1°C), and September (14.8°C), and above average for May (15.9°C), June (20.1°C) and July (22.2°C). The long term previous 10 year average temperatures were: May 12.3°C, June 18.2°C, July 20.7°C, August 19.5°C, and September 15.8°C. Monthly rainfall was below the previous long term 10 year average for May (49 mm) and June (55 mm), average for September (75 mm), and above average for July (140 mm), and August (79 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm, July 81 mm, August 67 mm, and September 74 mm. Data were analyzed using the general analysis of variance function of the Linear Models section of Statistix V. 9. Comparison of means was done using Fisher's Protected LSD Test with $P < 0.05$.

RESULTS: as presented in Tables 2, 3 and 4.

CONCLUSIONS: Temperatures were above average in May, June and July and consequently thrips populations increased rapidly in 2012. By 13 August, thrips numbers were reduced to acceptable levels (6 to 18 thrips per plant) after two applications of MOVENTO plus SYLGARD followed by one application of either DELEGATE, CONCEPT, AGRIMEK, GOWAN, or MATADOR, or three applications of DELEGATE or MOVENTO plus SYLGARD or DIBROM, followed by MOVENTO plus SYLGARD, followed by DIBROM (Table 3).
Onions sprayed with three applications of either DELEGATE or AGRIMEK or a regime of two applications of MOVENTO plus SYLGARD followed by AGRIMEK, had significantly higher yields than onions sprayed with two applications of MATADOR followed by CONCEPT, three applications of MATADOR, SYLGARD or DIBROM or the untreated check (Table 4). MOVENTO used in combination with other insecticides in a spray program is effective for controlling thrips and may help prevent

resistance in thrips populations.

Table 1. Rates of products and key for abbreviations used in the spray program for control of thrips on onions, cv. LaSalle, grown near the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Product	Rate per ha	Abbreviations Used in Tables 2 & 3
CONCEPT OD	650 mL	CON
DELEGATE WG	336 mL	DEL
MOVENTO 240 SC	375 mL	MOV
SYLGARD 309	0.25% v/v	SYL
MATADOR 120 EC	188 mL	MAT
AGRI-MEK SC	1.0 L	AGR
DIBROM	550 mL	DIB
GOWAN 10021 (experimental)	2% v/v	GOW

Table 2. Insecticide spray program for control of thrips on onions, cv. LaSalle, grown near the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

No.	1st App 20 Jul	2nd App 30 Jul	3rd App 8 Aug	4th App 15 Aug
1	CON[1]	CON	CON	CON
2	DEL	DEL	DEL	DEL
3	MOV + SYL	MOV + SYL	MOV + SYL	MOV + SYL
4	MAT	MAT	MAT	MAT
5	AGR	AGR	AGR	AGR
6	DIB + SYL	DIB + SYL	DIB + SYL	DIB + SYL
7	SYL	SYL	SYL	SYL
8	MOV + SYL	MOV + SYL	GOW	GOW
9	MOV + SYL	MOV + SYL	AGR	AGR
10	MOV + SYL	MOV + SYL	DEL	DEL
11	MOV + SYL	MOV + SYL	CON	CON
12	MOV + SYL	MOV + SYL	MAT	MAT
13	DIB + SYL	MOV + SYL	MOV + SYL	DIB + SYL
14	---[2]	---	---	---

[1] See Table 1 for rates and the full product names referred to by these abbreviations.
[2] untreated check

Funding for this project was provided by the Bradford Co-operative & Storage Ltd. through the Holland Marsh Growers' Association and Plant Production Systems of the Ontario Ministry of Agriculture, Food and Rural Affairs and the University of Guelph partnership.

Table 3. Onion thrips counts for onions, cv. LaSalle, treated with various insecticides grown near the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

#[1]	Treatment[2]	Mean # OT/Plant					AUIPC[3]
		18 July	24 July	2 Aug	13 Aug	20 Aug	
10	MOV[4]/DEL	25.8 ns[5]	46.7 ns	12.2 a[6]	5.9 a	5.2 a	620.1 a
11	MOV/CON	20.5	38.6	6.9 a	12.1 ab	24.9 a	616.1 a
9	MOV/AGR	24.3	43.9	9.8 a	12.6 ab	22.4 a	691.7 a
8	MOV/GOW	25.3	45.6	12.1 a	14.9 ab	30.7 ab	779.8 a
12	MOV/MAT	23.6	51.5	13.7 a	15.2 ab	27.8 a	828.4 a
3	MOV	28.5	54.0	12.1 a	17.0 ab	13.7 a	812.2 a
13	DIB/MOV/DIB	24.4	52.1	50.6 b	17.3 ab	17.1 a	1185.2 abc
2	DEL	31.9	22.2	13.2 a	17.6 ab	6.4 a	575.6 a
5	AGR	22.5	37.3	22.8 a	44.3 bc	22.3 a	1051.5 ab
1	CON	20.1	49.0	60.1 b	55.6 c	24.0 a	1612.7 bcd
7	SYL	27.2	59.1	49.9 b	60.0 c	57.8 bc	1765.2 cd
4	MAT	20.2	53.0	53.1 b	69.7 c	69.1 c	1858.1 d
6	DIB	28.0	46.3	45.6 b	74.3 c	59.0 bc	1762.1 cd
14	Check	27.0	48.5	55.0 b	108.9 d	71.3 c	2225.0 d

[1] Treatment numbers refer to the spray program described in Table 2.
[2] See Table 1 for full product names referred to using these abbreviations
[3] Area under the insect pressure curve (AUIPC) = $\sum (Y_i+Y_{i+1})/2(t_{i+1}-t_i)$
[4] All MOVENTO treatments were applied with the surfactant SYLGARD 302 at 0.25% v/v
[5] ns indicates no significant differences were found among the treatments
[6] Means in a column followed by the same letter are not significantly different at *P*=0.05, Fisher's Protected LSD test.

Table 4. Yield and size distribution for onions, cv. LaSalle, treated with foliar insecticides for control of onion thrips grown near Muck Crops Research Station, Holland marsh, Ontario, 2012.

#[1]	Treatment[2]	Marketable Yield (t/ha)	Size distribution (%)		
			Large (64-76 mm)	Medium (45-64 mm)	Small (<45 mm)
2	DEL	31.5 a[2]	6.3 ns[3]	77.5 ns	16.2 ns
5	AGR	30.6 ab	11.5	71.1	17.4
9	MOV[4]/AGR	28.7 ab	9.8	75.0	15.3
8	MOV/GOW	27.5 abc	3.5	77.0	19.5
10	MOV/DEL	26.6 abc	10.6	70.3	19.0
3	MOV	25.5 a-d	8.4	71.4	20.2
1	CON	25.2 a-e	11.7	68.5	19.8
13	DIB/MOV/DIB	24.4 a-e	4.9	76.3	18.8
12	MOV/MAT	24.1 a-f	8.0	67.2	24.8
11	MOV/CON	22.9 b-f	6.9	68.3	24.8
4	MAT	20.6 c-f	5.8	71.0	23.1
7	SYL	18.3 def	2.1	68.9	29.0
14	Check	16.8 ef	5.3	69.5	25.1
6	DIB	16.2 f	2.3	63.1	34.5

[1] Treatment numbers refer to the spray program described in Table 2.
[2] See Table 1 for full product names referred to using these abbreviations
[2] Means in a column followed by the same letter are not significantly different at *P*=0.05, Fisher's Protected LSD test.
[3] ns indicates no significant differences were found among the treatments
[4] All MOVENTO treatments were applied with the surfactant SYLGARD 302 at 0.25% v/v

CROP: Yellow cooking onions (*Allium cepa* L.) cv. Pulsar
PEST: Onion maggot, (*Delia antiqua* (Meigen))

AUTHORS: MCDONALD MR[1], VANDER KOOI K[1] & TAYLOR AG[2]
[1] University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station
[2] Cornell University, Dept. of Horticultural Science, New York State Agricultural Experiment Station

TITLE: EVALUATION OF INSECTICIDES FOR CONTROL OF ONION MAGGOT ON ONIONS, 2012

MATERIALS: APRON XL LS (metalaxyl-M 33.3%), AVICTA 400 (abamectin 37%), CAPTURE 2EC (bifenthrin 25.1%), CRUISER 70 WS (thiamethoxam 70.0%), ENTRUST 80 W (spinosad 80%), FORCE 3.0 G (tefluthrin 3.0%), LORSBAN 15 G (chlorpyrifos 15%), MOVENTO 240 SC (spirotetromat 240 g/L), PENFLUFEN FS 50 (penflufen 4.81%), SEPRESTO (clothianidin 56.25% + imidacloprid 18.75%), SYLGARD 309 (siloxylated polyether 76%), TRIGARD (cyromazine 75%)

METHODS: Various insecticide seed treatments, granular insecticides and foliar sprays were evaluated on yellow cooking onions in a field trial on organic soil (pH ≈ 6.4, organic matter ≈ 74.4%) naturally infested with *Delia antiqua* pupae at the Muck Crops Research Station, Holland Marsh, Ontario. A randomized complete block design with four replicates per treatment was used. Each experimental unit consisted of 4 rows, spaced 42 cm apart, 6 m in length. All onions were seeded on 11 May using a push cone seeder for seed treatments or a V-belt seeder for granular insecticide applications. Seed treatments were: TRIGARD at 5.0 g ai/100 g of seed, SEPRESTO at 6.15 g ai/100 g of seed, ENTRUST + CRUISER at 5.13 g ai + 2.56 g ai/100 g of seed, ENTRUST and AVICTA, at 5.13 g ai/100 g of seed. FORCE at 9.4 kg/ha, CAPTURE at 11.4 L/ha, MOVENTO at 375 mL/ha + SYLGARD at 0.375% v/v, and LORSBAN at 32 kg/ha. An untreated check was also included. All seeds were also treated with APRON XL at 15 mg ai/ 100 g seed, and PENFLUFEN FS 50 at 250 mg ai/100 g seed. Seeds were treated at Cornell University by Alan Taylor. LORSBAN and FORCE were applied as granular treatments on 16 May, CAPTURE was applied as a drench and MOVENTO + SYLGARD was applied as a foliar treatment on 17 July using a CO_2 backpack sprayer equipped with four 8002VK TeeJet fan type nozzle calibrated to deliver 375 mL/ha at 240 kPa. Three random 2 m sections were staked out in each experimental unit. Germination counts were conducted on 30 May and 6 June to determine initial stands prior to the first generation assessment. Plants were examined for onion maggot (OM) or damage caused by other pests within the staked-out sections on 8, 14, 21 June and 5 July. Damaged plants were removed and the cause recorded. OM damage was assessed two weeks after the end of the first (June) and second (August) generation peaks and at onion bulb maturity (10 September). On 12 September onions from a 2.33 m section of row were harvested and on 1 November, bulbs were counted and yield determined. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained using Fisher's Protected LSD Test at $P = 0.05$ level of significance.

RESULTS: as presented in Table 1

CONCLUSIONS: Significant differences in percent onion maggot losses were observed after the first generation and in total onion maggot damage for the season (Table 1). After first generation assessments, all seed treatments and FORCE (granular) and CAPTURE (drench) treatments had significantly lower OM losses than the untreated check and standard LORSBAN treatment. At bulb maturity, total onion maggot damage was significantly lower in the TRIGARD, ENTRUST and ENTRUST + CRUISER 70 WS treatments than the FORCE and LORSBAN treatments and the untreated check. No significant differences in marketable yield were observed among the treatments.

Table 1. Evaluation of seed treatments for control of onion maggot damage in onions, grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Application Type[1]	Rate (g ai/100 g seed)	% Onion Maggot Losses		t/ha
			1st Gen	Total Season	
TRIGARD	ST	5.0	1.3 a[2]	7.0 a	80.1 ns[3]
ENTRUST + CRUISER	ST	5.13 +2.56	2.1 a	6.7 a	82.1
SEPRESTO	ST	6.15	2.3 a	7.9 ab	66.2
AVICTA	ST	5.13	3.6 a	8.5 ab	77.9
ENTRUST	ST	5.13	4.5 a	5.0 a	72.6
FORCE	G	0.38 g/m of row	5.9 a	20.0 cd	71.5
CAPTURE	D	0.46 mL/m of row	6.5 a	9.6 abc	82.5
MOVENTO + SYLGARD	F	375 ml/ha	11.9 ab	12.7 abc	64.6
LORSBAN	G	32 kg/ha	20.3 bc	18.8 bcd	59.4
Check		--	24.5 c	25.4 d	65.5

[1] ST = Seed treatment, G = granular application, D = drench application, F = foliar spray.
[2] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher's Protected LSD test.
[3] ns = no significant differences

Funding was provided by the Holland Marsh Growers' Association through the Bradford Cooperative and Storage Ltd., and the California Onion and Garlic Research Advisory Board. The New York State Agricultural Experiment Station, Cornell University provided support for seed treatment application of new chemistry seed treatments. Any opinions, findings, conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of Cornell University or those of Rutgers, State University of New Jersey.

CROP: Yellow cooking onions (*Allium cepa L.*), cv. Tahoe
PESTS: Onion maggot (*Delia antiqua* (Meigen))

AUTHORS: MCDONALD MR & RICHES L
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: EVALUATION OF SPINOSAD BAIT FOR CONTROL OF ONION MAGGOT ON ONIONS, 2012

MATERIALS: SPINOSAD BAIT (spinosad 0.07%), LORSBAN 15 G (chlorpyrifos 15%)

METHODS: The trial was conducted on organic soil (pH ≈ 6.2, organic matter ≈ 76.9%) naturally infested with *Delia antiqua* pupae at the Muck Crops Research Station, Holland Marsh, Ontario. A randomized complete block design with four replicates per treatment was used. Each experimental unit consisted of 8 rows, spaced 42 cm apart and 5 m in length. On 2 May, onions, cv. Tahoe, were direct seeded (34 seed/m) on 2 May using a Stanhay Precision Seeder. Treatments were SPINOSAD BAIT at 22.4 and 49.3 kg/ha and LORSBAN 15 G at 32 kg/ha. An untreated check was also included. The LORSBAN 15 G was applied in-furrow at seeding and bait was applied by broadcasting by hand on 4 June (1st generation emergence), 13 July (five weeks after 1st application) and 7 August (after 2nd generation emergence). Three random 2 m sections were staked out in each experimental unit. Germination counts were conducted on 24 May to determine initial stands prior to the first generation assessment. Plants were examined for onion maggot (OM) or damage caused by other pests within the staked-out sections weekly. Damaged plants were removed and the cause recorded. OM damage was recorded two weeks after the end of the first (25 June) and second (15 August) generation peaks and at onion bulb maturity (11 September). On 31 August, all onions in a 2.32 m section of row were pulled and on 2 November, bulbs were counted and weighed to determine yield. Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1ºC), September (14.8ºC) and October (9.7ºC), and above average for May (15.9ºC), June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: May 12.3ºC, June 18.2ºC, July 20.7ºC, August 19.5ºC, September 15.8ºC and October 8.9ºC. Monthly rainfall was below the previous long term 10 year average for May (49 mm) and June (55 mm), average for August (69 mm), and above average for July (140 mm), September (94 mm) and October (124 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm, July 81 mm, August 67 mm, September 74 mm and October 59 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained using Fisher's Protected LSD Test at $P = 0.05$ level of significance.

RESULTS: Significant differences in the percent onion maggot losses were found at 1st and 2nd generation and at the total season assessments (Table 1). After the 1st and 2nd generation emergence and over the total season, onions treated with LORSBAN 15 G granular in-furrow at seeding had fewer onion maggot losses than onions treated with SPINOSAD BAIT and the check. However, when OM losses were assessed over the total season, onions treated with SPINOSAD BAIT at 49.3 kg/ha had significantly fewer losses than onions treated with SPINOSAD BAIT at 22.4 kg/ha and the check.
No significant differences in total yield (t/ha) were found among the treatments. Onions treated with LORSBAN had a smaller weight per bulb than other treatments and the check. LORSBAN treated onions had higher plant stands which resulted in smaller weights per bulb (Table 1).

CONCLUSIONS: Over the total season, three applications of SPINOSAD BAIT at 49 kg/ha reduced onion maggot losses compared to the untreated check. In future trials, adjusting the timing of the first bait application and the intervals between reapplications may improve efficacy.

Table 1. Percent onion maggot (OM) losses to onions, cv. Tahoe, treated with SPINOSAD BAIT, grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Rate (kg/ha)	% Onion Maggot Losses			Wgt/bulb (g)	Total Yield (t/ha)
		1st Gen	2nd Gen	Total Season		
LORSBAN	32.0	13.7 a[1]	20.3 a	11.1 a	122.9 a	64.0 ns[2]
SPINOSAD BAIT[3]	49.3	29.2 b	48.5 b	33.1 b	164.4 b	40.7
SPINOSAD BAIT	22.4	40.4 b	49.3 b	54.2 c	164.2 b	40.3
Check	--	30.4 b	42.5 b	60.6 c	164.4 b	41.2

[1] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher's Protected LSD test.
[2] ns = no significant differences were found among the treatments
[3] SPINOSAD BAIT was applied 3 times: 1st Gen OM emergence (4 June), 5 weeks following 1st app (13 July), at 2nd Generation OM peak (7 August).

Funding for this project was provided by W. Neudorff GrnbH, Emmerthal, Germany

CROP: Onion (*Allium cepa* L.) cv. Pulsar
PEST: Rhizoctonia seed rot, damping off and blight, *Rhizoctonia solani*

AUTHORS: MCDONALD MR & RICHES L
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: EFFICACY AND TOLERANCE OF EVERGOL PRIME FOR THE CONTROL OF RHIZOCTONIA ON ONIONS, 2012

MATERIALS: EVERGOL PRIME (penflufen 240 g ai/L), PRO-GRO (thiram 50%, carboxin 30%)

METHODS: The trial was conducted on mineral soil (organic matter ≈ 4.0%, pH ≈ 8.0) near the Muck Crops Research Station, Holland Marsh, Ontario. On 16 May, colonized and sterile barley grains were spread in trenches 5 cm deep adjacent to planned seeding rows at the rate of 50 mL/m, tamped and covered with a rake. To produce inoculum *Rhizoctonia solani* was isolated from beet samples grown in the Holland Marsh in 2011 and grown on PDA amended with streptomycin sulphate. Six, seven-day old 5 mm diameter mycelia-agar discs were transferred from the margin of growing colonies to sterilized barley grains and kept at 22°C in darkness for 21 days. Barley grains were sterilized by soaking for 12 hours in 400 mL of water in a 1000 mL Erlenmeyer flask, water was decanted and the grain was autoclaved twice on consecutive days for 20 minutes at 121°C. The colonized grain was air dried for 24 hours before spreading. On 23 and 25 May (7 and 9 DAI) inoculated rows were hand-watered using watering cans to add moisture to the soil. A randomized complete block arrangement with four replicates per treatment was used. Each experimental unit consisted of exactly 100 seeds (with the exception of one replication of untreated non-inoculated which used 86 seeds) seeded into one row, 3 m long, (42 cm apart), with in-row spacing of 3.5 cm. On 28 May, seed treatments for onions, cv. Pulsar, were hand-seeded using a peg board with pegs spaced 3.5 cm apart to mark seeding holes. Treatments were: EVERGOL PRIME at 1.3, 1.8 and 2.5 g ai/kg seed and PRO-GRO at 20 g ai/kg of seed. Untreated non-inoculated and inoculated checks were also included. All seeds were treated with Sepresto 75 WS (insecticide) at 8 g ai/kg of seed and Allegiance FL at 15.5 g ai/kg of seed. Treated seed was provided by Bayer Crop Science. On 13, 21 and 28 June and 5 and 12 July (16, 24, 31, 38 and 45 DAS) emerged plants were counted and numbers recorded. Percent emerged was calculated using the following equation:

$$\% \text{ emergence} = \frac{\text{no. of emerged plants}}{\text{no. of seeds used}} \times 100$$

On 5 July, after the count of emerged plants, all onions dead from heat canker were counted and removed. The percent emerged for 12 July was calculated on the number seeded minus the number of heat canker losses. Compared to the averaged previous 10 years, the air temperatures in 2012 were above average for May (15.9ºC), June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: May 12.3ºC, June 18.2ºC and July 20.7ºC. Monthly rainfall was below the previous long term 10 year average for May (49 mm) and June (55 mm) and above average for July (140 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm and July 81 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained by using Tukey's test at $P = 0.05$ level of significance.

RESULTS: Percent seedling emergence was similar among the treated seed treatments on all dates and ranged from 70 to 76%. When percent emergence for treatments on inoculated plots is analysed separately, (i.e. the untreated non-inoculated treatment is omitted), no significant difference is found among the treatments (Table 2). A significant difference in percent emergence was found between untreated seeds on inoculated and non-inoculated plots (Table 1). On 21, 28 June and 5 July the percentage of plants emerged from untreated seeds in the inoculated plots was significantly higher than in the non-inoculated plots.

DISCUSSION: The tested germination rate (% germ) for the onion seeds used in the trial before the seed treatments were applied is unknown and therefore cannot be compared to percent emergence of seeds treated with EVERGOL and PRO-GRO which ranged from 72 to 75% and might be considered low for commercial onion seeds.

Untreated seeds in inoculated plots had a higher rate of emergence compared to untreated seeds in non-inoculated plots and the cause for this cannot be determined with certainty. Many pathogenic fungi are present in soil and the trial did not investigate which pathogen caused the death of germinating seeds resulting in the lower percent emergence. *Rhizoctonia solani* in the inoculated plots may have excluded naturally occurring pathogenic soil fungi thus decreasing death of the germinating seeds compared to non-inoculated plots containing native pathogenic fungi. Opening a furrow and adding barley inoculum may have altered the soil structure and improved germination in the inoculated plots compared to the non-inoculated plots.

The effectiveness of the inoculation method was not determined. Plots were inoculated 12 days before seeding in order to allow time for the fungi to become established in the soil before seeding. After inoculation on 16 May, 16 days passed before the occurrence of the first significant rainfall. To compensate for the lack of rainfall, plots were hand watered 7 and 9 days after inoculation but this may not have been sufficient to encourage mycelia growth.

Table 1. Percent emergence for onions seeds treated with fungicides and grown in plots inoculated and not inoculated with *Rhizoctonia solani* near Muck Crop Research Station, Holland Marsh, Ontario, 2012.

Treatment[1]	Rate (gai/kg seed)	% Emergence[2]				
		13 Jun	21 Jun	28 Jun	5 Jul	12 Jul
EVERGOL PRIME	2.5	71.8 ab[3]	76.0 a	74.8 a	74.0 a	70.5 a
EVERGOL PRIME	1.8	76.5 a	74.0 a	74.3 a	72.3 a	72.0 a
EVERGOL PRIME	1.3	74.0 a	75.5 a	74.3 a	73.3 a	72.0 a
PRO-GRO	20	75.8 a	75.0 a	74.3 a	74.5 a	72.0 a
Untreated inoc	--	67.8 ab	70.8 a	70.8 a	69.3 a	67.0 ab
Untreated non-inoc	--	58.4 b	53.6 b	49.8 b	49.3 b	47.8 b

[1] All seed treatments include Sepresto WS 75 (insecticide) at 80 g ai/kg of seed and Allegiance FL at 15.5 g ai/kg seed.
[2] Percent emergence calculated using the number of seeds per experimental unit
[3] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Tukey's HSD.

Table 2. Percent emergence for onion seeds treated with fungicides and grown in plots inoculated with *Rhizoctonia solani* near Muck Crop Research Station, Holland Marsh, Ontario, 2012.

Treatment[1]	Rate (gai/kg seed)	% Emergence[2, 3]				
		13 Jun	21 Jun	28 Jun	5 Jul	12 Jul
EVERGOL PRIME	2.5	71.8 ns[4]	76.0 ns	74.8 ns	74.0 ns	70.5 ns
EVERGOL PRIME	1.8	76.5	74.0	74.3	72.3	72.0
EVERGOL PRIME	1.3	74.0	75.5	74.3	73.3	72.0
PRO-GRO	20	75.8	75.0	74.3	74.5	72.0
Untreated inoc	--	67.8	70.8	70.8	69.3	67.0

[1] All seed treatments include Sepresto WS 75 (insecticide) at 80 g ai/kg of seed and Allegiance FL at 15.5 g ai/kg seed.
[2] Percent emergence calculated using the following equation:

$$\% \text{ emergence} = \frac{\text{no. of emerged plants}}{\text{no. of seeds used}} \times 100$$

[3] Statistical analysis of treatments in inoculated plots only
[4] ns = not significantly different, $P = 0.05$, Tukey's HSD

Funding for this project was provided by Agriculture and Agri-food Canada.

CROP: Yellow cooking onions (*Allium cepa* L.), cv. Countach
PEST: Onion smut (*Urocystis colchici* var. *cepulae* Cooke)

AUTHORS: MCDONALD M R[1], VANDER KOOI K[1] & TAYLOR A G[2]
[1] University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station
[2] Cornell University, Dept. of Horticultural Science, New York State Agricultural Experiment Station

TITLE: EVALUATION OF FUNGICIDE SEED TREATMENTS FOR CONTROL OF ONION SMUT ON ONIONS, 2012

MATERIALS: ALLLEGIANCE (metalaxyl 28.4%), RANCONA (ipconazole 41%), DITHANE (mancozeb 75%), PRO-GRO (thiram 50%, carboxin 30%), SEPRESTO (clothianidin 56.25%, imidacloprid 18.75%), PENFLUFEN FS 50 (penflufen 4.81%)

METHODS: Seed treatments for yellow cooking onions, cv. Countach, were evaluated in a field trial on organic soil (pH ≈ 5.8, organic matter ≈ 78.6%) naturally infested with *Urocystis colchici* at the Muck Crops Research Station, Holland Marsh, Ontario. Treatments were the following chemicals used alone and in combination: DITHANE at 8.8 kg/ha, PRO-GRO at 0.5, 1.0 and 2.0 g ai/100 g seed, RANCONA at 100, 50 mg ai/100 g seed and PENFLUFEN at 250 mg ai/100g seed. An untreated check was also included. DITHANE was applied using a push V-belt seeder at a rate of 0.35 g/m. All seeds were treated with SEPRESTO (insecticide) at 6.57 g ai/100 g seed. Seeds were treated at Cornell University by Al Taylor. Treatments were replicated four times in a randomized complete block design. Each experimental unit consisted of four rows (42 cm apart), 5 m in length. All seed treatments were seeded on 7 May using a push-cone seeder. Three random 2 m sections were staked out, and germination counts were conducted on 31 May to determine initial stands prior to the first assessment. Plants were examined for onion smut (OS) or damage caused by other pests within the staked-out sections on a weekly basis throughout June and July. Damaged plants were rogued out and the cause recorded. At one (12 June), and three (25 June) true leaf stage, one of the 2 m sections was harvested and bulbs and leaves were visually evaluated for OS. On 20 September a 2.33 m section was harvested and on 17 November the bulbs were removed from storage, counted, and weighed to determine yield. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained by using Fisher's Protected LSD test at $P = 0.05$ level of significance.

RESULTS: as presented in Table 1

CONCLUSIONS: Significant differences were found in percent onion smut at the 1st and 3rd leaf stages (Table 1). At the 1st leaf stage, RANCONA at any rate alone or in combination with PENFLUFEN or PRO-GRO had lower OS losses than all other treatments. At the 3rd leaf stage, onions grown from seeds treated with PENFLUFEN or RANCONA+PENFLUFEN had significantly fewer OS losses than onions grown using PRO-GRO alone or the untreated check.
The addition of PRO-GRO to RANCONA as a seed treatment did not improve OS control and this may indicate that PRO-GRO interferes with RANCONA.
Significant differences were found among the treatments in weight per bulb and tonnes/ha. Treatments with high losses from smut (>20%) in the 1st and 3rd leaf had lower yields and higher weight/bulb. As the stand in thinned onions tend to have more room to grow resulting in larger onions. Onions treated with PENFLUFEN or PENFLUFEN+RANCONA had significantly higher yields than the PRO-GRO+DITHANE and PRO-GRO alone treatment.

Table 1. Percent onion smut (OS) for onions, cv. Countach, grown from seeds treated with various fungicides at Muck Crops Research Station, Holland Marsh, Ontario, 2012

Treatment	Rate (mg ai/100 g of seed)	% OS Losses within 2 m sections		Yield	
		1st Leaf	3rd Leaf	Wgt/Bulb (g)	t/ha
RANCONA + PENFLUFEN[1]	100 + 250	3.7 a[2]	2.6 a	113 d	70.2 ab
PENFLUFEN	250	2.6 a	5.1 a	113 d	77.6 a
RANCONA + PRO-GRO	100 + 500	5.2 a	9.1 ab	108 d	65.5 abc
RANCONA + PRO-GRO	100 + 1,000	1.2 a	9.0 ab	116 cd	56.8 bcd
RANCONA	50	4.8 a	10.0 ab	133 bcd	65.8 abc
RANCONA	100	4.8 a	15.3 abc	130 bcd	51.5 bcd
PRO-GRO + DITHANE	2,000 + 8.8 kg/ha	30.3 b	20.9 cd	144 abc	42.8 d
DITHANE	8.8 kg/ha	48.2 c	25.9 cd	162 a	58.0 a-d
PRO-GRO	2,000	37.4 bc	28.3 d	145 ab	47.9 cd
Check		35.1 bc	30.4 d	150 ab	60.5 a-d

[1] All treatments also include Allegiance + Sepresto at 30 mg ai/100 g of seed + 6.57 g ai/ 100 g of seed, respectively.
[2] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher's protected LSD Test.

Funding for this project was supplied by Chemtura and the OMAFRA/University of Guelph Sustainable Production Systems Program. The New York State Agricultural Experiment Station, Cornell University provided support for seed treatment application of new chemistry seed treatments. Any opinions, findings, conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of Cornell University or those of Rutgers, State University of New Jersey.

CROP: Onion (*Allium cepa* L.) cv. Pulsar
PEST: Onion smut (*Urocystis colchici* var. *cepulae* Cooke)

AUTHORS: MCDONALD MR & RICHES L
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: EFFICACY AND TOLERANCE OF EVERGOL PRIME FOR THE CONTROL OF ONION SMUT IN ONIONS, 2012

MATERIALS: EVERGOL PRIME (penflufen 240 g ai/L), PRO-GRO (thiram 50%, carboxin 30%)

METHODS: The trial was conducted on organic soil (organic matter ≈ 77.8%, pH ≈ 5.9) at the Muck Crops Research Station, Holland Marsh, Ontario. Treatments were: EVERGOL PRIME at 1.3 and 2.5 g ai/kg of seed and PRO-GRO at 20 g ai/kg of seed. An untreated check was also included. All seeds were treated with Sepresto 75 WS (insecticide) at 8 g ai/kg of seed and Allegiance FL at 15.5 g ai/kg of seed. Treated seeds were provided by Bayer Crop Science. Each experimental unit consisted of four rows, spaced 42 cm apart, 6 m long. All seed treatments were seeded on 11 May using a push V-belt seeder at the rate of 36 seeds/m. Three randomly chosen 2 m sections, one section for each assessment date, were staked out in each replication when onions were in the flag stage. Germination counts were conducted on 31 May to determine initial stands prior to the first assessment. Plants were examined for onion smut (OS) or damage caused by other pests within the staked-out sections. Damaged plants were removed and the cause recorded. At three (14 June) and five (10 July) true leaves, all onions in the assigned 2 m sections were pulled and visually examined for OS. The remaining 2 m section was evaluated throughout the season in the same manner until plants reached maturity (19 September) to assess OS losses for the total season. On 20 September, onions in a 2.32 m section of row per replicate were harvested and on 1 November the bulbs were removed from storage, sorted into size categories, counted and weighed to determine yield. Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1ºC) and September (14.8ºC) and above average for May (15.9ºC), June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: May 12.3ºC, June 18.2ºC, July 20.7ºC, August 19.5ºC and September 15.8ºC. Monthly rainfall was below the previous long term 10 year average for May (49 mm) and June (55 mm), average for August (69 mm), and above average for July (140 mm) and September (94 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm, July 81 mm, August 67 mm and September 74 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained using Tukey's HSD at $P = 0.05$ level of significance.

RESULTS: as presented in Tables 1 and 2

DISCUSSION: Significant differences in OS incidence at all stages of growth were found among the treatments (Table 1). At the 1st true leaf stage, onions grown from seeds treated with EVERGOL at 1.3 g ai/kg of seed had significantly less OS than onions grown from the untreated check. There were no significant differences in OS at the 1st true leaf stage among onions grown from seeds treated with EVERGOL at 2.5 g ai/kg of seed, PRO-GRO or untreated seeds. The 1st true leaf stage assessment includes smut found in the flag leaf which will eventually detach from the plant as growth progresses.
At the 3rd leaf stage, significantly less OS was found in onions grown from seeds treated with either rate of EVERGOL compared to the untreated check. At the 3rd leaf stage all OS found is in the onion bulb and will result in an unmarketable onion.
At bulb maturity, significantly less OS (≈5%) was found in onions grown from seeds treated with either rate of EVERGOL compared to onions grown from seeds treated with PRO-GRO at 20 g ai/kg of seeds or the untreated check (20 and 21% OS respectively).

No significant differences in yield or size distribution were found among the treatments (Table 2). No phytotoxicity was observed in the trial.

CONCLUSIONS: EVERGOL seed treatments at 1.3 and 2.5 g ai/kg of seeds reduced the incidence of onion smut over the total season and caused no injury to the plants.

Table 1. Onion smut (OS) losses for onions, cv. Pulsar, grown from seeds treated with fungicides and grown at Muck Crop Research Station, Holland Marsh, Ontario, 2012.

Treatment[1]	Rate (g ai/kg seed)	% OS Incidence within assigned 2 m section		
		1st Leaf	3rd Leaf	Maturity[2]
EVERGOL	2.5	3.7 ab[3]	7.0 a	5.4 a
EVERGOL	1.3	2.1 a	7.1 a	4.5 a
PRO-GRO	20	10.1 ab	24.8 ab	20.3 b
check	--	15.3 b	35.4 b	21.4 b

[1] All seed treatments include Sepresto WS 75 (insecticide) at 80 g ai/kg of seed and Allegiance FL at 15.5 g ai/kg seed.
[2] OS incidence at maturity is an assessment of losses over the total season.
[3] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Tukey's HSD test.

Table 2. Yield for onions, cv. Pulsar, grown from seeds treated with fungicides and grown at Muck Crop Research Station, Holland Marsh, Ontario, 2012.

Treatment[1]	Rate (g ai/kg seed)	% Marketable	Size Distribution (%)			Mkb Yield (t/ha)
			Jumbo (>76 mm)	Can. No. 1 (45-76 mm)	Cull (<4.5 mm)	
EVERGOL	2.5	97.9 ns[3]	48.0 ns[2]	50.0 ns	2.0 ns	72.9 ns
EVERGOL	1.3	97.7	47.2	50.6	2.3	67.7
PRO-GRO	20	96.8	55.9	41.0	3.2	60.0
check	--	97.9	68.3	29.7	2.0	54.2

[1] All seed treatments include Sepresto WS 75 (insecticide) at 80 g ai/kg of seed and Allegiance FL at 15.5 g ai/kg seed.
[2] ns = not significantly different, $P = 0.05$

Funding for this project was provided by Agriculture and Agri-food Canada.

CROP: Yellow cooking onions (*Allium cepa* L.), cv. Patterson
PEST: *Stemphylium vesicarium* (Wallr.)

AUTHORS: TESFAENDRIAS MT and MCDONALD MR
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: EVALUATION OF FUNGICIDES FOR CONTROL OF STEMPHYLIUM LEAF BLIGHT ON ONIONS, 2012

MATERIALS: PRISTINE (pyraclostrobin 25.2%, boscalid 12.8%), BRAVO 500 (chlorothalonil 50%), MANZATE 750 F (mancozeb 75%), SWITCH 62.5 WG (cyprodinil 37.5%, fluodioxinil 25.0%), FONTELIS 20 SC (penthiopyrad 20%), INSPIRE (difenoconzole 23.2%), LUNA TRANQUILITY (fluopyram 11.3%, pyrimethanil 33.8%), QUADRIS TOP (azoxystrobin 18.2%, difenoconazole 11.4%)

METHODS: Onions, cv. Patterson, were direct seeded (34 seeds/m) using a Stanhay Precision Seeder on 11 May into organic soil (organic matter ≈ 58%, pH ≈ 7.2) near the Muck Crops Research Station, Holland Marsh, Ontario. A randomized complete block arrangement with four replicates per treatment was used. Each experimental unit consisted of four rows, 42 cm apart, 5 m in length. Recommended control procedures for weeds and insects were followed. Treatments were: PRISTINE at 1.3 kg/ha, BRAVO 500 at 4.8 kg/ha, MANZATE 750 F at 3.25 kg/ha, SWITCH 62.5 WG at 975 g/ha, FONTELIS 20 SC at 1.4 L/ha, INSPIRE at 512 mL/ha, QUADRIS TOP at 1 L/ha and LUNA TRANQUILITY at 1.2 L/ha. An untreated check was also included. Treatments were applied on 12, 20 and 27 July, and 7 and 17 August using a CO_2 backpack sprayer equipped with four TeeJet 8002 VS fan nozzles spaced 40 cm apart and calibrated to deliver 400 L/ha at 240 kPa (boom). Experimental plots were assessed on 20 and 27 July, 7 and 17 August, and rated for stemphylium leaf blight using a 0-9 scale, where: 0 = 0%, 1 < 2%, 2 = 2-4%, 3 = 5-9%, 4 = 10-24%, 5 = 25-40 %, 6 = 41-55%, 7 = 56-70%, 8 = 71-85% and 9 > 85% foliar area diseased per plot. These values were used to calculate area under the disease progress curve (AUDPC) using the following equation:

$$\text{AUDPC} = \sum_{j=1}^{Nj-1} \left(\frac{y_j + y_{j+1}}{2}\right)\left(t_{j+1} - t_j\right)$$

Where j is the order index for the times and n_j is the total number of assessments, y_j is the rating for foliar area diseased per plot at day t_j, y_{j+1} is the rating for foliar area diseased per plot at day t_{j+1} and (t_{j+1} - t_j) is the number of days between two assessments.

On 20 August, ten plants from each replicate were pulled and assessed for percent of foliage infected. On 2 October, onions in two 2.32 m sections of row from each replicate were pulled for a yield sample. The onions were weighed and graded for size on 25 October.

Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1ºC) and September (14.8ºC), and above average for May (15.9ºC), June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: May 12.3ºC, June 18.2ºC, July 20.7ºC, August 19.5ºC and September 15.8ºC. Monthly rainfall was below the previous long term 10 year average for May (49 mm) and June (55 mm), average for August (69 mm), and above average for July (140 mm) and September (94 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm, July 81 mm, August 67 mm and September 74 mm. Data were analysed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained using Fisher's Protected LSD test with $P = 0.05$ level of significance.

RESULTS: as presented in Tables 1 and 2

CONCLUSIONS: In 2012, disease pressure was moderate. Stemphylium leaf blight started to develop in mid to late June in the Holland Marsh. Significant differences in stemphylium leaf blight severity were found among the treatments. All of the fungicides reduced disease compared to the untreated check. QUADRIS TOP, LUNA TRANQUILITY, INSPIRE and FONTELIS were the most effective in reducing stemphylium leaf blight with 12, 12.8, 16.8 and 18.9% foliage with symptoms respectively, as compared to 33% in the untreated check (Table 1). Significant differences among the treatments in disease severity and area under the disease progress curve (AUDPC) were observed. The AUDPC was significantly lower in QUADRIS TOP treated plots than all other treatments (Table 1). No differences in marketable yield or size distribution were found among the treatments (Table 2). However, reduced marketable yield was correlated ($r = -0.5$; $P = 0.002$) with percent total leaf length with stemphylium leaf blight symptoms. The percent of small onions (culls) also increased ($r = 0.39$; $P = 0.02$) with an increase in leaf length with disease symptoms. This indicates that fungicides which are registered for onion diseases can reduce stemphylium leaf blight and registration of the new materials can improve control. Incorporating the most effective fungicides into the integrated management of stemphylium leaf blight can reduce disease incidence and severity. All the products tested were non-phytotoxic to the crop.

Funding for this project was provided by the Holland Marsh Growers' Association through the support of the Bradford Co-operative Storage Ltd and by the Plant Production Systems of the OMAFRA/University of Guelph Partnership.

Table 1. Disease ratings for stemphyllium leaf blight symptoms of onions, cv. Patterson, treated with various fungicides, grown near the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

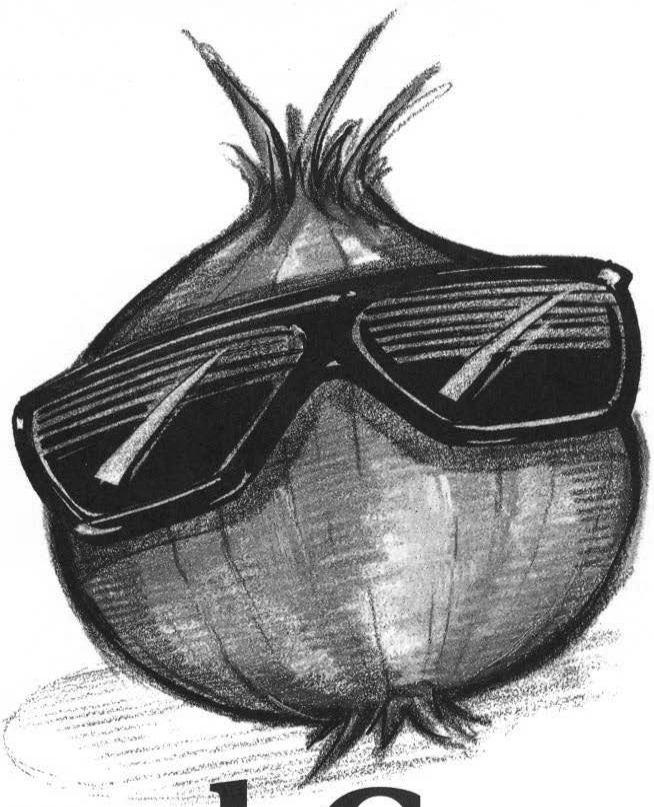
Treatment	Rate (per ha)	% foliage with Symptoms	Plot Rating[1]			AUDPC[2]
			July 27	Aug 7	Aug 17	
QUADRIS TOP	1.0 L	12.0 a[3]	1.0 a	1.8 a	2.3 a	43.5 a
LUNA TRANQUILITY	1.2 L	12.8 ab	1.5 ab	2.3 abc	2.8 ab	57.1 bc
INSPIRE	512 mL	16.8 abc	1.8 ab	2.8 bcd	3.8 cd	70.8 cd
FONTELIS	1.4 L	18.9 bcd	1.5 ab	2.0 ab	3.3 bc	56.9 bc
PRISTINE	1.3 kg	19.8 cd	1.5 ab	2.5 abc	4.0 cde	67.0 cd
MANZATE	3.25 kg	20.1 cd	2.0 b	2.8 bcd	4.8 e	78.3 de
SWITCH	975 g	23.1 d	2.0 b	3.0 cd	4.3 de	78.5 de
BRAVO	4.8 kg	23.4 d	1.5 ab	2.5 bcd	3.8 cd	65.8 cd
Check	--	33.0 e	2.0 b	3.5 d	6.3 f	94.0 e

[1]Disease rating using a 0-9 scale, where: 0 = 0%, 1 < 2%, 2 = 2-4%, 3 = 5-9%, 4 = 10-24%, 5 = 25-40 %, 6 = 41-55%, 7 = 56-70%, 8 = 71-85% and 9 > 85% foliar area diseased per plot.
[2]AUDPC = area under the disease progress curve.
[3] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher's Protected LSD test.

Table 2. Comparison of marketable yield and size distribution of onions, cv. Patterson, treated with various fungicides grown near the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Rate (per ha)	Marketable Yield (t/ha)	Size Distribution			
			% Jumbo (> 76 mm)	% Large (64 - 76 mm)	% Medium (45 - 64 mm)	% Cull (< 45 mm)
QUADRIS TOP	1.0 L	56.5 ns[1]	0.04 ns[1]	12.4 ns	75.7 ns	11.7 ns
LUNA TRANQUILITY	1.2 L	31.9	0.10	13.9	70.0	15.4
PRISTINE	1.3 kg	50.0	0.00	13.7	73.8	12.6
BRAVO	4.8 kg	49.1	0.03	9.2	78.3	12.2
MANZATE	3.25 kg	48.7	0.00	10.6	73.7	15.7
SWITCH	975 g	48.7	0.00	8.6	75.2	16.2
FONTELIS	1.4 L	47.9	0.00	13.6	69.6	16.8
INSPIRE	512 mL	46.8	0.03	10.6	71.9	17.2
Check	--	40.7	0.00	4.0	76.4	19.6

[1] not significantly different at $P = 0.05$, Fisher's Protected LSD test



MarshGrown

Cooks!

CROP: Onion (*Allium cepa*.), cv. Patterson
PEST: Onion downy mildew (*Peronospora destructor*)

AUTHORS: MCDONALD MR & RICHES L
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: EVALUATION OF PRESIDIO FUNGICIDE FOR CONTROL OF DOWNY MILDEW ON DRY BULB ONIONS, 2012

MATERIALS: DPX-QGU42 OD (DPX-QGU42 100 g ai/L), PRESIDIO (fluopicolide 478 g ai/L), REASON 500SC (fenamidone 500 g ai/L)

METHODS: Onions, cv. Patterson, were direct seeded (≈ 34 seeds/m) on 7 May using a Stanhay Precision Seeder into organic soil (organic matter ≈ 56.6%, pH ≈ 7.3) near the Muck Crops Research Station, Holland Marsh, Ontario. A randomized complete block arrangement with four replicates per treatment was used. Each replicate consisted of eight rows (42 cm apart), 5 m in length. Treatments were applied using a tractor mounted pull-type sprayer fitted with AI TeeJet Air Induction Even Flat spray tips (AI9503 EVS) at 120 psi calibrated to deliver 400 L/ha of water. The treatments were: PRESIDIO SC at 220, and 292 mL/ha, REASON 500 SC at 400 mL/ha, PRESIDIO SC + REASON 500 SC (tank mix) at 292 and 400 mL/ha respectively and DPX-QGU 42 OD at 250 mL/ha applied three times on 30 July, 15 and 23 August. A fourth application could not be applied as onions were lodged by the proposed date (23 August). An untreated check was also included. On 31 July, 17 and 24 August, onion leaves in 2, 1 m sections of row per replicate were visually examined for DM lesions and numbers recorded. Before the first treatment application (27 July) and following applications on 31 July, 16 and 27 August plots were rated for phytotoxicity on a scale of 0 to 5 where 0 = no injury, 1 = slight yellowing, 2 = some tissue death, 3 = over 50% plant tissue brown, 4 = >75% dead tissue, 5 = plant necrosis On 1 October, all onions in two, 2.33 sections of row per replicate were pulled, topped and placed in storage. On 12 November onions were removed from storage, weighed and counted for a yield assessment. Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1ºC), September (14.8ºC) and October (9.7ºC), and above average for May (15.9ºC), June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: May 12.3ºC, June 18.2ºC, July 20.7ºC, August 19.5ºC, September 15.8ºC and October 8.9ºC. Monthly rainfall was below the previous long term 10 year average for May (49 mm) and June (55 mm), average for August (69 mm), and above average for July (140 mm), September (94 mm) and October (124 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm, July 81 mm, August 67 mm, September 74 mm and October 59 mm.
Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained by using Fisher's Protected LSD test at $P = 0.05$ level of significance.

RESULTS: as presented in Tables 1 and 2

CONCLUSIONS: DOWNCAST, the onion downy mildew predictive model, predicted a sporulation infection period several times over the season, however, in 2012, no downy mildew incidence was reported in the Holland Marsh. No downy mildew was found in the trial, which resulted in no significant differences among the treatments at either site (Table 1). No significant differences were observed in yield or weight per bulb among the treatments.

Table 1. Percent marketable weight, yield and average weight per bulb for onions, cv. Patterson, treated with various fungicides grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Rate (mL/ha)	% Marketable	Yield (t/ha)	Weight/bulb (g)
PRESIDIO	220	73.4 ns[1]	23.2 ns	60.2 ns
PRESIDIO	292	75.5	22.2	62.0
REASON	400	76.6	26.1	64.4
PRESIDIO + REASON	292 + 400	79.3	26.6	64.9
QGU42	250	75.6	21.3	64.1
Check	--	79.8	25.2	63.7

[1] ns = not significantly different at $P = 0.05$, Fisher's Protected LSD test

Table 2. Downy mildew lesion (DM) counts for onions, cv. Patterson, treated with various fungicides and grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Rate (mL/ha)	# DM Lesions/m of row		
		31 July	17 August	24 August
PRESIDIO	220	0 ns[1]	0	0
PRESIDIO	292	0	0	0
REASON	400	0	0	0
PRESIDIO + REASON	292 + 400	0	0	0
QGU42	250	0	0	0
Check	--	0	0	0

[1] ns = not significantly different at $P = 0.05$, Fisher's Protected LSD test

Funding for this project was provided by Agriculture and Agri-food Canada.

CROP: Yellow cooking onions (*Allium cepa L.*), cv. Patterson
PEST: Downy mildew (*Peronospora destructor* Berk. Casp. In Berk)

AUTHORS: MCDONALD MR & RICHES L
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: EVALUATION OF GAVEL 75 DF FOR CONTROL OF DOWNY MILDEW ON ONIONS, 2012

MATERIALS: GAVEL 75 DF (mancozeb 66.7%, zoxamide 8.3%), AGRAL 90 (nonylphenoxy plyethyoxyethanol 90%), REVUS 250 SC (mandipropamid 23.3%), RIDOMIL GOLD MZ 68 (metalaxy-M 4%, mancozeb 64%)

METHODS: The trial was conducted to test the efficacy of GAVEL 75 DF fungicide to control downy mildew on onions. Yellow cooking onions, cv. Patterson, were direct seeded (≈ 34 seeds/m) on 11 May using a Stanhay Precision Seeder into organic soil (organic matter ≈ 58.0%, pH ≈ 7.2) near the Muck Crops Research Station, Holland Marsh, Ontario. A randomized complete block arrangement with four replicates per treatment was used in each trial. Each replicate consisted of four rows (42 cm apart), 5 m in length. Treatments were: GAVEL at 2.25 kg/ha, GAVEL + AGRAL 90 at 2.25 kg/ha + 0.25%, REVUS at 500 mL/ha, REVUS + AGRAL 90 at 500 mL/ha + 0.25% and RIDOMIL at 2.5 kg/ha. An untreated check was also included. Treatments were applied on 30 July and 6, 17, 24 August using a CO_2 backpack sprayer equipped with four TeeJet 8002 VS fan-type nozzles spaced 40 cm apart and calibrated to deliver 400 L/ha of water. The plots were regularly examined for downy mildew lesions on a weekly base. On 2 October, all onions in two, 2.33 sections of row per replicate were pulled, topped and placed in storage. On 5 November, onions were removed from storage, weighed, graded for size and counted for yield assessment. Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1ºC), September (14.8ºC) and October (9.7ºC), and above average for May (15.9ºC), June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: May 12.3ºC, June 18.2ºC, July 20.7ºC, August 19.5ºC, September 15.8ºC and October 8.9ºC. Monthly rainfall was below the previous long term 10 year average for May (49 mm) and June (55 mm), average for August (69 mm), and above average for July (140 mm), September (94 mm) and October (124 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm, July 81 mm, August 67 mm, September 74 mm and October 59 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained by using Fisher's test at $P = 0.05$ level of significance.

RESULTS: as presented in Table 1

CONCLUSION: DOWNCAST, the onion downy mildew predictive model, predicted a sporulation infection period several times over the season, however, in 2012, no downy mildew incidence was reported in the Holland Marsh. No downy mildew was found in the trial, which resulted in no significant differences in the number of downy mildew lesions per plant among the treatments (Table 1). No significant differences were observed in the weight per bulb among the treatments.

Table 1. Total downy mildew (DM) lesions, yield and weight per bulb for onion, cv. Patterson, treated with various fungicides at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Rate (per ha)	Yield (t/ha)	Weight/bulb (g)	Total DM Lesions
Check	--	48.9 a[1]	82.3 ns[2]	0.0 ns
GAVEL	2.25 kg	45.5 ab	78.2	0.0
RIDOMIL	2.5 kg	42.0 bc	76.3	0.0
GAVEL + AGRAL 90	2.25 kg + 0.25% v/v	40.5 bc	75.4	0.0
REVUS + AGRAL 90	500 mL + 0.25% v/v	39.5 c	73.3	0.0
REVUS	500 mL	37.9 c	71.8	0.0

[1] Numbers in a column followed by the same letter were not significantly different at P=0.05, Fisher's Protected LSD Test.
[2] ns = no significant differences were found among the treatments

Funding for this project was provided by Gowan Canada.

CROP: Onion (*Allium cepa*.), cv. La Salle
PESTS: Onion downy mildew (*Peronospora destructor*)

AUTHORS: MCDONALD MR & RICHES L
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: COMPARISON OF FUNGICIDES FOR CONTROL OF DOWNY MILDEW ON ONIONS, 2012

MATERIALS: RANMAN 400 SC (cyazofamid 34.5%), REVUS 250 SC (mandipropamid 23.3%), RIDOMIL GOLD MZ 68 wp (metalaxy-M 4%, mancozeb 64%), ALIETTE WDG (fosetyl-al 80%), DITHANE DG (mancozeb 75%), PHOSTROL (Mono and dibasic sodium, potassium and ammonium phosphite 53.6%)

METHODS: Onions, cv. LaSalle, were direct seeded (≈ 34 seeds/m) on 7 May using a Stanhay Precision Seeder into organic soil (organic matter ≈ 56.6%, pH ≈ 7.3) near the Muck Crops Research Station, Holland Marsh, Ontario. A randomized complete block arrangement with four replicates per treatment was used. Each replicate consisted of eight rows (42 cm apart), 5 m in length. Treatments were applied on 31 July and 8, 16, 23 August using a tractor mounted pull-type sprayer fitted with AI TeeJet Air Induction Even Flat spray tips (AI9503 EVS) at 120 psi calibrated to deliver 400 L/ha of water. Treatments were: RANMAN at 200 ml/ha, REVUS at 600 ml/ha, RIDOMIL MZ at 2.5 kg/ha alternated with ALIETTE at 2.8 kg/ha, DITHANE at 3.25 kg/ha and PHOSTROL at 4.3 L/ha. An untreated check was also included. The plots were regularly examined for downy mildew lesions on a weekly base. On 2 October, all onions in two, 2.33 sections of row per replicate were pulled, topped and placed in storage. On 5 November, onions were removed from storage, weighed, graded for size and counted for yield assessment. Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1ºC), September (14.8ºC) and October (9.7ºC), and above average for May (15.9ºC), June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: May 12.3ºC, June 18.2ºC, July 20.7ºC, August 19.5ºC, September 15.8ºC and October 8.9ºC. Monthly rainfall was below the previous long term 10 year average for May (49 mm) and June (55 mm), average for August (69 mm), and above average for July (140 mm), September (94 mm) and October (124 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm, July 81 mm, August 67 mm, September 74 mm and October 59 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained by using Fisher's Protected LSD test at $P = 0.05$ level of significance.

RESULTS: as presented in Table 1

DISCUSSION: DOWNCAST, the onion downy mildew predictive model, predicted a sporulation infection period several times over the season, however, in 2012, no downy mildew incidence was reported in the Holland Marsh. No downy mildew was found in the trial, which resulted in no significant differences among the treatments at either site (Table 1). No significant differences were observed in size distribution, yield or weight per bulb among the treatments.

CONCLUSION: Due to low disease pressure, no conclusions regarding fungicide efficacy could be reached.

Table 1. Downy mildew (DM) lesions, size distribution, yield and weight per bulb for onions, cv. LaSalle, treated with various fungicides grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Rate/ha	Size Distribution (%)			Yield (t/ha)	Weight/ bulb (g)	Total DM Lesions
		Jumbo (>76 mm)	Can. No. 1 (45-76 mm)	Cull (<45 mm)			
RANMAN	200	0.7 ns[1]	84.5 ns	14.8 ns	30.8 ns	71.8 ns	0.0 ns
REVUS	600 + 0.125	0.0	80.5	19.5	27.2	65.9	0.0
RIDOMIL MZ + ALIETTE[2]	2.5 kg + 2.8 kg	0.0	84.1	15.9	31.8	69.8	0.0
DITHANE	3.25 kg	0.0	84.7	15.3	30.7	67.2	0.0
PHOSTROL	4.3 L	0.0	82.3	17.7	28.2	65.4	0.0
Check	--	0.0	82.1	17.9	29.0	65.0	0.0

[1] Not significantly different at $P = 0.05$, Fisher's Protected LSD test.

Funding for this project was provided by the Holland Marsh Growers' Association through the Bradford Cooperative and Storage Ltd.

CROP: Onion (*Allium cepa* L.), cv. La Salle

AUTHORS: SWANTON C J, JANSE S & CHANDLER K
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: TOLERANCE OF ONIONS TO VARIOUS HERBICIDES, 2012

MATERIALS: DUAL II MAGNUM (s-metolachlor/benoxacor 91.5%), pyroxasulfone (85%), flufenacet (60%), NORTRON SC (ethofumesate 48%), REFLEX (fomesafen 24%), BLAZER (acifluorfen 24%), fluthiacet-methyl (10.9%).

OBJECTIVE: to evaluate the tolerance of onions to herbicides applied at 2X the proposed use rate

METHODS: The trial was conducted on the Muck Crops Research Station, Holland Marsh (organic matter 75%, pH 6.5). Plots were 4m long and 1.5m wide and arranged in a randomized complete block design with four replications. In each plot 4 rows of La Salle onions were seeded (33 seed /m) on 14 May in 43 cm rows. The trial consisted of 12 treatments including an untreated check (see Table 1 for details). All treatments were maintained weed-free with periodic hand-weeding as required. DUAL II MAGNUM, NORTRON SC, flufenacet and pyroxasulfone were applied at 2X rates on 28 May when onions were at the loop stage and on 29 June when onions were at the 3 leaf stage. Additional treatments of BLAZER, REFLEX, and fluthiacet-methyl were applied at the 3 leaf stage. All treatments were applied in 200 L/ha of water. Recommended management practices for soil fertility and pest control were followed. Visual assessments for crop injury were conducted periodically over the growing season. Onions were harvested at maturity. Data was analyzed by ANOVA and means separated using Fisher's Protected LSD test (P=0.05).

RESULTS: as presented in Table 1

CONCLUSIONS: Pyroxasulfone, flufenacet, DUAL II MAGNUM, and NORTRON SC caused significant crop injury and yield loss when applied at the onion loop stage. Crop tolerance to these herbicides was excellent when applied when onions were at the 3 leaf stage and yields were similar to the untreated. Fluthiacet-methyl and REFLEX caused greater injury than BLAZER but did not reduce yields, when applied at 2X the rate required to control redroot pigweed.

Table 1. Tolerance of onions to herbicides applied at 2X rates Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Dose gai/ha	Timing	Injury (%) DAT[1]		Yield
			37/5	59/27	(t/ha)
Untreated			0	0	38
Pyroxasulfone	178	Loop	10	10	28
Flufenacet	900	Loop	13	10	27
DUAL II MAGNUM	2746	Loop	19	25	27
NORTRON SC	7920	Loop	25	8	22
Pyroxasulfone	178	3 leaf	1	3	40
Flufenacet	900	3 leaf	1	0	41
DUAL II MAGNUM	2746	3 leaf	0	0	46
NORTRON SC	7920	3 leaf	3	1	35
BLAZER + ASSIST	37.5 + 1%	3 leaf	3	1	36
Fluthiacet-methyl + Agral 90	3.75 + 0.5%	3 leaf	19	5	32
REFLEX + TURBOCHARGE	10 + 1%	3 leaf	12	0	34
LSD (P=0.05)			*8*	*10*	*9*

[1] DAT (days after treatment) applied at loop/3 leaf onion stage, respectively.

Funding for this project was supplied by the OMAFRA/University of Guelph (Maintaining Plant Health with Effective Integrated Weed Management).

CROP: Onion (*Allium cepa* L.), cv. Prince

AUTHORS: SWANTON C J, JANSE S & CHANDLER K
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: TOLERANCE OF ONIONS TO HERBICIDES APPLIED THE PREVIOUS YEAR IN CARROTS, 2012

MATERIALS: GOALTENDER (oxyfluorfen 48%), GOAL 2XL (oxyfluorfen 24%), REFLEX (fomesafen 24%), BLAZER (acifluorfen 24%), AUTHORITY (sulfentrazone 48%), fluthiacet-methyl (10.9%), NORTRON SC (ethofumesate 48%).

OBJECTIVE: to evaluate the tolerance of onions to herbicides applied in carrots the year previously at twice the rate required for the control of redroot pigweed

METHODS: In 2011 the trial was established on the Muck Crops Research Station, Holland Marsh (organic matter 60%, pH 6.4). Plots were 4m long and 1.5m wide and arranged in a randomized complete block design with four replications. The trial consisted of 8 treatments, including an untreated control, arranged in a randomized complete block design with four replications. Treatments consisted of six PPO herbicides: GOALTENDER, GOAL 2XL, REFLEX, BLAZER, AUTHORITY and fluthiacet-methyl; and NORTRON SC. Treatments were applied postemergence at twice (2X) the rate required to provide ~80% control of redroot pigweed (determined in previous experiments). Treatments were applied on 27 July, 2011 when carrots were at the 2-3 leaf stage and again on 5 August, 2011 when carrots were at the 4-5 leaf stage. Treatments were applied in 200 L/ha of water with appropriate adjuvants as required (see below).

In 2012, onions (c.v. Prince) were seeded (33 seed /m) on 2 May in 43 cm rows. All treatments were maintained weed-free with periodic hand-weeding as required. Recommended management practices for soil fertility and pest control were followed. Visual crop injury assessments were made bi-weekly up to mid-July and onions were harvested on 18 September, 2012. Data were analyzed by ANOVA and means separated using Fisher's Protected LSD test (P=0.05).

RESULTS: as presented in Table 1

CONCLUSIONS: No significant injury or yield loss was observed in onions grown the year following application of GOALTENDER, GOAL 2XL, REFLEX, BLAZER, AUTHORITY, fluthiacet-methyl, or NORTRON SC, applied in 2 and 4 leaf carrots at 2X the rates required to control redroot pigweed.

Table 1. Tolerance of onions to herbicides applied twice the previous year, when carrots were at the 2-3 and 4-5 leaf stage Muck Crops Research Station, Holland Marsh, Ontario,, 2012.

Treatment	Dose	Injury (%) DAP[1]			Total yield
	gai/ha	16	47	71	(t/ha)
Untreated		0	0	0	65
GOALTENDER	140	0	5	0	70
GOAL 2XL	120	0	3	0	81
REFLEX + Turbocharge	7.5 + 0.5% v/v	0	0	0	68
BLAZER + Assist	37.5 + 0.5% v/v	5	0	0	74
AUTHORITY + Agral 90	30 + 0.25% v/v	0	5	0	69
Fluthiacet-methyl + Agral 90	3 + 0.25% v/v	0	6	0	68
NORTRON	4320	0	10	0	67
LSD (P=0.05)		*NS*	*NS*	*NS*	*NS*

[1]Days after planting.

Funding for this project was supplied by the OMAFRA/University of Guelph (Maintaining Plant Health with Effective Integrated Weed Management).

CROP: Lettuce, leaf (*Lactuca sativa L.*), cv. Bergams Green M.I.
PEST: Sclerotinia drop (*Sclerotinia sclerotiorum* (Lib.) de Bary; *Sclerotinia minor* Jagger)

AUTHORS: MCDONALD MR[1], RICHES L[1], & GOSSEN BD[2]
[1]University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station
[2]Agriculture and Agri-Food Canada, Saskatoon

TITLE: EVALUATION OF FUNGICIDES FOR CONTROL OF SCLEROTINIA DROP ON INOCULATED LEAF LETTUCE, 2012

MATERIALS: ALLEGRO 500 F (fluazinam 40.0%), LANCE WDG (boscalid 70.0%), DPX-QGU42 (experimental)

METHODS: The trial was conducted on organic soil (pH ≈ 7.0, organic matter ≈ 69.4%) at the Muck Crop Research Station, Holland Marsh, Ontario. Leaf lettuce (*Lactuca sativa L.*), cv. Bergams Green M.I., was seeded into 128-cell plug trays on July 16 and hand-transplanted (4 plants/m) on 2 August. A randomized complete block design with four replicates per treatment was used. Each replicate consisted of four 6.0 m long rows spaced 42 cm apart with in-row spacing of 25cm (95238 plants/ha). Treatments were ALLEGRO at 1.2 and 1.75 L/ha, LANCE at 385 g/ha, and DPX-QGU42 at 0.25 L/ha. An untreated, naturally infected check and checks inoculated with *S. minor* and *S. sclerotiorum* and both species were also included. DPX-QGU42 as well as the two treatments of ALEGRO were applied as transplant drenches at a rate of 220mL/plant on 2 August using a beaker. LANCE was applied on 22 August and 7 September.as foliar sprays using a CO_2 back pack sprayer equipped with four TeeJet 8002 fan nozzles spaced 40 cm apart and calibrated to deliver 400 L/ha at 240 kPa. On 7 September, *S. sclerotiorum* and *S. minor*-inoculated strips, 0.5 cm by 3.0 cm, were spread on the soil in between plant rows and on top of the plants respectively, at the rate of 1.5 g/m. Inoculum was obtained from Dr. B. Gossen, AAFC. On 26 September, the trial was monitored for sclerotinia drop, each species of *Sclerotinia* was counted, number of each recorded, and infected plants removed. On 4 October, all heads were cut and examined for *S. sclerotiorum* and *S. minor*. The numbers of each disease and the healthy heads were recorded. Ten heads from each replicate were weighed to determine yield. Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1ºC), September (14.8ºC) and October (9.7ºC). The long term previous 10 year average temperatures were: August 19.5ºC, September 15.8ºC and October 8.9ºC. Monthly rainfall was above the previous long term 10 year average for September (94 mm) and October (124 mm) and average for August (69 mm). The long term previous 10 year rainfall averages were: August 67 mm, September 74 mm and October 59 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained using Tukey's Protected LSD Test at $P = 0.05$ level of significance.

RESULTS: as presented in Table 1

CONCLUSIONS: There were no significant differences in the incidence of *S. sclerotiorum*, *S. minor* or total disease among the treatments. Disease incidence was low in trial. The addition of the inoculum strips increased disease incidence; however, weather conditions were not favorable for disease development. Drench applications were applied at transplanting and did not significantly improve control of Sclerotinia drop over the seven week trial. No significant difference was found in the weight per head among treatments. All products used were non-phytotoxic to the crops.

Table 1. Effects of fungicides on the incidence of *S. sclerotiorum* and *S. minor* and average plant weight in leaf lettuce, cv. Bergams Green M.I., grown at Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Rate/ha	Application Type	% Disease	% *S. minor*	% *S. sclerotiorum*	Average Wgt/Plant (g)
ALLEGRO	1.2 L	Drench	13.0 ns[1]	12.4 ns	0.6 ns	201.0 ns
Check Both	--	--	6.9	6.3	0.6	213.8
Check Minor	--	--	4.6	4.3	0.3	234.8
ALLEGRO	1.75 L	Drench	3.4	2.8	0.6	216.3
LANCE	385 g	Foliar	3.0	2.4	0.6	239.3
DPX-QGU42	0.25 L	Drench	1.2	1.2	0.0	235.0
Non Inoc Check	--	--	0.6	0.0	0.6	222.5
Inoc Check	--	--	0.3	0.3	0.0	264.0

[1] ns = no significant differences were found among treatments.

Funding for this project was provided by Agriculture and Agri-food Canada.

CROP: Head lettuce (*Lactuca sativa* L.), cv. Mighty Joe
PEST: Sclerotinia drop (*Sclerotinia sclerotiorum* (Lib.) de Bary; *Sclerotinia minor* Jagger)

AUTHORS: MCDONALD MR[1], RICHES L[1], & GOSSEN BD[2]
[1]University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station
[2]Agriculture and Agri-Food Canada, Saskatoon

TITLE: EVALUATION OF FUNGICIDES FOR CONTROL OF SCLEROTINIA DROP ON INOCULATED HEAD LETTUCE, 2012

MATERIALS: ALLEGRO 500 F (fluazinam 40.0%), LANCE WDG (boscalid 70.0%), IKF-5411 (experimental), DPX-QGU42 (experimental)

METHODS: The trial was conducted on organic soil (pH ≈ 7.0, organic matter ≈ 69.4%) at the Muck Crop Research Station, Holland Marsh, Ontario. Head lettuce (*Lactuca sativa L.*), cv. Mighty Joe, was seeded into 128-cell plug trays on 13 June and hand-transplanted (4 plants/m) on 18 July. A randomized complete block design with four replicates per treatment was used. Each replicate consisted of four 6.0 m long rows spaced 42 cm apart with in-row spacing of 25 cm (95238 plants/ha). Treatments were ALLEGRO at 1.2 and 1.75 L/ha, IKF-5411 400SC at 880 and 1000 mL/ha, LANCE at 385 g/ha, and DPX-QGU42 at 0.25 L/ha. Untreated, naturally infected and inoculated checks were also included. DPX-QGU42 and ALLEGRO at both rates were applied as transplant drenches at a rate of 200 mL/plant on 20 July using a beaker. LANCE and IKF-5411 at both rates were applied on 27 July and 8 August as a foliar spray using a CO_2 back pack sprayer equipped with four TeeJet 8002 fan nozzles spaced 40 cm apart and calibrated to deliver 400 L/ha at 240 kPa. On 7 August, *S. sclerotiorum* and *S. minor*-inoculated strips, 0.5 cm by 3.0 cm, were spread on the soil in between plant rows and on top of the plants respectively, at the rate of 1.5 g/m. Inoculum was obtained from Dr. B. Gossen, AAFC. On 21 and 28 August 7 and 17 September the trial was monitored for sclerotinia drop. Each species of *Sclerotinia* were counted, numbers of each recorded and infected plants removed. On 21 September, all heads were cut and examined for *S. sclerotiorum* and *S. minor*. The numbers of healthy and diseased heads were recorded. Ten heads from each replicate were weighed to determine yield. Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1ºC) and September (14.8ºC), and above average for July (22.2ºC). The long term previous 10 year average temperatures were: July 20.7ºC, August 19.5ºC and September 15.8ºC. Monthly rainfall was above the previous long term 10 year average for July (140 mm) and September (94 mm), average for August (69 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm, July 81 mm, August 67 mm, September 74 mm and October 59 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained using Fisher's Protected LSD Test at $P = 0.05$ level of significance.

RESULTS: as presented in Table 1

CONCLUSION: There were no significant differences in the incidence of *S. sclerotiorum*, *S. minor* or total disease among the treatments. Disease incidence was low in the non- inoculated check (15%). The addition of the inoculum strips increased disease incidence; however, weather conditions were not favorable for disease development. Disease appeared in the later stages of the trial and since all fungicide treatments were applied within 21 days of transplanting the fungicide treatments may not have been effective in the later stages of the trial. A significant difference was found in weight per head among treatments; however this may have been caused by downy mildew infection which also occurred near the end of the trial. All products used were non-phytotoxic to the crops.

Table 1. Effects of fungicides on the incidence of *S. sclerotiorum* and *S. minor* and average head weight in lettuce, cv. Mighty Joe, grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Rate/ha	Application Type	% *S. sclerotiorum*	% *S. minor*	% Disease	Average Wgt/Head (g)
Inoculated Check	--	--	23.3 ns[1]	12.0 ns	35.4 ns	746.5 abc[2]
LANCE	0.385 kg	Foliar	19.7	7.8	27.5	677.3 c
ALLEGRO	1.75 L	Drench	18.3	7.0	25.3	770.8 ab
IKF-5411 400 SC	1000 mL	Foliar	16.7	10.0	26.7	754.0 abc
IKF-5411 400 SC	880 mL	Foliar	16.1	6.1	22.1	787.5 ab
DPX-QGU42	0.25 L	Drench	14.8	14.2	29.0	676.0 c
Non-Inoc Check	--	--	12.5	2.0	14.5	715.5 bc
ALLEGRO	1.2 L	Drench	12.0	12.5	24.5	804.5 a

[1] ns = no significant differences were found among treatments
[2] Numbers in column followed by the same letter are not significantly different at P=0.05, based on Fisher's Protected LSD Test.

Funding for this project was provided by Agriculture and Agri-food Canada.

CROP: Head lettuce (*Lactuca sativa* L.), cv. Mighty Joe
PEST: Downy mildew (*Bremia lactucae* Regel)

AUTHORS: TESFAENDRIAS MT and MCDONALD MR
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: EVALUATION OF FUNGICIDES FOR CONTROL OF DOWNY MILDEW ON LETTUCE, 2012

MATERIALS: DPX QGU 42 OD (experimental), DPX QGU 42 SC (experimental), REVUS 250 SC (mandipropamid 23.3%), SYLGARD309 (siloxylate polyether 76%)

METHODS: The trial was conducted at the Muck Crops Research Station, Holland Marsh, Ontario, in organic soil (pH ≈ 7.0, organic matter ≈ 69.4%). Lettuce, cv. Mighty Joe, was seeded into plug trays on 12 July and hand transplanted into the field on 8 August. A randomized complete block design with four replicates per treatment was used. Each experimental unit consisted of four 5 m long rows, 42 cm apart. Treatments were: QGU 42 OD at 87.5, 175 and 350 mL/ha, QGU 42 OD at 350 mL/ha + SYLGARD at 0.25% v/v, QGU 42 SC at 350, 700 and 1400 mL/ha and REVUS at 400 mL/ha. An untreated check was also included. Foliar sprayed treatments (REVUS and all rates of QGU 42 OD) were applied on 15, 22, 29 August, and 7 September using a CO_2 backpack sprayer equipped with four TeeJet 8002 VS fan nozzles spaced 40 cm apart and calibrated to deliver 400 L/ha at 240 kPa (boom). All rates of QGU 42 SC were applied as soil drench applications (at 1000 L/ha) followed by irrigation on 8 and 22 August, and 7 September. Prior to the 1st assessment, the 10 plants per experimental unit to be assessed were randomly chosen and marked with stakes. Plants were assessed for disease incidence and severity. Disease severity was rated on a scale of 1 to 5: 0 = no lesions, 1 = 1 lesion, 2 = 2-5 lesions, 3 = 6-10 lesions, 4 = 11-15 lesions, 5 = >15 lesions on 29 June, 12, 19 and 26 July. The disease severity values were used to calculate the area under disease progress curve (AUDPC) and disease severity index (DSI). The AUDPC was calculated using the following equation:

$$\text{AUDPC} = \sum_{j=1}^{Nj-1} \left(\frac{y_j + y_{j+1}}{2}\right)\left(t_{j+1} - t_j\right)$$

Where j is the order index for the times and n_j is the total number of assessments, y_j is the downy mildew severity rating at day t_j, y_{j+1} is the downy mildew severity rating at day t_{j+1} and (t_{j+1} - t_j) is the number of days between two assessments.
Disease severity index was determined using the following equation:

$$\text{DSI} = \frac{\sum [(\text{rating class no.})(\text{no. of plants in each rating class})]}{(\text{total no. of plants per sample})\ (\text{no. classes} - 1)} \times 100$$

On 25 September, 10 heads from unmarked plants were harvested and untrimmed and trimmed weights recorded to determine harvest and marketable weights.
Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1 ºC) and September (14.8ºC). The long term previous 10 year average temperatures were: August 19.5ºC and September 15.8ºC. Monthly rainfall was average for August (69 mm) and above average for September (94 mm). The long term previous 10 year rainfall averages were: August 67 mm and September 74 mm. Data were analysed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained using Fisher's Protected LSD test with P = 0.05 level of significance.

RESULTS: as presented in Tables 1 and 2

CONCLUSIONS: In 2012, disease pressure was moderate to high and increased over the assessment period. BREMCAST, the lettuce downy mildew forecasting model, predicted sporulation infection periods (SIP) during the growing season starting mid-July and the risk of developing downy mildew remained moderate to high until September. Lettuce downy mildew symptoms started to develop around mid to late August in the Holland Marsh.

Significant differences in downy mildew incidence, DSI and AUDPC were found among the treatments (Table 1). All the fungicides at different rates controlled downy mildew compared to the untreated check. At harvest (25 Sep), percent downy mildew incidence and DSI was lower in lettuce treated with QUG 42 OD at 350 mL/ha + SYLGARD and REVUS than the drench applied QGU 42 SC (all rates), QGU 42 OD at 87.5 and 175 mL/ha, and the untreated check (Table 1). The AUDPC was lower in lettuce treated with REVUS, QUG 42 OD at 350 mL/ha or QUG 42 OD at 350 mL+ SYLGARD than lettuce treated with QGU 42 OD at 87.5 and 175 mL/ha, all rates of QGU 42 SC and lettuce from the untreated check. The area under the disease progress curve and DSI at the two assessment dates (29 Aug and 7 Sep) in lettuce treated with fungicide QUG 42 OD at 87.5 and 350 mL/ha and all rates of the drench applied QUG 42 SC was better than the untreated check.

Significant differences were found in total harvest weight and marketable yield among the treatments (Table 2). The total harvest weight of lettuce treated with fungicides was higher than the untreated check in. Lettuce treated with the REVUS had significantly higher marketable yield than lettuce treated with QGU 42 OD at 350 and 700 mL/ha, QGU 42 OD at 175mL/ha and the untreated check (Table 2). All the products tested were non-phytotoxic to the crop.

Funding for this project was provided by the Pest Management Centre of Agriculture and Agri-Food Canada.

Table 1. Downy mildew (DM) incidence and disease severity ratings for lettuce, cv. Mighty Joe, treated with fungicides, grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Rate (per ha)	DM Incidence (%)			Disease Severity Index			AUDPC[2]
		29 Aug	7 Sep	25 Sept	29 Aug	7 Sep	25 Sept	
DPX-QGU 42 OD +SYLGARD	350 mL. + 0.125%v/v	0.0 a[1]	2.5 a	72.5 a	0.0 a	1.0 a	34.0 a	23.8 a
REVUS	400 mL	2.5 a	2.5 a	85.0 ab	0.5 a	0.5 a	42.5 ab	33.8 ab
DPX-QGU 42 OD	350 mL	0.0 a	0.0 a	90.0 bc	0.0 a	0.0 a	49.5 bc	42.8 b
DPX-QGU 42 OD	175 mL	0.0 a	5.0 a	100.0 c	0.0 a	1.5 a	62.5 cd	66.7 c
DPX-QGU 42 SC	700 mL	5.0 a	7.5 a	100.0 c	1.0 a	1.5 a	77.0 de	69.6 c
DPX-QGU 42 SC	1.4 L	2.5 a	2.5 a	100.0 c	0.5 a	0.5 a	72.0 de	70.6 c
DPX-QGU 42 SC	350 mL.	0.0 a	2.5 a	97.5 bc	0.0 a	0.5 a	75.5 de	71.5 c
DPX-QGU 42OD	87.5 mL	10.0 a	27.5 b	100.0 c	2.0 b	13.0 b	74.0 de	81.0 c
Check	--	30.0 b	100.0 c	100.0 c	10.0 b	66.5 c	80.0 e	166.9 d

[1] Numbers in a column followed by a different letter were significantly different at $P = 0.05$, based on Fisher's Protected LSD test.
[2]AUDPC = Area under the disease progress curve

Table 2. Yield data for lettuce, cv. Mighty Joe, treated with fungicides, grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Rate (per ha)	Total Weight (g/head)	Marketable Weight (g/head)
REVUS	400 mL	698.8 a[1]	585.0 a
DPX-QGU 42 OD	350 mL	645.5 a	569.3 ab
DPX-QGU 42 OD + SYLGARD	350 mL+0.125%v/v	666.0 a	564.8 abc
DPX-QGU 42 OD	87.5 mL	609.7 a	516.8 abcd
DPX-QGU 42 SC	1.4 L	682.8 a	498.0 abcd
DPX-QGU 42 SC	350 mL	619.3 a	455.0 bcd
DPX-QGU 42 OD	175 mL	567.3 a	441.5 cd
DPX-QGU 42 SC	700 mL	609.7 a	410.8 de
Check	--	386.5 b	291.8 e

[1] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, based on Fisher's Protected LSD test.

CROP: Head lettuce (*Lactuca sativa* L.), cv. Mighty Joe
PEST: Downy mildew (*Bremia lactucae* Regal)

AUTHORS: MCDONALD MR & VANDER KOOI K
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: EFFICACY OF ZAMPRO FUNGICIDE FOR THE CONTROL OF DOWNY MILDEW ON GREENHOUSE HEAD LETTUCE, 2012

METHODS: ZAMPRO (ametoctradin 300 g/L, dimethomorph 225 g/L), REVUS (mandipropamid 250 g/L), SYLGARD 309 (siloxylated polyether 76%)

METHODS: The trial was conducted in a greenhouse at the Muck Crop Research Station, Holland Marsh, Ontario. Lettuce, cv. Mighty Joe was seeded into individual pots (ITML Horticultural Products, Brantford, ON) filled with ASB Soilless Mix on 1 October, 2012. Each experimental unit consisted of 15 pots, arranged in a 3 by 5 pot tray, in a randomized complete block arrangement with four replicates per treatment. Treatments were: ZAMPRO at 1.0 and 2.0 L/ha and ZAMPRO at 0.5, 0.8, 1.0 and 2.0 L/ha applied with SYLGARD 309 at 1.25 mL. Untreated non-inoculated and inoculated checks were also included. Treatments were applied on 13, 19 and 26 November as foliar sprays using a CO_2 back pack sprayer equipped with one TeeJet 8002 fan nozzle and calibrated to deliver 1000 L/ha at 240 kPa. Treatments were inoculated on 7 November. Disease tissue was obtained from field-grown lettuce plants with actively growing *Bremia lactucae*. The inoculation suspension was prepared by adding tissue bearing sporulating colonies to a centrifuge tube containing distilled water and shaking by hand. The suspension was diluted to a concentration of $3x10^5$ sporangia per mL and sprayed onto treatments using a hand-held misting bottle. Plants were shrouded in plastic for 24 hours immediately following inoculation to maintain leaf wetness as leaf wetness following inoculation is important for disease development. After the plastic was removed, plants were misted daily to encourage disease development. Prior to the 1st assessment, the five plants per experimental unit to be assessed were chosen in a V pattern from corner to corner in each tray. Plants were assessed for disease incidence and severity on 15, 22, 28 November and 3 December. Disease severity was rated on a scale of 1 to 5 where 0 = no lesions, 1 = 1 lesion, 2 = 2-5 lesions, 3 = 6-10 lesions, 4 = 11-15 lesions, 5 = >15 lesions. The disease severity values were used to calculate the area under disease progress curve (AUDPC) and disease severity index (DSI). AUDPC and DSI formulas were as follows:

$$\text{AUDPC} = \sum_{j=1}^{N_{j-1}} \left(\frac{y_j + y_{j+1}}{2}\right)(t_{j+1} - t_j)$$

Where y = percent disease at the jth observation, t = time (days) since the previous percent disease at the jth observation and n = total number of observations.

$$\text{DSI} = \frac{[(\text{class no.})(\text{no. of plants in each class})]}{(\text{total no. of plants per sample})(\text{no. classes} - 1)} \times 100$$

On 3 December (63 DAS), 15 plants from each replicate were harvested by cutting the tops from the roots at soil level and weights recorded to determine total yield. All diseased leaves were removed and tops reweighed to determine marketable yield. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained using Tukey's Protected LSD Test at $P = 0.05$ level of significance.

RESULTS: as presented in Tables 1, 2 and 3

CONCLUSIONS: Significant differences in downy mildew (DM) incidence, disease severity index (DSI), area under the disease progress curve (AUDPC) and marketable head weight were found among

treatments. The non-inoculated check had no downy mildew symptoms on any assessment dates. The non-inoculated check was removed for statistical analysis of disease incidence, DSI and AUDPC. All other treatments did not significantly differ from each other in disease incidence on all assessment dates other than 28 November, ZAMPRO at a rate of 2.0 L/ha with SYLGARD had significantly lower disease incidence at 70%, than all treatments other than ZAMPRO at a rate of 0.5 L/ha with SYLGARD at 85%. Howeve,r on the final assessment on 3 December there was no significant difference in DM incidence.

DSI was similar, ZAMPRO at a rate of 2.0 L/ha with SYLGARD had a significantly lower DSI than all treatments except ZAMPRO at a rate of 0.5 L/ha with SYLGARD on 28 November. On 3 December, ZAMPRO at a rate of 2.0 L/ha with SYLGARD had a significantly lower DSI than ZAMPRO at a rate of 0.8 L/ha with SYLGARD and ZAMPRO at 2.0 L/ha. ZAMPRO at a rate of 2.0 L/ha with SYLGARD had a significantly lower AUDPC than all other treatments with the exception of ZAMPRO at a rate of 0.5 and 1.0 L/ha with SYLGARD and ZAMPRO at 1.0 L/ha.

When the application of treatments was complete and the pre-harvest interval had been observed, before heads were formed (63 DAS), tops were cut to determine marketable weight. Significant differences in marketable top weight were found among the treatments. ZAMPRO at 2.0 L/ha + SYLGARD and REVUS + SYLGARD had significantly higher weights than the inoculated check. ZAMPRO at 2.0 L/ha + SYLGARD had significantly less DM incidence on 28 November, significantly lower DSI on 22 and 28 November and a significantly lower AUDPC than that of ZAMPRO at a rate of 2.0 L/ha without SYLGARD. No phytotoxicity was observed among the treatments.

Table 1. Downy mildew (DM) incidence for lettuce, cv. Mighty Joe, treated with fungicides, grown in a greenhouse at the Muck Crops Research Station, Holland Marsh, 2012.

Treatment	Rate (L/ha)	DM Incidence (%)			
		15 Nov	22 Nov	28 Nov	3 Dec
ZAMPRO + SYLGARD	2.0	0 ns[1]	70 ns	70 a[2]	95 ns
ZAMPRO + SYLGARD	0.5	0	75	85 ab	100
ZAMPRO	1.0	0	85	95 b	100
ZAMPRO + SYLGARD	1.0	0	95	100 b	100
REVUS + SYLGARD	0.4	0	90	95 b	100
ZAMPRO + SYLGARD	0.8	0	85	100 b	100
ZAMPRO	2.0	0	95	95 b	100
Inoculated check	--	0	90	95 b	100

[1] ns = no significant differences were found among treatments

[2] Numbers in column followed by the same letter are not significantly different at P=0.05, based on Tukey's Protected HSD Test.

Table 2. Downy mildew (DM) disease severity ratings for lettuce, cv. Mighty Joe, treated with fungicides, grown in a greenhouse at the Muck Crops Research Station, Holland Marsh, 2012.

Treatment	Rate (L/ha)	Disease Severity Index				AUDPC[3]
		15 Nov	22 Nov	28 Nov	3 Dec	
ZAMPRO + SYLGARD	2.0	0 ns[1]	27 ns	30 a[2]	42 a	22.3 a
ZAMPRO + SYLGARD	0.5	0	36	41 ab	55 ab	29.9 ab
ZAMPRO	1.0	0	44	53 b	58 ab	36.1 ab
ZAMPRO + SYLGARD	1.0	0	44	54 b	56 ab	36.2 ab
REVUS + SYLGARD	0.4	0	49	55 b	60 ab	38.6 b
ZAMPRO + SYLGARD	0.8	0	45	60 b	66 b	39.4 b
ZAMPRO	2.0	0	49	57 b	66 b	39.9 b
Inoculated check	--	0	52	58 b	61 ab	40.5 b

[1] ns = no significant differences were found among treatments
[2] Numbers in column followed by the same letter are not significantly different at P=0.05, based on Tukey's Protected LSD Test.
[3]AUDPC = Area under the disease progress curve

Table 3. Yield for lettuce, cv. Mighty Joe, treated with fungicides, grown in a greenhouse at the Muck Crops Research Station, Holland Marsh, 2012.

Treatment	Rate (L/ha)	Marketable Weight (g/top)
ZAMPRO + SYLGARD	2.0	26.7 a[1]
REVUS + SYLGARD	0.4	26.5 a
ZAMPRO + SYLGARD	0.8	24.8 ab
ZAMPRO	2.0	24.8 ab
ZAMPRO + SYLGARD	0.5	24.7 ab
ZAMPRO + SYLGARD	1.0	23.0 ab
Non-inoculated check	--	22.8 ab
ZAMPRO	1.0	22.8 ab
Inoculated check	--	18.7 b

[1] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, based on Tukey's HSD test.

Funding for this project was provided by Agriculture and Agri-food Canada.

CROP: Spinach (*Spinacia oleracea* L.), cvs. Greyhound and Norgreen HF
PEST: Fusarium wilt of spinach (*Fusarium oxysporum* f. sp. *spinaciae* (Sherb.) W.C. Snyder & H.N. Hans.)

AUTHORS: COLLINS B & MCDONALD MR
University of Guelph, Dept. of Plant Agriculture

TITLE: EFFECT OF LIMESTONE AMENDMENTS ON FUSARIUM WILT OF SPINACH, 2012

MATERIALS: dolomitic limestone (Agricultural Lime Index = 65)

METHODS: Field trials were conducted in July and August 2012 in mineral soil (pH ≈ 7.2) naturally infested with *Fusarium oxysporum* f. sp. *spinaciae* near Hamilton, Ontario. Two susceptible cultivars, Greyhound (Seminis Vegetable Seeds) and Norgreen HF (Alf Christianson Seed Co.), were treated with the industry standard: APRON XL LS (42 mL/100 kg seed) and THIRAM (500 g/100 kg seed). Each experimental unit consisted of two 6-row beds, spaced 2 m apart, 4 m in length. This field assay was arranged in a randomized complete block design as a two way factorial with three limestone treatments (0, 10, 20 tonnes/ha) and two cultivars per limestone treatment (Greyhound and Norgreen HF) with five replications. The limestone was applied May 8 and the spinach was seeded at the rate of 75 seeds/m on July 18 using a Stanhay Precision Seeder. Plots were irrigated as required using overhead irrigation. Two applications of ammonium nitrate fertilizer were applied 3 and 18 days after seeding providing 110 kg N/ha. Six weeks after seeding the Disease Severity Index (DSI) was determined by assessing all of the plants in a 1 m section taken from the two middle rows using a 0-4 scale: 0 = healthy; 1 = yellowing; 2 = slightly wilted; 3 = severe wilted; 4 = dead plant; calculated as shown below. The vascular discoloration severity of the roots was determined by sectioning ten roots per experimental unit longitudinally and rating the roots on a scale from 0-3: 0 = healthy white roots; 1 = one-third discoloration or less; 2 = one-third discoloration to two-thirds; 3 = more than two-thirds vascular discoloration. Vascular Discolouration Index (VDI) was calculated using the following equation:

$$\text{DSI/VDI} = \frac{\sum [(\text{class no.})(\text{no. of plants in each class})]}{(\text{total no. plants per sample})(\text{no. classes } -1)} \times 100$$

Soil samples were taken from the top 15 cm of each limestone treatment on May 7, July 16, August 15, September 14, and October 13 to determine the pH of the soil. Data were analyzed using the General Analysis of Variance function of the Factorial section of Statistix V.9. Means separation was obtained by using Tukey's LSD All-Pairwise Comparisons Test at $P = 0.05$ level of significance.

RESULTS: There was no increase in the soil pH over the course of the trial (pH ≈ 7.2). For the effect of cultivars and limestone on disease severity and vascular discolouration see Table 1.

CONCLUSIONS: The cultivar Norgreen HF was found to be more susceptible to Fusarium wilt than Greyhound. There was a decreasing disease severity with increasing applications of limestone. As no change in soil pH was observed, the reduced disease severity might be attributed to increased calcium levels supplied to the crop.

Table 1. Effect of spinach cultivar and limestone applications on the Disease Severity Index (DSI) and Vascular Discolouration Index (VDI) caused by Fusarium wilt grown near Hamilton, Ontario, 2012.

Cultivar	Lime (tonnes/ha)	Lime Rates Pooled	Cultivars Pooled	DSI[1]	VDI[2]
Norgreen HF	10			17.6 a[3]	44.7 ns[4]
Norgreen HF	0			15.9 ab	43.3
Greyhound	0			10.4 abc	32.0
Norgreen HF	20			9.6 bc	35.3
Greyhound	10			8.4 bc	34.0
Greyhound	20			7.1 c	32.0
		Norgreen HF		14.4 a	41.1 a
		Greyhound		8.6 b	32.7 b
			0	13.2 a	37.7 ns
			10	13.0 a	39.3
			20	8.3 b	33.7

[1] Disease Severity Index (DSI) was determined using the following equation:

$$\text{DSI/VDI} = \frac{\sum [(\text{class no.})(\text{no. of plants in each class})]}{(\text{total no. plants per sample})(\text{no. classes } -1)} \times 100$$

[2] Vascular Discolouration Index (VDI) was determined using the equation above

[3] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher's protected LSD Test.

[4] ns = not significantly different, $P = 0.05$ Fisher's Protected LSD Test

Funding was partially provided by the HQP Scholarship Program of the OMAFRA/ University of Guelph Partnership.

CROP: Spinach (*Spinacia oleracea* L.)
PEST: Fusarium wilt of spinach (*Fusarium oxysporum* f. sp. *spinaciae* (Sherb.) W.C. Snyder & H.N. Hans.)

AUTHORS: COLLINS B & McDONALD MR
University of Guelph, Dept. of Plant Agriculture

TITLE: EVALUATION OF SPINACH CULTIVARS FOR RESISTANCE AND SUSCEPTIBLITY TO FUSARIUM WILT, 2012

MATERIALS: Indurain, El Cajon (Rogers-Syngenta Seeds), Vancouver, Hellcat, Kauai, Falcon, Menorca, Unipack 151, Bolero, Sardinia, Seven R, Unipack 12, Greyhound (Seminis Vegetable Seeds), C2606, Norgreen HF, Olympia, Persius, Imperial Green, Imperial Star (Alf Christianson Seed Co.), Monza F1, POH-0438 F1, Stanton F1, Carmel F1, Tasman F1, POH-6116 F1 (Pop Vriend Seeds)

METHODS: Field trials were conducted in July and August 2012 in mineral soil (pH ≈ 7.2) naturally infested with *Fusarium oxysporum* f. sp. *spinaciae* near Hamilton, Ontario. A total of 24 spinach cultivars were treated with the industry standard: APRON XL LS (40mL/100 kg seed) and THIRAM (500g/100 kg seed). Plots were composed of a 6-row bed (1.5 m wide and 4 m in length) planted using a Stanhay Precision Seeder. This field assay was arranged in a randomized complete block design with four replications. Plots were irrigated as required using overhead irrigation. Two applications of ammonium nitrate fertilizer were applied 3 and 18 days after seeding providing 110 kgN/ha. After six weeks the Disease Severity Index (DSI) was determined by assessing all of the plants in 1 m of the two middle rows using a 0-4 scale: 0 = healthy; 1 = yellowing; 2 = slightly wilted; 3 = severe wilted; 4 = dead plant; calculated as shown below. The vascular discoloration severity of the roots was determined by sectioning ten roots per experimental unit longitudinally and rating the roots on a scale from 0-3: 0 = healthy white roots; 1 = one-third discoloration or less; 2 = one-third discoloration to two-thirds; 3 = more than two-thirds vascular discoloration. Vascular Discolouration Index (VDI) was calculated as displayed below. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained by using Fisher's Protected LSD Test at $P = 0.05$ level of significance.

$$\text{DSI/ VDI} = \frac{\sum [(\text{class no.})(\text{no. of plants in each class})]}{(\text{total no. plants per sample})(\text{no. classes } -1)} \times 100$$

RESULTS: as presented in Table 1

CONCLUSIONS: No statistically significant differences were found among cultivars for both disease severity and vascular discolouration caused by Fusarium wilt (Table 1). Although not significantly different, cultivars C2606, Sardinia, and POH-6116 F1 had the lowest DSI among cultivars tested. Cultivars Unipack 12, Norgreen HF, Seven R, and Falcon were most severely affected by Fusarium wilt. The inherent susceptibility to Fusarium wilt appears to vary between spinach cultivars.

Table 1. Evaluations of spinach cultivars for susceptibility to Fusarium wilt by measuring disease severity, vascular discolouration, and disease incidence in naturally infested fields near Hamilton, Ontario, 2012.

Cultivar	DSI[1]	VDI[2]	Disease Incidence (%)
C2606	10.9 ns[3]	32.5 ns	17.0 ns
Sardinia	15.7	39.2	24.1
POH-6116 F1	19.8	34.2	38.2
Carmel F1	19.9	41.7	29.7
POH-0438 F1	23.4	42.5	36.1
Unipack 151	23.7	48.4	34.0
Vancouver	24.2	52.5	39.4
Imperial Green	25.7	45.8	45.7
Hellcat	26.5	46.7	36.1
Stanton F1	27.8	38.3	37.9
El Cajon	28.3	52.5	35.8
Bolero	29.2	49.2	37.2
Menorca	29.3	41.7	38.4
Greyhound	29.4	54.2	43.3
Kauai	29.6	50.8	40.4
Imperial Star	30.3	48.3	43.9
Persius	31.2	58.3	45.2
Olympia	31.9	43.4	51.8
Monza F1	32.0	49.2	41.0
Falcon	32.3	60.9	43.2
Indurain	32.5	40.8	38.7
Tasman F1	33.0	47.5	45.6
Seven R	33.1	57.5	47.4
Norgreen HF	37.9	59.2	59.3
Unipack 12	38.1	60.8	49.9

[1] Disease Severity Index (DSI) was determined using the following equation:

$$\text{DSI/VDI} = \frac{\sum [(\text{class no.})(\text{no. of plants in each class})]}{(\text{total no. plants per sample})(\text{no. classes } -1)} \times 100$$

[2] Vascular Discolouration Index (VDI) was determined using the equation above.
[3] ns = not significantly different, $P = 0.05$ Fisher's Protected LSD Test

Funding was partially provided by the HQP Scholarship Program of the OMAFRA/ University of Guelph Partnership.

CROP: Spinach (*Spinacia oleracea*), cv. Spiros, S/L 37682

AUTHORS: MCDONALD MR & RICHES L
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: **SEED YIELD FROM DIRECT SEEDED AND TRANSPLANTED SPINACH, 2012**

OBJECTIVE: to investigate optimum cultural methods of spinach seed production on muck soil in Ontario

METHODS: Spinach, cv. Spiros, S/L 37682, was direct seeded and transplanted into organic soil (pH ≈7.4, organic matter ≈ 49.5) near the Muck Crop Research Station, Holland Marsh, Ontario, latitude 44° 02.50'N by 79° 35.92'W. Four treatments were used, spinach directly seeded using a V-belt Push Seeder (14 seeds/m), spinach directly seeded using an Earthway Push Seeder fitted with seed plate 1002-5 (34 seeds/m) and spinach transplants planted at 15 and 30cm spacing. Direct seeded treatments and transplants were seeded on 24 May; transplants were seeded into 200 cell plug trays, grown in a greenhouse and hand transplanted into organic soil on 26 June. A complete block design with four replicates per treatment was used with each experimental unit consisting of four rows, 5 m long and 40 cm apart. On 22 August, seed heads from 10 plants per replicate were cut, left to dry and the seeds were hand removed in November. The seed was weighed on December 10. Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1ºC), September (14.8ºC) and October (9.7ºC), and above average for May (15.9ºC), June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: May 12.3ºC, June 18.2ºC, July 20.7ºC, August 19.5ºC, September 15.8ºC and October 8.9ºC. Monthly rainfall was below the previous long term 10 year average for May (49 mm) and June (55 mm), average for August (69 mm), and above average for July (140 mm), September (94 mm) and October (124 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm, July 81 mm, August 67 mm, September 74 mm and October 59 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained using Fisher's Protected LSD test at $P = 0.05$ level of significance.

RESULTS: Significant differences in plants per meter were found among planting methods. Each treatment showed clear differences with the Earthway push seeder having the highest seeding rate, followed by the V-belt push seeder and then 15 and 30 cm spaced transplants. Seed produced per ten plants was only measured between the Earthway and V-belt push seeder replicates by reason that the spinach plants from the 15 and 30 cm spaced transplants bolted early and seeds were not collected in time. There were no significant differences in seed production between the Earthway and V-belt push seeders. (Table 1)

CONCLUSIONS: Significant differences were found in plant spacing among planting methods, however due to the lack of data, it is unknown whether or not these planting methods produce different seed yield. More research is needed to find the optimum plant spacing for seeded and transplanted spinach for maximum seed production.

Table 1. Weight of seed for 10 spinach plants, cv. Spiros, grown in the greenhouse and transplanted, or direct seeded at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Plants per Meter	Weight of Seed from 10 plants (g)
Seeded Earthway	19.8 a[1]	8.5 ns[2]
Seeded V-belt	11.6 b	11.0
15 cm Spaced Transplant	6.6 c	---[3]
30 cm spaced Transplant	3.3 d	---

[1] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher's protected LSD test.
[2] ns indicates there are no significant differences between treatments
[3] --- indicates no data

Funding for this project was supplied by Ocean Mist Farms, Castroville, CA

CROP: Spinach (*Spinacia oleracea* L.), cv. Greyhound
PEST: Fusarium wilt of spinach (*Fusarium oxysporum* f. sp. *spinaciae* (Sherb.) W.C. Snyder & H.N. Hans.)

AUTHORS: COLLINS B & McDONALD MR
University of Guelph, Dept. of Plant Agriculture

TITLE: EVALUATION OF BIOLOGICAL AND CHEMICAL CONTROLS FOR THE SUPPRESSION OF FUSARIUM WILT OF SPINACH, 2012

MATERIALS: APRON XL LS (metalaxyl 33.3%), THIRAM 50WP (thriam 50%), MAXIM 480 FS (fludioxonil 40.3%), MAXIM QUATTRO (metalaxyl 2.65%, fludioxonil 3.32%, azoxystrobin 1.33%, thiabendazole 26.5%), DIVIDEND XL RTA (metalaxyl 0.27%, difenconazole 3.37%), MERTECT SC (thiabendazole 500g/L), TRILEX AL (metalaxyl 10.8%, trifloxystrobin 13.5g/L), RAXIL FL (tebuconazole 6g/L), PROLINE 480 SC (480g/L), RANCONA 3.8 (ipconazole 40.7%), PRO-GRO (carbathiin 30%, thriam 50%), SENATOR PSPT (thiophanate-methyl 10%), CABRIO (pyraclostrobin 20%), HEADS UP (*Chenopodium quinoa* 49.7%), SERENADE SOIL (*Bacillus subtilis* 10^9 CFU/g), ACTINOVATE (*Streptomyces lydicus* 10^7 CFU/g), MYCOSTOP (*Streptomyces griseoviridis* 10^8 CFU/g), PRESTOP (*Gliocladium catenulatum* $2x10^8$ CFU/g), CONTANS (*Coniothyrium minitans* 10^9 CFU/g), "PROPHYTA-B" (*Trichoderma atroviride* 10^{10} CFU/g), "CLO" (*Clonostachys rose* ACM941 10^{10} CFU/g), FARMORE D300 (metalaxyl 33.3%, fludioxonil 40%, azoxystrobin 9.6%).

METHODS: Field trials were conducted in July and August 2012 in mineral soil (pH ≈ 7.2) naturally infested with *Fusarium oxysporum* f. sp. *spinaciae* near Hamilton, Ontario. The susceptible cultivar, Greyhound, was commercially treated with the industry standard (APRON XL LS and THIRAM). Biological and chemical controls (Table 1) were applied either to the treated seed (S), drenched after seeding (D), or applied to the foliage (F) three weeks after seeding. Each experimental unit consisted of the four inner rows of a 6-row (1.5 m wide) bed and 4 m in length seeded with a Stanhay Precision Seeder. This field assay was arranged in a randomized complete block design with four replications. Plots were irrigated as required using overhead irrigation. Two applications of ammonium nitrate fertilizer were applied 3 and 18 days after seeding providing 110 kg N/ha. Six weeks after seeding, the Disease Severity Index (DSI) was determined by assessing all of the plants in 1 m section of one of the two middle rows using a 0-4 scale: 0 = healthy; 1 = yellowing; 2 = slightly wilted; 3 = severe wilted; 4 = dead plant; calculated as shown below. The vascular discoloration severity of the roots was determined by sectioning ten roots per experimental unit longitudinally and rating the roots on a scale from 0-3: 0 = healthy white roots; 1 = one-third discoloration or less; 2 = one-third discoloration to two-thirds; 3 = more than two-thirds vascular discoloration. Vascular Discolouration Index (VDI) was calculated as displayed below. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained by using Fisher's Protected LSD Test at $P = 0.05$ level of significance.

$$\text{DSI/ VDI} = \frac{\sum [(\text{class no.})(\text{no. of plants in each class})]}{(\text{total no. plants per sample})(\text{no. classes } -1)} \times 100$$

RESULTS: as presented in Table 2

CONCLUSIONS: Significant differences were found in disease severity, vascular discolouration, and disease incidence among the treatments. The treatments with low disease severity had low vascular discolouration and disease incidence. The untreated check had lower disease severity than the standard seed treatment (APRON XL LS (S) + THRIAM (S)). The most effective chemical seed treatments included MAXIM QUATTRO (S), FARMORE D300 (S), and MAXIM QUATTRO (S) + PROLINE 480 SC (S). The biocontrols HEADSUP (S) and ACTINOVATE (D) + ACTINOVATE (F) reduced disease severity equivalent to the best chemical controls.

Table 1. Biological and chemical treatments evaluated for the suppression of Fusarium wilt of spinach, cv. Greyhound, grown near Hamilton, Ontario, 2012.

Product	Formulation (g ai/L or as noted)	App. Method	Rate/100 kg seed or as noted
Check	--	--	--
APRON XL LS	metalaxyl (33.3%)	S[1]	42 mL
THIRAM 50WP	thriam (50%)	S	500 g
MAXIM 480 FS	fludioxonil (40.3%)	S	10.4 mL
MAXIMQUATTRO	fludioxonil (3.32%) metalaxyl (2.65%) azoxystrobin (1.33%) thiabendazole (26.5%)	S	67 mL
DIVIDEND XL RTA	difenoconazole (3.37%) metalaxyl (0.27%)	S	650 mL
MERTECT SC	thiabendazole (500g/L)	S	100 mL
TRILEX AL	trifloxystrobin (13.5g/L) metalaxyl (10.8%)	S	370 mL
RAXIL FL	tebuconazole (6g/L)	S	256 mL
PROLINE 480 SC	prothioconazole (480g/L)	S	21 mL
PROLINE 480 SC x10	prothioconazole (480g/L)	S	210 mL
PROLINE 480 SC	prothioconazole (480g/L)	D	416 mL/ha
RANCONA 3.8	ipconazole (40.7%)	S	22 mL
RANCONA 3.8 x10	ipconazole (40.7%)	S	222 mL
PRO-GRO	carbathiin (30%) thiram (50%)	S	1250 g
SENATOR PSPT	thiophanate-methyl (10%)	S	500 g
SENATOR PSPT x3	thiophanate-methyl (10%)	S	1500 g
CABRIO	pyraclostrobin (20%)	D	1.12 L/ha
HEADS UP	*Chenpodium quinoa* saponins (49.7%)	S	28 g
HEADS UP x2	*Chenpodium quinoa* saponins (49.7%)	S	56 g
HEADS UP x2	*Chenpodium quinoa* saponins (49.7%)	S + F	56 g + 28 g
SERENADE SOIL	*Bacillus subtilis* (10^9 CFU/g)	D	5.6 L/ha
SERENADE SOIL x2	*Bacillus subtilis* (10^9 CFU/g)	D	11.2 L/ha
SERENADE SOIL x3	*Bacillus subtilis* (10^9 CFU/g)	D	16.8 L/ha
ACTINOVATE	*Streptomyces lydicus* (10^7 CFU/g)	D	840 mL/ha
ACTINOVATE	*Streptomyces lydicus* (10^7 CFU/g)	D + F	840 mL/ha
MYCOSTOP	*Streptomyces griseoviridis* (10^8 CFU/g)	S	500 g
PRESTOP	*Gliocladium catenulatum* ($2x10^8$ CFU/g)	D	200 g/10m^2
CONTANS	*Coniothyrium minitans* (10^9 CFU/g)	D	4 kg/ha
"PROPHYTA-B"	*Trichoderma atroviride* (10^{10} CFU/g)	D	2.24 kg/ha
"CLO"	*Clonostachys rose* ACM941 (10^{10} CFU/g)	S	133 g
FARMORE D300	APRON XL LS- metalaxyl (33.3%) DYNASTY- azoxystrobin (9.6%) MAXIM 480 FS- fludioxonil (40%)	S	40 mL 25 mL 5 mL
MAXIM QUATTRO	metalaxyl (2.65%) fludioxonil (3.32%) azoxystrobin (1.33%) thiabendazole (26.5%)	S	67 mL
PROLINE 480 SC	prothioconazole (480g/L)	S	21 mL

[1] Treatments applied as a seed treatment (S), soil drench (D), or foliar spray (F).

Table 2. Effect of biological and chemical controls on the disease severity, vascular discolouration, and disease incidence of Fusarium wilt of spinach grown near Hamilton, Ontario, 2012.

Treatment Name	Treatment Method	DSI[1]	VDI[2]	Disease Incidence (%)
ACTINOVATE + ACTINOVATE	D[3] + F	13.4 a[4]	34.2 ab	22.6 ab
MAXIM QUATTRO + PROLINE	S + S	13.9 a	35.9 abc	21.0 a
HEADS UP	S	14.4 a	41.7 a-f	21.7 a
FARMORE D300	S	15.5 ab	30.8 a	25.7 abc
MAXIM QUATTRO	S	16.7 ab	37.5 abc	27.0 abc
CABRIO	D	19.1 ab	41.7 a-f	32.0 a-e
TRILEX	S	19.6 abc	50.8 b-g	31.1 a-e
PRO-GRO	S	20.1 a-d	38.3 a-d	30.1 a-d
SERENADE SOIL x2	D	20.2 a-d	39.2 a-d	32.3 a-e
ACTINOVATE	D	20.2 a-d	36.7 abc	29.8 a-d
MERTECT SC	S	20.9 a-e	34.2 ab	32.7 a-e
SERENADE SOIL	D	21.8 a-e	37.5 abc	34.0 a-f
PRESTOP	D	22.1 a-e	40.8 a-e	36.7 a-g
“PROPHYTA-B”	D	22.9 a-e	38.3 a-d	31.5 a-e
Untreated check	--	23.3 a-e	52.5 c-g	36.3 a-g
SERENADE SOIL x3	D	24.5 a-f	40.8 a-e	34.5 a-f
PROLINE	D	24.7 a-f	41.7 a-f	38.6 a-g
HEADS UP x2	S	25.7 a-f	41.7 a-f	39.3 a-h
PROLINE	S	25.7 a-f	44.2 a-g	34.9 a-f
RAXIL FL	S	26.6 a-f	45.8 a-g	34.4 a-f
RANCONA 3.8 x10	S	27.4 a-f	47.5 a-g	38.2 a-g
“CLO”	S	29.9 a-g	51.7 b-g	37.7 a-g
CONTANS	D	32.0 a-g	45.8 a-g	48.0 c-h
PROLINE x10	S	35.1 b-g	52.5 c-g	46.2 b-h
MYCOSTOP	S	35.6 b-g	59.2 fg	43.1 a-h
RANCONA 3.8	S	39.3 c-g	49.2 b-g	48.4 c-h
HEADS UP x2 + HEADS UP	S + F	39.8 d-g	58.4 efg	53.4 d-h
SENATOR PSPT x3	S	39.8 d-g	55.9 d-g	47.3 c-h
SENATOR PSPT	S	40.9 efg	37.5 abc	57.7 fgh
DIVIDEND XL RTA	S	43.6 fg	50.9 b-g	54.8 e-h
MAXIM 480 FS	S	47.7 g	61.7 g	62.9 h
STD: APRON XL LS + THIRAM	S + S	48.1 g	49.2 b-g	59.6 gh

[1] Disease Severity Index (DSI) was determined using the following equation:

$$\text{DSI/VDI} = \frac{\sum [(\text{class no.})(\text{no. of plants in each class})]}{(\text{total no. plants per sample})(\text{no. classes } -1)} \times 100$$

[2] Vascular Discolouration Index (VDI) was determined using the equation above

[3] Treatments applied as a soil drench (D), foliar spray (F), and seed treatment (S).

[4] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher’s Protected LSD test.

Funding was partially provided by the HQP Scholarship Program of the OMAFRA/ University of Guelph Partnership.

PESTS: Botrytis leaf blight of onion (*Botrytis* squamosa Walker), Onion white rot (*Sclerotinia cepivorum* Berk), Sclerotinia rot of carrot (*Sclerotinia sclerotiorum* (Lib.) de Bary)

AUTHORS: BARBISON LC[1], MCDONALD MR[2] & BOLAND GJ[3]
[1 3]University of Guelph, School of Environmental Sciences
[2] University of Guelph, Dept. of Plant Agriculture

TITLE: EVALUATION OF THREE BIOLOGICAL CONTROL AGENTS ON THE SURVIVAL OF THREE SCLEROTIA-FORMING FUNGI, 2011/2012

MATERIALS: CONTANS (*Coniothyrium minitans* Campbell), *Trichoderma atroviride* Karsten, *Michrosphaeropsis ochracea* Carisse & Bernier

METHODS: In August and September 2011, sclerotia of *S. sclerotiorum* and *S. cepivorum* were collected from naturally-infested fields within the Holland Marsh area. Also during this time, laboratory-produced sclerotia were initiated on Potato Dextrose Agar (PDA) by germinating sclerotia originally obtained from the field. Biological control agents were obtained by the biocontrol distributor ProPhyta GmbH. Sclerotia were divided into groups of 50 sclerotia of *B. squamosa* and *S. cepivorum* and 25 sclerotia of *S. sclerotiorum*. Groups of sclerotia were placed in 5 cm x 6 cm mesh (158 meshcount) nylon bags, along with 10 mL of soil for *B. squamosa* and *S. sclerotiorum* and 5 mL of soil for *S. cepivorum.* Bags containing laboratory-produced sclerotia and soil were subjected to a total of four treatments: *C. minitans* solution, *M. ochracea* solution, *T. atroviride* solution, and untreated (negative control). Biocontrol solutions were composed of granular formulas provided by ProPhyta GmbH and sterile distilled water. Rates are shown in Table 1. Solutions were applied at rates of 2 mL for *B. squamosa* and *S. sclerotiorum* and 1 mL of soil for *S. cepivorum.* Each treatment was replicated five times for each sampling date, with a total of 9 sampling dates throughout the course of 2 years. Once treated, mesh bags were heat sealed and buried in 1.5 L pots of muck soil at a depth of 10-15 cm. In December 2011, pots were placed outdoors at the Muck Crops Research Station until allocated sampling dates. Sampling periods occurred once every 2-3 months. During each sampling date, a subset of pots were collected and mesh bags were removed. Sclerotia were separated from soil through dry sieving. Sclerotia were surface disinfested (1 min in ethanol, 4 min in 5% sodium hypochloride and rinsed 3 times with sterile distilled water) and individually plated onto partitioned quad-plate petri dishes (Fisher Scientific) of acidified PDA. Plates were monitored over the course of 3-4 weeks and the occurrence of germination and subsequent sclerotia production was recorded. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Multiple means comparisons were obtained using Tukey's HSD Test at $P = 0.05$ level of significance.

RESULTS: as presented in Table 2

CONCLUSIONS: Antagonistic activity of *T. atroviride* is similar to, or greater than that of *C. minitans*. The natural survival of sclerotia appears to differ between laboratory- and field-produced sclerotia. Reduced survival of laboratory-produced sclerotia may be attributed to dormancy requirements and/or other variables.

Table 1. Biocontrol treatment rates for inoculation of sclerotia of *B. squamosa*, *S. cepivorum* and *S. sclerotiorum* placed outdoors at the Muck Crops Research Station, Holland Marsh, Ontario, 2011.

Controls		**Treatments**	
Field-Produced Sclerotia	**Lab-Produced Sclerotia**	**Lab-Produced Sclerotia**	***C. minitans***
S. sclerotiorum	*B. squamosa*	*B. squamosa*	6.2 x10^7 spores/mL
S. cepivorum	*S. sclerotiorum*	*S. sclerotiorum*	***T. atroviride***
	S. cepivorum	*S. cepivorum*	1.1 x 10^8 spores/mL
			M. ochracea
			1.2 x 10^8 spores/mL

Table 2. Percent survival[z] of treated sclerotia of *B. squamosa*, *S. cepivorum*, and *S. sclerotiorum* placed outdoors at the Muck Crop Research Station, Holland Marsh, Ontario, 2011.

Treatments	1 Month Post Burial		
	B. squamosa	*S. sclerotiorum*	*S. cepivorum*
Field Control		3.4 c	6.0 a
Lab Control	95.6 a	98.4 a	1.2 a
C. minitans	90.9 a	64.2 b	0.8 a
T. atroviride	72.0 b	40.6 b	0.0 a
M. ochracea	94.8 a	95.2 a	2.0 a
Treatments	**3 Month Post Burial**		
	B. squamosa	*S. sclerotiorum*	*S. cepivorum*
Field Control		21.4 b	18.0 a
Lab Control	90.4 a	96.0 a	7.2 ab
C. minitans	91.2 a	99.2 a	2.0 a
T. atroviride	82.8 a	39.0 b	10.0 ab
M. ochracea	94.0 a	96.8 a	2.8 ab
Treatments	**5 Month Post Burial**		
	B. squamosa	*S. sclerotiorum*	*S. cepivorum*
Field Control		9.6 b	2.4 a
Lab Control	93.6 a	84.0 a	0.0 a
C. minitans	92.0 a	27.2 b	0.0 a
T. atroviride	33.6 b	31.2 b	6.0 a
M. ochracea	92.4 a	93.4 a	5.6 a
Treatments	**8 Month Post Burial**		
	B. squamosa	*S. sclerotiorum*	*S. cepivorum*
Field Control		12.8 b	13.2 a
Lab Control	73.6 ab	69.6 a	3.2 a
C. minitans	72.4 ab	18.4 ab	0.8 a
T. atroviride	32.0 b	30.4 ab	2.8 a
M. ochracea	84.8 a	64.8 ab	0.0 a
Treatments	**11 Month Post Burial**		
	B. squamosa	*S. sclerotiorum*	*S. cepivorum*
Field Control		4.0 b	0.0 a
Lab Control	58.0 a	34.6 ab	0.0 a
C. minitans	68.4 a	12.8 b	0.0 a
T. atroviride	23.6 b	4.8 b	0.0 a
M. ochracea	74.8 a	74.4 a	0.4 a

[z]Percent Survival = [(# of sclerotia recovered x % germination of recovered) / original # of sclerotia] x 100
a, b, c Means followed by the same letter are not significantly different at P=0.05 according to Tukey's HSD on arcsine-transformed values. Original values are presented.

Funding for this project was provided by OMAFRA HQP Scholarship Program.

CROP: Pea (*Pisum sativum* L.), cv. Sabre
PEST: Downy mildew (*Peronospora viciae* Berk.)

AUTHORS: TESFAENDRIAS MT and MCDONALD MR
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: EVALUATION OF FUNGICIDES FOR CONTROL OF DOWNY MILDEW ON PEAS, 2012

MATERIALS: DPX QGU 42 OD (experimental), HEADLINE EC (pyraclostrobin 25%), SYLGARD 309 (siloxylate polyether 76%)

METHODS: The trial was conducted at an off-station site near the Muck Crops Research Station, Holland Marsh, Ontario, in sandy loam soil (pH ≈ 7.9, organic matter ≈ 5.19%). Pea, cv. Sabre was direct seeded using Earthway Precision Seeder on 25 July. A randomized complete block design with four replicates per treatment was used. Each experimental unit consisted of four 5 m long rows, 42 cm apart. Treatments were: DPX-QGU at 87.5, 175 and 350 mL/ha, DPX-QGU at 350 mL/ha + SYLGARD 0.25% v/v and HEADLINE at 600 mL/ha. An untreated check was also included. Treatments were applied on 15, 22 and 29 August, and 7 September using a CO_2 backpack sprayer equipped with four TeeJet 8002 VS fan nozzles spaced 40 cm apart and calibrated to deliver 400 L/ha at 240 kPa (boom). Disease severity was rated on a scale of 0 to 5: 0 = no lesions, 1 = 1-20%, 2 = 21-40%, 3 = 41-55%, 4 = 56-75% and 5= > 75% of the plant part infected. The disease severity values were used to calculate the area under the disease progress curve (AUDPC) and disease severity index (DSI). The AUDPC was calculated using the following equation:

$$\text{AUDPC} = \sum_{j=1}^{Nj-1} \left(\frac{y_j + y_{j+1}}{2}\right)(t_{j+1} - t_j)$$

Where j is the order index for the times and n_j is the total number of assessments, y_j is the downy mildew severity rating at day t_j, y_{j+1} is the downy mildew severity rating at day t_{j+1} and (t_{j+1} - t_j) is the number of days between two assessments.
Disease severity index was determined using the following equation:

$$\text{DSI} = \frac{\sum [(\text{rating class no.})(\text{no. of plants in each rating class})]}{(\text{total no. of plants per sample})\ (\text{no. classes} - 1)} \times 100$$

On 3 October, a 1 meter long sample was removed from 2 rows of each replicate by cutting the plants at soil level. Total top plant part, total pod and marketable pod weights were determined. Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1 ºC) and September (14.8ºC), and above average for July (22.2ºC). The long term previous 10 year average temperatures were: July 20.7ºC, August 19.5ºC and September 15.8ºC. Monthly rainfall was above the previous long term 10 year average for July (140 mm) and September (94 mm), and average for August (69 mm). The long term previous 10 year rainfall averages were: July 81 mm, August 67 mm and September 74 mm. Data were analysed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained using Fisher's Protected LSD test with P = 0.05 level of significance.

RESULTS: as presented in Tables 1 and 2

CONCLUSIONS: Significant differences in downy mildew incidence, disease severity index (DSI) and area under the disease progress curve (AUDPC) were observed among the treatments (Table 1).

HEADLINE was the most effective fungicide in reducing downy mildew incidence and severity compared to DPX-QGU at any rate and the untreated check. At harvest, disease incidence was 100% for all the treatments. However, the DSI for peas treated with HEADLINE was lower at all evaluation periods than DPX-QGU and the untreated check. Differences were also observed in top plant part, total and marketable pod weights among the treatments (Table 2). Peas treated with HEADLINE had higher weights than DPX-QGU treated peas and the untreated check. No significant differences in percent downy mildew incidence, DSI, AUDPC, or yield were found among peas treated with DPX-QGU and the untreated check. All the products tested were non-phytotoxic to the crop.

Table 1. Downy mildew (DM) incidence and severity ratings for peas, cv. Sabre, treated with fungicides, grown near the Muck Crops Research Station, Holland Marsh, 2012.

Treatment	Rate (per ha)	DM Incidence (%)			Disease Severity Index			AUDPC[1]
		21 Sep	28 Sep	3 Oct	21 Sep	28 Sep	3 Oct	
HEADLINE	600 mL	37.5 a[2]	37.5 a	100.0 ns[2]	12.5 a	22.5 a	30.0 a	9.6 a
DPX-QGU + SYLGARD	350 mL. +0.125%v/v	97.5 b	97.5 b	100.0	34.0 b	39.0 b	54.0 b	28.9 b
DPX-QGU	350 mL	100.0 b	100.0 b	100.0	35.0 b	38.0 b	52.5 b	30.9 b
DPX-QGU	175 mL	97.5 b	97.5 b	100.0	39.0 b	46.0 b	50.5 b	33.1 b
DPX-QGU	87.5 mL	100.0 b	100.0 b	100.0	40.0 b	42.5 b	54.0 b	35.6 b
Check	--	100.0 b	100.0 b	100.0	43.0 b	44.5 b	55.5 b	36.2 b

[1]AUDPC = Area under the disease progress curve.
[2] Numbers in a column followed by a different letter were significantly different at $P = 0.05$, based on Fisher's Protected LSD test.
[3]ns = no significant differences were found among the treatments

Table 2. Yield data for peas, cv. Sabre, treated with fungicides, grown near the Muck Crops Research Station, Holland Marsh, 2012.

Treatment	Rate (per ha)	Top weight (g/plant)	Total pod weight (g/plant)	Marketable pod weight (g/plant
HEADLINE	600 mL	18.3 a[1]	5.8 a	5.8 a
DPX-QGU + SYLGARD	350 mL. +0.125%v/v	8.9 b	0.8 b	0.5 b
DPX-QGU	350 mL	8.3 b	1.1 b	0.4 b
DPX-QGU	175 mL	8.3 b	1.6 b	0.6 b
DPX-QGU	87.5 mL	8.2 b	0.9 b	0.0 b
Check	--	7.3 b	1.1 b	0.3 b

[1] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, based on Fisher's Protected LSD test.

Funding for this project was provided by the Pest Management Centre of Agriculture and Agri-Food Canada.

CROP: Onion, green (*Allium fistulosum*.), cv. Emerald Isle
PEST: Downy mildew (*Peronospora destructor* Berk. Casp. In Berk)

AUTHORS: MCDONALD MR & RICHES L
University of Guelph, Dept. of Plant Agriculture,Muck Crops Research Station

TITLE: EFFICACY AND TOLERANCE OF PRESIDIO AND DPX-QGU42 FUNGICIDES FOR CONTROL OF DOWNY MILDEW ON GREEN ONIONS , 2012

MATERIALS: DPX-QGU42 (experimental), REASON 500SC (fenamidone 44.4%), PRESIDIO (fluopicolide 39.5%), SYLGARD 309 (siloxylated polyether 76%)

METHODS: Two separate trials were conducted to test the efficacy of DPX-QGU42 and PRESIDIO fungicides to control downy mildew on green onions. Onions, cv. Emerald Isle, were direct seeded (≈ 65 seeds/m) on 6 July using a Stan Hay Precision Seeder into organic soil (organic matter ≈ 76.1%, pH ≈ 7.1) at the Muck Crops Research Station, Holland Marsh, Ontario. A randomized complete block arrangement with four replicates per treatment was used in each trial. Each replicate consisted of four rows (42 cm apart), 4 m in length. Treatments for the DPX-QGU42 trial were: DPX-QGU42 at 87.5, 175 and 350 mL/ha + SYLGARD at 0.25% v/v, PRESIDIO at 292 mL/ha, and REASON 500SC at 400 mL/ha applied four times and QGU42 at 350 mL/ha + SYLGARD at 0.25%v/v applied once (16 August). Treatments for the PRESIDIO trial were: PRESIDIO at 220, 292 and 400 mL/ha, PRESIDIO at 292 with REASON 500SC at 400 mL/ha and DPX-QGU42 at 250 and 150 mL/ha. Two untreated checks were also included in each trial. Treatments were applied on 16 and 30 August and 7 and 21 September using a CO_2 backpack sprayer equipped with four TeeJet 8002 VS fan-type nozzles spaced 40 cm apart and calibrated to deliver 400 L/ha of water. The plots were visually examined for DM lesions on a weekly basis and assessed for phytotoxicity on17, 31 August and 10 and 24 September. On 12 October for the DPX-QGU42 trial and 16 October for the PRESIDIO trial, all onions in two, one meter sections of the inside two rows per replicate were pulled, weighed and counted for a yield assessment. Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1ºC), September (14.8ºC) and October (9.7ºC), and above average for May (15.9ºC), June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: May 12.3ºC, June 18.2ºC, July 20.7ºC, August 19.5ºC, September 15.8ºC and October 8.9ºC. Monthly rainfall was below the previous long term 10 year average for May (49 mm) and June (55 mm), average for August (69 mm), and above average for July (140 mm), September (94 mm) and October (124 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm, July 81 mm, August 67 mm, September 74 mm and October 59 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained by using Fisher's Protected LSD test at $P = 0.05$ level of significance.

RESULTS: as presented in Tables 1 and 2

DISCUSSION: DOWNCAST, the onion downy mildew predictive model, predicted a sporulation infection period several times over the season, however, in 2012, no downy mildew incidence was reported in the Holland Marsh. No downy mildew was found in either trial, which resulted in no significant differences in the number of downy mildew lesions per plant among the treatments (Tables 1 and 2). No significant differences were observed in the weight per plant among the treatments within either trial. All the products tested were non-phytotoxic to the crop.

Table 1. Downy mildew (DM) rating and weight per plant for onions, cv. Emerald Isle, treated with various fungicides to test the efficacy and tolerance of QGU42 grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	# Applications	Rate (mL/ha)	DM lesions per m of row	Weight per plant (g)
check	--	--	0 ns[1]	77.9 ns
check	--	--	0	74.0
DPX-QGU42 + SYL[2]	4	87.5	0	78.4
DPX-QGU42 + SYL	4	175	0	62.6
DPX-QGU42 + SYL	1[3]	350	0	77.9
DPX-QGU42 + SYL	4	350	0	79.2
PRESIDIO	4	292	0	79.7
REASON 500	4	400	0	73.6

[1] ns indicates no significant differences were found among the treatments
[2] Sylgard 309 at 0.25% v/v
[3] sprayed once on 15 August

Table 2. Downy mildew (DM) rating and weight per plant for onions, cv. Emerald Isle, treated with various fungicides to test the efficacy and tolerance of PRESIDIO grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	# Applications	Rate (mL/ha)	DM lesions per m of row	Weight per plant (g)
check	--	--	0 ns[1]	77.9 ns
check	--	--	0	74.0
PRESIDIO	4	220	0	78.4
PRESIDIO	4	292	0	62.6
REASON	4	400	0	77.9
PRESIDIO + REASON	4	292 + 400	0	79.2
DPX-QGU42	4	250	0	79.7
DPX-QGU42	4	150	0	73.6

[1] ns indicates no significant differences were found among the treatments

Funding for this project was provided by Agriculture and Agri-food Canada.

CROPS: Melon, cantaloupe (*Cucumis melo*) cv. Athena
Cauliflower (*Brassica, oleracea*), cv. Snow Crown
Cucumber, field (*Cucumis sativus* L.), cv. Marketmore
Kale (*Brassica, oleracea*), cv. Red Russian
Spinach (*Spinacia oleracea*), cv. Unipak 151
Lettuce, head (*Lactuca sativa* L.), cv. Estival
Lettuce, romaine (*Lactuca sativa* L.), cv. Chistera

PEST: Rhizoctonia seed rot, damping off and seedling blight, *Rhizoctonia solani*

AUTHORS: MCDONALD MR & RICHES L
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: EVALUATION OF SEDAXANE SEED TREATMENT FOR CONTROL OF *RHIZOCTONIA SOLANI* IN VEGETABLE CROP SEEDLINGS, 2012

MATERIALS: VIBRANCE 500FS (sedaxane 50%)

METHODS: Seven separate trials were conducted to test the efficacy and tolerance of VIBRANCE seed treatment to control seed rot, damping off and blight caused by *Rhizoctonia solani* in various vegetable crops. Trials were conducted on mineral soil (organic matter ≈ 4.0%, pH ≈ 8.0) near the Muck Crops Research Station, Holland Marsh, Ontario. On 16 May, colonized and sterile barley grains were spread in trenches 5 cm deep adjacent to planned seeding rows at the rate of 50 mL/m and covered with a rake. To produce inoculum *Rhizoctonia solani* was isolated from beet samples grown in the Holland Marsh in 2011 and grown on PDA amended with streptomycin sulphate. Six, seven-day old 5 mm diameter mycelia-agar discs were transferred from the margin of growing colonies to sterilized barley grains and kept at 22°C in darkness for 21 days. Barley grains were sterilized by soaking for 12 hours in 400 mL of water in a 1000 mL Erlenmeyer flask, water was decanted and the grain was autoclaved twice on consecutive days for 20 minutes at 121°C. The colonized grain was air dried for 24 hours before spreading. A randomized complete block arrangement with four replicates per treatment was used in each trial. Each experimental unit consisted of exactly 100 seeds seeded into 2 rows (86 cm apart), 3 m in length with in-row spacing of 3.5 cm. Trials were seeded as follows: spinach, cv. Unipak 151, head lettuce, cv. Estival and romaine lettuce, cv. Chistera on 28 May, cantaloupe, cv. Athena and field cucumber, cv. Marketmore on 29 May and Cauliflower, cv. Snow Crown and Kale, cv. Red Russian on 15 June. All treatments were hand-seeded using a peg board with pegs spaced 3.5 cm apart to mark seeding holes. Treatments were: VIBRANCE 500 FS at 5 and 10 mL per 100 kg seed. Untreated non-inoculated and inoculated checks were also included. Treated seed was provided by Agriculture and Agri-Food Canada for all trials with the exception of cauliflower, which was treated at the Muck Crop Research Station. Cantaloupe and cucumber trials were assessed of on 13, 21 and 28 June and 5 July (15, 23, 30 and 37 DAS), head lettuce, romaine lettuce and spinach trials were assessed on 21 and 28 June and 5, 12 and 23 July (24, 31, 38, 45 and 56 DAS) and kale and cucumber trials were assessed on 28 June and 5, 12 and 19 July (13, 20, 27 and 34 DAS). Assessment consisted of counting emerged plants for seedling emergence and the recording of numbers. Compared to the averaged previous 10 years, the air temperatures in 2012 were above average for May (15.9ºC), June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: May 12.3ºC, June 18.2ºC and July 20.7ºC. Monthly rainfall was below the previous long term 10 year average for May (49 mm) and June (55 mm) and above average for July (140 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm and July 81 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained using Fisher's Protected LSD Test at $P = 0.05$ level of significance.

RESULTS: Percent seedling emergence was similar among seeds treated with VIBRANCE on all dates for all trials and ranged from 49.8-62.0% for kale, 53.3-68.5% for cauliflower, 54.3-72.8% for cantaloupe, 35.3-49.3% for head lettuce, 29.5-44.5% for romaine lettuce, 25.3-47.8% for spinach and 62.3-68% for cucumber. No significant difference in the percent seedling emergence was found among the treatments for all trials (Table 1, 2, 3 4, 5, 6 and 7).

DISCUSSION: The germination rate (% germ) for all seeds in each trial before VIBRANCE was applied is unknown and therefore cannot be compared to percent emergence of seeds treated with VIBRANCE which averaged ≈ 54.7% for kale, ≈ 60.8% for cauliflower, ≈ 41.3% for head lettuce, ≈ 36.0% for romaine lettuce, ≈ 36.8% for spinach and ≈ 65.3% for cucumber. Many pathogenic fungi are present in soil and the trial did not investigate which pathogen caused the death of germinating seeds resulting in the lower percent emergence. *Rhizoctonia solani* in the inoculated plots may have excluded naturally occurring pathogenic soil fungi thus decreasing death of the germinating seeds compared to non-inoculated plots containing native pathogenic fungi. The effectiveness of the inoculation method was not determined. Head lettuce, romaine lettuce and spinach plots were inoculated 12 days and cantaloupe and cucumber plots 13 days before seeding, in order to allow time for the fungi to become established in the soil before seeding. After inoculation on 16 May, 16 days passed before the occurrence of the first significant rainfall. To compensate for the lack of rainfall, plots were hand watered 7 and 9 days after inoculation but this may not have been sufficient to encourage mycelia growth. Cauliflower and kale plots were inoculated 30 days before seeding which may have been too great a time period for inoculum to persist within the soil.

Table 1. Seedling emergence counts for cantaloupe, cv. Athena treated with VIBRANCE for control of *Rhizoctonia* solani grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Rate (mL/100 kg seed)	13 June (15 DAS)	21 June (23 DAS)	28 June (30 DAS)	5 July (37 DAS)
Non-inoculated check	--	76.3 ns[1]	75.0 ns	71.3 ns	74.8 ns
Inoculated check	--	59.8	58.3	57.8	58.0
VIBRANCE	10	72.8	71.3	70.5	70.8
VIBRANCE	5	56.0	54.3	54.8	58.3

[1] ns = not significantly different at $P = 0.05$, Fisher's Protected LSD test

Table 2. Seedling emergence counts for cauliflower, cv. Snow Crown treated with VIBRANCE for control of *Rhizoctonia* solani grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Rate (mL/100 kg seed)	13 June (15 DAS)	21 June (23 DAS)	28 June (30 DAS)	5 July (37 DAS)
Non-inoculated check	--	66.0 ns[1]	59.8 ns	55.3 ns	52.8 ns
Inoculated check	--	60.5	52.0	48.8	41.8
VIBRANCE	10	67.8	59.5	59.3	59.3
VIBRANCE	5	68.5	64.0	54.8	53.3

[1] ns = not significantly different at $P = 0.05$, Fisher's Protected LSD test

Table 3. Seedling emergence counts for cucumber, cv. Marketmore treated with VIBRANCE for control of *Rhizoctonia* solani grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Rate (mL/100 kg seed)	13 June (15 DAS)	21 June (23 DAS)	28 June (30 DAS)	5 July (37 DAS)
Non-inoculated check	--	76.8 ns[1]	76.0 ns	73.0 ns	73.3 ns
Inoculated check	--	59.3	58.5	58.3	60.0
VIBRANCE	10	66.8	66.5	62.3	64.0
VIBRANCE	5	66.3	66.8	63.5	65.8

[1] ns = not significantly different at $P = 0.05$, Fisher's Protected LSD test

Table 4. Seedling emergence counts for kale, cv. Red Russian treated with VIBRANCE for control of *Rhizoctonia* solani grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Rate (mL/100 kg seed)	28 June (13 DAS)	5 July (20 DAS)	12 July (27 DAS)	19 July (34 DAS)
Non-inoculated check	--	59.8 ns[1]	53.0 ns	55.8 ns	54.3 ns
Inoculated check	--	70.0	62.3	58.5	56.0
VIBRANCE	10	62.0	55.5	54.8	53.3
VIBRANCE	5	58.8	50.3	52.8	49.8

[1] ns = not significantly different at $P = 0.05$, Fisher's Protected LSD test

Table 5. Seedling emergence counts for spinach, cv. Unipak 151 treated with VIBRANCE for control of *Rhizoctonia* solani grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Rate (mL/100 kg seed)	13 June (16 DAS)	21 June (24 DAS)	28 June (31 DAS)	5 July (38 DAS)	12 July (45 DAS)
Non-inoculated check	--	48.0 ns[1]	39.5 ns	28.5 ns	20.5 ns	17.8 ns
Inoculated check	--	46.5	37.5	28.3	22.5	19.3
VIBRANCE	10	46.8	46.3	38.5	31.8	28.3
VIBRANCE	5	47.8	39.8	33.0	30.8	25.3

[1] ns = not significantly different at $P = 0.05$, Fisher's Protected LSD test

Table 6. Seedling emergence counts for head lettuce, cv. Estival treated with VIBRANCE for control of *Rhizoctonia* solani grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Rate (mL/100 kg seed)	21 June (24 DAS)	28 June (31 DAS)	5 July (38 DAS)	12 July (45 DAS)	23 July (56 DAS)
Non-inoc check	--	41.5 ns[1]	41.8 ns	41.0 ns	40.5 ns	37.8 ns
Inoculated check	--	42.3	41.5	42.3	38.3	39.3
VIBRANCE	10	35.5	35.3	37.0	35.8	35.5
VIBRANCE	5	45.3	44.3	49.3	47.0	47.5

[1] ns = not significantly different at $P = 0.05$, Fisher's Protected LSD test

Table 7. Seedling emergence counts for romaine lettuce, cv. Chistera treated with VIBRANCE for control of *Rhizoctonia* solani grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Rate (mL/100 kg seed)	21 June (24 DAS)	28 June (31 DAS)	5 July (38 DAS)	12 July (45 DAS)	23 July (56 DAS)
Non-inoculated check	--	40.3 ns[1]	40.5 ns	39.8 ns	39.0 ns	37.0 ns
Inoculated check	--	33.5	33.0	33.0	33.0	32.8
VIBRANCE	10	44.5	42.5	41.0	40.5	38.3
VIBRANCE	5	32.0	32.5	30.8	29.5	28.8

[1] ns = not significantly different at $P = 0.05$, Fisher's Protected LSD test

Funding for this project was provided by Agriculture and Agri-food Canada.

PEST: *Sclerotium cepivorum* Berk.

AUTHORS: TESFAENDRIAS MT & MCDONALD MR
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: **EFFECT OF BIOCONTROL PRODUCTS ON SURVIVAL AND GERMINATION OF SCLEROTIA OF *SCLEROTIUM CEPIVORUM*, 2012**

OBJECTIVES: To evaluate different biological control products on their effect on recovery and viability of sclerotia of *Sclerotium cepivorum* the cause of white rot of onions.
To determine if the previous crop influences the recovery and viability of sclerotia of *Sclerotium cepivorum.*

MATERIALS: CONTANS (*Coniothyrium minitans* W.A. Campbell, strain CON/M/91-08), *Trichoderma atroviride* Karsten A, *Trichoderma atroviride* Karsten B, *Microsphaeropsis ochracea* Carisse & Bernier

METHODS: The field trial was conducted at two sites in organic soil (Site 1; pH ≈ 7.2, organic matter ≈ 58%) and (Site 2; pH ≈ 6.8, organic matter ≈ 64.8%) near or at the Muck Crops Research Station, Holland Marsh, Ontario, respectively. In 2011, Site 1 and Site 2 were planted to carrots and onions respectively. At Site 1, onions, cv. Patterson, were direct seeded using a Stanhay Precision Seeder on 11 May, 2012. Each plot consisted of 4 rows (42 cm apart), 6 m in length. At Site 2, carrots, cv. Cellobunch, were seeded on 25 May, 2012 at a rate of 85 seeds/m of row and a row spacing of 86 cm. Sclerotia of *S. cepivorum* collected from artificially inoculated onions in January 2011 were used in the trial. Nylon mesh bags (5 cm x 6 cm) were filled with 10 mL of muck soil, 50 sclerotia and biocontrol products. Treatments were: CONTANS (2×10^6 spores/mL), *Trichoderma atroviride* A (1×10^8 spores/mL), *T. atroviride* B (1×10^8 spores/mL) and *Microsphaeropsis ochracea* (1×10^8 spores/mL). An untreated check was also included. Each bag was treated with 2 mL of one of the four biofungicide suspensions. Treatments were applied using a micropipette to mimic drench application. The check was treated with 2 mL water. The bags were kept at room temperature over night. On 30 May (Site 1) and 6 June (Site 2), the bags were buried 10 cm deep between onion rows or in the middle of each carrot row with 50 cm between bags. Treatments were arranged in a randomized block design with five replications per treatment. Treatment efficacy was assessed as percent recovery, viability and survival of sclerotia. On 2 August, 4 October and 5 December (site 1) and 8 August, 10 October and 20 December (site 2) 2012, bags were collected 2, 4, and 6 months post-treatment for assessment. Sclerotia were recovered by sieving through 600 and 210 µm sieves. The sclerotia collected on the 210 µm sieve were retained, surface sterilized (1 min in 70% alcohol, 3 min in 5% sodium hypochlorite and rinsed 3 times in sterile water) and blotted dry. Percent recovery was determined as the proportion of the original 50 sclerotia recovered after sieving and sterilization. Sclerotia viability was evaluated by plating the recovered sclerotia from each replicate onto droplets of potato dextrose agar amended with streptomycin sulphate (PDA). Plates were kept for at least 4 weeks at room temperature before evaluation for viability. A sclerotium was considered viable when it germinated and formed sclerotia. Percent survival was calculated as the proportion of viable sclerotia of the original 50 sclerotia that were recovered and germinated. Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1 ºC), September (14.8ºC) and October (9.7ºC), and above average for May (15.9ºC), June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: May 12.3ºC, June 18.2ºC, July 20.7ºC, August 19.5ºC, September 15.8ºC and October 8.9ºC. Monthly rainfall was below the previous long term 10 year average for May (49 mm) and June (55 mm), average for August (69 mm), and above average for July (140 mm), September (94 mm) and October (124 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm, July 81 mm, August 67 mm, September 74 mm and October 59 mm. Data were analyzed using the Factorial Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation

was obtained using Fisher's Protected LSD test with $P = 0.05$ level of significance. If there were no significant ($P \geq 0.05$) isolate x treatment, isolate x assessment period, or treatment x assessment period interactions, data from the two sites and the 3 assessment periods were combined.

RESULTS: as presented in Tables 1 and 2

CONCLUSION: There was no significant location x treatment or treatment x assessment period interactions for percent sclerotia recovered, percent sclerotia germinated or percent sclerotia survived. However, there was significant location x assessment period interaction for all the evaluation parameters. No significant differences in recovery, germination and survival of sclerotia were found among the treatments (Table 1). Significant differences in recovery and survival of sclerotia at site 1, and germination of sclerotia at both sites were found among the assessment periods of 2, 4 and 6 months after treatment application (Table 2). The percentage of recovered sclerotia was lower at the third assessment period than at the first two assessment periods. Sclerotia germination and survival were lower at the second and third assessment periods.

Table 1. Percent recovery, germination and survival of sclerotia of *Sclerotium cepivorum* treated with biocontrol products in onion and carrot plots at or near the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	% Recovery[1]	% Germination[1]	% Survival[1]
Trichoderma atroviride A	9.3 ns[2]	23.4 ns	3.1 ns
Microsphaeropsis ochracea	9.5	23.7	3.2
CONTANS	10.0	24.2	3.2
Trichoderma atroviride B	10.1	22.7	3.5
Check	11.0	26.7	4.6

[1]Average of three assessment periods (2, 4 and 6 months post-treatment application) and 2 sites.
[2]ns = not significantly different at $P = 0.05$, Fisher's Protected LSD test

Table 2. Percent recovery, germination and survival of sclerotia of *Sclerotium cepivorum* treated with biocontrol products at different assessment periods at or near the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment[1]	% Recovery		% Germination		% Survival	
	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2
2 months	15.8 a[2]	9.6 ns[3]	39.0 a	21.5 ns	7.3 a	4.2 a
4 months	11.2 b	9.6	26.3 b	21.5	3.4 b	2.9 ab
6 months	7.1 c	6.6	15.7 b	20.7	1.5 b	1.8 b

[1]Average of all the biofungicides (CONTANS, *Microsphaeropsis ochracea*, *Trichoderma atroviride* A and *Trichoderma atroviride* B) and the check. Assessments were conducted 2, 4 and 6 months after treatment applications.
[2]Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher's Protected LSD test.
[3]ns -= not significantly different at $P = 0.05$, Fisher's Protected LSD test

Funding for this project was provided by the Plant Production Systems of the OMAFRA/University of Guelph Partnership.

CROP: Canola (*Brassica napus* L.), Field Pea (*Pisum sativum* L.), Barley (*Hordeum vulgare* L.), Wheat (*Triticum aestivum* L.)

AUTHORS: DEORA AD[1, 2], GOSSEN BD[1], MCDONALD MR[2]
[1]Agriculture and Agri Food Canada, Saskatoon,
[2]University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: EVALUATION OF BORON FOR RESIDUAL TOXICITY ON CANOLA, FIELD PEA, WHEAT AND BARLEY, 2012

MATERIALS: SOLUBOR (20.5% B, $Na_2B_8O_{13} \cdot 4H_20$)

METHODS: Field trials were conducted on a sandy-loam type haplaquoll soil (pH ≈ 6.8) adjacent to the Holland Marsh, ON to assess the potential phytotoxic effects of residual B on subsequent crops of wheat, barley, field pea and canola in 2012. The rates of the boron tested were considered as residual boron from previous year's application. Trial was laid out in a split plot design with six replicates. Main plots treatments were B level (0, 4, 8, 16 Kg B/ha) applied as SOLUBOR (: 20.5% B, $Na_2B_8O_{13} \cdot 4H_20$, powder, Borax Inc., Valencia, CA) which was sprayed using a 8002 TeeJet nozzles on CO_2 operated knapsack sprayer. The rate of application was 400 mL in 10 sec or 40 mL/sec. Subsequently, B was incorporated in soil by raking. The subplot treatments were crop type and cultivar: wheat cvs. Quantum and WW, barley cvs. Formosa and 6-row, field pea cvs. Nitouche and Cutlass, and canola cvs. InVigor 5030 and 45H21. Crops were sown on May 30, 2012 using an earth way. The plate numbers used for canola, pea, wheat and barley were: 1002-9, 1002-14, 1002-22 (two slots were blocked) and 1002-22 (one slot was blocked), and the seeding rates were 33, 27, 75 and 65 seeds/m, respectively. Each plot was a single 3-m-long row at both the locations.

Seedling establishment was counted at 2 wk after sowing on a 2-m-long length of row for canola and field pea and -m length for wheat and barley. Phytotoxicity symptoms were assessed on a 0–3 scale on 10 plants per plot at 2 wk after sowing, where 0 = no leaf area affected (LAA), 1 < 25% LAA, 2 = 25–50% LAA and 3 > 50% LAA. The symptoms of B toxicity on wheat are characterized by light browning of older leaf tips converging into light greenish-blue spots. On barley, elongated, dark-brown blotches at the tips of older leave gradually extend to the middle portion of the leaf. On field pea, the edges of older leaves appear burnt, and on canola, burning of the edges of older leaves, leaf cupping, stunted growth, chlorosis and necrosis are typical symptoms of toxicity. The incidence was calculated as the proportion (%) of plants showing phytotoxicity symptoms and severity of phytotoxicity (phytotoxicity index, PI) was calculated using the following equation:

$$PI = \frac{\sum [(\text{class no.})(\text{no. plants in each class})]}{(\text{total no. plants per sample})\ (\text{no. classes} - 1)} \times 100$$

A 2-m-long section of row per plot was harvested at maturity for each crop. Plants were cut just above the soil level and weighed to estimate fresh shoot weight. Wheat and barley were air dried, but the canola and field pea contained more moisture and so were dried in an oven at 70° C for 2 days before threshing to obtain yield data. The WW line of wheat did not produce heads because it had not been vernalized, so no yield data could be obtained.

The data obtained from all the trials were analyzed using an analysis of variance with MIXED procedure using SAS software (version 9.1). Means separation were obtained using Tukey test with P= 0.05 level of significance.

The average air temperature and rainfall for the growing period (May 30 to September 30) were 19.4°C and 2.7 mm.

RESULTS: Rates of pre-plant application of B (as residual soil rate) did not affect seedling establishment for any cultivar. The only exception was the field pea cv. Cutlass, where the number of seedlings was lower at 16 kg B/ha compared to the nontreated control (Table 1). Symptoms of B phytotoxicity were noted on the older leaves in each cultivar and crop at 3 weeks after seeding, except on canola cv. 45H21 (Table 2). The incidence and severity of toxicity symptoms increased with increasing residual B for each cultivar; but there were no differences between cultivars of a crop at the same rate of B (Table 2). Finally, symptoms were fairly transitory; no symptoms were observed on the new leaves of any crop at 4 weeks after seeding. Residual B had no effect on the fresh shoot weight of any cultivar (Table 3). Similarly, B had little or no effect on cultivar yield, except for the pea cv. Nitouche, where 16 kg of B reduced yield (Table 4).

CONCLUSIONS: Residual B in mineral soil at rates of up to 16 kg/ha at the time of planting did not effect vegetative growth or yield of wheat, barley or canola, but did reduce the yield of field pea.

Table 1. Effect of rate of pre-seeding B application on seedling establishment (per m) in canola, field pea, wheat and barley on mineral soil near the Holland Marsh, Ontario, 2012 (n = 6).

B (kg/ha)	Canola		Field pea		Wheat		Barley	
	45H21	5030	Cutlass	Nitouche	Quantum	WW	Formosa	6-row
0	9 ns[1]	7 ns	22 a	18 a	143 ns	122 ns	71 ns	40 ns
4	8	7	17 ab	16 ab	146	118	68	41
8	8	7	19 ab	14 ab	118	105	64	35
16	8	7	13 b	13 b	118	97	58	28

[1]Mean weight of 10 plants per plot.Values followed by the same letter under each column do not differ at P = 0.05 based on Tukey's Multiple Mean Comparison Test. ns- non-significant.

Table 2. Mean incidence and severity of phytotoxicity in canola, pea, wheat and barley cultivars 3 weeks after application of pre-seeding B (kg/ha) (broadcasted and incorporated) in mineral soil near the Holland Marsh, Ontario, 2012 (n = 6).

B	Canola		Pea		Wheat		Barley	
(kg/ha)	45H21	5030	Cutlass	Nitouche	Quantum	WW	Formosa	6-row
Incidence								
0	0 ns[1]	0 a	0 a	0 a	0 a	0 a	2 a	2 a
4	0	0 a	18 a	12 a	6 b	8 b	7 a	13 a
8	0	12 b	48 b	43 b	40 c	42 c	70 b	68 b
16	0	95 c	87 c	95 c	77 d	74 d	100 c	100 c
Severity								
0	0 ns	0 a	0 a	0 a	0 a	0 a	1 a	1 a
4	0	0 a	8 ab	4 ab	15 b	18 b	2 a	6 a
8	0	4 b	25 b	22 b	72 c	75 c	33 b	35 b
16	0	32 c	75 c	83 c	98 d	100 d	74 c	77 c

[1]Values followed by the same letter for a parameter (incidence/severity) under each cultivar do not differ at P = 0.05 based on Tukey's Multiple Mean Comparison Test. ns- non-significant.

Table 3. Mean fresh shoot weight of canola, pea, wheat and barley cultivars treated with B rates (kg/ha) (broadcasted and incorporated) in mineral soil near the Holland Marsh, Ontario, 2012 (n = 5).

B (kg/ha)	Canola[1]		Pea[2]		Wheat[2]		Barley[2]	
	45H21	5030	Cutlass	Nitouche	Quantum	WW	Formosa	6-row
0	1.2 ns[3]	1.4 ns	266 ns	259 ns	266 ns	544 a	174 ns	128 ns
4	1.2	1.2	221	345	304	421 ab	195	116
8	1.3	1.1	256	179	251	424 b	202	135
16	1.3	1.2	244	280	222	321 b	221	112

[1] and [2] reflect shoot weight of plants per m of row in kg and g, respectively, at harvesting.
[3]Values followed by the same letter under each cultivar do not differ at P = 0.05 based on Tukey's Multiple Mean Comparison Test. ns- non-significant.

Table 4. Mean yield (T/ha) of canola, field pea, wheat and barley cultivars treated with B rates (kg/ha) (broadcasted and incorporated) in mineral soil near the Holland Marsh, Ontario, 2012 (n = 5).

B	Canola		Pea		Wheat		Barley	
(kg/ha)	45H21	5030	Cutlass	Nitouche	Quantum	WW	Formosa	6-row
0	2.22 ab	2.32 a	3.22 ns	2.68 a	2.83 ns	-	2.50 ns	1.61 ns
4	1.95 b	2.28 ab	3.10	2.56 ab	2.95	-	2.34	1.24
8	2.31 a	2.06 b	3.12	2.61 ab	2.72	-	2.46	1.64
16	2.00 ab	2.18 ab	2.97	2.31 b	2.82	-	2.42	1.46

[1]Values followed by the same letter under each cultivar do not differ at P = 0.05 based on Tukey's Multiple Mean Comparison Test. ns- non-significant.

Funding for this project was provided by the Clubroot Mitigation Initiative of Agriculture and Agri-food Canada.

CROPS: Summer squash (*Cucurbita pepo*), cv. Vegetable Spaghetti
Pumpkin, (*Cucurbita spp.*), cv. Field Trip

PEST: Downy mildew (*Pseudoperonaspora cubensis*)

AUTHORS: MCDONALD MR & RICHES L
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: EVALUATION OF PHOSTROL FOR CONTROL OF DOWNY MILDEW ON SUMMER SQUASH AND PUMPKIN, 2012

MATERIALS: PHOSTROL (mono- and dibasic sodium, potassium and ammonium phosphites 53.6%), BRAVO (chlorothalonil 500 g/L)

METHODS: Trials were conducted at a site near the Muck Crop Research Station, Holland Marsh, Ontario, in mineral soil (pH ≈ 7.9, organic matter ≈ 2.0%). On 30 May, summer squash, cv. Vegetable Spaghetti, and pumpkin, cv. Field Trip, were hand-seeded through holes cut into 1.5 m wide black plastic mulch. A randomized complete block arrangement with four replicates per treatment was used. Each experimental unit consisted of one 8 m long row, spaced 2.8 m apart, with 50 cm in-row spacing. Treatments were: BRAVO at 4.8 L/ha, PHOSTROL at 2.9 and 5.8 L/ha. Untreated checks were also included. Treatments were applied as foliar sprays on 20 and 27 July, 3 and 22 August using a CO_2 backpack sprayer equipped with four TeeJet 8002 VS fan nozzles spaced 40 cm apart and calibrated to deliver 300 L/ha at 240 kPa (boom). Plots were monitored weekly for downy mildew symptoms. Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1ºC), September (14.8ºC) and October (9.7ºC), and above average for May (15.9ºC), June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: May 12.3ºC, June 18.2ºC, July 20.7ºC, August 19.5ºC, September 15.8ºC and October 8.9ºC. Monthly rainfall was below the previous long term 10 year average for May (49 mm) and June (55 mm), average for August (69 mm), and above average for July (140 mm), September (94 mm) and October (124 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm, July 81 mm, August 67 mm, September 74 mm and October 59 mm. All data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistics V.9. Means separation was obtained using Fishers Protected LSD test with P =0.05 level of significance.

RESULTS: as presented in Table 1

CONCLUSIONS: Weather conditions were not conducive to downy mildew of cucurbits in 2012. No downy mildew was found in the trial (Tables 1 and 2). All fungicides were non-phytotoxic to the crop.

Table 1. Downy mildew (DM) incidence for summer squash, cv. Vegetable Spaghetti, and pumpkin, cv. Field Trip, treated with fungicides and grown near the Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Treatment	Rate/ha	Total # DM Lesions/Leaf	
		Summer Squash	Pumpkin
Check	--	0.0 ns[1]	0.0 ns
BRAVO	4.8 L	0.0	0.0
PHOSTROL	2.9 L	0.0	0.0
PHOSTROL	5.8 L	0.0	0.0

[1]ns = no significant differences were found among treatments

Funding for this project was provided by the Engage Agro, Guelph Ontario.

CROP: Daikon radish (*Raphanus sativus* L.) cvs. Long White, New White Spring, Summer Cross No 3 and Everest

AUTHORS: MCDONALD MR & BILAL A
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: EVALUATION OF DAIKON RADISH CULTIVARS GROWN ON ORGANIC SOIL, 2012

INTRODUCTION: There is a growing demand for ethnic or non-traditional vegetables in Ontario, including many of the Asian vegetables that are traditionally grown in the Holland Marsh. In co-operation with the Vineland Research and Innovation Centre, an evaluation of four daikon cultivars was conducted to identify new cultivars for commercial production on organic soil in the Holland Marsh.

MATERIALS: daikon radish cultivars Long White and New White Spring (AgroHaitai Ltd.), Summer Cross No. 3 Hybrid (William Dam Seeds Ltd.) and Everest (Stokes Seeds Ltd.)

METHODS: On June 5, Daikon, cvs. Long White, New White Spring, Summer Cross No. 3 Hybrid and Everst were direct seeded using an Earthway push seeder fitted with a 1002-5 plate (≈ 18 seeds/m) into organic soil (pH ≈ 6.8, organic matter ≈ 71.8%) at the Muck Crops Research Station, Holland Marsh, Ontario. A randomized complete block design with four replicates per cultivar was used. Each experimental unit consisted of four 4 m long rows spaced 40 cm apart. On 11 June (6 DAS), a Lorsban 4 E drench at the rate of 85 mL in 380 L of water/1,000 m of row was applied to control cabbage maggot. On 10 July (35 DAS), the percentage of leaf area with holes caused by flea beetle feeding was visually assessed on 10 leaves per replicate using Key 3.2 from A Manual of Assessment Keys for Plant Diseases. On 16 August 25 daikon roots were pulled, topped and roots weighed and assessed for marketability and length. Names of root shapes were assigned using line drawings and names of carrot shapes (Fig 1).
Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1°C) and above average for June (20.1°C) and July (22.2°C). The long term previous 10 year average temperatures were: June 18.2°C, July 20.7°C, and August 19.5°C. Monthly rainfall was below the previous long term 10 year average for June (55 mm) and above average for July (140 mm), and August (79 mm). The long term previous 10 year rainfall averages were: June 74 mm, July 81 m, and August 67 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained using Fisher's Protected LSD Test at $P = 0.05$ level of significance.

RESULTS & DISCUSSION: Significant differences were found in root length, shape and flea beetle damage among the cultivars (Table 1). Long White and Summer Cross No. 3 where significantly longer than Everest and New White and had the "Long Orange" shape. Long White, Summer Cross No. 3 and New White had significantly less foliar insect damage than Everest. No significant differences in percent marketable were found among the cultivars; however, the percentage of marketable roots which ranged from 60 to 47% was low. Forking and cabbage maggot damage were the main causes of culls.

CONCLUSIONS: Daikon radish grew well in the trial and organic soil is suited for the production of long roots. Additional Lorsban 4 E drenches could reduce cabbage maggot damage in future trials.

Investment in this project has been provided by Agriculture and Agri-Food Canada through the Canadian Agricultural Adaptation Program (CAAP). In Ontario, this program is delivered by the Agricultural Adaptation Council.

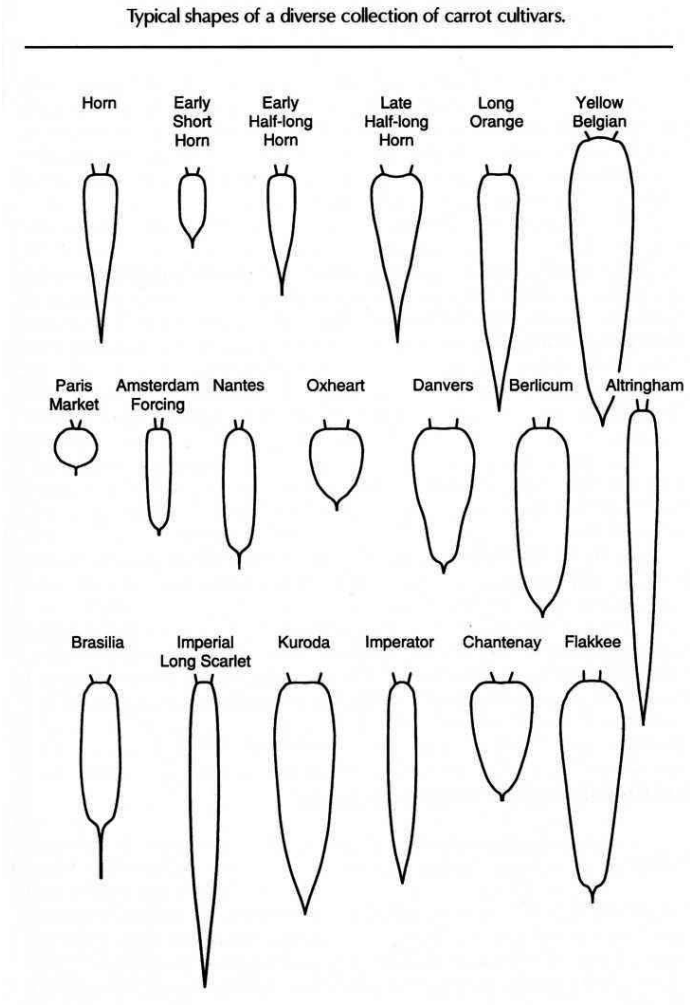
Vineland Research and Innovation Centre is funded in part by Growing Forward, a federal-provincial-territorial initiative.

Table 1. Qualities of daikon cvs. Summer Cross No 3, Hybrid, Everest, Long White and White Spring, grown at Muck Crops Research Station, Holland Marsh, Ontario, 2012.

Cultivar	Avg Length (cm)	Flea Beetle Damage Rating (%)	% Marketable	Shape[1]
Long White	24.7 a[2]	5.0 a	59.5 ns[3]	Long Orange
Summer Cross No. 3	23.5 a	1.5 a	48.8	Long Orange
Everest	15.1 b	13.8 b	46.6	Flakkee
New White	14.1 b	3.0 a	53.8	Berlicum

[1] Refer to Fig 1 for pictures of shapes.
[2] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher's Protected LSD test.
[3] ns = not significant at $P = 0.05$, Fisher's Protected LSD test

Figure 1. Various carrot shapes used to describe the shape of daikon roots, cvs. Summer Cross No 3, Hybrid, Everest, Long White and White Spring, grown at Muck Crops Research Station, Holland Marsh, Ontario, 2012.



CROP: Edible amaranth (*Amaranthus* spp.)

AUTHORS: MCDONALD MR & BILAL A
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: EVALUATION OF EDIBLE AMARANTH CULTIVARS GROWN ON ORGANIC SOIL, 2012

INTRODUCTION: There is a growing interest in non-traditional vegetables including edible amaranth in Ontario. In co-operation with the Vineland Research and Innovation Centre, an evaluation of four edible amaranth cultivars was conducted to identify cultivars suitable for commercial production on organic soil in the Holland Marsh.

MATERIALS: edible amaranth cultivars Red Star, Red Beauty, South Red and SD Green from AgroHaitai Ltd.

METHODS: Amaranth, cvs. Red Star, Red Beauty, South Red and SD Green (AgroHaitai Ltd.) were seeded into 200-cell plug trays on 4 May, placed on ebb and flow benches in the greenhouse. On 25 May plants were hand-transplanted into organic soil (pH ≈ 6.8, organic matter ≈ 71.8%) at the Muck Crops Research Station, Holland Marsh, Ontario. A randomized complete block design with four replicates per cultivar was used. Each experimental unit consisted of three 5 m long rows spaced 55 cm apart with 30 cm in-row spacing. On 16 July (52 DAT), and 13 August (80) 16 plants, 8 from an outside row and 8 from the inside row, were cut ≈ 20 cm from the soil. Tops were weighed and the weights recorded. From this sample, five plants were randomly chosen, all leaves removed, weighed and weights recorded. On 18 July all plants were cut to ≈ 20 cm above the soil using a Black and Decker hedge trimmer and allowed to regrow for a second harvest. On 10 August plots were rated for the percentage of plants with flower stalks. Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1°C), and above average for May (15.9°C), June (20.1°C) and July (22.2°C). The long term previous 10 year average temperatures were: May 12.3°C, June 18.2°C, July 20.7°C, and August 19.5°C. Monthly rainfall was below the previous long term 10 year average for May (49 mm) and June (55 mm), and above average for July (140 mm), and August (79 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm, July 81 m, and August 67 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.9. Means separation was obtained using Fisher's Protected LSD Test at $P = 0.05$ level of significance.

RESULTS & DISCUSSION: Significant differences were found in average weight per plants at both harvest dates, leaf weight per plant at the first harvest date and percentage with flower stalks (Table 1). At the first harvest, cultivars SD Green and Red Star had significantly heavier top weights and leaf weights per plant than Red Beauty and South Red. At the second harvest, Red Star had a significantly heavier top weight than Red Beauty and South Red. Red Beauty and South Red had significantly fewer flower stalks than Red Star and SD Green and Red Star had significantly fewer flower stalks than SD Green.

CONCLUSIONS: All amaranth cultivars grew well in the trial. After the first harvest and cutting back to 20 cm above the ground on 18 July, plants grew quickly to provide a second harvest on 13 August, 28 days later. Amaranth appears to be a viable option for commercial production. More research may be needed to determine consumer preference to specific varieties.

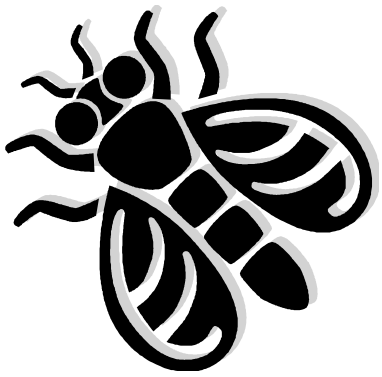
Table 1. Yield and incidence of flower stalks for edible amaranth, cvs. Red Star, Red Beauty, South Red and SD Green, grown at Muck Crops Research Station, Holland Marsh, Ontario, 2012.

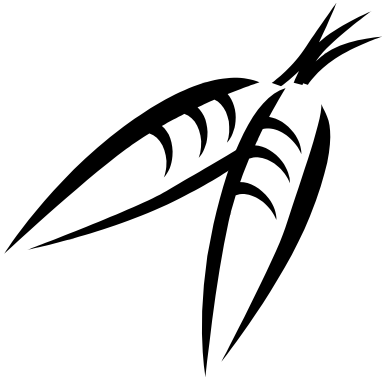
Cultivar	Weight/plant (g)		Leaf Wgt/plant (g)		Total Wgt/Plant	% Flower Stalk Rating
	52 DAT	80 DAT	52 DAT	80 DAT		
SD Green	506.9 a[1]	492.7 ab	242.0 a	154.0 ns[2]	999.5 a	100.0 c
Red Star	459.9 a	562.9 a	235.9 a	166.6	1022.8 a	1.8 b
Red Beauty	330.6 b	454.2 b	149.5 b	159.5	784.8 b	0.0 a
South Red	297.2 b	356.1 c	141.0 b	155.0	653.3 b	0.0 a

[1] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher's Protected LSD test.
[2] ns = not significantly different at $P = 0.05$, Fisher's Protected LSD test

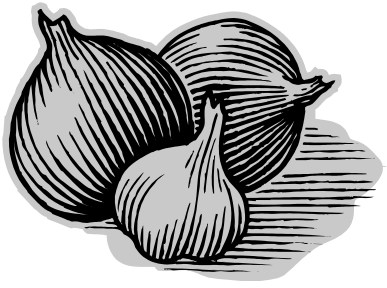
Investment in this project has been provided by Agriculture and Agri-Food Canada through the Canadian Agricultural Adaptation Program (CAAP). In Ontario, this program is delivered by the Agricultural Adaptation Council.

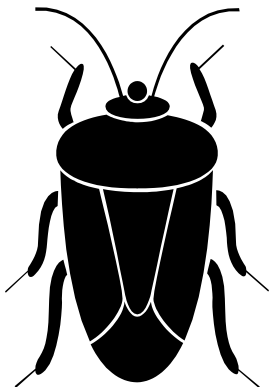
Vineland Research and Innovation Centre is funded in part by Growing Forward, a federal-provincial-territorial initiative.





Integrated Pest Management Report - 2012





AUTHORS: TESFAENDRIAS MT & MCDONALD MR
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: THE INTEGRATED PEST MANAGEMENT PROGRAM SUMMARY FOR MUCK VEGETABLE CROPS, 2012

Integrated pest management (IPM) is an integrated approach to crop management with the primary aim of protecting crops from significant damage from pathogens, weeds and insect pests, while minimizing pesticide use. An IPM program is provided to growers in the Holland/Bradford Marsh, Ontario, by the Muck Crops Research Station (MCRS). This project is funded through the Agricultural Biosecurity Program (ABP), part of the Best Practices Suite of programs under Growing Forward, a federal-provincial-territorial initiative. The Agricultural Adaptation Council assists in the delivery of several Growing Forward programs in Ontario. Funding was also provided by the Holland Marsh Growers' Association, the Bradford Co-Operative Storage Ltd. and chemical company sponsors. The main objectives of the project are: to scout growers' fields for diseases, weeds and insect pests, to provide growers with disease and insect forecasting information, to identify and diagnose diseases, insect pests and weeds, and to implement rotorod spore traps to trap and analyze spores of various vegetable crop pathogens.

SCOUTING

In 2012, 74 commercial vegetable fields, totalling 831 acres (onion 404 A., carrot 311 A., celery 106 A. and lettuce 10 A.), were intensively scouted for 31 growers. Fields were scouted twice a week during the growing season and growers received scouting reports after each field survey.

DIAGNOSTICS, EXTENSION & DISSEMINATION OF INFORMATION

Any grower, whether on the IPM program or not, could bring in samples (plant and/or insect) for diagnosis. On-site tools available for diagnosis were visual inspection and laboratory inspection using a microscope and culturing. Diagnoses were made by comparison to known symptoms, published descriptions of pathogens, insect pests and weeds and personal experience. Following assessment, the extension advice given was based on OMAFRA recommendations for pesticides

In 2012, the diagnostic laboratory of the MCRS received 239 samples for diagnosis. Of these, 58% were plant pathogens and 27% physiological disorders. These samples were associated with the following crops: onion (33.3%), carrot (21.7%), celery (17.9%), lettuce (5.8%), and other vegetable crops (22.3%). A total of 27 samples of insects or insect damage were assessed and 8 weed samples were identified. Other samples were diagnosed in-field during scouting and not brought in for analysis, thus the numbers mentioned above do not include these samples.

For extension services, data collected from growers' fields and the MCRS research plots were compiled twice per week, analyzed and summarized. The results (IPM report) were updated twice per week and circulated to participating growers, academia, industry, OMAFRA experts, posted at the MCRS web site (www.uoguelph.ca/muckcrop), and a copy was displayed at the Bradford Co-op. During the 2012 growing season, more than 100 phone inquiries and email requests for information concerning plant problems and recommendations were addressed.

PEST PREDICTIVE MODELS

The IPM program provides disease and insect forecasting based on spore traps, the disease forecasting models BOTCAST (for botrytis leaf blight of onion), DOWNCAST (for onion downy mildew), and BREMCAST (for lettuce downy mildew), and degree day models and insect traps. The disease and insect forecasts alerted growers to the potential for disease and insect pest in order to prepare ahead.

CROP PEST SUMMARIES

At the end of the scouting program, carrot samples were collected from each scouted field and assessed for damage from insects (Table 1) and diseases or physiological disorders (Table 2). Similarly, onions were assessed in mid-season and at the end of the scouting program for onion maggot damage and incidence of smut.

CARROT

Insects

In 2012, carrot fields were scouted for carrot weevil (*Listronotus oregonensis*), carrot rust fly (*Psila rosae*) and aster leafhopper (*Macrosteles quadrilineatus*). Degree day models were used to predict the occurrence of different life stages of these insects.

Table 1. Average percent carrot rust fly and carrot weevil damage on carrots at harvest in scouted fields around the Holland Marsh (HM), 2012.

Location	% Damaged Carrots	
	Weevil damage	Rust fly damage
South HM	0.0	0.0
West HM	0.5	1.8
North HM	3.6	2.3
Center HM	0.7	1.1
East HM	1.0	2.3

Carrot weevil adults were first found in wooden traps on 19 May in carrot fields. The threshold of 1.5 or more weevils/trap was reached by the end of May.

Orange sticky traps and degree day models were used to monitor and estimate carrot rust fly and aster leafhopper numbers. Aster leafhoppers are pests of carrots, celery, lettuce and leafy greens. Aster leafhopper adults were first found on orange sticky traps on 11 June in carrots, lettuce and celery. In 2012, aster leafhopper numbers and aster yellows, the disease caused by the infestation, were higher than in the previous 2 years in carrots, celery and lettuce.

Carrot rust flies were first found on sticky traps on 24 May. The spray threshold for fresh market carrots (0.1 flies/trap/day) was reached by the end of May.

Diseases

Carrot fields were scouted for all the important diseases of carrots around the Holland Marsh. Leaf blight, which is caused by the fungi *Alternaria dauci* and *Cercospora carotae*, was first seen in mid-July and certain fields reached the spray threshold within one week. The timely announcement of leaf blight incidence helped to keep the disease pressure at the threshold of 25% disease incidence.

Weather conditions in the 2012 growing season were conducive for most pathogens such as *Pythium, Sclerotinia and Rhizoctonia*. The above average rainfall in July generally resulted in excessive soil moisture. This excessive soil moisture in turn created ideal conditions for soil borne pathogens, particularly *Pythium and Rhizoctonia* spp., resulting in a high incidence of cavity spot, pythium root dieback and crater rot. Carrots from all of the surveyed fields had cavity spot (*Pythium* spp.) with incidence ranging from 9 to 34% and carrots in 96% of the fields had pythium root dieback (*Pythium* spp.) with disease incidence of 1-13%. High incidence of heat canker was observed in carrot fields due to a heat wave and shortage of rain in June.

Crater rot (*Rhizoctonia carotae*) occurred in 15 of the 28 carrot fields surveyed, compared to 3 fields (46%) surveyed in 2011.

In 2012, a high aster leafhopper infestation was observed, which resulted in a higher incidence of aster yellows compared to the 2010 and 2011 growing seasons. Of the fields surveyed, 64% had aster yellows.

Carrots in thirteen (47%) of the fields sampled had crown gall (*Agrobacterium tumefaciens*) with disease incidence ranging from 1 to 16%. Weather conditions were ideal for sclerotinia rot (*Sclerotinia sclerotiorum*) development and incidences were observed in carrot fields around the Holland/Bradford Marsh during the growing season. Sclerotinia rot was found on carrots from 5 sampled fields. Fusarium rot (*Fusarium* spp.) was found on carrots from 3 fields with disease incidence of 1-3%.

Carrot roots from 96% of the fields surveyed showed splitting (growth cracks) and forking with mean incidence of 4.1 and 3.9% respectively. These results are similar to those reported in 2011 growing season.

Table 2. Disease incidence on carrot samples collected from 28 commercial fields in the Bradford/Holland Marsh, Ontario, 2012.

Disease	Mean incidence (%) (n= 28)	# fields affected
Cavity spot	19.2	28
Pythium root dieback	3.4	27
Crown gall	2.1	13
Crater rot	1.0	15
Aster yellows	0.9	18
Sclerotinia rot	0.2	5
Fusarium rot	0.2	3
Splitting (Growth cracks)	4.1	27
Forking	3.9	27

ONION

Insects

Onion fields were scouted for onion maggot (*Delia antiqua*), onion thrips (*Thrips tabaci*) and cutworms. Predicted emergence of first generation onion flies was 15 May and flies were found on traps on 17 May. Damage plots were assessed after first and second generation peaks.

In 2012, high infestation rates of onion thrips were observed in all onion fields. Thrips were first found in onion plants in scouted fields on 28 May, 10-12 days earlier than in 2011. Several scouted fields reached the threshold of one thrips per leaf in early July. Thrips thrive in hot, dry conditions and the weather conditions in the 2012 growing season were favourable for thrips infestation.

Diseases

Onions were scouted for botrytis leaf blight (*Botrytis squamosa*), downy mildew (*Peronospora destructor*), purple blotch (*Alternaria porri*), white rot (*Sclerotium cepivorum*), pink root (*Phoma terrestris*), stemphylium leaf blight (*Stemphylium vesicarium*) and other diseases.

In 2012, stemphylium leaf blight and pink root were the main diseases that affected onions. Spores of *Botrytis* spp., *S. vesicarium* and *Alternaria* spp. were detected with the spore traps during the growing season. A few incidence of botrytis leaf blight were reported. No downy mildew was found in any scouted onion fields.

CELERY

Insects

In 2012, celery fields were scouted for were carrot weevil, aster leafhopper, tarnished plant bug (*Lygus lineolaris*), the pea leafminer (*Liriomyza huidobrensis)*, and aphids. Insect traps and degree day models were used to predict the occurrence of the various life stages of carrot weevil, aster leafhopper and tarnished plant bug. The scouting results of carrot weevil and aster leafhopper were as discussed in the carrot crop section. Tarnished plant bugs are pests of celery, lettuce and leafy greens. Tarnished plant bug

populations were assessed using plant inspections, orange sticky traps, and sweep nets. A few fields reached the damage threshold of 6% around early to mid-August. More tarnished plant bug infestation and damage was observed in 2012 than the 2011 growing season. Aphid, carrot weevil and leafminer infestations remained low throughout the growing season.

Diseases

Celery leaf blights in Ontario are caused by the fungi *Cercospora apii* (early blight) and *Septoria apiicola* (late blight) and the bacteria *Pseudomanas syringae* pv. *apii* (bacterial blight). The threshold for pesticide application is disease presence. Similar to the 2011 growing season, in 2012 the main issue for celery was bacterial blight. Incidence of early blight was observed in a few scouted fields. No late blight was observed in any scouted celery fields. Pink rot (*Sclerotinia sclerotiorum*) incidence remained low throughout the season. Blackheart (calcium deficiency) and symptoms related to boron and magnesium deficiency were seen in most celery fields.

LETTUCE

Insects

In 2012, lettuce fields were scouted for aster leafhopper, tarnished plant bug, aphids and other insects. The degree day model used to predict the occurrence of various life stages of the aster leafhopper and the scouting results were as discussed in the carrot crop section. The occurrence of tarnished plant bugs and leaf hoppers was higher this year resulted in more tarnished plant bug damage and aster yellows than the 2011 growing season. Aphid numbers were was low in lettuce fields.

Diseases

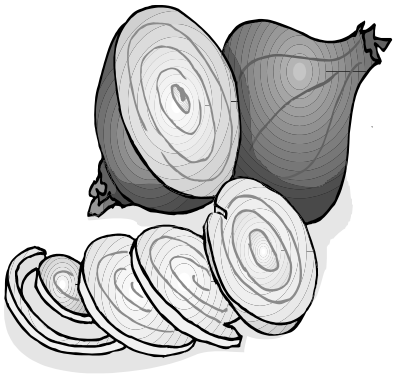
The lettuce fields were scouted for downy mildew (*Bremia lactucae*), Sclerotinia drop (*Sclerotinia sclerotiorum* and *S. minor*), grey mould (*Botrytis cinerea*) and other diseases. BREMCAST, the lettuce downy mildew forecasting model, predicted sporulation infection periods (SIP) during the growing season starting mid-July and the risk of developing downy mildew remained moderate to high until September. Lettuce downy mildew symptoms started to develop around mid to late August in the Holland Marsh. Downy mildew incidence was low in all scouted fields. Sclerotinia drop, botrytis grey mould and pythium stunt were all first noted around mid-June.

WEEDS

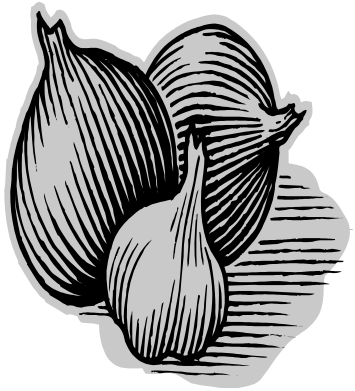
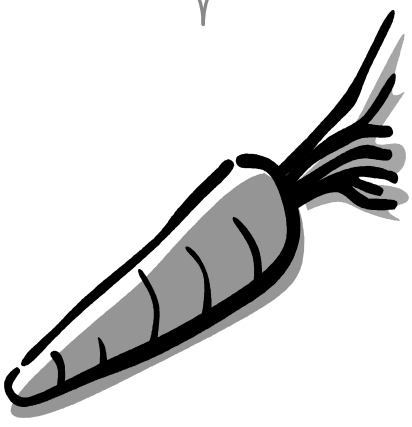
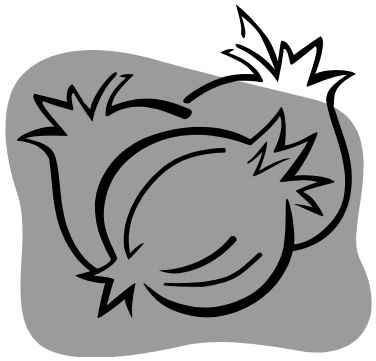
In 2012, broad-leaved weed, grass and sedge weed pressure differed among fields mainly depending on field location and management practices. In most fields, weeds were controlled during the critical weed-free period for each crop. Some herbicide resistant redroot pig weed has started to appear in a few fields. Yellow nutsedge was a problem for a number of growers in all crops around the Holland Marsh.

This project is funded through the Agricultural Biosecurity Program (ABP), part of the Best Practices Suite of programs under Growing Forward, a federal-provincial-territorial initiative. The Agricultural Adaptation Council assists in the delivery of several Growing Forward programs in Ontario.

Funding for the IPM program was also provided by the Holland Marsh Growers' Association, Bradford Co-operative Storage Ltd., Bayer Crop Science, E.I. DuPont Canada, BASF, Engage Agro, UAP, Syngenta Crop Protection and Dow AgroScience.


Cultivar Trials 2012

CARROT CULTIVAR TRIAL SEASONAL SUMMARY - 2012

The growing season brought early heat and dry conditions followed by seasonal temperatures and an increase in precipitation. Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1 ºC), September (14.8ºC) and October (9.7ºC), and above average for May (15.9ºC), June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: May 12.3ºC, June 18.2ºC, July 20.7ºC, August 19.5ºC, September 15.8ºC and October 8.9ºC. Monthly rainfall was below the previous long term 10 year average for May (49 mm) and June (55 mm), average for August (69 mm), and above average for July (140 mm), September (94 mm) and October (124 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm, July 81 mm, August 67 mm, September 74 mm and October 59 mm.

The carrot trial was seeded on May 28 & 29. Soil moisture levels were just adequate and temperatures were above the seasonal average, i.e. in the high twenties, at seeding. On May 31 irrigation water was applied at ½ inch to aid germination. A much needed rainfall on June 1 of 26 mm along with above seasonal air temperatures created idea germination conditions. Plant stands and vigor were very good. For the month of June air temperatures continued to remain well above average in the high twenties to low thirties. Rainfall was lacking for the entire month, which created dry conditions. On June 18 and 19 high temperatures and dry conditions created ideal conditions for heat canker. The carrot seedlings were at the first true leaf stage and very susceptible to heat canker, so 3/8 to 3/4 inch of irrigation water was applied on both days to help keep the soil cool and moist. This worked, and little damage occurred and stands remained good. Even with above seasonal temperatures in July there was adequate rainfall and the carrots established well. The carrots grew well for the rest of the season and were of good size and quality when samples were pulled at Grower Field Day on September 6.

Weed control was satisfactory throughout the entire season. The pre-emergence application of Gesagard did a good job of early weed control. Two Lorox + Assist Oil applications on June 22 & 27 did a fair job of taking out most of the weeds. A third application of Lorox + Assist Oil on July 20 helped, but in the end, hand weeding was necessary. The trial was hand weeded throughout the rest of the season to keep it free of weeds.

The fast accumulation of degree days due to warm weather resulted in an earlier than average emergence of carrot weevil populations at the Muck Station. Carrot weevil counts were at an accumulation count of 6 at seeding and remained above economical thresholds from seeding to late July. Even though the number of weevils counted in traps was high, damage was low at harvest. Two applications of Imidan in July appeared to be timed well and protected the carrots from weevil damage. Carrot rust fly emergence was early due to the warm spring temperatures. There never was a clear first generation peak. Population counts were above economical thresholds and fluctuated greatly in the month of June. A second small peak occurred in mid August, and then numbers dropped and remained low and constant for the rest of the season. Carrot rust fly damage was very low at harvest. Aster leaf hopper numbers were high throughout the entire season resulting in some aster yellows infection.

…/continued

CARROT CULTIVAR TRIAL SEASONAL SUMMARY – 2012 – continued

Alternaria and cercospora leaf blight never became an issue during the summer months. A couple of fungicide applications were applied to control any blight that may have been present, and leaf blight was kept below economical thresholds. To observe cultivar tolerance to both pathogens, regular fungicide sprays were discontinued in late August. Throughout the months of September & October, leaf blight levels steadily increased. Average air temperatures and above average rainfall during the fall encouraged the development of leaf blight in the trial. At harvest in October, differences in the incidence of leaf blight infections were noted among cultivars. On Grower Field Day in early September, the majority of cultivars had a low number of forked and/or split carrots. The quality, weight and length of carrots was good. Bolting was noted in the trial with several cultivars having a few seeders.

Harvest conditions in October were damp and temperatures were seasonal. Harvest began on the October 16 but was delayed for a week due to wet weather. The good moisture conditions of the late summer and early fall allowed the carrots to size up nicely. The above average rainfall in October did not appear to increase disease pressure from Sclerotinia, as only a few small pockets were found. Alternaria and cercospora disease levels were high and similar to 2011. When yield samples were taken, a limited number of forked carrots were found; splits however, were at moderate levels. Eighty percent of the cultivars in the trial had seeders occurring in very low numbers. The Jumbo cultivars appeared to have good yields, with good weight and all carrot cultivars appeared to have good length. Yields appeared to be much better than in the previous two years (2011 and 2010). The carrots were placed in the Filacell storage immediately after harvest.

At evaluation in mid December, it was confirmed that this year's trial had higher yields than in 2011 and 2010. Quality was good, however some issues were present. The weights of Jumbo carrots were average to slightly above average. The percentage of culled carrots was down quite a bit and culls consisted of splits, small undersized carrots, and some forking. The incidence of rot was very low. Cavity spot was a big problem in the 2012 trial. The degree of cavity spot was on average a light/medium lesion, with approximately 85-90% infection rate, which is a slight increase compared to last year. As well, there was a noticeable increase in the number of lesions per carrot root. In general, all cultivars had good lengths and widths but uniformity was quite uneven. Exterior colour was fair among all cultivars. Generally, most cultivars had a fairly smooth feel to the skin. Interior colour blending was a little below average, with fewer rings around cores or translucent cores. Green shoulders were not present in most carrot cultivars, and if found were just starting to develop. Insect damage was significantly lower compared to last year and there was very little damage found at evaluation. The number of carrots infected with aster yellows was lower than expected considering the high leaf hopper populations in summer. In conclusion, the carrot variety trial was successful with good yields, satisfactory quality but there was some concern regarding the high incidence cavity spot infection.

CARROT CULTIVAR TRIALS - 2012

MANAGEMENT PROCEDURES

Fertilizer:

40 kg/ha Nitrogen (Ammonium Nitrate 34-0-0) + 100 kg/ha Phosphorous (MAP 11-52-0) + 250 kg/ha Potassium (Potash 0-0-50) + 35kg/ha Manganese (32%) and 3.5 kg/ha of Boron (14%) was worked into the soil.

Seeded:

All trials were seeded 28 & 29 May using a V-Belt seeder equipped with a 5 cm wide scatter shoe. A germination rate of 95 to 100%, a target of 26-22 seeds per foot was desired for Cello type carrots and 15-18 seeds per foot for Jumbo type carrots. All trials were seeded on beds 86 cm apart. The seeding rate was done according to percent germination. **RIDOMIL 1G** was applied at 25 kg/ha in the seed furrow. The Main Trial was replicated three times and the Adaptation Trial was not replicated.

Weed Control:

Pre-emergence: 1 application: **GESAGARD 480** at 6.0 L/ha on 29 May.

Post-emergence: 1 application: **LOROX L** at 350 ml/ha + **ASSIST OIL** at 1.0 L/ha on 22 June.
1 application: **LOROX L** at 400 ml/ha + **ASSIST OIL** at 1.0 L/ha on 27 June.
1 application: **LOROX L** at 500 ml/ha + **ASSIST OIL** at 1.0 L/ha on 20 July.

Minor Elements:

Two foliar sprays: Epsom salt on 2 & 8 August (2.5 Kg/ha).
Two foliar sprays: Calcimax on 2 & 22 August (2.0 L/ha).
One foliar spray: Mag Max on 22 August (2.0 L/ha).
One foliar spray: Alexin on 22 August (2.0 L/ha).

Insect and Disease Control:

According to IPM recommendations.

IMIDAN at 2.25 Kg/ha on 4 July.
IMIDAN at 2.25 Kg/ha on 18 July.
UP-CYDE at 188 ml/ha on 24 July.
POLYRAM at 2.25 kg/ha + **DIAZINON** 1.1 L/ha and Minor Elements on 2 Aug.
BRAVO at 2.5 L/ha + **RIPCORD** at 200 ml/ha and Minor Elements on 8 Aug.
BRAVO at 3.0 L/ha + **UP-CYDE** at 280 ml/ha and Minor Elements on 22 Aug.

… / continued

Harvest:

The Main Trial and Adaptation Trial were harvested 16, 22, 24 & 25 October. All trials were immediately placed in a temperature and humidity controlled storage (0^{o}C, 95 % RH) respectively.

Irrigation:

Irrigation water was applied on 31 May (1/2 inch) to aid the germination.
Irrigation water was applied on 18 (3/4") & 19 June (3/8") and 3 July (1 3/8 inch).

EVALUATION PROCEDURES

The cultivars were evaluated on 4 through 14 December after 6 weeks in storage.

 # Carrots Harvested:

Total number of carrots harvested from 2.32 m of row.

Harvest Weight:

Weights from the harvested 2.32 m of row.

Marketable Yield t/ha + B/A:

Marketable yield includes the packaging size, 2.0 cm to 4.4 cm (¾" to 1¾") as well as the oversize > 4.4 cm (> 1¾").

% Oversize:

The percentage of carrots > 4.4 cm (> 1¾ ") and greater.

Majority of Culls:

SP = Splits F = Forked SM = Small (< 2.0 cm) R = Rot A = Aster Yellows

Shape:

GP = Gold Pak N = Nantes Imp = Imperator Cyl = Cylindrical LD = Long Danver SP = Spartan Bonus

Appearance:

Appearance is based on qualities of straightness of root and smoothness.
10.0 = very straight and smooth, 6.0 = a few rough carrots in mix, 1.0 = bends and curves in root with very rough surface.

... / continued

CARROT CULTIVAR TRIALS - 2012 - continued

Resistance to Greening:
The higher the number the less green tissue on the crown of the carrot 10.0 = no green tissue, 6.0 = moderate green tissue, 1.0 = total green tissue.

External Colour:
DO = Dark Orange O = Orange BO = Bright Orange LO = Light Orange

Internal Colour:
DO = Dark Orange O = Orange BO = Bright Orange LO = Light Orange

Blight Rating:
Regular fungicide applications were discontinued on 22 Aug to allow the cultivars to be evaluated for tolerance to leaf blights. Evaluation took place at harvest. 10.0 = Most Desirable, no lesions; 8.0 = Good, mild lesions on leaves, no lesions on petioles; 6.0 = Moderate, lesions on leaves, some lesions on petioles; 3.0 = Poor, numerous lesions on leaves, numerous lesions on petioles; 1.0 = Severe, tops completely rotted, crop cannot be harvested.

Score:
The average of the 9 marks from Uniformity of Shape to Blight Rating. 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average.

% Cavity Spot & Degree:
The number indicates the percentage of roots with cavity spots.
The letters indicate the degree to which the roots were infected.
VL = Very Light, cavity spots are few and barely visible. Lesion size < 1mm.
L = Light, few small spots. Lesion size 1 - 2 mm.
M = Medium, roots borderline marketable. Lesion size 2 - 5 mm.
H = Heavy, large cavity spots, roots unmarketable. Lesion size 5 -10 mm.
VH = Very Heavy, many large cavity spots, roots unmarketable. Lesion size > 10 mm.

Example: 50 H = 50% of the roots were heavily infected with cavity spots, roots unmarketable

Shape of Crown:
CV = Convex (no indentation around crown) CC = Concave (indentation around crown)

… / continued

Root Length (cm):
Twenty centimetres is approximately eight inches.

Root Width (cm):
One inch is approximately two and half centimetres.

Stand per Foot:
Stand per Foot times 3.28 equals Stand per Metre.

Top Length (cm):
Small = 20-30 centimetres Medium = 30-45 centimetres Large = 45 centimetres and greater

Leaf Colour:
LG = Light Green G = Green DG = Dark Green PG = Pale Green

% Weevil & Rust Fly Damage:
Percent of carrot roots damaged by carrot weevil & carrot rust fly that were found in the 2.32 m harvest sample.

Average Number of Seeders:
Average number of seeders found in each cultivar of 15 m of row.

CARROT CULTIVAR MAIN TRIAL CELLO TYPES - 2012

Cultivar	Source	# Carrots Harvested	# > 4.4 cm	# 2.0 to 4.4 cm	Total Harvest Weight (kg)	Weight > 4.4 cm (kg)	Weight 2.0 to 4.4 cm (kg)	Marketable Yield t/ha	Marketable Yield B/A
55-205	RZ	174	26 ab*	123 de	25.39 bc	7.77 ab	15.25 abc	115.1	1853 a
ENVY	Sto	175	27 ab	120 de	23.06 cde	8.52 a	12.24 cd	103.8	1671 abc
NUMANCIA	Bejo	192	13 d-g	143 bcd	21.53 d-g	3.96 c-g	15.35 abc	96.6	1554 bc
BONFIRE	UNF	158	9 f-j	128 cde	21.18 efg	2.81 e-i	15.91 ab	93.6	1507 c
NILAND	Bejo	232	15 def	157 abc	22.60 c-f	4.01 c-f	15.58 abc	98.0	1577 bc
OLYMPUS	Sto	199	12 e-h	140 b-e	18.19 hi	3.28 d-h	12.27 cd	77.8	1252 de
CELLOBUNCH	Sto	159	17 def	120 de	22.67 c-f	5.09 cde	14.06 abc	95.8	1542 c
DOMINION	Sto	192	20 bcd	135 b-e	23.07 cde	6.11 bc	13.04 bcd	95.8	1542 c
JERADA	RZ	115	26 abc	72 g	26.60 ab	8.82 a	13.22 bcd	110.2	1774 ab

Listed in order of % Marketable.

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

... / continued

CARROT CULTIVAR MAIN TRIAL CELLO TYPES - 2012 - continued

Cultivar	Source	# Carrots Harvested	# > 4.4 cm	# 2.0 to 4.4 cm	Total Harvest Weight (kg)	Weight > 4.4 cm (kg)	Weight 2.0 to 4.4 cm (kg)	Marketable Yield t/ha	Marketable Yield B/A
NAVAL	Bejo	223	10 f-i*	165 ab	24.32 bcd	2.60 f-i	17.16 a	98.8	1591 bc
NEW HALL CELLO	Bejo	174	18 cde	122 de	22.27 d-g	5.31 cd	12.77 bcd	90.4	1455 cd
CROFTON	RZ	141	2 j	109 ef	16.61 i	0.55 i	12.66 bcd	66.0	1063 ef
NOTABLE	Bejo	189	31 a	113 de	28.88 a	9.13 a	13.65 bc	113.9	1834 a
CR 2384	Sem	186	5 hij	129 cde	20.06 fgh	1.60 ghi	13.69 bc	76.5	1231 e
NERJA	Bejo	247	3 ij	176 a	21.19 efg	1.07 hi	14.89 abc	79.8	1284 de
CR 2289	Sem	125	12 e-h	78 fg	19.57 gh	4.47 c-f	9.95 de	72.1	1161 e
SS 3320	Sol	124	7 g-j	74 g	15.44 i	2.10 f-i	8.64 e	53.7	865 f
Trial Average		**176**	**11**	**121**	**21.04**	**3.35**	**12.93**	**81.4**	**1311**

Listed in order of % Marketable.

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

... / continued

CARROT CULTIVAR MAIN TRIAL CELLO TYPES - 2012 - continued

Cultivar	Source	% Marketable	% Oversize	Majority of Culls	Shape	Uniformity of Shape	Uniformity of Width	Uniformity of Length	Appearance	Resistance to Greening
55-205	RZ	90.7 a*	30.5 abc	SM	N	7.3	6.7	8.3	6.7 abc	9.3 abc
ENVY	Sto	90.2 a	36.9 a	SM	GP	6.7	5.3	4.3	5.3 e	9.0 bc
NUMANCIA	Bejo	89.7 ab	19.4 def	SM	Cyl	7.0	3.7	4.0	6.3 bcd	9.3 abc
BONFIRE	UNF	88.6 ab	13.1 e-h	SM	ImpCyl	7.7	4.7	7.0	5.3 e	10.0 a
NILAND	Bejo	86.6 abc	17.7 d-g	SM	N	5.7	5.7	7.0	6.3 bcd	10.0 a
OLYMPUS	Sto	85.5 abc	18.0 d-g	SM	Imp	6.0	4.3	5.0	5.7 de	9.3 abc
CELLOBUNCH	Sto	84.7 abc	22.7 cde	F	ImpCyl	6.3	5.3	5.3	6.3 bcd	9.3 abc
DOMINION	Sto	83.0 a-d	26.5 a-d	F SM SP	IMP	5.3	4.3	4.7	5.3 e	9.7 ab
JERADA	RZ	82.8 a-d	33.6 ab	F	Cyl	9.0	7.7	7.0	7.3 a	6.7 e

Listed in order of % Marketable. 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

... / continued

CARROT CULTIVAR MAIN TRIAL CELLO TYPES - 2012 - continued

Cultivar	Source	% Marketable	% Oversize	Majority of Culls	Shape	Uniformity of Shape	Uniformity of Width	Uniformity of Length	Appearance	Resistance to Greening
NAVAL	Bejo	81.5 b-e*	10.6 fgh	SP	N	6.0	4.7	5.7	7.0 ab	9.3 abc
NEW HALL CELLO	Bejo	81.4 b-e	23.7 b-e	SP	Cyl	5.3	4.7	5.3	6.3 bcd	8.7 cd
CROFTON	RZ	79.2 cde	3.2 h	SP	Cyl	7.7	6.3	6.0	6.7 abc	8.0 d
NOTABLE	Bejo	78.8 cde	31.5 abc	SP	N	6.0	5.7	5.0	5.3 e	6.0 e
CR 2384	Sem	76.0 def	7.9 gh	F SM	Cly	6.7	4.0	5.0	5.7 de	10.0 a
NERJA	Bejo	75.6 def	5.0 h	SM	Cyl	7.3	5.0	5.0	6.3 bcd	9.0 bc
CR 2289	Sem	73.8 ef	22.8 cde	F	Cyl	5.3	4.3	4.7	5.3 e	9.3 abc
SS 3320	Sol	69.5 f	13.1 e-h	SP	Imp	8.3	4.3	5.7	6.0 cde	10.0 a
Trial Average		**77.0**	**14.7**			**6.6**	**4.9**	**5.3**	**6.1**	**8.8**

Listed in order of % Marketable. 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

... / continued

CARROT CULTIVAR MAIN TRIAL CELLO TYPES - 2012 - continued

Cultivar	Source	External Colour	External Colour Rating	Internal Colour	Internal Colour Rating	% Core of Total Width	Blight Rating	Score	% Cavity Spot & Degree	Shape of Crown
55-205	RZ	O	7.0	O	6.7	41.1 bcd*	6.0 f	7.43 a	95LM ab	CC
ENVY	Sto	O	6.7	O	6.3	40.7 bcd	6.7 def	6.24 g-j	87L a-d	CV
NUMANCIA	Bejo	O	5.3	LO	5.7	47.3 a	7.2 cde	5.90 j	72LM e	CV
BONFIRE	UNF	DO	7.7	O	7.0	41.3 bcd	6.7 def	7.05 a-d	100M a	CV
NILAND	Bejo	O	6.0	LO	6.7	43.6 ab	7.7 a-d	6.76 c-f	82L b-e	CC
OLYMPUS	Sto	O	6.7	O	8.0	37.1 d-g	8.7 a	6.43 e-i	85L b-e	CV
CELLOBUNCH	Sto	O	6.3	O	5.3	41.8 a-d	6.0 f	6.33 f-j	87LM a-d	CV
DOMINION	Sto	O	6.3	O	6.0	42.0 a-d	8.0 abc	5.95 ij	85L b-e	CV
JERADA	RZ	LO	7.7	LO	6.0	38.9 b-e	7.0 c-f	7.33 ab	80L cde	CC

Listed in order of % Marketable. 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

... / continued

CARROT CULTIVAR MAIN TRIAL CELLO TYPES - 2012 - continued

Cultivar	Source	External Colour	External Colour Rating	Internal Colour	Internal Colour Rating	% Core of Total Width	Blight Rating	Score	% Cavity Spot & Degree	Shape of Crown
NAVAL	Bejo	O	7.0	LO	7.3	43.5 abc*	7.5 b-e	6.71 c-g	77L de	CC
NEW HALL CELLO	Bejo	LO	6.0	LO	5.7	42.2 a-d	8.3 ab	6.00 ij	78L de	CV
CROFTON	RZ	O	7.7	LO	7.3	32.7 fg	6.5 ef	7.10 abc	82LM b-e	CV
NOTABLE	Bejo	LO	7.0	O	7.3	43.9 ab	8.3 ab	6.05 ij	95LM ab	CC
CR 2384	Sem	O	5.7	O	6.0	37.6 c-g	8.5 ab	6.14 hij	72L e	CV
NERJA	Bejo	O	6.7	LO	6.7	34.3 efg	8.7 a	6.57 d-h	82LM b-e	CC
CR 2289	Sem	O	5.7	O	6.3	31.7 g	7.7 ab	5.86 j	93LM abc	CV
SS 3320	Sol	DO	6.3	O	7.3	38.1 b-f	6.5 ef	6.86 b-e	88LM a-d	CV
Trial Average			**6.5**		**6.8**	**38.0**	**7.8**	**6.41**	**85LM**	

Listed in order of % Marketable. 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

... / continued

CARROT CULTIVAR MAIN TRIAL CELLO TYPES - 2012 - continued

Cultivar	Source	Root Length (cm)	Root Width (cm)	Stand per Foot	Top Length (cm)	Leaf Colour	% Weevil Damage	% Rust Fly Damage	Average # of Seeders	% Aster Yellows
55-205	RZ	18.8 f*	3.5 a	23 def	35.2 ef	DG	0.3 a	0.8 a	0.0 a	0.6
ENVY	Sto	20.0 e	3.1 cd	23 def	48.9 a	G	2.2 a	0.0 a	2.7 bc	0.6
NUMANCIA	Bejo	20.0 e	3.1 cde	25 cde	41.6 bc	G	0.5 a	0.6 a	0.0 a	0.3
BONFIRE	UNF	22.7 b	3.2 bc	21 e-h	38.7 cde	LG	0.6 a	1.0 a	0.7 ab	0.2
NILAND	Bejo	17.3 g	3.4 ab	30 ab	40.6 bcd	G	0.1 a	0.3 a	0.3 ab	0.3
OLYMPUS	Sto	20.4 de	2.9 ef	26 bcd	40.9 bcd	LG	0.4 a	0.6 a	0.7 ab	0.7
CELLOBUNCH	Sto	22.3 b	3.2 bc	21 efg	40.9 bcd	G	1.4 a	0.0 a	1.7 abc	0.2
DOMINION	Sto	20.4 e	3.1 cde	25 cde	42.2 bc	G	0.2 a	0.0 a	3.3 c	0.5
JERADA	RZ	21.3 cd	3.5 a	15 i	40.3 bcd	G	1.2 a	0.0 a	0.0 a	1.2

Listed in order of % Marketable.

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

CARROT CULTIVAR MAIN TRIAL CELLO TYPES - 2012 - continued

Cultivar	Source	Root Length (cm)	Root Width (cm)	Stand per Foot	Top Length (cm)	Leaf Colour	% Weevil Damage	% Rust Fly Damage	Average # of Seeders	% Aster Yellows
NAVAL	Bejo	18.6 f*	3.4 ab	29 abc	38.8 cde	G	0.3 a	0.1 a	0.3 ab	0.1
NEW HALL CELLO	Bejo	18.6 f	3.1 cd	23 def	42.8 b	G	0.2 a	0.2 a	1.7 abc	0.6
CROFTON	RZ	20.1 e	3.1 cde	19 f-i	37.8 de	G	1.3 a	0.6 a	0.0 a	1.9
NOTABLE	Bejo	17.4 g	3.4 ab	25 cde	41.2 bcd	LG	2.2 a	0.2 a	13.3 d	0.7
CR 2384	Sem	21.9 bc	3.0 def	24 cde	40.6 bcd	G	0.7 a	0.3 a	0.0 a	0.5
NERJA	Bejo	18.7 f	2.9 f	33 a	33.1 f	G	0.4 a	0.4 a	1.7 abc	0.1
CR 2289	Sem	22.3 b	3.2 bc	16 ghi	41.3 bcd	G	0.2 a	0.8 a	1.0 abc	0.3
SS 3320	Sol	26.1 a	3.0 def	16 hi	42.7 b	G	0.4 a	0.5 a	0.3 ab	1.1
Trial Average		**20.5**	**3.1**	**23**	**39.8**		**0.7**	**0.4**	**2.3**	**0.7**

Listed in order of % Marketable.

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

CARROT CULTIVAR MAIN TRIAL JUMBO TYPES - 2012

Cultivar	Source	# Carrots Harvested	# > 4.4 cm	# 2.0 to 4.4 cm	Total Harvest Weight (kg)	Weight > 4.4 cm (kg)	Weight 2.0 to 4.4 cm (kg)	Marketable Yield t/ha	Marketable Yield B/A
CARADEC	UNF	126	33 def*	74 abc	24.04 bc	10.74 cd	10.57 ab	106.6	1716 bcd
WARMIA	RZ	115	38 cde	54 b-e	18.84 d	10.49 cd	5.98 d	82.4	1326 e
BASTIA	Bejo	126	43 bcd	54 b-e	22.60 c	13.18 bc	6.37 d	97.8	1574 cde
BELGRADO	Bejo	133	52 b	47 de	28.97 a	18.74 a	6.23 d	124.9	2010 a
BERLIN	Bejo	139	62 a	47 de	27.99 a	18.12 a	5.92 d	120.2	1935 ab
BEIJING	Bejo	132	45 bc	55 b-e	26.29 ab	15.10 ab	6.94 cd	110.2	1774 abc
FONTANA	Bejo	147	33 ef	72 a-d	22.29 cd	10.24 cd	8.27 bcd	92.6	1491 cde
MORELIA	RZ	119	25 fg	74 abc	22.02 cd	8.71 de	9.37 abc	90.4	1455 de
ACHIEVE	Sto	136	32 ef	77 abc	24.22 bc	10.77 cd	9.31 abc	100.4	1617 cde
NEW HALL JUMBO	Bejo	137	20 g	90 a	21.84 cd	5.59 e	11.44 a	85.2	1371 e
ABBOTT	Sol	110	32 ef	46 e	22.15 cd	10.66 cd	6.55 d	86.1	1386 e
COSTELLO	Sol	113	33 ef	51 cde	23.99 bc	10.70 cd	7.06 cd	88.8	1430 de
Trial Average		**128**	**37**	**62**	**23.77**	**11.92**	**7.84**	**98.8**	**1590**

Listed in order of % Marketable.

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

... / continued

CARROT CULTIVAR MAIN TRIAL JUMBO TYPES - 2012 - continued

Cultivar	Source	% Marketable	% Oversize	Majority of Culls	Shape	Uniformity of Shape	Uniformity of Width	Uniformity of Length	Appearance	Resistance to Greening
CARADEC	UNF	88.6 a*	44.8 cd	SM	N	7.3	8.0	5.7	6.7 bc	10.0 a
WARMIA	RZ	87.4 a	56.4 abc	SM	SP	5.7	7.0	6.0	3.3 e	7.7 cde
BASTIA	Bejo	86.6 a	58.5 ab	SM	GP	5.3	6.7	5.7	6.7 bc	9.3 ab
BELGRADO	Bejo	86.3 a	64.2 a	SM	GPN	5.3	6.3	4.7	6.7 bc	7.0 def
BERLIN	Bejo	85.9 a	64.9 a	SM	GP	7.7	7.0	6.0	7.7 a	8.7 bc
BEIJING	Bejo	83.5 a	57.2 ab	SM	GP	6.7	7.0	5.0	6.3 cd	5.7 g
FONTANA	Bejo	83.1 a	44.9 cd	SM	GP	4.7	7.0	6.0	5.7 d	6.3 fg
MORELIA	RZ	83.1 a	38.9 d	F	Cyl	6.3	7.3	5.0	7.3 ab	6.7 efg
ACHIEVE	Sto	83.0 a	44.3 cd	SP	GP	6.0	8.0	6.7	6.7 bc	8.7 bc
NEW HALL JUMBO	Bejo	77.9 a	25.5 e	SP	GPN	7.0	8.0	6.7	7.3 ab	8.0 cd
ABBOTT	Sol	77.3 a	48.3 bcd	SP	Cyl	6.7	8.3	6.3	6.7 bc	6.7 efg
COSTELLO	Sol	74.1 a	44.5 cd	SP	Cyl	7.3	8.3	5.7	6.3 cd	7.3 def
Trial Average		**83.1**	**49.4**			**6.3**	**7.4**	**5.8**	**6.4**	**7.7**

Listed in order of % Marketable. 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

... / continued

CARROT CULTIVAR MAIN TRIAL JUMBO TYPES - 2012 - continued

Cultivar	Source	External Colour	External Colour Rating	Internal Colour	Internal Colour Rating	% Core of Total Width	Blight Rating	Score	% Cavity Spot & Degree	Shape of Crown
CARADEC	UNF	O	8.0	LO	6.7	47.4 f*	6.0 e	7.48 a	98M a	CC
WARMIA	RZ	DO	7.3	O	5.7	49.7 ef	7.5 cd	6.10 d	82LM cd	CV
BASTIA	Bejo	O	6.3	O	6.3	52.9 cde	7.0 cde	6.62 bcd	97M a	CC
BELGRADO	Bejo	LO	7.7	LO	5.0	60.7 ab	8.0 abc	6.10 d	95L ab	CV
BERLIN	Bejo	O	7.0	O	6.7	58.7 ab	8.0 abc	7.24 ab	98M a	CV
BEIJING	Bejo	LO	6.7	LO	7.3	62.2 a	8.8 a	6.38 cd	92M abc	CV
FONTANA	Bejo	O	7.0	LO	5.7	52.4 def	3.3 f	6.05 d	78L d	CV
MORELIA	RZ	LO	6.7	LO	5.7	49.0 ef	7.7 bcd	6.43 cd	77LM d	CC
ACHIEVE	Sto	O	6.0	O	5.3	56.0 bcd	7.5 cd	6.76 bc	85LM bcd	CC
NEW HALL JUMBO	Bejo	LO	7.7	LO	7.7	48.6 ef	7.5 cd	7.48 a	98L a	CC
ABBOTT	Sol	LO	7.3	LO	6.7	58.0 abc	6.8 de	6.95 abc	90LM abc	CV
COSTELLO	Sol	O	6.7	O	6.7	52.5 def	8.7 ab	6.90 abc	88L a-d	CC
Trial Average			**7.0**		**6.3**	**54.0**	**7.2**	**6.71**	**90LM**	

Listed in order of % Marketable. 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

... / continued

CARROT CULTIVAR MAIN TRIAL JUMBO TYPES - 2012 - continued

Cultivar	Source	Root Length (cm)	Root Width (cm)	Stand per Foot	Top Length (cm)	Leaf Colour	% Weevil Damage	% Rust Fly Damage	Average # of Seeders	% Aster Yellows
CARADEC	UNF	21.7 abc*	5.0 a	17 a	42.2 c	G	0.3 a	0.0 a	8.0 c	0.8
WARMIA	RZ	22.1 abc	5.2 a	15 a	49.7 b	G	0.2 a	0.3 a	0.3 a	0.6
BASTIA	Bejo	21.1 cd	5.3 a	17 a	42.3 c	LG	1.3 a	0.0 a	1.3 a	1.1
BELGRADO	Bejo	20.8 cd	5.4 a	17 a	51.2 b	LG	0.5 a	0.0 a	1.7 ab	0.8
BERLIN	Bejo	19.6 d	5.3 a	18 a	49.9 b	LG	0.2 a	0.3 a	1.3 a	1.0
BEIJING	Bejo	21.7 abc	5.2 a	17 a	45.2 c	LG	0.0 a	0.0 a	2.3 ab	0.3
FONTANA	Bejo	21.5 bc	5.1 a	19 a	50.2 b	LG	0.5 a	0.2 a	2.0 ab	1.8
MORELIA	RZ	23.2 a	5.1 a	16 a	43.9 c	LG	0.0 a	0.3 a	0.7 a	0.6
ACHIEVE	Sto	23.1 ab	5.2 a	18 a	56.6 a	G	0.5 a	0.0 a	4.3 b	0.7
NEW HALL JUMBO	Bejo	21.3 c	4.5 a	18 a	42.6 c	G	0.2 a	0.3 a	1.3 a	1.7
ABBOTT	Sol	22.2 abc	4.7 a	14 a	43.8 c	G	0.0 a	0.5 a	1.0 a	0.3
COSTELLO	Sol	23.1 ab	5.0 a	15 a	42.9 c	LG	0.0 a	0.0 a	0.3 a	1.5
Trial Average		**21.8**	**5.1**	**17**	**46.7**		**0.3**	**0.1**	**2.1**	**0.9**

Listed in order of % Marketable.

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

MAIN CARROT CULTIVAR TRIAL CELLO TYPES EVALUATION NOTES - 2012

55-205: Nantes type carrot, Average length even, Some a bit short, Good width but a little uneven, Full tips, Average appearance, Good weight, Fair exterior colour, Fairly smooth, Uniformity of shape a little uneven, Cavity spot noticeable and a little concerning, Odd noticeable lenticel, Average core size, Red ring around core (10-30%), Dead center of core translucent (50-100%), Average interior blending, Nice Jumbo.

Envy: Length very uneven, Average width but uneven, Tapered tips, Average appearance, Average weight, Exterior colour a little uneven, Fairly smooth, Uniformity of shape a little uneven, Cavity spot slightly noticeable, A little ringy, Average interior blending, Red ring around core (30-80%), Dead center of core translucent (20-60%), Average core size, Fair Jumbo with tapered ends.

Numancia: Good length but very uneven, Some short carrots, Average width but very uneven, Full tips, Larger packers have slicer potential, Average appearance, Average weight, Exterior colour uneven, Fairly smooth, A few bends and curves, Average interior blending, Dead center of core translucent (60-90%), Red ring around core (10-30%), Large core size.

Bonfire: Good length, Slicer potential?, Average width but uneven, Tapered full tips, Rough appearance, Average weight, Nice even exterior colour, Uniformity of shape a little uneven, A few bends and curves, Cavity spot a very big concern, Very ringy, Average to good interior blending, Red ring around core (10-50%), Average to large core size.

…/continued

MAIN CARROT CULTIVAR TRIAL CELLO TYPES EVALUATION NOTES - 2012 - continued

Niland: Nantes carrot, Okay length & width but uneven, Bit short, Full tips, Good appearance, Good weight, Fair exterior colour but a little uneven, Fairly smooth, Uniformity of shape a little uneven, Odd noticeable cavity spot, Odd noticeable lenticel, Odd ringy carrot, Average to good interior blending, Dead center of core translucent (40-90%), Red ring around core (10-30%), Average to large core size.

Olympus: Average length & width but uneven, Tapered tips, Average appearance, Average weight, Exterior colour a little uneven, Uniformity of shape a little uneven, A few bends & curves, Odd noticeable cavity spot, A touch ringy, Good to nice interior blending, Red ring around core (30-70%), Average core size, Good Jumbo with tapered ends.

Cellobunch: Uniformity of shape a little uneven, A touch ringy, Good length & width but uneven, Tapered full tips, Average appearance, Average weight, Good even exterior colour, Average core size, Poor to average interior blending, Dead center of core translucent (30%), Odd noticeable cavity spot.

Dominion: Average length but uneven, Width very uneven, Tapered full tips, Rough appearance, Average weight, Exterior colour a little uneven, Varied smoothness, Uniformity of shape a little uneven, Some bends and curves, Odd ringy carrot, Average interior blending, Red ring around core (40%), Average core size.

…/continued

MAIN CARROT CULTIVAR TRIAL CELLO TYPES EVALUATION NOTES - 2012 - continued

Jerada: Good slicer potential, Good length & width and even, Full tips, Good appearance, Good to excellent weight, Exterior colour a little pale, Good smoothness, Uniformity of shape even, Odd bend and curve, Odd noticeable cavity spot, Odd ringy carrot, Poor to average interior blending, Dead center of core translucent (20-60%), Average core size, Nice Jumbo.

Naval: Nantes carrot, Length bit short and uneven, Average width but uneven, Full tips, Average appearance, Good weight, Good even exterior colour, Fairly smooth, Uniformity of shape uneven, Odd noticeable cavity spot, Odd ringy carrot, Average core size, Red ring around core (30%), Good interior blending, Dead center of core translucent (40-60%), Odd noticeable lenticel, Good Jumbo but bit short.

New Hall Cello: Length uneven, Bit short, Width very uneven, Average weight, Fairly smooth, Uniformity of shape uneven, Odd noticeable cavity spot, Odd ringy carrot, Average interior blending, Dead center of core translucent (30-50%), Full tips, Average appearance, Average to large core size.

Crofton: Slicer potential, Uniformity of shape even, Fair exterior colour, Good length, Good width but a little uneven, Average to good weight, Fairly smooth, Cavity spot slightly noticeable, Lenticels slightly noticeable, Odd ringy carrot, Good interior blending, Dead center of core translucent (50-80%), Full tips, Good appearance, Average core size, Green ring around core (30%).

…/continued

MAIN CARROT CULTIVAR TRIAL CELLO TYPES EVALUATION NOTES - 2012 - continued

Notable: Nantes carrot, Okay length but uneven, Good width but uneven, Full tips, Rough appearance, Good weight, Exterior colour a little pale, Uniformity of shape a little uneven, Noticeable cavity spot a slight concern, All carrots a touch ringy, Average core size, Average to good interior blending, Green ring around core (10%), Jumbo not bad but a bit short.

CR 2384: Good length but uneven, Average width but very uneven, Full tips, Average appearance, Average weight, Good exterior colour, Uniformity of shape a little uneven, A few bends and curves, Odd noticeable cavity spot, A touch ringy, Poor interior blending, Red ring around core (10-90%), Dead center of core translucent (10-40%), Average core size, Slicer potential?

Nerja: Length uneven, Width a little uneven, Full tips, Appearance a little rough, Poor to average weight, Exterior colour a little uneven, Fairly smooth, A few bends and curves, Cavity spot slightly noticeable, A little ringy, Average interior blending, Red ring around core (30-70%), Dead center of core translucent (10%), Small to average core size, Bit thin.

CR 2289: Good length & width but uneven, Tapered full tips, Rough appearance, Average weight, Exterior colour uneven, Poor smoothness, Uniformity of shape a little uneven, Ringy carrots, Average core size, Red ring around core (30%), Interior blending is a little uneven, Not a bad Jumbo.

SS 3320: Cut & Peel carrot, Length is long and uneven, Width very uneven, Tapered tips, Rough to average appearance, Poor to average weight, Fair exterior colour, Fairly smooth, A touch ringy, Some bends & curves, Odd noticeable cavity spot, Average core size, Red ring around core (40-70%), Good interior blending.

MAIN CARROT CULTIVAR TRIAL JUMBO TYPES EVALUATION NOTES - 2012

Caradec: Average to good length but a little uneven, Good width even, Full tips, Average to good appearance, Excellent weight, Uniformity of shape very even, Fair exterior colour, A lot of cavity spot a concern, A few noticeable lenticels, Large core size, Average interior blending, Translucency throughout core (20%), Red ring around core (60%), Odd ringy carrot, Fairly smooth, White in cores (10%).

Warmia: Average length bit uneven, Average width even, Tapered tips, Rough appearance, Average weight, Good exterior colour, Poor smoothness, Uniformity of shape a little uneven, Cavity spot noticeable on some carrots, Noticeable lenticels, Ringy carrots, Large core size, Red ring around core (10-50%), Green ring around core (10%), Poor interior blending, Heavy shoulders.

Bastia: Good length but uneven, Good width even, Tapered & full tips, Average to good appearance, Uniformity of shape a little uneven, Cavity spot slightly noticeable, Odd noticeable lenticel, Good exterior colour but a little uneven, Fairly smooth, Red/Yellow ring around core (10-20%), Average interior blending, Excellent weight, Extra-large core size, Translucency throughout core (20-70%).

Belgrado: Excellent weight, Average appearance, Uniformity of shape uneven, A few noticeable lenticels, Extra-large core size, Exterior colour a little pale, A touch ringy, Poor interior blending, Fairly smooth, Poor length uneven, Good width, Cavity spot noticeable a concern, Translucency throughout core (40%), White in cores (60%), Full tips, Red ring around core (50%).

Berlin: Excellent weight, Nice appearance, Fairly smooth, Uniformity of shape even, Cavity spot noticeable a concern, Odd noticeable lenticel, Extra-large core size, Exterior colour a little uneven, Average interior blending, Odd ringy carrot, Average length but a little uneven, Some a bit short, Good width, White in cores (30-50%), Tapered full tips, Red ring around core (20-50%), Translucency throughout core (20%).

Beijing: Good length but uneven, Good width even, Tapered & full tips, Average appearance, Exterior colour a little pale, Odd noticeable cavity spot, Odd ringy carrot, Fairly smooth, Red ring around core (10%), Good interior blending, A few noticeable lenticels, White in cores (30%), Excellent weight, Extra-large core size.

…/continued

MAIN CARROT CULTIVAR TRIAL JUMBO TYPES EVALUATION NOTES – 2012 - continued

Fontana: Good weight, Good length but a little uneven, Good width even, Tapered & full tips, Average appearance, Good smoothness, Uniformity of shape a little uneven, Fair exterior colour but a little uneven, Lenticels slightly noticeable, Poor to average interior blending, Translucency throughout core (20-40%), Large core size, Red ring around core (10-60%).

Morelia: Good length but uneven, Good width even, Full tips, Nice appearance, Good weight, Fair exterior colour, Fairly smooth, Uniformity of shape even, Odd noticeable lenticel, Large to extra-large core size, Dead center of core translucent (50-90%), Interior blending is a bit poor, White in core (20%), Packer not bad some short.

Achieve: Good length & width, Good smoothness, Good weight, Tapered & full tips, Good appearance, Uniformity of shape a little uneven, Fair exterior colour but a little uneven, Extra-large core size, Cavity spot slightly noticeable, Poor to average interior blending, Red ring around core (40-80%), Translucency throughout the core (20-80%).

New Hall Jumbo: Good length & width even, Full tips, Excellent weight, Exterior colour even, Good smoothness, Uniformity of shape even, Good interior blending, Translucency throughout core (50-70%), Average to nice appearance, Extra-large core size.

Abbott: Good length, A few short ones, Good width very even, Full tips, Good appearance, Uniformity of shape a little uneven, Exterior colour a little pale, Average interior blending, Good smoothness, Excellent weight, Extra-large core size, Cavity spot noticeable, Translucency throughout core (40%), Red ring around core (10%), Noticeable lenticels.

Costello: Good length but uneven, Good width even, Full tips, Average appearance, Good weight, Fairly smooth, Uniformity of shape even, Odd noticeable cavity spot, Fair exterior colour, Extra-large core size, Interior blending is a little poor, Translucency throughout core (20-70%), Red ring around core (10-20%), A touch ringy, Odd noticeable lenticel, Packers are nice but short.

LONG TERM AVERAGES OF CARROT CULTIVAR TRIALS

CULTIVAR	SOURCE	# YEARS TESTED	LENGTH cm	LENGTH Inches	MARKETABLE YIELD t/ha	MARKETABLE YIELD B/A	% MARKETABLE	SCORE *
DOMINION	Sto	5	25.4	10.0	92.3	1486	86	6.82
INDIANA	Bejo	7	25.3	10.0	73.2	1193	81	7.20
ENTERPRISE	Sto	8	25.0	9.8	86.4	1416	85	6.89
SIX SHOOTER	HM	5	24.8	9.8	87.4	1408	82	6.96
NEVADA	Bejo	4	24.7	9.7	83.1	1338	75	6.72
ENVY	Sem	8	24.5	9.6	101.1	1627	87	6.66
HY 8520	RZ	4	24.2	9.5	104.8	1687	86	6.81
ACHIEVE	Sto	6	24.1	9.5	101.8	1639	85	6.78
ORANGE PAK	Nor	7	23.7	9.3	85.1	1369	87	6.82
MAGNUM	HM	4	23.7	9.3	95.3	1534	86	6.75
CARO-CHIEF	Sem	4	23.7	9.3	76.1	1359	82	7.25
ORANGETTE	Sto	5	23.4	9.2	96.2	1368	87	6.90
CANADA SUPER X	Sol	14	23.3	9.2	80.8	1376	83	6.95
SIX PAK	HM	20	23.0	9.1	79.0	1273	86	6.98
SUNRISE	Cro	15	23.0	9.1	86.0	1438	86	6.82
BASTIA	Bejo	8	22.9	9.0	103.9	1674	88	6.92
CELLOBUNCH	Sem	23	22.9	9.0	95.5	1572	85	6.69
ORLANDO GOLD	Sto	7	22.6	8.9	69.2	1235	86	7.35
FONTANA	Bejo	11	22.6	8.9	108.7	1750	89	6.38
LEGEND	Sem	4	22.5	8.8	62.7	1119	75	6.80

Listed in order of length. * 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average

.../ continued

LONG TERM AVERAGES OF CARROT CULTIVAR TRIALS - continued

CULTIVAR	SOURCE	# YEARS TESTED	LENGTH cm	LENGTH Inches	MARKETABLE YIELD t/ha	MARKETABLE YIELD B/A	% MARKETABLE	SCORE *
COSTELLO	Sol	4	22.3	8.8	73.3	1181	74	6.81
SIX PAK II	HM	15	22.1	8.7	78.0	1328	84	6.80
BELGRADO	Bejo	5	22.0	8.7	105.9	1705	84	6.25
PRONTO	Sem	5	21.9	8.6	90.4	1482	85	7.35
IMPERATOR 58	Cro	9	21.7	8.5	50.3	899	78	6.40
AVENGER	Sem	7	21.5	8.5	81.0	1369	80	6.90
DAWN DEE	Sol	4	21.4	8.4	58.0	928	69	7.15
ITHACA	Bejo	3	21.4	8.4	78.0	1256	81	7.30
ORANGE SHERBET	Sto	10	21.2	8.3	73.4	1310	84	6.75
CAROPAK	Sem	8	20.9	8.2	74.1	1323	85	6.85
CHANCELLOR	Sem	7	20.9	8.2	76.8	1371	83	6.85
BRADFORD	Bejo	4	20.8	8.2	129.6	2087	94	6.75
GOLD PAK 28	FM	12	20.8	8.2	55.9	998	85	6.65
PAK MOR	HM	5	20.7	8.2	62.4	1114	81	6.55
PARAMOUNT	Sem	7	20.6	8.1	82.1	1467	85	6.75
ABBOTT	Sol	4	20.5	8.1	80.7	1298	79	6.63
PROSPECTOR	Sem	5	20.2	8.0	95.0	1696	83	7.15
DOMINATOR	Nun	13	19.7	7.8	63.9	1141	85	6.80
KLONDIKE NANTES	Sto	10	19.6	7.7	72.1	1288	85	6.85
SIX PENCE	HM	4	19.6	7.7	79.5	1419	80	6.70

Listed in order of length. * 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average

CARROT CULTIVAR ADAPTATION TRIAL - 2012

Cultivar	Source	# Carrots Harvested	# > 4.4 cm	# 2.0 to 4.4 cm	Total Harvest Weight (kg)	Weight > 4.4 cm (kg)	Weight 2.0 to 4.4 cm (kg)	Marketable Yield t/ha	Marketable Yield B/A	% Marketable	% Oversize	Majority of Culls
Jumbos												
VAC 51	Vil	136	43	65	25.14	12.74	7.23	99.9	1608	79.4	50.7	F
VAC 48	Vil	158	31	73	17.46	7.45	5.96	67.1	1080	76.8	42.7	SEED
Cellos												
PURPLE SUN	Bejo	133	14	77	14.76	3.29	8.10	57.0	917	77.2	22.3	SP
YOSEMITE	Vil	142	9	88	19.99	2.79	10.49	66.4	1069	66.4	14.0	F
SEQUOIA	Vil	102	9	42	17.75	3.20	4.88	40.4	650	45.5	18.0	F

Listed in order of % Marketable.

... / continued

CARROT CULTIVAR ADAPTATION TRIAL - 2012 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Width	Uniformity of Length	Appearance	Resistance to Greening	External Colour	External Colour Rating	Internal Colour	Internal Colour Rating	Score	Blight Rating
Jumbos													
VAC 51	Vil	GPN	7.0	8.0	8.0	8.0	9.0	O	8.0	LO	6.0	7.71	7.5
VAC 48	Vil	GPN	8.0	8.0	8.0	8.0	8.0	O	8.0	O	6.0	7.71	9.0
Cellos													
PURPLE SUN	Bejo	GP	6.0	6.0	6.0	7.0	10.0	DP	6.0	DP	7.0	6.86	4.0
YOSEMITE	Vil	Imp	8.0	4.0	6.0	8.0	10.0	O	6.0	LO	6.0	6.86	7.0
SEQUOIA	Vil	Imp	7.0	6.0	4.0	5.0	9.0	DO	7.0	O	5.0	6.14	6.0

Listed in order of % Marketable. 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average

... / continued

CARROT CULTIVAR ADAPTATION TRIAL - 2012 - continued

Cultivar	Source	% Core of Total Width	Leaf Length (cm)	% Cavity Spot & Degree	Shape of Crown	Root Length (cm)	Root Width (cm)	Stand per Foot	Leaf Colour	% Weevil Damage	% Rust Fly Damage	% Aster Yellows	Average # of Seeders
Jumbos													
VAC 51	Vil	47.5	60.7	75M	CC	19.3	5.5	18	G	2.9	0.0	0.7	6.0
VAC 48	Vil	52.1	99.1	60L	CC	18.5	4.8	21	G	2.5	0.0	1.9	29.0
Cellos													
PURPLE SUN	Bejo	42.9	49.5	15L	CV	18.3	3.4	17	DG	0.0	0.0	0.0	0.0
YOSEMITE	Vil	36.9	39.7	90L	CV	25.4	2.9	19	LG	2.8	0.0	1.4	1.0
SEQUOIA	Vil	36.6	38.2	90L	CV	21.9	3.2	13	G	0.0	0.0	1.0	0.0

Listed in order of % Marketable. 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average

ADAPTATION CARROT CULTIVAR TRIAL EVALUATION NOTES - 2012

Jumbos

Vac 51: Good even length & width, Full tips, Average to nice appearance, Excellent weight, Good exterior colour, Fairly smooth, Uniformity of shape is even, Slightly noticeable lenticels, Large core size, Red/Yellow ring around core (30%), Dead center of core translucent (10%), Average interior blending.

Vac 48: Okay length, Good even width, Full tips, Excellent weight, Good even exterior colour, Average to nice appearance, Uniformity of shape is even, Odd noticeable cavity spot, Good interior blending, Translucency throughout core (70%), Red ring around core (20%), Good smoothness, White in cores (20%), Odd lenticel noticeable, Large core size, High number of seeders.

Cellos

Purple Sun: Good length & width but uneven, Tapered tips, Rough to average appearance, Good weight, Exterior colour uneven, Uniformity of shape a little uneven, Noticeable lenticels, A little ringy, Average core size, Fair interior blending, White in cores (30%), Some a bit short, Whitish ring around core, Nice deep purple colour, Core colour bit light.

Yosemite: Cut & Peel type, Good length & width but uneven, Slightly tapered tips, Average weight, Average to nice appearance, Exterior colour a little uneven, Odd ringy carrot, Average interior blending, Some carrots have noticeable cavity spots, Red ring around core (50%), Good smoothness, Dead center translucent core (20%), Some bends & curves, Average core size.

Sequoia: Good length but very uneven, Average width, Tapered tips, Rough appearance, Average weight, Good exterior colour, Poor smoothness, Odd noticeable cavity spot, Very ringy, Average core size, Red ring around core (70%), Poor to average interior blending.

CARROT CULTIVAR STORAGE TRIAL - 2011 - 2012

Cultivar	Source	% Marketable	% Weight Loss	% Decay	Degree of Rot **	% Root Sprouts	% Top Sprouts
CROFTON	RZ	81.1 a*	17.0 a	1.8 a	8.7 ab	55 e-h	93 a
MORELIA	RZ	78.0 ab	17.4 a	4.7 a-d	8.7 ab	45 c-h	88 a
GRIVOLA	RZ	77.8 ab	17.9 a	3.6 abc	9.0 a	63 gh	95 a
COSTELLO	Sol	77.4 abc	18.5 a	3.8 abc	8.3 abc	20 a-d	88 a
HY 8567	RZ	77.1 abc	19.5 a	3.1 ab	8.3 abc	37 a-g	88 a
BELGRADO	Bejo	76.1 a-d	16.1 a	7.7 a-e	8.7 ab	8 a	92 a
ANKARA	Bejo	76.0 a-d	18.2 a	5.2 a-d	6.3 c-g	53 e-h	88 a
JERADA	RZ	75.5 a-d	19.0 a	5.1 a-d	8.0 a-d	18 a-d	90 a
NAVAL	Bejo	75.2 a-d	16.8 a	7.4 a-e	7.7 a-e	53 e-h	93 a
8503	RZ	75.0 a-d	21.6 a	3.0 ab	7.0 a-f	47 c-h	90 a
PX 2384	Sem	74.0 a-e	20.8 a	4.8 a-d	7.3 a-e	28 a-e	83 a
BELGRADO Germ Plus	Nor	73.5 a-e	17.8 a	8.5 a-f	7.8 a-d	7 a	93 a
W 10029	RZ	72.8 a-e	21.9 a	4.8 a-d	7.3 a-e	45 c-h	92 a
ACHIEVE	Sto	72.0 a-f	19.3 a	8.4 a-f	6.7 b-f	17 abc	87 a
BREST	Bejo	71.9 a-f	18.2 a	9.4 b-f	6.0 d-g	45 c-h	90 a
NOTABLE	Bejo	71.8 a-f	24.3 a	3.6 abc	8.7 ab	48 d-h	93 a

Listed in order of % Marketable.

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

** 10.0 = No Disease, 6.0 = Moderate, 1.0 = Severe (liquified)

… / continued

CARROT CULTIVAR STORAGE TRIAL - 2011 - 2012 - continued

Cultivar	Source	% Marketable	% Weight Loss	% Decay	Degree of Rot **	% Root Sprouts	% Top Sprouts
ABBOTT	Sol	71.5 b-f*	16.9 a	11.5 d-h	6.5 c-f	42 b-h	90 a
WARMIA	RZ	71.2 b-g	21.9 a	6.5 a-e	5.7 efg	27 a-e	77 a
CELLOBUNCH	Sto	70.3 b-h	23.4 a	5.8 a-e	7.0 a-f	55 e-h	93 a
FINLEY	Bejo	70.2 b-h	22.8 a	6.7 a-e	6.7 b-f	13 ab	83 a
SVR 2289 Grem Plus	Nor	68.1 c-i	23.0 a	8.7 b-f	6.3 c-g	42 b-h	88 a
BASTIA Grem Plus	Nor	67.7 d-i	14.3 a	17.6 hi	7.7 a-e	8 a	88 a
SS 3320	Sol	66.9 d-i	20.8 a	11.7 d-h	7.3 a-e	60 fgh	92 a
IBIZA Grem Plus	Nor	66.7 d-i	22.7 a	10.0 c-g	5.0 fg	70 h	80 a
NILAND	Bejo	65.2 e-i	18.0 a	16.6 ghi	8.3 abc	62 fgh	92 a
BASTIA	Bejo	64.6 e-i	25.3 a	10.0 c-g	7.0 a-f	20 a-d	80 a
B 2823 GP	Nor	62.6 f-i	15.6 a	21.0 i	5.7 efg	40 b-h	87 a
PX 2289	Sem	61.8 ghi	22.6 a	14.9 f-i	4.3 g	32 a-f	80 a
ENVY	Sto	61.1 hi	26.2 a	12.3 e-h	7.0 a-f	37 a-g	97 a
FONTANA	Bejo	59.9 i	22.8 a	17.6 hi	7.3 a-e	13 ab	93 a
Trial Average		**66.3**	**21.2**	**12.2**	**6.6**	**37**	**87**

Listed in order of % Marketable.

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

** 10.0 = No Disease, 6.0 = Moderate, 1.0 = Severe (liquified)

MAIN CARROT CULTIVAR STORAGE TRIAL EVALUATION NOTES 2011-2012

Crofton: Light to moderate amount of top sprouts 1-2.5cm, Top sprouts a slight concern, Root sprouts just starting 0-1cm, Mostly tip rot, Some canker rot, Rots are just starting and dry, Stored Good.

Morelia: Moderate to heavy amount of top sprouts 2.5-5cm, Top sprouts lengths uneven, Top sprouts a concern, Light amount of root sprouts 1-2.5cm, All tip rot, Rot is just starting and dry, Stored Okay.

Grivola: Heavy amount of top sprouts 2.5-5cm, Top sprouts lengths uneven, Top sprouts a concern, Light amount of root sprouts 1-2.5cm, All tip rot, Rot is just starting and dry, Stored Okay.

Costello: Moderate amount of top sprouts 1-2.5cm, Top sprouts lengths uneven, Root sprouts just starting 0-1cm, Mostly tip rot, Odd crown rot, Rots are just starting and dry, Stored Okay.

HY 8567: Light amount of top sprouts 1-2.5cm, Top sprouts lengths uneven, Root sprouts just starting 0-1cm, All tip rot, Rot is just starting and dry, Stored Good.

Belgrado: Light amount of top sprouts 0-2.5cm, Top sprouts lengths uneven, Root sprouts just starting 0-1cm, Tip & canker rot, Rots are just starting and dry, Some carrots are dried out, Stored Okay but uneven.

Ankara: Moderate amount of top & root sprouts 1-2.5cm, Top sprouts lengths uneven, Mostly tip rot, A few canker & crown rot, Rots are lightly established and moist, Some carrots are dried out, Stored Okay.

Jerada: Light to moderate amount of top sprouts 1-2.5cm, Top sprouts lengths uneven, Root sprouts just starting 0-1cm, All tip rot, Rot is just starting and dry, Stored Good.

.../continued

MAIN CARROT CULTIVAR STORAGE TRIAL EVALUATION NOTES 2011-2012 - continued

Naval: Moderate amount of top sprouts 1-2.5cm, Top sprouts lengths uneven, Light amount of root sprouts 1-2.5cm, Mostly tip rot, Rot is just starting and dry, Slight concern on rot, Stored Okay.

8503: Moderate amount of top sprouts 1-2.5cm, Top sprouts lengths uneven, Light to moderate root sprouts 1-2.5cm, Mostly tip rot, Some crown rot, Rots are just starting to light, Rots are both moist and dry, Some carrots dried out, Stored Fair.

PX 2384: Just starting to light amount of top sprouts 0-2.5cm, Root sprouts just starting 0-1cm, Tip & canker rot, Rots are just starting to light, Rots are moist and dry, Dried out carrots, Stored Okay but uneven.

Belgrado: **Germ Plus** Light to moderate top sprouts 0-5cm, Root sprouts just starting 0-2.5cm, Top & root sprouts lengths uneven, All tip rot, Rot is just starting to lightly established and moist, Stored Fair.

W 10029: Moderate amount of top sprouts 1-2.5cm, Top sprouts lengths uneven, Light amount of root sprouts 1-2.5cm, Sprouting a bit of an concern, All tip rot, Rot is lightly established, Rot is dry and moist, Stored Okay.

Achieve: Light to moderate amount of top sprouts 0-2.5cm, Top sprouts lengths uneven, Root sprouts just starting 0-1cm, Mostly tip rot, A few crown rot, Rots are lightly established and moist, Some dried out carrots, Stored Okay.

Brest: Moderate top sprouting 1-5cm, Top sprouts lengths uneven, Root sprouts just starting 0-1cm, Mostly tip rot, Odd crown rot, Rots are established and moist, Rot is a concern, Stored Okay.

Notable: Light amount of top sprouts approx. 1-2.5cm, Top sprouts lengths uneven, Root sprouts just starting 0-1cm, Mostly tip rot, Odd canker rot, Rots are just starting and dry, Carrots a bit dried out, Stored Okay.

.../continued

MAIN CARROT CULTIVAR STORAGE TRIAL EVALUATION NOTES 2011-2012- continued

Abbott: Light amount of top sprouts 0-2.5cm, Top sprouts lengths uneven, Root sprouts just starting 0-1cm, Tip, canker and crown rot, Rots lightly established moist, Stored Okay.

Warmia: Light amount of top sprouts 0-1cm, Top sprouts lengths uneven, Root sprouts just starting 0-1cm, Mostly tip rot, Odd canker rot, Rots are lightly established, Rots are dry and moist, Carrots a bit dried out, Stored a little poor.

Cellobunch: Moderate top sprouts 2.5-5cm, Top sprouts lengths uneven, Light amount of root sprouts1-2.5cm, Sprouting is a concern, Mostly tip rot, Odd canker rot, Rots are just starting to established, Rots are dry and moist, Stored Okay.

Finley: Light amount of top sprouts 0-1cm, Top sprouts lengths uneven, Root sprouts just starting 0-1cm, Mostly tip rot, Odd crown & canker rot, Rots just starting to moderate, Rots are dry to liquefied, Some dried out carrots, Stored Poor.

SVR 2289: **Germ Plus** Light to moderate top sprouts 0-2.5cm, Top sprouts lengths uneven, Root sprouts just starting 0-2.5cm, Mostly tip rot, Odd canker rot, Rots are lightly established and moist, Carrots a touch dried out, Stored Okay.

Bastia: **Germ Plus** Moderate top sprouts 1-2.5cm, Top sprouts lengths uneven, Root sprouts just starting 0-1cm, Mostly tip rot and a concern, Odd canker rot, Rots are just starting and dry, Carrots a touch dried out, Stored Okay.

SS 3320: Just starting to light amount of top sprouts 0-2.5cm, Root sprouts just starting 0-1cm, Mostly tip rot, Some crown & canker rot, Rots are lightly established and moist, Rots are a concern, Stored Poor.

Ibiza: **Germ Plus** Just starting to light top & root sprouts 0-2.5cm, Sprouts a slight concern, Mostly tip rot, Odd canker & crown rot, Rots are lightly established and moist, Carrots are dried out, Stored a little poor.

.../continued

MAIN CARROT CULTIVAR STORAGE TRIAL EVALUATION NOTES 2011-2012- continued

Niland: Moderate amount of top & root sprouts 1-2.5cm, Top & root sprouts lengths uneven and a concern, Mostly tip rot, A few crown rot, Rots is just starting, Rots are moist and dry, Slight concern on rot, Stored Poor.

Bastia: Light amount of top sprouts 0-2.5cm, Root sprouts just starting 0-1cm, Mostly tip rot, Some canker rot, Odd crown rot, Rots slightly established, Rots are dry and moist, Rots a bit of a concern, Stored Fair.

B 2823:
Germ Plus Light amount of top sprouts 1-2.5cm, Top sprouts lengths uneven, Root sprouts just starting 0-1cm, Tip & canker rot, Rots are established and moist, Stored Poor.

PX 2289: Light amount of top sprouts 1-2.5cm, Top sprouts lengths uneven, Root sprouts just starting 0-1cm, Mostly tip rot, Odd canker & crown rot, Rots are moderately established and moist, Rot is a big concern, Carrots a bit dried out, Stored Poor.

Envy: Moderate amount of top sprouts 1-5cm, Top sprouts lengths uneven and a concern, Root sprouts just starting 0-1cm, Mostly tip rot, Odd canker & crown rot, Rots are lightly established and moist, Stored Poor.

Fontana: Moderate amount of top sprouts 1-2.5cm, Top sprouts lengths uneven, Root sprouts just starting 0-1cm, Mostly tip rot, Odd canker rot, Rots are lightly to established, Rots are dry and moist, Rot is a concern, Stored Poor.

LONG TERM AVERAGES - CARROT CULTIVAR STORAGE TRIALS

CULTIVAR	SOURCE	# YEARS TESTED	% MARKETABLE	% WEIGHT LOSS IN STORAGE	% DECAY	DEGREE* OF DECAY
SPARTAN CLASSIC 80	Sto	4	97.6	6.8	2.4	5.5
BLAZE	Rog	4	95.2	10.0	4.8	4.9
LEGEND	Sem	3	94.7	8.4	5.3	5.0
HM 03	HM	3	94.6	16.0	5.4	7.3
KLONDIKE NANTES	Sto	4	93.7	8.1	6.3	6.0
PAK MOR	HM	6	93.5	11.5	6.5	4.2
ORANGETTE	Sto	5	92.4	16.8	7.6	6.3
ORANGE SHERBET	Sto	6	91.9	9.0	8.1	4.5
AVENGER	Sem	7	91.3	11.5	8.7	7.0
CANADA SUPER X	Sol	14	90.8	11.9	9.2	5.5
CARO-CHIEF	Sem	5	89.0	10.1	11.0	5.0
ORLANDO GOLD	Sto	6	87.9	12.7	12.1	4.2
SIX PAK II	HM	15	87.7	12.3	12.3	5.5
DISCOVERY	Rog	3	86.8	8.5	13.2	4.3
CHANCELLOR	Sem	7	86.7	11.3	13.3	4.2
PROSPECTOR	Sem	4	86.7	6.3	13.3	4.3
INFINITY	Bejo	5	83.4	11.4	4.9	7.8
FLAME	Rog	4	82.6	11.4	17.4	4.6
ENTERPRISE	Sem	7	82.2	10.7	7.0	6.9

Listed in order of % Marketable. Storage period is approximately 9 months.

* 10.0 = No Disease, 6.0 = Moderate, 1.0 = Severe (liquified)

... / continued

LONG TERM AVERAGES - CARROT CULTIVAR STORAGE TRIALS - continued

CULTIVAR	SOURCE	# YEARS TESTED	% MARKETABLE	% WEIGHT LOSS IN STORAGE	% DECAY	DEGREE * OF DECAY
BRADFORD	Bejo	5	82.1	10.0	7.9	7.8
SIX PENCE	HM	4	81.6	8.4	18.4	4.0
TRIGGER	Sem	4	81.6	10.6	7.6	6.3
SIX PAK	HM	20	79.8	11.5	8.6	5.8
BELGRADO	Bejo	3	79.1	12.1	8.6	7.0
CELLOBUNCH	Sem	20	78.9	13.3	7.8	6.6
ORANGE PAK	Nor	8	78.6	13.2	8.1	6.8
SUNRISE	Cro	15	78.6	12.8	8.2	6.8
CAROPAK	Sem	4	77.7	10.7	22.3	4.2
COSTELLO	Sol	3	77.1	13.4	9.3	7.5
INDIANA	Bejo	7	75.7	15.4	8.5	7.0
FONTANA	Bejo	11	74.7	12.1	12.9	7.1
DOMINION	Sem	3	72.5	14.4	12.8	5.9
ACHIEVE	Sem	5	72.0	14.8	12.9	6.8
ABBOTT	Sol	3	71.5	13.6	14.6	5.8
SIX SHOOTER	HM	5	71.5	11.0	17.5	6.0
BASTIA	Bejo	7	70.9	16.1	12.8	6.7
NEVADA	BEjo	4	69.1	16.5	14.2	5.8
ENVY	Sem	8	66.0	14.0	19.7	6.8

Listed in order of % Marketable. Storage period is approximately 9 months.

* 10.0 = No Disease, 6.0 = Moderate, 1.0 = Severe (liquified)

ONION CULTIVAR TRIAL SEASON SUMMARY – 2012

The weather conditions for the month of April were favourable for a good start to the growing season. The ground frost was well melted by mid-April and soil temperatures were in the 5°C range at the 5 cm depth by month's end. Above seasonal temperatures in early May allowed easy land preparation. In the marsh a fair amount of the onion seeding began in the last week of April and continued in the first few days of May. A heavy rainfall on May 3rd of 35 mm stopped seeding for a few days. Spring proved to have above seasonal temperatures and two significant rainfalls at the start of each month followed by a dry remainder of the months. The summer conditions were warm and rainfall was normal. The onion crop had a good start and good growing conditions continued throughout the season. Compared to the averaged previous 10 years, the air temperatures in 2012 were average for August (20.1ºC) and September (14.8ºC), and above average for May (15.9ºC), June (20.1ºC) and July (22.2ºC). The long term previous 10 year average temperatures were: May 12.3ºC, June 18.2ºC, July 20.7ºC, August 19.5ºC and September 15.8ºC. Monthly rainfall was below the previous long term 10 year average for May (49 mm) and June (55 mm), average for August (69 mm), and above average for July (140 mm) and September (94 mm). The long term previous 10 year rainfall averages were: May 77 mm, June 74 mm, July 81 mm, August 67 mm and September 74 mm.

Seeding of the variety trial occurred on May 11, a week later than desired. A heavy rainfall on May 3rd pushed back all preparations for seeding; however, this rainfall created ideal soil moisture levels. Air temperatures at seeding were above seasonal in the mid-twenties (^{o}C) and night temperatures where in the teens. For the rest of the month of May, temperatures continued to be above average and conditions became drier. It was approximately one month after seeding, before a nice rainfall occurred (June 1). Irrigation water was applied on May 17 and 30 (1/2") to help the new seedlings along. Plant vigour was good, with most cultivars showing fairly even germination. The above seasonal air temperatures for the first month encouraged good seedling growth. Some high temps in the low 30s (^{o}C) created some concern for heat canker losses but a very limited number were found.

The onions had to be irrigated two twice during the dry month of June. Irrigation water was applied on June 20 (5/8") and 28 (3/4") to compensate for the lack of rainfall. Rainfall occurred in a decent amount and frequency for the remainder of the season. Several showers occurred a few days after side dressing. This precipitation helped move the side dressed fertilizer down to the root zone and the crop responded well. Plant growth was normal for most of the season, bulb development was even throughout August and bulb size was quite nice by August 31.

Herbicide applications where a little tricky to time. The dry conditions of May and June meant adjusting herbicide applications and timing. A couple of applications of Pardner were applied in May for small weeds that had emerged. The dry weather conditions slowed weed development. An application of Frontier was applied on June 5, a few days following a nice rainfall on June 1. This Frontier application appeared to give a moderate level of control but due to dry conditions in June, it was hard to determine its effectiveness. The first replicate had a higher weed pressure due to the carry-over of weed seeds from a previous trial in 2011. The trial was hand-weeded several times throughout the summer months.

…/continued

ONION CULTIVAR TRIAL SEASON SUMMARY - 2012 – continued

At the Muck Crops Research Station, onion maggot emergence was early. Three days after seeding, May 14, a high level of 6.3 flies/trap/day was observed. There was a small first generation peak of 4 flies/trap/day on June 7. The second and third generation population numbers were low (below 2 flies/trap/day) and blended together, so there were no distinctive peaks. There was very little onion maggot damage noticed within the onion variety trial for the season. Thrips were first noticed in mid-June. The onions were sprayed several times through the months of July and August and thrips populations were kept well within economical thresholds (0.5 thrips/leaf) for the entire season and never had a spike in population. Aster leaf hopper numbers were high throughout the entire season resulting in aster yellows infection occurring in the onions. Visible infected onions were seen in all varieties. The level of infection was approximately 1%. Leaf diseases, which in the past were the number one problem, were kept at manageable levels by following a standard fungicide program. The Downy Mildew Forecasting System (DOWNCAST) predicted the possibility of disease development a few times, but with timely fungicide applications, downy mildew never became an issue. Botrytis leaf blight was first observed in July, and through a regular spray program remained at manageable levels for the entire season. A very limited number of onions with bacterial rot were noticed. Stemphylium leaf blight was present in or around the station but never became an issue for the onion trial.

The warm and dry conditions of May and June did not appear to be detrimental to onion bulb development. More seasonal weather conditions led to moderate, steady bulb growth. Lodging time (days to harvest) was shorter compared to the last two seasons. Cultivars Alpine, Pulsar, Nun 7408 and Hendrix were the first to lodge, beginning on July 25. It took approximately three weeks for the majority (75%) of the cultivars to reach 85% lodged. Strong winds on August 16 influenced lodging in some cultivars. The average days-to-harvest for the 2012 season (99 days) was lower compared to 2011 (103 days) and 2010 (111 days). Onion tops dried at an average rate. No seeders were found in the trial. A sample of each cultivar was pulled for judging and comparison on Grower Field Day on September 6. By Grower Field Day, all cultivars had lodged and the tops were about three quarters of the way to being desiccated. At harvest on September 24, the tops were dried out, resulting in good neck finishes. A harvest sample for each cultivar was placed in storage on October 17 and cured artificially for approximately 24 hours to remove any field moisture.

At evaluation in December, yields were slightly above average. The majority of the onion bulbs were in the 3-2½" size range for most cultivars. The trial average for percentage of jumbos (>3" diameter) was 14.1% which is comparable to the 16.4% in 2011. Stand counts were close to the desired level of approximately 8 to 9 plants per foot. The number of culls remained at very acceptable levels, and most culls were peewees (< 1 ¾"). The trial had a good percentage of marketable onions. All cultivars had good ratings on skin attachment, but average ratings for skin thickness. Colour was average. Greening of the outer scales, along with yellow or white speckling on the outer skins, was very limited as in 2011. The neck finish was good on most cultivars. A few cultivars had dry but a slightly rough neck finish. The majority of the onions stayed quite firm from harvest to evaluation, which is better than most years. Uniformity of shape was very uneven and most cultivars received below average ratings. Onion maggot damage ranged from 0% to 10.4% for onions in the evaluation samples. This was a little surprising considering the low onion maggot populations for the season. The trial average for onion maggot damage was 2.9% an approximate increase of 2% compared to the 2011 season.

ONION CULTIVAR TRIAL – 2012

MANAGEMENT PROCEDURES

Fertilizer:

90 kg/ha Nitrogen (Ammonium Nitrate 34-0-0) + 100 kg/ha Phosphorous (MAP 11-52-0) + 150 kg/ha Potassium (SOP 0-0-50) + 150 kg/ha K–Mag (0-0-22) + 35 kg/ha Manganese (15%) + 5 kg/ha Copper (99% Cu) was worked into the soil.

A side dressing of 15 kg/ha Nitrogen + 15 kg/ha Phosphorous (MAP 11-52-0) + 25 kg/ha of Potassium (SOP 0-0-50) + 70kg /ha Cal-U-Sol was applied on 27 June.
A second side dressing of 5 kg/ha Nitrogen + 20 kg/ha of Potassium (SOP 0-0-50) + 30 kg/ha of K-Mag (0-0-22) + 70kg /ha Cal-U-Sol was applied on 19 July.

Seeded:

All trials were seeded 11 May. Pelletized onion seed was seeded with a Stanhay Precision Seeder. Raw onion seed was seeded with a V-Belt seeder equipped with a 5 cm wide scatter shoe. Row spacing was 43 cm. The raw seed was coated with **PRO GRO** at 60 g/2.3 kg seed plus methyl cellulose at 100 ml/2.3 kg seed. **LORSBAN 15G** was applied at 18.5 kg/ha plus **DITHANE DG** at 8.8 kg/ha in the seed furrow. The Main Trial was replicated three times.

Weed Control:

Pre-emergence: 2 applications: **PARDNER** on 12 May (300 ml/ha) and 17 May (450ml/ha).

Post-emergence: 2 applications: **PARDNER** at 35 ml/ha + **GOAL** at 35 ml/ha and Manganese at 1.0 kg/ha on 28 & 31 May.
1 application: **FRONTIER MAX** at 800 ml/ha on 5 June.
1 application: **PARDNER** at 100 ml/ha + **GOAL** at 100 ml/ha and Manganese at 2.0 kg/ha on 14June.
1 application: **CHATEAU** at 70 g/ha on 27 June.

Minor Elements:

Nine foliar sprays: Supafeed on 22 & 28 June (2.0Kg/ha), 5, 12, 19 & 27 July, 2, 8, & 16 August (3.0 kg/ha)
Six foliar sprays: Calcimax on 16 & 22 June, 15, 12 & 19 July, 16 August (3.0 L/ha)
Four foliar sprays: TrioMax on 16 June, 2 & 27 July, 8 August (3.0 L/ha)
Four foliar sprays: Manganese Sulfate on 28 June (2.0 Kg/ha), 5, 12 & 27 July (3.0 kg/ha)
Three foliar sprays: Mag Max on 22 June (3.0 L/ha), 12 July (5.0L/ha) and 19 July (4.0L/ha)
Three foliar sprays: Boron Max on 27 July (1.0L/ha), 8 August (1.5 L/ha) and 16 August (2.5 L/ha)
Two foliar sprays: Mancozin on 22 June & 12 July (3.0 L/ha)
Two foliar sprays: Alexin on 2 & 16 August (3.0 L/ha)
Two foliar sprays: Zinc Max on 8 June (2.0L/ha) and 28 June (1.0 L/ha)
Two foliar sprays: 20-20-20 on 8 June (1.0 kg/ha) and 16 June (2.0 kg/ha)
One foliar spray: Copper Max on 19 July (2.0L/ha)

.../continued

Insect and Disease Control:

According to IPM recommendations.

DITHANE DG at 2.5 kg/ha + **UP-CYDE** at 280 ml/ha and Minor Elements on 28 June.
PENNCOZEB 80 WP at 2.5 kg/ha + **DELEGATE** at 300 g/ha and Minor Elements on 5 July.
BRAVO at 2.5 L/ha + **MATADOR** at 188 ml/ha and Minor Elements on 12 July.
RIDOMIL MZ 2.50 Kg/ha + **RIPCORD** at 175 ml/ha and Minor Elements on 19 July.
PRISTINE WG at 1.3 Kg/ha + **AGRI MEK** at 1.2L/ha and Minor Elements on 27 July.
DITHANE DG at 2.5 kg/ha + **DIBROM** at 550 ml/ha and Minor Elements on 2 August.
DITHANE DG at 3.0 kg/ha + **ROVRAL** at 750g/ha + **DELEGATE** at 300 g/ha and Minor Elements on 8 August.
PENNCOZEB 80 WP at 2.0 kg/ha + **RIPCORD** at 175 ml/ha and Minor Elements on 16 August.

Harvest:

The Main Trial was pulled on 12, 13 & 19 September and topped on 24 September. The trial was placed in a forced air and temperature controlled storage 17 October. The trial was cured for 48 hours (25^{o}C, minimum 65% RH). After curing the temperature was lowered 5^{o}C per week until 0^{o}C was attained.

Sprout Inhibition:

Royal MH 60SG at 3.75 kg/ha in 550 L/ha water on 13 & 29 August.

EVALUATION PROCEDURES

The cultivars were evaluated 19-23 and 26-30 November after 5 ½ weeks in storage.

 # Bulbs Harvested:

Total number of onions harvested from 4.66 m of row.

Harvest Weight:

Weights from the harvested 4.66 m of row.

.../continued

ONION CULTIVAR TRIAL – 2012 - continued

Marketable Yield B/A:
Number of onions > 76 mm (> 3"), 76 mm to 64 mm (3" to 2 ½) and 64 mm to 32 mm (2 ½" to 1¼").

Majority of Culls:
D = Double PW = Pee Wee R = Rot OC = Off Colours S = Seeders SP = Sprouts

Shape:
HG = High Globe FG = Flatten Globe G = Globe Sp = Spindle TD = Tear Drop T = Top

Colour:
LG = Light Golden G = Golden DG = Dark Golden LC = Light Copper C = Copper DC = Dark Copper DR = Dark Red

Skin Thickness:
10.0 = Most Desirable 7.5 = Good 6.0 = Average

Skinning:
10.0 = Most Desirable, skins well attached 7.5 = Good, skins have a few small cracks 6.0 = Average, skins have cracks but still attached

Overall Score:
Based on quality and general appearance.

Score:
The average of nine marks at evaluation from Uniformity of Shape to Firmness.

Average Weight/Bulb (g):
The total weight in grams of all bulbs divided by the total number of bulbs. A bulb 51 mm (2") in diameter weighs approximately 70 g. A bulb 57 mm (2¼") in diameter weighs approximately 100 g. A bulb 64 mm (2½") in diameter weighs approximately 135 g.

Days to Harvest:
Numbers of days from seeding until 85% of the tops were down.

Percent Onion Maggot Damage:
Percent of onions damaged by onion maggot ranging from pin hole to completely unmarketable that were found in the 4.66 m harvest sample.

.../continued

Top Height (cm):

The average length of 20 random onion tops from the all three replicates from the ground to the tips as taken on 26 July. 50 cm is equal to 20 inches.

Leaf Shape:

B = Leaves are bent or hanging U = Up right leaves, straight

Seeders:

There were no seeders found in any cultivar in the 2012 trial.

Irrigation:

Irrigation water was applied on: 17 & 30 May (1/2”), 20 June (5/8"), 28 June (3/4") and 14 July (1 1/8").

ONION CULTIVAR MAIN TRIAL - 2012

Cultivar	Source	# Bulbs Harvested	Total Harvest Weight (kg)	Wgt. Jumbo > 76 mm (kg)	Wgt. Large 76-64 mm (kg)	Wgt. Medium 64-32 mm (kg)	Marketable Yield B/A	% Marketable	Majority of Culls	% Single Centers
ADVENTURE	UNF	103 kl*	17.60	6.26	9.01 c-j	2.21	1318 b-j	98.4 a	PW	20 h-m
TENSHIN	UNF	114 h-l	18.49	4.16	11.08 abc	2.96	1372 b-g	96.8 ab	PW	17 i-m
PATTERSON	Bejo	133 cd	18.98	1.63	11.79 a	5.38	1418 bcd	96.7 ab	PW	57 bcd
MILESTONE	Tak	128 c-h	19.47	3.07	10.66 a-e	5.52	1451 abc	96.3 abc	PW	50 b-f
EX 18456	Sem	118 d-j	18.19	4.61	10.48 a-f	2.85	1352 b-i	96.3 abc	PW	40 d-h
PRINCE	Bejo	113 i-l	18.85	4.37	11.59 a	2.64	1403 b-e	96.2 abc	PW	17 i-m
FORTRESS	Sto	121 c-j	17.09	1.30	9.45 b-j	6.02	1265 d-k	96.2 abc	PW	27 g-l
SAFRANE	Bejo	101 l	19.08	9.19	7.97 g-k	1.54	1411 bcd	96.1 abc	PW	27 g-l
TREKKER	Tak	134 c	18.01	1.43	10.32 a-f	5.88	1330 b-j	96.0 abc	PW	27 g-l
TRAIL BLAZER	Tak	125 c-j	17.67	3.59	10.75 a-d	2.95	1304 b-k	95.5 a-d	PW	10 klm

Listed in order of % Marketable.

.../ continued

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

ONION CULTIVAR MAIN TRIAL - 2012 - continued

Cultivar	Source	# Bulbs Harvested	Total Harvest Weight (kg)	Wgt. Jumbo > 76 mm (kg)	Wgt. Large 76-64 mm (kg)	Wgt. Medium 64-32 mm (kg)	Marketable Yield B/A	% Marketable	Majority of Culls	% Single Centers
CROCKETT	Bejo	128 c-h*	18.45	2.97	9.87 a-g	5.21	1361 b-h	94.8 a-e	PW	43 c-g
MADRAS	Bejo	121 c-j	22.10	10.24	9.23 b-j	2.15	1631 a	94.8 a-e	PW	27 g-l
PULSAR	Nun	131 cde	16.63	2.24	8.17 g-k	5.82	1224 e-l	94.6 a-e	PW	53 b-e
La SALLE	Sem	124 c-j	18.92	4.25	10.09 a-g	4.15	1395 b-f	94.6 a-e	PW	53 b-e
TAHOE	Bejo	116 g-l	20.56	7.31	10.30 a-f	2.08	1485 ab	94.5 a-e	D	17 i-m
HENDRIX	Nun	116 f-k	15.85	3.10	8.61 e-j	3.79	1169 i-l	94.3 a-e	PW	67 ab
STANLEY	Sol	125 c-j	18.47	3.53	9.93 a-g	4.43	1349 b-i	94.1 a-e	PW	13 j-m
BRADDOCK	Bejo	124 c-j	18.30	3.76	9.73 a-i	4.28	1340 b-j	94.1 a-e	PW	37 d-i
ERIK THE RED	Sol	121 c-j	18.29	4.49	9.70 a-i	3.11	1305 b-k	93.4 b-e	PW	3 m
FRONTIER	Tak	120 c-j	16.88	1.57	11.15 ab	3.36	1212 f-l	93.3 b-f	OC	7 lm

Listed in order of % Marketable.

.../ continued

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

ONION CULTIVAR MAIN TRIAL - 2012 - continued

Cultivar	Source	# Bulbs Harvested	Total Harvest Weight (kg)	Wgt. Jumbo > 76 mm (kg)	Wgt. Large 76-64 mm (kg)	Wgt. Medium 64-32 mm (kg)	Marketable Yield B/A	% Marketable	Majority of Culls	% Single Centers
SCORPION	Cro	114 h-l*	15.89	2.79	8.39 f-k	4.46	1179 h-l	93.3 b-f	PW	67 ab
PONTIAC	Cro	120 c-j	17.28	4.29	7.72 h-k	4.82	1269 c-k	92.8 b-g	PW	80 a
NORSTAR	Tak	120 c-j	16.80	2.31	8.99 c-j	4.26	1173 i-l	92.8 b-g	R	3 m
FESTIVAL	Bejo	130 c-f	17.37	1.87	8.69 d-j	6.27	1269 c-k	92.6 b-g	PW	30 f-k
EX 18873	Sem	129 c-g	18.37	3.34	9.70 a-i	4.89	1352 b-i	92.5 b-h	PW	30 f-k
SCORPION	UNF	124 c-j	17.41	2.51	9.79 a-i	4.78	1288 c-k	92.2 b-h	PW	53 b-e
EX 13323	Sem	128 c-h	18.81	5.85	8.05 g-k	4.02	1351 b-i	92.2 b-h	PW	80 a
NEBULA	Nun	128 c-h	18.24	3.59	9.84 a-h	4.13	1324 b-j	92.2 b-h	PW	67 ab
HAMLET	Sto	114 h-l	17.21	2.49	10.92 abc	3.39	1267 d-k	91.8 c-h	PW	57 bcd
COOKE	Sol	112 jkl	18.47	6.30	8.04 g-k	3.08	1314 b-k	91.7 c-h	PW	7 lm

Listed in order of % Marketable.

.../ continued

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

ONION CULTIVAR MAIN TRIAL - 2012 - continued

Cultivar	Source	# Bulbs Harvested	Total Harvest Weight (kg)	Wgt. Jumbo > 76 mm (kg)	Wgt. Large 76-64 mm (kg)	Wgt. Medium 64-32 mm (kg)	Marketable Yield B/A	% Marketable	Majority of Culls	% Single Centers
ALPINE	Tak	128 c-h*	16.93	3.55	9.10 b-j	3.16	1192 g-l	90.9 d-h	D	20 h-m
BGS 297	Bejo	168 b	17.37	0.91	6.41 k	9.55	1272 c-k	90.9 d-h	PW	33 e-j
NUN 7408	Nun	127 c-i	14.95	0.81	7.71 ijk	5.68	1070 lm	90.8 d-i	PW	37 d-i
HENDRIX	UNF	117 e-k	16.89	4.59	7.45 jk	3.92	1204 g-l	90.6 e-i	R	33 e-j
HIGHLANDER	Tak	118 e-j	16.90	2.88	8.55 e-j	3.58	1132 klm	88.7 f-i	D	0 m
SCOUT	Cro	117 e-k	19.18	6.56	8.43 f-k	2.51	1320 b-j	88.3 ghi	R	63 abc
SHERMAN	Bejo	124 c-j	21.73	9.08	7.44 jk	2.52	1436 bcd	87.6 hi	D	13 j-m
CORONA	Bejo	130 c-f	19.78	4.31	9.03 b-j	3.79	1291 c-k	85.9 i	D	7 lm
ADONIS	UNF	188 a	16.60	0.15	3.95 l	11.29	1161 j-m	80.6 j	PW	50 b-f
AVALON	Cro	73 m	17.69	9.06	3.57 l	0.44	985 m	77.3 j	R	50 b-f
Trial Average		**123**	**18.04**	**4.01**	**9.04**	**4.17**	**1299**	**92.6**	**PW**	**35**

Listed in order of % Marketable.

.../ continued

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

ONION CULTIVAR MAIN TRIAL - 2012 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Colour	Colour Rating	Skin Thickness	Skinning	Neck Finish	Overall Score	Score
ADVENTURE	UNF	G	4.7	5.7	G	6.0	7.0 cd*	9.0 a-d	7.3 def	6.7	6.79 d-k
TENSHIN	UNF	HG	7.7	7.0	G	7.0	7.3 bc	8.7 b-e	7.3 def	7.2	7.54 abc
PATTERSON	Bejo	G	6.0	7.2	DG	5.7	6.3 def	9.3 abc	6.7 e-h	7.5	7.23 bcd
MILESTONE	Tak	HG	7.3	6.3	G	6.3	6.0 efg	8.7 b-e	5.3 i	6.0	6.56 e-l
EX 18456	Sem	G	4.3	6.0	DG	6.3	6.7 cde	8.3 c-f	7.0 efg	6.3	6.58 e-l
PRINCE	Bejo	HG	6.3	7.0	G	6.7	6.3 def	8.7 b-e	6.0 ghi	6.8	7.06 b-f
FORTRESS	Sto	HG	7.5	7.3	DG	6.7	6.7 cde	9.0 a-d	6.0 ghi	6.7	7.27 bcd
SAFRANE	Bejo	HG	5.7	5.3	G	8.3	6.3 def	10.0 a	5.7 hi	7.7	7.23 bcd
TREKKER	Tak	G	8.3	7.5	DG	8.3	8.7 a	7.8 ef	7.7 cde	8.0	8.13 a
TRAIL BLAZER	Tak	FG	6.3	7.3	G	6.7	7.0 cd	8.3 c-f	7.7 cde	7.5	7.35 bcd

Listed in order of % Marketable. 10.0 = Most Desirable, 8.0 = Good, 6.0 = Average

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

.../ continued

ONION CULTIVAR MAIN TRIAL - 2012 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Colour	Colour Rating	Skin Thickness	Skinning	Neck Finish	Overall Score	Score
CROCKETT	Bejo	G	6.3	6.0	DG	8.3	6.0 efg*	9.7 ab	5.3 i	6.3	7.06 b-f
MADRAS	Bejo	HG	6.0	5.0	G	5.3	5.7 fgh	8.0 def	6.0 ghi	5.7	6.08 l-o
PULSAR	Nun	HG	6.7	6.3	G	6.0	5.0 hij	8.7 b-e	7.3 def	6.8	6.81 d-j
La SALLE	Sem	HG	5.7	6.3	DG	7.0	7.2 bcd	9.2 abc	7.7 cde	7.3	7.23 bcd
TAHOE	Bejo	G	6.3	7.3	G	6.7	6.3 def	9.8 a	6.3 f-i	7.7	7.33 bcd
HENDRIX	Nun	G	6.7	4.0	DG	5.3	5.3 ghi	9.3 abc	7.0 efg	6.0	6.38 g-m
STANLEY	Sol	HG	5.0	5.3	G	7.7	6.7 cde	9.3 abc	6.0 ghi	7.0	6.98 c-h
BRADDOCK	Bejo	HG	6.0	5.0	G	7.7	6.0 efg	9.3 abc	7.0 efg	7.3	7.00 c-g
ERIK THE RED	Sol	G	5.0	6.0	DR	6.7	8.0 ab	4.0 i	7.3 def	5.0	6.23 j-o
FRONTIER	Tak	G	7.3	7.3	G	7.0	7.3 bc	8.7 b-e	7.7 cde	7.7	7.69 ab

Listed in order of % Marketable. 10.0 = Most Desirable, 8.0 = Good, 6.0 = Average

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

.../ continued

ONION CULTIVAR MAIN TRIAL - 2012 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Colour	Colour Rating	Skin Thickness	Skinning	Neck Finish	Overall Score	Score
SCORPION	Cro	HG	5.0	4.7	G	6.7	6.0 efg*	9.0 a-d	6.3 f-i	6.0	6.50 f-l
PONTIAC	Cro	HG	5.3	4.0	DG	5.3	6.3 def	9.0 a-d	6.0 ghi	5.7	6.17 k-o
NORSTAR	Tak	G	5.0	5.0	LG	5.3	5.3 ghi	5.3 gh	7.7 cde	5.2	5.60 op
FESTIVAL	Bejo	HGSP	6.0	7.0	G	7.0	5.7 fgh	9.7 ab	7.0 efg	7.2	7.19 b-e
EX 18873	Sem	HG	4.0	4.7	G	6.0	6.0 efg	8.3 c-f	5.7 hi	4.7	5.83 m-p
SCORPION	UNF	HG	6.0	6.3	G	7.3	6.5 c-f	8.7 b-e	6.7 e-h	6.8	7.08 b-f
EX 13323	Sem	G	6.3	4.3	G	5.7	4.7 ij	9.0 a-d	7.7 cde	6.0	6.33 i-m
NEBULA	Nun	G	7.0	7.3	DG	5.7	6.3 def	8.7 b-e	7.0 efg	7.3	7.19 b-e
HAMLET	Sto	HG	5.0	6.0	G	6.3	6.3 def	9.2 abc	5.3 i	5.7	6.35 h-m
COOKE	Sol	G	5.0	4.3	DG	6.0	6.3 def	9.0 a-d	5.7 hi	5.7	6.31 i-m

Listed in order of % Marketable. 10.0 = Most Desirable, 8.0 = Good, 6.0 = Average

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

.../ continued

ONION CULTIVAR MAIN TRIAL - 2012 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Colour	Colour Rating	Skin Thickness	Skinning	Neck Finish	Overall Score	Score
ALPINE	Tak	FG	6.7	6.7	LG	8.0	6.7 cde*	4.0 i	9.7 a	4.3	6.48
BGS 297	Bejo	G	7.3	6.0	G	7.0	6.3 def	9.0 a-d	8.7 abc	6.7	7.33
NUN 7408	Nun	G	7.3	5.7	G	6.3	6.0 efg	7.7 ef	9.0 ab	6.8	7.06
HENDRIX	UNF	G	7.7	4.3	G	6.7	5.7 fgh	9.3 abc	6.7 e-h	7.3	6.90
HIGHLANDER	Tak	G	5.0	6.0	LG	8.3	5.0 hij	4.7 hi	9.7 a	5.3	6.25
SCOUT	Cro	TD	5.3	4.7	LG	5.7	4.3 j	5.3 gh	7.3 def	5.3	5.63
SHERMAN	Bejo	G	4.3	5.3	LG	6.3	4.7 ij	7.3 f	7.0 efg	5.0	5.83
CORONA	Bejo	HG	5.7	6.3	G	6.0	5.0 hij	7.3 f	6.0 ghi	6.3	6.31
ADONIS	UNF	G	5.3	6.3	G	6.7	6.0 efg	8.3 c-f	8.3 bcd	7.3	7.10
AVALON	Cro	SP	5.0	6.7	LG	5.0	5.0 hij	6.0 g	6.3 f-i	3.0	5.40
Trial Average			**6.0**	**5.9**		**6.6**	**6.2**	**8.2**	**7.0**	**6.4**	**6.73**

Listed in order of % Marketable. 10.0 = Most Desirable, 8.0 = Good, 6.0 = Average

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

.../ continued

ONION CULTIVAR MAIN TRIAL - 2012 - continued

Cultivar	Source	Firmness at Harvest	Firmness	Average Weight/Bulb (g)	Stand/Foot	Days to Harvest	% Onion Maggot Damage	% Jumbo > 76 mm	Tops Height (cm)	Leaf Shape
ADVENTURE	UNF	10.0	8.0 c-g*	171.1 b-e	6.7 hi	108	1.3 a-d	25.6 cde	62.5 klm	U
TENSHIN	UNF	10.0	8.2 b-f	162.2 d-h	7.5 e-i	103	3.4 b-e	15.6 f-j	65.7 f-j	U
PATTERSON	Bejo	10.0	9.2 a	143.8 h-m	8.7 c	99	1.9 a-d	5.4 k-o	68.6 b-f	U
MILESTONE	Tak	9.8	6.5 jkl	152.3 f-j	8.4 c-f	100	3.2 a-e	9.3 i-o	64.6 h-k	U
EX 18456	Sem	9.7	7.7 e-h	153.3 e-i	7.7 d-g	97	4.7 de	16.4 e-i	66.7 e-i	U
PRINCE	Bejo	10.0	8.7 abc	166.9 c-f	7.4 f-i	110	1.8 a-d	15.4 f-j	65.4 g-j	U
FORTRESS	Sto	10.0	8.3 b-e	140.5 i-m	7.9 c-g	103	2.6 a-d	4.3 mno	66.4 e-i	U
SAFRANE	Bejo	9.8	8.8 ab	188.6 b	6.6 i	109	0.6 ab	35.1 b	62.4 klm	U
TREKKER	Tak	10.0	8.7 abc	134.8 j-n	8.7 c	89	1.5 a-d	4.6 l-o	63.4 jkl	U
TRAIL BLAZER	Tak	10.0	8.0 c-g	141.8 i-m	8.2 c-g	99	3.4 a-e	12.9 g-m	67.2 d-h	U

Listed in order of % Marketable. 10.0 = Most Desirable, 8.0 = Good, 6.0 = Average

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

.../ continued

ONION CULTIVAR MAIN TRIAL - 2012 - continued

Cultivar	Source	Firmness at Harvest	Firmness	Average Weight/Bulb (g)	Stand/Foot	Days to Harvest	% Onion Maggot Damage	% Jumbo > 76 mm	Tops Height (cm)	Leaf Shape
CROCKETT	Bejo	9.8	8.5 a-d*	143.9 h-m	8.4 cde	106	4.1 cde	9.8 h-o	70.1 a-d	U
MADRAS	Bejo	9.2	7.0 hij	182.2 bc	7.9 c-g	101	3.6 b-e	32.5 bc	72.5 a	U
PULSAR	Nun	9.5	7.7 e-h	127.5 mn	8.5 cd	92	3.1 a-e	7.0 j-o	60.8 lm	U
La SALLE	Sem	9.8	7.5 fgh	152.6 e-j	8.1 c-g	99	1.9 a-d	14.7 f-k	67.2 d-h	U
TAHOE	Bejo	10.0	8.2 b-f	177.8 bcd	7.6 e-i	99	2.5 a-d	25.6 cde	66.0 e-j	U
HENDRIX	Nun	10.0	7.3 ghi	136.4 i-m	7.6 d-i	99	2.3 a-d	12.0 h-n	72.9 a	U
STANLEY	Sol	10.0	8.8 ab	147.7 g-l	8.2 c-g	101	0.8 abc	11.2 h-n	66.3 e-j	U
BRADDOCK	Bejo	9.3	7.7 e-h	147.1 g-l	8.1 c-g	100	1.3 a-d	12.5 g-m	65.9 e-j	U
ERIK THE RED	Sol	9.5	7.8 d-g	150.7 f-l	7.9 c-g	94	2.7 a-d	15.9 f-j	68.1 c-g	U
FRONTIER	Tak	10.0	8.5 a-d	140.7 i-m	7.9 c-g	99	2.2 a-d	5.9 k-o	65.6 g-j	U

Listed in order of % Marketable. 10.0 = Most Desirable, 8.0 = Good, 6.0 = Average

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

.../ continued

ONION CULTIVAR MAIN TRIAL - 2012 - continued

Cultivar	Source	Firmness at Harvest	Firmness	Average Weight/Bulb (g)	Stand/Foot	Days to Harvest	% Onion Maggot Damage	% Jumbo > 76 mm	Tops Height (cm)	Leaf Shape
SCORPION	Cro	10.0	8.3 b-e*	139.5 i-m	7.5 e-i	99	3.9 b-e	10.1 h-n	70.3 abc	U
PONTIAC	Cro	9.5	7.7 e-h	144.5 h-m	7.8 c-g	108	1.6 a-d	14.5 f-k	63.8 ijk	U
NORSTAR	Tak	8.7	6.0 kl	140.8 i-m	7.8 c-g	91	4.3 de	8.5 i-o	64.0 ijk	U
FESTIVAL	Bejo	9.8	8.0 c-g	133.3 k-n	8.5 cd	99	1.8 a-d	5.9 k-o	66.2 e-j	U
EX 18873	Sem	9.5	7.3 ghi	142.3 i-m	8.4 cde	99	2.1 a-d	10.1 h-n	68.7 b-e	U
SCORPION	UNF	9.7	8.3 b-e	140.0 i-m	8.1 c-g	99	0.9 abc	8.0 i-o	68.3 b-g	U
EX 13323	Sem	8.7	7.0 hij	146.7 g-l	8.4 cde	105	3.3 a-e	19.0 e-h	66.0 e-j	U
NEBULA	Nun	9.3	8.2 b-f	142.5 i-m	8.4 c-f	101	3.1 a-e	11.7 h-n	63.4 jkl	B
HAMLET	Sto	9.7	7.0 hij	150.8 f-l	7.5 e-i	104	2.1 a-d	8.8 i-o	64.6 h-k	B
COOKE	Sol	9.2	8.5 a-d	164.9 c-g	7.3 ghi	103	3.8 b-e	22.4 def	62.6 klm	B

Listed in order of % Marketable. 10.0 = Most Desirable, 8.0 = Good, 6.0 = Average

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

ONION CULTIVAR MAIN TRIAL - 2012 - continued

Cultivar	Source	Firmness at Harvest	Firmness	Average Weight/Bulb (g)	Stand/Foot	Days to Harvest	% Onion Maggot Damage	% Jumbo > 76 mm	Tops Height (cm)	Leaf Shape
ALPINE	Tak	8.5	5.8 l*	132.5 lmn	8.4 c-f	81	3.9 b-e	12.2 g-n	56.0 n	B
BGS 297	Bejo	9.8	7.7 e-h	106.0 op	11.0 b	95	10.4 f	2.9 no	67.1 e-h	U
NUN 7408	Nun	9.2	7.7 e-h	117.3 no	8.3 c-f	89	2.4 a-d	2.9 no	71.3 ab	U
HENDRIX	UNF	9.7	7.5 fgh	144.2 h-m	7.7 d-h	95	2.3 a-d	15.6 f-j	72.2 a	U
HIGHLANDER	Tak	8.2	6.0 kl	143.2 i-m	7.7 d-h	83	1.7 a-d	11.0 h-n	59.8 m	B
SCOUT	Cro	8.2	7.0 hij	163.8 c-g	7.7 d-h	105	3.2 a-e	21.5 d-g	63.9 ijk	B
SHERMAN	Bejo	9.2	6.7 ijk	174.9 bcd	8.1 c-g	98	4.0 b-e	29.7 bcd	66.2 e-j	U
CORONA	Bejo	9.5	7.8 d-g	151.4 f-k	8.5 cd	99	4.5 de	13.9 f-l	64.9 h-k	U
ADONIS	UNF	9.2	8.5 a-d	89.6 p	12.3 a	89	6.3 e	0.4 o	68.2 c-g	U
AVALON	Cro	8.2	6.2 kl	241.3 a	4.8 j	99	0.0 a	44.7 a	68.3 c-g	B
Trial Average		**9.5**	**7.7**	**149.3**	**8.1**	**99**	**2.9**	**14.1**	**66.1**	**U**

Listed in order of % Marketable. 10.0 = Most Desirable, 8.0 = Good, 6.0 = Average

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

.../ continued

MAIN ONION CULTIVAR TRIAL EVALUATION NOTES - 2012

Adventure: Good appearance, Good tight neck finish but bit rough, Good skin, Odd one with skin cracking, Colour slightly uneven, Odd yellowing on skins, Odd greening of scales , Good Packer, Medium run size, Uniformity of shape very uneven, Firmness a little uneven, Firm & solid onion, Longer term storage onion.

Tenshin: Good appearance, Average to good neck finish but bit rough, Average skin, Odd one with skin cracking, Colour a little uneven, Odd yellowing on skins, Some greening of scales, Average to good Packer, Large run size, Uniformity of shape even, Firm onion, Longer term storage onion.

Patterson: Nice appearance, Odd one with skin cracking, Pretty good skin, Colour uneven, Neck finish bit rough but tight, Nice solid & firm onion, Odd greening of scales, Good to nice packer, Uniformity of shape a little uneven, Medium run size, Longer term storage onion.

Milestone: Medium to larger run size, Average skin, Average neck finish but rough, Odd one with skin cracking, Average appearance, Uniformity of shape uneven, Odd greening of scales, Average packer, Fairly firm, Some mechanical damage, Mid storage onion.

EX-18456: Average appearance, Odd one with skin cracking, Colour slightly uneven, Good neck finish but a little rough, Good firmness, Uniformity of shape very uneven, Average skin, Odd greening of scales, Average packer, Medium to larger run size, Size varies a lot, Mid to longer term storage onion.

... / continued

MAIN ONION CULTIVAR TRIAL EVALUATION NOTES - 2012– continued

Prince: Good appearance, Odd one with skin cracking, Larger run size, Colour slightly uneven, Pretty good skin, Average neck finish some a bit rough, Odd yellowing on skins, Odd greening of scales, Good packer, Uniformity of shape a little uneven, Nice firm & solid onion, Longer term storage onion.

Fortress: Good appearance, Colour uneven, Medium run size, Odd one with skin cracking, Good thicker skin left, Good packer, Average to good neck finish but a bit rough, Uniformity of shape even, Odd yellowing on skins, Good firm onion, Firmness is a little uneven, Longer term storage onion.

Safrane: Large run size, Nice skin, Average neck finish some rough, Odd yellowing on skin, Uniformity of shape uneven, Nice firm & solid onion, Good to nice appearance, Even colour, Good to nice packer, Longer term storage onion.

Trekker: Uniformity of shape even, Medium run size, Good tight neck finish, Nice even solid & firm onion, Odd white spots on skin, Colour dark & even, Nice skin, Odd one with skin cracking, Nice appearance, Nice packer, Longer term storage onion.

Trail Blazer: Good appearance, Medium run size, Some skin cracking, Good firm onion, Firmness even, Average skin, Great tight neck finish, Colour even, A lot greening of scales, Good packer, Uniformity of shape a little uneven, Mid storage onion.

... / continued

MAIN ONION CULTIVAR TRIAL EVALUATION NOTES – 2012 – continued

Crockett: Average to good appearance, Uniformity of shape a little uneven, Good thick skin, Average neck finish some rough, Colour dark & even, Odd yellowing on skins, Medium run size, Average packer, Nice firm & solid onion, Longer term storage onion.

Madras: Average appearance, Uniformity of shape uneven, Some skin cracking, Average skin, Average neck finish some rough, Colour uneven, Odd greening of scales, Odd yellowing on skins, Larger run size, Okay packer, Firmness a little uneven, A little mechanical damage, Mid storage onion.

Pulsar: Medium run size, Good tight neck finish, Odd one with skin cracking, Average skin, Good appearance, Good firm onion, Good to nice packer, Colour a little uneven, Some greening of scales, Uniformity of shape uneven, Odd mechanical damage, Mid to longer term storage onion.

La Salle: Good appearance, Large run size, Good neck finish, Odd yellowing on skin, Odd one skin cracking, Pretty good skin, Uniformity of shape uneven, Colour dark & a little uneven, Some greening of scales, Good packer, Good firm onion, Firmness a little uneven, Mid to longer term storage onion.

Tahoe: Good to nice appearance, Large run size, Colour a little uneven, Suspicion of doubles, Nice thick skin, Average neck finish a bit rough, Uniformity of shape very uneven, Nice firm & solid onion, Firmness a little uneven, Some yellowing on skins, Odd greening of scales, Good packer, Longer term storage onion.

... / continued

MAIN ONION CULTIVAR TRIAL EVALUATION NOTES – 2012 – continued

Hendrix: Average appearance, Average neck finish but a bit rough, Odd one with skin cracking, Average skin, Colour a little uneven, Odd greening of scales, Average to good packer, Medium to large run size, Uniformity of shape uneven, Good firm onion, Mid storage onion.

Stanley: Good appearance, Uniformity of shape very uneven, Large run size, Nice skin, Colour even, Odd yellowing on skins, Average neck finish but a little rough, Odd one with skin cracking, Suspicion of doubles, Firm & solid onion, Nice and even firmness, Good to nice packer, Longer term storage onion.

Braddock: Medium run size, Odd one with skin cracking, Pretty good skin, Good neck finish but a bit rough, A little copper shine, Good to nice appearance, Good firm onion, Uniformity of shape a little uneven, Odd yellowing on skins, Good packer, Mid to longer term storage onion.

Eric the Red: Appearance bit rough, Good tight neck finish, Most skin cracking a concern, Thin skin left, Colour a little uneven, Some mechanical damage, Odd browning on skins, Average packer, Medium run size, Uniformity of shape uneven, Firm onion, Good ring colour, Centers white, Mid storage onion.

Frontier: Medium run size, Odd one with skin cracking, Pretty good skin, Odd greening of scales, Good tight neck finish, Nice even firmness, Good packer, Nice appearance, Uniformity of shape even, Odd mechanical damage, Longer term storage onion.

... / continued

MAIN ONION CULTIVAR TRIAL EVALUATION NOTES – 2012 – continued

Scorpion: Medium run size, Pretty good skin, Odd one with skin cracking, Average neck finish but rough, Colour a little uneven, Average to good packer, Good appearance, Odd yellowing on skins, Odd greening of scales, Uniformity of shape uneven, Good firmness but a little uneven, Longer term storage onion.

Pontiac: Average appearance, Average neck finish some a bit rough, Pretty good skin, Colour a little uneven, A few with a copper shine, Odd yellowing of skins, Odd greening of scales, Average to good packer, Uneven sizes, Uniformity of shape uneven, Good firm onion, Mid storage onion.

Norstar: Medium run size, Great tight neck finish, Softer onion, Thinner skin, A lot of skin cracking a concern, Uniformity of shape uneven, Okay appearance, A lot of greening of scales, Colour a little uneven, A little mechanical damage, Okay packer, Early storage onion.

Festival: Good to nice appearance, Good neck finish odd one rough, Pretty good skin, Colour slightly uneven, Copper shine to skin, Good to nice packer, Medium run size, Uniformity of shape uneven, Good firm onion, Even firmness, Suspicion of doubles, Longer term storage onion.

EX 18873: Okay appearance, Some skin cracking, Very uneven sizes, Uniformity of shape very uneven, Average skin, Rough neck finish, Odd greening of scales, Uneven firmness, Colour uneven, Okay packer, Mid storage onion.

... / continued

MAIN ONION CULTIVAR TRIAL EVALUATION NOTES -2012 – continued

Scorpion: Medium run size, Good skin, Odd one with skin cracking, Average neck finish but a little rough, Colour a little uneven, Good packer, Good appearance, Some greening of scales, Uniformity of shape uneven, Nice firm & solid onion, Longer term storage onion.

EX 13233: Average appearance, Odd one with skin cracking, Medium to large run size, Uniformity of shape a little uneven, Average skin, Good neck finish but odd rough one, Odd yellowing on skins, Odd greening of scales, Firmness good but a little uneven, Colour uneven, Average packer, Suspicion of doubles, Mid storage onion.

Nebula: Good appearance, Uniformity of shape even, Odd one with skin cracking, Average skin, Good neck finish, Colour a little uneven, Odd greening of scales, Medium to larger run size, Average to good packer, Good even firmness, A little mechanical damage, Longer term storage onion.

Hamlet: Okay appearance, Blocky shapes, Medium run size, Pretty good skin, Good firm onion, Rough neck finish, Uniformity of shape very uneven, Odd yellowing on skins, Colour a little uneven, Okay to average packer, Mid to longer term storage onion.

Cooke: Average appearance, Average neck finish some are rough, Good thick skin, Colour uneven, Some onions with copper shine, Odd yellowing on skins, Average packer, Medium to large run size, Very uneven sizes, Uniformity of shape uneven, Nice firm & solid onion, Suspicion of doubles, Longer term storage onion.

... / continued

MAIN ONION CULTIVAR TRIAL EVALUATION NOTES – 2012 – continued

Alpine: Skin cracking on most onions a concern, Great tight neck finish, Thin skin, A lot of greening of scales, Soft onion, Poor appearance, Colour even, Medium run size, Okay packer, Concern on doubles, Early storage onion.

BGS 297: Good appearance, Great tight neck finish, Odd one with skin cracking, Average skin, Colour a little uneven, Some greening of scales, Average to good packer, Medium run size, Sizes a little uneven, Good firm onion, Even firmness, Mid to longer term storage onion.

Nun 7408: Good appearance, Great tight neck finish, Some skin cracking concern, Thin skin, Colour slightly uneven, Some greening of scales, Good packer, Medium run size, Uniformity of shape even, Good firm onion, Mid storage onion.

Hendrix: Good appearance, Average neck finish but a bit rough, Pretty good skin, Colour even, Average to good packer, Medium run size, Sizes uneven, Uniformity of shape even, Good firmness but a little uneven, Mid storage onion.

Highlander: Thin skin, Colour even, Most skin cracking a concern, Soft onion, Medium to large run size, Great neck finish, Uniformity of shape very uneven, Concern for suspicion of doubles, Poor appearance, Poor packer, Some mechanical damage, A lot of greening of scales, Firmness a little uneven, Early storage onion.

... / continued

MAIN ONION CULTIVAR TRIAL EVALUATION NOTES – 2012 – continued

Scout: Medium to large run size, Most skin cracking a concern, Average neck finish but a rough, Poor to okay appearance, Soft onion, Colour a little uneven, Some greening of scales, Okay packer, Uniformity of shape very uneven, Skin rot concerns, Mechanical damage, Early storage onion.

Sherman: Large run size, Thin skin, Some skin cracking, Average neck finish uneven, Colour a little uneven, Some greening of scales, Appearance a little poor, Average packer, Uniformity of shape uneven, Firmness bit soft, Suspicion of doubles, Odd mechanical damage, Early to mid storage onion.

Corona: Fair appearance, Medium to large run size, Neck finish a bit rough, Good firm onion, Suspicion of doubles, Some skin cracking, Average packer, Uniformity of shape uneven, Thin skin, Colour a little uneven, Some greening of scales, Mid storage onion.

Adonis: Good packer, Small run size, Nice firm onion, Average skin, Odd one with skin cracking, Great tight neck finish, Good appearance, Colour even, Some greening of scales, Uniformity of shape uneven, Firmness a little uneven, Longer term storage onion.

Avalon: Poor appearance, Uneven neck finishes bit rough, Some skin cracking, Thin poor skin, Colour uneven, A lot greening of scales, Poor packer, Very large run size, Uniformity of shape uneven, Soft onion, A lot of mechanical damage, Skin rot issues concern, Early storage onion.

LONG TERM AVERAGES OF ONION CULTIVAR TRIALS

CULTIVAR	SOURCE	# YEARS TESTED	MARKETABLE YIELD t/ha	MARKETABLE YIELD B/A	DAYS TO MATURITY	FIRMNESS* A	FIRMNESS* B
HIGHLANDER	Tak	8	64.8	1063	94	8.38	6.12
ALPINE	Tak	9	62.9	1017	95	8.6	6.12
HUSTLER	HM	11	46.7	832	96	8.10	5.15
PULSAR	Nun	7	70.9	1148	102	9.29	7.86
NORSTAR	Tak	24	63.9	1099	103	8.10	5.81
ADVANCER	HM	11	60.5	1078	104	8.54	6.05
FRONTIER	Tak	19	70.8	1156	105	9.86	8.11
RICOCHET	Sem	9	68.6	1134	105	9.60	8.02
TRAPP-7	Cro	5	65.5	1166	105	9.79	7.80
TRAIL BLAZER	Tak	5	71.4	1159	105	9.52	8.14
ARSENAL	Sem	13	72.9	1232	106	9.58	8.09
PATTERSON	Bejo	6	77.6	1255	106	9.65	8.66
MOUNTAINEER	Tak	9	65.9	1084	107	9.48	8.21
CORONA	Bejo	17	73.8	1258	108	9.49	7.19
BRADDOCK	Bejo	5	79.4	1285	108	9.44	7.58
NEBULA	Nun	8	76.8	1242	108	9.46	8.18
TAHOE	Bejo	9	75.0	1214	108	9.63	8.21
ROCKET	Sem	13	54.6	972	109	NA	6.37
MILESTONE	Tak	12	79.9	1310	109	9.42	7.58
FLAGSHIP	Sto	8	68.8	1195	110	9.89	8.57

Listed in order of Days to Maturity. * 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average

* Firmness: A = Evaluated at time of Harvest B = Evaluated in December

... / continued

LONG TERM AVERAGES OF ONION CULTIVAR TRIALS - continued

CULTIVAR	SOURCE	# YEARS TESTED	MARKETABLE YIELD t/ha	MARKETABLE YIELD B/A	DAYS TO MATURITY	FIRMNESS* A	FIRMNESS* B
STANLEY	Sol	15	71.5	1200	110	9.81	8.40
TAURUS	Sem	12	54.0	961	111	NA	6.27
HAMLET	Sem	19	72.2	1224	111	9.74	8.14
CAPABLE	Nun	7	55.3	979	112	8.16	6.39
CAVALIER	Sto	6	73.5	1287	112	9.92	8.21
CORTLAND	Bejo	6	76.4	1338	112	10.00	8.50
LIVINGSTON	Sol	14	67.1	1132	112	9.69	8.26
PARAGON	Nun	8	62.5	1110	112	8.85	7.38
TALON	Bejo	7	73.7	1192	112	9.64	8.69
TOPNOTCH	Cro	5	60.0	1067	112	9.92	8.36
TRAPP #8	E.J.	12	57.7	1027	112	8.30	7.72
FORTRESS	Sem	19	63.5	1070	112	9.65	7.94
SAFRANE	Bejo	7	77.5	1254	114	9.73	8.46
PRINCE	Bejo	20	72.2	1229	114	9.81	8.62
BENCHMARK	Sem	6	62.3	1087	115	9.85	8.42
FESTIVAL	Bejo	6	67.3	1159	115	9.62	8.25
INFINITY	Nun	9	68.1	1122	115	9.76	7.70
MILLENNIUM	Nun	9	71.2	1228	115	9.89	8.42
TAMARA	Bejo	11	68.5	1196	115	9.81	8.55
CANADA MAPLE	Sto	17	57.2	1018	116	NA	7.72

Listed in order of Days to Maturity. * 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average

* Firmness: A = Evaluated at time of Harvest B = Evaluated in December

ONION CULTIVAR ADAPTATION TRIAL - 2012

Cultivar	Source	# Bulbs Harvested	Total Harvest Weight (kg)	Wgt. Jumbo > 76 mm (kg)	Wgt. Large 76-64 mm (kg)	Wgt. Medium 64-32 mm (kg)	Marketable Yield B/A	% Marketable	Majority of Culls	% Single Centers	% Jumbo > 76 mm	Average Weight/Bulb (g)	% Onion Maggot Damage	Stand/Foot
OLYX 08-640	Cro	191	16.75	0.21	3.88	11.78	1197	87.4	PW	90	0.5	87.7	2.1	12
OLYX 06-19	Cro	155	14.67	0.46	2.61	10.53	1026	81.3	PW	80	1.3	94.6	5.2	10

Listed in order of % Marketable.

ONION CULTIVAR ADAPTATION TRIAL - 2012 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Colour	Colour Rating	Skin Thickness	Skinning	Neck Finish	Overall Score	Score	Firmness	Days to Harvest	Tops Height (cm)	Leaf Colour	Leaf Shape
OLYX 08-640	Cro	SP	7.0	8.0	G	8.0	6.0	9.0	8.0	8.0	7.75	8.0	92	65.9	G	U
OLYX 06-19	Cro	G	7.0	7.0	G	5.0	7.0	7.0	8.0	7.0	7.00	8.0	85	68.8	G	U

Listed in order of % Marketable.

10.0 = Most Desirable, 8.0 = Good, 6.0 = Average

ADAPTATION ONION CULTIVAR TRIAL EVALUATION NOTES - 2012

OLYX 08-640: Nice appearance, Good tight neck finish, Pretty good skins, Odd one with skin cracking, Even colour, Some greening of scales, Good packer, Small run size, Uniformity of shape is even, Good firmness, Odd mechanical damage, Mid to longer term storage onion.

OLYX 06-19: Average to good appearance, Some skin cracking, Average skin, Good neck finish, Colour a little uneven, Good firmness a little uneven, A lot of greening of scales, Good packer, Uniformity of shape uneven, Small run size, Long term storage onion.

ONION CULTIVAR STORAGE TRIAL - 2011 - 2012

Cultivar	Source	% Marketable	% Weight Loss	% Sprouts	% Rot	% Soft	Firmness In **	Firmness Out **	% Sprouting at Base	% Sprouting at Top
La SALLE	Sto	91.9 a*	4.8 a	0.3 a	2.7 abc	0.0 a	9.8	6.8	0.0	0.0
EX 18456	Sem	91.4 a	5.1 ab	1.0 ab	1.8 ab	0.4 a	9.7	6.7	0.0	0.0
GUNNISON GERM PLUS	Nor	91.3 a	6.9 d-i	0.7 ab	0.6 a	0.0 a	10.0	7.8	0.0	0.7
TAHOE GERM PLUS	Nor	91.2 ab	5.7 a-f	1.3 abc	1.0 ab	0.6 a	9.8	8.5	0.0	2.0
HAMLET	Sto	88.8 abc	5.8 a-g	1.4 abc	3.3 a-e	0.4 a	9.8	7.7	0.2	1.2
TRAIL BLAZER	Takii	88.2 a-d	5.5 a-d	4.9 a-e	1.0 ab	0.0 a	10.0	7.2	2.7	3.7
PATTERSON GERM PLUS	Nor	87.9 a-e	6.5 b-h	3.7 a-e	3.0 a-d	0.0 a	10.0	7.7	0.0	4.3
GENESIS	Sto	87.8 a-e	6.4 b-h	1.9 abc	4.3 a-f	0.2 a	9.7	7.3	0.2	0.5
FESTIVAL	Bejo	87.1 a-e	7.0 e-i	3.6 a-e	1.2 ab	0.5 a	9.5	6.0	0.3	0.3
LIVINGSTON	Sol	86.9 a-e	6.9 d-i	4.3 a-e	1.5 ab	0.0 a	9.7	6.7	1.2	0.3
NOBILITY	Num	86.9 a-e	6.9 d-i	1.5 abc	4.4 a-g	0.0 a	9.8	6.8	0.0	0.7
PATTERSON	Bejo	86.8 a-e	5.6 b-h	4.4 a-e	3.0 a-d	0.0 a	9.8	7.7	0.0	4.3
HUNTINGTON	SN	86.5 a-f	5.4 abc	6.3 a-e	1.2 ab	0.0 a	9.8	7.7	2.2	6.0
FORTRESS	Sto	85.1 a-f	7.1 f-i	2.8 a-d	4.8 a-g	0.0 a	10.0	7.0	0.3	0.2

Listed in Order of Percent Marketable.

* Numbers in a column followed by the same letter are not significantly different at P = 0.05 Fisher's Protected LSD Test.

** 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average

.../continued

ONION CULTIVAR STORAGE TRIAL - 2011 - 2012 - continued

Cultivar	Source	% Marketable	% Weight Loss	% Sprouts	% Rot	% Soft	Firmness In **	Firmness Out **	% Sprouting at Base	% Sprouting at Top
SAFRANE	Bejo	84.9 a-f*	6.3 b-h	2.9 a-d	5.4 a-g	0.2 a	10.0	7.3	0.2	2.0
01-214	Cro	84.8 a-f	6.1 a-h	2.3 abc	6.0 a-h	0.5 a	9.7	7.0	0.0	0.3
PULSAR	Num	84.1 a-f	5.6 a-e	1.0 ab	8.8 a-k	0.0 a	9.8	7.8	0.0	0.5
PRINCE	Bejo	83.7 a-f	7.0 e-i	0.9 ab	7.5 a-k	0.5 a	10.0	7.2	0.0	0.3
STANLEY	Sol	82.9 a-f	6.8 c-i	5.8 a-e	3.8 a-f	0.4 a	10.0	7.2	0.3	4.0
PONTIAC	Cro	81.6 b-f	7.0 e-i	8.5 b-e	2.2 ab	0.4 a	9.7	6.7	5.7	1.0
FRONTIER	Takii	81.4 c-f	8.0 ijk	9.1 cde	1.9 ab	0.5 a	10.0	7.0	0.3	6.3
BRADDOCK GERM PLUS	Nor	80.4 c-f	6.2 b-h	10.7 e	2.4 ab	0.0 a	10.0	6.8	0.7	9.3
BOONE	Sol	80.2 c-f	6.5 b-h	4.7 a-e	7.8 a-k	0.7 a	9.2	5.7	1.0	2.7
SHERRINGTON	SN	79.9 c-f	7.4 hij	10.2 de	1.9 ab	0.6 a	9.5	6.2	5.3	11.0
HENDRIXS	Num	79.6 c-f	5.7 a-f	1.4 abc	11.7 f-k	1.6 a	9.8	7.5	1.7	1.7
BRADDOCK	Bejo	78.8 def	6.4 b-h	7.1 a-e	7.0 a-j	0.5 a	9.7	7.0	3.3	6.0
TREKKER	Takii	78.7 def	6.9 d-i	7.9 a-e	6.2 a-i	0.0 a	9.7	6.7	1.7	9.3
NEBULA	Num	78.4 efg	5.8 a-f	6.9 a-e	8.2 a-k	0.3 a	9.8	7.2	2.0	7.7

Listed in Order of Percent Marketable.

* Numbers in a column followed by the same letter are not significantly different at P = 0.05 Fisher's Protected LSD Test.

** 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average

.../continued

ONION CULTIVAR STORAGE TRIAL - 2011 - 2012 - continued

Cultivar	Source	% Marketable	% Weight Loss	% Sprouts	% Rot	% Soft	Firmness In **	Firmness Out **	% Sprouting at Base	% Sprouting at Top
MILESTONE	Takii	77.1 fgh*	6.4 b-h	6.9 a-e	8.1 a-k	1.2 a	9.7	6.3	0.7	6.0
SHERMAN	Bejo	76.9 fgh	6.0 a-h	5.5 a-e	10.8 a-k	0.9 a	9.7	6.7	1.7	5.0
ESTEEM	Cro	68.9 ghi	8.9 kl	6.5 a-e	15.3 kl	0.3 a	9.8	6.2	2.7	3.3
MARCO	Sol	67.6 hi	5.9 a-g	8.9 cde	12.6 g-l	4.7 bc	8.8	5.0	3.3	3.8
CORONA	Bejo	66.4 i	6.2 a-h	8.2 b-e	14.1 h-l	4.9 c	9.7	5.3	1.7	5.7
COOKE	Sol	60.8 ij	8.9 kl	21.1 f	9.3 b-k	0.8 a	9.0	6.5	14	4.3
NORSTAR	Takii	51.9 j	7.3 ghi	29.1 gh	11.0 d-k	0.4 a	9.0	5.7	18.3	36.7
MEDEO	Bejo	51.5 j	8.9 kl	27.7 fgh	11.3 e-k	0.0 a	9.8	5.7	25.0	14.0
ALPINE	Takii	31.3 k	8.8 jkl	37.7 ij	14.6 jkl	7.6 c	9.2	4.3	30.0	46.7
ERIK THE RED	Sol	31.2 k	8.9 kl	43.8 j	14.4 i-l	1.4 a	9.3	6.3	43.3	48.3
HIGHLANDER	Takii	30.3 k	9.9 lm	34.0 hi	20.4 l	5.1 c	8.8	4.7	40.0	51.0
OSJ1014	SN	16.1 l	11.0 mn	24.6 fg	47.3 m	0.9 a	9.0	5.3	20	8.3
AVALON	Cro	10.3 l	12.1 n	22.8 fg	53.1 m	1.8 ab	8.2	5.0	1.7	25.0
Trial Average		**73.6**	**7.0**	**9.6**	**8.7**	**0.9**	**9.6**	**6.6**	**5.6**	**8.4**

Listed in Order of Percent Marketable.

* Numbers in a column followed by the same letter are not significantly different at P = 0.05 Fisher's Protected LSD Test.

** 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average

MAIN ONION STORAGE CULTIVAR TRIAL EVALUATION NOTES 2011-2012

La Salle: Mostly skin rot, Some neck rot, Okay firmness, Basal plates just starting to push out 60-70%, Mid to late storage onion, No sprouting, Stored good.

Ex 18465: A little internal rot, Basal plates pushing out 80%, Fairly firm, Late storage onion, Stored good.

Gunnison Germ Plus**:** All internal rot, Basal plates just starting to push out 65-90%, Firm onion, Late storage onion, Stored nice.

Tahoe Germ Plus**:** Firm onion, Late storage onion, Mostly neck rot, A few internal rot, Basal plates just starting to push out 20-50%, Top sprouts just starting 0-1cm, Stored nice to excellent.

Hamlet: Top sprouts just starting 0-1cm, Firm onion, Basal plates pushing out 50-70%, Late storage onion, All skin rot, Stored nice.

Trail Blazer: Firm onion, Neck & skin rot, Top & root sprouts just starting 0-1cm, Basal plates just starting to push out 20-70%, Late storage onion, Stored good to nice.

Patterson Germ Plus**:** Top sprouts just starting uneven lengths, Skin, neck and internal rot present, Firm onion, Basal plates pushing out 60-80%, Late storage onion, Stored nice.

... / continued

MAIN ONION STORAGE CULTIVAR TRIAL EVALUATION NOTES 2011-2012 – continued

Genesis: Top sprouts just starting 0-1cm, Mostly skin rot, A few internal rot, Basal plates pushing out 50-80%, Firm onion, Late storage onion, Stored good.

Festival: Light amount of top & root sprouts 0-1cm, All internal rot, Fairly firm but uneven, Basal plates pushing out 90-100%, Mid to late storage onion, Stored okay to good.

Livingston: Root sprouts just starting 0-1cm, Mostly skin rot, A little internal rot, Okay firmness, Basal plates pushing out 60-90%, A little concern for basal plates popping, Mid to late storage onion, Stored fair.

Nobility: Top sprouts just starting 0-1cm, Either skin or neck rot, Basal plates just starting to push out 70-80%, Firmness a little uneven, Late storage onion, Stored good.

Patterson: Top sprouts just starting 0-1cm, Skin, neck and internal rot present, Fairly firm, Basal plates just starting to push out 40-80%, Late storage onion, Stored good to nice.

Huntington: Top & root sprouts just starting 0-1cm, All skin rot, Basal plates just starting to push out 75-90%, Firm but slightly uneven, Late storage onion, Stored nice.

Fortress: Top sprouts just starting 0-1cm, Mostly neck rot, Okay firmness but slightly uneven, Late storage onion, Basal plates just starting to push out 40-70%, Stored fair.

... / continued

MAIN ONION STORAGE CULTIVAR TRIAL EVALUATION NOTES 2011-2012 – continued

Safrane: Top sprouts just starting 0-1cm, Mostly neck rot, A few skin rot, Basal plates just starting to push out 30-70%, Fairly firm, Mid to late storage onion, Stored good.

01-214: Top sprouts just starting 0-1cm, Okay firmness, Basal plates just starting to push out 30-60%, Mostly internal rot, Mid to late storage onion, Stored good.

Pulsar: Top sprouts just starting 0-1cm, Mostly neck rot, A few skin & internal rot, Basal plates just starting to push out 10-40%, Firm onion, Late storage onion, Stored good to nice.

Prince: Top sprouts just starting 0-1cm, Mostly internal & neck rot, Mid to late storage onion, Basal plates just starting to push out 20-70%, Firmness a little uneven, Fairly firm, Stored good.

Stanley: Top sprouts just starting 0-1cm, Skin, internal and neck rot present, Basal plates just starting to push out 30-75%, Fairly firm, Firmness a little uneven, Mid to late storage onion, Stored good.

Pontiac: Top & root sprouts just starting 0-1cm, Mostly internal rot, A few skin rot, Basal plates pushing out 80-90%, Firmness a little uneven, Mid to late storage onion, Stored good.

Frontier: Top & root sprouts just starting 0-1cm, Slightly firm, Basal plates just starting to push out 40-80%, Skin & internal rot, Mid to late storage onion, Stored good.

... / continued

MAIN ONION STORAGE CULTIVAR TRIAL EVALUATION NOTES 2011-2012 – continued

Braddock Germ Plus**:** Top & root sprouts just starting 0-1cm, Mostly internal rot, Okay firmness, Basal plates just starting to push out 30-70%, Mid to late storage onion, Stored okay to good.

Boone: Uneven top sprouting 1-2.5cm, Root sprouting just starting 0-1cm, Mostly skin rot, A few neck & internal rot, Basal plates pushing out 80-90%, Firmness slightly soft, Early to mid storage onion, Stored a little poor.

Sherrington: Uneven top sprouting 1-5cm, Root sprouts just starting 0-1cm, Skin, internal and neck rots present, Basal plates pushing out 90%, Firmness uneven, Mid storage onion, Stored okay.

Hendrix: Mostly skin & neck rot, Odd internal rot, Basal plates just starting to push out 10-30%, Fairly firm, Mid to late storage onion, Stored good.

Braddock: Top sprouts just starting 0-1cm, Skin, internal and neck rots present, Okay firmness, Basal plates just starting to push out 20-40%, Mid to late storage onion, Stored good.

Trekker: Top sprouts just starting 0-1cm, Skin, internal and neck rots present, Basal plates just starting to push out 30-70%, Okay firmness but uneven, Mid storage onion, Stored good.

Nebula: Root sprouts just starting 0-1cm, Okay firmness, Mostly skin & neck rot, Some internal rot, Basal plates just starting to push out 10-30%, Mid storage onion, Light amount of top sprouts 1-2.5cm, Stored okay.

... / continued

MAIN ONION STORAGE CULTIVAR TRIAL EVALUATION NOTES 2011-2012 – continued

Milestone: Top sprouts just starting 0-1cm, Mostly skin rot, Odd neck & internal rot, Basal plates just starting to push out 50-80%, Firmness uneven, Mid storage onion, Stored okay.

Sherman: Uneven top sprouting 0-2.5cm, Root sprouting just starting 0-1cm, Skin, internal and neck rots present, Basal plates just starting to push out 30-80%, Slightly firm, Mid storage onion, Stored okay.

Esteem: Top & root sprouts just starting 0-1cm, Skin, internal and neck rots present, Basal plates just starting to push out 20-50%, Okay firmness, Mid storage onion, Stored okay.

Marco: Top sprouts just starting 0-1cm, Mostly skin rot, A few internal rot, Mid storage onion, Basal plates pushing out 90% concern, Firmness soft & uneven, Early to mid storage onion, Stored a little poor.

Corona: Mostly skin rot, A few internal rot, Firmness uneven, Light amount of top sprouts approx. 1-2.5cm, Mid storage onion, Basal plates just starting to push out 40-60%, Stored fair to okay.

Cooke: Top & root sprouts just starting 0-1cm, Firmness uneven, Fairly firm, Mid storage onion, Mostly neck rot, A few skin rot, Basal plates just starting to push out 40-80%, Stored okay.

Norstar: Moderate amount of top sprouts 1-3cm, Root sprouts just starting 0-1cm, Soft onion, Firmness uneven, Mostly skin rot, Basal plates pushing out 80-90%, Early storage onion, Stored a little poor.

... / continued

MAIN ONION STORAGE CULTIVAR TRIAL EVALUATION NOTES 2011-2012 – continued

Medeo: Top & root sprouts just starting 0-1cm, Root sprouts a bit concerning, Mostly skin rot, A few internal rot, Basal plates just starting to push out 35-50%, Firmness uneven, Mid storage onion, Stored fair.

Alpine: Firmness uneven & soft, Basal plates pushing out 80%, Top sprouts uneven & a concern 0-5cm, Light root sprouting 0-1cm, Mostly skin rot, A few internal rot, Not a storage onion, Stored poor.

Erik the Red: Heavy top sprouts concern >5cm, Root sprouts uneven concern 1-2.5cm, Mostly skin rot, Some neck & internal rot, Early to mid storage onion, Basal plates pushing out 80-100%, Firmness soft & slightly uneven, Stored a little poor.

Highlander: Moderate top sprouts concern 0-5cm, Light root sprouting 1-2.5cm, Mostly skin rot, Odd internal rot, Basal plates pushing out 80%, Soft, Not a storage onion, Stored poor.

OSJ 1014: Top & root sprouts just starting 0-1cm, Soft, Mostly skin rot, Odd internal rot, Rot is a concern, Basal plates just starting to push out 20%, Early to mid storage onion, Stored very poor.

Avalon: Top sprouts just starting 0-1cm, Soft, Rot a big concern, Skin, internal and neck rots present, Not a storage onion, Basal plates just starting to push out 60-90%, Stored very poor.

LONG TERM AVERAGES OF ONION STORAGE TRIALS

CULTIVAR	SOURCE	# YEARS TESTED	% MARKETABLE	% WT LOSS IN STORAGE	% ROT, SOFT & SPROUT	FIRMNESS * IN	FIRMNESS * OUT
CAVALIER	Sem	6	87.8	6.4	6.9	9.85	7.30
PATTERSON	Bejo	4	86.6	5.8	7.1	9.53	7.48
COPRA	Bejo	5	86.2	8.6	5.7	8.00	7.25
TRAIL BLAZER	Tak	4	84.9	4.8	9.7	9.40	7.38
INFINITY	Nun	9	84.6	5.9	8.3	9.68	6.68
FLAGSHIP	Sem	7	83.6	6.8	9.6	4.94	7.08
CANADA MAPLE	Sto	9	83.3	8.3	8.3	NA	7.40
TAURUS	Sem	9	82.9	7.3	9.8	NA	5.85
MILLENNIUM	Nun	8	82.8	6.6	10.5	4.95	6.85
TAHOE	Bejo	8	81.7	5.0	13.0	9.66	7.70
STANLEY	Sol	13	80.6	7.0	11.8	9.80	7.28
PULSAR	Nun	6	80.4	5.5	13.3	9.25	7.12
TRAPPS #8	E.J.	9	79.9	8.9	11.3	NA	6.35
CORTLAND	Bejo	5	79.0	7.7	13.6	9.85	6.85
SALEM	Bejo	5	79.0	8.1	14.0	9.85	6.80
BRADDOCK	Bejo	7	78.6	6.4	14.6	9.40	6.70
NEBULA	Nun	7	77.0	5.9	16.5	9.64	7.36
HAMLET	Sem	20	76.9	7.8	16.3	9.55	6.38
FORTRESS	Sem	18	76.4	8.6	15.3	9.42	6.84
LIVINGSTON	Sol	13	76.1	6.9	13.8	9.70	6.90

Listed in order of % Marketable.

* 10.0 = Most Desirable, 8.0 = Good, 6.0 = Average

…/continued

LONG TERM AVERAGES OF ONION STORAGE TRIALS - continued

CULTIVAR	SOURCE	# YEARS TESTED	% MARKETABLE	% WT LOSS IN STORAGE	% ROT, SOFT & SPROUT	FIRMNESS * IN	FIRMNESS * OUT
TALON	Bejo	6	75.2	5.4	19.0	9.70	6.82
ARSENAL	Sem	13	74.7	7.0	18.7	9.65	6.02
TRAPPS # 7	Cro	4	74.2	9.7	18.5	7.30	5.80
MOUNTAINEER	Tak	9	73.8	5.8	20.1	9.31	6.69
PARAGON	Nun	10	73.5	11.2	17.1	9.00	6.90
SPECTRUM	Nun	6	73.5	11.2	18.9	8.85	5.50
PRINCE	Bejo	19	73.1	9.4	18.7	9.64	6.84
TAMARA	Bejo	9	71.9	9.9	21.8	9.85	6.75
TARMAGON	Sto	6	70.5	10.1	19.1	8.25	5.25
BENCHMARK	Sem	5	70.5	12.8	21.3	9.45	6.91
CAPABLE	Nun	9	70.1	11.1	18.8	7.85	5.30
MILESTONE	Tak	11	69.7	6.1	23.5	9.43	5.91
FRONTIER	Tak	17	68.9	7.9	24.8	9.82	7.11
ADVANCER	HM	11	65.5	11.0	26.6	8.30	4.00
HUSTLER	HM	11	64.1	9.9	27.8	8.00	5.30
AUTUMN KEEPER	Cro	5	61.1	12.6	26.4	7.42	5.65
RICOCHET	Sem	9	58.0	6.1	33.9	9.60	5.93
MARCO	Sol	4	55.9	6.5	37.0	8.38	5.13
CORONA	Bejo	16	52.9	10.5	39.8	9.41	5.34
NORSTAR	Tak	23	49.6	10.3	41.4	8.17	4.67

Listed in order of % Marketable. Storage period approximately 11 months.

* 10.0 = Most Desirable, 8.0 = Good, 6.0 = Average

RED ONION TRANSPLANT CULTIVAR TRIAL – 2012

MANAGEMENT PROCEDURES

Seeded:

On 9 March seeded in seedling trays, 288 plugs/tray, filled with ASB soilless mixture with two seeds/cell. The onion plants were clipped regularly to a height of 8 cm to promote sturdy plants.

Fertilizer:

Greenhouse – 20-20-20 at a rate of 50ppm for the first two weeks after emergence then 100 ppm (Ebb & Flow Bench) prior to transplant.
One application of 10-52-10 at a rate of 3.1 kg/1000 L of water just prior to transplant.

Field - 90 kg/ha Nitrogen (Ammonium Nitrate 34-0-0) + 100 kg/ha Phosphorous (MAP 11-52-0) + 150 kg/ha Potassium (SOP 0-0-50) + 150 kg/ha K–Mag (0-0-22) + 35 kg/ha Manganese (15%) + 5 kg/ha Copper (99% Cu) was worked into the soil.

A side dressing of 15 kg/ha Nitrogen + 15 kg/ha Phosphorous (MAP 11-52-0) + 25 kg/ha of Potassium (SOP 0-0-50) + 30 Kg/ha of K-Mag (0-0-22) + 30kg /ha Cal-U-Sol was applied on 27 June.

Transplanted:

Three replications were planted in the field on 3 May at a spacing of 43 cm (row) and 12 cm (plant) apart.
A tray drench of Lorsban 4E was applied at 1.6 ml product per 475 ml water per tray 2 days before transplanting on 1 May.

Weed Control:

Pre-emergence:	3 applications: **PARDNER** on 12 May (300 ml/ha) and 17 & 22 May (450ml/ha).
Post-emergence:	1 application: **PARDNER** at 35 ml/ha + **GOAL** at 35 ml/ha and Manganese at 1.0 kg/ha on 28 May.
	1 application: **FRONTIER** at 1.0 L/ha on 29 June.
	1 application: **PARDNER** at 100 ml/ha + **GOAL** at 100 ml/ha and Manganese at 2.0 kg/ha on 14June.
	1 application: **SELECT** at 200ml/ha + **AMIGO** 200 ml/ha on 10 July.

.../continued

Minor Elements:

Nine foliar sprays: Supafeed on 22 & 28 June (2.0Kg/ha), 5, 12, 19 & 27 July, 2, 8, & 16 August (3.0 kg/ha)
Six foliar sprays: Calcimax on 16 & 22 June, 15, 12 & 19 July, 16 August (3.0 L/ha)
Five foliar sprays: Manganese Sulfate on 24 May, 28 June (2.0 Kg/ha), 5, 12 & 27 July (3.0 kg/ha)
Four foliar sprays: TrioMax on 16 June, 2 & 27 July, 8 August (3.0 L/ha)
Three foliar sprays: Mag Max on 22 June (3.0 L/ha), 12 July (5.0L/ha) and 19 July (4.0L/ha)
Three foliar sprays: Boron Max on 27 July (1.0L/ha), 8 August (1.5 L/ha) and 16 August (2.5 L/ha)
Three foliar sprays: Zinc Max on 24 May, 8 June (2.0L/ha) and 28 June (1.0 L/ha)
Three foliar sprays: 20-20-20 on 24 May, 8 June (1.0 kg/ha) and 16 June (2.0 kg/ha)
Two foliar sprays: Mancozin on 22 June & 12 July (3.0 L/ha)
Two foliar sprays: Alexin on 2 & 16 August (3.0 L/ha)
One foliar spray: Copper Max on 19 July (2.0L/ha)

Insect and Disease Control:

According to IPM recommendations.

DITHANE DG at 2.5 kg/ha + **UP-CYDE** at 280 ml/ha and Minor Elements on 28 June.
PENNCOZEB 80 WP at 2.5 kg/ha + **DELEGATE** at 300 g/ha and Minor Elements on 5 July.
BRAVO at 2.5 L/ha + **MATADOR** at 188 ml/ha and Minor Elements on 12 July.
RIDOMIL MZ 2.50 Kg/ha + **RIPCORD** at 175 ml/ha and Minor Elements on 19 July.
PRISTINE WG at 1.3 Kg/ha + **AGRI MEK** at 1.2L/ha and Minor Elements on 27 July.
DITHANE DG at 2.5 kg/ha + **DIBROM** at 550 ml/ha and Minor Elements on 2 August.
DITHANE DG at 3.0 kg/ha + **ROVRAL** at 750g/ha + **DELEGATE** at 300 g/ha and Minor Elements on 8 August.
PENNCOZEB 80 WP at 2.0 kg/ha + **RIPCORD** at 175 ml/ha and Minor Elements on 16 August.

Harvest:

The trial was pulled on 19 September and topped on 19 September. The trial was placed in a forced air and temperature controlled storage 17 October. The trial was cured for 24 hours (25^{o}C, minimum 65% RH). After curing the temperature was lowered 5^{o}C per week until 0^{o}C was attained.

Sprout Inhibition:

ROYAL MH 60SG at 3.75 kg/ha in 550 L/ha water on 13 August

.../continued

RED ONION TRANSPLANT CULTIVAR TRIAL - 2012 - continued

EVALUATION PROCEDURES

The cultivars were evaluated 7, 8 & 9 January after 11 weeks in storage.

 # Bulbs Harvested:

Total number of onions harvested from 4.66 m of row.

Harvest Weight:

Weights from the harvested 4.66 m of row.

Marketable Yield B/A:

Number of onions > 76 mm (> 3"), 76 mm to 64 mm (3" to 2 ½) and 64 mm to 32 mm (2 ½" to 1¼").

Majority of Culls:

D = Double PW = Pee Wee R = Rot OC = Off Colours S = Seeders SP = Sprouts

Shape:

HG = High Globe FG = Flatten Globe G = Globe Sp = Spindle TD = Tear Drop T = Top

Interior & Exterior Colour:

LR = Light Red R = Red DR = Dark Red DEEP = Deep Dark Red

Skin Thickness:

10.0 = Most Desirable 7.5 = Good 6.0 = Average

Skinning:

10.0 = Most Desirable, skins well attached 7.5 = Good, skins have a few small cracks 6.0 = Average, skins have cracks but still attached

.../continued

RED ONION TRANSPLANT CULTIVAR TRIAL - 2012 - continued

Overall Score:
Based on quality and general appearance.

Score:
The average of nine marks at evaluation from Uniformity of Shape to Firmness.

Average Weight/Bulb (g):
The total weight in grams of all bulbs divided by the total number of bulbs. A bulb 51 mm (2") in diameter weighs approximately 70 g. A bulb 57 mm (2¼") in diameter weighs approximately 100 g. A bulb 64 mm (2½") in diameter weighs approximately 135 g.

Days to Harvest:
Numbers of days from transplant until 85% of the tops were down.

Percent Onion Maggot Damage:
Percent of onions damaged by onion maggot ranging from pin hole to completely unmarketable that were found in the 4.66 m harvest sample.

Seeders:
The average number of seeders found in all three replicates of each cultivar.

Top Height (cm):
The average length of 20 random onion tops from the all three replicates from the ground to the tips as taken on 26 July.
50 cm is equal to 20 inches.

Leaf Shape:
B = Leaves are bent or hanging U = Up right leaves, straight

Irrigation:
Irrigation water was applied on: 17 & 30 May (1/2”), 20 June (5/8"), 28 June (3/4") and 14 July (1 1/8").

RED ONION TRANSPLANT CULTIVAR TRIAL - 2012

Cultivar	Source	# Bulbs Harvested	Total Harvest Weight (kg)	Wgt. Jumbo > 76 mm (kg)	Wgt. Large 76-64 mm (kg)	Wgt. Medium 64-32 mm (kg)	Marketable Yield B/A	% Marketable	Majority of Culls	Percent Single Centres
RED WING	Bejo	74	19.70	16.81 a*	2.09 cde	0.12	1434 a	95.5 a	PW	16.7 b-e
RED BULL	Bejo	74	20.08	16.65 a	2.27 b-e	0.11	1435 a	94.6 ab	D	6.7 de
RUBY RING	Sto	74	16.10	10.00 cde	4.51 a	0.36	1122 b	92.3 ab	R	23.3 a-d
MARENGE	Nun	68	19.02	14.58 ab	1.82 de	0.83	1300 ab	88.7 abc	R	10.0 cde
RED BERET	Cro	72	17.06	12.23 bc	2.72 b-e	0.23	1145 b	88.0 abc	R	30.0 ab
PURPLE HAZE	Cro	72	15.84	10.82 cd	2.91 b-e	0.40	1066 b	86.2 a-d	R	36.7 a
RED DEVIL	Cro	73	18.33	12.10 bc	3.41 abc	0.09	1176 ab	85.3 bcd	R	40.0 a

Listed in order of % Marketable.

.../ continued

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

RED ONION TRANSPLANT CULTIVAR TRIAL - 2012 - continued

Cultivar	Source	# Bulbs Harvested	Total Harvest Weight (kg)	Wgt. Jumbo > 76 mm (kg)	Wgt. Large 76-64 mm (kg)	Wgt. Medium 64-32 mm (kg)	Marketable Yield B/A	% Marketable	Majority of Culls	Percent Single Centres
MERCURY	Sto	71	19.35	10.97 c*	3.66 ab	1.40	1208 ab	81.3 cd	SPR	3.3 e
RED HAWK	Bejo	72	17.59	11.74 bc	2.44 b-e	0.16	1081 b	80.6 cde	R	10.0 cde
SV 4643	Sto	75	20.86	15.10 ab	1.52 e	0.13	1263 ab	77.7 de	D	26.7 abc
NUN 9005	Nun	72	14.26	5.66 f	3.40 abc	0.61	729 c	70.5 ef	R	13.3 b-e
RED SKY	Bejo	75	16.07	7.19 ef	3.33 a-d	0.15	804 c	65.3 fg	R	0.0 e
RED JEWEL	Bejo	72	18.71	8.26 def	1.46 e	0.14	744 c	56.2 g	R	6.7 de
Trial Average		**73**	**17.81**	**9.82**	**2.63**	**0.43**	**972**	**71.9**	**R**	**10.0**

Listed in order of % Marketable.

.../ continued

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

RED ONION TRANSPLANT CULTIVAR TRIAL - 2012 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Exterior Colour	Exterior Colour Rating	Interior Colour	Interior Colour Rating	Skin Thickness	Skinning	Neck Finish	Overall Score	Score
RED WING	Bejo	SP	5.7	6.7	DR	6.0	R	6.0 cd*	7.7	8.7	6.7	7.0	6.93 a
RED BULL	Bejo	HG	5.0	6.7	R	6.3	R	6.3 bcd	6.7	8.0	7.0	7.5	6.87 ab
RUBY RING	Sto	HG	6.7	7.3	R	6.7	R	6.7 bcd	7.0	5.7	7.0	6.8	6.83 ab
MARENGE	Nun	FG	6.0	5.3	DR	7.0	DR	7.3 abc	7.0	5.0	8.0	6.7	6.56 abc
RED BERET	Cro	Top	4.7	5.3	R	5.3	R	7.7 ab	6.7	6.3	6.0	5.7	6.11 cde
PURPLE HAZE	Cro	FG	5.3	4.7	DR	5.7	R	5.3 d	5.0	5.3	7.0	5.7	5.69 e
RED DEVIL	Cro	G	5.3	6.0	R	5.0	R	6.3 bcd	6.7	7.0	6.0	5.8	6.17 cde

Listed in order of % Marketable. 10.0 = Most Desirable, 8.0 = Good, 6.0 = Average

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

.../ continued

RED ONION TRANSPLANT CULTIVAR TRIAL - 2012 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Exterior Colour	Exterior Colour Rating	Interior Colour	Interior Colour Rating	Skin Thickness	Skinning	Neck Finish	Overall Score	Score
MERCURY	Sto	SP	5.7	4.3	LR	6.3	R	6.7 bcd*	7.7	6.7	7.3	5.7	6.33 a-d
RED HAWK	Bejo	G	5.7	5.3	DR	6.7	DR	8.3 a	6.3	7.3	6.3	6.2	6.52 abc
SV 4643	Sto	Mix	4.7	4.7	R	6.3	LR	5.7 d	6.3	6.0	7.0	5.3	5.89 de
NUN 9005	Nun	G	6.3	4.7	R	5.3	R	5.7 d	6.7	5.0	7.7	5.3	5.93 cde
RED SKY	Bejo	SP	4.7	5.3	LR	6.7	DR	7.3 abc	5.7	6.7	8.0	5.7	6.26 b-e
RED JEWEL	Bejo	Top	4.7	4.0	DR	7.3	DR	7.7 ab	5.0	6.7	7.7	5.3	6.11 cde
Trial Average			**5.3**	**4.7**		**6.4**		**6.9**	**6.3**	**6.9**	**6.3**	**7.3**	**5.58**

Listed in order of % Marketable. 10.0 = Most Desirable, 8.0 = Good, 6.0 = Average

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

.../ continued

RED ONION TRANSPLANT CULTIVAR TRIAL - 2012 - continued

Cultivar	Source	Firmness at Harvest	Firmness	Average Weight/Bulb (g)	Stand/Foot	Days to Harvest	% Onion Maggot Damage	% Jumbo > 76 mm	Number of Seeders	Tops Height (cm)	Leaf Shape
RED WING	Bejo	9.2	8.0 ab*	266.2 ab	4.8	104 g	0.5 a	78.8 a	0.0 a	83.4 a	U
RED BULL	Bejo	9.3	8.3 a	270.1 a	4.9	99 f	0.0 a	77.1 ab	0.3 a	78.6 b	U
RUBY RING	Sto	9.8	7.7 abc	217.6 bcd	4.8	92 de	0.9 a	54.5 def	0.0 a	71.6 e	U
MARENGE	Nun	9.2	6.7 cd	278.5 a	4.4	93 e	0.5 a	71.5 abc	0.0 a	73.6 cde	U
RED BERET	Cro	9.3	7.3 a-d	236.0 a-d	4.7	91 cde	0.9 a	64.2 bcd	1.3 a	80.5 b	U
PURPLE HAZE	Cro	9.3	7.2 bcd	219.2 bcd	4.7	89 bcd	0.0 a	57.7 cde	2.0 a	72.5 de	U
RED DEVIL	Cro	9.3	7.3 a-d	251.5 abc	4.8	89 bcd	0.5 a	60.0 cde	1.7 a	75.2 c	U

Listed in order of % Marketable.

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

.../ continued

RED ONION TRANSPLANT CULTIVAR TRIAL - 2012 - continued

Cultivar	Source	Firmness at Harvest	Firmness	Average Weight/Bulb (g)	Stand/Foot	Days to Harvest	% Onion Maggot Damage	% Jumbo > 76 mm	Number of Seeders	Tops Height (cm)	Leaf Shape
MERCURY	Sto	9.2	6.7 cd*	270.6 a	4.7	89 bc	0.0 a	46.6 efg	0.0 a	72.6 de	U
RED HAWK	Bejo	8.8	6.5 d	243.2 a-d	4.7	87 b	0.9 a	59.9 cde	1.0 a	83.1 a	U
SV 4643	Sto	9.5	7.0 bcd	279.4 a	4.9	84 a	0.5 a	63.9 bcd	1.7 a	78.9 b	U
NUN 9005	Nun	9.0	6.7 cd	197.4 d	4.7	89 bc	0.0 a	31.7 h	0.3 a	68.5 f	U
RED SKY	Bejo	8.2	6.3 d	214.3 cd	4.9	83 a	0.0 a	37.9 gh	0.0 a	72.9 cde	U
RED JEWEL	Bejo	8.5	6.7 cd	259.7 abc	4.7	83 a	0.4 a	42.1 fgh	0.0 a	74.3 cd	U
Trial Average		**8.9**	**6.6**	**244.1**	**4.8**	**86**	**0.3**	**47.0**	**0.5**	**75.0**	**U**

Listed in order of % Marketable.

* Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

.../ continued

RED ONION TRANSPLANT CULTIVAR TRIAL EVALUATION NOTES 2012

Red Wing: Nice appearance, Good tight neck finish but a little rough, Odd skin cracking, Good skins, Exterior colour slightly uneven, Odd browning on skins, Odd white specks on skins, Good to nice packer, Uniformity of shape uneven, Nice firm & solid onion, Large run size, White centers, Interior colour uneven, Late storage onion.

Red Bull: Nice appearance, Good tight neck finish but uneven, Odd skin cracking, Pretty good skins, Exterior colour a little uneven, Odd browning on skins, Good to nice packer, Large run size, Uniformity of shape uneven, Good firmness, Dead centers white, Interior colour a little uneven, Late storage onion.

Ruby Ring: Average to good appearance, Good neck finish but a little rough, A lot of skin cracking a concern, Average skins, Exterior colour slightly uneven, Some browning on skins, Good packer, Medium run size, Uniformity of shape a little uneven, Firm & solid onion, Nice interior slightly pale, Dead centers white, Late storage onion.

Marenge: Good to nice appearance, Good tight neck finish, A lot of skin cracking a concern, Average skins, Dark exterior colour and a little uneven, Odd browning on skins, Good packer, Medium to large run size, Uniformity of shape a little uneven, Firm onion, Dead centers white, Dark interior colour and a little uneven, Mid storage onion.

Red Beret: Average appearance, Average neck finish but a bit rough, A lot of skin cracking, Average skins, Exterior colour uneven, Odd browning on skins, Average packer, Uniformity of shape uneven, Medium run size, Good firmness, Some skin rot, Dead centers white, Interior colour even, Mid to late storage onion.

Purple Haze: Average appearance, Average neck finish but a little rough, Most skins cracking, Average skins, Exterior colour uneven, Some browning on skins, Average to good packer, Medium to large run size, Uniformity of shape uneven, Good firmness but a little uneven, White centers, Interior colour uneven, Mid to late storage onion.

Red Devil: Average appearance, Uneven neck finish a bit rough, Some skin cracking, Average skins, Exterior colour uneven, Average packer, Odd browning on skins, Medium run size, Uniformity of shape very uneven, Firm onion, White centers, Interior colour uneven, Late storage onion.

... / continued

RED ONION TRANSPLANT CULTIVAR TRIAL EVALUATION NOTES 2012 - continued

Mercury: Okay appearance, Good neck finish, Some skin cracking, Average skins, Exterior colour slightly uneven and a little pale, Some browning on skins, Okay packer, Uneven run size, Suspicion of doubles, Uniformity of shape very uneven, Firmness a little soft, White centers, Interior colour uneven, Some skin rot, Mid storage onion.

Red Hawk: Average to good appearance, Average neck finish but a bit rough, Odd skin cracking, Pretty good skins, Exterior colour dark and even, Some browning on skins, Dark interior colour, Average to good packer, Medium to large run size, Uniformity of shape uneven, Okay firmness, Dead centers white, Skin rot concerns, Nice interiors, Early to mid storage onion.

SV 4643: Fair appearance, Good neck finish some bit rough, Some skin cracking, Fair to average skins, Exterior colour uneven, Odd browning on skins, Okay packer, Large run size, Uniformity of shape very uneven, Good firmness, White centers, Interior colour a little pale, A little skin rot, Suspicion of doubles, Early to mid storage onion.

Nun 9005: Poor appearance, Good tight neck finish, A lot of skin cracking a concern, Poor skins, Exterior colour uneven, Okay packer, Very uneven run size, Uniformity of shape uneven, Good firmness, A lot of skin rot a concern, White centers, Interior colour uneven, Mid storage onion.

Red Sky: Poor to okay appearance, Great tight neck finish, Some skin cracking, Poor skins, Exterior colour pale, Some browning on skins, Okay to average packer, Medium run size, Uniformity of shape uneven, Soft firmness, Skin rot, Interior colour slightly dark & even, Mechanical damage, Early storage onion.

Red Jewel: Poor rough appearance, Good tight neck finish, Some skin cracking, Average skins, Dark exterior colour, Okay packer, Medium run size, A lot of skin rot a concern, Uniformity of shape very uneven, Mechanical damage a concern, Good firmness, Dead centers white, Dark interior colour even, Early to mid storage onion.

RED ONION CULTIVAR STORAGE TRIAL - 2011 - 2012

Cultivar	Source	% Marketable	% Weight Loss	% Sprouts	% Rot	% Soft	Firmness In **	Firmness Out **	% Sprouting at Base	% Sprouting at Top
06-91'	Cro	84.3 a*	4.7 a	1.3 a	9.3 a	0.0 a	9.3	7.8 ab	0.2 a	0.2
RUBY RING	Tak	83.9 a	4.3 a	0.8 a	10.5 a	0.0 a	9.7	8.3 ab	0.2 a	0.0
RED WING	Bejo	79.6 ab	5.0 a	3.6 ab	11.3 ab	0.0 a	10.0	7.3 bc	2.2 ab	0.0
RED BULL	Bejo	79.2 ab	5.6 a	0.7 ab	14.0 ab	0.0 a	9.3	8.0 ab	0.0 a	0.0
SANGRIA	Nor	78.7 ab	6.3 a	2.2 ab	12.5 ab	0.0 a	10.0	8.8 a	1.7 ab	0.0
06-264	Cro	78.2 ab	4.7 a	0.9 a	15.7 ab	0.0 a	9.3	8.7 a	0.0 a	0.0
MARENGE	Nun	74.8 ab	7.0 a	1.7 a	15.3 ab	0.8 a	9.3	8.0 ab	0.3 a	0.0

Listed in Order of Percent Marketable.

* Numbers in a column followed by the same letter are not significantly different at P = 0.05 Fisher's Protected LSD Test.

** 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average

.../continued

RED ONION CULTIVAR STORAGE TRIAL - 2011 - 2012 - continued

Cultivar	Source	% Marketable	% Weight Loss	% Sprouts	% Rot	% Soft	Firmness In **	Firmness Out **	% Sprouting at Base	% Sprouting at Top
RED HAWK	Bejo	70.1 ab*	8.2 ab	2.5 abc	18.7 ab	0.0 a	9.0	6.5 cd	0.5 a	0.0
08-633	Cro	67.1 ab	7.9 ab	8.4 abc	15.0 ab	1.3 a	9.5	6.5 cd	5.5 ab	0.5
MERCURY	Sto	64.7 b	7.4 a	12.8 bc	14.8 ab	0.0 a	9.0	6.5 cd	10.0 ab	0.0
COUNTACH	Nun	47.0 c	12.6 bc	16.1 c	23.9 b	0.0 a	10.0	7.5 bc	13.7 b	0.7
RED BEAUTY	Bejo	39.3 cd	8.2 ab	37.4 d	14.6 ab	0.0 a	9.5	7.3 bcd	40.0 c	1.0
Nun 9005	Nun	32.6 d	15.6 c	13.6 bc	38.1 c	0.0 a	8.8	7.3 bc	12.0 ab	0.0
RED SKY	Bejo	29.3 d	6.9 a	55.4 e	8.1 a	0.0 a	9.0	6.0 d	65.0 d	0.5
Trial Average		**64.9**	**7.5**	**11.3**	**15.8**	**0.1**	**9.4**	**7.5**	**10.8**	**0.2**

Listed in Order of Percent Marketable.

* Numbers in a column followed by the same letter are not significantly different at P = 0.05 Fisher's Protected LSD Test.

** 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average

RED ONION STORAGE TRIAL EVALUATION NOTES 2011-2012

06-91: Root sprouts just starting 0-1cm, Mostly skin rot, Some Botrytis rot, Firm onion, Good skins, Stored nice, Mid to late storage onion.

Ruby Ring: Root sprouts just starting 0-1cm, Internal, neck and skin rot present, Firm onion, Stored nice, Great skins, Late storage onion.

Red Wing: Root sprouts just starting 0-1cm, Mostly Botrytis rot, Basal plates just starting to push out 20-80%, Stored good, Good skins, Mid storage onion.

Red Bull: Root sprouts just starting 0-1cm, Mostly Botrytis rot, Basal plates just starting to push out 15-25%, Good firmness but slightly uneven, Stored nice, Mid to late storage onion.

Sangria: Root sprouts just starting 0-1cm, Mostly Botrytis rot, Firm & solid onion, Stored nice to excellent, Good Skins, Late storage onion.

06-264: Root sprouts just starting 0-1cm, Botrytis and skin rots, Firm & solid onion, Stored nice, Good skins, Late storage onion.

Marenge: Root sprouts just starting 0-1cm, Some Botrytis and skin rots, Nice firm onion, Stored nice, Good skins, Late storage onion.

... / continued

RED ONION STORAGE TRIAL EVALUATION NOTES 2011-2012 - continued

Red Hawk: Root sprouts just starting 0-1cm, Botrytis rot, Okay firmness but slightly uneven, Stored good, Good skins, Mid storage onion.

08-633: Root sprouts just starting 0-1cm, Botrytis rot, Basal plates just starting to push out 15%, Okay firmness, Stored okay, Good skins, Early to mid storage onion.

Mercury: Root sprouts just starting 0-1cm, Botrytis rot, Basal plates just starting to push out 10-25%, Firmness uneven, Stored fair, Skins a little poor, Early to mid storage onion.

Countach: Root sprouts just starting 0-1cm, Botrytis and internal rot a concern, Good firmness but a little uneven, Stored a little poor, Good skins, Mid storage onion.

Red Beauty: Root sprouts just starting 0-1cm, Moderate amount of onions with root sprouts, Botrytis rot, Basal plates pushed out 40-60% a concern, Firmness uneven, Stored fair, Mid storage onion.

Nun 9005: Root sprouts just starting 0-1cm, Botrytis and skin rot, Basal plates pushed out 60%, Firmness uneven, Stored poor, Poor skins, A lot of rot, Early to mid storage onion.

Red Sky: Root sprouts just starting 0-1cm, Botrytis rot, Basal plates pushed out 60%, Firmness slightly uneven, Stored a little poor, Sprouting concerns, Early to mid storage onion.

Check out the Muck Crops Research Station's Web Page

www.uoguelph.ca/muckcrop/

Grower Field Day & Muck Conference Information

Integrated Pest Management Information

IPM Report Updates

Weather Data

Insect & Disease Forecasting Data

Publications

Cultivar Trial Results

Research Reports

Research Documents