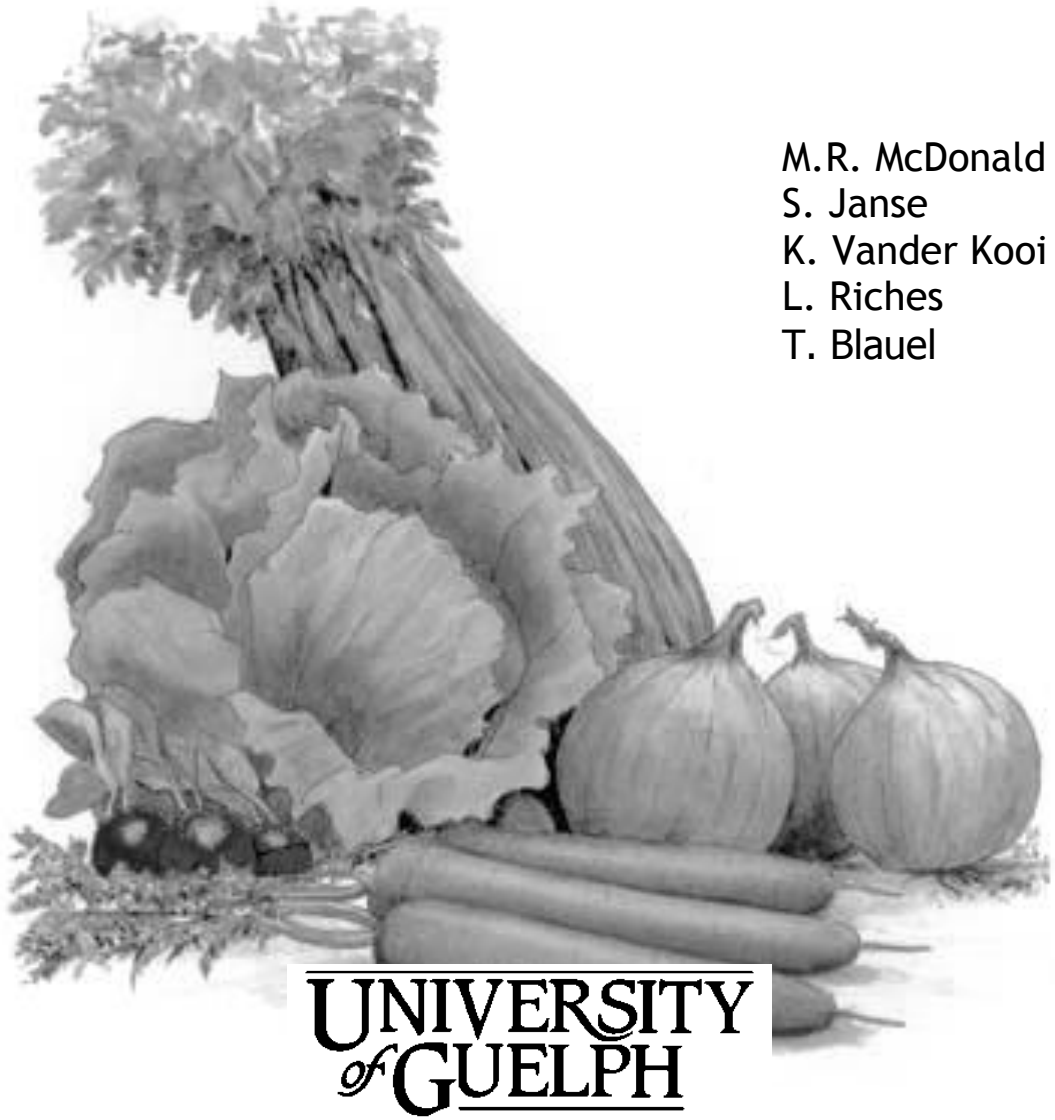
Muck Vegetable Cultivar Trial & Research Report 2019



M.R. McDonald
S. Janse
K. Vander Kooi
L. Riches
T. Blauel

Office of Research &
Dept. of Plant Agriculture
Report No. 69

Muck Crops
Research Station
King, Ontario

Research and Cultivar Trial Report for 2019

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

1125 Woodchoppers Lane
King, Ontario L7B 0E9
Phone (905) 775-3783

Web Site: www.uoguelph.ca/muckcrop/
Twitter Account: @MuckIPM

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Onions

Celery

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Miscellaneous

Integrated Pest Management

CULTIVAR TRIALS

STAFF - 2019

UNIVERSITY OF GUELPH
Office of Research and
Department of Plant Agriculture

MUCK CROPS RESEARCH STATION

Staff:

Shawn Janse	Research Station Manager
Mary Ruth McDonald, Ph.D., P.Ag.	Research Scientist
Kevin Vander Kooi	Agricultural Technician
Laura Riches	Agricultural Technician
Miško Mitrović	Agricultural Assistant
Zach Telfer	IPM Supervisor
Tyler Blauel	IPM Supervisor / Research Associate

IPM Scouts: Alex Balduckie Olivia Baxter Lauren Orlovski

Seasonal Contracts:

Alex Balduckie	Summer Assistant
Dylan Bartlett	Summer Experience
Johanna Bronsveld	Summer Assistant
Christine Dervaric	Summer Assistant
Tess Greenhow	Summer Assistant
Madalena Liougas	Summer Experience
Clarie Penstone	Summer Assistant
Alec Schaefer	Summer Assistant

Graduate Students:

Dillon Muldoon	Department of Environmental Science
Tarunpriya Rainu	Department of Plant Agriculture
Stephen Reynolds	Department of Plant Agriculture
Afsaneh Sedaghatkish	Department of Plant Agriculture
Alexandra Stinson	Department of Environmental Science
Sara Stricker	Department of Plant Agriculture
Sarah Drury	Department of Plant Agriculture

CO-OPERATING COMPANIES 2019

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

Stokes Seed Ltd	Bridget Visser
Bejo Seeds Inc.	Jan Van Der Heide
Seminis Seeds	Ron Garton

CO-OPERATING RESEARCH STAFF - EDUCATION/RESEARCH/GOVERNMENT

Clarence Swanton	Dept. of Plant Agriculture, University of Guelph, ON, Canada
Peter Smith	Dept. of Plant Agriculture, University of Guelph, ON, Canada
Cynthia Scott-Dupree	School of Environmental Science, University of Guelph, ON, Canada
Bruce Gossen	Agriculture & Agri-Food Canada, Saskatoon, SK, Canada
Alan Taylor	Dept. Horticultural Science, Cornell University, NY, USA
Brian Nault	Dept. of Entomology, Cornell University, NY, USA
Phil Simon	USDA/ARS, Madison, WI, USA
Dennis Van Dyk	Ontario Ministry of Agriculture, Food and Rural Affairs, Guelph, ON, Canada

CO-OPERATING RESEARCH STAFF - INDUSTRY/PRIVATE SECTOR

Matt Sheppard	Bradford Cooperative Storage Ltd, Bradford, ON, Canada
Alan Butterfield	California Fresh Carrot Advisory Board, Dinuba, CA, USA
Dan Brotslaw	California Garlic & Onion Research Advisory Board, Clovis, CA, USA
Jeff Douglas	Douglas Agricultural Services, Simcoe, ON, Canada
Inna Teshler	Petro-Canada Lubricants Inc, Suncor Energy Company, Mississauga, ON, Canada
Tom Miedema	Fresh Vegetable Growers of Ontario, Ridgetown, ON, Canada
Thomas van Hengstum	Rijk Zwaan, DeLier, Netherlands
Laura Smith	Corteva Agriscience, Winnipeg, MB, Canada
Colin Smith	Sylvar Technologies Inc, Fredericton, NB, Canada
Bachar Blar	Acadian Seaplants Ltd., Cornwallis, NS, Canada

SEED SOURCES - 2019 - CULTIVAR TRIALS

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

CF **Clifton Seed Company**, P.O. Box 206, Faison, North Carolina, 28341, U.S.A.
Tel: (800) 231-9359

EZ **Enza Zaden**, 360 St Patrice, Sherrington, Quebec, J0L 2N0, Canada
Tel: (518) 390-2837

Haz **Hazera Seeds**, 3155 SW 10th Street, Suite 6L, Deerfield Beach, Florida, 33442, U.S.A.
Tel: (954) 429-9445

Nor **Norseco**, 2914 Boul. Cure-Labelle, Laval, Quebec, H7P 5R9, Canada
Tel: (514) 332-2275

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

SN **Seminova,** 20 rue de l'Industrie, C.P. 3640, St-Remi, Quebec, J0L 2N0, Canada
Tel: (450) 454-5155

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

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 2019.

LEGEND OF SEED SOURCES

Bejo Bejo Seeds Inc.

BCSVS Bayer Crop Science Vegetable Seeds

CF Clifton Seed Company

Cro Crookham Company

EZ Enza Zaden

Haz Hazera Seeds Inc

HM Harris Moran Seeds

Nor Norseco Inc.

Rog Rogers Seed

RZ Rijk Zwaan Export B.V.

Sak Sakata Seed America Inc.

Sem Seminis Vegetable Seeds

Sieg Siegers Seed Co.

Sol Solar Seed Co.

Sto Stokes Seeds Ltd.

SN Seminova

Swy Seedway Inc.

Toz Tozer Seeds America

Tak American Takii Inc.

UNF Co-op Uniforce

Vil Vilmorin 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 2019, 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 University; research departments of the Crop Production Chemical Industry, numerous seed companies, growers' organizations and growers.

This report consists of two sections: the first contains highlights of research projects which were conducted in 2019 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 2019 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. and two Ph.D. graduate students 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 registration of Delegate and Movento for thrips on onions and Evergol Prime (penflufen) for onion smut (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 2019

PRECIPITATION

Month	2009		2010		2011		2012		2013		2014	
	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	0*	44	9*	21	15	38	39	13	36	16	28	19
February	48*	26	189*	33	17	40	15	19	17	58	19	45
March	56*	5	36*	0	56	21	30	2	12	6	9	16
April	105	0	12	0	75	0	51	0	82	4	82	2
May	117	0	52	0	92	0	49	0	112	0	58	0
June	49	0	170	0	68	0	55	0	94	0	88	0
July	135	0	146	0	56	0	140	0	104	0	92	0
August	89	0	74	0	113	0	69	0	87	0	63	0
September	51	0	95	0	67	0	94	0	83	0	113	0
October	62	0	60	0	83	0	123	0	92	0	67	0
November	31	2	41	0	85	1	32	0	24	15	24	5
December	46	9	61	72	49	4	35	14	29	40	11	22
Annual	**789**	**86**	**789**	**126**	**776**	**104**	**732**	**48**	**772**	**139**	**654**	**109**
Total Precip.	**875**		**901**		**880**		**780**		**911**		**763**	

LTA = Long Term Average for U of Guelph, Dept. of Plant Agriculture - Kettleby
1125 Woodchoppers Lane, King, ON, L7B 0E9 45 Years (1975-2019)

* Data collected from Egbert, ON

PRECIPITATION

Month	2015		2016		2017		2018		2019		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	0	15	23	2	61	14	34	25	14	52	20	27
February	0	32	29	12	28	23	28	32	14	43	20	26
March	10	5	80	30	54	8	21	14	39	17	31	14
April	48	0	22	18	87	12	117	12	89	0	57	4
May	40	0	45	0	120	0	82	0	77	0	73	0
June	171	0	39	0	209	0	59	0	100	0	81	0
July	36	0	51	0	74	0	104	0	93	0	84	0
August	79	0	58	0	53	0	109	0	80	0	79	0
September	27	0	25	0	38	0	20	0	61	0	79	0
October	54	0	41	0	99	0	69	0	74	0	69	1
November	40	0	40	5	22	11	63	31	27	31	52	9
December	39	3	20	65	2	32	44	10	44	40	26	28
Annual	**544**	**55**	**473**	**132**	**847**	**100**	**750**	**124**	**712**	**183**	**671**	**109**
Total Precip.	**599**		**605**		**947**		**874**		**895**		**780**	

LTA = Long Term Average for U of Guelph, Dept. of Plant Agriculture - Kettleby
1125 Woodchoppers Lane, King, ON, L7B 0E9 45 Years (1975-2019)

MEAN TEMPERATURE (°C)

Month	2009		2010		2011		2012		2013		2014	
	Max.	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**
January	-6.2*	-16.2*	-3.8*	-11.6*	-3.0	-14.2	1.3	-6.9	2.1	-6.3	-3.9	-14.7
February	-0.8*	-10.5*	-2.4*	-8.9*	-0.8	-11.3	2.7	-5.6	-1.0	-10.3	-2.2	-17.3
March	4.5*	-6.3*	7.4*	-2.9*	3.7	-5.6	12.7	-0.1	3.7	-4.3	1.9	-12.2
April	12.7	0.8	16.2	3.4	12.7	1.2	12.5	0.0	11.4	0.7	11.9	0.3
May	18.7	5.5	22.6	7.6	19.8	8.4	23.4	8.4	21.8	7.6	20.9	6.6
June	22.3	10.2	23.9	12.9	24.8	12.0	26.9	13.2	24.2	12.8	27.1	11.6
July	23.6	11.7	29	15.6	30.1	15.5	29.7	14.7	27.5	15.1	25.9	12.5
August	25.2	13.0	27.8	14.4	26.9	13.4	27.0	13.1	26.7	12.4	25.8	12.5
September	21.9	7.5	21.1	9.8	22.6	10.6	21.7	8.0	22.4	8.1	22.8	8.5
October	11.9	2.8	15.2	3.5	15.4	4.7	14.6	4.8	16.3	4.6	15.3	5.5
November	9.7	-0.4	7.9	-1.0	11.1	1.1	7.3	-1.4	6.6	-3.2	5.2	-1.0
December	0.3	-6.0	-4.6	-6.7	3.7	-3.9	3.8	-3.4	-1.0	-9.4	2.0	-2.9
Mean	**12.0**	**1.0**	**13.4**	**3.0**	**13.9**	**2.7**	**15.3**	**3.7**	**13.4**	**2.3**	**12.7**	**0.8**

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* Data collected from Egbert, ON

MEAN TEMPERATURE (°C)

Month	2015		2016		2017		2018		2019		LTA	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
January	-3.2	-13.1	0.4	-7.8	0.8	-5.2	3.3	-3.2	-3.7	-12.3	-2.3	-10.9
February	-8.2	-19.8	1.9	-8.3	3.7	-5.0	1.7	-7.7	-0.4	-9.9	-1.2	-10.5
March	2.7	-7.4	6.6	-2.8	3.4	-5.0	2.9	-4.5	2.8	-6.0	3.3	-5.5
April	13.0	0.8	10.3	-1.7	14.4	3.4	7.0	-1.9	5.8	1.3	11.3	1.0
May	23.5	8.3	21.2	6.3	17.3	7.2	23.4	9.0	16.5	6.3	19.2	6.8
June	23.8	11.8	26.2	11.1	24.1	12.8	25.1	12.2	23.5	11.6	24.1	11.6
July	28.1	13.3	28.8	15.3	26.4	14.9	28.4	15.0	29.3	15.4	26.8	14.1
August	25.7	13.2	29.6	15.5	25.2	12.6	27.8	16.9	26.3	12.4	25.6	13.0
September	25.9	12.1	24.8	10.0	25.0	9.6	23.7	11.3	21.6	9.6	21.3	9.1
October	14.6	3.9	15.9	5.9	17.2	5.8	12.2	3.8	14.8	4.3	13.9	3.8
November	10.8	0.6	11.5	0.9	7.3	-1.8	3.3	-3.2	4.0	-3.9	6.7	-1.0
December	6.9	-0.1	1.3	-5.8	-2.0	-11.6	1.7	-4.3	2.2	-6.7	0.5	-6.6
Mean	**13.6**	**2.0**	**14.9**	**3.2**	**13.6**	**3.1**	**13.4**	**3.6**	**11.9**	**1.8**	**12.4**	**2.1**

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EXTREME TEMPERATURE (°C)

Month	2009		2010		2011		2012		2013		2014	
	H	**L**	**H**	**L**	**H**	**L**	**H**	**L**	**H**	**L**	**H**	**L**
January	1.9 *	-30.3 *	4.3*	-25.8*	11.7	-28.7	7.9	-20.3	14.0	-22.4	8.3	-30.4
February	8.9 *	-2.7 *	2.5*	-16.1*	9.7	-24.8	9.2	-17.3	6.5	-23.8	7.6	-30.2
March	15.3 *	-18.9 *	18.7*	-10.7*	14.8	-14.8	26.4	-15.6	12.3	-10.3	12.9	-27.8
April	27.3	-5.3	26.2	-2.7	23.5	-3.0	25.7	-5.9	24.7	-7.4	23.4	-7.3
May	29.9	-1.8	32.3	-0.5	28.3	-0.2	34.9	1.1	31.3	0.0	31.9	-0.1
June	32.2	1.7	31.1	5.2	33.4	5.2	35.5	7.6	33.4	6.1	32.7	2.8
July	27.6	4.9	35.4	7.4	36.3	6.8	35.3	9.7	35.3	7.6	31.4	6.5
August	31.3	4.5	35.1	7.0	31.5	8.5	32.6	6.4	31.7	7.3	32.6	5.7
September	26.6	-0.7	33.2	4.0	30.8	5.4	29.9	1.7	35.3	-0.5	32.1	0.1
October	18.2	-6.1	24.4	-2.4	29.2	-3.6	23.5	-4.7	24.7	-5.7	24.4	-1.5
November	18.8	-7.2	14.5	-5.4	19.2	-6.6	18.5	-5.8	16.0	-19.0	16.6	-10.3
December	9.8	-15.7	11.1	-5.4	14.3	-19.6	15.1	-12.7	15.9	-25.3	10.5	-11.1
Annual High & Low	**32.2**	**-30.3**	**35.4**	**-25.8**	**36.3**	**-28.7**	**35.5**	**-20.3**	**35.3**	**-25.3**	**32.6**	**-30.4**

Extreme Temperatures for U of Guelph, Dept. of Plant Agriculture - Kettleby
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* Data collected from Egbert, ON

EXTREME TEMPERATURE (°C)

Month	2015		2016		2017		2018		2019		EXTREME TEMPERATURES			
	H	L	H	L	H	L	H	L	H	L	H	Year	L	Year
January	5.3	-21.4	10.3	-19	7.2	-16.8	11.4	-28.6	6.6	-23.5	15.8	2005	-36.0	1977
February	-1.8	-30.8	15.4	-28.8	16.7	-14.8	14.7	-21.7	11.2	-23.4	16.7	2017	-33.0	1979
March	12.9	-26.3	18.5	-14.7	14.8	-17.3	10.3	-11.7	11.6	-18.7	26.4	2012	-29.0	1984
April	22.7	-5.1	26.2	-15.3	26.6	-1.6	18.8	-8.3	14.4	-6.4	30.0	1990	-15.3	2016
May	30.8	-1.2	33.2	-1.6	31.5	1.1	30.6	-1.0	24.2	-0.3	34.6	2006	-4.0	1983
June	29.1	4.1	34.2	3.1	32.6	4.5	33.2	5.9	31.4	2.8	35.5	1988	-2.0	1977
July	34.2	7.2	35.1	8.4	30.8	10.5	35.3	8.6	34	9.3	36.3	2011	2.5	1984
August	32.8	6.9	34.8	9.8	30.4	5.3	33.1	10.9	30.8	6.8	36.3	2001	0.5	1982
September	34.1	4.3	34.2	1.2	34.6	1.1	33.4	1.9	29.9	1.0	35.3	2013	-6.5	1991
October	23.9	-3.1	25.8	-3.5	26.0	-1.6	28.7	-3.3	27.2	-2.4	30.0	89 & 07	-9.0	1975
November	22.1	-6.8	19.1	-6.5	22.6	-14.4	14.5	-25.3	11.5	-19.1	24.0	1990	-25.3	2018
December	15.4	-8.1	9.1	-15.9	12.1	-29.0	11.0	-12.4	8.9	-21.6	20.0	1982	-31.5	1980
Annual High & Low	**34.2**	**-30.8**	**35.1**	**-28.8**	**34.6**	**-29.0**	**35.3**	**-28.6**	**31.4**	**-23.5**	**36.3**		**-36.0**	

Extreme Temperatures for U of Guelph, Dept. of Plant Agriculture - Kettleby
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GROWING DEGREE DAYS (5°C Base)

Month	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	LTA
January	0*	0*	1	0	9	0	0	1	0	2	0	1
February	1*	0*	0	0	0	0	0	8	8	7	2	1
March	7*	15*	5	123	8	0	1	31	12	0	2	15
April	84	147	74	54	78	63	79	56	123	25	19	76
May	220	312	282	338	304	271	337	273	220	348	200	243
June	338	395	403	450	405	431	390	409	404	410	375	385
July	391	536	552	533	507	443	480	528	486	518	535	476
August	436	499	472	467	450	438	456	543	431	531	446	441
September	291	314	348	295	306	320	419	372	368	375	323	305
October	72	139	163	145	177	171	141	188	203	108	142	131
November	29	14	69	15	28	30	72	67	20	11	2	31
December	0	2	6	11	4	4	22	2	1	2	2	4
Annual	**1869***	**2373***	**2375**	**2431**	**2276**	**2171**	**2397**	**2478**	**2276**	**2338**	**2048**	**2110**

LTA = Long Term Average for U of Guelph, Dept. of Plant Agriculture - Kettleby
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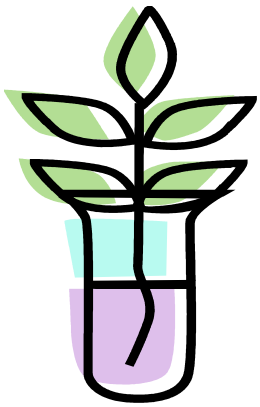
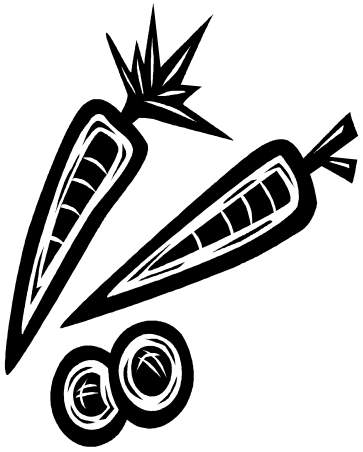
* Data collected from Egbert, ON





Research Reports 2019

CROP: Carrots (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang), cv. Cellobunch
PESTS: Carrot Weevil, *Listronotus oregonensis* (LeConte)
Carrot Rust Fly, *Psila rosae* (Fab.)

AUTHORS: DACEY A[1], MCDONALD MR[2], VANDER KOOI K[2], SCOTT-DUPREE C[1]
[1]School of Environmental Sciences, University of Guelph
[2]Dept. of Plant Agriculture, University of Guelph, Muck Crops Research Station

TITLE: FIELD EVALUATION OF SEEDING DATE ON CARROT WEEVIL AND CARROT RUST FLY INJURY IN CARROT, 2019

METHODS: Carrots (cv. Cellobunch) were direct seeded (70 seeds/m) onto raised beds using a precision seeder on six different planting dates, 30 April; 10 and 21 May; 3, 11, and 20 June 2019, at the University of Guelph, Muck Crops Research Station, Holland Marsh, ON (soil: pH ~= 5.6, organic matter ~= 70.6%). A randomized complete block arrangement containing five replications per seeding date was used for plots consisting of three rows, 66 cm apart and 8 m in length. Each plot received an application of LOROX L (linuron 750 mL/ha) and ASSIST OIL (mineral oil 1.0 L/ha) at the second true-leaf stage (TLS) for weed control. Two 1.5 m sections of row from each plot were flagged and the number of carrots was recorded weekly from emergence until the eighth TLS to determine the number of dead carrots and overall stand decrease for each seeding date. On 12 August and 7 October, carrots from one 1.5 m section of row were collected from each plot to assess the carrots for carrot weevil (CW) and carrot rust fly (CRF) injury. On 12 August and 9 October, carrot samples were washed in a small drum washer and visually inspected for CW and CRF injury, recording the number and weight of damaged and marketable carrots (marketable was defined as no insect injury). Data were analyzed using a one-way ANOVA generalized linear model using RStudio (RStudio Team, Boston, MA) to determine the impact of planting date on CW and CRF injury, and yield. For CW, both harvest dates were assessed in the same analysis and Tukey's Test was performed to compare planting dates. Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C), October (9.4°C), and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C, August 20.2°C, September 16.4°C and October 9.7°C. Monthly rainfall was above the 10-year average for October (106 mm), average for May (77 mm), September (62 mm), and below average for June (84 mm), July (42 mm) and August (46 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm, August 80 mm, September 61 mm and October 74 mm.

RESULTS: Results are presented in Table 1.

CONCLUSIONS: Both CW and CRF injury was extremely high in this trial. Overall, delaying seeding reduced CW injury, however CRF injury was highest on 11 June. Similar to 2016, 2017, and 2018, optimal planting dates that minimize CW attack appear to begin in early June. In contrast to CW, early seeding appeared to avoid the highest CRF injury. Marketable yield was very low in 2019, due to high amounts of injury caused by both CW and CRF. Carrots seeded at the end of June had significantly lower stand losses than carrots seeded at the end of April. Young carrots are at risk of dying from CW attack when seeded early, and insecticides may need to be applied at the 2nd TLS to ensure protection.

Table 1. Average carrot weevil (CW), carrot rust fly (CRF) injury, and yield in a carrot seeding date trial at the University of Guelph – Muck Crops Research Station, Holland Marsh, ON, 2019.

Seeding Date	% Stand Decrease	CW Injury (%)[1]		CRF Injury (%)[1]	Marketable Yield (t/ha)[2]
		12 Aug	4 Oct		
30 April	19.3 a[3]	82.2 a	88.3 a	28.6 a	4.88 ns
10 May	17.5 ab	66.7 b	69.8 a	65.4 ab	4.28
21 May	15.0 ab	40.4 c	57.9 ab	71.2 ab	3.50
3 June	8.2 ab	23.1 d	35.7 bc	73.8 bc	13.7
11 June	11.4 ab	19.0 de	19.9 c	87.9 c	5.98
20 June	2.6 b	11.9 e	21.6 c	73.7 b	11.3

[1] Percent injury is based on carrot number.
[2] Yield in t/ha was extrapolated from the average marketable yield of two 1.5 m carrot row section samples on Oct 7.
[3] Different letters within columns denote significantly different groups according to Tukey's HSD (α =0.05).

The authors thank the University of Guelph – Muck Crop Research Station staff for technical advice and assistance. Funding for this project was received from the Ontario Agri-Food Innovation Alliance – Plant Protection, OMAFRA- HQP Scholarship to AD, Bradford Co-operative Storage, Ltd., Belchim Crop Protection Canada, Corteva Agriscience, and the Fresh Vegetable Growers of Ontario.

CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang), cv. Bolero
PEST: Carrot weevil (*Listronotus oregonensis* (LeConte))

AUTHORS: VANDER KOOI K[1], TELFER Z[1], TAYLOR A[2], SCOTT-DUPREE C[3] & MCDONALD MR[1]
[1]Dept. of Plant Agriculture, University of Guelph, Muck Crops Research Station
[2]College of Agriculture and Life Sciences, Cornell University
[3]School of Environmental Sciences, University of Guelph

TITLE: EVALUATION OF THE SEED TREATMENT FORTENZA FOR CARROT WEEVIL CONTROL, 2019

MATERIALS: FORTENZA (cyantraniliprole 50%), RIMON 10 EC (novaluron 10%)

METHODS: Carrots (cv. Bolero) were direct seeded (70 seed/m) onto raised beds using a push cone seeder on 8 and 24 May, (early and late seeded plots respectively). A randomized complete block arrangement with five replications per treatment was used. Each plot consisted of two rows, 66 cm apart and 6 m in length. The experiment was established as a factorial, with factors including seeding date, seed treatment, and foliar applications of RIMON. The FORTENZA seed treatment was applied as a seed film coating with 7.29 g AI/100 g seed. RIMON was applied on 30 May (early seeded plots only), 11 June (early and late seeded plots), and 21 June (late seeded plots only). On 1 August and 10 October, carrots from two randomly chosen 1.16 m sections of row were taken from each plot to assess for carrot weevil (CW) damage. On 9 August and 14 November, carrot samples were washed in a small drum washer and visually inspected for CW damage, recording the number and weight of damaged and marketable carrots. Marketable was defined as carrots with no insect damage.

Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C), October (9.4°C) and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C, August 20.2°C, September 16.4°C and October 9.7°C. Monthly rainfall was above the 10-year average for October (106 mm), average for May (77 mm), September (62 mm), and below average for June (84 mm), July (42 mm) and August (46 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm, August 80 mm, September 61 mm and October 74 mm. Data were analyzed using the General Analysis of Variance function of Statistics V.10. Means separation was obtained using Fisher's Protected LSD test with $P = 0.05$ level of significance.

RESULTS: Results are presented in Table 1 & 2.

CONCLUSIONS: Between sampling dates, carrot weevil damage significantly increased in all treatments in the trial from 7.6 to 15.3. This increase in CW damage between dates would indicate that a 2nd generation of CW is causing damage (Table 1). When all treatment effects were accounted for, RIMON was effective at reducing carrot weevil damage. FORTENZA alone does not appear to be effective at reducing carrot weevil damage. This research confirms that both delaying seeding and using RIMON are the most effective methods to control carrot weevil.

Table 1. Treatment effects on carrot weevil damage in a seed treatment, foliar insecticide, and seeding date trial at the University of Guelph – Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Treatments			Carrot Weevil Damage (%)[1,2]		Yield (t/ha)[1]
SEEDING	RIMON	FORTENZA	Mid-Season	Late Season	
Early	No	No	26.7 c	37.0 c	62.2 b
Early	No	Yes	8.2 ab	22.7 abc	67.2 b
Early	Yes	No	16.6 bc	26.4 bc	75.5 ab
Early	Yes	Yes	5.6 ab	8.8 ab	91.6 a
Late	No	No	3.1 a	8.2 ab	80.1 ab
Late	No	Yes	0.0 a	9.0 ab	81.1 ab
Late	Yes	No	0.0 a	5.5 a	90.6 a
Late	Yes	Yes	0.5 a	5.0 a	89.1 a

[1, 2] Numbers in a column followed by the same letter are not significantly different at P= 0.05, Fisher's Protected LSD test.
[2] Percent damaged is based on the number of carrots.

Table 2. Individual effects of treatment factors on carrot weevil (CW) damage at harvest in a seed treatment, foliar insecticide, and seeding date interaction trial at the University of Guelph – Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Treatment		CW Damage (%)[1,2,3]	Yield (t/ha)[1]
SEEDING DATE	Early	23.7 b	74.1 b
	Late	6.9 a	85.2 a
RIMON	Yes	11.4 ns	86.7 a
	No	19.2	72.6 b
FORTENZA	Yes	11.4 ns	82.2 ns
	No	19.3	77.1

[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 difference
[3] Percent damaged is based on the number of carrots.

Funding for this project was provided by the Plant Production Systems of the Ontario Agri-Food Innovation Alliance, the Bradford Co-Op Storage, Ltd. and the Fresh Vegetable Growers of Ontario.

CROP: Carrots (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang), cv. Cellobunch
PESTS: Carrot Weevil, *Listronotus oregonensis* (LeConte)
Carrot Rust Fly, *Psila rosae* (Fab.)

AUTHORS: DACEY A[1], MCDONALD MR[2], VANDER KOOI K[2], SCOTT-DUPREE C[1]
[1]School of Environmental Sciences, University of Guelph
[2]Dept. of Plant Agriculture, University of Guelph, Muck Crops Research Station

TITLE: FIELD EVALUATION OF FOLIAR INSECTICIDES FOR CONTROL OF CARROT WEEVIL AND CARROT RUST FLY DAMAGE IN CARROTS, 2019

MATERIALS: BEETLEGONE! (*Bacillus thuringiensis* 76.5%), BOTANIGARD (*Beauvaria bassiana* 22%), DELEGATE (spinetoram 25%), EXIREL (cyantraniliprole 100 g/L), IMIDAN 70 WP (phosmet 70%), RIMON 10 EC (novaluron 10%)

METHODS: Carrots (cv. Cellobunch) were direct seeded (70 seeds/m) onto raised beds using a precision seeder on 17 May 2019, at the University of Guelph, Muck Crops Research Station, Holland Marsh, ON (soil: pH ~ 6.0, organic matter ~68.7%). A randomized complete block arrangement with five replications per treatment was used. Plots consisted of two rows, 86 cm apart and 5 m in length. Treatments were BEETLEGONE! (11.2 kg/ha), BOTANIGARD (1170 ml/ha), DELEGATE (400 ml/ha), EXIREL (1000 ml/ha and 1500 ml/ha), IMIDAN 70 WP (1.6 kg/ha), RIMON 10 EC (820 ml/ha). An untreated control was also included. All treatments were applied on 19 and 27 June, and 9 July using a CO_2 backpack sprayer equipped with four TeeJet 8002 fan nozzles calibrated to deliver 350 L/ha at 240 kPa. On 12 August and 7 October, carrots from two 1.2 m sections of row were taken from each plot to assess the carrots for CW and CRF injury. On 15 August and 9 October 2019, carrot samples were washed in a small drum washer and visually inspected for CW and CRF injury. The number and weight of injured and marketable carrots was recorded. Marketable was defined as no insect injury. Data were analyzed using a one-way ANOVA generalized linear model using RStudio (RStudio Team, Boston, MA) to determine the effect of treatments on CW and CRF injury, and marketable yield. For CW, both harvest dates were assessed in the same analysis and Tukey's Test was performed to compare injury among treatments. Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C), October (9.4°C), and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C, August 20.2°C, September 16.4°C and October 9.7°C. Monthly rainfall was above the 10-year average for October (106 mm), average for May (77 mm), September (62 mm), and below average for June (84 mm), July (42 mm) and August (46 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm, August 80 mm, September 61 mm and October 74 mm.

RESULTS: Results are presented in Table 1.

CONCLUSIONS: Overall, CW and CRF injury was high. IMIDAN 70 WP, the high rate of EXIREL, and RIMON 10 EC all significantly reduced CW injury compared to the control at both the midseason and harvest assessments, with the low rate of EXIREL also significantly reduced CW injury, but only at the midseason assessment. The organic products, BOTANIGARD and BEETLEGONE!, did not reduce CW injury compared to the control. IMIDAN 70 WP, both rates of EXIREL, and RIMON 10 EC resulted in significantly higher yields than the control. Both IMIDAN 70 WP and the high rate of EXIREL resulted in significantly less CRF injury at harvest.

Table 1. Effect of foliar insecticides on average carrot weevil (CW), and carrot rust fly (CRF) injury, and yield in a carrot trial at the University of Guelph – Muck Crops Research Station, Holland Marsh, ON, 2019.

Treatment	CW Injury (%)[1]		CRF Injury (%)[1]	Yield (t/ha)[2]
	9 Aug	4 Oct		
EXIREL 1500	8.57 d[3]	7.55 c	24.4 c	62.5 d
RIMON 10 EC	10.0 d	9.32 c	34.8 ab	56.5 bc
IMIDAN 70 WP	10.9 cd	17.1 bc	20.6 c	59.4 d
EXIREL 1000	8.45 d	18.9 ab	27.2 bc	56.5 cd
BOTANIGARD	19.2 bc	25.0 a	36.8 a	38.9 ab
DELEGATE	20.4 b	27.6 a	33.3 a	37.3 ab
BEETLEGONE!	34.8 a	30.1 a	28.6 ab	46.2 abc
Control	23.9 ab	34.7 a	32.7 ab	40.1 a

[1] Percent injury is based on carrot number.
[2] Yield in t/ha was extrapolated from the average marketable yield of two 1.16 m carrot row section samples on Oct 7.
[3] Different letters within columns denote significantly different groups according to Tukey's HSD (α =0.05).

The authors thank staff at the University of Guelph – Muck Crop Research Station for technical advice and assistance. Funding for this project was received from the Ontario Agri-Food Innovation Alliance, OMAFRA- HQP Scholarship to AD, Bradford Co-operative Storage, Ltd., Belchim Crop Protection Canada, Corteva Agriscience, and the Fresh Vegetable Growers of Ontario.

CROP: Carrots (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang), cv. Cellobunch
PESTS: Carrot Weevil, *Listronotus oregonensis* (LeConte)
Carrot Rust Fly, *Psila rosae* (Fab.)

AUTHORS: DACEY A[1], MCDONALD MR[2], VANDER KOOI K[2], SCOTT-DUPREE C[1]
[1]School of Environmental Sciences, University of Guelph
[2]Dept. of Plant Agriculture, University of Guelph, Muck Crops Research Station

TITLE: EVALUATING TIMING OF RIMON APPLICATIONS FOR CONTROL OF CARROT WEEVIL AND CARROT RUST FLY DAMAGE IN CARROTS, 2019

MATERIALS: RIMON 10 EC (novaluron 10%)

METHODS: Carrots (cv. Cellobunch) were direct seeded (70 seeds/m) onto raised beds using a Stanhay precision seeder on 17 May 2019, at the University of Guelph, Muck Crops Research Station, Holland Marsh, ON (soil: pH ~= 7.0, organic matter ~= 59.0%). A randomized complete block arrangement with four replications per treatment was used. Plots consisted of four rows, 86 cm apart and 5 m in length. RIMON 10 EC (820 ml/ha) was applied at the 2 true-leaf stage (TLS), 4 TLS, 2+4 TLS, 4+6 TLS, and 2+4+6 TLS. An untreated control (no spray) was also included. Treatments were applied on 20 June (2 TLS), 2 July (4 TLS), and 12 July (6 TLS) using a tractor-mounted sprayer fitted with TeeJet Air Induction Even Flat spray tips (AI9503 EVS) at 415 kPa calibrated to deliver 500 L/ha. On 12 August and 7 October, carrots from two 1.16 m sections of row were taken from the center rows of each plot to be assessed for carrot weevil (CW) and carrot rust fly (CRF) injury. On 12 August and 10 October 2019, carrot samples were washed in a small drum washer and visually inspected for CW and CRF injury, and the number and weight of injured and marketable carrots was recorded. Marketable was defined as no insect injury. Data were analyzed using a one-way ANOVA generalized linear model using RStudio (RStudio Team, Boston, MA) to determine the impact of treatments on CW and CRF injury, and yield. Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C), October (9.4°C), and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C, August 20.2°C, September 16.4°C and October 9.7°C. Monthly rainfall was above the 10-year average for October (106 mm), average for May (77 mm), September (62 mm), and below average for June (84 mm), July (42 mm) and August (46 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm, August 80 mm, September 61 mm and October 74 mm.

RESULTS: Results are presented in Table 1.

CONCLUSIONS: Carrot weevil and carrot rust fly injury was low in this trial. Applications of RIMON were very effective at reducing CW injury compared to the control, regardless of how often or when the product was applied. The lowest CW injury occurred in plots sprayed at the 4+6 TLS, but this was not different from sprays at 2+4+6 TLS. Yield was significantly higher than the untreated check in plots treated with RIMON either three times or twice (4+6 TLS). However, there were no significant differences in yield among any of the insecticide timing treatments. No treatment significantly reduced CRF injury compared to the control.

Table 1. Average carrot weevil (CW), carrot rust fly (CRF) injury, and yield in a trial evaluating application timings of RIMON 10 EC at the University of Guelph – Muck Crops Research Station, Holland Marsh, ON, 2019.

Treatment	Applications (TLS)[1]	CW Injury (%)[2]		CRF Injury (%)[2]	Marketable Yield (t/ha)[3]
		12 Aug	4 Oct		
Control	n/a	5.8 ns[4]	12.7 a[5]	7.2 ab	44.2 a
RIMON	2	5.3	5.1 b	8.4 ab	53.7 ab
	4	5.9	5.3 b	10.9 a	53.1 ab
	2 + 4	1.8	2.6 b	9.9 ab	56.6 ab
	2 + 4 + 6	2.2	2.5 bc	6.1 b	56.5 b
	4 + 6	0.0	0.6 c	7.2 ab	49.5 b

[1] TLS=true leaf stage

[2] Percent damaged is based on carrot number.

[3] Yield in t/ha was extrapolated from the average marketable yield of two 1.5 m carrot row section samples on Oct 7.

[4] ns indicates all numbers in the column are not significantly different compared to the control at $\alpha = 0.05$ according to Tukey's test.

[5] Different letters within columns denote significantly different groups according to Tukey's HSD ($\alpha = 0.05$).

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

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

TITLE: EVALUATING TIMING OF RIMON AND EXIREL APPLICATIONS FOR CONTROL OF CARROT WEEVIL AND CARROT RUST FLY DAMAGE IN CARROTS, 2019

MATERIALS: EXIREL (cyantraniliprole 100 g/L), RIMON 10 EC (novaluron 10%)

METHODS: Carrots (cv. Enterprise) were direct seeded (70 seeds/m) onto raised beds using a Stanhay precision seeder on 24 May near the University of Guelph, Muck Crops Research Station, Holland Marsh, ON (soil: pH ~= 6.8, organic matter ~= 64.8%). A randomized complete block arrangement with four replications per treatment was used. Plots consisted of four rows, 86 cm apart and 5 m in length. RIMON (820 mL/ha) and EXIREL (1.0 L/ha) were applied at the 2+4+6 true-leaf stage (TLS). Treatments alternating RIMON (R) and EXIREL (E) were applied at the 2 TLS (R) + 4 TLS (E) + 6 TLS (R) or 2 TLS (E) + 4 TLS (R) + 6 TLS (E) and 2 TLS (R) + 4 TLS (R) + 6 TLS (E). An untreated control (no spray) was also included. Treatments were applied on 21 June (2 TLS), 2 July (4 TLS) and 12 July (6 TLS) using a tractor-mounted sprayer fitted with TeeJet Air Induction Even Flat spray tips (AI9503 EVS) at 415 kPa calibrated to deliver 500 L/ha. On 8 August and 18 October, carrots from two 1.16 m sections of row were taken from the centre rows of each plot to be assessed for carrot weevil (CW) and carrot rust fly (CRF) damage. On 8 August and 8 November, carrot samples were washed in a small drum washer and visually inspected for CW and CRF damage, and the number and weight of damaged and marketable carrots was recorded. Marketable was defined as no insect damage. Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C) and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C, August 20.2°C and September 16.4°C. Monthly rainfall was below the 10-year average for June (84 mm), July (42 mm), August (46 mm) and average for May (77 mm) and September (62 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm, August 80 mm and September 61 mm.
Data were analyzed using the General Analysis of Variance with Statistix V.10. Means separation was obtained using Fisher's Protected LSD Test at P = 0.05 level of significance.

RESULTS: Results are presented in Table 1.

CONCLUSIONS: Carrot weevil damage was low in this trial. Applications of RIMON were very effective at reducing CW damage when applied multiple times over the CW oviposition period. Alternating between applications of RIMON and EXIREL did not significantly reduce CW damage compared to multiple applications of RIMON alone. No significant differences in yield were observed in any plots treated with EXIREL or RIMON or combinations compared to the untreated control. Carrot rust fly damage was very low in this trial and no treatment significantly reduced CRF damage compared to the control. (Data not shown)

Table 1. Average carrot weevil damage and yield in a trial evaluating application timings of RIMON and EXIREL at the Muck Crops Research Station, Holland Marsh, ON, 2019.

Treatment	Applications (TLS)	CW Damage (%)[1]		Marketable Yield (t/ha)
		9 Aug	4 Oct	
Control	n/a	4.1 ns[2]	8.3 b[3]	66.0 ns
RIMON	2 + 4 + 6	0.0	0.3 a	75.3
EXIREL	2 +4 + 6	0.0	0.0 a	75.0
RIMON + EXIREL	2 (E) + 4 (R) + 6 (R)	0.3	0.2 a	78.5
RIMON + EXIREL	2 (R) + 4 (E) + 6 (R)	0.0	0.5 a	75.7
RIMON + EXIREL	2 (R) + 4 (R) + 6 (E)	1.1	0.0 a	72.4

[1] Percent damaged is based on carrot number.
[2] ns = no significant differences were found among the treatments
[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 received from the Plant Production Systems of the Ontario Agri-Food Innovation Alliance and the Fresh Vegetable Growers of Ontario.

CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang), cv. Enterprise
PEST: Carrot weevil (*Listronotus oregonensis* (LeConte))

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

TITLE: EVALUATING TIMING OF EXIREL APPLICATIONS FOR CONTROL OF CARROT WEEVIL IN CARROT, 2019

MATERIALS: EXIREL (cyantraniliprole 100 g/L)

METHODS: Carrots (cv. Enterprise) were direct seeded (70 seeds/m) onto raised beds using a precision seeder on 24 May near the University of Guelph - Muck Crops Research Station, Holland Marsh, ON (soil: pH ≈ 6.8, organic matter ≈ 64.8%). A randomized complete block arrangement containing four replications per treatment was used with plots consisting of four rows, 86 cm apart and 5 m in length. EXIREL (1.0 L/ha) was applied at the following timings: 2 TLS (true-leaf stage), 4 TLS, 2+4 TLS, 4+6 TLS, 2+4+6 TLS. An untreated control (no spray) was also included. Treatments were applied on 21 June (2 TLS), 2 July (4 TLS), and 12 July (6 TLS) using a tractor mounted sprayer fitted with TeeJet Air Induction Even Flat spray tips (AI9503 EVS) at 415 kPa calibrated to deliver 500 L/ha. On 9 August and 18 October, carrots from two 1.16 m sections of row were taken from the centre rows of each plot to be assessed for carrot weevil (CW) damage. On 9 August and 8 November, carrot samples were washed in a small drum washer and visually inspected for CW damage, recording the number and weight of damaged and marketable carrots. Marketable was defined as no insect damage. All data were analyzed using the General Analysis of Variance function of Statistics V.10. Means separation was obtained using Fisher's Protected LSD test with $P = 0.05$ level of significance.

RESULTS & DISCUSSION: Results are presented in Table 1.

CONCLUSIONS: No treatments reduced CW damage. Carrot weevil damage overall was low in the trial. In 2019, EXIREL provided no CW control despite some success in previous years. There was increased CW damage seen between sampling dates, likely caused by a 2nd generation of CW.

Table 1. Mean carrot weevil (CW) damage in carrots in a trial evaluating application timings of EXIREL at the University of Guelph – Muck Crops Research Station, Holland Marsh, ON, 2019.

Insecticide Treatment	Application Timing (TLS[1])	CW Damage (%)[2]			Mkb Yield (t/ha)
		9 August	8 November	Combined	
CONTROL	N/A	2.2 ns[2]	5.2 ns	3.7 ns	65.9 ns
EXIREL	2	0.4	5.3	2.8	67.4
	4	0.3	2.3	1.3	66.9
	2+4	0.0	0.0	0.0	70.7
	4+6	0.5	1.1	0.8	72.1
	2+4+6	0.0	0.0	0.0	72.1

[1] True leaf stage
[2] ns = no significant differences

Funding for this project was proved by the Plant Production Systems of the Ontario Agri-Food Innovation Alliance, Bradford Co-Op Storage Ltd, and the Fresh Vegetable Growers of Ontario.

CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang.), cv. Cellobunch
PEST: Carrot cyst nematode (*Heterodera carotae* Jones)

AUTHORS: BLAUEL T[1], VANDER KOOI K[1], VAN DYK D[2] and MCDONALD MR[1]
[1]University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station
[2]Ontario Ministry of Agriculture, Food and Rural Affairs, Guelph, ON, Canada

TITLE: FIELD EVALUATIONS OF NEMATICIDES AND FUMIGANTS FOR CARROT CYST NEMATODE CONTROL IN CARROTS, 2019

MATERIALS: BUSAN (metam sodium 42%), EXP#019-01 (*Trichoderma* spp.), MAJESTENE (*Burkholderia* spp. strain A396), MOVENTO 240 SC (spirotetramat 240 g/L), PIC PLUS (chloropicrin 85.1%), SALIBRO (fluazaindolizine), VYDATE (oxamyl 240 g/L)

METHODS: The trial was conducted in a commercial field in the Holland/Bradford Marsh, Ontario known to be infested with carrot cyst nematode (*Heterodera carotae*). A randomized complete block design with five replicates per treatment was used. The pre-seeding treatment BUSAN at 467 L/ha rate was applied on 6 June using a 2 meter wide custom fumigator with 14 John Blue fumigant shanks spaced 17 cm apart, applying the product 25 cm below the soil surface. The BUSAN was immediately sealed into the soil with a roller attached to the fumigator.
Treatments at seeding were: EXP#019-01 at 5 g/ha, MAJESTENE at 20 L/ha, MOVENTO at 365 mL/ha, PIC PLUS at 54 L/ha, SALIBRO at 4.48 L/ha and VYDATE at 9.3 L/ha. PIC PLUS was applied 25 cm below the carrot hills using shanks attached directly to the bed shaper of the carrot seeder. All other treatments were applied to the soil surface, at a rate of 300 L/ha, using TeeJet 8003 flat fan nozzles mounted on the front of the carrot bedder/seeder. Two additional drench applications of all nematicide treatments (EXP#019-01, MAJESTENE, MOVENTO, SALIBRO and VYDATE) at 400 mL/m were applied directly over the carrot beds using watering containers two and four weeks after seeding (WAS). Carrots, cv. Cellobunch, were direct seeded in all treatments at 65 seeds/m on raised beds on 12 June. Each experimental unit consisted of three rows, 66 cm apart and 11 m in length. An untreated check was also included. On 10 June (pre-plant) and 26 June (post-treatment), ten soil cores were taken from each replicate using a 25 cm long soil probe to create one soil sample. Pre-plant and post-treatment samples underwent nematode extractions at the University of Guelph Muck Crops Research Station using the Baermann pan method for juvenile nematodes.
A harvest sample of carrots from two 1.5 m sections of row were harvested by hand on 23 October and placed in cold storage until assessment on 31 November. Carrot samples were assessed for nematode damage (stunting and forking) and sorted into the following classes: 0 = no galling or forking (healthy); 1 = very minor stunting or forking with no noticeable cysts; 2 = minor stunting and forking with no noticeable cysts; 3 = moderate stunting and forking with visible cysts; 4 = moderate to severe stunting and forking with visible cysts; 5 = very severe stunting with many visible cysts. Marketable yield was also determined from the harvest samples. Carrots in classes 0 to 2 were considered to be marketable. The damage severity index (DSI) was determined using the following equation:

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

Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C), October (9.4°C) and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C, August 20.2°C, September 16.4°C and October 9.7°C. Monthly rainfall was above the 10-year average for October (106 mm), average for May (77 mm), September (62 mm), and below average for

June (84 mm), July (42 mm) and August (46 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm, August 80 mm, September 61 mm and October 74 mm.
Data were analyzed using the General Analysis of Variance function of the Linear Analysis section of Statistix V.10. Means separation was obtained using Tukey's test with $P = 0.05$ level of significance.

RESULTS: Data are presented in Tables 1 and 2.

CONCLUSION: Carrot cyst nematode damage was low throughout the trial. There were no significant differences between the nematicide treatments and the untreated check for carrot marketability and carrot cyst nematode damage factors. In addition, there were no differences in carrot cyst nematode populations before and after application among the treatments. However, trends indicate that MOVENTO and SALIBRO may have potential in managing carrot cyst nematode in the field. The significantly lower percent of marketable carrots treated with BUSAN compared to the untreated carrots may be due to phytotoxicity of the fumigant or non-target effects that suppress beneficial nematodes or other microorganisms.

Table 1. Yield data, nematode damage incidence and severity (DSI) for carrots, cv. Cellobunch, grown in soil treated with fumigants and nematicides in the Holland Marsh, Ontario, 2019.

Treatment	% Marketable Carrots	Marketable Yield (t/ha)	Nematode Damage Incidence (%)	DSI[1]
MOVENTO	91.4 a[2]	56.6 ns[3]	13.0 a	7.1 a
SALIBRO	91.3 a	56.0	14.4 a	7.7 a
VYDATE	89.9 a	47.2	17.9 ab	9.5 ab
Untreated	88.9 a	44.9	18.7 ab	9.8 ab
MAJESTENE	88.8 a	49.9	15.9 ab	9.3 a
PIC PLUS	88.5 a	55.4	17.5 ab	9.5 ab
EXP#019-01	85.2 ab	41.7	18.1 ab	11.5 ab
BUSAN	81.5 b	46.4	23.3 b	14.4 b

[1] DSI was calculated using the following equation:

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

[2] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Tukey's test
[3] ns indicates that no significant differences were found among the treatments at $P = 0.05$, Tukey's test

Table 2. Carrot cyst nematode soil counts (juveniles/kg of soil) and reproduction ratio from carrot soil before (pre-plant) and after (post-treatment) treatment with fumigants and nematicides in the Holland Marsh, Ontario, 2019.

Treatment	Carrot Cyst Nematode Counts (juveniles/kg soil)		Reproduction Ratio[1]
	Pre-plant (10 June)	Post-treatment (26 June)	
VYDATE	2648 ns[2]	696 ns	-0.5 ns
EXP#019-01	1376	480	-0.3
MAJESTENE	808	456	0.8
BUSAN	600	136	-0.8
Untreated	528	432	-0.1
SALIBRO	512	648	0.4
MOVENTO	272	232	1.7
PIC PLUS	184	240	0.6

[1] Reproduction ratio = (final population – initial population)/initial population
[2] ns indicates no significant differences were found among the treatments at $P = 0.05$, Tukey's test

Funding for this project was provided by the Ontario Agri-Food Innovation Alliance, the Bradford Cooperative Storage Ltd and the Fresh Vegetable Growers of Ontario.

CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang.)
PEST: Carrot cyst nematode, (*Heterodera carotae* Jones)

AUTHORS: BLAUEL T[1], SIMON P[2], VANDER KOOI K[1] & MCDONALD MR[1]
[1]University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station
[2]USDA- ARS, Madison, WI, USA

TITLE: SCREENING OF ROOT-KNOT NEMATODE RESISTANT CARROT LINES FOR SUSCEPTIBILITY TO CARROT CYST NEMATODE, 2019

MATERIALS: eight USDA experimental carrot breeding lines and the commercial cultivar Cellobunch

METHODS: Eight root-knot nematode resistant carrot lines from the United States Department of Agriculture (USDA) carrot breeding program were assessed along with the commercial cultivar 'Cellobunch' in both high organic matter (muck) soil and sand. Tall narrow pots (conetainers) were used to grow each individual carrot. The trials were arranged in a randomized complete block design with five replications and 14 conetainers per replicate for each carrot line. Sand was inoculated with carrot cyst nematode (CCN) eggs and homogenized with a cement mixer to produce 150 eggs per conetainer before seeding. Muck soil was naturally infested with approximately 22 CCN juveniles and 111 cysts per conetainer. On 25 January, carrots were seeded with 2 seeds per conetainer and were later thinned to one. Carrots were grown in the greenhouse for ~14 weeks. On 3 May, carrots were harvested, assessed for nematode damage (stunting and forking) and sorted into the following classes using the Becker rating scale for root-knot nematode damage on carrots, adapted for CCN: 0 = no cysts on roots; 1 = few small cysts difficult to find; 2 = small cysts only but clearly visible, main root clean; 3 = some larger cysts visible, but main root clean; 4 = larger cysts predominate but main root clean; 5 = 50% of roots having cysts, stunting/forking on parts of main root system; 6 = stunting/forking on some of main roots; 7 = majority of main root stunted/forked; 8 = root stunted/forked, few clean roots visible; 9 = root severely stunted/forked, plant usually dying; 10 = no root, plant dead. Percent marketable yield was recorded at harvest and a 4 or higher on the rating scale was considered non-marketable. The damage severity index (DSI) was determined using the following equation:

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

Data were analyzed using the General Analysis of Variance and Correlations functions of the Linear Analysis section of Statistix V.10. Means separation was obtained using Fisher's LSD test with $P = 0.05$ level of significance.

RESULTS: Data are presented in Tables 1 and 2.

CONCLUSIONS: The commercial carrot cultivar Cellobunch had the highest percentage of marketable carrots followed by the USDA lines N111041 4002B, Nb8503, 129156-2 HMXSFF, Nb3999 and Ns5154 in the muck soil trial. In addition, the cultivar and lines Cellobunch, N111041 4002B, Nb8503, 129156-2 HMXSFF and Ns5154 had lower nematode damage severity in the muck soil trial. Similar results were found in the sand trial where carrot lines PDxPI 326011, Mb6526B and S304-1 had lower percent marketable yield and higher nematode damage severity compared to the cultivar Cellobunch. No significant differences were found for nematode damage incidence in either of the trials. These results indicate that the commercial carrot cultivar Cellobunch may be less susceptible to carrot cyst nematode parasitism compared to other carrot lines or cultivars.

Table 1. Percent of marketable carrots, nematode damage incidence and severity of eight USDA carrot lines and the commercial cultivar 'Cellobunch' grown in carrot cyst nematode infested muck soil.

Carrot Line	% Marketable Carrots	Nematode Damage Incidence (%)	DSI[3]
Cellobunch	89.2 a[1]	84.5 ns[2]	19.5 a
N111041 4002B	86.7 ab	84.4	20.2 a
Nb8503	80.2 ab	81.9	21.6 a
129156-2 HMXSFF	75.7 ab	83.3	23.4 a
Nb3999	73.4 ab	83.3	25.8 ab
Ns5154	71.0 ab	82.1	25.0 a
PDxPI 326011	69.6 b	80.9	26.3 ab
S304-1 Homs	49.9 c	81.9	32.1 bc
Mb6526B	40.1 c	83.3	36.0 c

[1] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher's LSD test
[2] ns indicates that no significant differences were found among the treatments at $P = 0.05$, Fisher's LSD test
[3] DSI was calculated using the following equation:

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

Table 2. Percent of marketable carrots, nematode damage incidence and severity of eight USDA carrot lines and the commercial cultivar 'Cellobunch' grown in sand inoculated with carrot cyst nematode.

Carrot Line	% Marketable Carrots	Nematode Damage Incidence (%)	DSI[3]
Cellobunch	96.2 a[1]	80.9 ns[2]	15.1 a
Ns5154	89.7 ab	79.4	15.8 a
129156-2 HMXSFF	87.1 abc	81.5	17.1 ab
Nb3999	86.2 abc	81.0	19.0 abc
Nb8503	85.2 abc	79.5	18.0 abc
N111041 4002B	85.0 abc	69.1	17.4 ab
PDxPI 326011	76.3 bcd	76.4	22.1 bcd
Mb6526B	74.7 cd	81.9	23.1 cd
S304-1 Homs	62.6 d	82.1	26.1 d

[1] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher's LSD test
[2] ns indicates that no significant differences were found among the treatments at $P = 0.05$, Fisher's LSD test
[3] DSI was calculated using the following equation:

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

Funding for this project was provided by the Plant Production Systems of the Ontario Agri-Food Innovation Alliance, the Bradford Cooperative Storage Ltd and the Fresh Vegetable Growers of Ontario.

CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang.), cv. Cellobunch
PEST: Carrot cyst nematode (*Heterodera carotae* Jones)

AUTHORS: VAN DYK D[1], BLAUEL T[2], VANDER KOOI K[2], and MCDONALD MR[2]
[1] University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station
[2] Ontario Ministry of Agriculture, Food and Rural Affairs, Guelph, ON, Canada

TITLE: EVALUATION OF SEED TREATMENTS TO MANAGE CARROT CYST NEMATODE PARASITISM IN CARROTS, 2019

MATERIALS: PROLIANT (gibberellic acid (GA3) 40%), ILEVO (48.4%), MOVENTO (spirotetramat 240 g/L)

METHODS: The trial was conducted in a commercial field known to be infested with carrot cyst nematode (*Heterodera carotae*) in the Holland/Bradford Marsh, Ontario. A randomized complete block design with five replicates per treatment was used. The following products were treated directly on carrot seed, cv. Cellobunch, using a tabletop laboratory seed treater: MOVENTO LOW at 0.053 mg a.i./seed, MOVENTO HIGH at 0.089 mg a.i./seed, ILEVO LOW at 0.0175 mg a.i./seed, ILEVO MID at 0.032 mg a.i./seed, ILEVO HIGH at 0.064 mg a.i./seed, PROLIANT LOW at 0.000025 mg a.i./seed and PROLIANT HIGH at 0.00025 mg a.i./seed. Carrots were direct seeded in all treatments using a push cone seeder at 70 seeds/m on raised beds on 18 June. Each experimental unit consisted of one row, 66 cm apart and 6 m in length. An untreated check was also included.
A harvest sample of carrots from one 1.5 m section of row were harvested by hand on 23 October and placed in cold storage until assessment on 15 November. Carrot samples were assessed for nematode damage (stunting and forking) and sorted into the following classes: 0 = no galling or forking (healthy); 1 = very minor stunting or forking with no noticeable cysts; 2 = minor stunting and forking with no noticeable cysts; 3 = moderate stunting and forking with visible cysts; 4 = moderate to severe stunting and forking with visible cysts; 5 = very severe stunting with many visible cysts. Marketable yield was also determined from the harvest samples. Carrots in classes 0 to 2 were considered to be marketable. The damage severity index (DSI) was determined using the following equation:

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

Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C), October (9.4°C) and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C, August 20.2°C, September 16.4°C and October 9.7°C. Monthly rainfall was above the 10-year average for October (106 mm), average for May (77 mm), September (62 mm), and below average for June (84 mm), July (42 mm) and August (46 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm, August 80 mm, September 61 mm and October 74 mm.
Data were analyzed using the General Analysis of Variance function of the Linear Analysis section of Statistix V.10. Means separation was obtained using Tukey's test with $P = 0.05$ level of significance.

RESULTS: Data are presented in Table 1.

CONCLUSION: There were no significant differences among the treatments when assessing for yield and carrot cyst nematode damage. Overall, carrot cyst nematode damage was very low throughout the trial, which had a significant impact on comparisons among treatments.

Table 1. Harvest assessment for carrot seed, cv. Cellobunch, treated with various products to manage carrot cyst nematode parasitism in naturally infested muck soil in the Holland Marsh, Ontario, 2019.

Treatment	Yield (t/ha)	% Marketable	Nematode Damage Incidence (%)	DSI[1]
PROLIANT LOW	75.9 ns[2]	94.2 ns	12.4 ns	6.0 ns
MOVENTO HIGH	73.7	94.3	12.7	5.7
ILEVO HIGH	70.8	94.1	11.9	5.7
Untreated	66.8	93.3	15.5	7.3
MOVENTO LOW	64.4	92.8	16.1	7.1
ILEVO MID	62.6	95.3	12.9	4.9
ILEVO LOW	58.8	91.4	14.0	7.5
PROLIANT HIGH	58.6	91.0	13.8	8.0

[1] DSI was calculated using the following equation:

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

[2] ns indicates no significant differences were found among the treatments at $P = 0.05$, Tukey's test

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

AUTHORS: VANDER KOOI K[1], VAN DYK D[2], BLAUEL T[1] & MCDONALD MR[1]
[1]University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station
[2]Ontario Ministry of Agriculture, Food and Rural Affairs, Guelph, On, Canada

TITLE: FIELD EVALUATIONS OF SALIBRO FOR NEMATODE CONTROL IN CARROTS, 2019

MATERIALS: SALIBRO (fluazaindolizine 500 g/L), NIMITZ (fluensulfone 480 g/L)

METHODS: The trial was conducted in a commercial field with a history of nematode damage to carrots near Lakeshore, Ontario. Soil characteristics at the site were as follows: loamy sand (sand 77%, silt 19%, clay 4%), pH = 7.8, organic matter = 2.5% and CEC (mEQ 100g) = 17.0. A randomized complete block design with five replicates per treatment was used. Pre-application soil samples for northern root-knot nematode population assessment were taken from each plot before nematicide application on 7 June. Treatments at seeding (7 June) were: SALIBRO at 1.12, 2.24, 3.36 and 4.48 L/ha and NIMITZ at 4 L/ha applied 40 cm from the surface of each experimental unit using a tractor mounted electric pump plot sprayer equipped with five TeeJet 8003 (50 screen size) flat fan nozzles. Nozzle output during application was 0.75 L/min/nozzle at 138 kPa while traveling 3.2 km/h for an overall spray volume of 300 L/ha. During application, wind speeds were 15 km/h NNE, relative humidity was 50% and air temperature was 25°C with clear skies and no dew. Beds were formed at seeding with a power bedder which incorporated the products 23 cm deep throughout the bed following application. The trial was direct seeded with carrots, cv. Belgrado, at 80 seeds/m on 7 June. Each experimental unit consisted of three rows, 70 cm apart and 11 m in length. An untreated check was also included. Stand counts, phytotoxicity (percentage affected per plot) ratings and plant vigor (0-10 rating scale; where 1 = poorest growth and 10 = best growth) as a percent of the untreated check were assessed on 4 and 19 July. Plant vigor as a percent of the untreated check was calculated using the following equation:

$$\text{Vigor as a \% of the Untreated} = \frac{(\text{treatment vigor rating} - \text{untreated vigor rating})}{\text{untreated vigor rating}} \times 100$$

Twenty-five carrots per plot were sampled on 8 August to assess for midseason nematode damage. A harvest sample of carrots from two 1.0 m sections per plot were pulled by hand on 9 September. Carrot samples were assessed on 11 September for nematode damage (stunting and forking) and sorted into the following classes using the Becker rating scale for root-knot nematode damage on carrots: 0 = no knots on roots; 1 = few small knots difficult to find; 2 = small knots only but clearly visible, main roots clean; 3 = some larger knots visible but main roots clean; 4 = larger knots predominate but main roots clean; 5 = 50% of roots knotted, knotting on parts of main root system; 6 = knotting on some of main roots; 7 = majority of main roots knotted; 8 = all main roots knotted, few clean roots visible; 9 = all roots severely knotted, plant usually dying; 10 = all roots severely knotted, no root. A four or higher on the rating scale was considered to be a non-marketable carrot. Marketable yield was also determined from the harvest samples. The damage severity index (DSI) was determined using the following equation:

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

Average air temperature at the trial site for each month was June (21.0°C), July (24.6°C), August (22.1°C) and September (18.4°C). Average relative humidity for each month was June (70.3%), July (68.5%), August (73.7%) and September (59.3%). Total rainfall for each month was June (12.8mm), July (81.8mm), August (49.6mm) and September (17mm). Soil temperature for each month was June (22.5°C), July (26.4°C), August (22.6°C) and September (19.3°C)
Data were analyzed using the General Analysis of Variance function of the Linear Analysis section of Statistix V.10. Means separation was obtained using Tukey's test with $P = 0.05$ level of significance.

RESULTS: Data are presented in Tables 1, 2 and 3.

CONCLUSIONS: Carrot emergence was significantly higher in the SALIBRO 4.48 L/ha treatment compared to the untreated check during the first (5 June) assessment (Table 1). There was no phytotoxicity observed. For the 8 weeks after seeding assessment, the percentage of marketable carrots treated with SALIBRO 3.36 L/ha and SALIBRO 1.12 L/ha were higher than carrots treated with NIMITZ 4 L/ha (Table 2). Nematode damage severity was also lower for carrots treated with SALIBRO 3.36 L/ha and SALIBRO 2.24 L/ha compared to the NIMITZ 4 L/ha treatment. At harvest, the SALIBRO 4.48 L/ha and SALIBRO 2.24 L/ha treatments had significantly higher marketable carrot yields by weight than the untreated check (Table 3). Carrots treated with SALIBRO at 2.24, 3.36 and 4.48 L/ha also had a higher percentage of marketable carrots per plot compared to the untreated check. Nematode damage incidence and damage severity (DSI) in all SALIBRO treatments was lower than in the untreated check. Northern root-knot nematodes were present in the soil of all treatments; however, populations varied throughout the trial area. Overall, damage to carrots caused by root knot nematode was moderate in the trial.

Table 1. Emergence, vigor (% of the untreated check) and phytotoxicity (phyto) ratings at various assessment periods after nematicide application for carrots, cv. Belgrado, grown in Lakeshore, Ontario, 2019.

Treatment	4 July			19 July		
	Emergence (per meter)	Vigor (% of untreated)	Phyto	Emergence (per meter)	Vigor (% of untreated)	Phyto
SALIBRO 4.48L	106.4 a[1]	6.9 a	0 ns[2]	102.4 ns	22.2 ns	0 ns
SALIBRO 2.24L	93.0 ab	3.0 ab	0	89.6	22.9	0
SALIBRO 1.12L	89.0 ab	0.5 ab	0	92.0	7.9	0
NIMITZ 4L	85.6 ab	-4.2 ab	0	89.0	7.0	0
SALIBRO 3.36L	83.8 b	-6.2 b	0	86.6	6.3	0
Untreated	81.0 b	0.0 ab	0	76.6	0.0	0

[1] Numbers in the same column followed by the same letter are not significantly different at $P = 0.05$, Tukey's test
[2] ns indicates that no significant differences were found among the treatments at $P = 0.05$, Tukey's test

Table 2. Average root-knot nematode soil counts before (pre) and after (post) nematicide application, percent marketable carrots, percent nematode damage and damage severity index of carrots, cv. Belgrado, grown for eight weeks in Lakeshore, Ontario, 2019.

Treatment	Root-knot Nematode Population (100 cc soil)			% Marketable Carrots	Nematode Damage Incidence (%)	DSI[2]
	Pre	Post	Reproduction Ratio[1]			
SALIBRO 3.36L	5.3 ns[3]	0.9 ns	-0.8 ns	93.8 a[4]	38.6 ns	8.3 a
SALIBRO 1.12L	6.7	7.1	1.9	93.0 a	45.0	10.5 ab
SALIBRO 4.48L	6.2	2.7	-0.3	92.1 ab	38.0	9.6 ab
SALIBRO 2.24L	3.2	3.6	1.6	91.4 ab	33.0	8.9 a
Untreated	4.9	2.7	-0.5	84.8 ab	40.0	12.6 ab
NIMITZ 4L	7.1	2.7	-0.7	81.9 b	41.0	14.7 b

[1] Reproduction ratio = (final population - initial population)/initial population

[2] DSI was calculated using the following equation:

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

[3] ns indicates that no significant differences were found among the treatments at $P = 0.05$, Tukey's LSD test

[4] Numbers in the same column followed by the same letter are not significantly different at $P = 0.05$, Tukey's test

Table 3. Marketable yield, percent marketable, total yield, nematode damage incidence and damage severity index (DSI) for carrots, cv. Belgrado, at harvest grown in root-knot nematode infested soil treated with nematicides in Lakeshore, Ontario, 2019.

Treatment	Marketable Weight (t/ha)	# of Marketable Carrots/Plot	% Marketable	Nematode Damage Incidence (%)	DSI[1]
SALIBRO 4.48L	26.5 a[2]	759 a	82.1 a	40.1 a	13.9 a
SALIBRO 2.24L	25.5 a	704 a	84.1 a	41.3 a	13.8 a
SALIBRO 3.36L	24.8 ab	614 ab	83.1 a	36.9 a	13.3 a
SALIBRO 1.12L	24.5 ab	683 a	80.1 ab	42.9 a	15.1 a
NIMITZ 4L	21.0 ab	505 b	77.8 ab	48.0 ab	17.5 ab
Untreated	19.0 b	460 b	68.7 b	67.8 b	24.4 b

[1] DSI was calculated using the following equation:

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

[2] Numbers in the same column followed by the same letter are not significantly different at $P = 0.05$, Tukey's test

Funding for this project was provided by Corteva Agriscience.

CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang.), cv. Enterprise
PESTS: Alternaria leaf blight (*Alternaria dauci* (Kühn) Groves & Skolko)
Cercospora leaf blight (*Cercospora carotae* (Pass.) Solheim))

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

TITLE: EVALUATION OF ACADIAN SEAPLANTS PRODUCTS FOR LEAF BLIGHT CONTROL IN CARROTS, 2019

MATERIALS: PROTEA (experimental), STELLA MARIS (aquatic plant extract *Ascophyllum nodosum*), QUADRIS TOP (azoxystrobin 200 g/L, difenoconazole 125 g/L), FONTELIS (penthiopyrad 200 g/L)

METHODS: The trial was conducted on organic soil (pH ≈ 7.2, organic matter ≈ 58.7 %) near the Muck Crops Research Station, Holland Marsh, Ontario. Carrots, cv. Enterprise, were direct seeded (82 seeds/m) into raised beds using a Stanhay precision seeder on 24 May. A randomized complete block design with four replicates per treatment was used. Each experimental unit consisted of two rows, 86 cm apart, and 5 m in length. Treatments were drench applications of STELLA MARIS at 4 L/ha followed by various foliar applications of PROTEA in combination with standard fungicides QUADRIS TOP or FONTELIS applied at standard or extended interval timings as described in Table 1. An untreated check was also included. Drench applications (7, 27 June) were applied to the base of the plants using a CO_2 backpack sprayer equipped with a single Syngenta 65-06 vegetable nozzle calibrated to deliver 1000 L/ha. Foliar sprays were applied using a CO_2 backpack sprayer equipped with four TeeJet 8002 VS fan nozzles spaced 40 cm apart and calibrated to deliver 500 L/ha at 275 kPa. On 1 October, the leaves of ten carrots per replicate were removed for a blight assessment. Green leaves were visually assessed for leaf blight, not differentiating between Alternaria and Cercospora, and sorted into the following classes: 0=0%, 1 = 1-5%, 2 = 6-10%, 3= 11-25%, 4= 265-50%, 5= 51-75%, 6 >75% leaf blight. Dead leaves (completely brown) were counted separately. The disease severity index (DSI) was determined using the following formula:

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

On 25 October, carrots in two 1.16 m sections of row were pulled, topped and placed in cold storage for a yield sample. On 11 November, yield samples were graded by quality and size to determine yield. Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C), October (9.4°C) and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C, August 20.2°C, September 16.4°C and October 9.7°C. Monthly rainfall was above the 10-year average for October (106 mm), average for May (77 mm), September (62 mm), and below average for June (84), July (42 mm) and August (46 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm, August 80 mm, September 61 mm and October 74 mm. Data were analyzed using the General Analysis of Variance with Statistix V.10. Means separation was obtained using Fisher's Protected LSD Test at P = 0.05 level of significance.

RESULTS: as presented in Tables 2 & 3

CONCLUSIONS: Leaf blight incidence was moderate in this trial, with low severity. Significant differences in leaf blight incidence, severity and the percentage of dead leaves were found among the treatments (Table 2). Treatments that included the standard fungicide applied weekly, biweekly, in combination with PROTEA or used alone had lower leaf blight incidence (10-13%) than carrots treated with PROTEA every 7 days or untreated carrots (48 & 51% respectively). Treatments that included the standard fungicide had lower leaf blight severity compared to carrots treated with PROTEA weekly or untreated carrots; however, PROTEA applied weekly significantly reduced leaf blight severity compared to untreated carrots. No significant differences in yield, percent marketable or size distribution were found among the treatments (Table 3).

Table 1. Methods and dates of product applications for carrots, cv. Enterprise, treated with Acadian Seaplants products and grown near Muck Crops Research Station, Holland Marsh, Ontario, 2019.

#	Treatment[1]	7 Jun[2]	27 Jun[3]	29 Jul	8 Aug	19 Aug	26 Aug	3 Sep	12 Sep	20 Sep
1	Stn fungicide	–	–	QT	F	QT	F	QT	F	QT
2	Ext Interval Stnd fungicide	–	–	QT	-	F	-	QT	-	F
3	Ext Interval Std + **tank mix** PROTEA	SM drench	SM drench	QT + PROTEA	–	F + PROTEA	–	QT + PROTEA	–	F + PROTEA
4	Stnd fungicide **alternated** with PROTEA	SM drench	SM drench	QT	PROTEA	F	PROTEA	QT	PROTEA	F
5	PROTEA	SM drench	SM drench	PROTEA	PROTEA	PROTEA	PROTEA	PROTEA	PROTEA	PROTEA
6	check	–	–	–	–	–	–	–	–	–

[1] QT = QUADRIS TOP at 1 L/ha, F = FONTELIS at 2.25 L/ha, PROTEA at 4 L/ha using spray volume: 500 L/ha at 500 L/ha. SM = STELLA MARIS at 4 L/ha using drench volume: 1000 L/ha.
[2] Drench applied at 14 DAS (days after seeding (24 May))
[3] Drench applied 20 days after first drench

Table 2. Leaf blight incidence, severity and percentage of dead leaves for carrots, cv. Enterprise, treated with Acadian Seaplants products and grown near the Muck Crops Research Station, Holland Marsh, Ontario, 2019.

#[1]	Treatment	Leaf Blight Incidence (%)	DSI[2]	% Dead Leaves[3]
2	Extended interval fungicide	10.0 a[4]	2.6 a	1.5 a
4	Weekly alternate fungicide or PROTEA	10.4 a	2.1 a	3.4 ab
1	Weekly fungicide	10.6 a	2.3 a	2.9 ab
3	Extended interval fungicide + PROTEA (tank mix)	12.9 a	2.4 a	2.2 a
5	PROTEA weekly	48.3 b	8.8 b	5.6 bc
6	check	51.2 b	10.9 c	7.1 c

[1] Refer to Table 1 for treatment details.
[2] Leaves of 10 plants were sorted into the following classes: 0=0%, 1 = 1-5%, 2 = 6-10%, 3= 11-24%, 4= 25-50%, 5= 51-75%, 6 >75% DSI was calculated with the following formula:

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

[3] Dead leaves were completely brown, not assessed for leaf blight and counted separately.
[4] Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD test.

Table 3. Yield and size distribution of carrots, cv. Enterprise, treated with Acadian Seaplants products and grown near the Muck Crops Research Station, Holland Marsh, Ontario, 2019.

#	Treatment	Yield (t/ha)	Size Distribution (%)			% Mkb
			Jumbo (> 4.4 cm)	Medium (2.0-4.4 cm)	Cull[1]	
1	Weekly fungicide	56.6 ns[2]	37.7 ns	43.7 ns	18.6 ns	81.4 ns
2	Ext interval fungicide	59.9	40.3	39.5	20.1	79.9
3	Ext interval fungicide + PROTEA (tank mix)	62.0	35.1	46.7	18.2	81.8
4	Weekly alternate fungicide or PROTEA	64.7	36.8	46.4	16.8	83.1
5	PROTEA weekly	64.8	33.9	52.9	13.2	86.8
6	Check	67.3	36.9	51.8	11.4	88.6

[1] cull carrots include carrots < 2.0 cm, forked & split
[2] ns= no significant differences were found among the treatments

Funding for this project was provided by Acadian Seaplants Limited, Dartmouth, NS and the Plant Production Systems of the Ontario Agri-Food Innovation Alliance.

CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang.), cv. Enterprise
PESTS: Alternaria leaf blight (*Alternaria dauci* (Kühn) Groves & Skolko)
Cercospora leaf blight (*Cercospora carotae* (Pass.) Solheim))

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

TITLE: EVALUATION OF VARIOUS PRODUCTS FOR CONTROL OF LEAF BLIGHT OF CARROTS, 2019

MATERIALS: QUADRIS TOP (azoxystrobin 200 g/L, difenoconazole 125 g/L), T-77 (*Trichoderma atroviride*)

METHODS: The trial was conducted on organic soil (pH ≈ 7.0, organic matter ≈ 65.8%) near the Muck Crops Research Station, Holland Marsh, Ontario. Carrots, cv. Enterprise, were direct seeded (82 seeds/m) into raised beds using a Stanhay precision seeder on 24 May. A randomized complete block design with four replicates per treatment was used. Each experimental unit consisted of four rows, 86 cm apart, and 5 m in length. Treatments were: QUADRIS TOP at 1.0 L/ha and T-77 at 250 g/ha and 500 g/ha. An untreated check was also included. Treatments were applied on 15, 23, 30 August and 12, 20 September using a tractor mounted sprayer fitted with AI TeeJet Air Induction Even Fan spray nozzles (AI9503 EVS) at 620 kPa calibrated to deliver 500 L/ha. On 8 October, the leaves were removed from ten carrots per replicate chosen from the inside two rows. Leaves were visually assessed for leaf blight, not differentiating between Alternaria and Cercospora, and sorted into the following classes: 0 = no disease, 1 = 1-5%, 2 = 6-10%, 3 = 11-25%, 4 = 26-50%, 5 = 51-75% and 6 = >75% leaf blight per leaf. Dead leaves were counted separately. The disease severity index (DSI) was calculated using the following formula:

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

On 18 October carrots in two 1.16 m sections of row were harvested and placed in cold storage for a yield sample. On 7 November, yield samples were graded by quality and size into four categories: > 4.4 cm (Jumbo), 1.9 - 4.4 cm (packers), and culls < 1.9 cm including forked and split carrots. Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C), October (9.4°C) and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C, August 20.2°C, September 16.4°C and October 9.7°C. Monthly rainfall was above the 10-year average for October (106 mm), average for May (77 mm), September (62 mm), and below average for June (84 mm), July (42 mm) and August (46 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm, August 80 mm, September 61 mm and October 74 mm. Data were analyzed using the General Analysis of Variance with Statistix V.10. Means separation was obtained using Fisher's Protected LSD Test at P = 0.05 level of significance.

RESULTS & DISCUSSION: as presented in Tables 1 & 2

CONCLUSIONS: Significant differences in leaf blight incidence and severity were found among the treatments (Table 1). Carrots treated with foliar applications of QUADRIS TOP had significantly less leaf blight incidence than untreated carrots. Carrots sprayed with QUADRIS TOP and T-77 at 250 g/ha had significantly lower leaf blight severity compared to the untreated carrots.
No significant differences in marketable yield (t/ha) were found among the treatments (Table 2).

Table 1. Leaf blight incidence and severity of carrots, cv. Enterprise, treated with various products and grown near the Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Treatment	Leaf Blight Incidence (%)[1]	DSI[1,2]	% Dead Leaves
QUADRIS TOP	32.3 a[3]	6.4 a	2.5 a
T-77 at 500 g/ha	57.0 b	16.2 bc	6.0 ab
T-77 at 250 g/ha	58.1 b	14.7 b	5.2 b
Check	69.2 b	21.0 c	9.1 b

[1] Leaves of 10 plants sorted into the following classes: 0 = no disease, 1 = 1-5%, 2 = 6-10%, 3 = 11-25%, 4 = 26-50%, 5 = 51-75% and 6 = >75% leaf blight per leaf on 27 September

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

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

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

Table 2. Yield and size distribution of carrots, cv. Enterprise, treated with various products and grown near the Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Treatment	Yield (t/ha)	% Jumbo (> 4.4 cm)	% Medium (2.0-4.4 cm)	% Cull[1]	Harvested carrots/m
QUADRIS TOP	70.8 ns[2]	51.1 ns	26.5 ns	22.4 ns	39.9 ns
Check	70.1	45.6	22.7	31.7	37.5
T-77 at 500 g/ha	69.6	44.9	23.5	13.4	33.6
T-77 at 250 g/ha	63.8	48.1	18.4	8.4	32.4

[1] cull category includes small (<2.0 cm), forked & split carrots

[2] ns= no significant differences were found among the treatments

Funding for this project was provided by Sylvar Technologies Inc. and the Plant Production Systems of the Ontario Agri-Food Innovation Alliance.

CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang.), cv. Cellobunch
PESTS: Cavity spot, stunting, forking (*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: VAN DYK D[2], BLAUEL T[1], VANDER KOOI K[1], and MCDONALD MR[1]
[1] Ontario Ministry of Agriculture, Food and Rural Affairs, Guelph, ON, Canada
[2] University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: EVALUATION OF VARIOUS FUNGICIDES AS SEED AND SOIL APPLICATIONS TO CONTROL PYTHIUM DISEASES IN CARROTS, 2019

MATERIALS: ORONDIS GOLD A (oxathiapiprolin 35 g/L), ORONDIS GOLD B (metalaxyl-M & S-isomer 480 g/L), PICARBUTRAZOX 10 SC (picarbutrazox 100 g/L), RIDOMIL 1G (metalaxyl-M & S-isomer 1%), RHIZOVITAL 42 (*Bacillus amyloliquefaciens*), VAYANTIS (picarbutrazox 400 g/L)

RATIONALE: The Pythium species found in the Holland Marsh may be resistant to RIDOMIL. New products currently used in soybean and potato production may reduce damage from Pythium in carrot production. ORONDIS GOLD (metalaxyl-M and oxathiapiprolin) is a fungicide applied in-furrow to potatoes. PICARBUTRAZOX is available as a foliar formulation and as a new seed treatment called VAYANTIS. RHIZOVITAL 42 (*Bacillus amyloliquefaciens*) is a biological agent for control of soilborne diseases.

METHODS: The trial was conducted at the Muck Crops Research Station (MCRS) in muck soil that was naturally infested with *Pythium* spp. A randomized complete block design with four replicates per treatment was used. Each experimental unit consisted of one row, 66 cm apart and 6 m in length. Seed treatments were: VAYANTIS at 0.5, 1.0 and 2.5 g a.i./100 kg seed (cv. Cellobunch), applied using a tabletop laboratory seed treater. The following treatments were applied in a directed application over the row after seeding: ORONDIS GOLD A at 2.8 and 5.6 L/ha + ORONDIS GOLD B at 650 mL/ha, PICARBUTRAZOX 10 SC at 1.0 and 3.0 L/ha, RIDOMIL 1G at 25 kg/ha and RHIZOVITAL 42 at 0.5 L/ha. These treatments were applied using a CO_2 backpack sprayer fitted with a single TeeJet XR8004 nozzle in a water volume of 250 L/ha. An untreated check was also included. Carrots, cv. Cellobunch, in all treatments were direct seeded at 70 seeds/m onto raised beds using a push cone seeder on 17 June. For a mid-season assessment, 25 carrots were harvested and assessed on 5 September. 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 width). The six classes were: 0 = no disease, 1 = very light (< 1 mm), 2 = light (1-2 mm), 3 = medium (3-5 mm), 4 = heavy (6-10 mm), and 5 = very heavy (> 10 mm). For a harvest sample, carrots from a 1.5 m section of row were harvested by hand on 22 October and placed in cold storage. On 25 November, carrots were assessed and sorted into classes as described for the mid-season assessment. The disease severity index (DSI) was determined using the above classes and the following equation:

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

Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C), October (9.4°C) and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C, August 20.2°C, September 16.4°C and October 9.7°C. Monthly rainfall was above the 10-year average for October (106 mm), average for May (77 mm), September (62 mm), and below average for June (84 mm), July (42 mm) and August (46 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm, August 80 mm, September 61 mm and October 74 mm. Data were analyzed using the General Analysis of

Variance function of the Linear Analysis section of Statistix V.10. Means separation was obtained using Tukey's test with $P = 0.05$ level of significance.

RESULTS: Data are presented in Table 1.

CONCLUSION: There were no significant differences in *Pythium* spp. diseases found among the treatments at the mid-season and harvest assessments. However, the fungicide treatments resulted in numerically lower cavity spot incidence and severity compared to the untreated check. Overall, *Pythium* spp. damage to carrots was low throughout the trial.

Table 1. Cavity spot incidence and severity (DSI) and percent stunted and forked for carrots, cv. Cellobunch, grown in muck soil naturally infested with *Pythium* spp. at the Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Treatment	Cavity Spot Incidence (%)		Cavity Spot (DSI[1])		Stunted (%)	Forked (%)
	Mid-season[2]	Harvest[3]	Mid-season	Harvest		
PICARBUTRAZOX 10 SC 1.0	6.0 ns[4]	5.5 ns	1.4 ns	1.8 ns	2.0 ns	18.0 ns
VAYANTIS 2.5	0.0	6.0	0.0	2.0	1.0	7.0
ORONDIS GOLD 2.8	10.0	8.5	2.8	3.5	0.0	8.5
PICARBUTRAZOX 10 SC 3.0	3.0	9.0	1.0	2.9	1.0	9.5
VAYANTIS 1.0	6.0	9.0	1.6	3.4	0.5	11.0
VAYANTIS 0.5	8.0	9.5	2.0	3.2	0.0	11.0
RIDOMIL 1G	7.0	9.5	2.4	3.7	0.5	11.5
RHIZOVITAL 42	4.0	10.6	1.2	3.7	1.5	14.2
ORONDIS GOLD 5.6	4.0	11.0	1.0	4.1	4.0	21.5
Untreated	3.0	18.4	0.6	7.8	0.0	13.3

[1] DSI was calculated using the following equation:

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

[2] Mid-season assessments were conducted on a 25-carrot sample on 5 September

[3] Harvest assessments were conducted on carrots from a 1.5 m section of row on 22 October

[4] ns indicates that no significant differences were found among the treatments at P = 0.05, Tukey's test

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

TITLE: EVALUATION OF CARROT LINES FOR SUSCEPTIBILITY TO CAVITY SPOT, 2019

MATERIALS: nineteen Rijk Zwaan carrot lines

METHODS: The trial was conducted on organic soil (pH ≈ 6.5, organic matter ≈ 65.3%) naturally infested with *Pythium* spp. at the Muck Crops Research Station, Holland Marsh, Ontario. Nineteen Rijk Zwaan carrot lines were direct seeded (≈ 70 seeds/m) onto raised beds using a push cone seeder on 4 June. A randomized complete block design with four replicates per treatment was used. Each experimental unit consisted of one row, 6 m in length, spaced 66 cm apart. On 24 October, up to 100 carrots from each replicate were harvested depending on the stand of carrots in each plot, placed into cold storage, and assessed for cavity spot on 12-14 November. 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 width). The six classes were: 0 = no disease, 1 = very light (< 1 mm), 2 = light (1-2 mm), 3 = medium (3-5 mm), 4 = heavy (6-10 mm), and 5 = very heavy (> 10 mm). These classes were used to determine the disease severity index (DSI) using the following formula:

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

The percentage of marketable carrots was determined by combining the number of carrots found in classes 0, 1 and 2 for disease. Carrots with these small sized lesions are considered marketable.
Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C) and October (9.4°C). The 10-year average temperatures were: June 18.4°C, July 21.1°C, August 20.2°C, September 16.4°C and October 9.7°C. Monthly rainfall was above the 10-year average for October (106 mm), average for September (62 mm), and below average for June (84 mm), July (42 mm) and August (46 mm). The 10-year rainfall averages were: June 100 mm, July 93 mm, August 80 mm, September 61 mm and October 74 mm.
All data were analyzed using the General Analysis of Variance function of Statistics V.10. Means separation was obtained using Fisher's Protected LSD test with $P = 0.05$ level of significance.

RESULTS: as presented in Table 1

CONCLUSIONS: Cavity spot was low in the trial. The Rijk Zwaan carrot entries differed in their susceptibility to cavity spot with incidence ranging from 0.0 to 37.3%. The two purple carrots lines, RZ102 and RZ113, had a low incidence of cavity spot. These results are consistent with previous research results for purple pigmented carrots. Orange line RZ106 was the least susceptible orange carrot with cavity spot incidence of 1.2%. The most susceptible line, RZ109, had cavity spot incidence of 37.3% (Table 1). Many Rijk Zwaan orange lines had lower cavity spot incidence than the standard cultivar Cellobunch. Cavity spot severity was relatively low in many lines indicating only small sized lesions on carrot roots. All but four Rijk Zwaan carrot lines had over 95% percent marketable carrots. Results indicate differences among the lines of carrots tested.

Table 1. Cavity spot incidence and severity for various Rijk Zwaan carrot entries grown at Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Cultivar/Line Code	Colour[1]	Cavity Spot Incidence (%)	DSI[2]	% Marketable
RZ102	PUR	0.0 a[3]	0.0 a	100.0 a
RZ113	PUR	0.6 a	0.3 a	100.0 a
RZ106	OR	1.2 a	0.5 a	99.8 a
RZ101	OR	1.4 a	0.6 a	99.8 a
RZ107	OR	1.8 a	0.8 ab	99.8 a
RZ112	OR	2.3 ab	0.8 ab	99.8 a
RZ114	OR	2.8 abc	1.2 ab	99.3 ab
RZ117	OR	3.0 abc	1.5 ab	98.5 ab
RZ108	OR	3.1 abc	1.6 ab	98.4 ab
RZ119	OR	3.3 abc	1.3 ab	99.3 ab
RZ104	OR	3.4 abc	1.4 ab	99.5 a
RZ103	OR	4.8 abc	1.7 abc	99.3 ab
Cellobunch	OR	5.0 abc	2.4 abc	97.5 ab
RZ105	OR	8.6 bc	3.6 bc	97.8 ab
RZ115	OR	9.0 cd	4.5 cd	95.5 bc
RZ111	OR	15.0 de	6.5 de	95.5 bc
RZ116	OR	16.9 ef	9.1 ef	88.7 de
RZ110	OR	21.8 f	9.5 f	91.8 cd
RZ118	OR	22.3 f	10.4 f	91.5 d
RZ109	OR	37.3 g	15.7 g	86.9 e

[1] PUR = purple, OR = orange

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

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

[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 Rijk Zwaan Export B.V.

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[1], VANDER KOOI K[1] & SIMON P[2]
[1]University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station
[2]USDA/ARS, Horticulture Dept., University of Wisconsin-Madison, WI

TITLE: EVALUATION OF CARROT BREEDING LINES FOR SUSCEPTIBILITY TO CAVITY SPOT, 2019

MATERIALS: USDA experimental carrot breeding lines, commercial cultivars Cellobunch, Envy (Seminis Vegetable Seeds), Atomic Red and Purple Haze (Johnny's Select Seeds), Upper Cut, Honey Snax and Maverick (Nunhems USA) and Nairobi (Bejo Seeds Inc)

METHODS: The trial was conducted on organic soil (pH ≈ 6.4, organic matter ≈ 68.3%) naturally infested with *Pythium* spp. at the Muck Crops Research Station, Holland Marsh, Ontario. Carrots were direct seeded (≈70 seeds/m) onto raised beds using a push cone seeder on 7 June. A randomized complete block design with four replicates per treatment was used. Each experimental unit consisted of one row, 6 m in length, spaced 66 cm apart. On 7 October, plots were visually assessed for: leaf blight, (0-5 scale where 0= no blight to 5= leaf/ petiole necrosis), and bolting, (0-3 scale where 3 = more than 50% flowering, 2 = 5 to 49%, 1 = <5% and 0 = no flowering). On 30 and 31 October, 50 carrots from each replicate were harvested, placed into cold storage, and assessed for cavity spot on 18-27 November. 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 width). The six classes were: 0 = no disease, 1 = very light (< 1 mm), 2 = light (1-2 mm), 3 = medium (3-5 mm), 4 = heavy (6-10 mm), and 5 = very heavy (> 10 mm). The disease severity index (DSI) was determined using the above classes and 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 previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), and average for June (17.5°C), August (19.4°C), September (15.8°C) and October (9.4°C). The 10-year average temperatures were: June 18.4°C, July 21.1°C, August 20.2°C, September 16.4°C and October 9.7°C. Monthly rainfall was above the 10-year average for October (106 mm), average for September (62 mm), and below average for June (84 mm), July (42 mm) and August (46 mm). The 10-year rainfall averages were: June 100 mm, July 93 mm, August 80 mm, September 61 mm and October 74 mm.
Data were analyzed using the General Analysis of Variance function of Statistics V.10. 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 2019, the weather was drier than average in August and cavity spot incidence and severity was lower than in previous years. A wide range of susceptibility to cavity spot was observed among the lines tested (Table 1). The orange line crosses (6366 x 2226) x 1137 and 1138 had low cavity spot incidence (1.5 & 4.3% respectively) similar to Purple Haze (0.5%). Parent lines with resistance to cavity spot have been identified and new selections will help improve the understanding of cavity spot resistance. Significant differences in leaf blight incidence was also observed among the lines tested (Table 2). Poor seed germination was an issue with several lines (Table2). Several lines had high incidence of carrots that bolted, assessing these lines for cavity spot can be difficult.

Table 1. Cavity spot incidence and severity index (DSI) and percent forked for carrot breeding lines from the University of Wisconsin grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Field Number	Pedigree/Name	Incidence (%)	DSI[1]	% Forked
CS 959	Purple Haze	0.0 a[2]	0.0 a	5.5 ab
CS 916	(6366 x 2226) x 1138	1.5 ab	0.7 a	4.6 ab
CS 958	Cellobunch	2.0 abc	0.7 a	6.5 ab
CS 964	Honey Snax	3.5 a-d	1.9 a	5.5 ab
CS 911	(6366 x 2226) x 1137	4.3 a-d	1.5 a	14.0 abc
CS 915	1138A	4.6 a-d	2.5 ab	3.8 ab
CS 921	6366A x 2226[2]	4.8 a-d	1.9 a	1.2 ab
CS 943	SFF (011-1)	4.9 a-d	1.7 a	3.2 ab
CS 963	Nairobi	5.0 a-d	2.0 a	4.0 ab
CS 922	6366A x 2226[3]	5.6 a-d	2.8 ab	5.1 ab
CS 944	Nb3999	6.1 a-e	3.1 abc	5.4 ab
CS 923	2226A	6.3 a-e	3.1 abc	3.9 ab
CS 907	B1111A	7.1 a-f	3.6 abc	3.5 ab
CS 927	(6366 x 2226) x 5494	7.7 a-f	2.3 ab	5.9 ab
CS 920	2226	8.6 a-f	4.2 abc	4.3 ab
CS 952	F7737B	9.5 a-f	4.5 abc	5.5 ab
CS 929	(6366 x 2226) x 5494[2]	9.9 a-f	3.9 abc	7.6 ab
CS 917	Nb2159A	10.0 a-f	4.4 abc	3.5 ab
CS 906	B1111B	10.4 a-f	5.2 abc	4.0 ab
CS 942	[(6366 x 2226) x 1129[2]] x 8502MjiRB	10.5 a-f	3.4 abc	12.0 abc
CS 905	1111A	11.2 a-f	4.0 abc	6.1 ab
CS 962	Uppercut	12.0 a-f	5.5 abc	4.0 ab
CS 936	7322C	12.4 a-f	5.3 abc	10.9 abc
CS 930	[(5280A x 6366B) x 6526MjRB] x 6526MjRB	12.9 a-f	6.1 abc	3.8 ab
CS 904	1111B	14.4 a-g	6.0 abc	7.4 ab
CS 908	D1131B	14.6 a-g	6.1 abc	5.7 ab
CS 954	White Pop	15.6 a-g	6.2 abc	4.7 ab
CS 947	Nb8503	16.3 a-g	8.0 a-d	5.1 ab
CS 902	(2144A x 2126B) x 1111	16.9 a-g	7.2 a-d	13.1 abc
CS 903	1111A	17.7 a-g	7.5 a-d	6.7 ab
CS 933	Nb6526B	18.1 a-g	6.8 a-d	0.0 a
CS 953	R6636B	18.5 a-g	9.8 a-e	8.0 ab
CS 937	8524MjR-B	21.8 a-g	10.4 a-f	5.8 ab
CS 901	1111	23.3 a-g	7.4 a-d	14.5 abc
CS 965	Envy	23.5 a-g	10.6 a-f	3.5 ab
CS 955	D2289A	25.5 a-g	11.0 a-f	4.0 ab
CS 945	6526B	25.6 a-g	11.7 a-f	1.6 ab
CS 909	C1131A	26.3 a-g	11.9 a-f	7.1 ab
CS 961	Maverick	30.0 a-g	13.4 a-g	4.5 ab
CS 949	R6220B	30.4 a-g	16.4 a-g	11.4 abc
CS 925	Nb4001	32.0 b-h	13.8 a-g	4.0 ab
CS 951	Y5665	33.5 c-h	16.4 a-g	9.5 abc

CS 946	Nb8524A	33.6 c-h	19.8 c-g	6.7 ab
CS 919	(6366A x 2226B) x 2205[2]	33.7 d-h	19.1 b-g	6.9 ab
CS 948	HM	37.5 e-i	16.0 a-g	31.2 de
CS 960	Atomic Red	38.1 f-i	25.4 e-h	15.1 bc
CS 918	2205	45.3 g-j	29.0 gh	10.8 abc
CS 956	D2289B	46.0 g-i	18.9 b-g	3.4 ab
CS 941	Nh8502B	62.7 hij	27.2 fgh	23.5 cd
CS 940	8502MjRB	63.4 hij	23.6 d-g	40.3 e
CS 957	Nb8483 x 9256	68.8 ij	48.4 i	14.8 bc
CS 926	(Nb4001 x Nb4002) x Nb4001	70.7 i	42.0 hi	6.6 ab
CS 910[3]	1137	-	-	-
CS 912	1138B	-	-	-
CS 913	1138A	-	-	-
CS 914	1138B	-	-	-
CS 924	5494A	-	-	-
CS 928	5494B	-	-	-
CS 931	6526B	-	-	-
CS 934	7322C	-	-	-
CS 935	7322B	-	-	-
CS 938	8524MjR-A	-	-	-
CS 939	8524MjRB	-	-	-
CS 950	Y5654B	-	-	-

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

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

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

[3] Carrots listed below the line had very poor emergence with sample sizes <10 and therefore were not be assessed for cavity spot.

Table 2. Stand (7 July), bolting and leaf blight ratings (7 October), for carrot breeding lines from University of Wisconsin grown at the Muck Crops Research Station, Holland Marsh, 2019.

Number	Name	Stand [1] (7 July)	Bolting [2] (7 Oct)	Leaf Blight [3,4] (3 Oct)
CS 965	Envy	4.5	0.1	**1.5**
CS 962	Uppercut	4.0	0.0	1.0
CS 917	Nb2159A	3.9	0.4	**1.6**
CS 959	Purple Haze	3.9	0.7	**1.6**
CS 942	[(6366 x 2226) x 1129[2]] x 8502MjiRB	3.8	0.5	**2.1**
CS 964	Honey Snax	3.8	0.0	1.1
CS 958	Cellobunch	3.8	0.1	1.4
CS 941	Nh8502B	3.6	0.2	**2.4**
CS 925	Nb4001	3.4	0.1	1.1
CS 961	Maverick	3.4	0.0	1.0
CS 952	F7737B	3.2	1.2	**2.0**
CS 955	D2289A	3.2	0.0	0.9
CS 907	B1111A	3.1	1.2	**1.6**
CS 946	Nb8524A	3.1	0.5	**1.9**
CS 963	Nairobi	3.1	0.1	**1.8**
CS 908	D1131B	3.0	0.0	**2.3**
CS 953	R6636B	3.0	1.2	**2.1**
CS 906	B1111B	2.9	0.9	1.4
CS 949	R6220B	2.9	2.0	**2.0**
CS 919	(6366A x 2226B) x 2205[2]	2.8	0.1	**1.6**

CS 905	1111A	2.6	1.5	**1.8**
CS 909	C1131A	2.6	0.0	**2.1**
CS 948	HM	2.6	1.6	**2.5**
CS 956	D2289B	2.6	0.0	1.1
CS 903	1111A	2.5	0.2	0.9
CS 926	(Nb4001 x Nb4002) x Nb4001	2.5	1.2	**1.6**
CS 954	White Pop	2.5	1.1	**1.8**
CS 940	8502MjRB	2.4	0.4	**2.4**
CS 943	SFF (011-1)	2.4	0.0	**2.6**
CS 960	Atomic Red	2.4	0.6	**2.4**
CS 957	Nb8483 x 9256	2.2	0.0	1.3
CS 918	2205	2.1	0.0	**1.5**
CS 923	2226A	2.1	0.0	**1.9**
CS 916	(6366 x 2226) x 1138	2.0	0.0	1.1
CS 944	Nb3999	2.0	0.0	**2.6**
CS 950	Y5654B	2.0	3.0	**2.4**
CS 933	Nb6526B	1.9	3.0	1.1
CS 951	Y5665	1.9	1.5	**1.6**
CS 927	(6366 x 2226) x 5494	1.7	0.0	1.1
CS 945	6526B	1.7	3.0	**1.5**
CS 911	(6366 x 2226) x 1137	1.7	0.0	1.0
CS 901	1111	1.5	0.7	1.0
CS 921	6366A x 2226[2]	1.5	0.2	**1.8**
CS 936	7322C	1.5	0.0	0.5
CS 902	(2144A x 2126B) x 1111	1.4	0.2	0.9
CS 915	1138A	1.4	1.2	**2.3**
CS 930	[(5280A x 6366B) x 6526MjRB] x 6526MjRB	1.4	1.2	1.4
CS 904	1111B	1.2	0.7	1.4
CS 920	2226	1.2	0.0	1.1
CS 922	6366A x 2226[3]	1.2	0.0	0.9
CS 931	6526B	1.2	3.0	1.0
CS 929	(6366 x 2226) x 5494[2]	1.2	3.0	1.4
CS 947	Nb8503	1.1	0.4	**1.6**
CS 910	1137	0.9	--	1.1
CS 914	1138B	0.5	--	**1.5**
CS 937	8524MjR-B	0.5	0.3	1.0
CS 938	8524MjR-A	0.4	--	0.8
CS 913	1138A	0.1	--	1.5
CS 928	5494B	0.1	--	0.8
CS 912	1138B	0.0	--	--
CS 924	5494A	0.0	--	**1.6**
CS 932	6526B	0.0	--	--
CS 934	7322C	0.0	--	--
CS 935	7322B	0.0	--	--
CS 939	8524MjRB	0.0	--	0.8

[1] Stand (carrot emergence) was rating on 7 July using a 0-5 scale where 0 = <5 carrots, 1 = very poor, 2 = poor, 3 = good, 4 = very good, 5 = excellent.

[2] Bolting was rated on 7 October using a comparative 0-3 scale where 0 = no flowering, 1 = <5% flowering, 2 = 5 – 49% flowering, 3 = >50% flowering.

[3] Leaf blight was rated on a 0-5 scale where 0 = no light, 1 = 1-10% leaf area blighted, 2 = 11-25% leaf/petiole blighted, 3 = 26-50% leaf/petiole blighted, 4 = >75% leaf/petiole area blighted, 5 = leaf/petiole necrotic.

[4] Leaf blight ratings 1.5 or higher (the rating for Cellobunch) are noted in bold.

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CROP: Carrot (*Dauca carota* subsp sativus), cv. Enterprise

AUTHORS: SWANTON C & SMITH P
University of Guelph, Dept. of Plant Agriculture, Crop Science Building

TITLE: EFFECT OF VARIOUS HERBICIDE APPLICATIONS ON YIELD OF CARROTS, 2019

MATERIALS: GESAGARD (prometryne 480 g/L), PARDNER (bromoxynil 280 g/L), ZIDUA (pyroxasulfone 85%), BLAZER (aciflurofen 240 g/L), LOROX-L (linuron 480 g/L), GOAL 2XL (oxyflurofen 240 g/L), PROWL H_2O (pendimethalin 455g/L), DUAL II MAGNUM (S-metolachlor 915 g/L), SENCOR (metribuzin 480 g/L)

METHODS: Carrots, cv. Enterprise, were direct seeded on 23 May into muck soil (organic matter ≈ 55.6%, 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 two raised beds spaced 85 cm apart, and 6 m in length. Treatments were applied using a backpack mounted sprayer fitted with AIXR110-02 spray tips calibrated to deliver 200 L/ha at 206.84 kPa. Treatments are presented in Table 1. Treatments were applied on 29 May, 5, 17, 28 June, and 10, 18 July. On 29 October, carrots in two 1.16 m sections of row per plot were harvested. Yield samples were processed on 18 December; carrots were sorted into marketable and non-marketable and converted to metric tonnes per hectare. Yield data were analyzed using ARM Version 2019.8 Analysis of Variance function. Means separation was obtained by using Duncan's New MRT test at P = 0.05 level of significance.

RESULTS: as presented in Table 1

CONCLUSIONS: No significant differences in yield were observed among the treatments (Table 1).

Table 1. Crop yield for carrots, cv. Enterprise, treated with herbicides and grown near the Muck Crop Research Station, Holland Marsh, Ontario, 2019

Trt #	Treatment	Rate (g ai/ha)	Crop stage at application	Yield (t/ha)
1	Weed Free Check			74.7 ns[1]
2	Prometryne	3400	Early PRE emergence	74.5
	Bromoxynil	300	Late PRE emergence	
	Pyroxasulfone	89	Bunny ear	
	Aciflurofen	18.75	1-3 leaf carrot	
	Linuron	1000	1-3 leaf carrot	
	Oxyfluorfen	60	3-4 leaf carrot	
	Linuron	1000	3-4 leaf carrot	
3	Prometryne	3400	Early PRE emergence	69.6
	Bromoxynil	300	Late PRE emergence	
	Pendimethalin	89	Bunny ear	
	Aciflurofen	18.75	1-3 leaf carrot	
	Linuron	1000	1-3 leaf carrot	
	Oxyfluorfen	60	3-4 leaf carrot	
	Linuron	1000	3-4 leaf carrot	
4	Prometryne	3400	Early PRE emergence	71.6

	Bromoxynil	300	Late PRE emergence	
	S-Metolachlor	89	Bunny ear	
	Aciflurofen	18.75	1-3 leaf carrot	
	Linuron	1000	1-3 leaf carrot	
	Oxyfluorfen	60	3-4 leaf carrot	
	Linuron	1000	3-4 leaf carrot	
5	Prometryne	3400	Early PRE emergence	78.5
	Bromoxynil	300	Late PRE emergence	
	Pyroxasulfone	89	Bunny ear	
	Aciflurofen	18.75	1-3 leaf carrot	
	Metribuzin	D	1-3 leaf carrot	
	Oxyfluorfen	60	3-4 leaf carrot	
	Linuron	1000	3-4 leaf carrot	
6	Prometryne	3400	Early PRE emergence	73.6
	Bromoxynil	300	Late PRE emergence	
	Pyroxasulfone	89	Bunny ear	
	Aciflurofen	18.75	1-3 leaf carrot	
	Linuron	1000	1-3 leaf carrot	
	Oxyfluorfen	60	3-4 leaf carrot	
	Linuron	1000	3-4 leaf carrot	
	Pyroxasulfone	89	4-5 leaf carrot	
7	Prometryne	3400	Early PRE emergence	76.0
	Bromoxynil	300	Late PRE emergence	
	Pyroxasulfone	89	Bunny ear	
	Aciflurofen	18.75	1-3 leaf carrot	
	Linuron	1000	1-3 leaf carrot	
	Oxyfluorfen	60	3-4 leaf carrot	
	Linuron	1000	3-4 leaf carrot	
	S-Metolachlor	1098	4-5 leaf carrot	
8	Prometryne	3400	Early PRE emergence	75.7
	Bromoxynil	300	Late PRE emergence	
	Pendimethalin	89	Bunny ear	
	Aciflurofen	18.75	1-3 leaf carrot	
	Linuron	1000	1-3 leaf carrot	
	Oxyfluorfen	60	3-4 leaf carrot	
	Linuron	1000	3-4 leaf carrot	
	Pyroxasulfone	89	4-5 leaf carrot	

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

CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) cv. Enterprise

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

TITLE: EVALUATION OF PHOSPHORUS REQUIREMENTS ON ORGANIC (MUCK) SOIL ON YIELD OF CARROTS, 2019

RATIONALE: This trial site was established in 2010 as part of an ongoing phosphorus management project to determine the effect of zero applied phosphorus to the yields of onions and carrots over time. Onions and carrots have been grown in rotation on plot areas designated as a zero-phosphorus check and a commercial phosphorus rate (100 kg P_2O_5). The objective of this work is to determine the number of cropping seasons needed to reduce soil phosphorus levels to a number in which a yield response would be observed when phosphorus is applied.

MATERIALS: mono ammonium phosphate (11% NH_4, 52% P_20_5, 1.5% SO_4)

METHODS: Carrots, cv. Enterprise, were seeded into organic soil (organic matter ≈ 64.7 %, pH ≈ 6.9) near Muck Crops Research Station in the Holland Marsh, Ontario on 31 May using a Stanhay Precision Seeder. On 22 May fertilizer treatments were applied by hand to plot areas. The commercial phosphorus rate treatment received MicroEssentials® SZ™ (MESZ) at 100 kg P/ha and the zero-phosphorus check received no phosphorus fertilizer. Both treatments received ammonium sulfate applied at 60 kg N/ha and potassium using ASPIRE (0-0-50) at 40 kg K/ha and sulphate of potash-magnesia (0-0-22 K-Mag) at 40 kg K/ha. A randomized complete block design with four replicates per treatment was used. Each replicate consisted of four rows (86 cm apart), 20 m in length. On 11 October carrots from four 11.6 m sections of row were harvested for a yield sample. On 8 November carrots were graded for size and weighed to determine yield. Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C), October (9.4°C) and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C, August 20.2°C, September 16.4°C and October 9.7°C. Monthly rainfall was above the 10-year average for October (106 mm), average for May (77 mm), September (62 mm), and below average for June (84), July (42 mm) and August (46 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm, August 80 mm, September 61 mm and October 74 mm. Data were analyzed using Statistic V. 10, and a General Analysis of Variance for linear models was used. Means were compared using Fisher's Protected LSD test at P = 0.05 level of significance.

RESULTS: No significant differences in yield or size distribution were found between the treatments (Table 1).

CONCLUSIONS: Pre-plant P soil levels of 90 and 59 ppm are considered high and in the no and rare response ratings (respectively) (Vegetable Production Recommendations, 2010-11, Pub 363 p. 13). Phosphorus fertilizer applied to the commercial P rate treatments in 2019 did not result in a significant crop response. These results validate the recommendation that additional P does not increase overall yield of carrots and that excess phosphorus may be lost to leaching.

Table 1. Pre-plant soil phosphorus (P) and yield for carrots, cv. Enterprise, grown on zero- and commercial rates of phosphorus plots, near Muck Crops Research Station, Holland Marsh, 2019.

Treatment	Pre-plant P (ppm)	Yield (t/ha)	bu/A	Size Distribution (%)		
				Jumbo (>4.4 cm)	Packers (1.9-4.4 cm)	Cull (<1.9 cm)
Commercial phosphorus[1]	90.5	26.8 ns[2]	434.9 ns	19.6 ns	68.7 ns	11.8 ns
Zero-phosphorus	59.6	23.8	386.2	13.3	76.9	9.8

[1] 100 kg P_2O_5/ha applied since 2010

[2] ns indicates that no significant differences were found between the treatments

Funding for this project was provided by the Plant Production Systems of the Ontario Ministry of Agriculture and Food and Ministry of Rural Affairs and the University of Guelph partnership.

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

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

TITLE: EVALUATION OF INSECTICIDE TRAY DRENCHES AND SEED TREATMENTS FOR CONTROL OF MAGGOTS IN YELLOW COOKING ONIONS, 2019

MATERIALS: PRO-GRO (thiram 50% + carboxin 30%), GOVERNOR 75 SP (cyromazine 75%), SEPRESTO 75 WS (clothianidin 56.25% + imidacloprid 18.75%), PYRINEX 480 EC (chlorpyrifos 480 g/L), VERIMARK (cyantraniliprole 200 g/L), DELEGATE WG 400 (spinetoram 25%)

METHODS: Various insecticide tray drenches and commercial seed treatments for yellow cooking onion transplants, cv. Trekker, were evaluated in a field trial conducted on organic soil (pH ≈ 6.8, organic matter ≈ 67.3%) naturally infested with *Delia antiqua* and *D. platura* pupae near the Muck Crops Research Station, Holland Marsh, Ontario. On 11 March, onions were seeded, 3 seeds/cell, into 288-cell trays filled with soilless mix (Grower Mix, ASB Greenworld Ltd., Mount Elgin, ON). Insecticide seed treatments were: GOVERNOR at 6.6 g/100 g seed and SEPRESTO at 0.21 g/1000 seeds. An undrenched check consisting of onions grown from untreated check seed (PRO-GRO only) was also included. On 8 May, trays of onions grown from the check seed were drenched with 500 mL solution/tray of the following treatments: PYRINEX 480 EC at 1.6 mL/tray, VERIMARK at 4.32 mL/tray and DELEGATE at 3.75 g/tray. An untreated check using onions grown from PRO-GRO treated pellets was also included. A randomized complete block design with four replicates per treatment was use. Each experimental unit consisted of four rows, spaced 40 cm apart, 7 m in length. Onions were transplanted into the field on 16 May using a mechanical transplanter. Two randomly chosen 2 m sections and a 2.32 m yield section of row were staked out in each replicate. On 27 May, plants within the 2 m sections were counted and numbers recorded to determine initial stands. Beginning on 18 June, plants within the 2 m sections were examined for onion maggot losses or damage caused by other pests on a weekly basis. Damaged plants were removed, and the cause recorded. Final destructive assessments of the remaining plants within the assigned 2 m sections were conducted on 2 July (three weeks after the first generation peak), and after onions were lodged on 8 August (to assess total season damage). On 23 August, yield samples from the 2.32 m yield section of row were harvested and on 24 October samples were graded for size to determine yield. Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C, and August 20.2°C. Monthly rainfall was below the 10-year average for June (84 mm), July (42 mm), August (46 mm) and average for May (77 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm and August 80 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.10. Means separation was obtained using Fisher's Protected LSD Test at P = 0.05 level of significance.

RESULTS: as presented in Tables 1 & 2

CONCLUSIONS: Significant differences in the percentage of onions lost due to maggot damage from the first generation and for the total season were observed among the treatments (Table 1). Onion transplants treated with VERIMARK, DELEGATE, or GOVERNOR had fewer losses from first generation maggot damage compared to onions treated with PYRINEX, SEPRESTO or the untreated check. Over the total season, all insecticide treatments resulted in fewer losses compared to untreated onions. At harvest, there were more onion bulbs per meter from onion transplants treated with VERIMARK, DELEGATE or

PYRINEX 480 EC than from the SEPRESTO seed treatment or untreated onions (Table 1). No significant differences in size distribution or the percent marketable were found among treatments; however, onion transplants treated with DELEGATE, VERIMARK, PYRINEX or GOVENOR had higher yields (56 to 46 t/ha) than untreated transplants (Table 2).

Table 1. Onion losses caused by maggot damage for transplanted onions, cv. Trekker, treated with insecticide seed treatments or tray drenches and grown near the Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Treatment	Rate/tray[1]	Method of Application	% Onions Lost from Maggot Damage		Onions/m
			1st Gen[2]	Total Season[3]	
VERIMARK	4.3 mL	500 mL solution/tray	2.2 a[4]	1.1 a	23.2 a
DELEGATE	3.75 g	500 mL solution/tray	6.0 a	0.5 a	24.0 a
GOVERNOR	–	6.6 g/100 g seed	9.0 a	8.9 a	19.6 ab
PYRINEX	1.6 mL	500 mL solution/tray	19.5 b	14.4 a	24.4 a
SEPRESTO	–	0.21 g/1000 seeds	22.2 b	11.7 a	18.0 bc
Check	–	--	30.8 b	37.3 b	14.2 c

[1] Trays were drenched on 8 May, 66 days after seeding and 8 days before transplanting (16 May).
[2] Onions in the 2 m staked out section were removed and assessed for maggot damage on 2 July
[3] Final assessment was conducted on 8 August after the 2nd generation peak when onions were lodged.
[4] Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD Test.

Table 2. Yield and size distribution for transplanted onions, cv. Trekker, treated with insecticide seed treatments or tray drenches and grown near the Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Treatment	Rates[1]	Yield (t/ha)	% Mkb	Size Distribution (%)[2]		
				Jumbo (>76 mm)	Can No. 1 (45-76 mm)	Cull[3] (<45 mm)
DELEGATE	3.75 g/tray	55.3 a[4]	98.5 ns[5]	3.1 ns	95.4 ns	1.5 ns
VERIMARK	4.3 mL/tray	55.8 a	97.0	4.5	92.5	3.0
PYRINEX	1.6 mL/tray	50.5 ab	95.7	1.0	94.6	4.3
GOVERNOR	6.6 g/100 g seed	46.2 ab	95.0	7.9	87.0	5.0
SEPRESTO	0.21 g/1000 seeds	40.3 bc	97.4	5.6	91.8	2.6
Check	--	26.8 c	93.9	0.0	93.9	6.1

[1] Insecticide drenches were applied using 500 mL water per tray.
[2] Percentage was determined using weight.
[3] The cull category also includes unmarketable onions due to maggot damage.
[4] Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD test.
[5] ns = no significant differences at P = 0.05, Fisher's Protected LSD Test

Funding for this project was provided by the Plant Production Systems of the Ontario Ministry of Agriculture, Food and Rural Affairs and University of Guelph partnership.

CROP: Yellow cooking onions (*Allium cepa* L.), cv. Fortress
PESTS: Onion maggot, (*Delia antiqua* (Meigen))
Seed corn maggot, (*Delia platura* (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 VARIOUS INSECTICIDES FOR CONTROL OF MAGGOTS IN YELLOW COOKING ONIONS, 2019

MATERIALS: SEPRESTO 75 WS (clothianidin 56.25%, imidacloprid 18.75%), REGARD (spinosad 22.5%), CRUISER 70 WS (thiamethoxam 70%), GOVERNOR (cyromazine 75%), EVERGOL PRIME (penflufen 22.7%), 42-S THIRAM (tetramethylthiuram disulfide 42%), LORSBAN 15 G (chlorpyrifos 15%)

METHODS: The trial was conducted on organic soil (pH ≈ 6.2, organic matter ≈ 68.1%) naturally infested with *Delia antiqua* and *D. platura* 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 four rows, spaced 40 cm apart, 6 m in length. Onions, cv. Fortress, were seeded (≈ 35 seeds/m) on 16 May using a Stanhay precision seeder. Insecticide seed treatments applied at the manufacturers recommended rates were: SEPRESTO, REGARD + CRUISER, REGARD and GOVERNOR. A no-insecticide check and the no-insecticide check + LORSBAN 15G applied in-furrow were also included. All treatments also include thiram and EVERGOL PRIME for smut control. Refer to Table 1 for treatment rates. Treatments and pelleting were done by Incotec using standard methods. Three randomly chosen 2 m sections of row plus a 2.32 m section for a yield sample were staked out in each replicate. Emergence counts were conducted within the 2 m sections on 6 June to determine initial stands. Beginning on 10 June and continuing weekly, plants within the 2 m sections were examined for onions lost due to maggot damage or damage caused by other pests. Damaged onions were removed and numbers and the cause recorded. The remaining onions within the assigned 2 m sections were removed and visually examined for maggot damage on 4 July (three weeks after the first generation peak), 14 August (three weeks after the second generation peak) and after lodging on 18 September. On 18 September, onions from the 2.32 m yield section of row were pulled, sorted by size and weighed to determine yield. Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C), and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C, August 20.2°C and September 16.4°C. Monthly rainfall was below the 10-year average for June (84 mm), July (42 mm), August (46 mm) and average for May (77 mm) and September (62 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm, August 80 mm and September 61 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.10. Means separation was obtained using Fisher's Protected LSD Test at P = 0.05 level of significance.

RESULTS: as presented in Tables 2 & 3

CONCLUSIONS: In 2019, onion maggot pressure was low in the trial. No significant differences in the number of onions lost to maggot damage were found among the treatments (Table 2). No significant differences in yield or size distribution were found among the treatments (Table 3).

Table 1. Seed treatments label rates for onion seed, cv. Fortress, pelleted by Incotec and grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2019.

#	Treatment	Insecticide Active Ingredients and Label Rates
1	Check seed[1]	–
2	REGARD[1]	spinosad 0.2 g ai/1,000 seeds
3	REGARD + CRUISER[1]	spinosad 0.2 g ai + thiamethoxam 0.2 g ai/1,000 seeds
4	SEPRESTO[1]	clothianidin 0.18 g ai + imidacloprid 0.6 g ai/1,000 seeds
5	GOVERNOR	cyromazine 49.5 g ai/kg
8	Check seed[1] + *LORSBAN 15G*	*15% chlorpyrifos at 16 kg product/ha in-furrow*

[1] Pellet also included EVERGOL PRIME (penflufen 0.0087 g ai/1,000 seeds) and thiram at 12.5 g ai/kg seed for smut control.

Table 2. Percentage of maggot damage in onions, cv. Fortress, treated with various insecticides and pelleted by Incotec and grown at the Muck Crop Research Station, Holland Marsh, Ontario, 2019.

#	Treatment[1]	Emergence 6 June (plants/m)	% Onions Lost Due to Maggot Damage		
			1st Gen	1st & 2nd Gen	Total Season
8	LORSBAN 15G	23.2 ns[2]	0.0 ns	2.0 ns	1.6 ns
2	REGARD	24.5	4.3	2.5	1.7
4	SEPRESTO	24.1	4.9	2.7	2.2
3	REGARD + CRUISER	24.9	1.5	1.0	2.6
5	GOVERNOR	22.9	4.1	9.1	7.6
1	Check seed	21.9	6.5	15.5	11.7

[1] Treatment details are listed in Table 1.
[2] ns = no significant differences were found among treatments at P = 0.05, Fisher's Protected LSD test.

Table 3. Yield and size distribution for onions, cv.Fortress, treated with various insecticides, pelleted by Incotec and grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Treatment[1]	Yield (t/ha)	% Mkb	Size Distribution (%)			Onions/ m
			Jumbo (>76mm)	Can. No. 1 (45-76mm)	Cull[2] (<45mm)	
REGARD	65.3 ns[3]	98.1 ns	2.8 ns	95.2 ns	1.9 ns	22.2 ns
GOVERNOR	65.4	98.6	3.8	94.8	1.4	21.0
LORSBAN 15G	58.6	97.1	2.0	95.2	2.9	22.5
SEPRESTO	58.7	95.7	0.0	95.7	4.3	23.5
REGARD + CRUISER	57.4	98.2	6.7	91.4	1.8	21.1
Check	55.9	98.9	15.7	83.2	1.1	16.9

[1] See treatment details listed in Table 1.
[2] The cull category also includes unmarketable onions due to maggot damage.
[3] ns = no significant differences at P = 0.05, Fisher's Protected LSD test.

Funding was provided by Incotec for seed pelleting, by Bayer Crop Science for the Sepresto insecticide and by the Plant Production Systems of the Ontario Agri-Food Innovation Alliance. Dr. Taylor's effort was supported under the United States Multi-State project, W-3168.

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

AUTHORS: MCDONALD MR[1], VANDER KOOI K[1] & NAULT B[2]
[1]University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station
[2] Cornell University, Dept. of Entomology

TITLE: EVALUATION OF TRIGARD FOR CONTROL OF MAGGOTS IN YELLOW COOKING ONIONS, 2019

MATERIALS: FARMORE F300 ((APRON XL (metalaxyl-M and S-iromer 33.3%), MAXIM 4 FS (fludioxonil 40.3%), DYNASTY (azoxystrobin 9.6%)), FARMORE FI500 ((APRON XL (metalaxyl-M and S-iromer 33.3%), MAXIM 4 FS (fludioxonil 40.3%), DYNASTY (azoxystrobin 9.6%), REGARD (spinosad 22.5%), CRUISER 70 WS (thiamethoxam 70%)), CRUISER 70 WS (thiamethoxam 70%), TRIGARD (cyromazine 75%)

METHODS: The trial was conducted on organic soil (pH ≈ 6.0, organic matter ≈ 70.4%) naturally infested with *Delia antiqua* and *D. platura* pupae near 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 four rows, spaced 40 cm apart, 6 m in length. Onions, cv. Highlander, were seeded (≈ 35 seeds/m) on 7 May using a Stanhay precision seeder. Insecticide seed treatments applied at the manufacturers recommended rates were: FI500 (REGARD+CRUISER), TRIGARD+CRUISER and CRUISER alone. FARMORE F300 was used for onion smut control in this trial. A no-insecticide check was also included. Three randomly chosen 2 m sections of row were staked out in each replicate. Emergence counts were conducted within these 2 m sections on 5 June to determine initial stands. Beginning on 8 June and continuing weekly, plants within the 2 m sections were examined for onions lost due to maggot damage or damage caused by other pests. Damaged onions were removed and numbers and the cause recorded. The remaining onions within the assigned 2 m sections were removed and visually examined for maggot damage on 3 July (three weeks after the first generation peak), 15 August (three weeks after the second generation peak) and after lodging on 25 September. On 11 September, onions from a 2.32 m section of row were pulled, sorted by size and weighed to determine yield.
Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C) and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C, August 20.2°C and September 16.4°C. Monthly rainfall was below the 10-year average for June (84 mm), July (42 mm), August (46 mm) and average for May (77 mm) and September (62 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm, August 80 mm and September 61 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.10. Means separation was obtained using Fisher's Protected LSD Test at P = 0.05 level of significance.

RESULTS: as presented in Tables 1 & 2

CONCLUSIONS: Significant differences in the percentage of onions lost due to maggot damage were found among the treatments on all assessment dates. All insecticide seed treatments had significantly fewer maggot losses after the first generation and season total assessments (Table 1).
Total season onion maggot losses were low in the FI500 treatment and were significant lower than all other treatments. No significant differences in the percentage of Jumbo and Canada No. 1 onions were found among the treatments (Table 2). All insecticide treatments had more onions per meter at harvest the untreated check.

Table 1. Percentage of maggot damage in onions, cv. Highlander, treated with various insecticides at the Muck Crop Research Station, Holland Marsh, Ontario, 2019.

Treatment	Insecticide Active Ingredients and Label Rates	% Onions Lost Due to Maggot Damage		
		1st Gen	2nd Gen	Total Season
FI500 (CRUISER + REGARD)	spinosad 0.2 g ai + thiamethoxam 0.2 g ai/1,000 seeds	3.7 a[1]	2.8 a	0.0 a
TRIGARD + CRUISER	cyromazine 49.5 g ai/kg + thiamethoxam 0.2 g ai/1,000 seeds	4.6 a	43.4 a	7.7 b
CRUISER	thiamethoxam 0.2 g ai/1,000 seeds	10.1 a	12.8 b	11.6 b
Check	--	20.6 b	17.0 b	28.0 c

[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. Yield and size distribution for onions, cv. Highlander, treated with various insecticides, grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Treatment	Onions/ m	Yield (t/ha)	% Mkb	Size Distribution (%)		
				Jumbo (>76mm)	Can. No. 1 (45-76mm)	Cull (<45mm)
FI500 (CRUISER + REGARD)	22.1 a[1]	33.4 ns[2]	86.7 ns	3.0 ns	83.7 ns	13.3 ns
TRIGARD + CRUISER	19.2 ab	36.5	87.5	0.0	87.5	12.5
CRUISER	15.1 b	29.9	93.3	1.8	91.4	6.7
Check	14.3 c	31.3	90.1	8.1	82.1	9.9

[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 at P = 0.05, Fisher's Protected LSD test.

Funding was provided by the Plant Production Systems of the Ontario Agri-Food Innovation Alliance.

CROP: Yellow cooking onions (*Allium cepa* L.), cv. Fortress
PESTS: Onion maggot, (*Delia antiqua* (Meigen))
Seed corn maggot, (*Delia platura* (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: A COMPARISON OF FILM COAT AND PELLETED APPLICATION METHODS FOR CONTROL OF MAGGOTS IN YELLOW COOKING ONIONS, 2019

MATERIALS: SEPRESTO 75 WS (clothianidin 56.25%, imidacloprid 18.75%), REGARD (spinosad 22.5%), GOVERNOR (cyromazine 75%), EVERGOL PRIME (penflufen 22.7%), 42-S THIRAM (tetramethylthiuram disulfide 42%), PRO-GRO (carboxin 30% + thiram 30%), FARMORE F300 ((APRON XL (metalaxyl-M and S-isomer 33%) + MAXIM 4 FS (fludioxonil 40.3%) + DYNASTY (azoxystrobin 9.6%))

METHODS: The trial, which compared film coat and pelleting methods of treating onion seed, cv. Fortress, was conducted on organic soil (pH ≈ 6.8, organic matter ≈ 62.0%) naturally infested with *Delia antiqua* and *D. platura* 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 four rows, spaced 40 cm apart, 6 m in length. The trial was seeded (≈ 35 seeds/m) on 16 May using a Stanhay Precision Seeder for pelleted seed and a push cone seeder for film coated seed. Fungicide and insecticide seed treatments applied as a film coat and pelleted at the manufacturers recommended rates were: SEPRESTO + THIRAM + EVERGOL PRIME, SEPRESTO + PRO-GRO + F300 and REGARD + THIRAM + EVERGOL. Treatments and pelleting were done by Incotec using standard methods.
Three randomly chosen 2 m sections of row and a 2.32 m section for a yield sample were staked out in each replicate. Emergence counts were conducted within the 2 m sections on 6 June to determine initial stands. Beginning on 10 June and continuing weekly, plants within the 2 m sections were examined for onions lost due to maggot damage or damage caused by other pests. Damaged onions were removed and numbers and the cause recorded. The remaining onions within the assigned 2 m sections were removed and visually examined for maggot damage on 4 July (three weeks after the first generation peak), 19 August (three weeks after the second generation peak) and on 18 September (after lodging). On 27 September, onions from the 2.32 m yield section of row were pulled, sorted by size and weighed to determine yield. Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C), and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C, August 20.2°C and September 16.4°C. Monthly rainfall was below the 10-year average for June (84 mm), July (42 mm), August (46 mm) and average for May (77 mm) and September (62 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm, August 80 mm and September 61 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.10. Means separation was obtained using Fisher's Protected LSD Test at P = 0.05 level of significance.

RESULTS & DISCUSSION: as presented in Tables 2 - 4

CONCLUSIONS: When seed treatments are grouped for means comparison, film coated seed had higher seed emergence (Table 3), lower yield, lower percent marketable and a higher percentage of cull onions compared to pelleted onions (Table 6). This was probably caused by a seeding rate that was > 35 seeds/m using a push cone seeder.
When application methods (film coated or pelleted) are combined for statistical analysis, there are no

significant differences in the number of plants emerged on 6 June in onion grown from seeds treated the EVERGOL PRIME compared to seeds treated with F300 (Table 4).

Table 1. Label rates for seed treatments, pelleted or film coat, on onion seed, cv. Fortress, grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2019.

#	Treatment	Insecticide Active Ingredients and Label Rates
1	SEPRESTO THIRAM EVERGOL PRIME	clothianidin 0.18 g ai + imidacloprid 0.6 g ai/1,000 seeds thiram 1.875 g ai/kg seed penflufen 0.0087 g ai/1,000 seeds
2	SEPRESTO PRO-GRO F300	clothianidin 0.18 g ai + imidacloprid 0.6 g ai/1,000 seeds carboxin 7.5 g ai/kg seed + thiram 12.5 g ai/kg seed mefenoxam 0.075 g ai + fludioxonil 0.025 g ai + azoxystrobin 0.025 g ai per kg seed
3	REGARD THIRAM EVERGOL PRIME	spinosad 0.2 g ai/1,000 seeds thiram 1.875 g ai/kg seed penflufen 0.0087 g ai/1,000 seeds
4	SEPRESTO THIRAM EVERGOL PRIME	*same as treatment 1 applied as a film coat*
5	SEPRESTO PRO-GRO F300	*same as treatment 2 applied as a film coat*
6	REGARD THIRAM EVERGOL PRIME	*same as treatment 3 applied as a film coat*

Table 2. Percentage of maggot damage in onions, cv. Fortress, treated with various insecticides and pelleted by Incotec and grown at the Muck Crop Research Station, Holland Marsh, Ontario, 2019.

#	Treatment[1]	Coating Method	Emergence 6 June (plants/m)	% Onions Lost Due to Maggot Damage		
				1st Gen	1st & 2nd Gen	Total Season
	RG + Th + EV	FC	45.0 a[2]	3.9 ns[3]	2.0 ns	0.8
	SEP + PG + F300	FC	38.0 b	2.7	5.2	1.7
	SEP + Th + EV	FC	37.9 b	4.2	3.4	1.1
	SEP + PG + F300	pellet	26.0 c	3.6	8.9	3.4
	SEP + Th + EV	pellet	25.1 c	4.8	4.2	0.0
	RG + Th + EV	pellet	24.5 c	5.2	2.1	3.0

[1] Treatment details are listed in Table 1.

[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 were found among treatments at P = 0.05, Fisher's Protected LSD test.

Table 3. Maggot damage in onions cv. Fortress, treated with various insecticides pelleted or film coated and grown at the Muck Crop Research Station, Holland Marsh, Ontario, 2019.

Coating Type	Emergence 6 June (plants/m)	% Onions Lost Due to Maggot Damage[1]		
		1st Gen	1st & 2nd Gen	Total Season
Film Coat	40.3 a[2]	3.6 ns[3]	3.5 ns	0.8 a
Pellet	25.2 b	4.5	5.1	2.5 b

[1] As there was no interaction between treatment and coating type, data were combined for means comparison.
[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 were found among treatments at P = 0.05, Fisher's Protected LSD test.

Table 4. Yield and size distribution for onions, cv. Fortress, treated with various insecticides with a film coat or in a pellet and grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Treatment[1]	Coating Type	Yield (t/ha)	% Mkb	Size Distribution (%)			Onions/ m
				Jumbo (>76mm)	Can. No. 1 (45-76mm)	Cull[2] (<45mm)	
RG + Th + EV	P	26.3 ns[3]	71.3 ns	1.3 ns	70.1 ns	28.7 ns	19.2 ns
S + Th + EV	P	24.7	70.1	1.5	68.6	29.9	19.6
SEP + PG + F300	P	18.6	74.6	0.0	74.8	25.5	15.0
RG + Th + EV	FC	7.6	36.8	0.0	36.8	63.2	20.9
SEP + Th + EV	FC	8.8	36.0	1.5	34.5	64.0	24.0
SEP + PG + F300	FC	10.9	42.4	0.0	42.4	57.6	21.3

[1] See treatment details listed in Table 1.
[2] The cull category also includes unmarketable onions due to maggot damage.
[3] ns = no significant differences at P = 0.05, Fisher's Protected LSD test.

Funding was provided by Incotec for seed pelleting, by Bayer Crop Science for the Sepresto insecticide and by the Plant Production Systems of the Ontario Agri-Food Innovation Alliance. Dr. Taylor's effort was supported under the United States Multi-State project, W-3168.

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

AUTHORS: SWANTON C & SMITH P
University of Guelph, Dept. of Plant Agriculture, Crop Science Building

TITLE: CROP TOLERANCE AND WEED CONTROL WITH PYROXASULFONE +/- FLUMIOXAZIN APPLIED POST EMERGENCE FOR BULB ONION, 2019

MATERIALS: ZIDUA HERBICIDE (pyroxasulfone 85%), FIERCE HERBICIDE (pyroxasulfone + flumioxazin 76%)

METHODS: Onions, cv. Traverse, were direct seeded on 8 May into organic soil (organic matter ≈ 55.6%, 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 four rows spaced 40 cm apart, and 6 m in length. Treatments were applied using a backpack mounted sprayer fitted with AIXR110-02 spray tips calibrated to deliver 200 L/ha at 206.84 kPa. Treatments were: ZIDUA at 149, 223 and 298 g ai/ha, and FIERCE at 80, 160 and 266 g ai/ha. Two checks were included: standard pest management treatments and standard pest management treatments plus hand weeding. Treatments were applied on 17 June when onions were at the 2-3 leaf stage and on 2, 15 July and 7 August. All onions in each plot were examined for evidence of visual injury. On 13 September, onions in one 2.32 m section of row per plot were hand harvested and field cured for 14 days. On 23 October, onions were removed from storage, sorted into size categories, weighed and counted to determine yield in tonnes per hectare. Yield data were analyzed using ARM Version 2019.8 Analysis of Variance function. Means separation was obtained by using Duncan's New MRT test at P = 0.05 level of significance.

RESULTS: As presented in Table 1

CONCLUSIONS: No significant differences in visual injury or yield were observed among the treatments (Table 1).

Table 1. Visual injury and onion yield, cv. Traverse, treated with herbicide and grown near the Muck Crop Research Station, Holland Marsh, Ontario, 2019

Treatments	Rate (g a.i./ha)	% Visual Injury[1]			Yield (t/ha)
		2 July	15 July	7 Aug	
Standard	--	0	0	0	90.4 ns[2]
Standard + hand weeding	--	0	0	0	84.6
Pyroxasulfone	149	0	0	0	92.1
Pyroxasulfone	223	0	0	0	85.2
Pyroxasulfone	298	0	0	0	86.4
Pyroxasulfone + flumioxazin	80	0	0	0	91.8
Pyroxasulfone + flumioxazin	160	0	0	0	88.3
Pyroxasulfone + flumioxazin	266	0	0	0	89.7

[1] not analyses statistically
[2] ns = No significant differences were found among treatments.

Funding for this trial was provided by KI-USA

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

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 VARIOUS FUNGICIDES FOR CONTROL OF ONION SMUT IN YELLOW COOKING ONIONS, 2019

MATERIALS: EVERGOL PRIME (penflufen 22.7%), RANCONA (ipconazole 9.38 g/L), PRO-GRO (carboxin 30% + thiram 30%), 42-S THIRAM (tetramethylthiuram disulfide 42%), SEPRESTO 75 WS (clothianidin 56.25%, imidacloprid 18.75%), DITHANE DG 75 (mancozeb 75%), LORSBAN 15 G (chlorpyrifos 15%)

METHODS: The trial was conducted on organic soil (pH ≈ 6.8, organic matter ≈ 68.1%) naturally infested with *Urocystis colchici* 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 four rows, spaced 42 cm apart, 6 m in length. Onions, cv. Fortress, were seeded (≈ 35 seeds/m) on 16 May using a Stanhay Precision Seeder. Treatments applied at the manufacturers recommended rates were: EVERGOL PRIME, RANCONA and PRO-GRO. A standard treatment of DITHANE at 8.8 kg/ha applied in-furrow along with LORSBAN at 16 kg/ha and a no-fungicide check were also included. Both treatments and pelleting were done by Incotec using standard methods. Two randomly chosen 2 m sections of row and a 2.32 m yield section were staked out in each replicate. Emerged onions were counted within the 2 m sections on 6 June to determine initial stands. Beginning on 11 June and continuing weekly, plants within the 2 m sections were examined for onions lost due to onion smut or damage caused by other pests. Damaged onions were removed and numbers and the cause recorded. The remaining onions within the assigned 2 m sections were removed and visually examined for smut damage at the first true-leaf stage on 14 June and at the 3-leaf stage (15 July). On 27 September, onions from the 2.32 m yield section of row were pulled, sorted by size and weighed to determine yield. Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C), and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C, August 20.2°C and September 16.4°C. Monthly rainfall was below the 10-year average for June (84 mm), July (42 mm), August (46 mm) and average for May (77 mm) and September (62 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm, August 80 mm and September 61 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.10. Means separation was obtained using Fisher's Protected LSD Test at P = 0.05 level of significance.

RESULTS: as presented in Tables 2 & 3

CONCLUSIONS: Significant differences in the incidence of smut at the 1st and 3rd-leaf stages were found among the treatments (Table 2). At the 1st-leaf stage, onions treated with any of the fungicide treatments had less smut compared to the check. At the 3rd-leaf stage, onions treated with EVERGOL PRIME or the DITHANE standard had less smut (3.6 and 1.4 % respectively) than the RANCONA treatment (12.7%) or the check (10.7%). More smut was found in untreated onions at the 1st true leaf stage (21%), compared to smut incidence at the 3-leaf stage (11%). Smut at the 1st leaf stage includes smut found only in the flag leaf which falls off and may not infect the bulb. By the 3rd-leaf stage, smut is located in the bulb, incidence is lower and will result in an unmarketable onion.
No significant differences in emergence, yield, size distribution or onions per meter were found between the treatments (Table 3).

Table 1. Seed treatment label rates for onion seed, cv. Fortress, pelleted by Incotec and grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2019.

#	Treatment	Fungicide Active Ingredients and Label Rates
1	Check seed[1]	–
2	EVERGOL PRIME[1]	penflufen 0.0087 g ai/1,000 seeds
3	RANCONA[1]	ipconazole at 100 g ai/100 g seed
4	PRO-GRO[1]	carboxin 7.50 g ai + thiram 12.5 g ai per kg seed
5	PRO-GRO + *DITHANE in-furrow*[2]	carboxin 7.50 g ai + thiram 12.5 g ai/kg seed + *mancozeb 75% at 8.8 kg/ha*

[1] Pellet also included insecticide SEPRESTO 75 WS (clothianidin 0.18 g ai + imidacloprid 0.6 g ai/1,000 seeds) for maggot control and fungicide 42-S THIRAM (1.875 g ai/kg seed) for damping off control.
[2] Applied along with the insecticide LORSBAN 15 G at 16 kg /ha as part of the standard treatment.

Table 2. Smut incidence for onions, cv. Fortress, treated with various fungicides and grown at Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Treatment[1]	6 June Emergence (plants/m)	Smut Incidence (%)	
		1st True Leaf	3rd-leaf Stage
EVERGOL PRIME	25.1 ns[2]	9.1 a[3]	3.4 a
PRO-GRO + DITHANE	24.3	2.0 a	1.4 a
PRO-GRO	25.1	8.5 a	4.3 ab
RANCONA	23.3	9.9 a	12.7 c
Check	23.5	20.7 b	10.7 bc

[1] All treatments included SEPRESTO 75 WS (clothianidin 0.18 g ai + imidacloprid 0.6 g ai/1,000 seeds) and 42-S Thiram (1.875 g ai/kg seed)
[2] ns = no significant differences were found among treatments.
[3] Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD test.

Table 3. Yield and size distribution for onions, cv. Fortress, treated with various fungicides, pelleted by Incotec and grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Treatment	Yield (t/ha)	Onions/m	Size Distribution[1] (%)		
			Jumbo (>76 mm)	Can No. 1 (45-76 mm)	Cull (<45 mm)
EVERGOL PRIME	28.0 ns[2]	16.1 ns	1.0 ns	79.7 ns	19.3 ns
PRO-GRO + DITHANE	34.6	19.7	0.0	84.5	15.5
PRO-GRO	40.3	18.9	6.0	83.8	10.2
RANCONA	34.5	15.7	1.6	89.8	8.6
Check	34.8	18.1	1.7	88.5	9.8

[1] Percentage was determined by weight
[2] ns = no significant differences were found among the treatments

Funding was provided by Incotec for seed pelleting, by Bayer Crop Science for the Sepresto insecticide and by the Plant Production Systems of the Ontario Agri-Food Innovation Alliance. Dr. Taylor's effort was supported under the United States Multi-State project, W-3168.

CROP: Yellow cooking onions (*Allium cepa* L.), cv. La Salle
PEST: Stemphylium leaf blight (*Stemphylium vesicarium* (Wallr.))

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

TITLE: EFFECT OF LUNA TRANQUILITY AND CHATEAU COMBINATIONS ON STEMPHYLIUM LEAF BLIGHT OF ONIONS, 2019

MATERIALS: CHATEAU (flumioxazin 51.1%), LUNA TRANQUILITY (fluopyram 125 g/L, pyrimethanil 375 g/L)

METHODS: Onions, cv. La Salle, were direct seeded (35 seeds/m) on 17 May using a Stanhay precision seeder into organic soil (organic matter ≈ 58.6%, pH ≈ 7.1) 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 eight rows (40 cm apart), 6 m in length. Treatments were: CHATEAU at 70 and 140 g/ha, CHATEAU at 70 g/ha + LUNA TRANQUILITY at 1.2 L/ha, CHATEAU at 140 g/ha + LUNA TRANQUILITY at 1.2 L/ha and LUNA TRANQUILITY at 1.2 L/ha. An untreated check was also included. CHATEAU treatments were applied on 25 June and LUNA TRANQUILITY was applied on 11, 22 July and 8 and 13 August using a tractor-mounted sprayer fitted with AI TeeJet Air Induction Even Flat spray tips (AI9503 EVS) at 620 kPa to deliver 500 L solution/ha. On 26 August, 20 onions were pulled from each replicate. Leaves were removed and green leaves sorted into classes based on the percentage of the leaf area infected with stemphylium. The seven classes were: 0= no disease, 1 = 1-4%, 2 = 5-10%, 3 = 11-25%, 4 = 26-50%, 5 = 51-75%, 6 > 75% infected with stemphylium. These classes were used to determine the disease severity index (DSI) using the following formula:

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

On 19 September, the onions in two 2.32 m sections of row were pulled from the middle six rows for a yield sample. Onions were weighed and graded for size on 22 October to determine yield.
Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C) and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C, August 20.2°C and September 16.4°C. Monthly rainfall was below the 10-year average for June (84 mm), July (42 mm), August (46 mm) and average for May (77 mm) and September (62 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm, August 80 mm and September 61 mm. Data were analyzed using the General Analysis of Variance function of Statistix V.10. Means separation was obtained by using Fisher's Protected LSD test at $P = 0.05$ level of significance.

RESULTS: Stemphylium incidence was moderate in the three oldest leaves and no significant differences in stemphylium severity were observed among the treatments on 26 August assessment (Table 1). Stemphylium incidence and severity for onions sprayed with low or high rate of CHATEAU did not differ from the LUNA TRANQUILITY treated onions or the untreated check. No significant differences in yield and percent marketable were observed among the treatments (Table 2).

CONCLUSIONS: In 2019, one application of CHATEAU did not increase stemphylium incidence or severity.

Table 1. Stemphylium incidence and severity index (DSI) for onions, cv. La Salle, treated with LUNA TRANQUILITY and CHATEAU combinations at the Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Treatment	Rate of Chateau (g/ha)	Stemphylium Incidence[1] (%)	% Leaves rated 0 or 1	DSI[2]	Healthy Leaves/Plant
CHATEAU + LUNA	140	40.7 ns[3]	78.2 ns	16.3 ns	4.0 ns
CHATEAU + LUNA	70	53.0	64.2	26.2	3.3
CHATEAU	70	60.6	63.1	25.7	2.5
CHATEAU	140	61.1	61.7	26.4	2.6
LUNA TRANQUILITY	-	68.0	52.2	31.0	2.0
Check	-	76.7	45.3	36.3	1.4

[1] On 26 Aug, leaves of 20 plants/replicate were removed and sorted into the following classes: 0 = 0 Stemphylium, 1 = 1-4%, 2 = 5-10%, 3 = 11-25%, 4 = 26-50%, 5 = 51-75%, 6 = >75% of the leaf area diseased.

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

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

[3] ns indicates no significant differences were found among treatments

Table 1. Yield and size distribution for onions, cv. La Salle, treated with various fungicides and grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Treatment	Yield (t/ha)	% Mkb	Size Distribution %[1]		
			Jumbo (>76 mm)	Can No. 1 (45-76 mm)	Cull (<45 mm)
CHATEAU Low	59.3 ns[2]	96.2 ns	10.9 ns	85.3 ns	3.8 ns
CHATEAU High	56.0	94.1	11.4	87.4	5.9
CHATEAU Low + LUNA	68.1	96.1	15.9	80.2	3.9
CHATEAU High + LUNA	50.0	95.7	8.2	87.4	4.3
LUNA	44.0	95.7	4.3	91.3	4.3
Check	65.2	99.5	11.9	87.7	0.5

[1] Percentage was determined by weight.

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

Funding for this project was provided by the Plant Production Systems of the Ontario Ministry of Agriculture and Food and Ministry of Rural Affairs and the University of Guelph partnership.

CROP: Yellow cooking onions (*Allium cepa* L.), cv. La Salle
PEST: Stemphylium leaf blight (*Stemphylium vesicarium* (Wallr.))

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

TITLE: EVALUATION OF VARIOUS FUNGICIDES FOR CONTROL OF STEMPHYLIUM LEAF BLIGHT ON ONIONS, 2019

MATERIALS: LUNA TRANQUILITY (fluopyram 125 g/L, pyrimethanil 375 g/L), APROVIA TOP (benzovindiflupyr 78 g/L, difenoconazole 117 g/L), T 77 (*Trichoderma atroviride* strain 77B < 2.5 x 109 spores/g), PRISTINE (pyraclostrobin 25.2%, boscalid 12.8%), SERCADIS (fluxapyroxad 300 g/L)

METHODS: Onions, cv. La Salle, grown as transplants (3 seeds per plug) were transplanted with 10 cm in-row spacing on 24 May into organic soil (organic matter ≈70.2%, pH ≈6.1) 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 eight rows (40 cm apart), 5 m in length. Treatments were: LUNA TRANQUILITY at 1.2 L/ha, APROVIA TOP at 767 mL/ha, T 77 at 250 g/ha, PRISTINE at 1.3 kg/ha and SERCADIS at 666 mL/ha. An untreated check was also included. Treatments were applied on 11, 22, 31 July using a tractor-mounted sprayer fitted with hollow cone D-3 spray nozzles at 620 kPa to deliver 500 L solution/ha. On 13 August, three leaves on 20 onions per replicate were visually examined for stemphylium symptoms and rated on a 0-4 scale where 0 = no stemphylium symptoms, 1 = 1-4% of leaf, 2 = 5-10%, 3 = 11-25%, 4 = 26-50%, 5 = 51-75% and 6 = >75% of leaf area infected with stemphylium symptoms. These classes were used to determine the disease severity index (DSI) using the following formula:

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

On 11 September, the onions in two 2.32 m sections of row were pulled from the middle six rows for a yield sample. Onions were weighed and graded for size on 15 October to determine yield**.**
Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C) and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C, August 20.2°C and September 16.4°C. Monthly rainfall was below the 10-year average for June (84 mm), July (42 mm), August (46 mm) and average for May (77 mm) and September (62 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm, August 80 mm and September 61 mm.
Data were analyzed using the General Analysis of Variance function of Statistix V.10. Means separation was obtained by using Fisher's Protected LSD test at $P = 0.05$ level of significance.

RESULTS: as presented in Tables 1 & 2

CONCLUSIONS: No significant differences in stemphylium incidence or severity were found among the treatments at any of the assessment dates (Table 1). No significant differences in yield or percent marketable were found among the treatments (Table 2).

Table 1. Stemphylium disease ratings for onions, cv. La Salle, treated with various fungicides and grown at Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Treatments	Incidence[1] (%)	% Leaves rated 0 or 1	DSI[2]	Healthy Leaves/Plant
SERCADIS	61.8*	65.3 ns[3]	21.4 ns	2.3 ns
APROVIA TOP	64.0	56.9	24.4	2.2
T-77	66.7	60.3	22.1	1.9
PRISTINE	66.9	55.6	24.5	2.0
LUNA TRANQUILITY	69.5	57.2	26.5	1.7
Check	75.7	54.6	26.5	1.5

[1] On 13 Aug, leaves of 20 plants/replicate were removed and sorted into the following classes: 0 = 0 stemphylium, 1 = 1-4%, 2 = 5-10%, 3 = 11-25%, 4 = 26-50%, 5 = 51-75%, 6 = >75% of the leaf area diseased.

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

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

[3] ns indicates no significant differences were found among treatments

* No significant differences were found among treatments at P = 0.05 Fisher's Protected LSD test; however, SERCADIS was significantly different from the check using Dunnett's test.

Table 2. Yield data for onions, cv. La Salle, treated with fungicides and grown near Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Treatments	Yield (t/ha)	% Mkb	Size Distribution (%)[1]		
			Jumbo (>76 mm)	Can No. 1 (45-76 mm)	Small (<45 mm)
SERCADIS	68.2 ns[2]	98.5 ns	19.2 ns	79.4 ns	1.4 ns
Check	66.3	98.4	25.8	72.5	1.7
T77	65.9	98.9	19.8	79.0	1.2
PRISTINE	65.9	98.5	13.4	85.1	1.5
APROVIA TOP	63.0	97.6	12.0	85.7	2.3
LUNA TRANQUILITY	60.4	98.4	19.3	79.1	1.6

[1] Percentage was determined by weight.

[2] ns = no significant differences were found among the treatments

Funding for this project was provided by Plant Production Systems of the Ontario Ministry of Agriculture, Food and Rural Affairs and the University of Guelph partnership and the Bradford Co-operative and Storage.

CROP: Yellow cooking onions (*Allium cepa* L.), cv. Fortress
PEST: Stemphylium leaf blight (*Stemphylium vesicarium* (Wallr.) E.G. Simmons)

AUTHORS: STRICKER S[1], GOSSEN BD[2] & MCDONALD MR[1]
[1]Dept. of Plant Agriculture, University of Guelph, Guelph, ON, Canada N1G 2W1
[2]Agriculture and Agri-Food Canada, Saskatoon Research and Development Centre

TITLE: FUNGICIDE APPLICATION TIMING FOR MANAGEMENT OF STEMPHYLIUM LEAF BLIGHT OF ONION, 2019

MATERIALS: APROVIA (benzovindiflupyr 100 g/L), BRAVO ZN (chlorothalonil 500 g/L), EVERGOL PRIME (22.7% penflufen), FARMORE F300 (33.3% mefenoxam, MAXIM 4FS [40.3% fludioxonil], DYNASTY [9.6% azoxystrobin])

METHODS: Onions, cv. Fortress, were direct seeded (35 seeds/m) on 17 May 2019 using a Stanhay Precision Seeder into organic soil (organic matter ≈ 69.3, pH ≈ 6.1) at the Muck Crops Research Station, King, Ontario in a randomized complete block design with four replicates. Each plot consisted of two adjacent beds, each 6 m x 1.75 m and seeded with four paired rows, with 7.5 cm between paired rows and 35 cm between pairs of rows. Blocks were separated by a 1.5 m-wide pathway.
The treatments consisted of an untreated control, two fungicide seed treatments (EVERGOL PRIME or FARMORE F300) that either received no foliar fungicide in the growing season or were sprayed every 7–10 days, weekly sprays starting at 2-leaf growth stage, and two forecasting models; TOMCAST at a disease severity value threshold of 15 and a slightly modified version of BSPCAST. EVERGOL PRIME was applied at a rate of 2.5 g ai/kg seed, and the FARMORE F300 was a combination of DYNASTY applied at 0.025 g ai/kg seed, APRON XL at 0.075 g ai/kg seed, and MAXIM 4FS at 0.0275 g ai/kg seed. Foliar sprays of APROVIA (750 mL/ha in 500 L/ha of water) alternated with BRAVO ZN (3.6 L/ha in 500 L/ha of water) were applied at several different timings. A scale of 0 to 4 was used to assess disease severity of the three oldest leaves for 20 onions per plot and separate them into classes: 0 = no yellowing, 1 = 1–10% yellowed, 2 = 11–25% yellowed, 3 = 26–50% yellowed, 4 > 51% yellowed area. A disease severity index (DSI) was calculated as:

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

On 18 September, onion plants in two 2.3-m-long sections were harvested from the middle rows of each plot, weighed, and graded to determine yield**.** Data were analyzed using the GLIMMIX function of SAS version 9.4 (SAS Institute 2017). Means separation was assessed using Tukey's honest significant difference (HSD) test at $P = 0.05$. Compared to the previous 10-year average, ;the air temperature in 2019 was below average for May (11.4°C), average for June (17.5°C), August (19.4°C) and September (15.8°C), and above average for July (22.3°C). The 10-year average temperatures were as follows: May (14.3°C), June (18.4°C), July (21.1°C), August (20.2°C), and September (16.4°C). Monthly rainfall was below the 10-year average for June (84 mm), July (42 mm) and August (46 mm), and within average for May (77 mm) and September (62 mm). The 10-year rainfall averages were: May (77 mm), June (100 mm), July (93 mm), August (80 mm), and September (61 mm).

RESULTS: As presented in Tables 1 and 2

CONCLUSIONS: Disease pressure was relatively low in 2019. Foliar fungicide applications made weekly or timed using forecasting models did not reduce blight incidence or severity relative to the untreated control. The weekly schedules resulted in seven foliar applications of fungicide. The forecasting models reduced fungicide applications, with six applications recommended by TOMCAST and five applications by BSPCAST. However, EVERGOL PRIME fungicide seed treatment in combination with weekly foliar sprays reduced incidence by 27% and severity by 43% compared to the unsprayed control (Table 1). This

is consistent with the 2018 field trial, where this seed treatment reduced incidence by 31% and severity by 53% relative to the control. There were no differences in yield among treatments.

Table 1. The effect of fungicide applications on Stemphylium leaf blight incidence and severity on 15 August 2019, for onions, cv. Fortress, grown at the Muck Crops Research Station.

Treatment	# Applications	Incidence (%)	Severity (DSI)
Control (no spray)	0	96 a[1]	37 a
FARMORE F300 seed coating (no spray)	0	84 ab	34 a
FARMORE F300 seed coating + weekly spray	7	88 ab	30 ab
BSPCAST	5	85 ab	28 ab
EVERGOL PRIME seed coating (no spray)	0	84 ab	29 ab
Weekly spray	7	81 ab	27 ab
TOMCAST	6	80 ab	29 ab
EVERGOL PRIME seed coating + weekly spray	7	70 b	21 b

[1] Means in column followed by the same letter do not differ at $P = 0.05$ based on Tukey's HSD test.

Table 2. Effect of fungicide application on yield and size distribution (by weight) for onions, cv. Fortress, grown at the Muck Crops Research Station in 2019.

Treatment	Yield (t/ha)	Size distribution by weight (%)		
		Cull (<32 mm)	Can. No. 1 (32–76 mm)	Jumbo (>76 mm)
Control (no spray)	74.3 ns[1]	0.8 ns	86.7 ns	12.5 ns
TOMCAST	75.2	1.3	87.5	11.1
EVERGOL PRIME seed coating (no spray)	75.1	3.3	87.3	9.4
FARMORE F300 seed coating + weekly spray	74.3	1.3	80.3	18.4
Weekly spray	73.1	0.6	84.8	14.6
FARMORE F300 seed coating	71.7	1.0	88.6	10.4
EVERGOL PRIME seed coating + weekly spray	71.7	2.9	89.5	7.6
BSPCAST	70.1	1.8	93.7	4.5

[1] ns = No significant differences ($P = 0.05$) were found among the treatments.

Funding for this project was provided by the Ontario Agri-Food Innovation Alliance, the Bradford Cooperative Storage Inc., and the Fresh Vegetable Growers of Ontario.

CROP: Yellow cooking onions (*Allium cepa* L.), cv. Traverse
PESTS: Stemphylium leaf blight (*Stemphylium vesicarium* (Wallr.) Simmons)
Onion downy mildew (*Peronospora destructor* [Berk] Casp.

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

TITLE: EVALUATION OF EXPERIMENTAL PRODUCTS FOR CONTROL OF DISEASES IN YELLOW COOKING ONIONS, 2019

MATERIALS: experimental Suncor products (A, B, C, N, SN, HAF, GUE, V, T), LUNA TRANQUILITY (fluopyram 125 g/L, pyrimethanil 375 g/L), ORONDIS ULTRA (oxathiapiprolin 30 g/L, mandipropamid 250 g/L), SYLGARD 309 (siloxylated polyether 76%)

METHODS: Onions, cv. Traverse, were direct seeded (≈ 35 seed/m) into organic soil (organic matter ≈ 67.3%, pH ≈ 6.8) on 21 May using a Stanhay precision seeder, 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 four rows (40 cm apart), 5 m in length. Treatment 2 received a drench application on 25 June using a single Syngenta vegetable 65-06 nozzle at 275 kPa pressure calibrated to deliver 2,000 L/ha. Starting when onions were at the 4-leaf stage, foliar treatments were applied on 18, 25 July, 1, 9 and 15 August using a CO_2 backpack sprayer equipped with four TeeJet 8002 VS fan nozzles spaced 40 cm apart and calibrated to deliver 500 L/ha at 275 kPa. See Table 1 for details. On 23 August, 20 onions (10 from each of the inside two rows) were pulled from each replicate. Leaves were removed and green leaves sorted into categories based on the percentage of the leaf area infected with stemphylium. The seven categories were: 0 = 0-1%, 1 = 2-4%, 2 = 5-10%, 3 = 11-25%, 4 = 26-50%, 5 = 51-75%, 6 = >75%. Plots were visually inspected for downy mildew lesions weekly. On 12 September onions in two 2.32 m sections of row from the middle two rows per replicate were harvested. On 4 November, onions were sorted by size and weighed to determine yield. Compared to the previous 10-year average, air temperatures in 2018 were above average for May (15.8°C), August (21.9°C), September (17.5°C), average for June (18.4°C), July (22.0°C) and below average for October (8.3°C). The 10-year average temperatures were: May 13.9°C, June 18.6°C, July 21.2°C, August 20.1°C, September 16.0°C and October 9.4°C. Monthly rainfall was above the 10-year average for August (109 mm), average for May (82 mm), July (104 mm), October (69 mm) and below average for June (59 mm) and September (20 mm). The 10-year rainfall averages were: May 74 mm, June 101 mm, July 97 mm, August 75 mm, September 67 mm and October 72 mm. Data were analysed using the General Analyses of Variance function of the Linear Models section of Statistix V.10. Means separation was obtained using Fisher's Protected LSD test with P = 0.05 level of significance.

RESULTS & DISCUSSION: Stemphylium leaf blight (SLB) appeared later in the season and pressure was lower than average in 2019. No significant differences in SLB incidence and severity were found among the treatments (Table 2). The weather was not conducive for the development of onion downy mildew in 2019 and downy mildew was not observed in the trial.
Significant differences in yield (t/ha) were found among treatments (Table 3). Onions sprayed with treatment 2 had a lower yield than untreated onions and onions sprayed with treatment 5.

CONCLUSIONS: The experimental treatments used in 2019 did not reduce stemphylium incidence. Experimental treatments 2 and 3 had the highest SLB incidence and the lowest yields.

Table 1. Suncor products, application rates and timing for onions, cv. Traverse, grown near the Muck Crops Research Station, Holland Marsh, Ontario, 2019.

#	Soil Drench at 2-Leaf Stage[1]	Foliar Applications[2]
1	--	--
2	0.15% A + 0.05% C + 0.5% HAF	0.15% A + 0.05% C + 0.5% HAF-01
3	--	0.15% M + 0.1% N + 0.05% SN + 0.05% GUE-01
4	--	0.15% M + 0.1% N + 0.05% SN + 0.1% V + 0.05% GUE-01
5	--	0.15% M + 0.05% T + 0.05% SN + 0.05% GUE-01
6	--	LUNA TRANQUILITY or ORONDIS ULTRA[3]

[1] Applied on 25 June as an over-the-row drench using a single vegetable nozzle 65-06
[2] Applied on 18, 25 July, 1, 9, 15 August using four TeeJet 8002 VS fan nozzles.
[3] LUNA TRANQUILITY (LT) was applied on 18 July, 9 & 15 August. ORONDIS ULTRA was applied 25 July & 1 August.

Table 2. Stemphylium (SLB) incidence and severity for onions, cv. Traverse, treated with experimental products and grown near the Muck Crops Research Station, Holland Marsh, Ontario, 2019.

#[1]	Foliar Treatment	SLB Incidence[2] (%)	DSI	% Leaves rated 0-1	Healthy Leaves/Plant
6	LT or ORONDIS ULTRA	50.9 ns[3]	20.1 ns	71.1 ns	3.2 ns
1	check	52.4	21.6	69.0	2.8
5	M + T +SN + GUE	54.3	22.9	66.5	2.7
4	M + N + SN + V + GUE	58.9	24.7	62.4	2.5
3	M + N + SN + GUE	64.2	27.7	57.9	2.2
2	A + C + HAF	65.8	26.9	61.6	1.9

[1] Refer to Table 1 for application methods, products used and timing.
[2] On 23 August leaves of 20 plants/replicate were removed and sorted into the following classes: 0 = 0-1% stemphylium, 1 = 2-4%, 2 = 5-10%, 3 = 11-25%, 4 = 26-50%, 5 = 51-75%, 6 = >75% of the leaf area infected with SLB.
[3] ns indicates no significant differences were found among the treatments.

Table 3. Yield and size distribution for onions, cv. Traverse, treated with experimental products and grown near the Muck Crops Research Station, Holland Marsh, Ontario, 2019.

#[1]	Treatment	Yield (t/ha)	% Mkb	Size Distribution (%)[2]			Wgt/bulb (g)
				Jumbo (>76mm)	Can.No.1 (45-76mm)	Cull (<45mm)	
5	M + T +SN + GUE	60.8 a[3]	97.2 ns[4]	2.4 ns	94.8 ns	4.5 ns	110.9 ns
1	Check	57.4 ab	96.5	0.0	96.5	3.5	100.5
6	LT or ORONDIS ULTRA	52.8 abc	97.1	0.0	97.1	2.9	95.0
4	M + N + SN + V + GUE	51.5 abc	96.6	0.5	96.0	3.4	97.1
3	M + N + SN + GUE	50.8 bc	95.5	0.0	95.5	2.8	91.5
2	A + C + HAF	45.7 c	92.0	0.5	91.4	8.0	87.7

[1] Refer to Table 1 for application methods, products and timing.
[2] Percentage values were determined using weight.
[3] Numbers in a column followed by the same letter at not significantly different at P = 0.05, Fisher's Protected LSD test.
[4] ns= no significant differences were found at P = 0.05, Fisher's Protected LSD test.

CROP: Onion (*Allium cepa* L.), cv. SV4643
PEST: Onion downy mildew (*Peronospora destructor* (Berk.) Casp. in Berk.)

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

TITLE: EVALUATION OF FUNGICIDES FOR CONTROL OF DOWNY MILDEW ON DRY BULB ONIONS, 2019

MATERIALS, DITHANE 750 F (mancozeb 75%), ORONDIS ULTRA PREMIX (oxathiapiprolin 30 g/L, mandipropamid 250 g/L), REASON 500 SC (fenamidone 500 g/L), RIDOMIL GOLD MZ 68 WG (metalaxyl-M and S-isomer 4%, mancozeb 64%), ZAMPRO (ametoctradin 300 g/L, dimethomorph 225 g/L), QUADRIS TOP (azoxystrobin 200 g/L, difenoconazole 125 g/L), PHOSTROL (Mono- and dibasic sodium, potassium, and ammonium phosphites 53.6%), SYLGARD 309 (siloxylated polyether 76%),

METHODS: Red onions, cv. SV4643, grown as transplants (3 seeds per plug) were transplanted with 10 cm in-row spacing on 17 May into organic soil, (organic matter ≈ 67.3%, pH ≈ 6.8) 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 four rows spaced 40 cm apart, and 6 m in length. Treatments were applied as foliar sprays using a CO_2 back pack sprayer equipped with four TeeJet 8002 fan nozzles calibrated to deliver 500 L/ha at 275 kPa. Treatments were: DITHANE at 3.25 kg/ha, ORONDIS ULTRA PREMIX at 350 mL/ha + SYLGARD at 0.25% v/v, ZAMPRO at 1.0 L/ha + SYLGARD at 0.25% v/v, REASON at 400 mL/ha, RIDOMIL MZ at 2.5 kg/ha, QUADRIS TOP at 1.0 L/ha and PHOSTROL at 4.3 L/ha. An untreated check was also included. Treatments were applied on 16, 23 July and 2 August. On 2, 13 and 24 August, all onions in each replicate were visually examined for the presence of downy mildew (DM) lesions. On 23 August, onions in two, 2.32 m sections of row per replicate were pulled. On 17 October, onions were removed from storage, sorted into size categories, weighed and counted to determine yield.
Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C and August 20.2°C. Monthly rainfall was below the 10-year average for June (84 mm), July (42 mm), August (46 mm) and average for May (77 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm and August 80 mm.
Yield data were analyzed using the General Analysis of Variance function of Statistix V.10. Means separation was obtained by using Fisher's Protected LSD test at $P = 0.05$ level of significance.

RESULTS: as presented in Table 1 & 2

CONCLUSIONS: The weather in 2019 was not conducive to the development of downy mildew in onions. No downy mildew was observed in the trial (Table 1). No significant differences in yield or size distribution were observed among the treatments (Table 2).

Table 1. Downy mildew (DM) incidence for red onions, cv. SV4643, treated with fungicides and grown near the Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Treatment	Product rate (per ha)	DM Lesions/plot[1]		
		2 Aug	13 Aug	24 Aug
DITHANE	3.25 kg	0	0	0
ORONDIS ULTRA+ SYLGARD	350 mL + 0.25% v/v	0	0	0
ZAMPRO+ SYLGARD	1.0 L + 0.25% v/v	0	0	0
RIDOMIL GOLD MZ	2.5 kg	0	0	0
REASON 500 SC	400 mL	0	0	0
QUADRIS TOP	1.0 L	0	0	0
PHOSTROL	4.3 L	0	0	0
Check	--	0	0	0

[1] Data was not analysed statistically.

Table 2. Yield and size distribution for red onions, cv. SV4643, treated with fungicides and grown near the Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Treatment	Yield (t/ha)	% Mkb	Size Distribution %[1]		
			Jumbo (>76 mm)	Can No. 1 (45-76 mm)	Cull (<45 mm)
DITHANE	71.2 ns[2]	99.0 ns	34.1 ns	64.8 ns	1.0 ns
ORONDIS + SYLGARD	73.1	99.0	37.7	61.4	1.0
ZAMPRO + SYLGARD	68.7	99.0	38.7	60.3	1.0
RIDOMIL GOLD	71.2	99.2	39.9	59.2	0.8
REASON	67.6	98.4	33.8	64.6	1.6
QUADRIS TOP	72.1	99.1	40.6	58.6	0.9
PHOSTROL	68.1	99.3	34.9	64.3	0.7
Check	71.0	99.4	39.3	60.1	0.6

[1] Percentage was determined by weight.
[2] ns = no significant differences at P = 0.05, Fisher's Protected LSD Test

Funding for this project was provided by the Plant Production Systems of the Ontario Agri-Food Innovation Alliance and by the California Garlic and Onion Research Advisory Board.

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

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

TITLE: EVALUATION OF PHOSPHORUS REQUIREMENTS ON ORGANIC (MUCK) SOIL ON YIELD OF ONIONS, 2019

RATIONALE: This trial site was established in 2010 as part of an ongoing phosphorus management project to determine the effect of zero applied phosphorus to the yields of onions and carrots over time. Onions and carrots have been grown in rotation on plot areas designated as a zero-phosphorus check and a commercial phosphorus rate (100 kg P_2O_5). The objective of this work is to determine the number of cropping seasons needed to reduce soil phosphorus levels to a number in which a yield response would be observed when phosphorus is applied.

MATERIALS: mono ammonium phosphate (11% NH_4, 52% P_20_5, 1.5% SO_4)

METHODS: Onions, cv. La Salle, were transplanted into organic soil (organic matter ≈ 64.7 %, pH ≈ 6.9) on 23 May using a mechanical transplanter near Muck Crops Research Station in the Holland Marsh, Ontario. On 22 May fertilizer treatments were applied by hand to plot areas. The commercial phosphorus rate treatment received MicroEssentials® SZ™ (MESZ) at 100 kg P/ha and the zero-phosphorus check received no phosphorus fertilizer. Both treatments received ammonium sulfate applied at 90 kg N/ha and potassium using ASPIRE (0-0-50) at 40 kg K/ha and sulphate of potash-magnesia (0-0-22 K-Mag) at 40 kg K/ha. A randomized complete block design with four replicates per treatment was used. Each replicate consisted of 8 rows (40 cm apart), 20 m in length. On 13 September onions from four 2.32 m sections of row were harvested for a yield sample. On 24 October onions were graded for size and weighed to determine yield. Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C), October (9.4°C) and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C, August 20.2°C, September 16.4°C and October 9.7°C. Monthly rainfall was above the 10-year average for October (106 mm), average for May (77 mm), September (62 mm), and below average for June (84), July (42 mm) and August (46 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm, August 80 mm, September 61 mm and October 74 mm. Data were analyzed using Statistic V. 10, and a General Analysis of Variance for linear models was used. Means were compared using Fisher's Protected LSD test at P = 0.05 level of significance.

RESULTS: No significant differences in yield or size distribution were found between the treatments (Table 1).

CONCLUSIONS: The pre-plant P soil levels for the commercial P treatment (127 ppm) and the zero P treatment (74 ppm) are in the no response and rare response ratings respectively (Vegetable Production Recommendations, 2010-11, Pub 363 p. 13). Phosphorus fertilizer applied to the commercial P rate treatments in 2019 did not result in a significant crop response. These results validate the recommendation that additional P does not increase overall yield of carrots and that excess phosphorus may be lost to leaching.

Table 1. Pre-plant soil phosphorus (P) and yield for onions, cv. La Salle, grown on zero- and commercial rates of phosphorus plots, near Muck Crops Research Station, Holland Marsh, 2019.

Treatment	Pre-plant P (ppm)	Yield (t/ha)	bu/A	Size Distribution (%)		
				Jumbo (>76 mm)	Can. No. 1 (45-76 mm)	Cull (<45 mm)
Commercial phosphorus[1]	127.3	19.8 ns[2]	319.6 ns	0.66 ns	85.4 ns	15.4 ns
Zero-phosphorus	74.4	16.0	259.7	0.25	82.1	8.0

[1] 100 kg P_2O_5/ha applied since 2010

[2] ns indicates that no significant differences were found between the treatments

Funding for this project was provided by the Plant Production Systems of the Ontario Ministry of Agriculture and Food and Ministry of Rural Affairs and the University of Guelph partnership.

CROP: Celery (*Apium graveolens*) cv. TZ 6200
PEST: Celery anthracnose (*Colletotrichum fioriniae*)

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

TITLE: EVALUATION OF INSECTICIDES FOR THE CONTROL OF CARROT WEEVIL IN CELERY, 2019

MATERIALS: DELEGATE (spinetoram 25%), EXIREL SC (cyantraniliprole 100 g/L), VERIMARK SC (cyantraniliprole 200 g/L), RIMON (novaluron 10%)

METHODS: The trial was conducted on organic soil at the Muck Crops Research Station (pH ≈ 7.1 organic matter ≈ 59%), Holland Marsh, Ontario. Celery, cultivar TZ 6200, was seeded in the greenhouse on 15 February, and hand transplanted in the field on 7 May, with in-row plant spacing of 18 cm. A randomized block arrangement with four replicates was used. Each replicate consisted of 3 rows, 55 cm apart and 5 m in length.

Treatments were: DELEGATE at 200 mL/ha, EXIREL at 1500 mL/ha and RIMON at 603 mL/ha applied as foliar sprays. Treatments were applied on 17 May 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 275 kPa. Prior to transplanting, drench applications of VERIMARK at 4.32 mL/tray and DELEGATE at 3.75 g/tray were applied in 500 mL/tray using a watering can. An untreated check was also included. Carrot weevil oviposition pits were counted on five celery plants/treatment on 27, 30 May, 5, 14 and 19 June to determine product efficacy.

On 19 August, 15 celery plants were harvested from the center row of each replicate and inspected for the presence of carrot weevil damage based on visual symptoms such as chewing at the base of the celery and the number of damaged plants was recorded. Celery was sorted into marketable and unmarketable categories based on the presence of carrot weevil feeding damage. Celery in both categories were counted and weighed to determine marketable yield. Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C) and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C and August 20.2°C. Monthly rainfall was below the 10-year average for June (84 mm), July (42 mm), August (46 mm) and average for May (77 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm and August 80 mm.

All data were analyzed using the General Analysis of Variance function of Statistics V.10. Means separation was obtained using Fisher's Protected LSD test with $P = 0.05$ level of significance.

RESULTS: as presented in Table 1

CONCLUSIONS: Celery was established early to expose the plants to early carrot weevil feeding and egg laying. Damage caused by carrot weevil was has high at the final assessment in August, however insecticide treatments did not provide any control of the pest (Table 1). No significant differences were found in percentage of marketable celery.

Table 1. Carrot weevil oviposition pits and marketable yield for celery, cv. TZ 6200, treated with insecticides and grown at Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Treatment	Carrot Weevil Damage/Harvest Incidence (%)	Total Number Ovipostion Pits	% Marketable
DELEGATE - Drench	40.0 ns[1]	4.8 ns	79.9 ns
RIMON	41.7	12.8	78.6
Check	42.6	8.0	91.2
EXIREL	50.8	8.5	68.5
VERIMARK - Drench	56.7	5.8	77.3
DELEGATE	58.3	12.8	70.0

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

Funding for this project was provided by the Plant Production Systems of the Ontario Agri-Food Innovation Alliance, the Fresh Vegetable Growers of Ontario and the Bradford Co-operative and Storage.

CROP: Celery (*Apium graveolens*) cv. TZ 6200
PEST: Celery anthracnose (*Colletotrichum fioriniae*)

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

TITLE: EVALUATION OF FUNGICIDES FOR THE CONTROL OF CELERY LEAF CURL (ANTHRACNOSE), 2019

MATERIALS: BRAVO ZN (chlorothalonil 500 g/L), QUADRIS FLOWABLE (azoxystrobin 250 g/L), FONTELIS (penthiopyrad 200 g/L), SWITCH (cyprodinil 37.5%, fludioxinil 25.5%), MIRAVIS DUO (pydiflumetofen 7.5%, difenoconazole 12.5%), MIRAVIS PRIME (pydiflumetofen 12.8%, fludioxonil 21.4%)

METHODS: The trial was conducted on organic soil near the Muck Crops Research Station (pH ≈ 7.0, organic matter ≈ 65.6%), Holland Marsh, Ontario. Celery, cultivar TZ 6200, was seeded in the greenhouse on 4 April, and mechanically transplanted into the field on 7 June, with in-row plant spacing of 18 cm. A randomized block arrangement with four replicates was used. Each replicate consisted of three rows, 55 cm apart and 5 m in length. Treatments were: MIRAVIS PRIME at 1 L/ha, MIRAVIS DUO at 1 L/ha, FONTELIS at 1.75 L/ha, BRAVO ZN at 2.4 L/ha and QUADRIS FLOWABLE at 1.12 L/ha alternated with SWITCH at 975 g/ha. An untreated check was also included. Application dates for MIRAVIS DUO and MIRAVIS PRIME were 11 July, 1, 8, 16 and 28 August. The other treatments were applied on 11, 23 July, 1, 8, 16 and 28 August. Treatments and inoculant were applied using a CO_2 backpack sprayer equipped with four TeeJet 8002 VS fan nozzles spaced 40 cm apart. An inoculant of *Colletotrichum fioriniae* was produced from freshly collected diseased celery leaves, grown on V8 agar at 25°C and allowed to colonize the plate. On 15 July, conidia were scraped from the plates and suspended in sterile water to a concentration of 10^5 spores/mL and immediately applied at the rate of 300 mL/replicate. The plants in the inside row of each replicate were counted on 17 July, then were visually examined for disease symptoms weekly. On 20 September, 15 celery plants were harvested from the center row of each replicate and inspected for leaf curl based on visual symptoms such as leaf cupping and petiole twisting and the presence of lesions in the heart of the celery and number of diseased plants recorded. Celery was trimmed to 40 cm, sorted into marketable and unmarketable categories based on the presence of leaf curl symptoms remaining after trimming. Celery in both categories were counted and weighed to determine marketable yield. Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), and average for June (17.5°C), August (19.4°C) and September (15.8°C). The 10-year average temperatures were: June 18.4°C, July 21.1°C, August 20.2°C and September 16.4°C. When compared to the 10-year average, monthly rainfall was average for September (62 mm), and below average for June (84 mm), July (42 mm) and August (46 mm). The 10-year rainfall averages were: June 100 mm, July 93 mm, August 80 mm and September 61 mm. All data were analyzed using the General Analysis of Variance function of Statistics V.10. Means separation was obtained using Fisher's Protected LSD test with P = 0.05 level of significance.

RESULTS: as presented in Tables 1 & 2

CONCLUSIONS: The incidence of leaf curl increased through August and by 22 August significant differences in leaf curl incidence were found among the treatments (Table 1). Celery treated with MIRAVIS PRIME, MIRAVIS DUO, BRAVO ZN or SWITCH alternated with QUADRIS had less disease than untreated celery. By 29 August, celery treated with MIRAVIS PRIME had significantly less disease (24%) than celery treated with FONTELIS (57%) or the untreated check (45%). Significant differences in leaf curl incidence in the harvest sample were found among the treatments (Table 2). Celery treated with SWITCH alternated with QUADRIS, BRAVO ZN, or MIRAVIS PRIME had less disease than the untreated check. No differences in the percent marketable or the weight of marketable heads were found among the treatments (Table 2).

Table 1. Leaf curl incidence and area under the disease progress curve (AUDPC) for celery, cv. TZ 6200, inoculated with *Colletotrichum acutatum*, treated with various fungicides and grown near Muck Crop Research Station, Holland Marsh, Ontario 2019.

Treatment	Leaf Curl Incidence							AUDPC[1]
	17 Jul	25 Jul	1 Aug	8 Aug	15 Aug	22 Aug	29 Aug	
MIRAVIS PRIME	0.0	0.8 a[2]	14.4 ns[3]	18.1 ns	21.9 ns	23.5 a	24.2 a	506.8 ns
BRAVO ZN	0.0	0.0 a	11.5	15.3	17.5	22.2 a	27.6 ab	457.0
SWITCH/QUADRIS[4]	0.0	0.0 a	11.6	14.7	20.1	24.0 a	29.4 ab	483.4
MIRAVIS DUO	0.0	4.6 b	16.3	25.5	28.7	28.7 a	31.0 ab	660.6
FONTELIS	0.0	1.5 a	13.2	30.4	38.9	35.9 ab	57.5 c	916.1
Check	0.0	1.6 a	14.9	25.1	29.8	49.8 b	45.4 bc	734.4

[1] Area under the disease progress curve (AUDPC) was calculated using the following formula:

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

[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 difference among the treatments

[4]SWITCH was applied on 11 July, 1, 16 August and QUADRIS FLOWABLE was applied on 23 July, 8, 28 August.

Table 2. Leaf curl incidence at harvest and yield data for celery, cv. TZ 6200, inoculated with *Colletotrichum acutatum*, treated with various fungicides and grown near and grown at Muck Crop Research Station, Holland Marsh, Ontario 2019.

Treatment	Leaf Curl Incidence[1] (%)	% Marketable[2]	Wgt/mkb Head (g)
SWITCH or QUADRIS	16.7 a[3]	70.6 ns[4]	700.3 ns
BRAVO ZN	18.3 a	71.2	794.7
MIRAVIS PRIME	21.7 ab	70.4	798.7
FONTELIS	38.3 bc	63.1	910.3
MIRAVIS DUO	38.3 bc	62.9	785.1
Check	45.0 c	61.9	923.4

[1] The harvest sample taken 20 September (15 plants) was assessed for leaf curl before trimming.

[2] Marketability was determined after trimming.

[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 = no significant difference among the treatments

Funding for this project was provided by Syngenta Canada Inc. and the Fresh Vegetable Growers of Ontario.

CROP: Celery (*Apium graveolens* L.) cvs. TZ 6200 and Kelvin
PEST: Anthracnose leaf curl (*Colletotrichum fioriniae* (Marcelino & Gouli) Pennycook)

AUTHORS: REYNOLDS S[1], CELETTI MJ[2], JORDAN KS[1], PAULS P[1], MCDONALD MR[1]
[1]University of Guelph, Dept. of Plant Agriculture, ON, Canada
[2]Ontario Ministry of Agriculture and Food and Rural Affairs, Guelph, ON, Canada

TITLE: EVALUATION OF WEATHER-BASED FORECASTING MODELS TO MANAGE LEAF CURL ON CELERY CROPS IN ONTARIO, 2019

MATERIALS: QUADRIS FLOWABLE (250 g/L azoxystrobin), SWITCH 62.5WG (cyprodinil 37.5% and fludioxonil 25.0%)

METHODS: The trial was conducted in 2019 at the Muck Crops Research Station in the Holland Marsh, Ontario. Celery cultivars TZ 6200 and Kelvin, which are moderately and highly susceptible to leaf curl, respectively, were used for this trial. Both cultivars were seeded into 288-cell plug trays on 3 April. On 7 June, celery was transplanted using a mechanical transplanter into the field in organic soil (soil: pH ≈ 7.3, organic matter ≈ 60.4%). A strip plot design was used, with spraying treatments as the main plot, and cultivars as the strip plots, in which each treatment was replicated five times. Each replicate plot consisted of six rows (three rows for Kelvin and three rows for TZ 6200) that were 55 cm apart, 6 m in length with in-row spacing of 15 cm. Fungicides QUADRIS FLOWABLE at 1.12 L/ha alternated with SWITCH 62.5 WG at 1 kg/ha were applied using a tractor mounted sprayer fitted with TeeJet nozzles AI9503 calibrated to deliver 500 L/ha at 415 kPa. Fungicide application timing was determined using weather-based forecasting models: TOMCAST at a Disease Severity Value (DSV) threshold of 15, and TOMCAST with a DSV threshold of 25. The weather-based forecasting models were compared to a 7 to 10-day CALENDAR spray program and a non-treated CONTROL. Leaf wetness and temperature data were collected from a weather station on site within a nearby field. The border rows of each replicate plot were inoculated with *Colletotrichum fioriniae* (1×10^5 spores/mL) on 5 July. Three litres of the spore suspension were applied using a CO_2 backpack sprayer fitted with a single nozzle fan-type TeeJet 8002, at a rate of 10 mL per row meter. The inner rows were visually assessed weekly for the presence of leaf curl symptoms. Celery was harvested on 17 and 18 of September, and a total of 20 plants/plot (ten plants/inner row/plot) were assessed. Marketable weight was first determined by removing stalks with lesions or discarding plants with crown rot and weighing only disease-free plants after trimming to marketable length (40 cm). The percent marketable by weight was determined by dividing the marketable weight by the total weight, which was the weight of the marketable and unmarketable tissue. The marketable weight per plant was determined by dividing the marketable weight by the number of marketable plants in each replicate plot.
Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C) and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C, August 20.2°C and September 16.4°C. Monthly rainfall was below the 10-year average for June (84 mm), July (42 mm), August (46 mm) and average for May (77 mm) and September (62 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm, August 80 mm and September 61 mm. All statistical analyses were performed using the General Analysis of Variance function of Statistix 10. Means separation was obtained using Tukey's HSD test with $P = 0.05$ level of significance.

RESULTS: as outlined in Table 1

CONCLUSION: For both TZ 6200 and Kelvin cultivars, disease incidence was lower in the TOMCAST (15 and 25 DSV) and CALENDAR spray program treatments, relative to the no-spray CONTROL. TOMCAST 15 and 25 provided the same amount of control as the CALENDAR spray program, and

resulted in the same percent marketable weight, but were only significantly higher than the no-spray CONTROL for cv. TZ 6200. CALENDAR spray program had seven fungicide applications; however, the number of fungicide applications was reduced to six for TOMCAST 15, and four for TOMCAST 25. Despite cv. Kelvin being highly susceptible to leaf curl, cv. TZ 6200 was more susceptible than Kelvin in the no-spray CONTROL. In conclusion, TOMCAST 15 and 25 resulted in the lowest number of fungicide applications and associated costs, with a comparable reduction in disease incidence compared to the CALENDAR spray program, for both cultivars.

Table 1. Number of sprays, estimated spray cost, disease incidence, and percent marketable yield by weight for forecasting fungicide applications to manage leaf curl on celery cvs. TZ 6200 and Kelvin at the Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Cultivar	Treatment	Application date (DAFA)[1]	No. of sprays	Spray cost ($/ha)[2]	Incidence (%)[3]	Market. by Wt. (%)
TZ 6200	CALENDAR	0, 10, 20, 27, 37, 48, 58	7	1223.71	7.6 c[4]	98.8 a
	TOMCAST 15	0, 10, 20, 30, 44, 57	6	1209.75	5.2 c	96.7 a
	TOMCAST 25	0, 14, 27, 48	4	728.50	12.5 bc	87.1 ab
	CONTROL	--	--	--	29.9 a	73.3 b
Kelvin	CALENDAR	0, 10, 20, 27, 37, 48, 58	7	1223.71	5.4 c	95.6 a
	TOMCAST 15	0, 10, 20, 30, 44, 57	6	1209.75	5.0 c	96.2 a
	TOMCAST 25	0, 14, 27, 48	4	728.50	10.3 bc	93.9 a
	CONTROL	--	--	--	20.6 b	79.6 ab

[1] DAFA = Days after first spray; first fungicide application was on 2 July for TOMCAST 15, TOMCAST 25 and the CALENDAR spray program treatments (first application = 0 days)

[2] Cost per spray: QUADRIS FLOWABLE = $130.96/ha, and SWITCH 62.5WG = $233.29/ha

[3] Disease incidence of inner rows measured prior to harvest

[4] Values with different letters within columns were significantly different at $P = 0.05$, based on Tukey's HSD test

Funding was provided by the Plant Production Systems of the Ontario Agri-Food Innovation Alliance, the Bradford Cooperative Storage and the Fresh Vegetable Growers of Ontario.

CROP: Celery (*Apium graveloens* L.), cv. TZ 6200
PEST: Fungus Gnat, (*Bradysia sp.* (Winnertz))

AUTHORS: MULDOON DB[1,2], VANDER KOOI K[1], MCDONALD MR[1],
[1]Dept. of Plant Agriculture, University of Guelph, Muck Crops Research Station
[2]School of Environmental Sciences, University of Guelph

TITLE: EVALUATING THE BIOCONTROL POT POPPER PEARLS FOR FUNGUS GNAT CONTROL, 2019

MATERIALS: ENVIRONMENTAL FACTOR, INC. POT POPPER PEARLS (*Steninernema feltiae*), CITATION 75WP (cyromazine 75%)

METHODS: The trial was conducted in 2019 at the Muck Crops Research Station greenhouse in the Holland Marsh, Ontario. The experiment was designed to evaluate the efficacy of Environmental Factor, Inc. Pot Popper Pearls (*Steninernema feltiae*) to control fungus gnats (*Bradysia sp.*) in vegetable transplant production. The experimental unit was a 60 cm x 60 cm domed Headless – Soil Emergence Trap (BugDorm) containing one 288-cell plug tray of celery transplants. Treatments were: Pot Popper Pearls at 10-15 (low), 16-30 (mid) and 60-70 (high) nematodes/pearl, untreated control (with fungus gnats), untreated control (no fungus gnats), and CITATION 75WP (commercial standard). There were four replications per treatment. Celery, cv. TZ 6200, was seeded 1 seed/cell using a vacuum seeder into 288-cell plug trays filled with ASB soilless mix. Pot Popper Pearls of the corresponding treatments (low, mid, and high) were added at 1 pearl/cell on 27 September. All plug trays were watered to ensure high soil moisture to promote fungus gnat development and placed on an ebb and flow table covered with a thrips-mesh in the appropriate BugDorm enclosure. Each enclosure (excluding the untreated control with no fungus gnats) was infested with 20 adult fungus gnats on 3, 10, and 18 October, and with 25 larval fungus gnats on 31 October, allowing high population pressures to establish. Fungus gnats used for the infestations were collected from a nearby infested greenhouse on each the day of infestation. CITATION was applied at 0.13 g/L on 19, 26 November and 3 December at a rate of ~200 ml/tray using a watering can (OMAFRA Crop Protection Guide for Greenhouse Vegetables recommendations). Celery plants were grown for ~10 weeks (27 September – 10 December) on ebb and flow benches, watering occurred twice per week that included 20-20-20 fertilizer at 50 ppm). Adult fungus gnat emergence was monitored weekly from 12 November to 10 December for a 48-hour period using 4.5 cm x 5.5 cm one-sided yellow sticky cards that were placed in each enclosure ~3cm above the canopy. Adult fungus gnats caught on sticky cards were counted at the end of each 48-hour period and included the observation of visible flying adults in each BugDorm. Total population counts of adult fungus gnats were combined over the five weeks of collection. On 10 December trays were removed from the enclosures and 20 plants/tray were assessed for the following criteria: plant height, fresh weight of tops and roots. Ten plugs/tray were assessed for the number of fungus gnat larva per plug. Six plugs/tray were taken from each of the Pot Popper Pearl treatments and nematodes were extracted from the soil using the Baermann pan method and nematodes numbers counted and recorded.
Data were analyzed using an ANOVA general linear model using RStudio (RStudio Team, Boston, MA, version 3.5.2) to determine the effect of treatment on mean plant height, mean fresh weight of tops, mean fresh weight of roots, mean number of fungus gnat larva per plug, and mean number of nematodes per plug. The total population counts of adult fungus gnats were analyzed using an ANOVA general linear model log transformed with a negative binomial distribution using RStudio (RStudio Team, Boston, MA, version 3.5.2) to determine the effect of treatment on total cumulative adult fungus gnat population. Mean separation was obtained using a Tukey's HSD test with $p = 0.05$ level of significance.

RESULTS: as presented in Tables 1 & 2

DISCUSSION: Celery grown in plug trays with Pot Popper Pearls at the high rate had fewer adult fungus gnats than the untreated control but did not differ from Pot Popper Pearl at the lower rates or trays treated with CITATION (Table 1). There were no significant differences in fungus gnat larva per plug among treatments when assessed on 10 December (Table 1). Higher numbers of nematodes were extracted from the celery plugs from all three Pot Popper Pearl treatments than those contained initially in the Pearls. The increase in nematodes suggests that nematode populations were able to establish in the celery plugs. The number of nematodes was significantly higher in the mid and high rates compared to the low rate (Table 1). Celery plants that received the low rate of Pot Poppers were taller and had higher root and shoot weights than both controls (fungus gnats and no fungus gnats) and plants were taller than the plants treated with the CITATION (Table 2). Plants that received the high rate of Pot Poppers were also taller than the those that were treated with CITATION. Fresh weight of the shoots was also higher in plants receiving the middle rate of nematodes. Root fresh weight was significantly higher in all treatments when compared to the control with fungus gnats (Table 2). These results demonstrate that fungus gnat larva can significantly reduce the mass of plant roots from feeding. There were significant differences in both average plant height and fresh top weight (Table 2) these variations could be attributed to fungus gnat populations or greenhouse table placement. A repetition of this study would be beneficial to support the conclusions provided.

CONCLUSIONS: This study indicates that the addition of nematodes in the Pot Popper Pearls at the high rate reduced the number of adult fungus gnats, and the low rate consistently increased plant growth. These beneficial nematodes could be an effective addition to an IPM program for vegetable transplants.

Table 1. Total cumulative adult fungus gnats per treatment in celery transplants treated with Pot Poppers Pearls, 2019

Treatments	Cumulative adult fungus gnats per 48 hr		Fungus gnat larva per plug 10 Dec		Nematodes per plug 10 Dec	
	Mean	SE	Mean	SE	Mean	SE
Control (no fungus gnats)	0 a[1]		0 ns[2]		NA	
Control (fungus gnats)	143 c	±44.9	6	±5.5	NA	
Pot Popper Pearls – Low	79 bc	± 9.9	7	±3.0	65 a	±22.0
Pot Popper Pearls – Mid	103 bc	± 33.7	13	±5.8	285 b	±65.8
Pot Popper Pearls – High	46 b	± 19.6	9	±4.4	296 b	±82.9
CITATION	67 bc	± 15.6	0	±0.0	NA	

Cumulative number of adults in a 48-hour period, averaged from 12 November until 10 December, 2019, and fungus gnat larva per plug and nematodes per plug assessed on December 10, 2019.

[1-] Different letters within columns denote significantly different groups according to Tukey's HSD (α =0.05).

[2-] ns indicates all numbers in the column are not significantly different at $\alpha = 0.05$ according to Tukey's HSD test.

Table 2. Mean (±SE) plant height, fresh weight of tops and roots of celery transplants treated with Pot Popper Pearls for the control of fungus gnats grown University of Guelph, 2019.

Treatments	Plant height/plug(cm)		Top fresh weight/plug (g)		Root fresh weight/plug (g)	
	Mean[1]	SE	Mean[1]	SE	Mean[1]	SE
Control (no fungus gnats)	13 d	±0.9	0.7 c	±0.06	0.29 b	±0.03
Control (fungus gnats)	16 bcd	±0.4	0.9 c	±0.05	0.14 c	±0.02
Pot Popper Pearls – Low	21 a	±1.0	1.7 a	±0.14	0.44 a	±0.05
Pot Popper Pearls – Mid	18 abc	±1.6	1.5 ab	±0.22	0.30 b	±0.02
Pot Popper Pearls – High	19 ab	±0.7	1.1 bcd	±0.10	0.41 ab	±0.04
CITATION	15 cd	±0.5	1.0 bc	±0.08	0.35 ab	±0.04

[1-] Different letters within columns denote significantly different groups according to Tukey's HSD (α =0.05).

Funding for this project was provided by ENVIRONMENTAL FACTOR, INC.

HOST: Canola (*Brassica napus* L.), cv. InVigor 5030
PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

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

TITLE **EVALUATION OF CLUBROOT DISTRIBUTION AT MUCK CROPS RESEARCH STATION, 2019**

OBJECTIVE: to map clubroot incidence on the front 60 m of range four at the Muck Crops Research Station, King, ON

METHODS: Canola, cv. InVigor 5030, was bulk seeded on 27 June at the University of Guelph Muck Crops Research Station at a 60 m-long site naturally infested with *P. brassicae* pathotype 2 using an Earthway Precision Garden Seeder fitted with seeding disc 1002-10. The seeded area was divided into plots consisting of eight, 8.5 m long rows of canola spaced 40 cm apart. On 20 August, five consecutive plants from all eight rows (40 plants in total) were pulled and the roots visually examined for clubroot symptoms. Clubroot severity was rated on a 0–4 scale and plants were divided into classes where 0 = no clubs, 0.2 = 1 tiny club, 1 = small clubs on less than 1/3 of roots, 2 = small or intermediate clubs on 1/3 to 2/3 of roots, and 3 = intermediate or large clubs on over 2/3 of roots. These classes were used to determine the disease severity index (DSI) using the following formula:

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

Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), and average for June (17.5°C), and August (19.4°C). The 10-year average temperatures were: June 18.4°C, July 21.1°C, and August 20.2°C. When compared to the 10-year average, monthly rainfall was below average for June (84 mm), July (42 mm) and August (46 mm). The 10-year rainfall averages were: June 100 mm, July 93 mm, and August 80 mm.

RESULTS: see Fig 1

CONCLUSION: *P. brassicae* is not evenly distributed over the front 60 m of Range four at MCRS and incidence was observed to be the highest across the south end of the 60 m length.

Fig 1. Map showing clubroot incidence in canola, cv. InVigor 5030, grown on the first 60 m of range four, Muck Crops Research Station, Holland Marsh, Ontario, 2019.

*70% / 26.8	67% / 26.6	62% / 19.9	40% / 12.1	SW corner
55% / 16.6	55% / 12.6	37% / 9.5	20% / 2.5	
17% / 2.5	42% / 13.4	10% / 2.3	7.5% / 0.4	
5% / 0.3	7.5% / 2.1	0% / 0	2.5% / 0.1	
15% / 1.3	2.5% / 0.1	2.5% / 0.1	0% / 0	
10% / 1.0	0% / 0	2.5% / 0.1	0% / 0	
2.5% /0.1	0% / 0	0% / 0	0% /0	
NE corner 0% /0	0% / 0	0% / 0	0% / 0	

*clubroot incidence / severity

HOST: Canola (*Brassica napus* L.)
PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

AUTHORS: RAINU TP[1], GOSSEN BD[2], MCDONALD MR[1]
[1]University of Guelph, Department of Plant Agriculture, Guelph
[2]Agirculture and Agri-Food Canada, Saskatoon

TITLE: **EVALUATION OF CLUBROOT RESISTANCE IN CANOLA CULTIVARS FOR ONTARIO, 2019**

OBJECTIVE: to evaluate the resistance of canola cultivars to pathotype 2 of *Plasmodiophora brassicae* at the Muck Crops Research Station, King, ON, 2019 and in a growth room trial.

METHODS: A field trial was conducted at University of Guelph Muck Crop Research Station in muck soil on range 4 (pH 6.4, 68.6% organic matter), a site naturally infested with *P. brassicae* pathotype 2. The four canola cultivars were seeded on 25 July 2019 in a randomised complete block design with four replicates. The trial consisted of canola cultivars 45H29, 45CS40, 45H33 and 45H37 (CORTEVA AGRISCIENCE™) that are marketed as resistant to clubroot. A susceptible check, cv. Mei Qing Choi (Shanghai pak choi, Stokes Seeds ON), was also included. The trial was seeded at 50 seeds per metre of row using an Earthway Precision Garden Seeder fitted with seeding plate 1002-10. Each experimental unit consisted of one row, 5 m in length with 40 cm between rows. Six weeks after seeding, the plants were uprooted and cleaned, and the roots were evaluated for clubroot severity. Visual assessment was conducted using a 0-3 rating scale, and were divided into classes where 0 = no clubbing, 1 < 1/3 of root area clubbed, 2 = 1/3 to 2/3 of the root area is clubbed, 3 > 2/3 of the root area is clubbed (Créte *et al.* 1963). Clubroot incidence (CI) was determined as the percentage of plants with clubroot symptoms. A disease severity index (DSI) was calculated using the following formula:

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

Compared to the previous 10-year average air temperatures in 2019 were above for July (22.3°C) average for August (19.4°C) and September (15.8°C). The 10-year average temperatures were: July 21.1°C, August 20.2°C and September 16.4°C. Monthly rainfall was average September (62 mm), and below average for July (42 mm) and August (46 mm). The 10-year rainfall averages were: July 93 mm, August 80 mm, and September 61 mm. Clubroot incidence, DSI, and fresh and dry shoot weights were analyzed with the Analysis of Variance function for a randomized complete block design of Statistix 10.0. Tukey's test was used for the all-pairwise comparisons.

The canola cultivars evaluated in the field trials were also tested for resistance to pathotype 2 in a growth room trial. A randomized compete block design with four replicates and 12 plants per experimental unit was used. Plants were seeded in soilless mix (Sunshine Soil Mix, L4A) in tall narrow pots known as conetainers. The soilless mix was mixed with fertilizer solution consisting of 0.1% nitrogen, phosphate, potassium (20-20-20), and magnesium sulfate. Two seeds were planted in each pot and thinned to one plant per pot prior to inoculation. Frozen clubs were defrosted at room temperature before inoculum preparation, to ensure that the resting spores were mature. To inoculate, 5 ml of 1×10^7 resting spores of *P. brassicae* pathotype 2 (9-week-old clubs of ACS N39 grown at the Muck Crops Research Station in 2018) was applied to the stem base of each plant 6 days after seeding. The plants were watered with tap water adjusted to pH 6.0 with white vinegar. The growth room was set to 24/19°C day/night with 16-hr photoperiod. Clubroot symptoms were assessed on all plants at 6 weeks after inoculation on the 0–3 scale, and clubroot incidence and DSI were determined as described above.

RESULTS & DISCUSSION: Cultivars 45H29, 45CS40, 45H33 and 45H37 had very low incidence and severity of clubroot and were confirmed as resistant (CI = 2–7%, DSI = 1–4). The Shanghai pak choi cultivar Mei Qing Choi (CI=87.50% and DSI=66.25) were susceptible to clubroot. The fresh shoot weight

of resistant cultivars was higher than Mei Qing Choi, as expected and there were no differences in shoot weight among the canola cultivars. Dry weight showed a similar trend, but the differences were not significant (Table 1).
As in the field trial, CI and DSI in the growth room study were high (CI= 95 and DSI =87) for Mei Qing Choi. CI was significantly higher in 45H33 as compared to other canola cultivars (Table 2) but there was no significant difference in DSI among canola cultivars.

CONCLUSIONS: The cultivars marketed as resistant to clubroot (45H29, 45CS40, and 45H37) were confirmed to be resistant to pathotype 2 of *P. brassicae* both in the field and growth room trials. The cultivar 45H33 was confirmed to be resistant to pathotype 2 of *P. brassicae* in the field trial and moderately resistant to pathotype 2 in the growth room trial.

Table 1. Clubroot incidence (%) and disease severity index (DSI), and fresh weight and dry weight, of clubroot susceptible and resistant canola cultivars grown at the Muck Crops Research Station, 2019.

Cultivar	Expected Reaction	Incidence (%)	DSI (0-100)	Fresh wt. (kg plant $^{-1}$)	Dry wt. (g plant^{-1})
45H29	Resistant	2.5 b[1]	1.3 b	2.8 ns[2]	179.1 ns
45CS40	Resistant	6.3 b	3.3 b	2.8	187.3
45H33	Resistant	3.8 b	1.3 b	2.8	158.5
45H37	Resistant	2.5 b	2.1 b	2.6	177.3
Mei Qing Choi	Susceptible	87.5a	66.3 a	2.1	91.7

[1]Means followed by the same letter in a column are not significantly different at P = 0.05, Tukey's test
[2]ns indicates no significant differences between treatments

Table 2. Clubroot incidence (%) and disease severity index (DSI) of clubroot on clubroot resistant canola cultivars as compared to susceptible Mei Qing Choi, grown in the growth room study (2019) and inoculated with pathotype 2

Cultivar	Expected Reaction	Incidence (%)	DSI (0-100)
45H29	Resistant	12.5 c[1]	5.6 b
45CS40	Resistant	12.5 c	4.9 b
45H33	Resistant	39.5 b	16.0 b
45H37	Resistant	12.5 c	4.9 b
Mei Qing Choi	Susceptible	95.9 a	87.5 a

[1]Means followed by the same letter in a column are not significantly different at P = 0.05, Tukey's test

CROP: Shanghai pak choi (*Brassica rapa* L. var. *communis* Tsen and Lee), cv. Mei Qing
PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

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

TITLE: EVALUATION OF SOIL FUMIGANTS FOR CLUBROOT CONTROL ON SHANGHAI PAK CHOI, 2019

MATERIALS: PIC PLUS (85.1% chloropicrin), BUSAN 1236 (metam sodium 42%)

METHODS: The trial was conducted at the Muck Crops Research Station, Holland Marsh, Ontario on a muck soil (pH ≈ 6.0, organic matter ≈ 66%) naturally infested with *Plasmodiophora brassicae*, in 2019. A randomized complete block design with five replicates per treatment was used. Each experimental unit (plot) was 2.0 m × 12 m. Treatments were: PIC PLUS at 164 & 280 kg/ha and BUSAN 1236 at 150 and 300 kg/ha. An untreated and untarped check and an untreated check covered with totally impermeable film (TIF) (Raven Industries, Sioux Falls, South Dakota) were also included. On 9 July, PIC PLUS was applied using a 2 m wide tractor-mounted PIC PLUS fumigator equipped with shanks to inject the product 25-30 cm into the soil and BUSAN 1236 was applied using a separate 2 m wide custom tractor-mounted fumigator with shanks spaced 17 cm apart applying the product 25-30 cm into the soil. After the treatments were applied, each plot was rolled and covered using the TIF product. HOBO pendant dataloggers were placed 5 cm below the soil surface in both the TIF covered check and the uncovered check treatments. After 14 days, on 23 July, the TIF was removed. On 24 July, each plot was seeded with four rows of Shanghai pak choi, cv. Mei Qing Choi, with 40 cm between rows using a Stanhay precision seeder. On 4 September, 50 plants per replicate were removed and top weight recorded. Clubroot incidence and severity were assessed on these roots plus the roots of 50 additional plants (100 roots in total) using a 0 to 4 scale where 0 = no clubbing, 0.2 = small club (2 cm), 1 = <1/4 of root clubbed, 2 = 1/4 – 1/2 of roots clubbed and 3 = > 1/2 of roots clubbed. Disease severity index (DSI) was determined using the following equation:

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

Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.10. Means separation was obtained by using Fisher's Protected LSD test at $P = 0.05$ level of significance.

RESULTS: as presented in Tables 1 & 2

CONCLUSIONS: Disease incidence in the trial was high. Significant differences were observed among the treatments in disease incidence, disease severity (DSI) and fresh plant weight. Both PIC PLUS treatments had lower incidence and severity than the uncovered check. Fresh weights were significantly higher in the PIC PLUS treatments. The TIF covered check also had significantly lower disease incidence and severity than the uncovered check and had fresh weights similar to the PIC PLUS treatments. Soil temperatures under the TIF check were 10°C higher than the uncovered check. The high temperatures under the TIF may provide a solarization effect. More work is needed to investigate the effect of solarization on clubroot spores.

Funding was provided by the Clubroot Mitigation Initiative of Agriculture and Agri-Food Canada and the Canola Council of Canada. We wish to thank Douglas Ag Inc. and TriEst Ag Group Inc, Simcoe, Ontario.

Table 1. Clubroot incidence and severity for Shanghai pak choy grown in muck soil naturally infested with *Plasmodiophora brassicae*, treated with fumigants at the Muck Crops Research Station, Ontario, 2019.

Treatment	Rate (kg/ha)	Incidence (%)	DSI[1]	Fresh Top Wgt/plant (g)
PIC PLUS	164	41.6 a[2]	18.5 a	109.1 ab
PIC PLUS	280	46.5 a	18.1 a	132.6 a
TIF Check	---	47.0 a	26.1 a	97.4 b
BUSAN 1236	300	54.6 a	29.1 a	107.5 ab
BUSAN 1236	150	64.0 ab	24.2 a	95.0 b
Uncovered Check	--	98.2 b	57.2 b	50.2 c

[1] Roots of 100 plants were sorted into the following classes: 0=0%, 0.2 = 2cm club, 1 = 1-25%, 2 = 25-50%, 3= 50 - 100%. DSI was calculated with the following formula:

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

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

Table 2. Average daily soil temperatures 5 cm below totally impermeable film (TIF) and an untarped check compared to air temperatures at the Muck Crops Research Station, Ontario, July 9-23, 2019.

Date	TIF		Untarped		Air	
	Max Temp °C[1]	Min Temp °C	Max Temp °C	Min Temp °C	Max Temp °C	Min Temp °C
July 9	34.3	21.3	25.6	21.6	29.0	11.1
July 10	37.5	22.5	25.5	18.6	32.1	9.8
July 11	32.0	25.9	24.4	21.1	29.4	17.1
July 12	29.0	23.8	22.2	19.5	25.6	13.7
July 13	28.8	22.1	23.2	18.0	28.7	13.2
July 14	33.4	22.0	23.9	18.0	26.3	13.7
July 15	34.1	22.3	25.1	17.4	28.7	9.3
July 16	32.1	24.7	24.4	20.3	31.8	18.1
July 17	33.8	25.6	26.3	21.9	29.7	20.2
July 18	36.5	25.5	27.2	21.4	30.4	17.4
July 19	33.6	27.4	25.8	22.5	31.9	21.6
July 20	36.1	27.8	27.9	23.3	34.0	23.4
July 21	36.9	27.1	26.8	22.6	27.9	16.2
July 22	32.9	25.9	25.2	20.5	25.9	14.7
July 23	28.9	24.2	22.6	19.2	26.1	12.1
Average[1]	**37.5**	**21.3**	**27.9**	**17.4**	**29.2**	**15.4**

[1]Average daily soil temperature recorded using a HOBO Pendant temperature data logger buried 5 cm below the soil

HOST: Canola (*Brassica napus* L.)
PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

AUTHORS: DRURY SC[1], GOSSEN BD[2], MCDONALD MR[1]
[1]University of Guelph, Department of Plant Agriculture, Guelph
[2]Agriculture and Agri-Food Canada, Saskatoon

TITLE: EVALUATION OF CLUBROOT RESISTANCE IN CANOLA CULTIVARS FOR ONTARIO, 2019

OBJECTIVE: to evaluate the resistance of canola cultivars grown commercially in Ontario to pathotypes 2 and 6 of *P. brassicae* (Williams' system)

MATERIALS AND METHODS: A field trial was conducted at the University of Guelph Muck Crops Research Station at a site naturally infested with *P. brassicae* pathotype 2. Canola cultivars from Bayer Crop Science (Bayer), the control canola cultivars ACS N39 (susceptible to *P. brassicae*), InVigor 5030 (moderately resistant), and 45H29 (resistant to pathotypes 2 and 6) and the control Shanghai pak choi cultivar Mei Qing Choi (highly susceptible) were assessed. Cultivars L255PC, L2421C, L135C and L234PC from Bayer are marketed as resistant to clubroot. A randomized complete block design with six replicates was used. The trial was seeded on 12 June at 50 seeds per meter of row. Each experimental unit consisted of one row, 5 m in length, with 40 cm between rows. An Earthway Precision Garden Seeder fitted with seeding disc 1002-10 was used to seed the trial.
Assessments for clubroot infection on 50 plants per plot took place six weeks after seeding on 25 July. Clubroot symptoms on the roots of each plant were rated on a 0-3 scale and plants were divided into classes where 0 = no clubs, 1 = small clubs on less than 1/3 of roots, 2 = small or intermediate clubs on 1/3 to 2/3 of roots, and 3 = intermediate or large clubs on over 2/3 of roots. Clubroot incidence (CI) was determined as the percentage of plants with clubroot symptoms. Disease severity index (DSI) was calculated using the following formula:

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

At harvest, shoot fresh weight was determined from 10 plants per plot. Shoot dry weight of the same plants was determined after 48 hours of oven drying at 60ºC. Clubroot incidence, DSI, and fresh and dry shoot weights were analyzed with the Analysis of Variance procedure in Statistix 10.0. Tukey's test was used for the all-pairwise comparisons.
The canola cultivars evaluated in the field trial were also tested for resistance to pathotypes 2 and 6 in growth room studies. A non-inoculated susceptible control (ACS N39 or Mei Qing Choi) was also included. A randomized compete block design with four replicates and 12 plants per experimental unit was used. Plants were seeded in soilless mix (Sunshine Soil Mix, L4A) in tall narrow pots known as conetainers. The soilless mix was mixed with fertilizer solution consisting of 0.1% nitrogen, phosphate, potassium (20-20-20), and magnesium sulfate. Two seeds were planted in each pot and thinned to one plant per pot prior to inoculation. To inoculate, 5 mL of 1×10^7 resting spores of *P. brassicae* pathotypes 2 and 6 was applied to the stem base of each plant 6 days after seeding. The experiment was conducted twice with both pathotypes. The plants were watered with tap water adjusted to pH 6.0 with white vinegar. The growth room was set to 24/19°C day/night with a 17-hr photoperiod. Clubroot symptoms were assessed on all plants at six weeks after inoculation on the 0–3 scale, and clubroot incidence and DSI were determined as described above.

RESULTS &DISCUSSION: Cultivars L234PC, L255PC, L135C, 45H29 and L2421C had low incidence and severity of clubroot (CI = 0-21%, DSI = 0-7). The canola cultivars L252, L233P, ACS N39, InVigor 5030 were susceptible to clubroot (CI = 71-99% and DSI = 66-86). The fresh shoot weight of resistant

cultivars was greater than the susceptible cultivars, but differences were not always significant. Dry weight showed a similar trend (Table 1).

The same cultivars were resistant in the growth room study testing clubroot resistance to pathotype 2. Both CI and DSI in the growth room study were very low (CI and DSI = 0) in the clubroot resistant cultivars. CI and DSI were significantly higher in the other canola cultivars and Mei Qing Choi (CI = 98–100%, DSI = 90-96) (Table 2). It is interesting to note that CI and DSI for Mei Qing Choi were lower than the susceptible canola cultivars in the field, but numerically higher in the growth room trial.

In the growth room study testing clubroot resistance to pathotype 6, all Bayer cultivars were resistant (CI = 0-8%, DSI = 0-2). The control cultivars InVigor 5030 and 45H29 were also resistant. The susceptible controls Mei Qing Choi and ACS N39 were susceptible, although ACS N39 had a low disease severity (DSI = 29) (Table 3).

CONCLUSION: The cultivars marketed as resistant to clubroot (L234PC, L255PC, L2421 and L135C) were confirmed to be resistant to pathotype 2 of *P. brassicae* in both the field and growth room trials. All cultivars were resistant against pathotype 6 of *P. brassicae* in growth room study.

Table 1. Clubroot incidence (%) and severity (disease severity index, DSI), and fresh weight and dry shoot weight of clubroot susceptible and resistant canola cultivars grown at the Muck Crops Research Station, 2019.

Cultivar	Expected reaction	Incidence (%)	DSI (0-100)	Fresh wt. (g plant^{-1})	Dry wt. (g plant^{-1})
L234PC	Resistant	0 b[2]	0 c	109 a	12072 a
L2421C	Resistant	1 b	0 c	83 abc	7703 abc
L135C	Resistant	1 b	0 c	96 ab	8340 ab
45H29	Resistant	2 b	2 c	-	-
L255PC	Resistant	21 b	7 bc	123 a	11723 a
Mei Qing Choi	Susceptible	67 a	49 ab	50	1497
L252	Susceptible	71 a	66 a	59 bc	6447 bc
InVigor 5030	Moderately resistant	79 a	66 a	42 c	4213 c
ACS N39	Susceptible	81 a	68 a	46 c	5532 c
L233P	Susceptible	99 a	86 a	52 bc	5955 bc

[2] Means followed by the same letter in a column do not differ based on Tukey's test at $P = 0.05$.

Table 2. Clubroot incidence (%) and disease severity index (DSI) of clubroot susceptible and resistant canola cultivars inoculated with *Plasmodiophora brassicae* pathotype 2 in a growth room study.

Cultivar	Expected reaction	Incidence (%)	DSI (0-100)
L255PC	Resistant	0 b[2]	0 b
L135C	Resistant	0 b	0 b
L2421C	Resistant	0 b	0 b
L252	Susceptible	98 a	90 a
ACS N39	Susceptible	98 a	90 a
L233P	Susceptible	98 a	94 a
InVigor 5030	Moderately resistant	100 a	93 a
Mei Qing Choi	Susceptible	100 a	96 a

[2] Means followed by the same letter in a column do not differ based on Tukey's test at $P = 0.05$.
The data from the two repetition of the experiment were pooled for analysis.

Table 3. Clubroot incidence (%) and disease severity index (DSI) of clubroot susceptible and resistant canola cultivars inoculated with *Plasmodiophora brassicae* pathotype 6 in a growth room study.

Cultivar	Expected reaction	Incidence (%)	DSI (0-100)
L255PC	Resistant	0 b[2]	0 c
L135C	Resistant	0 b	0 c
L2421C	Resistant	0 b	0 c
L234PC	Resistant	0 b	0 c
L252	Susceptible	4 b	1 c
InVigor 5030	Moderately resistant	6 b	3 c
45H29	Resistant	6 b	4 c
L233P	Susceptible	8 b	2 c
ACS N39	Susceptible	97 a	29 b
Mei Qing Choi	Susceptible	100 a	100 a

[2] Means followed by the same letter in a column do not differ based on Tukey's test at $P = 0.05$.
The data from the two repetition of the experiment were pooled for analysis.

Funding for this project was provided by the Ontario Agri-Food Innovation Alliance and the Ontario Canola Growers Association.

HOSTS: Cabbage (*Brassica oleracea* L. var. *capitata*), cauliflower (*B. oleracea* var. *botrytis*), broccoli (*B. oleracea* var. *italica*), napa cabbage (*B. rapa* L. spp. *chinensis*) and rutabaga (*B. napus* var. *napobrassica*)

PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

AUTHORS: DRURY SC[1], GOSSEN BD[2], MCDONALD MR[1]
[1]University of Guelph, Department of Plant Agriculture, Guelph
[2]Agriculture and Agri-Food Canada, Saskatoon

TITLE: EVALUATION OF CLUBROOT RESISTANCE IN BRASSICA VEGETABLE CULTIVARS, 2019

OBJECTIVE: Evaluate resistance of Brassica vegetable cultivars to pathotypes 2 and 6 (Williams' system) of *P. brassicae* at the Muck Crops Research Station, King, ON.

MATERIALS AND METHODS: A field trial to evaluate the clubroot reaction of Brassica vegetable cultivars was conducted on a site naturally infested with *P. brassicae* pathotype 2 at the University of Guelph Muck Crops Research Station. The vegetable cultivars marketed as resistant were: Tekila (cabbage), Lodero (red cabbage), Bejo 2962 (white cabbage), Clarify (cauliflower), Emerald Jewel (broccoli) and Yuki (napa cabbage), and susceptible vegetables were: Bronco (white cabbage), Fremont (cauliflower), Asteroid (broccoli), Blue (napa cabbage) and Laurentian rutabaga obtained from Stokes Seed and the University of Wisconsin. Mei Qing Choi (Shanghai pak choi) was included as a susceptible check. The study was arranged in a randomized complete block design with six replicates.

Cabbage, cauliflower, broccoli and rutabaga were grown from transplants. These crops were seeded in 128-cell plug trays in soilless mix and grown in a greenhouse. Cabbage, cauliflower and broccoli were seeded on 7 June and transplanted in the field on 11 July. Rutabaga was seeded on 27 June and transplanted on 18 July. There were 30 cm between each transplant and a mean of 16 plants per row. Napa cabbage and Shanghai pak choi were direct seeded on 11 July with an Earthway Precision Garden Seeder fitted with seeding disc 1002-10 at 50 seeds per meter of row. Each plot consisted of one row, 5 m in length, with 40 cm between rows.

Clubroot was assessed on 30 plants per plot at 6 weeks after seeding/transplanting on 22 and 23 August. Rutabaga was assessed on 29 August. Symptoms of clubroot were assessed on the roots of each plant on a 0-3 scale, where 0 = no clubs, 1 = small clubs on less than 1/3 of roots, 2 = small or intermediate clubs on 1/3 to 2/3 of roots, and 3 = intermediate or large clubs on over 2/3 of roots. The proportion of plants with clubroot symptoms was used to determine clubroot incidence (CI). A disease severity index (DSI) was calculated using the following formula:

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

Shoot fresh weight was recorded at harvest from 10 plants per plot. Shoot dry weight of 5 plants per replicate was determined after oven drying at 60ºC. Clubroot incidence, DSI, and fresh and dry shoot weights were analyzed with the Analysis of Variance procedure in Statistix 10.0. Tukey's test was used for the all-pairwise comparisons.

The same cultivars were also tested for resistance against pathotypes 2 and 6 in separate growth room studies. A non-inoculated control, Shanghai pak choi cultivar Mei Qing Choi was also included. The study was arranged in a randomized compete block design with four replicates and 12 plants per experimental unit. Plants were seeded in soil-less mix (Sunshine Soil Mix, L4A) in tall narrow pots known as conetainers. The soil-less mix was mixed with fertilizer solution consisting of 0.1% nitrogen, phosphate, potassium (20-20-20), and magnesium sulfate. Two seeds were planted in each pot and were thinned to one plant per pot prior to inoculation. To inoculate, 5 mL of 1×10^7 resting spores of *P. brassicae* pathotypes 2 or 6 was

applied to the stem base of each plant at 6 days after seeding. The plants were watered with tap water adjusted to pH 6.0 with white vinegar. The growth room was set to 24/19°C day/night with a 17-hr photoperiod. Clubroot symptoms were assessed on all plants at 6 weeks after inoculation on the 0–3 scale, and clubroot incidence and DSI were determined as described above.

RESULTS & DISCUSSION: Overall clubroot incidence and severity were low in the field trial. CI and DSI were low (CI = 0-21%, DSI = 0-9) for resistant cultivars (Bejo 2962, Lodero and Tekila cabbage, Emerald Jewel broccoli, Clarify cauliflower, and Yuki napa cabbage). The susceptible cultivars (Bronco cabbage, Asteroid broccoli, Fremont cauliflower, Laurentian rutabaga, Blue napa cabbage, and Mei Qing Choi) had a range of reactions (CI = 12-77%, DSI = 4-55). CI and DSI were significantly lower in resistant cultivars compared to susceptible cultivars, except for the broccoli cultivar Emerald Jewel, where CI did not differ from the susceptible cv. Asteroid. Fresh shoot weight was higher in the resistant cultivars Bronco 2962 cabbage and Yuki napa cabbage compared to the susceptible cultivars for these crops, but fresh shoot weight of the other resistant cultivars (Tekila and Lodero cabbage, Emerald Jewel broccoli, and Clarify cauliflower) did not differ from the susceptible cultivars (Table 1).

In the growth room study where the crops were inoculated with pathotype 2, CI and DSI were low (CI = 0-4%, DSI = 0-4) for resistant cultivars (Bejo 2962 and Tekila cabbage, Clarify cauliflower, and Yuki napa cabbage) and high (CI = 100%, DSI = 99-100) in susceptible cultivars (Lodero and Bronco cabbage, Asteroid and Emerald Jewel broccoli, Fremont cauliflower, Blue napa cabbage, and Mei Qing Choi) (Table 2).

Lodero cabbage, Emerald Jewel broccoli and Laurentian rutabaga from Stokes Seed and from the University of Wisconsin were resistant to pathotype 2 and were susceptible with pathotype 6 in the growth room inoculation studies. In the growth room study testing resistance to pathotype 6, CI and DSI were low (CI = 0-15%, DSI = 0-6) in resistant cultivars (Bejo 2962, Tekila, and Lodero cabbage, Emerald Jewel broccoli, Clarify cauliflower, Laurentian rutabaga, Yuki napa cabbage) and high (CI = 100%, DSI = 100) in susceptible cultivars (Bronco cabbage, Asteroid broccoli, Fremont cauliflower, Blue napa cabbage, and Mei Qing Choi) (Table 3).

CONCLUSIONS: The cultivars marketed as resistant were generally resistant to *P. brassicae* pathotype 2. Susceptible cultivars generally had a lower CI and DSI than resistant cultivars in the field trial. Cultivars Lodero cabbage and Emerald Jewel broccoli, which were marketed as resistant to clubroot, were susceptible to pathotype 2 in the growth room study. All cultivars marketed as resistant were resistant to pathotype 6 in the growth room study.

Table 1. Clubroot incidence (%) and severity (disease severity index, DSI), and fresh and dry shoot weight of clubroot susceptible (S) and resistant (R) Brassica vegetables in a field trial at the Muck Crops Research Station, 2019.

Crop & Cultivar	Source	Expected (S/R)	Incidence (%)	DSI (0-100)	Fresh wt. (g plant^{-1})	Dry wt. (mg plant^{-1})
Cabbage[1]						
Bejo 2962	Bejo	R	1 b[2]	0 b	1064 a	40833 a
Tekila	Stokes	R	0 b	0 b	642 b	27583 b
Lodero	Bejo	R	12 b	5 b	517 b	2250 b
Bronco	Bejo	S	48 a	27 a	703 b	26817 b
Broccoli						
Emerald Jewel	Stokes	R	21 a	9 b	654 a	23333 a
Asteroid	Stokes	S	48 a	31 a	656 a	28333 a
Cauliflower						
Clarify	Stokes	R	1 b	1 b	707 a	31750 a
Fremont	Stokes	S	45 a	23 a	549 a	28083 a
Rutabaga						
Laurentian	Stokes	S	38 a	3 a	336 a	18 a
Laurentian	U of Wisc	S	12 a	4 a	316 a	16 a
Napa cabbage						
Yuki	Stokes	R	0 b	0 b	198 b	4 b
Blue	Stokes	S	77 a	55 a	484 a	13 a
Shanghai pak choi						
Mei Qing Choi	Stokes	S	15	11	101	2

[1] Statistical analysis was conducted for each crop species separately.
[2] Means followed by the same letter in a column do not differ based on Tukey's test at $P = 0.05$.

Table 2. Clubroot incidence (%) and severity (disease severity index, DSI) of clubroot susceptible (S) and resistant (R) Brassica vegetables inoculated with *Plasmodiophora brassica* pathotype 2 in a growth room study.

Crop & Cultivar	Source	Expected (S/R)	Incidence (%)	DSI (0-100)
Cabbage[1]				
Bejo 2962	Bejo	R	0 b[2]	0 b
Tekila	Stokes	R	0 b	0 b
Lodero	Bejo	R	100 a	99 a
Bronco	Bejo	S	100 a	100 a
Broccoli				
Emerald Jewel	Stokes	R	100 a	100 b
Asteroid	Stokes	S	100 a	100 a
Cauliflower				
Clarify	Stokes	R	0 b	0 b
Fremont	Stokes	S	100 a	100 a
Rutabaga				
Laurentian	Stokes	S	100 a	100 a
Laurentian	U of Wisc	S	100 a	100 a
Napa cabbage				
Yuki	Stokes	R	4 b	4 b
Blue	Stokes	S	100 a	100 a
Shanghai pak choi				
Mei Qing Choi	Stokes	S	100	100

[1] Statistical analysis was conducted for each crop species separately.
[2] Means followed by the same letter in a column do not differ based on Tukey's test at $P = 0.05$.

Table 3. Clubroot incidence (%) and severity (disease severity index, DSI) of clubroot susceptible (S) and resistant (R) Brassica vegetables inoculated with *Plasmodiophora brassica* pathotype 6 in a growth room study.

Crop & Cultivar	Source	Expected (S/R)	Incidence (%)	DSI (0-100)
Cabbage[1]				
Bejo 2962	Bejo	R	0 b[2]	0 b
Tekila	Stokes	R	0 b	0 b
Lodero	Bejo	R	15 b	5 b
Bronco	Bejo	S	100 a	100 a
Broccoli				
Emerald Jewel	Stokes	R	5 a	2 b
Asteroid	Stokes	S	100 a	100 a
Cauliflower				
Clarify	Stokes	R	0 b	0 b
Fremont	Stokes	S	100 a	100 a
Rutabaga				
Laurentian	Stokes	S	0 a	0 a
Laurentian	U of Wisc	S	4 a	4 a
Napa cabbage				
Yuki	Stokes	R	6 b	6 b
Blue	Stokes	S	100 a	100 a
Shanghai pak choi				
Mei Qing Choi	Stokes	S	100	100

[1] Statistical analysis was conducted for each crop species separately.
[2] Means followed by the same letter in a column do not differ based on Tukey's test at $P = 0.05$

Funding for this project was provided by the Ontario Agri-Food Innovation Alliance and the Fresh Vegetable Growers of Ontario.

CROP: Asparagus (*Asparagus officinalis*), cvs. Jersey Giant, Guelph Millennium, Eclipse, and Gijnlim

PEST: Stemphylium leaf spot/Purple spot (*Stemphylium vesicarium*)

AUTHORS: AUSTIN G, MCDONALD MR, & WOLYN D
University of Guelph, Dept. of Plant Agriculture, Simcoe Research Station

TITLE: SURVEYING AND TESTING ASPARAGUS CULTIVARS FOR RESISTANCE TO STEMPHYLIUM VESICARIUM, 2019

METHODS: Field data: In 2019 the asparagus season in Simcoe commenced May 17th and ran until June 14th. Twice a week during this period #1 spears were scouted for purple spot lesions an hour prior to their harvest. The data was collected from a randomized complete block design plot with four blocks planted in 2007 which contained asparagus cultivars Guelph Millennium, Eclipse, Jersey Giant, and Gijnlim. Stemphylium leaf spot lesions were counted from August to October. Five branches from the top two feet of the fern were scanned for lesions on the cladodes, lesions were also counted on the stem of the top two feet of the fern. Rust pustules were counted on these two sections of the fern due to a potential interaction. Defoliation due to infection was minimal and unmeasurable. If cultivars senesce infected cladodes at different speeds the data collected would be undermined.
Bioassay: Twice a week during the asparagus season, #1 spears were quickly harvested, trimmed to 23 cm, stood up in a cooler containing an inch of water, and brought to the lab for immediate sterilization and inoculation. Spears were disinfected in a 0.5% sodium hypochlorite bath for 30 seconds then transferred to a water bath before air-drying for an hour. While the spears dried, fresh conidia solutions were created from one-week old colonies of *S. vesicarium* grown on V-8 agar under a 12 hour blacklight and 12 hour dark cycle at room temperature. Two wounds were created on each spear by placing a thin flexible cover with an opening measuring 1x2 cm over each spear and lightly stroking the exposed area seven times using cheesecloth. Within minutes of wounding the spears were sprayed to run-off (~1 mL of solution per spear) on the wounded side as they were laid flat. The spears were then placed standing up in test tube racks in two clear boxes with one inch of water in the bottom and walls sprayed with water to ensure a sufficient spear wetness period vital for the infection process. The boxes were then divided between two growth chambers both set to 100% humidity and 20°C but differing in lighting; one was set to a cycle of 12 hours light and 12 hours dark while the other was set to continuous darkness. Lesions were counted 72 hours post-inoculation. Data was analyzed using Proc Glimmix in SAS 9.4 M6. Significance was determined using Tukey's test at $P = 0.05$.

RESULTS: as presented in Table 1 & 2

CONCLUSIONS: The field survey showed Jersey Giant to have more spears infected and a higher number of lesions on infected spears than the other three cultivars. On the fern, Jersey Giant showed more lesions on the stem than Gijnlim, but all other fern results are lost due to high variability in the field. The results of the bioassay show that Guelph Millennium and Eclipse produce a similar number of lesions across strains whether wounded or not. In the bioassay, Gijnlim and Jersey Giant developed fewer lesions than Guelph Millennium on unwounded spears. On wounded spears, Gijnlim and Jersey Giant sometimes had fewer lesions develop compared to Guelph Millennium.

Table 1. Purple spot incidence and lesion count by asparagus cultivar at the Simcoe Research Station, 2019.

	On Spears		AUDPC on fern[1]		
Cultivar	Incidence[2]	Lesion count	Cladodes	Stem	Rust
Guelph Millennium	32.1 b[3]	1.2 b	82.9 a	127.2 ab	186.9 a
Eclipse	36.2 b	1.1 b	127.9 a	114.6 ab	126.3 a
Jersey Giant	61.6 a	3.5 a	122.3 a	185.6 a	101.6 a
Gijnlim	37.2 b	0.9 b	67.0 a	72.0 b	384.6 a

[1] Area under disease progress curve on fern cladodes and upper stem as well as asparagus rust caused by *Puccinia asparagi*.
[2] Incidence is percent of spears with at least one lesion.
[3] Within a column, values with the same letter are not significantly different using Tukey's test at P <0.05.

Table 2. Purple spot lesion count by asparagus cultivars and *Stemphylium vesicarium* strains on the wounded or unwounded section of a detached spear.

Cultivar	Isolate					
	OA03[1]		NA61		OA101	
	Wounded	Unwounded[2]	Wounded	Unwounded	Wounded	Unwounded
Guelph Millennium	6.5 a[3]	0.8 a	8.1 a	9.7 a	14.9 a	62.3 a
Eclipse	5.6 ab	1.3 a	8.2 a	8.3 ab	15.3 a	68.2 a
Jersey Giant	3.6 bc	0.7 a	7.0 a	3.0 c	18.3 a	27.0 b
Gijnlim	2.9 c	0.8 a	6.0 a	6.2 bc	13.1 a	32.2 b

[1] Data for OA03 and NA61 are pooled from five bioassays, data for OA101 is from a single bioassay.
[2] OA03 conidia were found to have a very low germination rate on unwounded spear surfaces.
[3] Within a column, values with the same letter are not significantly different using Tukey's test at P <0.05.

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CROP: Red beets (*Beta vulgaris*), cvs. various
PEST: Rhizomania (*beet necrotic vein virus* (BNYVV) vectored by *Polymyxa betae*)

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

TITLE: EVALUATION OF VARIOUS BEET CULTIVARS WITH TOLERANCE TO RHIZOMANIA IN RED BEETS, 2019

MATERIALS: ROXY (Rijk Zwaan), REDVAL, GRENADE (Vilmorin North America), SOLO (Stokes Seeds), AY17113, XBE 7110 (Sakata Seed America)

RATIONALE: Rhizomania, caused by beet necrotic yellow vein virus (BNYVV) is considered a serious disease of beet crops worldwide. It can cause major losses to marketable yield. In red beets, the roots become fibrous with excessive secondary root hair growth. Limited control options are available once the disease is present in a field. New beet cultivars have been selected that are resistant to Rhizomania.

METHODS: Beets were direct seeded (40 seed/m) onto raised beds using a Stanhay air seeder on 11 June in organic soil in a commercial beet field that was naturally infested with the soil-borne plasmodiophorid-like organism *Polymyxa betae* (Rhizomania). A randomized complete block arrangement with four replications per cultivar was used. Each plot consisted of one row, 60 cm apart and 30 m in length. On 23 August, random samples of 10 beet roots were pulled and assessed for damage caused by Rhizomania. Beet tops were rated on a scale of 0-4 for size, vigour and overall growth. The scale was 0 = healthy tops, 1 = slightly stunted, 2 = smaller tops, some stunting, 3 = stunted tops, 4 = severe stunting. Beet roots were also rated on a 0-4 scale were 0 = no symptoms, healthy root, 1 = minor bearding, few extra root hairs, normal shape, 2 = bearding on tap root, round roots slightly elongated, 3 = bearding on roots, roots elongated, 4 = heavy bearding, stunted roots. These classes were used to determine the disease severity index (DSI) using the following formula:

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

On 23 September, beets from two randomly chosen 1.0 m sections of row were taken from each cultivar to assess beets for Rhizomania damage and determine yield. Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C) and September (15.8°C). The 10-year average temperatures were: June 18.4°C, July 21.1°C, August 20.2°C and September 16.4°C.
Monthly rainfall was below the 10-year average for June (84 mm), July (42 mm), August (46 mm) and average for September (62 mm). The 10-year rainfall averages were: June 100 mm, July 93 mm, August 80 mm and September 61 mm. All data were analyzed using the General Analysis of Variance function of Statistics V.10. Means separation was obtained using Fisher's Protected LSD test with $P = 0.05$ level of significance.

RESULTS: Results are presented in Table 1 and 2.

CONCLUSIONS: All cultivars had symptoms of damage caused by the Rhizomania pathogen. Significant differences were found among the cultivars in disease incidence severity and yield. Cultivar FOXY had the lowest incidence and severity. FOXY also had the highest marketable yield among the cultivars. GRENADE had incidence over 70% but relativity moderate severity on the roots. AY 17113, an oblong beet, was similar to GRENADE in incidence and severity. XBE 7110 and REDVAL had incidence of Rhizomania and did not appear to be resistant to the pathogen. The SOLO variety was used as a susceptible check.

Table 1. Disease incidence and severity to beet Rhizomania in various cultivars of red beets grown at a commercial field near the University of Guelph – Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Cultivar	% Rhizomania	DSI[1]	MKB Yield (t/ha)[2]
FOXY	38.4 a[3]	16.0 a	43.9 a
GRENADE	70.3 b	38.0 b	22.7 b
AY 17113	72.9 bc	34.7 b	36.1 a
XBE 7110	85.3 cd	52.7 c	22.9 b
REDVAL	87.1 d	49.4 c	20.1 bc
SOLO	100.0 e	89.7 d	10.3 c

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

$$DSI = \frac{\sum [(\text{class no.})\ (\text{no. beets in each class})}{(\text{total no. beets assessed})\ (\text{no. classes} - 1)} \times 100$$

[2] Marketable yield was based on beets with a diameter greater than 44 mm.
[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. Top and root rating of various cultivars for Rhizomania symptoms in red beets grown at a commercial field near the University of Guelph – Muck Crops Research Station, Holland Marsh, Ontario, 2019.

Cultivar	August		September
	Top Rating	Root Rating	Top Rating
FOXY	0.0 a[1]	0.3 a	2.0 a
AY 17113	1.3 b	2.0 a	3.0 b
SOLO	1.8 bc	3.3 c	4.0 c
XBE 7110	1.8 bc	2.0 b	3.8 bc
GRENADE	2.0 cd	2.0 b	3.5 bc
REDVAL	2.5 d	2.3 b	3.3 bc

[1]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 the Plant Production Systems of the Ontario Agri-Food Innovation Alliance and participating seed companies.

CROPS: Garlic (*Allium sativum* L.), Onion (Allium cepa L.)
PEST: Stem and bulb nematode (*Ditylenchus dipsaci* (Kühn, 1857)) Filip'ev, 1936

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

TITLE: EVALUATING GARLIC AND ONION CULTIVAR SENSITIVITY TO STEM AND BULB NEMATODE PARASITISM, 2018-19

MATERIALS: Garlic cultivars: Music, Georgian Fire, Purple Glazer, Ivan, Thermadore, Saba Gold, Messadore; Onion cultivars: La Salle, Red Sky, Braddock

METHODS: The field trial was conducted in muck soil (organic matter ~ 66%, pH~ 6.7) naturally infested with stem and bulb nematode (SBN) within an enclosed site at the Muck Crops Research Station (MCRS). The soil at the site had a SBN population of 45 SBN/kg of soil, determined at the University of Guelph MCRS using the sugar centrifugal flotation method. A randomized complete block design with four (4) replicates per cultivar was used. The cultivars tested were the garlic cultivars MUSIC, GEORGIAN FIRE, PURPLE GLAZER, IVAN, THERMADORE, SABA GOLD and MESSADORE and onion cultivars LA SALLE, RED SKY and BRADDOCK. Each cultivar consisted of 10 garlic cloves or onion transplants planted 10 cm apart in 1 m long single rows spaced 40 cm apart. Garlic cloves were planted ~5 cm deep on 3 December 2018. Onions were seeded in the greenhouse on 13 March 2019 and transplanted on 21 May. Plants were visually assessed for SBN infection on 6 and 28 June. Garlic and onions were harvested on 26 July and were counted, weighed and rated for nematode damage by assessing the percent of basal plate rot using a 0-4 rating scale, where: 0 = no damage, 1 = 1-24% basal plate missing; 2 = 25-50% basal plate missing; 3 = > 50% basal plate missing and 4 = completely desiccated basal plate. Garlic or onions rated 0 to 1 were considered marketable. These classes were used to calculate a disease severity index (DSI) using the formula below.

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

Stem and bulb nematodes were extracted from a 10 g sample of garlic and onions taken from each replicate after harvest using the Baermann pan method. Ten 5 cm deep soil cores were taken from each cultivar row using a soil probe and combined for each cultivar sample. A 25 g aliquot of soil was used to extract SBN nematodes using the sugar centrifugal flotation method.
Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C), October (9.4°C) and below average for May (11.4°C). The 10-year average temperatures were: May (14.3°C), June (18.4°C), July (21.1°C), August (20.2°C), September 16.4°C and October 9.7°C. Monthly rainfall was above the 10-year average for October (106 mm), average for May (77 mm), September (62 mm), and below average for June (84 mm), July (42 mm) and August (46 mm). The 10-year rainfall averages were: May (77 mm), June (100 mm), July (93 mm), August (80 mm), September (61 mm) and October (74 mm).
Data were analyzed using the General Analysis of Variance function of the Linear Analysis section of Statistix V.10. Means separation was obtained using Tukey's test with $P = 0.05$ level of significance.

RESULTS: Data are presented in Tables 1, 2 and 3.

CONCLUSION: The garlic cultivars MUSIC, GEORGIAN FIRE and IVAN showed more symptoms of SBN parasitism compared to the onion cultivars BRADDOCK and LA SALLE on 28 June; however, no significant differences were found among the garlic cultivars alone. All garlic and onion cultivars tested showed some level of stem and bulb nematode parasitism at harvest. Stem and bulb nematode damage incidence was significantly higher for the SABA GOLD garlic cultivar compared to the LA SALLE onion cultivar. There were no significant differences in percent marketability or damage severity among the cultivars. Stem and bulb nematode populations in the soil and plant tissue varied and were not statistically different among the cultivars. Due to cultivar differences, no plant height or yield weight results are presented.

Table 1. Percentage of garlic and onion plants showing symptoms of stem and bulb nematode infection on 6 June and 28 June in naturally infested soil at the Muck Crops Research Station, 2019.

Cultivar	% SBN Symptoms	
	6 June	28 June
MESSADORE	32.0 ns[1]	37.1 ab[2]
SABA GOLD	21.3	33.8 ab
MUSIC	18.6	50.0 a
THERMADORE	17.7	25.8 ab
GEORGIAN FIRE	17.1	53.2 a
IVAN	16.0	57.3 a
PURPLE GLAZER	10.0	35.7 ab
RED SKY	5.0	22.5 ab
BRADDOCK	0.0	0.0 b
LA SALLE	0.0	0.0 b

[1] ns indicates that no significant differences were found among the cultivars at $P = 0.05$, Tukey's test
[2] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Tukey's test

Table 2. Percent marketable, damage incidence and disease severity index (DSI) from harvested garlic and onions in soil naturally infested with stem and bulb nematode at the Muck Crops Research Station, 2019.

Cultivar	% Marketable	Nematode Damage Incidence (%)	DSI[3]
BRADDOCK	87.5 ns[1]	51.1 ab[2]	19.7 ns
LA SALLE	85.5	40.0 b	16.9
RED SKY	77.8	56.4 ab	23.1
MESSADORE	56.0	93.8 ab	43.5
IVAN	54.2	66.7 ab	36.5
GEORGIAN FIRE	50.0	72.9 ab	46.4
THERMADORE	47.3	77.6 ab	41.3
PURPLE GLAZER	42.6	73.7 ab	46.8
MUSIC	32.6	76.7 ab	54.3
SABA GOLD	19.6	100.0 a	53.8

[1] ns indicates that no significant differences were found among the cultivars at $P = 0.05$, Tukey's test
[2] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Tukey's test
[3] DSI was calculated using the following equation:

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

Table 3. Stem and bulb nematode populations at harvest in garlic and onion bulbs and soil after growing in a site naturally infested with stem and bulb nematode at the Muck Crops Research Station, 2019.

Cultivar	Soil (SBN/kg soil)	Basal Plate (SBN/g plant tissue)
LA SALLE	140.0 ns[1]	0.8 ns
BRADDOCK	110.0	0.4
MUSIC	20.0	78.5
GEORGIAN FIRE	10.0	0.2
MESSADORE	10.0	0.8
PURPLE GLAZER	10.0	0.4
IVAN	0.0	41.5
RED SKY	0.0	0.0
SABA GOLD	0.0	0.5
THERMADORE	0.0	9.9

[1] ns indicates that no significant differences were found among the cultivars at $P = 0.05$, Tukey's test

Funding for this project was provided by the California Garlic and Onion Research Advisory Board, the Plant Production Systems of the Ontario Agri-Food Innovation Alliance, the Fresh Vegetable Growers of Ontario and the Garlic Growers Association of Ontario.

CROP: Garlic (*Allium sativum* L.), cv. Music
PEST: Stem and bulb nematode (*Ditylenchus dipsaci* (Kühn, 1857)) Filip'ev, 1936

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

TITLE: EVALUATION OF NEMATICIDES FOR CONTROL OF STEM AND BULB NEMATODE IN GARLIC, 2018-19

MATERIALS: AGRI-MEK SC (abamectin 84 g/L), EXP#019-01 (*Trichoderma* spp.), PROMAX (thyme oil 3.5%), RHIZOVITAL 42 (*Bacillus amyloliquefaciens*), VELUM PRIME (fluopyram 500 g/L)

METHODS: The field trial was conducted in a mineral soil field (organic matter 5%, pH 7.6) free of stem and bulb nematode (SBN) near Cookstown, Ontario. A randomized complete block design with four (4) replicates per treatment was used. Three types of garlic cloves (seed) were included in the trial: high SBN infested seed (HN, 18 nematodes/g), low stem and bulb nematode infested seed (LN, 2 nematodes/g) and clean seed free of SBN. Nematode counts were determined at the University of Guelph Muck Crops Research Station using the Baermann pan method. The treatments were AGRI-MEK SC, EXP#019-01, PROMAX, RHIZOVITAL 42 and VELUM PRIME and where applied as a soak (S), drench (D) or seed treatment (ST). Soak treatments were: AGRI-MEK HN S at 0.9 mL/L, PROMAX HN S at 37 mL/L, and RHIZOVITAL 42 HN S at 5 mL/L and VELUM PRIME HN S and VELUM PRIME S at 1.7 mL/L and were applied by placing the cloves in a mesh bag and soaking for four hours in 10 L of each treatment solution. After treatment, bulbs were air dried before planting. Drench treatments: VELUM PRIME HN D and VELUM PRIME LN D at 500 mL/ha were applied directly over the cloves at planting at an application rate of 33 mL per meter. The seed treatment was EXP#019-01 at 1 g/kg of seed. An Untreated HN check, Untreated LN check and a CLEAN SEED check were also included. Each experimental unit consisted of 30 garlic cloves planted ~5 cm deep and 10 cm apart in 3 m long single rows spaced 40 cm apart. The trial was planted on 25 October 2018. The heights of 10 plants were taken on 14 and 28 June. A visual assessment of plants showing symptoms of SBN infection were counted on 28 June. Garlic was harvested on 12 August 2019. Garlic bulbs were counted, weighed and rated for nematode damage by assessing the percent of basal plate rot using a 0-4 rating scale where: 0 = no damage, 1 = 1-24% basal plate missing; 2 = 25-50% basal plate missing; 3 = > 50% basal plate missing and 4 = completely desiccated bulb. Bulbs rated 0 and 1 were considered marketable. These classes were used to calculate a disease severity index (DSI) using the formula below.

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

Stem and bulb nematodes were extracted from a 10 g sample of cloves taken from each replicate after harvest using the Baermann pan method. Ten 5 cm deep soil cores were taken from each treatment row using a soil probe, combining for each treatment sample. A 25 g aliquot of soil was used to extract SBN nematodes using the sugar centrifugal flotation method.

Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C), October (9.4°C) and below average for May (11.4°C). The 10-year average temperatures were: May (14.3°C), June (18.4°C), July (21.1°C), August (20.2°C), September 16.4°C and October 9.7°C. Monthly rainfall was above the 10-year average for October (106 mm), average for May (77 mm), September (62 mm), and below average for June (84 mm), July (42 mm) and August (46 mm). The 10-year rainfall averages were: May (77 mm), June (100 mm), July (93 mm), August (80 mm), September (61 mm) and October (74 mm).

Data were analyzed using the General Analysis of Variance function of the Linear Analysis section of Statistix V.10. Means separation was obtained using Tukey's test with $P = 0.05$ level of significance.

RESULTS: Data are presented in Tables 1, 2 and 3.

CONCLUSION: The VELUM PRIME treatments (soak and drench) provided excellent control of the stem and bulb nematode. There was an increase in percent marketability and yield of garlic as well as lower nematode damage in both the low (LN) and high (HN) SBN population seed. The AGRI-MEK treatment also provided good control with lower SBN damage and increased number of marketable bulbs. No statistically significant differences were found in the populations of stem and bulb nematode in the garlic cloves and soil at harvest. The harsh winter resulted in winter kill for some garlic plants in one of the replications.

Funding for this project was provided by the California Garlic and Onion Research Advisory Board, the Plant Production Systems of the Ontario Agri-Food Innovation Alliance, and the Fresh Vegetable Growers of Ontario representing the Ontario Garlic Growers Association.

Table 1. Garlic plant heights and percent of plants showing symptoms of stem and bulb nematode infection on 14 June and 28 June after nematicide application near Cookstown, Ontario, 2019.

Treatment	App. Method[1]	14 June	28 June	
		Height (cm)	Height (cm)	% SBN Symptoms
VELUM PRIME HN	S	56.4 ns[2]	75.7 ns	15.9 ns
Untreated HN	-	53.9	68.3	34.3
Untreated LN	-	51.4	72.1	10.0
AGRI-MEK HN	S	51.3	69.5	2.9
PROMAX HN	S	51.2	66.6	20.3
VELUM PRIME HN	D	50.7	69.1	16.1
VELUM PRIME LN	S	50.2	69.2	37.5
CLEAN SEED	-	50.2	74.5	17.3
RHIZOVITAL 42 HN	S	48.0	66.8	11.1
VELUM PRIME LN	D	47.6	68.9	17.5
EXP#019-01 HN	ST	45.9	60.4	36.7

[1] Application Method: S = Soak; D = Drench; ST = Seed Treatment

[2] ns indicates that no significant differences were found among the treatments at $P = 0.05$, Tukey's test

Table 2. Marketable yield, percent marketable bulbs, damage incidence and disease severity index (DSI) from harvested garlic in relation to nematicide application to control stem and bulb nematode in a mineral soil field trial near Cookstown, Ontario, 2018-2019.

Treatment	App. Method[1]	% Marketable Bulbs	Marketable Yield (g/plot)	% Nematode Damage	DSI[2]
VELUM PRIME HN	S	100.0 a[3]	466.8 abc	35.9 a	8.4 a
VELUM PRIME LN	S	100.0 a	595.7 ab	25.1 a	6.3 a
VELUM PRIME HN	D	96.9 a	212.6 abc	53.9 abc	15.1 a
CLEAN SEED	-	95.8 a	525.4 abc	33.9 a	11.1 a
VELUM PRIME LN	D	95.7 a	704.9 a	30.1 a	8.9 a
AGRI-MEK HN	S	85.1 a	218.9 abc	45.9 ab	17.8 a
Untreated LN	-	76.3 ab	478.0 abc	45.6 ab	22.2 ab
EXP#019-01 HN	ST	33.1 bc	39.2 bc	90.2 cd	55.0 bc
PROMAX HN	S	32.1 bc	95.4 bc	81.9 bcd	52.7 bc
RHIZOVITAL 42 HN	S	11.1 b	52.7 bc	94.4 cd	75.1 cd
Untreated HN	-	0.0 b	0.0 c	100.0 d	91.3 d

[1] Application Method: S = Soak; D = Drench; ST = Seed Treatment

[2] DSI was calculated using the following equation:

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

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

Table 3. Stem and bulb nematode populations at harvest found in garlic cloves and soil following nematicide application in a mineral soil field trial near Cookstown, Ontario, 2018-2019.

Treatment	App. Method[1]	Cloves (SBN/g clove)	Soil (SBN/kg soil)
VELUM PRIME HN	S	0.0 ns[2]	10 ns
CLEAN SEED	-	0.0	0
VELUM PRIME LN	D	0.0	0
VELUM PRIME LN	S	0.2	0
VELUM PRIME HN	D	0.4	0
EXP#019-01HN	ST	3.5	10
AGRI-MEK HN	S	6.3	10
PROMAX HN	S	13.6	1550
Untreated HN	-	14.2	130
RHIZOVITAL 42 HN	S	15.5	1100
Untreated LN	-	20.7	760

[1] Application Method: S = Soak; D = Drench; ST = Seed Treatment

[2] ns indicates that no significant differences were found among the treatments at $P = 0.05$, Tukey's test

CROP: Leek (*Allium porrum*), cv. Megaton

PESTS: Pigweed species (*Amaranthus retroflexus* and *Amaranthus powellii*), common lamb's-quarters (*Chenopodium album*), Common groundsel (*Senicio vulgaris*), Yellowcress (*Rorippa* sp), Common Purslane (*Portulaca oleracea*), Yellow foxtail (*Setaria pumila*), Barnyard grass (*Echinachloa crusgalli*)

AUTHORS: SWANTON C & SMITH P
University of Guelph, Dept. of Plant Agriculture, Crop Science Building

TITLE: CROP TOLERANCE AND WEED CONTROL WITH PYROXASULFONE IN LEEKS GROWN ON MUCK SOIL, 2019

MATERIALS: ZIDUA HERBICIDE (pyroxasulfone 85%)

METHODS: Leeks, cv. Megaton, grown as plugs, were transplanted with 10 cm in-row spacing on 23 May into organic soil (organic matter ≈ 55.6%, 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 four rows spaced 40 cm apart, and 6 m in length. Treatments were applied using a backpack mounted sprayer fitted with AIXR110-02 spray tips calibrated to deliver 200 L/ha at 206.84 kPa. Treatments were: ZIDUA at 149, 223 and 298 g ai/ha applied 1 and 14 days after transplanting. Two checks were included: standard pest management treatments and standard pest management treatments plus hand weeding. Treatments were applied on 24 May and 7 June. On 2, 15 July and 7 August all leeks in each replicate were visually examined for evidence of visual injury. As well, visual control of weed species was recorded. On 08 October, leeks in two 1 m sections of row per replicate were harvested. Yield samples were processed on 9 October (roots were trimmed, outer leaves were removed and top growth was trimmed to 40 cm). Yield data were analyzed using ARM Version 2019.8 Analysis of Variance function. Means separation was obtained by using Duncan's New MRT test at P = 0.05 level of significance.

RESULTS: as presented in Tables 1 & 2

CONCLUSIONS: No significant difference in visual crop injury or yield were observed among the treatments (Table 1). Full season control of pigweed, lamb`s-quarters and common groundsel was significantly affected by treatment (Table 2).

Table 1. Visual crop injury and leek yield, cv. Megaton, treated with herbicide and grown near the Muck Crop Research Station, Holland Marsh, Ontario, 2019

Treatments	Rate (g a.i./ha)	# Days post transplant	% Visual Injury			Yield (t/ha)
			2 July	15 July	7 Aug	
Std trts	--	--	0	0	0	49.2 ns[1]
Std trt + hand weeding	--	--	0	0	0	52.9
Pyroxasulfone	149	1	0	0	0	52.4
Pyroxasulfone	223	1	0	0	0	52.8
Pyroxasulfone	298	1	0	0	0	43.6
Pyroxasulfone	149	14	0	0	0	47.0
Pyroxasulfone	223	14	0	0	0	49.9
Pyroxasulfone	298	14	0	0	0	47.1

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

Table 2. Full season visual weed control by species when treated with herbicide near the Muck Crop Research Station, Holland Marsh, Ontario, 2019

Treatments	Rate (g a.i./ha)	# Days post transplant	% Visual Injury				
			AMASS[1]	CHEAL[2]	SENVU[3]	RORSS[4]	POROL[5]
Standard	--	--	100 a[6]	100 a	100 a	100 a	100 a
Std + hand weeding	--	--	100 a	100 a	100 a	100 a	100 a
Pyroxasulfone	149	1	96 ab	63 b	90 ab	96 a	96 a
Pyroxasulfone	223	1	92 b	59 b	90 ab	94 a	91 a
Pyroxasulfone	298	1	87 b	60 b	91 ab	94 a	95 a
Pyroxasulfone	149	14	94 b	59 b	79 c	95 a	91 a
Pyroxasulfone	223	14	95 ab	58 b	85 bc	94 a	91 a
Pyroxasulfone	298	14	95 ab	65 b	88 bc	98 a	95 a

[1] = AMASS (pigweed species), [2] = CHEAL (common lamb's quarters), [3] = SENVU (common groundsel), [4] = RORSS (yellowcress species), [5] = POROL (common purslane)

[6] Numbers in a column followed by the same letter are not significantly different at P = 0.05, using Duncan's New MRT test.

Funding for this trial was provided by KI-USA

CROP: Leek (*Allium porrum*), cv. Megaton

PESTS: Pigweed species (*Amaranthus retroflexus* and *Amaranthus powellii*), common lamb's-quarters (*Chenopodium album*), Common groundsel (*Senicio vulgaris*), Yellowcress (*Rorippa* sp), Common Purslane (*Portulaca oleracea*), Yellow foxtail (*Setaria pumila*), Barnyard grass (*Echinachloa crusgalli*), Annual Sowthistle (*Sonchus oleraceus*)

AUTHORS: SWANTON C & SMITH P
University of Guelph, Dept. of Plant Agriculture, Crop Science Building

TITLE: CROP TOLERANCE AND WEED CONTROL WITH PYROXASULFONE IN LEEKS GROWN ON SANDY SOIL, 2019

MATERIALS: ZIDUA HERBICIDE (pyroxasulfone 85%)

METHODS: Leeks, cv. Megaton, grown as plugs, were transplanted with 10 cm in-row spacing on 23 May into mineral soil (organic matter ≈ 1.8%, pH ≈ 7.1) at a mineral soil site 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 four rows spaced 40 cm apart, and 6 m in length. Treatments were applied using a backpack mounted sprayer fitted with AIXR110-02 spray tips calibrated to deliver 200 L/ha at 206.84 kPa. Treatments were: ZIDUA at 149, 223 and 298 g ai/ha applied 1 and 14 days after transplanting. Two checks were included: standard pest management treatments and standard pest management treatments plus hand weeding. Treatments were applied on 24 May and 7 June. On 2, 15 July and 7 August all leeks in each plot were visually examined for evidence of visual injury. As well, visual control of weed species was recorded. On 08 October, leeks in two 1 m sections of row per replicate were harvested. Yield samples were processed on 09 October (roots were trimmed, outer leaves were removed and top growth was trimmed to 40 cm). Yield data were analyzed using ARM Version 2019.8 Analysis of Variance function. Means separation was obtained by using Duncan's New MRT test at P = 0.05 level of significance.

RESULTS: as presented in Tables 1, 2 & 3

CONCLUSIONS: No significant difference in visual crop injury or yield were observed among the treatments (Table 1). No significant difference in visual weed control were observed among the treatments for all species (Table 2 & 3).

Table 1. Visual crop injury and leek yield, cv. Megaton, treated with herbicide and grown on mineral soil near the Muck Crop Research Station, Holland Marsh, Ontario, 2019.

Treatments	Rate (g a.i./ha)	# Days post transplant	% Visual Injury			Yield (t/ha)
			2 July	15 July	7 Aug	
Standard	--	--	0 ns[1]	0 ns	0 ns	62.0 ns
Std + hand weeding	--	--	0	0	0	54.1
Pyroxasulfone	149	1	0	0	0	49.0
Pyroxasulfone	223	1	0	0	0	61.0
Pyroxasulfone	298	1	0	0	0	53.6
Pyroxasulfone	149	14	0	0	0	57.8
Pyroxasulfone	223	14	0	0	0	59.7
Pyroxasulfone	298	14	0	0	0	59.5

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

Table 2. Full season visual broadleaf weed control by species when treated with herbicide near the Muck Crop Research Station, Holland Marsh, Ontario, 7 August 2019

Treatments	Rate (g a.i./ha)	# Days post transplant	% Visual Injury				
			AMASS[1]	CHEAL[2]	SENVU[3]	RORSS[4]	POROL[5]
Standard	--	--	100 ns[6]	100 ns	100 ns	100	100 ns
Std + hand weeding	--	--	100	100	100	100	100
Pyroxasulfone	149	1	100	100	100	93	100
Pyroxasulfone	223	1	100	96	100	84	100
Pyroxasulfone	298	1	100	100	100	84	100
Pyroxasulfone	149	14	100	94	100	90	100
Pyroxasulfone	223	14	100	100	100	94	100
Pyroxasulfone	298	14	100	100	100	90	100

[1] = AMASS (pigweed species), [2] = CHEAL (common lamb's quarters), [3] = SENVU (common groundsel), [4] = RORSS (yellowcress species), [5] = POROL (common purslane)
[6] ns = No significant differences were found among treatments.

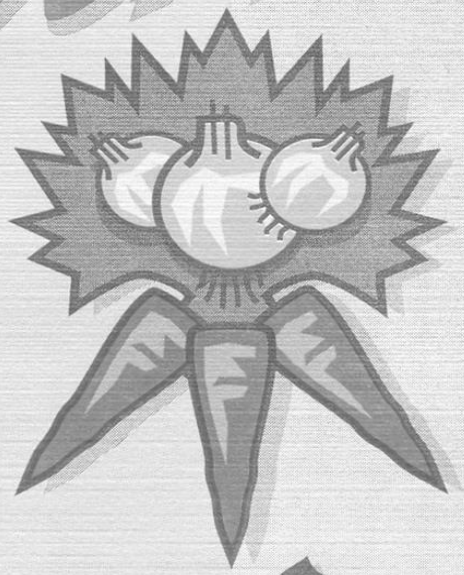
Table 3. Full season visual weed control by species when treated with herbicide near the Muck Crop Research Station, Holland Marsh, Ontario, 2019

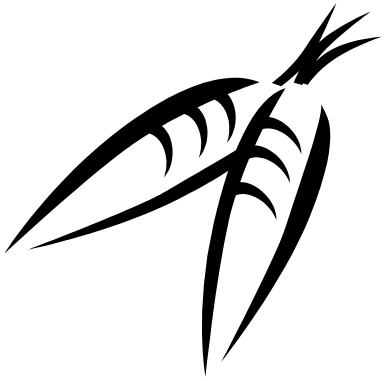
Treatments	Rate (g a.i./ha)	# Days post transplant	% Visual Injury		
			SETPU[1]	ECHCR[2]	SONOL[3]
Standard	--	--	100 ns[4]	100 ns	100 ns
Std + hand weeding	--	--	100	100	100
Pyroxasulfone	149	1	100	100	92
Pyroxasulfone	223	1	100	100	100
Pyroxasulfone	298	1	100	100	83
Pyroxasulfone	80	14	100	92	99
Pyroxasulfone	160	14	100	96	99
Pyroxasulfone	266	14	100	100	98

[1] = SETPU (yellow foxtail), [2] = ECHCR (barnyard grass), [3] = SONOL (annual sowthistle)
[4] ns = No significant differences were found among treatments

Funding for this trial was provided by KI-USA

Carrots AND Onions





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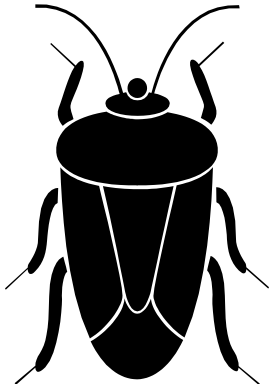


AUTHORS: BLAUEL T & MCDONALD MR
University of Guelph, Dept. of Plant Agriculture, Muck Crops Research Station

TITLE: THE INTEGRATED PEST MANAGEMENT PROGRAM SUMMARY FOR MUCK VEGETABLE CROPS, 2019

An Integrated Pest Management (IPM) program is provided to growers in the Holland/Bradford Marsh, Ontario, by the University of Guelph - Muck Crops Research Station. This project was funded in part through the Ontario Agri-Food Innovation Alliance. Funding was also provided in part by the Bradford Cooperative Storage Ltd., agrochemical companies, and growers participating in the Muck Crops Research Station IPM program. 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 roto-rod spore traps to trap and analyze spores of various vegetable crop pathogens.

SCOUTING

In 2019, 61 commercial vegetable fields, totalling 621 acres (onion 293 A., carrot 298 A., celery 20 A., potato 10 A.), were intensively scouted for 22 growers. Fields were scouted twice per week during the growing season and growers received scouting reports after each field survey.

DIAGNOSTICS, EXTENSION & DISSEMINATION OF INFORMATION

Any grower, whether participating in the IPM program or not, may bring in samples (plant, insect, or weed) for diagnosis. The on-site tools available for diagnosis are visual inspection and laboratory inspection using a microscope and culturing. Diagnoses are 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 Ontario Ministry of Agriculture and Food and Rural Affairs (OMAFRA) recommendations for pesticides.

From 23 May to 14 October, 2019, the diagnostic laboratory of the MCRS received 72 samples for diagnosis. Of these, 71% were diagnosed with infectious diseases (51 samples), 10% with insect issues (7 samples) and 19% were diagnosed with an abiotic disorder (14 samples). These samples were associated with the following crops: carrot (46%), onion (33%), celery (11%) and other crops (10%). For extension services, data collected from growers' fields and the MCRS research plots were compiled twice per week, analyzed and summarized. The results were compiled in an 'IPM report' and updated twice per week and circulated to participating growers, academia, industry, OMAFRA staff, posted on the MCRS website (www.uoguelph.ca/muckcrop), and a copy was displayed at the Bradford Co-op.

PEST PREDICTIVE MODELS

The IPM program provides disease and insect forecasting based on spore traps, disease forecasting models BOTCAST (for botrytis leaf blight of onion), DOWNCAST (for onion downy mildew), and BREMCAST (for lettuce downy mildew), degree day models, and insect traps. These disease and insect forecasts alert growers by predicting the potential for disease and insect pest incidence.

CROP PEST SUMMARIES

At the end of the scouting program, 100 onions were examined after lodging or 100 carrot samples were collected from each scouted field and assessed for damage from insects and diseases/physiological disorders.

CARROT

Insects

In 2019, carrot fields were scouted for carrot weevil (*Listronotus oregonensis*), carrot rust fly (*Psila rosae*), aster leafhopper (*Macrosteles quadrilineatus*) and other insect pests. Degree day models were used to predict the occurrence of the various life stages of these insects. Rust fly damage was more common in the harvest samples this year, which is likely due to second generation feeding.

Table 1. Average percent carrot rust fly and carrot weevil damage on carrots at harvest in scouted fields in the Holland Marsh, 2019.

Location	% Damaged Carrots	
	Weevil damage	Rust fly damage
West HM	0.6	0.4
South HM	0.0	4.7
Central HM	0.5	4.0
North HM	0.0	4.6
East HM	0.0	0.8
Average	0.2	2.9

Carrot weevil adults were first found in wooden traps on 23 May in carrot fields (Fig. 1). The threshold of 1.5 or more weevils/trap was reached by 24 May in most regions of the Holland Marsh. Overall, 53% of fields in the IPM program reached the 1.5 weevil/trap threshold, and 31% of fields reached the 5 weevil/trap threshold.

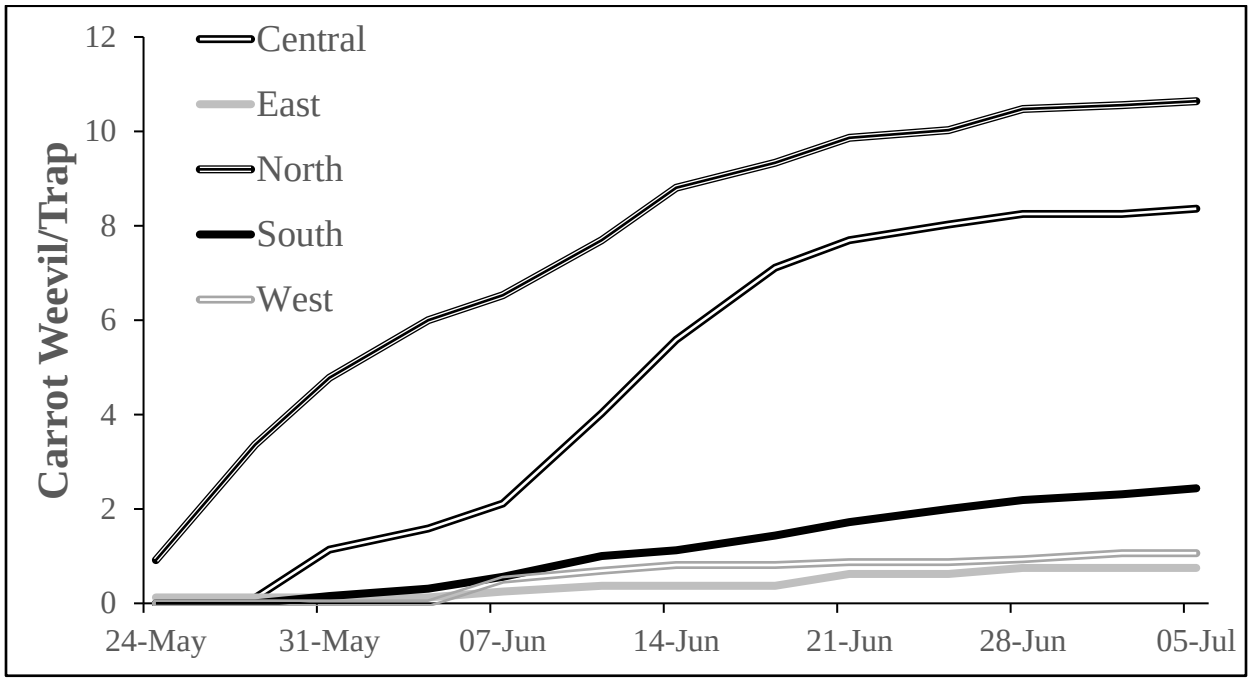


Figure 1. Average cumulative number of carrot weevils/trap in different regions of the Holland Marsh, 2019.

Carrot weevil counts were similar to counts over the past five years; however, damage in most fields was lower than expected. This is likely due to grower adoption of the new control product, Rimon.

Orange sticky traps and degree day models were used to monitor and estimate carrot rust fly (Fig. 2). Carrot rust flies were first found on sticky traps on 11 June, which was ~10 days after the degree day model predicted first generation emergence. The highest rust fly activity during the first generation was on 26 July, when 16% of scouted fields had exceeded the threshold of 0.1 flies/trap/day, with the highest activity during the second generation on 18 September when 44% of scouted fields had exceeded the threshold.

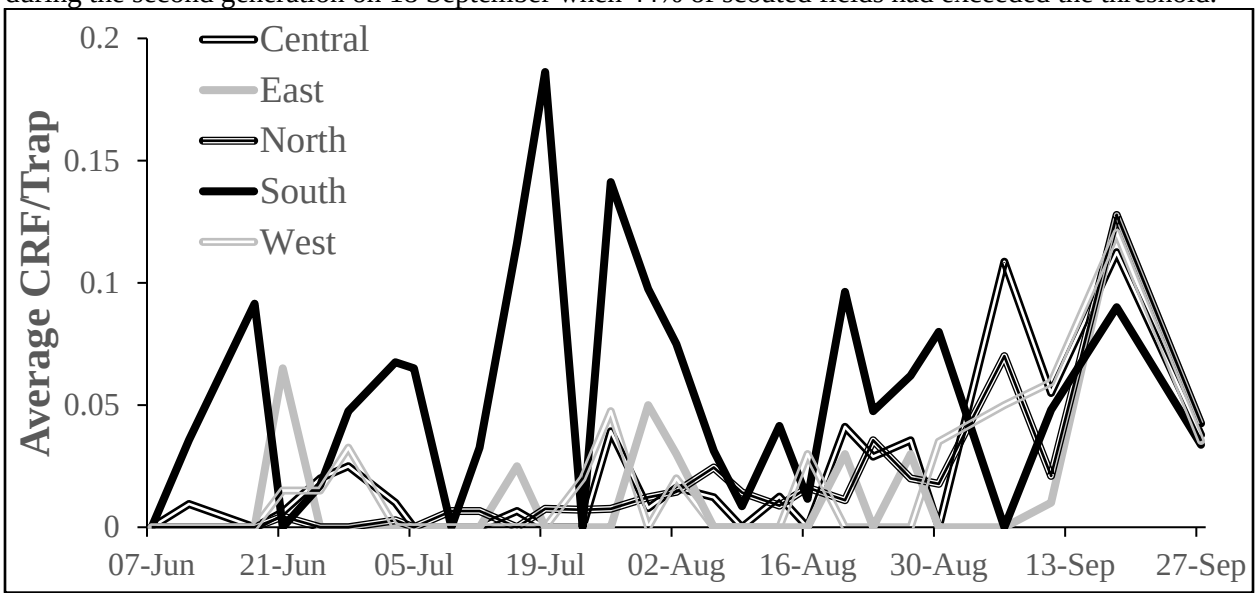


Figure 2. Average carrot rust fly (CRF) counts/trap/day in different regions of the Holland Marsh, 2019.

Aster leafhoppers are pests of carrots, celery, lettuce and leafy greens. Aster leafhopper adults were first found on orange sticky traps on 11 July in carrots and celery. Sweepnetting (100 sweeps per field) were used to estimate populations occurring within fields. Counts peaked around the end of July and generally dropped below threshold for the rest of the season.

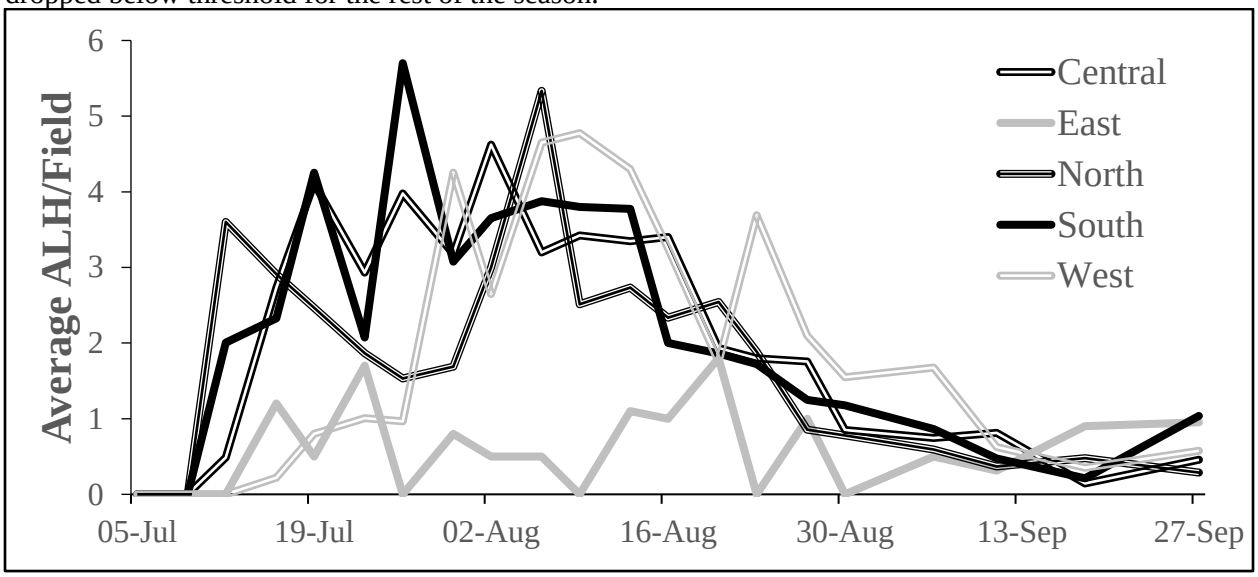


Figure 3. Average aster leafhopper counts/trap in different regions of the Holland Marsh, 2019.

Diseases

Carrot fields were scouted for diseases throughout the growing season. Leaf blights, which are caused by the fungi *Alternaria dauci* and *Cercospora carotae*, were first seen on 11 July. No scouted carrot fields exceeded the leaf blight threshold of 25% of plants infected during the growing season.

Samples of 100 carrots were taken from each scouted fields and roots were assessed for diseases (Table 2). Overall, samples often had several disease issues, typically at low rates. Cavity spot (*Pythium* spp.) and forking/splitting were common throughout most fields, which is similar to previous years in the Holland Marsh. Fusarium dry rot, crater rot and crown gall were present, but disease incidence was low in most affected fields.

Table 2. Disease incidence on carrot samples collected from commercial fields in the Holland Marsh, Ontario in 2019.

DISEASE	CAUSAL AGENT	FIELDS INFECTED (%)	INCIDENCE (%)
Cavity Spot	*Pythium* spp.	93	1-56
Fusarium Dry Rot	*Fusarium* spp.	10	1-8
Crater Rot	*Rhizoctonia* spp.	13	1-8
Crown Gall	*Agrobacterium tumefaciens*	43	1-21
Aster Yellows	*Phytoplasma*	3	1
Forking/Split		100	3-34

ONION

Insects

Onion fields were scouted for onion maggot (*Delia antiqua*) (Fig. 5), onion thrips (*Thrips tabaci*) (Fig. 6), cutworms and other insect pests. The degree day threshold for emergence of first generation onion flies was reached on 22 May. The first onion flies were found on 23 May and, which has been typical for several years in the marsh, counts were generally low throughout the season (Figure 5).

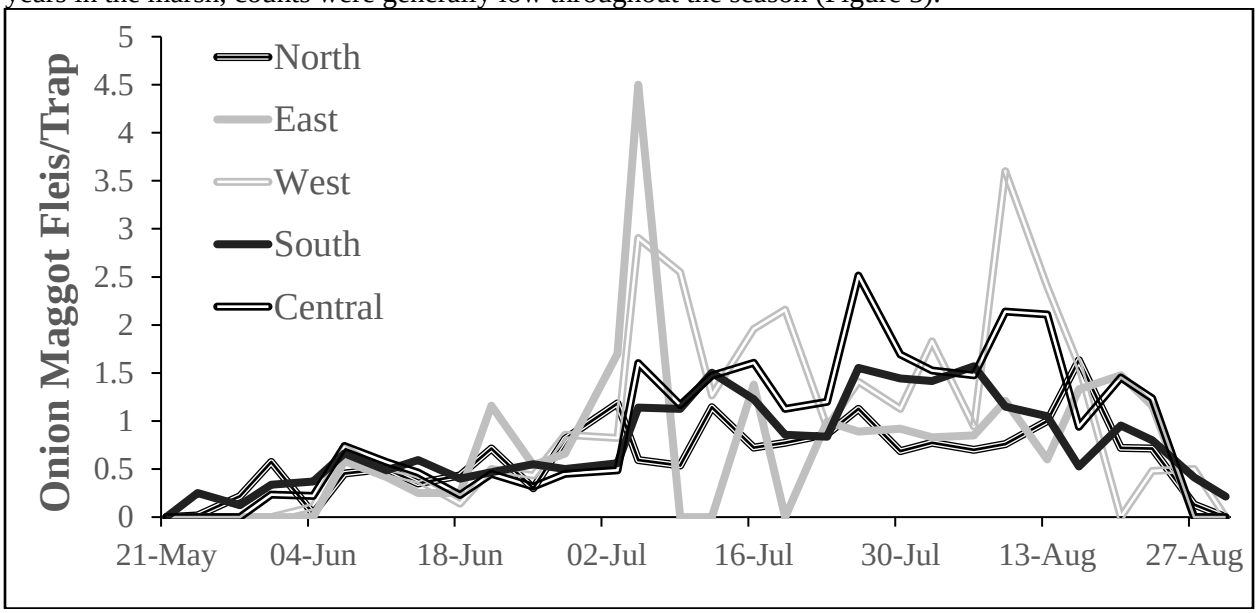


Figure 5. Average onion fly counts/trap/day in different regions of the Holland Marsh, 2019.

Thrips populations were generally low in scouted onion fields in 2019. Average counts increased slightly after the middle of July, although most fields stayed below threshold throughout the season. Thrips were first found on 4 July. The threshold of 1 thrips/leaf was first reached on 29 July, and counts peaked with 6% of fields exceeding the threshold on 5 August.

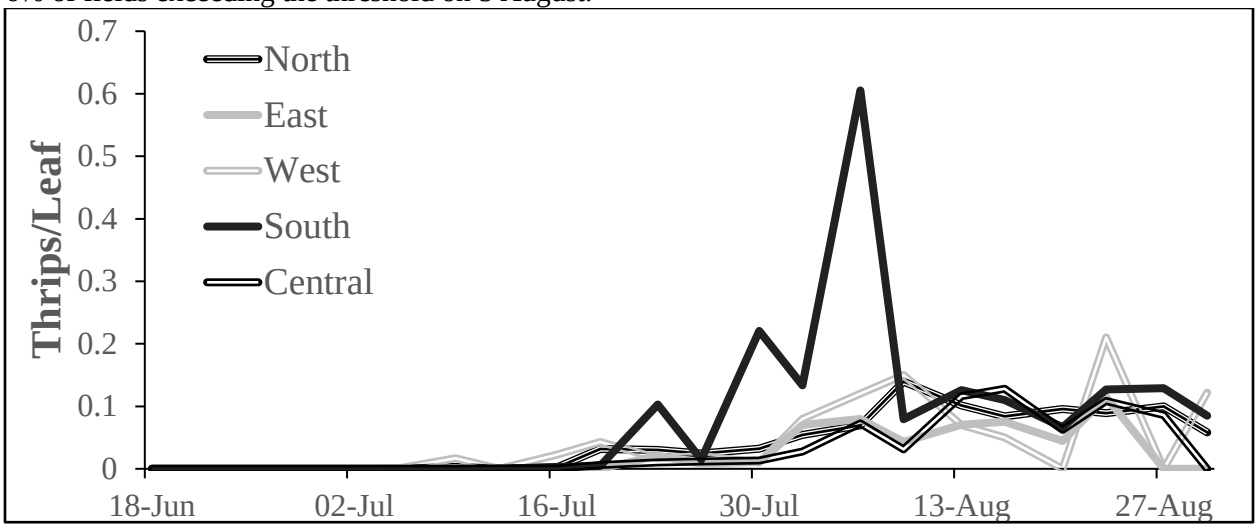


Figure 6. Average thrips counts in different regions of the Holland Marsh, 2019.

Diseases

Onion fields 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.

The main disease on onions in 2019 was stemphylium leaf blight (Table 3). All scouted onion fields showed symptoms of stemphylium leaf blight. First symptoms of stemphylium leaf blight in scouted fields were seen on 27 June, when scouting for stemphylium began. There was a low risk of downy mildew throughout most of the growing season as disease forecasting only predicted warranted sprays on 7 and 18 September. White rot was observed in 33% of fields, with the highest incidence up to 8%. For the second year in a row, no botrytis spores were detected in 2019 and no symptoms of botrytis leaf blight were seen in the marsh.

Table 3. Disease incidence on onion samples examined in commercial fields in the Holland/Bradford Marsh, Ontario in 2019.

DISEASE	CAUSAL AGENT	FIELDS INFECTED (%)	INCIDENCE (%)
White rot	*Sclerotium cepivorum*	33	1-8
Bacterial rot/soft rot	*Erwinia carotovora*	3	1
Smut	*Urocystis cepulae*	27	1-5
Pink root	*Setophoma terrestris*	27	3-10
Stemphylium leaf blight	*Stemphylium vesicarium*	100	1-90
Purple blotch	*Alternaria porri*	0	0

CELERY

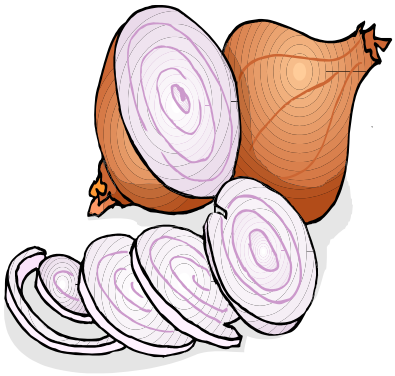
Insects

In 2019, two celery fields were scouted for carrot weevil, aster leafhopper, tarnished plant bug (*Lygus lineolaris*) 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. In 2019, tarnished plant bug and aster leaf hopper populations and damage were low, while no leaf miner or aphid damage was reported. Also, carrot weevil damage in celery fields was infrequent.

Diseases

Celery leaf curl or celery anthracnose (*Colletotrichum fioriniae*), is a relatively new disease threatening celery production in Ontario. Celery leaf curl was found in both scouted celery fields, while black heart was found in one scouted field. Leaf blight was identified in one celery field during the 2019 growing season.

This project was funded in part through the Knowledge Translation and Transfer (KTT) Funding Program, a program of the Ontario Agri-Food Innovation Alliance. Funding for the IPM program was also provided by the Bradford Co-operative Storage Ltd., growers participating in the program, FS Partners, Bayer Crop Science, BASF, Belchim Crop Protection, Corteva and Syngenta Crop Protection.


Cultivar Trials 2019



CARROT CULTIVAR TRIAL SEASON SUMMARY – 2019

May daytime air temperatures fluctuated from the mid-teens to the low twenties and night air temperatures fluctuated from 1.5-14°C. During the ten days prior to seeding there was only 10.5 mm of rain which lead to good soil conditions for carrot seeding. In the marsh, most of the carrot seeding occurred within a two-week period, 20-31 May. Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C), October (9.4°C) and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C, August 20.2°C, September 16.4°C and October 9.7°C. Monthly rainfall was above the 10-year average for October (106 mm), average for May (77 mm), September (62 mm), and below average for June (84 mm), July (42 mm) and August (46 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm, August 80 mm, September 61 mm and October 74 mm.

The carrot trial was seeded on 27 May. Soil moisture at seeding was favourable for forming the carrot hills, and the half inch of rain on 28 May and seasonal air temperature provided good conditions for germination. Emergence and plant vigour were good. Throughout the first two weeks of June there were several rainfall events with a total accumulation of 50 mm. This moisture along with average air temperatures provided good growing conditions for the carrots. The last two weeks of June brought slightly drier conditions with slightly higher air temperatures, allowing the carrots to establish well with no visible loss of stand. For the rest of the growing season, seasonal temperatures and timely rainfalls or irrigation (1") on 30 July, 7 & 15 August allowed for good carrot growth.

The rainfall on 28 May provided ideal moisture for the application and activation of the pre-emergence herbicide Gesagard. The Gesagard application helped to clean up early weeds and provided some weed suppression. Lorox + Assist Oil was applied on 21 June and twice in July to burn the larger weeds and kill smaller ones. These herbicide applications provided good weed control for the growing season. The trial was hand weeded a few times to keep it free of weeds.

Carrot weevils were first counted at the Muck Station on 6 June (0.5 weevils/trap/day). On 18 June, weevil numbers had quickly accumulated to the spray threshold of 1.5 cumulative weevils/trap. Weevil counts remained very low and never increased above an accumulated count of 1.5 weevils/trap. Rimon was applied twice on 18 & 25 June and no weevil damage was observed in the variety trial and only limited amounts were observed at evaluation. The trial average for carrot weevil damage at evaluation was 0.1%.

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CARROT CULTIVAR TRIAL SEASON SUMMARY – 2019 – continued

This is the second year in a row with a dramatically less weevil damage compared to the record highs of 32% and 31% damage in 2015 and 2017 respectively when Imidan was the only registered insecticide for weevil control. Carrot rust fly emergence was first recorded 11 June. There were three rust fly peaks on 18 June, 19 July and 27 August (0.4, 0.7, 0.2 flies/trap/day respectively). Through a seven week period in mid July to early September, the rust fly population was between the fresh market and the processing spray threshold (0.1 and 0.2 flies/trap/day, respectively. At evaluation there was significant rust fly damage to carrots with a very high trial incidence of 83.5% from this small but consistent population. This unexpected damage was thought to be caused by larva from the second and third peaks because there was no damage observed on the carrots displayed on grower field day. Regular insecticide and fungicide sprays had been discontinued after 16 August so carrots could be evaluated for blight tolerance at harvest. In hindsight, insecticide sprays should have been continued into September. Aster leaf hopper numbers were nil to low throughout the season and no aster yellows infection was found in the yield samples.

Alternaria and Cercospora leaf blights where managed throughout the growing season with three applications of fungicides (see Cultivar Management Procedures) to control both leaf blights. In order to observe cultivar tolerance to both pathogens, regular fungicide sprays were discontinued on 16 August. Throughout the months of September & October, leaf blight incidence remained low and most cultivars were still at very acceptable levels of leaf blight infection at harvest in October. Differences in the incidence of leaf blight were evaluated and noted among cultivars. For Grower Field Day on 5 September, carrots in a 1-1.5 m section of row are pulled for display. At this time root length was average, the weight of carrots was good, and quality was good, with very few forked and/or split carrots were observed. Low levels of bolting (1-3 per plot) were noted in a few cultivars in the trial. At this point very little rust fly damage was observed.

Weather conditions in October were favourable for harvest which began on 21 October and continued for five days. At harvest, carrots had increased in diameter and had visible rust fly damage compared to the samples pulled on 5 September. There were some forked and split carrots in the yield samples. Stand and yield appeared to be good. The carrot tops had low levels of leaf blight, but were slightly weak in attachment to the root. Several lights frosts had occurred before and during harvest and this may have weakened

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attachment. No sclerotinia was found in the trial at harvest, and only the odd carrot had bacterial canker rot. Seven of the cultivars in the trial produced seeders, but in very low numbers. Cultivar Extremo had the highest number of seeders with eight seeders in 18 meters of row. Carrots samples were placed in the Filacell storage immediately after harvest

At evaluation in early December, the trial average yields for cello and jumbo cultivars were similar at 1195 and 1316 bu/A respectively. The cellos were of average length, but did not have the expected width and therefore were lighter. The jumbos had good width but, were slightly shorter than desired and this shortness contributed to a lower than desired yield. The percentage of cull carrots was a little higher than last year. Most of the culls were small, undersized carrots with forked and splits making up the other culls. A minimal amount of canker rot was noted during evaluation. At evaluation, the percent marketable for cello and jumbo carrots was similar (78% and 80% respectively). The last time the trial average was above 80% for percent marketable was in 2014. The percent marketable for cellos was significantly different between the first and the third replicate. For cellos, the stand average was 19 carrots/foot compared to the desired trial seeding average of 24 carrots/foot. For the jumbos, the stand average was 12 carrots/foot compared to the desired trial seeding average of 17 carrots/foot. These low stands were disappointing because in the spring, the emergence and establishment of carrots appeared to be good. The trial average for cavity spot incidence was 45% and this is down compared to 2018 (76%). Cavity spot severity was also lower with a trial average of light sized lesions compared to the last four years with a light/medium sized lesion trial average. Most of the cello cultivars had poor uniformity of length and width. The jumbos were shorter by an inch then the potential or expected length of the various cultivars. Exterior colour for all cultivars was a shade darker than usual and this was consistent for all carrots within the sample. Most of the jumbo cultivars had very few visible lenticels. The cello and jumbo carrots both had average trial ratings for appearance. Most cultivars had a smooth exterior skin. Interior colour blending was good, with very few carrots having any translucency in the core or red/green rings around the core. Green shoulders were not present in most cello cultivars, and if found, were mostly in the jumbos and just starting to develop. There were some cultivars that had a small number with galls (see Carrot Management Procedures). Yields were average and quality was good for the 2019 carrot cultivar trial, but the heavy rust fly damage was disappointing and a concern.

CARROT CULTIVAR TRIALS - 2019

MANAGEMENT PROCEDURES

Fertilizer:

40 kg/ha Nitrogen (Calcium Ammonium Nitrate 27-0-0) + 50 kg/ha Phosphorous (MESZ 10-40-0) + 100 kg/ha Potassium (ASPIRE 0-0-58) + 100 kg/ha of K-Mag (0-0-22) + 3.5 kg/ha of Boron (10%) was worked into the soil.

Seeded:

All trials were seeded on 27 May using a push cone seeder. If seed had 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 6.5 L/ha on 29 May.
Post-emergence:	1 application: **LOROX L** at 500 ml/ha + **ASSIST OIL** at 1.0 L/ha on 21 June.
Post-emergence:	2 applications: **LOROX L** at 750 ml/ha + **ASSIST OIL** at 1.0 L/ha on 9 & 12 July.

Minor Elements:

Four foliar sprays: Epsom Salts on 23 & 31 July, 8 August (2.0 kg/ha) and 16 August (3.0 kg/ha).
Three foliar sprays: Suprafeed on 23 July and 8 & 16 August (2.0 kg/ha).
Two foliar sprays: Maganese Sulfate on 23 July and 8 August (2.0 kg/ha).
One foliar spray: Calcimax on 23 July (3.0 L/ha).
One foliar spray: 20-20-20 on 27 June (1.0 kg/ha).
One foliar spray: Magmax on 27 June (2.0 L/ha).
One foliar spray: Alexin on 31 July (3.0 L/ha).
One foliar spray: Solubor on 27 June (1.5 kg/ha)

Insect and Disease Control:

According to IPM recommendations.

RIMON at 840 ml/ha on 26 June.
RIMON at 840 ml/ha on 5 July.
PRISTINE at 735 g/ha and Minor Elements on 31 July.
BRAVO ZN at 2.5 L/ha and Minor Elements on 8 August.
DITHANE DG at 3.0 kg/ha and Minor Elements on 16 August.

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Harvest:

The Main and Adaptation Trials were harvested on 21-25 October. All trials were immediately placed in a temperature and humidity controlled storage (1°C, 95 % RH) respectively.

Irrigation:

Irrigation water was applied three times during the 2019 growing season.
On 30 July, 7 August and 15 August at 1 inch.

EVALUATION PROCEDURES

The cultivars were evaluated on 4-18 December after 5 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.

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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 LY = Light Yellow

Internal Colour:

DO = Dark Orange O = Orange BO = Bright Orange LO = Light Orange YO = Yellow Orange

Blight Rating:

Regular fungicide applications were discontinued on 16 August 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 < 1 mm.
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)

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CARROT CULTIVAR TRIALS - 2019 - continued

Root Length (cm):
Twenty centimetres is approximately eight inches.

Root Width (cm):
One inch is approximately two and a half centimetres.

Seeding Rate:
Number of seeds per foot as specified by seed company.

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

Leaf Structure:
F = Fine leaf structure ST = Standard leaf structure C = Course heavy leaf structure

% 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.

Aster Yellows:
No Aster yellows infected root were found in any of the cultivars yield samples.

Root Gall:
Root gall was found in the 2019 carrot cultivar trial at low levels.

No gall found			*Gall found in one replicate*			*Gall found in two replicates*
PV 5041	Intrepid	Belgrado	Speedo	Orange Blaze	Extremo	Cellobunch
SV 2384	Volcano	Blanes	Envy	New Hall - Cello	Bastia	B 3136 - Jumbo
Naval	Volcano - Inicium	Diamento	Istanbul	New Hall - Jumbo		
Navedo	Brava	Berlin	Enterprise	B 3136 - Cello		

CARROT CULTIVAR MAIN TRIAL CELLO TYPES - 2019

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
PV 5041	Nor	137 bc*	17 cd	90 ab	13.00 d	5.09 b-e	6.24 c	56.7	912 e
SV 2384	Sto	141 abc	17 cd	97 a	20.72 abc	5.28 b-e	12.31 a	88.0	1416 a
SPEEDO	Vil	99 d	31 ab	50 d	19.97 abc	7.93 ab	8.51 bc	82.2	1324 ab
CELLOBUNCH	Sto	136 bc	26 bc	78 abc	19.94 abc	7.73 abc	8.64 bc	81.9	1318 ab
ENVY	Sem	136 bc	40 a	57 cd	21.66 ab	10.85 a	6.66 c	87.5	1409 a
ISTANBUL	BEJO	130 bcd	20 bcd	77 abc	18.07 abc	5.35 b-e	8.90 bc	71.2	1147 a-e
ENTERPRISE	Sto	175 a	18 cd	95 a	19.40 abc	5.08 b-e	10.07 ab	75.8	1220 a-d
NAVAL	BEJO	162 ab	12 d	98 a	20.16 abc	3.21 e	12.35 a	77.8	1253 abc
ORANGE BLAZE	Sem	159 ab	17 cd	99 a	19.02 abc	4.37 cde	10.35 ab	73.6	1185 a-e
NAVEDO	BEJO	153 ab	19 cd	86 ab	21.79 a	5.65 b-e	10.97 ab	83.1	1338 ab
NEW HALL Cello	BEJO	112 cd	26 bc	53 cd	17.42 c	6.93 bcd	6.29 c	66.1	1064 b-e
INTREPID	Sem	152 ab	14 d	85 ab	17.65 c	3.95 de	8.55 bc	62.5	1006 cde
B 3136 Cello	BEJO	143 abc	16 cd	65 bcd	17.89 bc	4.94 b-e	6.73 c	58.4	939 de
Trial Average		**141**	**21**	**79**	**18.98**	**5.87**	**8.97**	**74.2**	**1195**

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.

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CARROT CULTIVAR MAIN TRIAL CELLO TYPES - 2019 - continued

Cultivar	Source	% Marketable	% Oversize	Majority of Culls	Shape	Uniformity of Shape	Uniformity of Length	Uniformity of Width	Appearance	Resistance to Greening
PV 5041	Nor	86.9 a*	38.1 ab	Sm	Imp	8.7 abc	4.7 bcd	5.0 cd	5.3 c	9.8 a
SV 2384	Sto	85.3 ab	25.7 bcd	F	ImpCyl	8.3 abc	4.3 cd	4.7 d	6.3 bc	10.0 a
SPEEDO	Vil	82.2 abc	39.6 ab	F	N	9.7 a	7.7 a	8.7 a	7.8 a	7.0 c
CELLOBUNCH	Sto	82.1 abc	39.1 ab	F&Sm	ImpCyl	5.7 fg	4.3 cd	4.0 de	6.3 bc	9.5 ab
ENVY	Sem	80.5 abc	49.7 a	F&Sp	Imp	5.3 g	6.0 abc	6.3 b	6.0 bc	10.0 a
ISTANBUL	BEJO	78.7 a-d	29.6 bcd	Sp	Imp	8.0 bcd	4.7 bcd	4.7 d	6.0 bc	9.7 a
ENTERPRISE	Sto	78.1 a-d	26.5 bcd	F&Sm	Imp	9.0 ab	3.7 d	3.0 e	6.0 bc	10.0 a
NAVAL	BEJO	77.3 bcd	16.1 d	Sm	N	6.8 def	6.7 a	6.3 b	6.3 bc	9.7 a
ORANGE BLAZE	Sem	76.5 bcd	22.6 cd	F	Imp	7.3 cde	4.7 bcd	4.3 d	6.3 bc	9.3 ab
NAVEDO	BEJO	76.2 bcd	25.9 bcd	F	GPN	6.0 efg	6.3 ab	5.0 cd	6.7 abc	9.5 ab
NEW HALL Cello	BEJO	75.8 cd	37.0 abc	Sp	Cyl	6.7 d-g	6.0 abc	6.0 bc	7.3 ab	8.8 b
INTREPID	Sem	70.9 de	22.2 cd	F	Imp	7.3 cde	4.7 bcd	5.0 cd	5.3 c	9.7 a
B 3136 Cello	BEJO	65.2 e	26.7 bcd	Sp	GP	5.7 fg	7.7 a	6.3 b	6.3 bc	9.7 a
		78.1	**30.7**			**7.3**	**5.5**	**5.3**	**6.3**	**9.4**

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.

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CARROT CULTIVAR MAIN TRIAL CELLO TYPES - 2019 - 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
PV 5041	Nor	DO	7.0 abc*	O	6.3 bc	41.4 a	7.3 abc	6.69 b-e	53L abc	CV
SV 2384	Sto	O	6.0 c	LO	5.7 cd	39.0 a	8.0 a	6.48 cde	38LM bc	CV
SPEEDO	Vil	LO	8.3 a	O	5.0 d	37.9 a	8.0 a	7.74 a	43LM bc	CC
CELLOBUNCH	Sto	O	7.0 abc	LO	6.3 bc	40.7 a	6.3 cd	6.17 e	33L c	CC
ENVY	Sem	O	6.7 bc	O	6.7 abc	38.6 a	7.7 ab	6.71 b-e	60L abc	CC
ISTANBUL	BEJO	DO	6.7 bc	DO	7.7 a	40.9 a	6.0 de	6.76 bcd	37LM bc	CC
ENTERPRISE	Sto	O	6.7 bc	O	7.3 ab	35.0 a	7.7 ab	6.52 cde	38L bc	CC
NAVAL	BEJO	O	6.7 bc	O	6.3 bc	40.9 a	5.7 de	6.98 bc	33L c	CC
ORANGE BLAZE	Sem	O	6.3 bc	O	5.0 d	35.6 a	6.7 bcd	6.19 de	62LM abc	CC
NAVEDO	BEJO	O	7.0 abc	LO	7.3 ab	38.3 a	5.0 e	6.83 bc	37LM bc	CC
NEW HALL Cello	BEJO	O	7.0 abc	O	7.0 ab	40.2 a	7.3 abc	6.98 bc	45L bc	CC
INTREPID	Sem	DO	6.7 bc	O	7.0 ab	38.0 a	7.3 abc	6.52 cde	52L abc	CV
B 3136 Cello	BEJO	O	7.7 ab	O	7.0 ab	40.8 a	6.7 bcd	7.19 ab	77M a	CV
			6.9		**6.5**	**39.0**	**6.9**	**6.75**	**46LM**	

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.

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CARROT CULTIVAR MAIN TRIAL CELLO TYPES - 2019 - continued

Cultivar	Source	Root Length (cm)	Root Width (cm)	Seeding Rate	Stand per Foot	Top Length (cm)	Leaf Colour	Leaf Structure	% Weevil Damage	% Rust Fly Damage	Average # of Seeders
PV 5041	Nor	20.9 bcd*	3.4 cd	22	18 abc	45.8 a	G	STC	0.0 a	92.5 de	0.3 a
SV 2384	Sto	22.6 a	3.3 d	25	19 abc	48.5 a	G	ST	0.0 a	78.2 bcd	0.0 a
SPEEDO	Vil	18.8 fg	4.0 a	17	13 d	44.2 a	G	ST	0.3 a	52.5 a	0.0 a
CELLOBUNCH	Sto	21.1 bcd	3.5 bcd	25	18 bc	47.2 a	LG	ST	0.0 a	73.2 bc	0.3 a
ENVY	Sem	20.4 d	3.7 ab	25	18 bc	45.5 a	G	ST	0.0 a	90.6 de	0.0 a
ISTANBUL	BEJO	21.5 bc	3.5 bcd	25	17 bcd	49.0 a	G	FST	0.0 a	94.3 e	0.0 a
ENTERPRISE	Sto	21.8 ab	3.3 d	28	23 a	49.3 a	G	ST	0.2 a	78.9 b-e	0.0 a
NAVAL	BEJO	18.0 g	3.7 abc	25	21 ab	44.2 a	DG	FST	0.0 a	83.3 b-e	0.0 a
ORANGE BLAZE	Sem	21.0 bcd	3.5 bcd	25	21 ab	49.1 a	G	ST	0.7 a	70.4 b	0.7 a
NAVEDO	BEJO	20.1 de	3.5 bcd	25	20 ab	49.0 a	LG	FST	0.0 a	90.6 de	0.0 a
NEW HALL Cello	BEJO	18.3 fg	3.5 bcd	25	15 cd	47.7 a	G	ST	0.0 a	84.8 b-e	0.7 a
INTREPID	Sem	20.5 cd	3.3 d	25	20 ab	50.6 a	G	ST	0.0 a	84.8 b-e	0.0 a
B 3136 Cello	BEJO	19.2 ef	3.5 bcd	25	19 abc	48.1 a	G	C	0.0 a	88.7 cde	0.0 a
Trial Average		**20.3**	**3.5**	**24**	**19**	**47.5**			**0.1**	**81.8**	**0.2**

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 JUMBO TYPES - 2019

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
VOLCANO	Vil	70 ef*	45 bcd	17 bc	19.48 cde	14.94 abc	2.53 bcd	87.3	1406 b
COREO	Vil	84 cde	35 de	39 a	18.23 de	9.94 de	6.00 a	79.7	1283 bc
VOLCANO Inicium	Vil	51 f	39 cde	5 c	16.94 e	13.58 a-d	0.95 d	72.7	1170 bc
BRAVA	BEJO	72 def	52 abc	7 c	20.88 bcd	16.85 ab	1.02 d	89.3	1438 ab
BELGRADO	BEJO	133 a	60 a	29 ab	26.30 a	17.18 a	3.98 ab	105.8	1703 a
B 3136 Jumbo	BEJO	97 bcd	27 e	45 a	17.84 de	8.28 e	5.72 a	70.0	1127 c
BLANES	BEJO	101 bc	54 ab	14 bc	23.14 abc	15.97 abc	1.97 bcd	89.7	1444 ab
EXTREMO	Sto	98 bcd	49 abc	17 bc	21.43 bcd	14.44 abc	2.13 bcd	82.9	1334 bc
DIAMENTO	Vil	75 c-f	44 bcd	7 c	17.95 de	13.00 cd	0.90 d	69.5	1119 c
NEW HALL Jumbo	BEJO	91 b-e	29 e	39 a	17.68 de	7.91 e	5.69 a	68.0	1095 c
BASTIA	BEJO	131 a	51 abc	29 ab	21.56 bcd	13.20 bcd	3.36 bc	82.8	1333 bc
BERLIN	BEJO	112 ab	54 ab	12 bc	23.78 ab	14.94 abc	1.74 cd	83.4	1343 bc
Trial Average		**93**	**45**	**22**	**20.43**	**13.35**	**3.00**	**81.8**	**1316**

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.

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CARROT CULTIVAR MAIN TRIAL JUMBO TYPES - 2019 - continued

Cultivar	Source	% Marketable	% Oversize	Majority of Culls	Shape	Uniformity of Shape	Uniformity of Width	Uniformity of Length	Appearance	Resistance to Greening
VOLCANO	Vil	90.2 a*	76.8 abc	F	Imp	7.7 a	6.3 bcd	6.7 bcd	8.0 a	8.5 abc
COREO	Vil	87.5 ab	54.0 ef	F	ImpCyl	7.0 ab	7.0 abc	7.7 ab	7.7 ab	8.0 bcd
VOLCANO Inicium	Vil	85.9 ab	80.4 ab	F	Imp	7.7 a	8.0 a	8.3 a	8.0 a	8.7 ab
BRAVA	BEJO	85.5 ab	80.7 a	F	GPD	6.3 abc	5.3 d	5.3 e	6.7 cde	9.0 ab
BELGRADO	BEJO	80.7 abc	65.0 cde	Sm	GP	5.3 bc	5.7 cd	6.7 bcd	6.7 cde	8.3 bc
B 3136 Jumbo	BEJO	78.5 abc	46.7 f	F	GP	6.3 abc	7.0 abc	6.7 bcd	6.3 de	9.7 a
BLANES	BEJO	77.9 bc	69.2 a-d	Sm	GP	6.3 abc	6.3 bcd	7.0 bc	7.0 bcd	6.0 e
EXTREMO	Sto	77.3 bc	67.4 bcd	Sm	D	5.7 bc	7.7 ab	5.7 de	6.0 e	8.3 bc
DIAMENTO	Vil	77.2 bc	72.2 a-d	F	D	5.3 bc	7.0 abc	5.3 e	7.3 abc	7.3 cd
NEW HALL Jumbo	BEJO	76.9 bc	45.1 f	Sp	Cyl	6.3 abc	6.7 a-d	7.3 ab	6.7 cde	7.0 de
BASTIA	BEJO	76.6 bc	61.1 de	Sm	GP	5.0 c	6.3 bcd	6.7 bcd	6.7 cde	9.0 ab
BERLIN	BEJO	71.2 c	63.7 de	Sm	GPD	6.0 abc	6.0 cd	6.0 cde	6.7 cde	8.3 bc
Trial Average		**80.4**	**65.2**			**6.3**	**6.6**	**6.6**	**7.0**	**8.2**

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.

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CARROT CULTIVAR MAIN TRIAL JUMBO TYPES - 2019 - 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
VOLCANO	Vil	LO	7.7 ab*	LO	6.3 bc	51.6 cd	8.0 ab	7.31 b	22L d	CC
COREO	Vil	O	7.3 ab	O	6.3 bc	42.2 g	8.7 a	7.29 b	37L cd	CC
VOLCANO Inicium	Vil	LO	8.0 a	O	7.0 ab	48.1 def	8.0 ab	7.95 a	22L d	CC
BRAVA	BEJO	O	7.3 ab	O	5.3 cd	60.2 a	7.3 abc	6.48 cd	28L cd	CC
BELGRADO	BEJO	LO	6.0 cd	O	5.0 cd	53.5 bc	6.0 c	6.24 d	40LM cd	CC
B 3136 Jumbo	BEJO	O	6.0 cd	O	7.0 ab	50.3 c-f	7.0 bc	7.00 bc	77LM a	CV
BLANES	BEJO	LO	7.0 abc	O	4.7 d	60.4 a	8.0 ab	6.33 d	42LM cd	CC
EXTREMO	Sto	O	5.7 d	O	6.3 bc	47.9 ef	6.0 c	6.48 cd	53L abc	CC
DIAMENTO	Vil	O	7.7 ab	O	8.0 a	51.1 cde	8.7 a	6.86 bcd	48LM bc	CC
NEW HALL Jumbo	BEJO	O	7.0 abc	O	6.0 bcd	47.4 f	6.0 c	6.71 bcd	35LM cd	CV
BASTIA	BEJO	O	6.7 bcd	O	5.7 bcd	50.0 c-f	6.7 bc	6.57 cd	65LM ab	CC
BERLIN	BEJO	O	7.0 abc	O	5.7 bcd	55.3 b	8.7 a	6.52 cd	42LM cd	CC
Trial Average			**6.9**		**6.1**	**51.5**	**7.4**	**6.81**	**43LM**	

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.

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CARROT CULTIVAR MAIN TRIAL JUMBO TYPES - 2019 - continued

Cultivar	Source	Root Length (cm)	Root Width (cm)	Seeding Rate	Stand per Foot	Top Length (cm)	Leaf Colour	Leaf Structure	% Weevil Damage	% Rust Fly Damage	Average # of Seeders
VOLCANO	Vil	23.8 ab*	5.5 ab	14	9 de	49.3 cde	G	ST	0.0 a	81.0 bcd	0.3 a
COREO	Vil	22.6 b	4.9 c	17	11 bcd	42.2 g	G	FST	0.0 a	75.0 abc	2.0 bc
VOLCANO Inicium	Vil	25.1 a	5.5 ab	14	7 e	49.0 cde	G	ST	0.0 a	67.3 a	0.0 a
BRAVA	BEJO	20.8 c	5.9 a	18	9 cde	50.5 c	G	ST	0.0 a	99.2 f	0.3 a
BELGRADO	BEJO	20.6 c	5.1 bc	18	18 a	44.4 fg	LG	ST	0.3 a	77.5 abc	0.0 a
B 3136 Jumbo	BEJO	22.7 b	5.3 bc	18	13 bcd	49.9 cd	G	C	0.0 a	94.3 def	0.3 a
BLANES	BEJO	20.7 c	5.2 bc	18	13 bc	47.6 de	G	ST	0.0 a	95.1 ef	0.0 a
EXTREMO	Sto	18.9 d	5.5 ab	18	13 bcd	61.4 a	G	F	0.0 a	94.3 def	2.7 c
DIAMENTO	Vil	19.0 d	5.5 ab	12	10 cde	57.0 b	LG	FST	0.5 a	73.3 ab	0.7 ab
NEW HALL Jumbo	BEJO	20.9 c	4.5 d	18	12 bcd	48.9 cde	G	ST	0.0 a	88.3 c-f	0.0 a
BASTIA	BEJO	20.2 cd	5.3 bc	20	17 a	46.7 ef	LG	FST	0.0 a	83.1 b-e	0.0 a
BERLIN	BEJO	19.1 d	5.4 b	18	15 ab	44.3 fg	G	ST	0.0 a	91.5 def	0.0 a
Trial Average		**21.2**	**5.3**	**17**	**12**	**49.3**			**0.1**	**85.0**	**0.5**

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 EVALUATION NOTES – 2019

PV 5041: *Norseco sample,* Average length but uneven, Average width but slightly uneven, Tapered tips, Appearance a little rough, Poor + average weight, Good exterior colour even, Smoothness a little poor, Uniformity of shape even, Some carrots with bends and curves, 1 to 2 cavity spots per root, A touch ringy, Average interior blending, Red ring around core (20-40%), White or yellow in cores (10%), Average core size, Jumbos are an oversized packer but with tapered ends.

SV 2384: *Stokes sample,* Good length but uneven, Average & good width but very uneven, Full tips, Good appearance, Average to good weight, Fair exterior colour a little uneven, Fairly smooth, Uniformity of shape even, Soome carrots with bends and curves, 1 to 2 cavity spots per root, Odd carrot ringy, Average interior blending, Dead center of core translucent (10%), Red ring around core (30-50%), Average core size, Long but some too thin, Okay Jumbo needs bit more weight.

Speedo: *Vilmorin sample,* Nante style carrot, Okay to good length even, Good very even width, Full tips, Nice appearance, Good weight, Fair exterior colour a little uneven, Nice smooth carrot, Uniformity of shape very even, 1 to 2 cavity spots per root, Interior blending bit poor uneven, Translucent core (30-40%), Yellow ring around core (20-60%), Average core size, Good size in Jumbos but some too short.

Cellobunch: *Stokes sample,* Average length but uneven, Average to good width but uneven, Tapered & full tips, Average appearance, Average weight, Good exterior colour even, Fairly smooth, Uniformity of shape even, Odd carrot with bends and curves, 1 to 3 cavity spots per root, A touch ringy, Average interior blending, White or yellow in cores (10-20%), Average to large core size, One carrot with Gull, Some roots need a bit more weight, Jumbos are an oversized packer heavy shoulder tapered end.

Envy: *Seminis sample,* Okay length but slightly uneven, Average width, Tapered tips, Average appearance, Poor & average weight, Fair exterior colour uneven, Fairly smooth, Uniformity of shape a little uneven, Odd carrot with bends and curves, 1 to 2 or 3 to 5 cavity spots per root, Some noticeable cavity spot, Odd ringy carrot, Average interior blending, Dead center of core translucent (40-50%), Red ring around core (20-60%), Average to large core size, Some carrots too short, Good Jumbo in size and weight, Good mix of Packers (60%) and Jumbos (40%).

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CARROT CULTIVAR MAIN TRIAL CELLO TYPES EVALUATION NOTES – 2019 - continued

Istanbul: *Bejo sample,* Good length but uneven, Average & good width uneven, Tapered & full tips, Bit rough in appearance, Average & good weight, Nice exterior colour even, Fairly smooth, Uniformity of shape uneven, Odd carrot with bends and curves, 1 to 2 cavity spots per root, Some carrots ringy, Nice interior blending even, Red ring around core (20-50%), Average core size, Some carrots too short, Heavy rust fly damage, Average Jumbo are oversized packer.

Enterprise: *Stokes sample,* Good length but very uneven, Average width but very uneven, Tapered tips, Average appearance, Average weight, Fair exterior colour a little uneven, Fairly smooth, Uniformity of shape very even, Some carrots with bends and curves, 1 to 2 cavity spots per root, A touch ringy, Good interior blending, Red ring around core (40-80%), Average core size, Some roots a bit thin, Fair Jumbo but tapered ends.

Naval: *Bejo sample,* Nantes carrot, Average length but slightly even, Good width but slightly uneven, Full tips, Average appearance, Good weight, Exterior colour a little uneven, Fairly smooth, Uniformity of shape a little even, 1 to 2 cavity spots per root, Odd noticeable lenticel, Good interior blending, Dead center of core translucent (40-50%), Red ring around core (20-40%), Average & large core size, Some a bit short, Jumbos are oversized nantes and a bit short.

Orange Blaze: *Seminis sample,* Average length but uneven, Okay to average width but uneven, Slightly tapered tips, Average appearance, Average weight, Fair exterior colour slightly uneven, Fairly smooth, Uniformity of shape even, Odd carrot with bends and curves, 1 to 3 cavity spots per root, Odd noticeable cavity spot, A touch ringy, Interior blending uneven, Translucent core (10%), Yellow or red ring around core (10-50%), Average core size, Uneven lengths a slight concern, Jumbos are an oversized packer needs bit more weight.

Navedo: *Bejo sample,* Good length but slightly uneven, Average width but uneven, Full tips, Average appearance, Average & good weight, Fair exterior colour even, Fairly smooth, Uniformity of shape a little uneven, Odd carrot with bends and curves, 1 to 2 cavity spots per root, Average to good interior blending, Dead center of core translucent (10-30%), Red ring around core (30-40%), Average core size, Slicer potential, Good Jumbos.

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CARROT CULTIVAR MAIN TRIAL CELLO TYPES EVALUATION NOTES – 2019 - continued

New Hall: *Bejo sample,* Poor to average length & width but uneven, Full tips, Good appearance, Average weight, Exterior colour a little uneven, Fairly smooth, Uniformity of shape even, 1 to 2 cavity spots per root, Average interior blending, Dead center of core translucent (20-40%), Red ring around core (10-20%), Average core size, Uneven lengths and too many are short, Good Jumbos but some carrots too short.
Cello

Intrepid: *Seminis sample,* Good length but uneven, Okay to average width but uneven, Tapered tips, Rough appearance, Average weight, Good exterior colour even, Smoothness poor, Uniformity of shape even, Odd carrots with bends and curves, 1 to 3 cavity spots per root, A little ringy, Average interior blending, Red ring around core (40-60%), Average core size, A lot of breakage, A lot of side roots, Fair Jumbos but long.

B 3136: *Bejo sample,* Okay length very even, Average width slightly even, Slightly tapered full tips, Appearance a little rough, Average weight, Good exterior colour even, Smoothness a bit poor , Uniformity of shape uneven, Odd carrots with bends and curves, 3 to 5 cavity spots per root, Slightly noticeable cavity spot, A touch ringy carrot, Average interior blending, Red ring around core (40-80%), Average core size, All carrots a bit short, A lot of rust fly damage, Good Jumbos but a bit short.
Cello

CARROT CULTIVAR MAIN TRIAL JUMBO TYPES EVALUATION NOTES – 2019

Volcano: *Vilmorin sample,* Good length slightly even, Good width but slightly uneven, Slightly tapered full tips, Nice appearance, Good weight, Slightly pale exterior colour, Nice smoothness, Uniformity of shape even, 1 to 2 cavity spots per root, Odd noticeable lenticel, Average interior blending, Translucent core throughout (30-40%), Yellow ring around core (30-40%), White in cores (10-20%), Large core size, Heavy shoulders, Good Packers weight and length.

Coreo: *Vilmorin sample,* Good length even, Good width slightly even, Full tips, Good appearance, Good weight, Good exterior colour, Good smoothness, Uniformity of shape even, 1 to 2 cavity spots per root, Odd noticeable lenticel, Average interior blending, Dead center of core translucent (10-40%), White or yellow in cores (20%), Large core size, Bit more weight needed, Good Packers bit short.

Volcano:
Inicium *Vilmorin sample,* Good length very even, Good width even, Slightly tapered full tips, Nice appearance, Good weight, Slightly pale exterior colour, Fairly smooth, Uniformity of shape even, 1 to 2 cavity spots per root, A few noticeable lenicels, A touch ringy, Average interior blending, Translucent core throughout (40-100%), Yellow ring around core (10-50%), Large core size, A little more weight would be good, Less visible rust fly damage.

Brava: *Bejo sample,* Good length but uneven, Good width but slightly uneven, Slightly tapered full tips, Good appearance, Excellent weight, Fair exterior colour a little uneven, Fairly smooth, Uniformity of shape a little uneven, 1 to 2 cavity spots per root, Slightly noticeable lenticels, Interior blending a bit poor, Dead center of core translucent (20-50%), Red ring around core (30-50%), Extra large core size, A lot of rust fly damage.

Belgrado: *Bejo sample,* Okay to average length slightly uneven, Average to good width even slightly uneven, Full tips, Good appearance, Good weight, Fair exterior colour slightly pale, Fairly smooth, Uniformity of shape uneven, 1 to 3 cavity spots per root, Slightly noticeable lenticels, Poor to average interior blending, Dead center of core translucent (20-40%), Red ring around core (30-40%), White in cores (30-40%), Extra-large core size, Some carrots bit short.

B 3136:
Jumbo *Bejo sample,* Good length even, Good width even, Full tips, Average appearance, Good weight, Fair exterior colour slightly uneven, Fairly smooth, Uniformity of shape even, 1 to 5 cavity spots per root, Odd noticeable cavity spot, A touch ringy, Average to good interior blending, Red ring around core (40-100%), Large core size, A little more weight at tip would be good, Good Packers.

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CARROT CULTIVAR MAIN TRIAL JUMBO TYPES EVALUATION NOTES – 2019 - continued

Blanes: *Bejo sample,* Okay to good length even, Good width slightly even, Full tips, Good appearance, Good weight, Good exterior colour slightly pale, Good smoothness, Uniformity of shape even, 1 to 2 cavity spots per root, A few noticeable lenticels, Poor to average interior blending, Red ring around core (20-30%), White in cores (20-80%), Extra-large core size, A few carrots too short.

Extremo: *Stokes sample,* Average length very even, Good width even, Full tips, Good appearance, Excellent weight, Fair exterior colour slightly uneven, Good smoothness, Uniformity of shape a little uneven, 1 to 3 cavity spots per root, Odd noticeable cavity spot, Odd noticeable lenticel, Good interior blending, Red ring around core (40-60%), White in cores (10-60%), Large core size, Some carrots a bit short, A lot of rust fly damage.

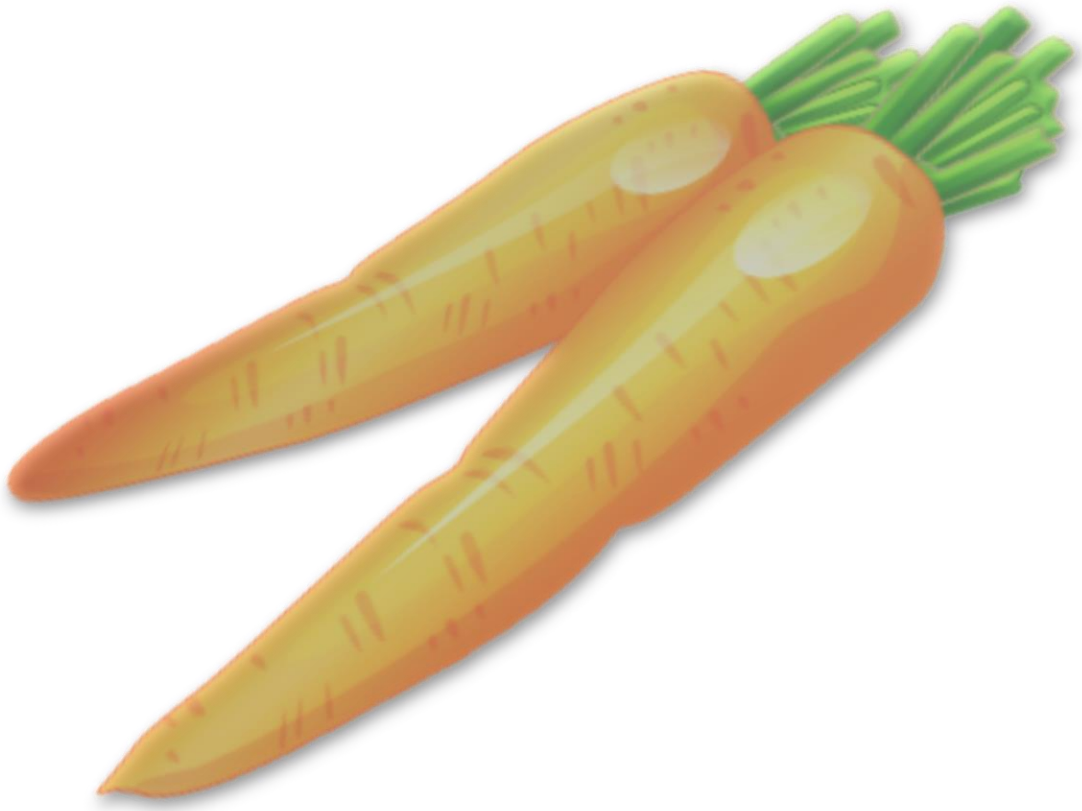
Diamento: *Vilmorin sample,* Average length slightly uneven, Good width slightly uneven, Slightly tapered full tips, Good appearance, Good weight, Good exterior colour even, Good smoothness, Uniformity of shape uneven, 1 to 2 cavity spots per root, Odd noticeable lenticel, Good to nice interior blending even, Red ring around core (30-50%), Large to extra large core size.

New Hall: Jumbo *Bejo sample,* Good length slightly uneven, Good width very even, Full tips, Good appearance, Good weight, Good exterior colour even, Good smoothness, Uniformity of shape even, 1 to 2 cavity spots per root, Average interior blending, Dead center of core translucent (40-50%), Red or yellow ring around core (20%), Large core size, Splits are a concern.

Bastia: *Bejo sample,* Average to good length slightly even, Average to good width slightly uneven, Full tips, Average appearance, Good weight, Fair exterior colour a little uneven, Fairly smooth, Uniformity of shape uneven, 1 to 3 cavity spots per root, Odd noticeable cavity spot, Odd noticeable lenticel, Average interior blending, Translucent core throughout (10-20%), Green ring around core (10%), Large core size, Odd carrot too short.

Berlin: *Bejo sample,* Length uneven, Good width slightly uneven, Full tips, Good appearance, Good weight, Fair exterior colour, Fairly smooth, Uniformity of shape a little even, 1 to 3 cavity spots per root, Odd noticeable lenticel, Interior blending a little poor, Red ring around core (10%), White in cores (40-50%), Extra-large core size, A third too short.

ADAPTATION TRIAL



CARROT CULTIVAR ADAPTATION TRIAL - 2019

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
3165	BEJO	81	52	15	22.79	16.80	2.37	95.9	1543	84.1	73.7	F
3187	BEJO	74	22	33	17.03	7.57	6.01	67.9	1093	79.7	44.5	Sp
3188	BEJO	111	14	67	17.96	4.47	9.58	70.3	1131	78.2	24.9	Sp
NORWAY	BEJO	78	27	34	17.33	7.34	5.19	62.7	1009	72.3	42.4	F

Listed in order of % Marketable.

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CARROT CULTIVAR ADAPTATION TRIAL - 2019 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Length	Uniformity of Width	Appearance	Resistance to Greening	External Colour	External Colour Rating	Internal Colour	Internal Colour Rating	Score	Blight Rating
3165	BEJO	GPN	6.0	6.0	7.0	6.0	6.0	LO	7.0	O	6.0	6.29	8.0
3187	BEJO	Cyl	7.0	5.0	8.0	7.0	8.0	DO	8.0	DO	7.0	7.14	5.0
3188	BEJO	Cyl	8.0	5.0	6.0	7.0	10.0	DO	7.0	O	7.0	9.00	7.0
NORWAY	BEJO	GPN	8.0	8.0	9.0	8.0	9.0	O	8.0	LO	5.0	7.86	7.0

Listed in order of % Marketable. 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average

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CARROT CULTIVAR ADAPTATION TRIAL - 2019 - continued

Cultivar	Source	% Core of Total Width	% Cavity Spot & Degree	Shape of Crown	Root Length (cm)	Root Width (cm)	Seeding Rate	Stand per Foot	Leaf Heights cm	Leaf Colour	Leaf Structure	% Weevil Damage	% Rust Fly Damage	Average # of Seeders
3165	BEJO	51.0	45M	CC	21.4	5.2	25	10.6	47.2	G	FST	0.0	75.3	0.0
3187	BEJO	40.5	75M	CC	24.3	4.0	25	9.7	51.5	G	ST	0.0	94.6	1.0
3188	BEJO	37.1	85LM	CC	24.7	3.4	25	14.6	49.3	G	ST	0.9	95.5	2.0
NORWAY	BEJO	51.9	60M	CC	21.5	4.8	18	10.3	40.9	G	FST	0.0	89.7	0.0

Listed in order of % Marketable.

ADAPTATION CARROT CULTIVAR TRIAL EVALUATION NOTES - 2019

3165: *Bejo sample,* Jumbo, Average length but slightly uneven, Good width slightly even, Full tips, Average appearance, Excellent weight, Fair exterior colour slightly pale, Good smoothness, Uniformity of shape uneven, 1 to 2 cavity spots per root, Noticeable lenticels, Large core size, Average interior blending, Translucent core (20%), Red ring around core (10%), White in cores (10%), Odd carrots short, Okay Packer Nante style but bit short.

3187: *Bejo sample,* Jumbo/Packer, Good length but uneven, Good width very even, Full tips, Good appearance, Good weight, Nice exterior colour even, Fairly smooth, Uniformity of shape very even, Odd carrot with bends and curves, 1 to 5 cavity spots per root, Odd noticeable cavity spot a slight concern, Odd noticeable lenticel, Average core size, Average interior blending, Translucent core (10%), Red ring around core (50%), Good mix of Packers (60%) and Jumbos (40%), Good Jumbo but bit long.

3188: *Bejo sample,* Packer, Good length but uneven, Average & good width slightly uneven, Full tips, Average appearance, Average to good weight, Good exterior colour even, Fairly smooth, Uniformity of shape even, A lot of carrots with bends and curvers, 1 to 2 or 3 to 5 cavity spots per root, Odd noticeable cavity spot slight concern, Average core size, Nice interior blending, Red ring around core (30%), Odd carrot to thin, Very long carrots, Cut & Peel?, Okay Jumbo.

Norway: *Bejo sample,* Jumbo/Packer, Good length even, Good width even, Full tips, Good appearance, Good weight, Good exterior colour even, Good smoothness, Uniformity of shape a little even, 1 to 2 or 3 to 5 cavity spots per root, Odd cavity spot noticeable, Cavity spots are a slight concern, Large core size, Interior blending bit poor, Red ring around core (40%), Dead center of core translucent (10%), White in cores (20%), Good mix of Packers (60%) and Jumbos (40%), Some noticeable canker rot slight concern.

LONG TERM AVERAGES OF CARROT CULTIVAR TRIALS

CULTIVAR	SOURCE	# Years Tested	Length (cm)	Length (Inches)	Width (cm)	Marketable t/ha	Martketable B/A	% Marketable	Avg Leaf Length (cm)
DOMINION	Sto	5	25.4	10.0	4.0	92.3	1486	85.5	45.7
SIX SHOOTER	HM	5	24.8	9.8	3.4	87.4	1408	82.3	41.2
ACHIEVE	Sto	7	23.8	9.4	5.2	98.0	1578	82.8	53.6
ENTERPRISE	Sto	15	23.7	9.3	3.4	79.0	1281	80.4	49.6
ORANGE PAK	Nor	7	23.7	9.3	3.5	85.1	1369	87.1	--
CANADA SUPER X	Sol	14	23.3	9.2	3.4	80.8	1376	82.7	--
SV 2384	Sem	8	23.2	9.1	3.3	76.3	1228	77.6	45.6
SIX PAK	HM	20	23.0	9.1	3.5	79.0	1273	85.5	--
SUNRISE	Cro	15	23.0	9.1	3.5	86.0	1438	85.6	--
CELLOBUNCH	Sem	30	22.6	8.9	3.5	92.2	1511	83.2	47.0
ENVY	Sem	15	22.5	8.9	3.9	91.3	1470	83.6	50.9
FONTANA	Bejo	13	22.4	8.8	5.1	108.7	1750	88.5	46.9
WARMIA	RZ	5	22.1	8.7	5.1	69.7	1121	82.4	48.1

Listed in order of length.

* 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average

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LONG TERM AVERAGES OF CARROT CULTIVAR TRIALS - continued

CULTIVAR	SOURCE	# Years Tested	Length (cm)	Length (Inches)	Width (cm)	Marketable t/ha	Martketable B/A	% Marketable	Avg Leaf Length (cm)
JERADA	RZ	6	22.0	8.7	4.1	97.0	1564	84.6	44.0
COSTELLO	Sol	5	21.9	8.6	4.8	81.3	1309	77.1	45.2
BASTIA	Bejo	15	21.8	8.6	5.2	95.6	1539	83.6	46.1
OLYMPUS	Sto	5	21.8	8.6	3.4	73.8	1188	73.9	45.8
ORANGE SHERBET	Sto	10	21.2	8.3	--	73.4	1310	84.0	--
BELGRADO	Bejo	12	21.1	8.3	5.3	104.3	1680	81.5	46.8
CAROPAK	Sem	8	20.9	8.2	--	74.1	1323	85.0	--
PARAMOUNT	Sem	7	20.6	8.1	--	82.1	1467	85.0	--
BERLIN	Bejo	8	20.1	7.9	5.5	99.8	1606	79.3	44.9
CROFTON	RZ	6	19.9	7.8	3.2	61.9	997	81.5	37.8
DOMINATOR	Nun	13	19.7	7.8	--	63.9	1141	85.0	--
NEW HALL - Cello	Bejo	8	18.7	7.4	3.5	65.2	1049	70.6	44.5
NAVAL	Bejo	9	17.9	7.0	3.5	82.4	1327	78.9	43.4

Listed in order of length.

* 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average

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LONG TERM AVERAGES OF CARROT CULTIVAR TRIALS - continued

CULTIVAR	SOURCE	# Years Tested	Blight Rating *	% Cavity Spots	SCORE *	% Weevil Damage	% Rust Fly Damage	Avg # of Seeders
DOMINION	Sto	5	7.3	73.0	6.82	1.3	1.3	1.1
SIX SHOOTER	HM	5	7.1	45.0	6.96	5.0	2.7	1.1
ACHIEVE	Sto	7	7.4	74.1	6.74	4.3	4.7	2.8
ENTERPRISE	Sto	15	7.9	56.0	6.65	11.1	9.1	0.5
ORANGE PAK	Nor	7	6.9	--	6.82	--	--	--
CANADA SUPER X	Sol	14	7.0	--	6.95	--	--	--
SV 2384	Sem	8	7.9	69.0	6.15	14.7	11.4	0.2
SIX PAK	HM	20	7.9	--	6.98	--	--	--
SUNRISE	Cro	15	8.4	--	6.82	--	--	--
CELLOBUNCH	Sem	30	7.1	58.3	6.55	9.2	6.9	1.7
ENVY	Sem	15	7.4	75.7	6.53	8.6	11.1	1.0
FONTANA	Bejo	13	5.6	51.0	6.33	4.8	3.8	1.3
WARMIA	RZ	5	7.0	75.0	6.51	11.7	6.4	0.5

Listed in order of length.

* 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average

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LONG TERM AVERAGES OF CARROT CULTIVAR TRIALS - continued

CULTIVAR	SOURCE	# Years Tested	Blight Rating *	% Cavity Spots	SCORE *	% Weevil Damage	% Rust Fly Damage	Avg # of Seeders
JERADA	RZ	6	7.2	63.2	7.18	12.2	3.6	0.2
COSTELLO	Sol	5	8.0	67.0	6.78	7.0	4.2	0.6
BASTIA	Bejo	15	7.3	78.1	6.81	7.6	7.6	1.0
OLYMPUS	Sto	5	8.3	86.0	6.31	15.8	4.5	1.1
ORANGE SHERBET	Sto	10	--	--	6.75	--	--	--
BELGRADO	Bejo	12	6.6	73.0	6.36	9.8	9.2	1.1
CAROPAK	Sem	8	--	--	6.85	--	--	--
PARAMOUNT	Sem	7	--	--	6.75	--	--	--
BERLIN	Bejo	8	8.4	73.0	6.42	10.6	14.9	0.7
CROFTON	RZ	6	6.6	62.0	6.77	16.6	2.1	0.1
DOMINATOR	Nun	13	--	--	6.80	--	--	--
NEW HALL	Bejo	8	7.5	68.0	6.23	13.0	11.9	1.1
NAVAL	Bejo	9	7.5	54.2	6.95	12.9	11.7	0.2

Listed in order of length.

* 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average

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CARROT CULTIVAR STORAGE TRIAL - 2018 - 2019

Cultivar	Source	% Marketable	% Weight Loss	% Decay	Degree of Rot **	% Root Sprouts	% Top Sprouts
NEW HALL - Jumbo	Bejo	96.3 a*	13.0 a	3.3 a	7.3 abc	22.0 c-f	83.0 a
NEW HALL - Cello	Bejo	95.8 a	12.3 a	3.7 ab	7.7 ab	23.0 c-g	82.0 a
CELLOBUNCH 2	Sto	95.0 ab	11.9 a	4.7 abc	7.3 abc	55.0 e-h	96.0 a
55-604	RZ	94.1 abc	15.4 a	5.3 bcd	7.2 a-d	4.0 a	85.0 a
INSTANBUL	Bejo	93.8 abc	13.1 a	5.7 cde	8.0 ab	25.0 d-h	93.0 a
CELLOBUNCH 1	Sto	93.6 abc	13.8 a	6.0 de	6.3 b-e	37.0 e-h	93.0 a
MUSICO	Vil	93.0 abc	10.9 a	6.6 def	8.0 ab	7.0 ab	88.0 a
SPEEDO	Vil	92.7 abc	13.3 a	6.9 d-g	8.3 a	10.0 ab	96.0 a
SV 2384 DL	Sem	92.3 abc	15.3 a	7.4 e-h	6.7 a-d	25.0 d-h	77.0 a
CELLOBUNCH 3	Sto	92.2 abc	14.0 a	10.1 e-h	7.3 abc	62.0 fgh	95.0 a
NAVAL	Bejo	90.5 a-d	10.0 a	8.8 e-h	8.3 a	27.0 d-h	88.0 a
SV 7627 DL	Sem	89.7 a-d	13.6 a	9.7 e-h	6.3 b-e	25.0 c-h	90.0 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)

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CARROT CULTIVAR STORAGE TRIAL - 2018 - 2019 - continued

Cultivar	Source	% Marketable	% Weight Loss	% Decay	Degree of Rot **	% Root Sprouts	% Top Sprouts
B 3136- Cello	Bejo	89.6 a-d*	16.5 a	9.8 e-h	5.7 c-f	77.0 gh	93.0 a
ENTERPRISE	Sto	89.5 a-d	10.9 a	10.1 e-h	5.3 def	11.0 abc	83.0 a
ENVY	Sto	87.7 a-e	12.3 a	11.7 fgh	7.2 a-d	30.0 d-h	92.0 a
BELGRADO	Bejo	86.4 b-e	11.3 a	13.2 fgh	7.7 ab	14.0 bcd	78.0 a
EAGLE PAK	Sto	85.6 cde	13.8 a	14.0 fgh	5.3 def	45.0 e-h	92.0 a
OLIMPO	Vil	82.1 de	16.0 a	17.4 fgh	7.0 a-d	92.0 h	95.0 a
BERLIN	Bejo	82.1 de	14.9 a	17.6 fgh	7.0 a-d	35.0 d-h	88.0 a
EXTREMO	Vil	79.3 ef	13.2 a	20.4 fgh	4.3 f	80.0 gh	98.0 a
B 3136- Jumbo	Bejo	72.8 fg	16.3 a	26.7 gh	4.7 ef	42.0 e-h	88.0 a
BASTIA	Bejo	71.5 fg	11.3 a	28.2 h	7.0 a-d	18.0 cde	87.0 a
BLANES	Bejo	69.1 g	12.6 a	30.6 h	6.0 c-f	25.0 d-h	92.0 a
Trial Average		**87.6**	**13.3**	**12.1**	**6.8**	**34.4**	**89.2**

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.

** 10.0 = No Disease, 6.0 = Moderate, 1.0 = Severe (liquified)

MAIN CARROT CULTIVAR STORAGE TRIAL EVALUATION NOTES 2018-2019

New Hall: Jumbo *Bejo sample,* Top sprouts just starting to moderate 0-2.5cm, Root sprouts just starting to light 0-1cm, Majority tip rot, Odd canker and crown rot, Rot is just starting to moderately establish, Rot is dry & moist, Stored good to excellent.

New Hall: Cello *Bejo sample,* Top sprouts just starting to light 0-1cm, Root sprouts just starting 0-1cm, Majority tip rot, Odd crown rot, Rot is just starting to lightly establish, Rot is moist, Stored good to excellent.

Cellobunch 2: *Stokes sample,* Top sprouts moderate 1-5cm, Root sprouts just starting to light 0-2.5cm, Top sprouts lengths uneven a concern, Mostly tip rot, Some canker rot, Rot is just starting to lightly establish, Rot is moist, Stored fair to good.

55-604: *Rijk Zwaan sample,* Top sprouts just starting to light 0-2.5cm, Root sprouts just starting 0-1cm, Mostly tip rot, Some canker rot, Odd crown rot, Rot is lightly established, Rot is dry, Stored good to excellent.

Istanbul: *Bejo sample,* Top sprouts just starting to light 0-2.5cm, Root sprouts just starting 0-1cm, Majority tip rot, Odd canker rot, Rot is just starting to heavily establish, Rot is dry or moist, Stored good.

Cellobunch 1: *Stokes sample,* Top sprouts light to moderate 1-2.5cm, Root sprouts just starting to light 0-2.5cm, Top sprouts lengths uneven, Mostly tip rot, Some canker rot, Rot is lightly established, Rot is moist, Stored good.

Musico: *Vilmoran sample,* Top sprouts light 1-2.5cm, Root sprouts just starting 0-1cm, Top sprouts lengths uneven, Mostly tip rot, Odd canker rot, Rot is just starting to lightly establish, Rot is dry or moist, Stored good.

Speedo: *Vilmoran sample,* Top sprouts just starting to light 0-2.5cm, Root sprouts just starting 0-1cm, Mostly tip rot, Odd canker rot, Rot is just starting to moderately establish, Rot is dry or moist, Stored excellent.

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MAIN CARROT CULTIVAR STORAGE TRIAL EVALUATION NOTES 2018-2019 - continued

SV 2384: *Seminis sample,* Top sprouts just starting to light 1-2.5cm, Root sprouts just starting 0-1cm, Some tip rot, A few canker rot, Odd crown rot, Rot is just starting to moderately establish, Rot is dry or moist, Stored good.

Cellobunch 3: *Stokes sample,* Top sprouts just starting to moderate 0-2.5cm, Root sprouts just starting to light 0-2.5cm, Tip, canker & crown rot, Rot is just starting to moderately establish, Rot is moist or dry, Rot is a slight concern, Stored fair.

Naval: *Bejo sample,* Top sprouts just starting to moderate 0-2.5cm, Root sprouts just starting to light 0-2.5cm, Majority tip rot, Odd canker & crown rot, Rot is just starting to lightly establish, Rot is dry, Stored good to excellent.

SV 7627: *Seminis sample,* Top sprouts light to moderate 1-2.5cm, Root sprouts just starting 0-1cm, Top sprouts lengths are uneven, Majority tip rot, Odd crown rot, Rot is lightly to moderately establish, Rot is moist, Stored fair.

B 3136: *Bejo sample,* Top sprouts light to moderate 1-2.5cm, Root sprouts just starting to light 0-2.5cm, Top & root sprouting a slight
Cello concern, Majority tip rot, A few crown rot, Rot is just starting to moderately establish, Rot is moist, Rot is a slight concern, Stored fair.

Enterprise: *Stokes sample,* Top & root sprouts just starting 0-1cm, Tip, canker and crown rot, Rot is lightly to heavily establish, Rot is dry or moist, Rot is a concern, Stored fair.

Envy: *Stokes sample,* Top sprouts light to moderate 1-2.5cm, Root sprouts just starting 0-1cm, Majority tip rot, Odd canker or crown rot, Rot is just starting to lightly establish, Rot is dry or moist, Stored okay.

Belgrado: *Bejo sample,* Top sprouts just starting to light 0-2.5cm, Root sprouts are just starting 0-1cm, Majority tip rot, Odd canker rot, Rot is just starting to lightly establish, Rot is dry or moist, Stored okay.

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MAIN CARROT CULTIVAR STORAGE TRIAL EVALUATION NOTES 2018-2019 - continued

Eagle Pak: *Stokes sample,* Top & root sprouts light to moderate 1-2.5cm, Mostly tip rot, A few crown rot, Odd canker rot, Rot is lightly to moderately establish, Rot is dry or moist, Rot is a concern, Stored a little poor, Some carrots a little dried out.

Olimpo: *Vilmoran sample,* Top sprouts moderate 1-5cm, Root sprouts heavy 2.5-5cm, Top & root sprouts lengths uneven, Root & root sprouting is a concern, Majority tip rot, A few canker rot, Odd crown rot, Rot is just starting to lightly establish, Rot is moist, Rot is a concern, Stored a little poor.

Berlin: *Bejo sample,* Top sprouts light 1-2.5cm, Root sprouts just starting 0-1cm, Majority tip rot, A few canker rot, Rot is just starting to heavily establish, Rot is dry or moist, Rot is a concern, Stored a bit poor.

Extremo: *Vilmoran sample,* Top sprouts moderate to heavy 2.5-5cm, Root sprouts light to moderate 1-2.5cm, Top sprouts lengths uneven, Top sprouting is a concern, Majority tip rot, Odd canker & crown rot, Rot is slightly to moderately establish, Rot is moist, Rot is a concern, Stored poor.

B 3136: **Jumbo** *Bejo sample,* Top & root sprouts just starting to moderate 0-2.5cm, Top sprouting uneven, Majority tip rot, A few crown & canker rot, Rot is just starting to moderately establish, Rot is moist, Rot is a concern, Stored poor.

Bastia: *Bejo sample,* Top sprouts just starting to light 0-2.5cm, Root sprouts just starting 0-1cm, Majority tip rot, A few canker rot, Rot is just starting to moderately establish, Rot is dry or moist, Rot is a concern, Stored a bit poor to fair.

Blanes: *Bejo sample,* Top & root sprouts just starting 0-1cm, Majority tip rot, A few canker rot, Rot is just starting to heavily establish, Rot is moist, Rot is a concern, Stored poor.

Growers' Association

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
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
CHANCELLOR	Sem	7	86.7	11.3	13.3	4.2
PROSPECTOR	Sem	4	86.7	6.3	13.3	4.3
NEW HALL	Bejo	7	85.5	11.8	4.4	7.6
CROFTON	RZ	6	84.8	11.5	3.0	7.5
INFINITY	Bejo	5	83.4	11.4	4.9	7.8
2384	Sem	8	82.4	13.6	6.1	6.7
BRADFORD	Bejo	5	82.1	10.0	7.9	7.8
ENTERPRISE	Sem	13	82.0	10.5	8.5	6.4
JERADA	RZ	6	81.6	11.3	6.7	7.9

Listed in order of % Marketable.

Storage period is approximately 9 months.

* 10.0 = No Disease, 6.0 = Moderate, 1.0 = Severe (liquified)

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LONG TERM AVERAGES - CARROT CULTIVAR STORAGE TRIALS - continued

CULTIVAR	SOURCE	# YEARS TESTED	% MARKETABLE	% WEIGHT LOSS IN STORAGE	% DECAY	DEGREE * OF DECAY
NAVAL	Bejo	8	81.3	11.0	9.0	7.9
BELGRADO	Bejo	10	80.5	10.3	10.7	7.4
SIX PAK	HM	20	79.8	11.5	8.6	5.8
BERLIN	Bejo	7	79.5	11.8	10.8	7.2
COSTELLO	Sol	5	79.3	11.6	8.7	7.3
WARMIA	RZ	5	79.1	13.6	6.9	7.1
ORANGE PAK	Nor	8	78.6	13.2	8.1	6.8
SUNRISE	Cro	15	78.6	12.8	8.2	6.8
CELLOBUNCH	Sem	27	77.9	13.2	7.2	6.8
INDIANA	Bejo	7	75.7	15.4	8.5	7.0
FONTANA	Bejo	14	75.5	11.2	13.0	6.7
DOMINION	Sem	4	74.9	13.7	11.1	5.8
OLYMPUS	Sak	5	74.7	10.7	14.0	6.2
ABBOTT	Sol	4	73.6	12.8	13.4	6.1
ACHIEVE	Sem	8	73.0	13.0	13.6	6.4
BASTIA	Bejo	14	72.6	13.6	14.7	6.5
ENVY	Sem	15	71.9	12.7	16.1	6.6
SIX SHOOTER	HM	5	71.5	11.0	17.5	6.0
NEVADA	Bejo	4	69.1	16.5	14.2	5.8

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 – 2019

In the marsh, onion seeding in 2019 was very sporadic. Weather did not allow for extend periods of ideal seeding conditions. Instead, over approximately the first twenty days of May, growers had to seed when field and weather circumstances allowed. Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C), and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C, August 20.2°C and September 16.4°C. Monthly rainfall was below the 10-year average for June (84 mm), July (42 mm), August (46 mm) and average for May (77 mm) and September (62 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm, August 80 mm and September 61 mm.

Rain in late April followed by cool, cloudy weather into early May and an additional 32 mm of rain in the first nine days of May created less then ideal seeding conditions. The soil conditions for the variety trial were uneven. The first replicate was wet and the third replicate was dry enough for seeding. On 15 May, the decision was made to seed the variety trial even with the less then favourable circumstances. The 15 May seeding date for the variety trial was approximately 10 days later than the expected seeding date. During onion seed germination and emergence, daytime air temperatures fluctuated from the mid-teens to the low twenties and night air temperatures fluctuated between 1.5-11°C. There was adequate moisture during emergence; however; onion emergence, vigor and plant stand were uneven. By 6 June when the onions were only in full loop to flag leaf, the herbicide Prowl was applied at the recommended rate. A heavy flush of grass occurred in early June in the third replicate of the trial. An application of Select and Amigo on 21 June cleaned up the grasses, but this may have caused a noticeable reduction in the onion stand. Weed flushes remained a problem throughout the entire season and several hand weedings were required to keep the trial free from weeds. For the first half of June, onion growth was slow but steady and growth remained satisfactory for the rest of June and July, although leaf size and density were less then expected. There were significant differences in leaf lengths among the replicates. The first replicate had the longest leaf lengths and the shortest leaf lengths were found in the third replicate.

On station, onion maggot fly emergence monitoring began on 21 May. Throughout the entire monitoring period, onion maggot fly counts never reached above 1.7 flies/trap/day. This was the third year in a row that onion maggot numbers never reached over 2 flies/trap/day. Low onion maggot counts appeared to positively correlated to low onion maggot damage in the variety trial.

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At evaluation damage varied among cultivars with some cultivars having over 10 percent damage. Thrips were present from late July through August. Onion thrips numbers in the variety trial reached a high of 1.8 thrips/leaf on 6 August. The combination of 1 inch of irrigation water on 7 August plus the insecticide Delegate applied on 9 August reduced the population to only 0.12 thrips/leaf when scouted on 13 August. A second irrigation (1") on 15 August and an application of Agri-Mek on 16 August kept thrips numbers below the spray threshold of 1 thrips/leaf until onions were fully lodged. Stemphylium leaf blight was found in the cultivar trial in late July and several fungicide applications (see Onion Management Procedures) kept severity to a minimum. Two timely fungicide applications to control downy mildew kept the disease from establishing in the cultivar trial. No onions with bacterial rot were found in the variety trial.

Even with a late seeding date, bulb development started as expected in late July. Most bulb sizing occurred in mid August. Cultivars A 1762 (2 Aug) and Highlander (9 Aug) were the first to lodge. It took approximately three weeks for 75% of the cultivars to reach 85% lodged. Two thirds of the cultivars reached full maturity by 28 August when at least 85% of the onions had lodged. Even with the seeding date 6 days later than in the 2018 season, the average days to harvest (103 days) for the 2019 season was three days shorter than in 2018. The second replicate of onions lodged significantly sooner then the other two replicates. The onion tops dried down in a satisfactory time frame. No seeders were found. A sample from each cultivar was pulled for judging and comparison for Grower Field Day on 5 September. By this time, most cultivars had lodged but leaves were only 20-40% desiccated. The yield samples were harvested on 25 September. At harvest a few cultivars still had some moisture in the neck. Harvest samples from each cultivar were placed in storage on 29 October and cured artificially for approximately 48 hours.

At evaluation on 11-25 November, quality and yield were good in most of the cultivars. The trial yield average was a respectable 1223 bu/A. This is highest its been since the 2014 season. Significant differences in yield (bu/A) were found among the replicates. The first replicate had the highest average yield (1470 bu/A) and the third, the lowest (985 bu/A). Most cultivars had the highest number of onion bulbs in the 2½-3" size range, and the first replicate had the highest number of bulbs in the larger size

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categories. The trial average for the percentage of jumbos (>3" diameter) was 16%, which is an increase of approximately 6% compared to the last three years. Uniformity of size was a little poor and significant differences where found among cultivars and replicates. Size was the most uniform in the first replicate and the least uniform in the third replicate. The uniformity of shape rating varied among cultivars, with shapes highly variable and many elongated onions. The average stand count was acceptable at 7.5 plants per foot. The third replicate was significant lower (6.8 plants/ft) compared to the first and second replicates (8 & 7.6 plants/ft). The majority of unmarketable onions (culls) were undersized onions (peewees). The trial average for marketable onions was 89.4% with significant variability among the replicates. Replicate one had the highest percentage of marketable onions (94%) and the lowest was in replicate three at (84%). Skin quality was very good among cultivars as in 2018. Skins were generally thick and only the odd skin cracking was observed in most cultivars. There was very limited skin rot found in the trial. Exterior colour was slightly darker and more even in all cultivars. There was only the very odd onion with mechanical damage. Greening of the outer scales and yellow or white speckling on the outer skins was present but very limited. Neck finish was good with some rough finishes in the cultivars that had taken longer to mature. When evaluated again in November for firmness, onions were found to be quiet firm and solid. Maggot damage to onion bulbs in the evaluation samples ranged from 0-20.3% with a trial average of 5%. This is a 1% increase in the average onion maggot damage for the trial compared to the 2018 season (4.1%) but some cultivars had a high percentage of damage. The second replicate had the most onion maggot damage (6.3%) and was significantly different from the third replicate which had only 3.8% damage. At evaluation it appeared that there were fewer multiple centers but in fact the average of multiple centres was the same as 2018 (4.8%). When the onions were cut in half for single center evaluation, it was also noted that only a few onions had greening in the interiors. Even though the onion trial was seeded late, onions matured in a appropriate time frame with good quality and good yields.

ONION CULTIVAR TRIAL – 2019

MANAGEMENT PROCEDURES

Fertilizer:

90 kg/ha Nitrogen (Calcium Ammonium Nitrate 27-0-0) + 100 kg/ha Phosphorous (MESZ 10-40-0) + 200 kg/ha Potassium (ASPIRE 0-0-58) + 100 kg/ha K–Mag (0-0-22) + 35 kg/ha Manganese + 7 kg/ha Copper (99% Cu) was worked into the soil on 6 May.

A side dressing blend of 12 kg/ha Nitrogen + 12 kg/ha Potassium + 6 kg/ha Manganese + 2.5 kg/ha Calcium + 13.6 kg/ha Sulphur was applied on 17 July.

Seeded:

All trials were seeded on 15 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: 1 application: **PARDNER** 310 ml/ha 20 May.

Post-emergence: 1 application: **PROWL H2O** 6.0 L/ha on 6 June.
1 application: **PARDNER** at 100 ml/ha and **GOAL** at 210 ml/ha and Manganese at 1.0 kg/ha on 12 June.
1 application: **CHATEAU** at 0.056 kg/ha on 16 June.
1 application: **SELECT** at 375 ml/ha + **AMIGO** at 1.5 L/ha on 21 June.
1 application: **PARDNER** at 140 ml/ha and **GOAL** at 140 ml/ha and Manganese at 2.0 kg/ha on 26 June.

Minor Elements:

Seven foliar sprays: Mag Max on 28 June, 4, 10, 16, 22 and 31 July & 9 August (3.0 L/ha)
Seven foliar sprays: Calcimax on 28 June, 10, 16, 22 and 31 July, 9 & 16 August (3.0 L/ha)
Six foliar sprays: Manganese Sulfate on 9 August (1.0 kg/ha) and 28 June, 16 & 31 July (2.0 kg/ha) and 4 & 22 July (3.0 kg/ha)
Six foliar sprays: Alexin on 4, 22 & 31 July and 9, 16 & 23 August (3.0 L/ha)
Five foliar sprays: Suprafeed on 22 & 31 July and 9 & 16 August (3.0 kg/ha) and 23 August (4.0 kg/ha)
Four foliar sprays: 20-20-20 on 28 June and 4, 10 & 16 July (3.0 kg/ha)

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Minor Elements continued:

Three foliar sprays: TruPhos on 28 June, 4 & 16 July (3.0 L/ha)
Three foliar sprays: Zinc Max on 28 June (1.0 L/ha), August 9 (2.0 L/ha), and 31 July (3.0L/ha)
Two foliar sprays: Mancozin on 10 July (3.0 L/ha) and 16 August (4.0 L/ha)
Two foliar sprays: Epsom Salt on 23 August (1.5 kg/ha) and 16 August (3.0 kg/ha)
Two foliar sprays: Nutri Bor on 16 August (1.0 L/ha) and 23 August (1.5 L/ha)
One foliar spray: Copper Max on 22 July (1.0 L/ha)

Insect and Disease Control:

According to IPM recommendations.

DITHANE DG at 2.25 kg/ha and Minor Elements on 10 July.
SERCADIS at 666 ml/ha + **UP-CYDE** at 280 ml/ha and Minor Elements on 22 July.
MOVENTO at 365 ml/ha + **SYLGARD** at 0.002% solution on 26 July.
QUADRIS TOP at 1.0 L/ha + **RIDOMIL MZ** 2.25 kg/ha + **MATADOR** at 188 ml/ha on 31 July.
MOVENTO at 365 ml/ha + **SYLGARD** at 0.002% solution on 2 August.
QUADRIS TOP at 1.0 L/ha + **DELEGATE** at 336 g/ha and Minor Elements on 9 August.
QUADRIS TOP at 1.0 L/ha + **RIDOMIL MZ** at 2.25 kg/ha + **AGRI-MEK SC** at 175 ml/ha and Minor Elements on 16 August.
DITHANE DG at 3.0 kg/ha and Minor Elements on 23 August.

Harvest: The Main Trial was pulled on 12 to 18 and topped on 25 September. The trial was placed in a forced air and temperature-controlled storage on 29 October. The trial was cured for 48 hours (25ºC, minimum 65% RH). After curing the temperature was lowered 5ºC per week until 0ºC was attained.

Sprout Inhibition:

Royal MH 30 XTRA at 8.63 L/ha in 550 L/ha water on:

August 23			August 30					September 6
Trail Blazer Takii	Saddleback	SV NY 1496	Traverse	Haeckero	Y 621	SV NY 1568	Braddock	La Salle
37 118	Redstone	Trail Blazer	Traverse Myco+Inicium	Hades	Milestone	Safrane	E61L 10156	Pocono
Oneida	Trekker	Trail Blazer Inicium	SV NY 1141	Champ	Fortress	Catskill	Stanley	Crockett
Highlander	A 1769	Trail Blazer Myco+Inicium	Dawson	Frontier	Patterson	Armstrong	37 120	Prospector
			Norstar	Starter	Ridge Line Inicium	Traverse Takii	Ridge Line Takii	Ceresco
			Cartier	E61L 10699	Ridge Line			Powell

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EVALUATION PROCEDURES

The cultivars were evaluated 11 through 25 November after 6 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.

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.

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 = Flattened Globe G = Globe Sp = Spindle TD = Tear Drop T = Top

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

Neck Finish:

10.0 = Most Desirable, small tight neck 6.0 = Average, neck closed, 4.0 = Poor, neck bit rough and open

Overall Score:

Based on quality and general appearance.

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ONION CULTIVAR TRIAL - 2019 - continued

Score:
The average of eight evaluation ratings taken from Uniformity of Shape to Firmness.

Firmness:
10 = Desirable solid and firm, 6.0 = Average firm but some elasticity 1.0 = Poor spongy

Interior Colour:
G = Green W = White C = Cream R = Red DR = Dark Red

Exterior Colour:
LG = Light Golden G = Golden DG = Dark Golden LC = Light Copper C = Copper DC = Dark Copper

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.

Seeders:
Average number of seeders found in each cultivar of 20m of row.

% Single Centers:
Percentage of onions with only one heart

% Double Centers:
Percentage of onions with two hearts

% Multiple Centers:
Percentage of onions with three or more hearts

% Hollowness in Centers:
Percentage of onions with a small hollow pocket at the heart of the onion.

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ONION CULTIVAR TRIAL - 2019 - 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 22 July.
50 cm is equal to 20 inches.

Leaf Shape:

B = Leaves are bent or hanging U = Up right leaves, straight

Leaf Colour:

LG = Light Green, G = Green, BG = Blue Green, DG = Dark Green

Irrigation:

Irrigation water was applied five times for the 2019 season:

8 July in the amount of 1 ½ inches
17 July in the amount of 5/8 inch
25 July in the amount of 1 inch
7 August in the amount of 1 inch
15 August in the amount of 1 inch

ONION CULTIVAR MAIN TRIAL - 2019

Cultivar	Source	# Bulbs Harvested	# Bulbs Jumbos > 89 mm	# Bulbs Lrg 89 - 76 mm	# Bulbs Med 76 - 64 mm	# Bulbs Small 64 - 32 mm	Stand/Foot	Average Weight/Bulb (g)
RIDGELINE	Tak	126 b-e*	3 c-g	29 a-e	63 a	28 a-h	8.2 b-f	189.5 ab
SV NY 1141	Sem	113 b-i	4 a-d	27 a-e	52 a-g	26 a-g	7.4 b-j	180.2 a-e
37 120	Haz	114 b-i	2 d-h	26 a-g	51 a-h	32 a-i	7.4 b-i	166.9 a-i
SV NY 1568	Sem	114 b-i	5 abc	33 a	42 c-m	31 a-h	7.5 b-i	184.2 abc
MILESTONE	Tak	116 b-h	2 d-h	32 ab	54 a-d	24 a-f	7.6 b-i	193.9 ab
TRAVERSE	Tak	123 b-f	3 c-g	30 abc	62 ab	23 a-e	8.0 b-g	179.9 a-e
CROCKETT	BEJO	111 b-j	2 e-h	32 ab	54 a-d	18 abc	7.2 b-k	191.3 ab
FORTRESS	Sto	118 b-g	0 h	5 k-o	52 a-g	55 i-l	7.7 b-h	146.0 f-m
SV NY 1496	Sem	106 c-j	7 a	34 a	44 a-g	17 ab	7.0 d-k	198.5 a
SADDLEBACK	Sto	109 b-j	3 b-e	28 a-e	43 b-m	30 a-h	7.2 b-k	174.8 a-f
ARMSTRONG	CF	103 e-j	0 h	17 d-k	54 a-d	26 a-g	6.8 f-k	162.5 b-i
PATTERSON	BEJO	113 b-i	2 d-h	26 a-f	52 a-g	26 a-g	7.4 b-j	167.5 a-h

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.

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ONION CULTIVAR MAIN TRIAL - 2019 - continued

Cultivar	Source	# Bulbs Harvested	# Bulbs Jumbos > 89 mm	# Bulbs Lrg 89 - 76 mm	# Bulbs Med 76 - 64 mm	# Bulbs Small 64 - 32 mm	Stand/Foot	Average Weight/Bulb (g)
DAWSON	BEJO	108 b-j*	2 e-h	15 f-m	46 a-j	39 b-k	7.1 c-k	152.8 c-k
CATSKILL	Sem	120 b-g	1 e-h	29 a-d	49 a-h	34 a-i	7.9 b-h	168.0 a-h
HIGHLANDER	Tak	104 d-j	3 c-g	30 abc	40 c-m	25 a-f	6.8 f-k	182.2 a-d
BRADDOCK	BEJO	133 b	0 h	17 d-k	57 abc	50 h-l	8.7 b	152.9 c-k
HAECKERO	Haz	116 b-h	1 fgh	13 g-o	43 b-m	51 h-l	7.6 b-i	142.7 f-n
SAFRANE	BEJO	120 b-g	2 e-h	21 a-h	42 c-m	46 f-l	7.9 b-h	150.6 d-l
PROSPECTOR	BEJO	100 f-k	1 e-h	28 a-e	42 c-m	22 a-d	6.6 g-l	173.8 a-g
CERESCO	Haz	93 h-j	3 b-f	25 a-g	35 e-n	24 a-f	6.1 i-l	173.9 a-g
POWELL	BEJO	105 c-j	1 e-h	20 b-i	46 a-l	30 a-h	6.9 d-k	161.5 b-i
TRAVERSE MYCO+INICIUM	SN	115 b-h	2 c-h	18 c-j	41 c-m	44 d-l	7.5 b-i	147.8 e-l
LA SALLE	Sto	77 k	4 a-d	25 a-g	27 lmn	15 a	5.0 l	194.1 ab
A 1762	Sem	103 e-j	1 e-h	19 c-j	40 c-m	34 a-j	6.8 f-k	140.2 h-n

Listed in order of % Marketable.

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ONION CULTIVAR MAIN TRIAL - 2019 - continued

Cultivar	Source	# Bulbs Harvested	# Bulbs Jumbos > 89 mm	# Bulbs Lrg 89 - 76 mm	# Bulbs Med 76 - 64 mm	# Bulbs Small 64 - 32 mm	Stand/Foot	Average Weight/Bulb (g)
CHAMP	CF	119 b-g*	0 h	14 f-n	48 a-i	46 f-l	7.8 b-h	141.2 g-n
POCONO	Sto	119 b-g	3 b-e	26 a-f	42 c-m	37 a-k	7.8 b-h	162.0 b-i
FRONTIER	Tak	118 b-g	0 h	3 mno	46 a-k	58 kl	7.7 b-h	118.5 l-o
TRAVERSE	SN	131 b	0 h	17 d-k	51 a-g	50 h-l	8.6 bc	137.1 h-n
REDSTONE	Haz	111 b-j	0 h	4 l-o	54 a-e	43 d-l	7.3 b-k	125.5 j-o
TREKKER	Tak	124 b-f	0 h	8 i-o	53 a-f	49 h-l	8.1 b-g	126.7 j-o
STANLEY	CF	128 bcd	0 h	18 c-j	53 a-g	42 d-l	8.4 b-e	144.8 f-n
HADES	SN	90 ijk	5 ab	17 d-k	27 k-n	29 a-h	5.9 jkl	156.0 c-j
TRAILBLAZER	Tak	113 b-i	0 h	7 j-o	50 a-h	42 d-l	7.4 b-j	124.5 j-o
STARTER	Haz	111 b-j	2 e-h	14 f-n	40 c-m	40 c-l	7.2 b-k	133.8 i-n
37 118	Haz	110 b-j	1 e-h	15 f-m	50 a-h	31 a-h	7.2 b-k	140.7 g-n
RIDGELINE	SN	129 bc	1 e-h	16 e-l	45 a-m	48 g-l	8.4 bcd	143.5 f-n

Listed in order of % Marketable.

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ONION CULTIVAR MAIN TRIAL - 2019 - continued

Cultivar	Source	# Bulbs Harvested	# Bulbs Jumbos > 89 mm	# Bulbs Lrg 89 - 76 mm	# Bulbs Med 76 - 64 mm	# Bulbs Small 64 - 32 mm	Stand/Foot	Average Weight/Bulb (g)
NORSTAR	Sto	102 e-j*	0 h	10 h-o	36 d-m	42 d-l	6.7 g-k	122.3 k-o
RIDGELINE INICIUM	SN	123 b-f	1 e-h	11 h-o	29 j-n	63 l	8.0 b-g	120.1 k-o
TRAILBLAZER MYCO+INI	SN	117 b-h	0 h	8 i-o	39 c-m	51 h-l	7.6 b-i	114.2 m-p
TRAILBLAZER	SN	98 g-k	0 h	9 h-o	34 g-n	38 b-k	6.4 h-l	118.4 l-o
CARTIER	BEJO	104 d-j	0 h	11 h-o	45 a-m	34 a-j	6.8 e-k	112.1 n-q
Y 621	SN	108 b-j	0 h	10 h-o	30 i-n	46 f-l	7.1 b-k	117.9 l-o
TRAILBLAZER INICIUM	SN	102 e-j	0 h	10 h-o	34 f-n	38 b-k	6.7 f-k	126.7 j-o
E61L 10156	EZ	88 jk	1 e-h	2 no	16 n	46 e-l	5.8 kl	99.6 opq
ONEIDA	BEJO	221 a	0 h	1 o	32 h-n	124 m	14.4 a	80.6 q
E61L 10699	EZ	129 bc	0 h	4 mno	26 mn	57 jkl	8.4 bcd	84.2 pq
Trial Average		**114.2**	**1.5**	**17.7**	**43.7**	**39.2**	**7.5**	**148.4**

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.

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ONION CULTIVAR MAIN TRIAL - 2019 - continued

Cultivar	Source	Total Harvest Weight (kg)	Wgt. Jumbo > 89 mm (kg)	Wgt. Large 89 - 76 mm (kg)	Wgt. Medium 76-64 mm (kg)	Wgt. Small 64-32 mm (kg)	Marketable Yield B/A	% Marketable	Majority of Culls
RIDGELINE	Tak	23.81 a*	1.02 b-g	7.60 a-d	11.89 a	3.05 e-o	1776 a	97.6 a	PW
SV NY 1141	Sem	20.42 a-f	1.40 b-e	6.93 a-g	9.27 a-f	2.50 k-o	1516 a-g	97.5 a	PW
37 120	Haz	18.94 b-h	0.67 e-j	6.24 a-i	8.57 b-i	3.33 e-o	1419 b-j	97.4 a	PW
SV NY 1568	Sem	21.20 a-e	1.71 abc	8.54 ab	7.57 c-n	3.04 e-o	1573 a-d	96.9 ab	PW
MILESTONE	Tak	22.58 ab	0.70 e-j	8.70 a	10.14 abc	2.62 i-o	1671 ab	96.8 ab	R
TRAVERSE	Tak	22.08 abc	0.92 c-i	7.51 a-e	10.87 ab	2.34 l-o	1632 abc	96.3 ab	PW
CROCKETT	BEJO	21.21 a-d	0.60 e-j	8.21 ab	10.05 a-d	1.82 mno	1560 a-e	95.6 ab	PW
FORTRESS	Sto	17.21 e-m	0.00 j	1.38 n-q	9.09 a-g	6.44 b	1274 d-m	95.6 ab	PW
SV NY 1496	Sem	21.17 a-e	2.37 a	8.75 a	7.89 b-m	1.61 no	1555 a-f	95.4 ab	PW
SADDLEBACK	Sto	19.18 b-h	1.23 b-f	7.06 a-f	7.58 c-n	2.85 f-o	1412 b-j	94.8 abc	PW
ARMSTRONG	CF	16.82 f-n	0.00 j	4.35 e-n	9.45 a-e	2.74 h-o	1247 e-o	94.3 a-d	PW
PATTERSON	BEJO	19.25 b-h	0.68 e-j	6.58 a-h	9.11 a-g	2.61 i-o	1431 b-i	94.0 a-d	PW

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.

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ONION CULTIVAR MAIN TRIAL - 2019 - continued

Cultivar	Source	Total Harvest Weight (kg)	Wgt. Jumbo > 89 mm (kg)	Wgt. Large > 76 mm (kg)	Wgt. Medium 76-64 mm (kg)	Wgt. Small 64-32 mm (kg)	Marketable Yield B/A	% Marketable	Majority of Culls
DAWSON	BEJO	16.47 f-p*	0.61 e-j	3.77 g-p	8.08 b-l	3.70 c-m	1218 g-q	93.6 a-d	R
CATSKILL	Sem	20.33 a-f	0.50 f-j	7.54 a-d	8.58 b-i	3.47 d-o	1514 a-g	93.5 a-d	PW
HIGHLANDER	Tak	18.95 b-h	0.97 b-h	7.72 abc	6.85 d-o	2.49 k-o	1360 b-k	93.5 a-d	D
BRADDOCK	BEJO	20.17 a-g	0.12 ij	4.63 c-m	9.97 a-d	4.94 b-e	1482 a-h	93.4 a-d	PW
HAECKERO	Haz	16.65 f-o	0.19 g-j	3.33 i-q	7.74 b-n	5.02 b-e	1227 g-q	92.9 a-d	PW
SAFRANE	BEJO	17.82 d-k	0.60 e-j	5.47 b-k	7.32 c-o	3.98 c-l	1310 d-l	92.8 a-d	PW
PROSPECTOR	BEJO	17.54 d-l	0.32 g-j	7.14 a-f	7.41 c-o	2.27 l-o	1293 d-m	92.7 a-e	PW
CERESCO	Haz	16.24 g-q	1.01 b-g	6.19 a-j	5.76 h-p	2.27 l-o	1148 i-s	92.5 a-e	PW
POWELL	BEJO	16.93 f-n	0.31 g-j	5.03 c-l	7.81 b-m	3.24 e-o	1235 g-p	92.4 a-e	PW
TRAVERSE MYCO+INICIUM	SN	16.85 f-n	0.84 d-j	4.59 c-m	7.01 c-o	4.05 c-l	1244 f-o	91.7 a-e	PW
LA SALLE	Sto	14.94 i-r	1.58 a-d	6.78 a-g	4.84 m-p	1.44 o	1104 j-s	91.0 a-f	PW
A 1762	Sem	14.53 j-r	0.42 f-j	4.34 e-n	6.12 f-o	3.04 e-o	1050 k-t	90.9 a-f	PW

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.

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ONION CULTIVAR MAIN TRIAL - 2019 - continued

Cultivar	Source	Total Harvest Weight (kg)	Wgt. Jumbo > 89 mm (kg)	Wgt. Large > 76 mm (kg)	Wgt. Medium 76-64 mm (kg)	Wgt. Small 64-32 mm (kg)	Marketable Yield B/A	% Marketable	Majority of Culls
CHAMP	CF	17.00 f-m*	0.00 j	3.51 h-q	8.55 b-i	4.56 b-j	1253 e-n	90.8 a-f	PW
POCONO	Sto	19.32 b-h	1.22 b-f	6.77 a-g	7.13 c-o	3.61 c-n	1413 b-j	90.7 a-g	PW
FRONTIER	Tak	14.21 k-r	0.00 j	0.81 pq	7.58 c-n	5.51 bc	1048 k-t	90.4 a-g	PW
TRAVERSE	SN	17.98 d-k	0.00 j	4.06 f-o	8.61 b-i	4.83 b-f	1320 c-l	90.1 a-g	PW
REDSTONE	Haz	14.10 k-r	0.00 j	0.94 opq	8.68 a-i	4.04 c-l	1030 l-t	90.0 a-g	PW
TREKKER	Tak	15.74 h-q	0.00 j	2.04 l-q	8.80 a-h	4.42 b-k	1151 i-s	89.5 a-g	PW
STANLEY	CF	18.76 b-i	0.09 ij	4.50 d-n	9.05 a-g	4.18 c-l	1343 c-l	87.6 a-g	D
HADES	SN	13.73 l-r	1.80 ab	4.19 f-n	4.51 nop	2.55 j-o	984 m-t	87.4 a-g	PW
TRAILBLAZER	Tak	14.25 k-r	0.10 ij	1.49 m-q	8.27 b-k	3.85 c-m	1034 l-t	87.2 a-g	PW
STARTER	Haz	14.50 j-r	0.55 f-j	3.39 i-q	6.70 e-o	3.36 e-o	1055 k-t	86.8 a-g	PW
37 118	Haz	15.59 h-q	0.32 g-j	3.36 i-q	8.44 b-j	2.75 g-o	1121 i-s	86.8 a-g	PW
RIDGELINE	SN	18.48 c-j	0.35 g-j	4.42 d-n	8.08 b-l	4.78 b-g	1329 c-l	85.9 b-g	PW

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.

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ONION CULTIVAR MAIN TRIAL - 2019 - continued

Cultivar	Source	Total Harvest Weight (kg)	Wgt. Jumbo > 89 mm (kg)	Wgt. Large > 76 mm (kg)	Wgt. Medium 76-64 mm (kg)	Wgt. Small 64-32 mm (kg)	Marketable Yield B/A	% Marketable	Majority of Culls
NORSTAR	Sto	12.66 o-r*	0.11 ij	2.31 k-q	6.01 g-o	3.74 c-m	919 q-t	85.7 b-g	PW
RIDGELINE INICIUM	SN	14.62 j-r	0.36 g-j	3.01 j-q	4.96 l-p	5.50 bcd	1043 l-t	84.0 c-h	PW
TRAILBLAZER MYCO+IN	SN	13.24 m-r	0.00 j	1.77 m-q	6.10 f-o	4.60 b-i	940 n-t	83.9 c-h	PW
TRAILBLAZER	SN	11.56 rs	0.12 hij	2.19 l-q	5.50 i-p	3.26 e-o	836 stu	83.4 d-h	PW
CARTIER	BEJO	12.57 pqr	0.00 j	2.62 k-q	6.49 e-o	3.11 e-o	921 p-t	81.4 e-i	PW
Y 621	SN	12.42 qr	0.00 j	2.42 k-q	5.09 k-p	4.16 c-l	880 rst	79.9 f-i	PW
TRAILBLAZER INICIUM	SN	12.97 n-r	0.00 j	2.29 l-q	5.30 j-p	4.77 b-h	932 o-t	79.4 ghi	PW
E61L 10156	EZ	8.29 s	0.37 g-j	0.50 q	2.63 p	3.89 c-l	529 u	73.3 hij	PW
ONEIDA	BEJO	17.76 d-k	0.00 j	0.34 q	4.99 l-p	10.34 a	1182 h-r	71.1 ij	PW
E61L 10699	EZ	11.16 rs	0.00 j	0.89 opq	4.25 op	4.80 b-f	750 tu	65.8 j	PW
Trial Average		**16.79**	**0.53**	**4.48**	**7.49**	**3.73**	**1223**	**89.4**	**PW**

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.

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ONION CULTIVAR MAIN TRIAL - 2019 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Skin Thickness	Skin Attachment	Neck Finish	Overall Score	Score
RIDGELINE	Tak	SPG	6.7 a-e*	7.2 ab	7.2 abc	8.7 b-f	7.3 c-g	7.0 bcd	7.38 a-i
SV NY 1141	Sem	SPG	3.7 f	6.0 a-e	5.3 fg	7.7 fgh	7.7 b-e	6.3 def	6.17 r
37 120	Haz	G	7.3 abc	6.0 a-e	5.0 g	9.0 a-e	6.3 ghi	7.3 abc	6.98 h-p
SV NY 1568	Sem	TOP	5.7 de	6.5 a-d	5.7 efg	6.0 ij	6.8 e-h	6.3 def	6.21 r
MILESTONE	Tak	HG	6.3 b-e	7.3 a	7.0 a-d	9.7 ab	6.3 ghi	6.7 cde	7.25 c-l
TRAVERSE	Tak	G	7.3 abc	7.3 a	7.0 a-d	9.0 a-e	7.0 d-h	7.0 bcd	7.54 a-f
CROCKETT	BEJO	HG	6.7 a-e	7.3 a	6.3 c-f	9.7 ab	5.0 j	7.0 bcd	7.44 a-h
FORTRESS	Sto	SPG	7.3 abc	6.7 abc	6.3 c-f	9.3 a-d	6.3 ghi	7.0 bcd	7.21 e-l
SV NY 1496	Sem	G	6.7 a-e	6.7 abc	5.7 efg	7.7 fgh	7.0 d-h	6.7 cde	6.71 m-q
SADDLEBACK	Sto	G	6.0 cde	6.0 a-e	5.7 efg	8.8 a-f	6.7 e-h	5.7 f	6.44 qr
ARMSTRONG	CF	HG	6.0 cde	7.0 ab	6.3 c-f	9.7 ab	6.0 hij	6.7 cde	7.15 e-m
PATTERSON	BEJO	HG	6.0 cde	6.3 a-d	7.7 ab	9.7 ab	7.7 b-e	7.7 ab	7.75 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.

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ONION CULTIVAR MAIN TRIAL - 2019 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Skin Thickness	Skin Attachment	Neck Finish	Overall Score	Score
DAWSON	BEJO	G	6.3 b-e*	6.8 abc	6.0 d-g	10.0 a	7.5 c-f	7.0 bcd	7.31 b-j
CATSKILL	Sem	HG	6.0 cde	5.7 b-f	6.3 c-f	8.7 b-f	7.0 d-h	6.0 ef	6.71 m-q
HIGHLANDER	Tak	SPG	5.7 de	5.3 c-f	5.0 g	3.7 k	9.3 a	5.7 f	6.17 r
BRADDOCK	BEJO	HG	7.0 a-d	5.0 d-g	5.0 g	8.7 b-f	6.8 e-h	7.2 a-d	6.77 l-q
HAECKERO	Haz	HG	5.7 de	5.0 d-g	6.3 c-f	10.0 a	6.3 ghi	7.0 bcd	7.04 g-n
SAFRANE	BEJO	SPG	5.3 e	5.0 d-g	6.7 b-e	9.7 ab	7.3 c-g	7.5 abc	7.27 b-k
PROSPECTOR	BEJO	G	7.0 a-d	7.0 ab	6.0 d-g	10.0 a	7.0 d-h	7.0 bcd	7.58 a-e
CERESCO	Haz	G	6.0 cde	4.7 efg	6.0 d-g	9.2 a-e	6.7 e-h	6.3 def	6.71 m-q
POWELL	BEJO	G	6.3 b-e	5.0 d-g	5.7 efg	9.3 a-d	5.3 ij	5.7 f	6.50 pqr
TRAVERSE MYCO+INICIUM	SN	G	7.0 a-d	4.7 efg	7.0 a-d	8.8 a-f	7.5 c-f	7.0 bcd	7.08 f-n
LA SALLE	Sto	HG	5.7 de	4.7 efg	6.3 c-f	9.7 ab	6.0 hij	6.3 def	6.56 o-r
A 1762	Sem	G	7.0 a-d	6.3 a-d	6.0 d-g	5.3 j	8.7 ab	6.3 def	6.71 m-q

Listed in order of % Marketable. 10.0 = Most Desirable, 8.0 = Good, 6.0 = Average

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ONION CULTIVAR MAIN TRIAL - 2019 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Skin Thickness	Skin Attachment	Neck Finish	Overall Score	Score
CHAMP	CF	HG	7.0 a-d*	5.8 a-f	7.3 abc	9.3 a-d	6.8 e-h	7.7 ab	7.63 a-e
POCONO	Sto	HG	6.3 b-e	5.3 c-f	6.3 c-f	9.3 a-d	6.5 fgh	7.3 abc	7.06 f-n
FRONTIER	Tak	G	8.0 a	5.7 b-f	6.7 b-e	10.0 a	8.3 abc	7.7 ab	7.81 a
TRAVERSE	SN	G	7.3 abc	5.0 d-g	6.3 c-f	8.7 b-f	7.7 b-e	6.7 cde	6.90 i-q
REDSTONE	Haz	G	6.7 a-e	7.3 a	7.3 abc	7.7 fgh	7.0 d-h	6.7 cde	7.38 a-i
TREKKER	Tak	G	7.0 a-d	6.8 abc	8.0 a	9.5 abc	7.0 d-h	7.0 bcd	7.83 a
STANLEY	CF	G	6.7 a-e	7.3 a	6.3 c-f	9.3 a-d	6.3 ghi	7.3 abc	7.52 a-g
HADES	SN	FG	6.0 cde	4.3 fg	6.3 c-f	9.7 ab	7.3 c-g	6.7 cde	6.79 k-q
TRAILBLAZER	Tak	G	8.0 a	7.0 ab	6.0 d-g	9.5 abc	8.0 bcd	7.7 ab	7.83 a
STARTER	Haz	FG	5.3 e	4.7 efg	6.3 c-f	9.5 abc	7.0 d-h	6.0 ef	6.85 j-q
37 118	Haz	G	5.3 e	6.0 a-e	5.7 efg	8.3 c-g	6.3 ghi	5.7 f	6.21 r
RIDGELINE	SN	HG	5.7 de	6.0 a-e	6.7 b-e	8.3 c-g	7.0 d-h	6.7 cde	6.77 l-q

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ONION CULTIVAR MAIN TRIAL - 2019 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Skin Thickness	Skin Attachment	Neck Finish	Overall Score	Score
NORSTAR	Sto	G	7.3 abc*	6.0 a-e	5.3 fg	7.0 hi	8.0 bcd	6.0 ef	6.42 qr
RIDGELINE INICIUM	SN	HG	6.7 a-e	3.7 g	6.7 b-e	8.2 d-h	8.0 bcd	5.7 f	6.63 n-r
TRAILBLAZER MYCO+IN	SN	G	8.0 a	5.7 b-f	7.0 a-d	8.7 b-f	8.3 abc	8.0 a	7.71 a-d
TRAILBLAZER	SN	G	6.7 a-e	4.7 efg	7.7 ab	9.0 a-e	8.0 bcd	6.3 def	7.23 d-l
CARTIER	BEJO	G	7.7 ab	6.8 abc	6.3 c-f	9.7 ab	8.0 bcd	7.2 a-d	7.73 abc
Y 621	SN	G	5.7 de	5.3 c-f	7.7 ab	9.0 a-e	7.3 c-g	6.7 cde	7.00 h-o
TRAILBLAZER INICIUM	SN	G	7.7 ab	5.3 c-f	6.7 b-e	9.0 a-e	8.0 bcd	7.7 ab	7.58 a-e
E61L 10156	EZ	G	5.7 de	4.7 efg	7.7 ab	7.3 gh	7.0 d-h	4.3 g	6.42 qr
ONEIDA	BEJO	G	7.7 ab	6.7 abc	5.7 efg	8.0 e-h	7.3 c-g	6.8 b-e	7.00 h-o
E61L 10699	EZ	TD	5.7 de	6.7 abc	5.3 fg	7.7 fgh	7.7 b-e	6.0 ef	6.71 m-q
Trial Average			**6.5**	**5.9**	**6.4**	**8.7**	**7.1**	**6.7**	**7.04**

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.

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ONION CULTIVAR MAIN TRIAL - 2019 - continued

Cultivar	Source	Firmness at Harvest	Firmness at Evluation	Interior Colour	Exterior Colour	Exterior Colour Rating	Days to Harvest	% Onion Maggot Damage	% Jumbo > 76 mm
RIDGELINE	Tak	9.8 ab*	7.3 g-j	W	DG	7.7 abc	101 c-g	0.0 a	22.9 a-h
SV NY 1141	Sem	9.3 cde	6.3 k	W	LG	6.3 cde	105 f-k	3.0 a-e	24.4 a-f
37 120	Haz	9.8 ab	8.2 c-g	W	G	6.7 bcd	105 f-k	4.7 a-f	22.7 a-h
SV NY 1568	Sem	8.8 f	6.3 k	W	LG	6.3 cde	101 c-f	1.4 abc	28.7 ab
MILESTONE	Tak	9.5 bcd	7.3 g-j	W	G	7.3 abc	109 klm	4.4 a-f	27.7 a-d
TRAVERSE	Tak	9.2 def	8.0 d-h	W	DG	7.7 abc	105 f-k	4.2 a-f	25.0 a-e
CROCKETT	BEJO	9.5 bcd	9.2 ab	W	DG	8.3 a	112 m	2.6 a-e	29.0 ab
FORTRESS	Sto	10.0 a	7.3 g-j	C	G	7.3 abc	107 i-l	1.4 abc	4.3 lmn
SV NY 1496	Sem	9.2 def	7.0 ijk	W	G	6.3 cde	98 bcd	2.2 abc	31.1 a
SADDLEBACK	Sto	9.5 bcd	7.3 g-j	C	G	5.3 de	98 bcd	3.4 a-e	25.0 a-e
ARMSTRONG	CF	10.0 a	8.8 a-d	W	G	6.7 bcd	109 klm	1.6 abc	17.1 c-k
PATTERSON	BEJO	9.8 ab	9.7 a	C	G	7.3 abc	105 f-k	5.8 a-g	22.3 a-h

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.

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ONION CULTIVAR MAIN TRIAL - 2019 - continued

Cultivar	Source	Firmness at Harvest	Firmness at Evluation	Interior Colour	Exterior Colour	Exterior Colour Rating	Days to Harvest	% Onion Maggot Damage	% Jumbo > 76 mm
DAWSON	BEJO	10.0 a*	7.8 e-i	C	DG	7.0 abc	103 e-i	3.7 a-e	13.8 e-m
CATSKILL	Sem	9.5 bcd	7.7 f-i	W	G	6.3 cde	105 g-k	3.4 a-e	23.8 a-g
HIGHLANDER	Tak	8.8 f	6.3 k	W	LG	8.3 a	94 b	1.6 abc	28.6 abc
BRADDOCK	BEJO	9.8 ab	7.5 f-j	C	LG	7.0 abc	105 g-k	0.8 ab	12.8 g-m
HAECKERO	Haz	9.8 ab	9.0 abc	W	LG	7.0 abc	103 e-i	3.3 a-e	11.6 h-n
SAFRANE	BEJO	10.0 a	9.0 abc	W	G	7.7 abc	108 j-m	1.3 abc	18.3 b-j
PROSPECTOR	BEJO	10.0 a	9.7 a	C	G	7.0 abc	111 lm	2.0 abc	27.9 abc
CERESCO	Haz	8.8 f	7.5 f-j	G	G	7.3 abc	111 lm	4.0 a-e	26.1 a-d
POWELL	BEJO	9.8 ab	8.0 d-h	C	DG	6.7 bcd	111 lm	4.8 a-f	19.3 b-i
TRAVERSE MYCO+INICIUM	SN	9.5 bcd	8.0 d-h	W	G	6.7 bcd	105 f-k	6.0 a-g	16.5 d-k
LA SALLE	Sto	9.7 abc	7.2 h-k	C	G	6.7 bcd	111 lm	1.8 abc	32.4 a
A 1762	Sem	8.8 f	7.0 ijk	W	LG	7.0 abc	85 a	6.8 b-g	18.2 b-j

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.

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ONION CULTIVAR MAIN TRIAL - 2019 - continued

Cultivar	Source	Firmness at Harvest	Firmness at Evluation	Interior Colour	Exterior Colour	Exterior Colour Rating	Days to Harvest	% Onion Maggot Damage	% Jumbo > 76 mm
CHAMP	CF	10.0 a*	9.7 a	W	DG	7.3 abc	107 i-l	5.5 a-f	11.6 h-n
POCONO	Sto	9.7 abc	7.7 f-i	W	G	7.7 abc	108 j-m	9.0 e-h	21.8 a-h
FRONTIER	Tak	9.8 ab	8.8 a-d	C	G	7.3 abc	103 e-i	1.8 abc	3.0 lmn
TRAVERSE	SN	9.2 def	8.2 c-g	W	G	5.3 de	104 e-j	7.6 c-h	13.2 f-m
REDSTONE	Haz	10.0 a	8.7 b-e	W	R	7.7 abc	97 bc	2.1 abc	3.5 lmn
TREKKER	Tak	9.8 ab	9.0 abc	C	DG	8.3 a	97 bc	2.4 a-d	6.5 k-n
STANLEY	CF	10.0 a	8.8 a-d	W	G	8.0 ab	105 f-k	2.5 a-d	14.3 e-l
HADES	SN	9.3 cde	7.7 f-i	C	G	6.3 cde	105 f-k	7.5 c-g	19.3 b-i
TRAILBLAZER	Tak	10.0 a	9.0 abc	C	G	7.5 abc	100 cde	3.6 a-e	6.0 k-n
STARTER	Haz	9.3 cde	8.3 b-f	C	G	7.7 abc	106 g-k	2.5 a-d	13.3 f-m
37 118	Haz	9.7 abc	7.0 ijk	C	LG	5.3 de	101 c-f	5.5 a-f	13.2 f-m
RIDGELINE	SN	9.7 abc	7.5 f-j	W	G	6.3 cde	102 d-h	8.6 d-h	12.6 g-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.

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ONION CULTIVAR MAIN TRIAL - 2019 - continued

Cultivar	Source	Firmness at Harvest	Firmness at Evluation	Interior Colour	Exterior Colour	Exterior Colour Rating	Days to Harvest	% Onion Maggot Damage	% Jumbo > 76 mm
NORSTAR	Sto	9.0 ef*	6.7 jk	C	LG	5.0 e	98 bcd	3.1 a-e	9.0 i-n
RIDGELINE INICIUM	SN	10.0 a	7.8 e-i	W	DG	6.3 cde	100 cde	13.9 hi	9.6 i-n
TRAILBLAZER MYCO+IN	SN	9.8 ab	8.3 b-f	C	G	7.7 abc	98 bcd	11.9 gh	7.2 j-n
TRAILBLAZER	SN	10.0 a	9.2 ab	C	G	6.3 cde	98 bcd	18.4 ij	9.3 i-n
CARTIER	BEJO	10.0 a	9.2 ab	C	G	7.0 abc	106 g-k	3.8 a-e	9.8 i-n
Y 621	SN	9.8 ab	8.0 d-h	C	G	6.3 cde	106 h-k	10.4 fgh	10.0 i-n
TRAILBLAZER INICIUM	SN	10.0 a	8.3 b-f	C	G	8.0 ab	98 bcd	20.3 j	9.3 i-n
E61L 10156	EZ	9.8 ab	8.3 b-f	C	DG	6.3 cde	108 j-m	2.8 a-e	2.4 mn
ONEIDA	BEJO	8.8 f	7.2 h-k	W	G	6.7 bcd	94 b	4.4 a-f	0.6 n
E61L 10699	EZ	9.3 cde	7.3 g-j	W	G	7.3 abc	107 i-l	6.1 a-g	2.6 mn
Trial Average		**9.6**	**8.0**			**7.0**	**103**	**5.0**	**16.0**

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.

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ONION CULTIVAR MAIN TRIAL - 2019 - continued

Cultivar	Source	Seeders	% Single Centers	% Double Centers	% Multiple Centers	% Hollowness in Centers	Tops Height (cm)	Leaf Shape	Leaf Colour
RIDGELINE	Tak	0.0 a*	47 d-i	53 d-i	0 a	90 o	54.3 a-i	U	G
SV NY 1141	Sem	0.0 a	53 c-h	43 c-g	3 ab	43 f-m	61.5 a	U	G
37 120	Haz	0.0 a	73 a-d	27 a-d	0 a	50 h-n	55.8 a-h	B	LG
SV NY 1568	Sem	0.0 a	30 h-l	50 c-i	20 de	73 no	50.7 f-j	B	LG
MILESTONE	Tak	0.0 a	40 e-j	57 e-i	0 a	27 a-i	56.6 a-g	B	G
TRAVERSE	Tak	0.0 a	57 c-h	43 c-g	0 a	43 f-m	57.8 a-f	U	G
CROCKETT	BEJO	0.0 a	50 c-h	47 c-h	3 ab	17 a-f	59.0 a-d	B	G
FORTRESS	Sto	0.0 a	67 b-e	33 b-e	0 a	47 g-n	51.8 d-j	B	G
SV NY 1496	Sem	0.0 a	30 h-l	47 c-h	23 ef	63 k-o	50.9 f-j	B	G
SADDLEBACK	Sto	0.0 a	37 f-j	53 d-i	10 bc	20 a-g	60.0 ab	U	LG
ARMSTRONG	CF	0.0 a	53 c-h	47 c-h	0 a	73 no	55.4 a-i	B	G
PATTERSON	BEJO	0.0 a	50 c-h	50 c-i	0 a	40 e-l	57.2 a-f	U	BG

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ONION CULTIVAR MAIN TRIAL - 2019 - continued

Cultivar	Source	Seeders	% Single Centers	% Double Centers	% Multiple Centers	% Hollowness in Centers	Tops Height (cm)	Leaf Shape	Leaf Colour
DAWSON	BEJO	0.0 a*	93 ab	7 ab	0 a	10 a-d	55.3 a-i	B	G
CATSKILL	Sem	0.0 a	53 c-h	43 c-g	3 ab	7 abc	58.3 a-e	U	G
HIGHLANDER	Tak	0.0 a	3 l	67 ghi	30 f	67 l-o	48.4 ijk	B	G
BRADDOCK	BEJO	0.0 a	30 h-l	67 ghi	3 ab	47 g-n	54.5 a-i	B	G
HAECKERO	Haz	0.0 a	50 c-h	50 c-i	0 a	20 a-g	55.8 a-h	B	G
SAFRANE	BEJO	0.0 a	60 c-g	40 c-g	0 a	33 c-j	54.0 b-i	B	G
PROSPECTOR	BEJO	0.0 a	50 c-h	47 c-h	3 ab	3 ab	53.9 b-j	B	BG
CERESCO	Haz	0.0 a	30 h-l	50 c-i	20 de	43 f-m	49.2 h-k	B	G
POWELL	BEJO	0.0 a	73 a-d	27 a-d	0 a	23 a-h	55.5 a-i	U	BG
TRAVERSE MYCO+INICIUM	SN	0.0 a	97 a	3 a	0 a	53 i-n	55.3 a-i	B	G
LA SALLE	Sto	0.0 a	57 c-h	43 c-g	0 a	30 b-j	51.9 d-j	U	G
A 1762	Sem	0.0 a	20 i-l	77 i	3 ab	57 j-n	43.3 k	B	BG

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 - 2019 - continued

Cultivar	Source	Seeders	% Single Centers	% Double Centers	% Multiple Centers	% Hollowness in Centers	Tops Height (cm)	Leaf Shape	Leaf Colour
CHAMP	CF	0.0 a*	57 c-h	40 c-g	3 ab	53 i-n	59.3 abc	U	BG
POCONO	Sto	0.0 a	77 abc	23 abc	0 a	30 b-j	57.2 a-f	U	BG
FRONTIER	Tak	0.0 a	47 d-i	53 d-i	0 a	37 d-k	59.6 abc	U	BG
TRAVERSE	SN	0.0 a	93 ab	7 ab	0 a	47 g-n	56.9 a-g	B	G
REDSTONE	Haz	0.0 a	7 kl	73 hi	20 de	57 j-n	54.5 a-i	U	G
TREKKER	Tak	0.0 a	33 g-k	67 ghi	0 a	27 a-i	55.0 a-i	U	BG
STANLEY	CF	0.0 a	30 h-l	60 e-i	10 bc	20 a-g	55.1 a-i	B	BG
HADES	SN	0.0 a	33 g-k	63 f-i	3 ab	30 b-j	57.6 a-f	B	BG
TRAILBLAZER	Tak	0.0 a	53 c-h	43 c-g	3 ab	3 ab	50.6 f-k	U	BG
STARTER	Haz	0.0 a	40 e-j	47 c-h	13 cd	13 a-e	52.9 b-j	B	BG
37 118	Haz	0.0 a	43 e-i	47 c-h	10 bc	23 a-h	49.8 g-k	B	G
RIDGELINE	SN	0.0 a	50 c-h	50 c-i	0 a	67 l-o	54.7 a-i	U	G

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 - 2019 - continued

Cultivar	Source	Seeders	% Single Centers	% Double Centers	% Multiple Centers	% Hollowness in Centers	Tops Height (cm)	Leaf Shape	Leaf Colour
NORSTAR	Sto	0.0 a*	13 jkl	77 i	10 bc	33 c-j	46.7 jk	B	BG
RIDGELINE INICIUM	SN	0.0 a	60 c-g	40 c-g	0 a	70 mno	54.6 a-i	U	G
TRAILBLAZER MYCO+IN	SN	0.0 a	47 d-i	53 d-i	0 a	7 abc	53.8 b-j	U	BB
TRAILBLAZER	SN	0.0 a	40 e-j	60 e-i	0 a	13 a-e	51.2 e-j	U	BG
CARTIER	BEJO	0.0 a	40 e-j	60 e-i	0 a	0 a	49.1 h-k	B	BG
Y 621	SN	0.0 a	37 f-j	50 c-i	13 cd	17 a-f	52.3 c-j	U	BG
TRAILBLAZER INICIUM	SN	0.0 a	47 d-i	53 d-i	0 a	3 ab	51.2 e-j	U	BG
E61L 10156	EZ	0.0 a	33 g-k	67 ghi	0 a	17 a-f	48.4 ijk	U	LG
ONEIDA	BEJO	0.0 a	57 c-h	43 c-g	0 a	13 a-e	61.5 a	U	LG
E61L 10699	EZ	0.0 a	63 c-f	37 c-f	0 a	0 a	51.2 e-j	U	LG
Trial Average		**0.0**	**47.9**	**47.5**	**4.6**	**33.9**	**54.1**		

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 EVALUATION NOTES – 2019

Ridgeline: *American Takii sample*, Good appearance, Average tight neck finish, Neck finish a bit rough, Neck sizes uneven, Thicker skins, Pretty good skin quality, Odd one with skin cracking, Colour a little dark, Skin colour even, Odd one with yellowing or white spots on skins, Average packer, Uniformity of shape uneven, Good firmness, Firmness is a little uneven, Larger run size a little even, Mid-term storage onion.

SV NY 1141: *Seminis sample*, Average appearance, Good tight neck finish, Neck finish odd one a bit rough, Medium & larger sized necks, Thinner skins, Average skin quality, Some with skin cracking, Colour uneven, Average packer, Uniformity of shape very uneven, Average firmness, Firmness is a little uneven, Medium to large run size a little uneven, Early term storage onion.

37 120: *Hazera sample*, Average appearance, Average neck finish, Neck finish a bit rough, Medium sized necks, Average skin thickness, Pretty good skin quality, Colour a little uneven, Odd yellowing on skin, Average packer, Uniformity of shape a little even, Average firmness, Firmness is a little uneven, Medium run size uneven, Early to mid-term storage onion.

SV NY 1568: *Seminis sample*, Average appearance, Average tight neck finish, Medium & larger sized necks, Thinner skins, Fair skin quality, Some with skin cracking, Skin cracking a little concern, Colour a little uneven, Okay packer, Uniformity of shape uneven, Average firmness, Firmness is a little uneven, Large run size a little uneven, Early term storage onion.

Milestone: *American Takii sample*, Average appearance, Average neck finish, Neck finish bit rough, Large sized necks, Average to thicker skins, Nice skin quality, Colour even, Odd one with yellowing or white spots on skins, Good packer, Uniformity of shape uneven, Average firmness, Firmness a little uneven, Large run size even, Mid-term storage onion.

…/continued

ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2019 - continued

Traverse: *American Takii sample*, Good appearance, Good tight neck finish, Medium sized necks, Thicker skins, Nice skin quality, Even colour, Odd one with yellowing or white spots on skins, Nice packer, Uniformity of shape a little even, Good firm onion, Firmness even, Medium to large run size uneven, Mid to longer term storage onion.

Crockett: *Bejo sample*, Good appearance, Average tight neck finish, Neck finish bit rough, Large sized necks, Thicker skins, Nice skin quality, Odd one with skin rot, Dark colour even, Some yellowing on skin, Good packer, Uniformity of shape a little uneven, Nice firm solid onion, Firmness even, Large run size a little uneven, A few onions still not fully mature, Longer term storage onion.

Fortress: *Stokes sample*, Average appearance, Average tight neck finish, Neck finish a bit rough, Uneven sized necks, Thicker skins, Pretty good skin quality, Colour even, Odd one with yellowing or white spots on skins, Good packer, Uniformity of shape uneven, Good firm solid onion, Firmness even, Small to medium run size a little uneven, Mid to longer term storage onion.

SV NY 1496: *Seminis sample*, Average appearance, Good tight neck finish, Medium sized necks, Thin to average skin thickness, Average skin quality, Some with skin cracking, Skin cracking a little concern, Colour a little uneven, Odd greening of scales, Average packer, Uniformity of shape a little uneven, Average firmness, Large run size a little uneven, Early term storage onion.

Saddleback: *Stokes sample*, Average appearance, Average tight neck finish, Medium sized necks, Average skin thickness, Pretty good skin quality, Odd one with skin cracking, Colour uneven, Odd one with white spots on skins, Average packer, Uniformity of shape uneven, Average to good firmness, Medium to large run size uneven, Mid-term storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2019 - continued

Armstrong: *Clifton sample,* Nice appearance, Average neck finish, Neck finish a bit rough, Medium & large sized necks, Average skin thickness, Nice skin quality, Colour a little uneven, Nice packer, Uniformity of shape a little uneven, Good firm solid onion even, Medium to large run size uneven, Longer term storage onion.

Patterson: *Bejo sample,* Good appearance, Good tight neck finish, Medium sized necks, Thicker skins, Nice skin quality, Colour even, Odd one with white spots on skins, Nice packer, Uniformity of shape uneven, Nice firm solid onion even, Medium to large run size uneven, Longer term storage onion.

Dawson: *Bejo sample,* Good appearance, Good tight neck finish, Small and medium sized necks, Thicker skins, Nice skin quality, Colour a little even, Good packer, Uniformity of shape a little uneven, Good firm onion a little uneven, Medium run size uneven, Mid to longer term storage onion.

Catskill: *Seminis sample,* Average appearance, Good neck finish, Medium sized necks uneven, Average skin thickness, Pretty good skin quality, Odd one with skin cracking, Colour a little uneven, Average packer, Uniformity of shape uneven, Good firm onion, Firmness a little uneven, Run size very uneven, Mid term storage onion.

Highlander: *American Takii sample,* Fair appearance, Perfect tight neck finish, Small sized necks, Thin skins, Poor skin quality, Most have skin cracking a big concern, Some skin rot, Colour even, Some greening of scales, Okay packer, Uniformity of shape a little uneven, Softer onion, Firmness a little uneven, Large run size alittle uneven, Suspicion of doubles, Doubles are a slight concern, Mechanical damage, Early storage onion.

Braddock: *Bejo sample,* Good appearance, Average tight neck finish, Neck finish bit rough, Medium sized necks, Thinner to average skin thickness, Average skin quality, Odd one with skin cracking, Colour even, Some yellowing on skins, Good packer, Uniformity of shape uneven, Good firm onion even, Medium run size uneven, Mid to longer term storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2019 - continued

Haeckero: *Hazera sample*, Good appearance, Average tight neck finish, Neck finish a bit rough, Medium to large sized necks, Average skin thickness, Nice skin quality, Colour a little uneven, Odd yellowing on skin, Good packer, Uniformity of shape uneven, Nice firm solid onion, Firmness even, Run size uneven, Longer term storage onion.

Safrane: *Bejo sample*, Nice appearance, Average tight neck finish, Neck finish a little rough, Medium sized necks, Average skin thickness, Nice skin quality, Colour even, Odd one with yellowing or white spots on skins, Nice packer, Uniformity of shape uneven, Nice firm solid onion, Firmness even, Medium run size uneven, Longer term storage onion.

Prospector: *Bejo sample*, Good appearance, Average tight neck finish, Neck finish bit rough, Medium sized necks uneven, Thicker skins, Nice skin quality, Colour a little even, Odd one with yellowing or white spots on skins, Good packer, Uniformity of shape a little even, Nice firm solid onion, Firmness even, Medium to large run size, Longer term storage onion.

Ceresco: *Hazera sample*, Good appearance, Good tight neck finish, Medium sized necks, Average skin thickness, Nice skin quality, Colour even, Odd one with white spots on skin, Good packer, Uniformity of shape uneven, Good firm onion, Firmness a little uneven, Run size uneven, Mid to longer term storage onion.

Powell: *Bejo sample*, Average appearance, Poor to average neck finish, Neck finish rough & ripped, Medium to large sized necks, Thicker skins, Pretty good skin quality, Colour even, Some with yellowing on skin, Average packer, Uniformity of shape uneven, Good firm solid onion even, Run size uneven, Mid to longer term storage onion.

Traverse: *Seminova sample*, Good appearance, Good tight neck finish, Small to medium sized necks, Average skin thickness, Pretty good skin quality, Colour a little even, Odd one with white spots on skins, Average packer, Uniformity of shape a little uneven, Good firm onion, Firmness even, Small to medium run size uneven, Mid-term storage onion.
Myco + Inicium

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2019 - continued

La Salle: *Stokes sample*, Good appearance, Average neck finish, Neck finishes uneven, Medium to large sized necks, Thicker skins, Pretty good skin quality, Colour even, Odd one with yellowing or white spots on skins, Good packer, Uniformity of shape uneven, Good firm onion, Firmness uneven, Large run size uneven, Mid-term storage onion.

A 1762: *Seminova sample*, Fair appearance, Perfect tight neck finish, Small sized necks, Thin skins, Fair skin quality, A lot of skin cracking a concern, Lighter colour even, Some greening of scales, Okay packer, Uniformity of shape even, Softer onion, Firmness even, Small to medium run size uneven, Early storage onion.

Champ: *Clifton sample*, Good appearance, Average neck finish, Neck finish a bit rough, Medium sized necks, Average skin thickness, Nice skin quality, Odd one with skin cracking, Colour even, Odd one with white spots, Good packer, Uniformity of shape a little uneven, Nice firm solid onion even, Run size uneven, Longer term storage onion.

Pocono: *Stokes sample*, Average appearance, Average neck finish, Neck finish a bit rough, Medium & large sized necks, Average skin thickness, Pretty good skin quality, Colour even, Some yellowing on skins, Average packer, Uniformity of shape a little uneven, Average to good firmness, Firmness a little uneven, Medium to large run size uneven, Mid-term storage onion.

Frontier: *American Takii sample*, Nice appearance, Great tight neck finish, Small to medium sized necks, Thicker skins, Nice skin quality, Colour a little even, Odd one with white spots on skin, Nice packer, Uniformity of shape even, Good firm solid onion, Firmness even, Small to medium run size, Run size uneven, Longer term storage onion.

Traverse: *Seminova sample*, Good appearance, Good tight neck finish, Varied sized necks, Average skin thickness, Pretty good skin quality, Odd one with skin cracking, Colour a little uneven, Odd one with white spots on skins, Good packer, Uniformity of shape even, Good firm onion, Firmness even, Medium run size uneven, Mid-term storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2019 - continued

Red Stone: *Hazera sample*, Good appearance, Good tight neck finish, Medium sized necks, Average skin thickness, Average skin quality, Some skin cracking a little concern, Colour even, Some white spots on skin, Average interior colour, Rings bit light in colour, Good packer, Uniformity of shape a little uneven, Good firm solid onion, Firmness even, Small to medium run size, Run size uneven, Longer term storage onion.

Trekker: *American Takii sample*, Good appearance, Good tight neck finish, Medium sized necks, Thicker skins, Nice skin quality, Dark even colour, Some with white spots on skins, Good packer, Uniformity of shape a little uneven, Nice firm solid onion, Firmness even, Medium run size uneven, Longer term storage onion.

Stanley: *Clifton sample*, Nice appearance, Average tight neck finish, Neck finish a bit rough, Medium sized necks, Average to thick skin thickness, Nice skin quality, Colour even, Some yellowing on skins, Nice packer, Uniformity of shape a little uneven, Nice firm solid onion even, Small to medium run size uneven, Longer term storage onion.

Hades: *Seminova sample*, Average appearance, Good tight neck finish, Small & medium sized necks, Average skin thickness, Pretty good skin quality, Colour a little uneven, Odd one with yellowing on skins, Good packer, Uniformity of shape a little uneven, Good firm onion, Firmness uneven, Run size very uneven, Mid to longer term storage onion.

Trailblazer: *American Takii sample*, Nice appearance, Great tight neck finish, Small & medium sized necks, Average to thick skin thickness, Nice skin quality, Colour even, Odd one with white spots on skins, Nice packer, Uniformity of shape even, Nice firm solid onion, Firmness even, Small run size uneven, Longer term storage onion.

Starter: *Hazera sample*, Average appearance, Average tight neck finish, Medium sized necks, Average skin thickness, Pretty good skin quality, Colour uneven, Odd yellowing on skins, Good packer, Uniformity of shape uneven, Good firm onion, Firmness a little uneven, Run size very uneven, Mid-term storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2019 - continued

37 118: *Hazera sample*, Fair appearance, Average tight neck finish, Neck finish bit rough, Medium sized necks, Average skin thickness, Average skin quality, Odd one with skin cracking, Colour uneven, Odd greening of scales, Okay packer, Uniformity of shape a little uneven, Average firmness, Firmness a little uneven, Medium run size uneven, Suspicion of doubles, Early to mid-term storage onion.

Ridgeline: *Seminova sample*, Average appearance, Average neck finish, Small & medium sized necks, Average skin thickness, Pretty good skin quality, Odd one with skin cracking, Odd skin and basal plate rot, Colour uneven, Good packer, Uniformity of shape uneven, Good firmness, Firmness uneven, Large run size uneven, Odd double onion, Mid-term storage onion.

Norstar: *Stokes sample*, Fair appearance, Great tight neck finish, Small sized necks, Thinner skins, Fair skin quality, Some skin cracking, Colour uneven, Some greening of scales, Average packer, Uniformity of shape a little uneven, Average firmness, Firmness a little uneven, Medium run size uneven, Early storage onion.

Ridgeline: Inicium *Seminova sample*, Average appearance, Good tight neck finish, Small to medium sized necks, Thicker skins, Pretty good skin quality, Odd one with skin cracking, Colour a little even, Odd one with white spots on skins, Average packer, Uniformity of shape a little uneven, Good firmness, Firmness a little uneven, Run size very uneven, Mid-term storage onion.

Trailblazer: Myco + Inicium *Seminova sample*, Nice appearance, Good tight neck finish, Small to medium sized necks, Average skin thickness, Pretty good skin quality, Odd one with skin cracking, Colour even, Odd one with white spots on skins, Nice packer, Uniformity of shape very even, Good firm onion, Firmness even, Small to medium run size uneven, Mid to long term storage onion.

Trailblazer: *Seminova sample*, Good appearance, Great tight neck finish, Small & medium sized necks, Average skin thickness, Pretty good skin quality, Odd one with skin cracking, Colour a little uneven, Odd one with white spots on skins, Odd one with greening of scales, Average packer, Uniformity of shape a little uneven, Nice firm solid onion, Firmness even, Small run size very uneven, Longer term storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2019 - continued

Cartier: *Bejo sample*, Good appearance, Great tight neck finish, Small sized necks, Average skin thickness, Nice skin quality, Colour a little even, Odd one with white spots on skins, Nice packer, Uniformity of shape even, Good firm onion, Firmness even, Small to medium run size very uneven, Long term storage onion.

Y 621: *Seminova sample*, Good appearance, Good tight neck finish, Small & medium sized necks, Average skin thickness, Pretty good skin quality, Colour a little even, Some with white spots on skins, Some with greening of scales, Average packer, Uniformity of shape uneven, Good firm onion, Firmness even, Small run size very uneven, Mid to longer term storage onion.

Trailblazer: *Seminova sample*, Good appearance, Great tight neck finish, Small to medium sized necks, Average skin thickness, Nice good skin quality, Colour very even, Odd one with yellowing or white spots on skins, Nice packer, Uniformity of shape even, Nice firm solid onion, Firmness even, Small run size uneven, Long term storage onion.

Inicium

E61L 10156: *Enza Zaden sample*, Poor appearance, Average tight neck finish, Neck finish a bit rough, Small & medium sized necks, Thicker skins, Fair skin quality, Some skin cracking, Colour a little uneven, Odd one white spots on skins, Okay packer, Uniformity of shape uneven, Good firm onion, Firmness even, Small run size uneven, Mid to long term storage onion.

Oneida: *Bejo sample*, Average appearance, Good tight neck finish, Medium sized necks, Average skin thickness, Pretty good skin quality, Odd one with skin cracking, Colour a little uneven, Odd one with white spots on skins, Okay packer, Uniformity of shape even, Average onion, Firmness a little uneven, Small run size, Run size uneven, Early to mid term storage onion.

E61L 10699: *Enza Zaden sample*, Average appearance, Good tight neck finish, Small sized necks, Average skin thickness, Average skin quality, Odd one with skin cracking, Colour a little even, Average packer, Uniformity of shape a little uneven, Average firmness, Small run size, Early to mid term storage onion.

LONG TERM AVERAGES OF ONION CULTIVAR TRIALS

Cultivar	Source	# Years Evaluated	Yeild B/A	% Marketable	% Jumbos <3"	Days to Maturity	Firmness In*	Firmness out*	Neck Finish	Score	% Onion Maggot Damage	# of Seeders	Leaf Length (cm)
HIGHLANDER	Tak	15	1055	86.2	13.8	92	8.5	5.9	9.3	6.22	3.8	0.0	55
ALPINE	Tak	11	1035	89.6	14.4	95	8.5	5.9	9.6	6.24	4.9	0.0	58
TREKKER	Tak	10	1099	92.8	9.2	100	9.7	8.2	7.5	7.47	3.4	0.0	61
NORSTAR	Tak	28	1079	91.2	12.5	102	8.2	5.9	8.6	6.34	4.2	0.0	59
PULSAR	BCSVS	7	1148	95.1	15.8	102	9.3	7.9	7.0	6.85	4.8	0.3	64
GENESIS	Cro	5	1047	88.9	11.0	103	9.4	7.7	7.1	6.67	4.5	0.3	70
SHERMAN	Bejo	8	1329	86.8	26.2	104	9.1	7.0	7.5	6.52	4.9	0.3	64
LA SALLE	Sem	11	1153	92.4	15.6	105	9.4	7.5	7.3	6.71	6.9	0.3	65
RICOCHET	Sem	9	1134	96.8	30.5	105	9.6	8.0	7.5	7.11	7.8	0.5	64
TRAILBLAZER	Tak	12	1118	91.6	16.2	105	9.7	8.2	8.0	7.42	4.5	0.0	64
ARSENAL	Sem	13	1232	97.6	15.0	106	9.6	8.1	7.6	7.16	5.2	1.7	64
FRONTIER	Tak	26	1147	94.1	10.2	106	9.8	8.1	8.0	7.60	4.3	0.0	63
MOUNTAINEER	Tak	9	1084	96.9	21.3	107	9.5	8.2	7.9	7.65	6.0	0.0	62
CORONA	Bejo	23	1230	86.6	20.0	108	9.5	7.1	7.1	6.26	5.8	0.0	65

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

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LONG TERM AVERAGES OF ONION CULTIVAR TRIALS - continued

Cultivar	Source	# Years Evaluated	Yeild B/A	% Marketable	% Jumbos <3"	Days to Maturity	Firmness In*	Firmness out*	Neck Finish	Score	% Onion Maggot Damage	# of Seeders	Leaf Length (cm)
TAHOE	Bejo	9	1214	95.0	20.0	108	9.6	8.2	7.1	7.32	6.5	1.9	66
PATTERSON	Bejo	13	1235	93.7	12.2	108	9.8	8.6	7.0	7.42	4.8	0.8	67
STANLEY	Sol	21	1203	92.4	18.1	111	9.8	8.4	6.5	7.13	4.7	0.9	65
POCONO	Sem	6	1234	92.1	22.2	111	9.6	7.4	7.0	6.62	6.7	0.1	70
BRADDOCK	Bejo	12	1269	91.0	16.9	111	9.5	7.5	6.5	6.83	2.5	0.6	66
MILESTONE	Tak	18	1344	96.0	24.6	111	9.5	7.4	6.6	7.15	4.5	0.1	64
FORTRESS	Sem	26	1079	95.5	10.1	112	9.7	7.9	6.8	7.34	3.6	1.3	64
HAMLET	Sem	23	1230	94.1	13.3	112	9.8	8.1	7.1	7.19	8.1	0.2	65
LIVINGSTON	Sol	14	1132	95.3	12.1	112	9.7	8.3	6.5	7.07	5.5	0.3	64
TALON	Bejo	7	1192	96.7	14.9	112	9.6	8.7	6.9	7.42	4.8	1.7	66
SAFRANE	Bejo	14	1270	93.6	21.7	114	9.8	8.4	6.7	7.21	3.0	2.9	66
INFINITY	BCSVS	9	1122	93.6	31.3	115	9.8	7.7	6.8	7.07	6.6	28.3	64
PRINCE	Bejo	24	1233	93.6	22.2	115	9.8	8.6	6.2	7.20	5.4	0.4	66
CROCKETT	Bejo	8	1270	91.6	18.5	118	9.9	8.6	5.3	6.99	6.1	1.7	71

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

MAIN ONION STORAGE TRIAL 2018 - 2019

Cultivar	Source	% Marketable	% Weight Loss	% Sprouts	% Rot	% Soft	Firmness In **	Firmness Out **	% Sprouting at Base	% Sprouting at Top
CROCKETT	Bejo	88.7 a*	8.7 d-i	0.7 a	0.8 de	0.2 d-g	10.0 a	7.0 abc	0.0 b	0.0 bc
FORTRESS	Sto	88.4 ab	8.7 e-j	1.5 b	0.5 cde	0.2 d-g	10.0 a	6.8 a-d	0.0 b	0.0 b
PATTERSON	Bejo	87.3 ab	8.2 c-h	1.8 bcd	0.9 de	0.9 efg	10.0 a	7.5 ab	0.0 a	0.0 a
SAFRANE	Bejo	87.3 ab	7.3 abc	3.4 d-g	0.1 ab	0.9 efg	10.0 a	6.7 b-e	0.3 bc	0.8 e-i
MILESTONE	Tak	84.4 ab	7.3 bc	1.7 bc	2.1 e	3.4 g	9.8 ab	5.3 g	0.0 b	0.2 b-e
POWELL	Bejo	84.4 ab	9.1 g-j	4.5 d-h	0.7 cde	0.1 c-f	10.0 a	6.8 a-d	1.3 de	1.7 f-i
LA SALLE	Sto	84.2 ab	6.5 a	2.4 cde	1.3 de	3.2 g	9.5 bc	6.7 b-e	1.0 cde	0.7 e-i
PROSPECTOR	Bejo	83.5 ab	10.5 ij	2.4 cde	3.1 e	0.1 c-g	9.7 ab	6.7 b-e	4.0 e	0.2 bcd
BRADDOCK	Bejo	83.5 ab	8.4 c-h	5.2 e-i	0.6 cde	1.5 g	9.2 c	6.3 c-f	1.0 cde	1.0 f-i
POCONO	Sem	83.4 ab	8.4 c-h	3.0 cde	1.0 de	3.3 g	9.5 bc	6.3 c-f	0.2 b	0.3 c-f
TREKKER	Tak	82.2 abc	8.5 c-i	6.8 f-j	1.0 de	0.7 efg	10.0 a	6.3 c-f	3.2 e	4.5 f-i
CATSKILL	Sem	80.4 a-d	7.5 b-f	9.1 g-j	1.0 de	1.2 fg	9.8 ab	5.8 efg	1.7 de	3.2 f-i
RIDGELINE	Tak	80.4 a-d	7.7 b-g	3.3 def	2.3 e	4.2 g	10.0 a	5.8 efg	0.3 bcd	0.5 d-g
TRAVERSE	Tak	80.2 a-e	8.5 c-i	6.1 e-i	1.4 de	2.7 g	9.5 bc	6.0 d-g	2.3 e	0.7 e-h
TRAILBLAZER	Tak	79.8 a-e	7.5 b-e	11.4 g-j	0.4 bcd	0.0 a	9.8 ab	7.7 a	6.7 e	5.3 ghi

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

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MAIN ONION STORAGE TRIAL 2018 - 2019 - continued

Cultivar	Source	% Marketable	% Weight Loss	% Sprouts	% Rot	% Soft	Firmness In **	Firmness Out **	% Sprouting at Base	% Sprouting at Top
SV NY 0046	Sem	79.1 a-f*	8.3 c-h	8.2 f-j	2.4 e	0.9 efg	10.0 a	6.5 c-f	3.7 e	3.7 f-i
CENTERSTONE	Tak	78.3 a-g	7.4 bcd	11.6 hij	0.7 cde	1.1 efg	9.7 ab	6.3 c-f	10.3 e	15.0 hi
CORONA	Bejo	77.9 b-g	6.9 ab	2.9 cde	4.2 e	7.4 g	10.0 a	5.7 fg	0.3 bcd	0.7 e-i
CARTIER	Bejo	72.5 c-h	9.5 g-j	16.9 ij	0.4 b-e	0.0 cde	9.8 ab	7.0 abc	25.0 e	11.7 hi
DAWSON	Bejo	71.1 d-h	8.7 e-j	19.0 ij	0.4 b-e	0.0 bc	9.8 ab	6.8 a-d	17.7 e	16.0 hi
ONEIDA	Bejo	69.8 e-h	9.9 hij	15.5 ij	2.0 e	2.0 g	9.2 c	6.3 c-f	7.7 e	6.7 hi
TRAILBLAZER C	SN	68.9 f-i	8.4 c-i	20.9 ij	0.8 de	0.0 cd	10.0 a	7.2 abc	17.7 e	13.0 hi
TRAILBLAZER A	SN	68.6 ghi	9.7 hij	18.9 ij	1.9 de	0.0 cde	9.7 ab	6.8 a-d	23.3 e	22.3 i
SADDLEBACK	Sem	66.9 hij	7.9 c-h	14.2 ij	4.8 e	5.2 g	9.8 ab	5.7 fg	2.5 e	8.0 hi
TRAILBLAZER B	SN	64.7 hij	9.0 f-j	23.6 j	0.8 de	0.8 efg	9.8 ab	0.0 c-f	29.0 e	30.0 i
FRONTIER	Tak	62.9 hij	9.6 hij	26.5 j	0.0 a	0.2 efg	6.0 ab	6.8 a-d	30.0 e	30.7 i
TRAILBLAZER D	SN	58.5 ij	8.1 c-h	18.7 ij	0.2 abc	0.0 b	10.0 ab	7.2 abc	11.3 e	17.7 i
SOHO	Nor	57.8 j	8.3 c-h	30.8 j	1.8 de	0.6 efg	9.7 ab	5.7 fg	28.3 e	33.3 i
HIGHLANDER	Tak	17.3 k	11.4 j	48.0 j	6.2 e	16.5 g	9.8 ab	4.0 h	71.7 e	78.3 i
Trial Averages		**74.9**	**8.5**	**11.7**	**1.5**	**2.0**	**9.7**	**6.2**	**10.4**	**10.6**

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

ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2018-2019

Crockett: *Bejo sample,* Very little top or root sprouts and just starting 0-1 cm, Internal & skin rot, Basal plates just starting & pushing out 20-60%, Fairly firm onion, Late storage onion, Stored nice.

Fortress: *Stokes sample,* Top sprouts just starting 0-1 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Odd internal rot, Basal plates just starting 20-30%, Fairly firm onion, Mid to late storage onion, Stored good.

Patterson: *Bejo sample,* Top sprouts just starting 0-1 cm, Majority internal rot, Some skin rot, Basal plates just starting & pushing out 15-50%, Firm onion, Late storage onion, Stored nice.

Safrane: *Bejo sample,* Top & root sprouts just starting 0-1 cm, A little skin rot, Basal plates just starting 20-75%, Fairly firm onion, Firmness slightly uneven onion, Mid to late storage onion, Stored good.

Milestone: *American Takii sample,* Top sprouts just starting 0-1 cm, Majority skin rot, A few internal rot, Basal plates pushing out 60-80%, Firmness slightly soft and uneven, Early to mid storage onion, Stored fair.

Powell: *Bejo sample,* Top & Root sprouts just starting 0-1 cm, Majority skin rot, Some internal rot, Basal plates just starting to push out 15-40%, Firmness slightly uneven, Mid to late storage onion, Stored good.

La Salle: *Stokes sample,* Top & root sprouts just starting 0-1 cm, Mostly skin rot, A few internal rot, Basal plates & pushing out 10-80%, Firmness uneven, Mid to late storage onion, Stored fair.

Prospector: *Bejo sample,* Top & root sprouts just starting 0-1 cm, Internal rot, Basal plates just starting 15-65%, Fairly firm onion, Late storage onion, Stored nice.

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ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2018-2019 -- continued

Braddock: *Bejo sample,* Top & Root sprouts just starting 0-1 cm, Internal & skin rot, Basal plates just starting to push out 10-50%, Okay firmness but uneven, Mid storage onion, Stored fair to good.

Pocono: *Seminis sample,* Top & Root sprouts just starting 0-1 cm, Mostly skin rot, Odd internal, Basal plates pushing out 25-80%, Okay firmness slightly uneven, Mid storage onion, Stored fair.

Trekker: *American Takii sample,* Top sprouts uneven 0-5 cm, Root sprouts just starting to light 0-1 cm, Mostly internal rot, Odd skin rot, Basal plates just starting to push out 10-15%, Fairly firm uneven but slightly uneven, Mid storage onion, Stored good.

Catskill: *Seminis sample,* Top & Root sprouts just starting 0-1 cm, Internal & skin rot, Basal plates just starting & pushing out 70-80%, Okay firmness but slightly uneven, Early to mid storage onion, Stored a little poor to fair.

Ridgeline: *American Takii sample,* Top sprouts just starting to moderate 0-2.5 cm, Root sprouts just starting 0-1 cm, Mostly skin rot, Odd internal rot, Basal plates just starting & pushing out 35-60%, Firmness slightly soft and uneven, Early to mid storage onion, Stored fair.

Traverse: *American Takii sample,* Top & Root sprouts just starting 0-1 cm, Majority skin rot, Odd internal rot, Basal plates just starting & pushing out 40-70%, Okay firmness, Firmness slightly uneven, Mid storage onion, Stored fair.

Trailblazer: *American Takii sample,* Top sprouts just starting to moderate 0-2.5 cm, Root sprouts just starting 0-1 cm, Internal & skin rot, Basal plates just starting 10-15%, Firm onions, Late storage onion, Stored nice.

SV NY 0046: *Seminis sample,* Top & Root sprouts just starting 0-1 cm, Majority skin rot, Some internal rot, Basal plates pushing out 30-40%, Firmness uneven, Mid storage onion, Stored good.

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ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2018-2019 -- continued

Centerstone: *American Takii sample,* Top sprouts just starting to moderate 0-2.5 cm, Root sprouts just starting 0-1 cm, Internal & skin rot, Basal plates just starting 10-20%, Okay firmness, Mid storage onion, Stored good .

Corona: *Bejo sample,* Top & root sprouts just starting 0-1 cm, Mostly skin rot, A few internal rot, Basal plates pushing out 40-70%, Firmness slightly soft and uneven, Early to mid storage onion, Stored a little poor to fair.

Cartier: *Bejo sample,* Top sprouts just starting to moderate 0-5 cm, Root sprouts just starting 0-1 cm, Internal rot, Basal plates just starting 15-50%, Fairly firm, Mid to late storage onion, Stored fair to nice.

Dawson: *Bejo sample,* Top & Root sprouts just starting 0-1 cm, Majority skin rot, Odd internal rot, Basal plates just starting & pushing out 40-75%, Fairly firm and slightly uneven, Mid to late storage onion, Stored good.

Oneida: *Bejo sample,* Top & Root sprouts just starting 0-1 cm, Mostly internal rot, Odd skin rot, Basal plates just starting 15-60%, Fairly firm and slightly uneven, Mid storage onion, Stored good.

Trailblazer C: *Seminova sample,* Top sprouts just starting to moderate 0-2.5 cm, Root sprouts just starting 0-1 cm, Skin & internal rot, Basal plates just starting 10-25%, Fairly firm onion, Mid to late storage onion, Stored good.

Trailblazer A: *Seminova sample,* Top sprouts light to moderate 0-2.5 cm, Root sprouts just starting 0-1 cm, Odd internal rot, Basal plates just starting 10-15%, Fairly firm onion, Mid storage onion, Stored good.

Saddleback: *Seminis sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, Mostly skin rot, Odd internal rot, Basal plates just starting to push out 25-40%, Okay firmness slightly uneven, Early to mid storage onion, Stored fair.

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ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2018-2019 -- continued

Trailblazer B: *Seminova sample,* Top sprouts just starting to moderate 0-2.5 cm, Top sprouts uneven, Root sprouts just starting 0-1 cm, Skin & internal rot, Basal plates just starting 15-30%, Okay firmness slightly uneven, Mid to late storage onion, Stored good.

Frontier: *American Takii sample,* Top sprouts just starting to moderate 0-5 cm, Top sprouts are a concern, Root sprouts just starting 0-1 cm, Basal plates just starting 25-60%, Fairly firm, Firmness slightly uneven, Mid storage onion, Stored good.

Trailblazer D: *Seminova sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, All internal rot, Basal plates just starting 20-50%, Fairly firm onion, Mid to late storage onion, Stored good.

Soho: *Norseco sample,* Top sprouts light to moderate 1-2.5cm, Top sprouts a little uneven, Root sprouts just starting 0-1 cm, Root sprouts are a concern, Mostly skin rot, Some internal rot, Basal plates pushing out 40-70%, Firmness slightly soft, Frimness uneven, Early storage onion, Stored a little poor.

Highlander: *American Takii sample,* Top sprouts heavy >5 cm, Top sprouts uneven, Root sprouts light to heavy 1-2.5 cm, Top & Root sprouts are a concern, Majority skin rot, A few internal rot, Basal plates just starting & pushing out 50-70%, Very soft onion, Not a storage onion, Stored poor.

LONG TERM AVERAGES OF ONION STORAGE TRIALS

CULTIVAR	SOURCE	# YEARS TESTED	% MARKETABLE	% WT LOSS IN STORAGE	% ROT, SOFT & SPROUT	FIRMNESS * IN	FIRMNESS * OUT
INFINITY	BCSVS	9	84.6	5.9	8.3	9.68	6.68
GENESIS	Cro	5	83.9	6.1	9.3	9.42	6.88
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	BCSVS	8	82.8	6.6	10.5	4.95	6.85
TAHOE	Bejo	9	82.8	5.0	11.9	9.70	7.68
TRAILBLAZER	Tak	11	82.4	5.3	11.5	9.70	7.53
LA SALLE	Sem	10	82.6	6.4	10.8	9.34	6.57
PATTERSON	Bejo	11	81.6	6.0	11.6	9.83	7.59
SCORPION	Cro	5	81.1	6.4	13.6	9.76	7.36
PULSAR	BCSVS	7	80.7	5.6	12.9	9.29	7.00
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
CHAMP	Sol	4	78.9	5.9	14.3	9.85	7.63
STANLEY	Sol	19	78.6	6.9	13.8	9.83	7.23
HAMLET	Sem	25	78.1	7.4	15.2	9.60	6.46
NEBULA	Nun	8	77.2	5.8	16.3	9.60	7.40
TREKKER	Tak	9	77.2	7.2	14.9	9.88	6.56
LIVINGSTON	Sol	13	76.1	6.9	13.8	9.70	6.90

Listed in order of % Marketable. Storage period approximately 11 months.

* 10.0 = Most Desirable, 8.0 = Good, 6.0 = Average

LONG TERM AVERAGES OF ONION STORAGE TRIALS - continued

CULTIVAR	SOURCE	# YEARS TESTED	% MARKETABLE	% WT LOSS IN STORAGE	% ROT, SOFT & SPROUT	FIRMNESS * IN	FIRMNESS * OUT
BRADDOCK	Bejo	14	75.8	6.5	17.4	9.48	6.74
FORTRESS	Sem	25	75.1	8.2	16.7	9.56	6.87
ARSENAL	Sem	13	74.7	7.0	18.7	9.65	6.02
PRINCE	Bejo	24	73.9	8.9	17.9	9.70	6.92
MOUNTAINEER	Tak	9	73.8	5.8	20.1	9.31	6.69
PARAGON	BCSVS	10	73.5	11.2	17.1	9.00	6.90
SAFRANE	Bejo	12	73.4	6.6	19.0	9.74	7.33
TAMARA	Bejo	9	71.9	9.9	21.8	9.85	6.75
POCONO	Sem	5	71.6	6.6	20.9	9.58	6.38
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
MILESTONE	Tak	17	70.3	6.4	22.5	9.55	5.86
CROCKETT	Bejo	7	68.5	7.7	23.0	9.93	7.51
FRONTIER	Tak	24	68.0	7.7	25.2	9.82	7.13
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
SEDONA	Bejo	4	58.6	6.8	33.8	9.73	7.10
RICOCHET	Sem	9	58.0	6.1	33.9	9.60	5.93
CORONA	Bejo	23	55.4	9.6	37.0	9.47	5.56
NORSTAR	Tak	27	51.5	9.9	40.3	8.23	4.69

Listed in order of % Marketable. Storage period approximately 11 months.

* 10.0 = Most Desirable, 8.0 = Good, 6.0 = Average

RED ONION CULTIVAR TRIAL SEASON SUMMARY – 2019

In the marsh, onion seeding in 2019 was very sporadic. Weather conditions did not allow for extend periods of ideal seeding conditions and this was true for onion transplanting too. Instead, over approximately the first twenty days of May, growers had to transplant onions when field and weather circumstances allowed. Compared to the previous 10-year average, air temperatures in 2019 were above average for July (22.3°C), average for June (17.5°C), August (19.4°C), September (15.8°C), and below average for May (11.4°C). The 10-year average temperatures were: May 14.3°C, June 18.4°C, July 21.1°C, August 20.2°C and September 16.4°C. Monthly rainfall was below the 10-year average for June (84 mm), July (42 mm), August (46 mm) and average for May (77 mm) and September (62 mm). The 10-year rainfall averages were: May 77 mm, June 100 mm, July 93 mm, August 80 mm and September 61 mm.

The cultivar trial was seeded, two seeds/cell, into 288-cell plugs trays filled with ASB soilless mixture on 18 & 19 March. The trays were placed on ebb & flow benches in the greenhouse with the daytime temperature set at 65°C and night-time temperature set at 68°C. The onion plants were clipped regularly to a height of 8 cm to promote sturdy plants. On 9 May the transplants were placed outside on a wagon to harden off. A tray drench of Pyrinex 480 EC at 1.6 mL/475 mL water per tray was applied on 13 May. Rain in late April followed by cool, cloudy weather into early May and an additional rainfall of approximately 32 mm in the first nine days of May created soil conditions that were less then satisfactory for transplanting, but the decision was made to go ahead and transplant even in these less then favourable circumstances. Transplanting on 14 May was 7 days later from what would be standard.

For the first two weeks after transplanting daytime air temperatures fluctuated from the mid-teens to the low twenties and night air temperatures fluctuated from 1.5-11°C. The transplants established slowly and plant vigor was poor. By 29 May root growth was extending outside the plug zone and the herbicide Prowl was applied at the recommended rate. A heavy weed flush occurred in early June and the trial was sprayed twice with a Goal and Pardner mix. A heavy flush of grasses occurred in mid June and an application of Select and Amigo was applied on 21 June. Weed flushes remained a problem throughout the entire season. The trial was hand-weeded several times to keep it free from weeds. For the first half of June, onion growth was slow, but steady and growth remained satisfactory for the rest of June and July, although leaf size and density were less then expected. There were significant differences in leaf length between the first replicate and replicates two and three. The first replicate had the shortest leaf lengths.

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RED ONION CULTIVAR TRIAL SEASON SUMMARY - 2019 – continued

On station, onion maggot fly emergence monitoring began on 21 May. Throughout the entire monitoring period onion maggot fly counts never reached above 1.7 flies/trap/day. This was the third year in a row that onion maggot numbers never reached over 2 flies/trap/day. Low onion maggot counts appeared to be positively correlated to low onion maggot damage in the variety trial and at evaluation were there was only 1.5 percent damage. Thrips were present from late July through August. Onion thrips numbers in the cultivar trial reached a high of 1.8 thrips/leaf on 6 August. The combination of irrigation (1") on 7 August plus the application of the insecticide Delegate on 9 August reduced the population to only 0.12 thrips/leaf when scouted on 13 August. A second irrigation (1") on 15 August and an Agri-Mek application on 16 August kept thrips numbers below the spray threshold of 1 thrips/leaf until onions were fully lodged.

Stemphylium leaf blight was found in the cultivar trial in early July and several fungicide applications (see Onion Management Procedures) were applied and this kept Stemphylium severity low. Cultivar Monastrell had the highest Stemphylium severity of all the cultivars. Two timely fungicide applications to control downy mildew kept the disease from establishing in the cultivar trial. No onions with bacterial rot were found in the variety trial.

Bulb development started in mid July. Most bulb sizing occurred in early August. Cultivars Monastrell and Red Spring were the first to lodge starting on 22 July. By 16 August two thirds of the cultivars had reached full maturity after three weeks when at least 85% of the onions had lodged. The average days to harvest for the 2019 season was 90 days from transplant when at this time onion tops were 85% lodged. This was three days longer then for the 2018 season. The first replicate of onions matured significantly sooner then the other two replicates. The onion tops dried down in a satisfactory time frame. No seeders were found. A sample from each cultivar was pulled for judging and comparison for Grower Field Day on 5 September. By this time, most cultivars had lodged, but were only 60-100% desiccated. All cultivars had matured naturally resulting in a good neck finish when yield samples were harvested on 25 September. Harvest samples from each cultivar were placed in storage on 29 October and were cured artificially for approximately 48 hours.

At evaluation on 26 & 27 November and 2 December, quality & yields were found to be good. Half the cultivars had the majority of bulbs in the >3" size ranges. Cultivars Red Wing, Red Carpet, Red Hawk and SV 4643 had the most bulbs in the >3" size

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ranges. Even though half the onions had bulb sizes less then 3", the average yield of 1230 bu/A was 100 bu/A more than the yield in 2018 and was 400 bu/A more than in 2017. Yield for the first replicate was significantly lower than for the other two replicates. The percentage of jumbos (>3" diameter) was 51%. This is up by 3% from 2018. Cultivar Red Nugent, Red Hawk and SV 4643 had the highest number of bulbs >3½". Uniformity of shape was variable and many had an elongated shape. Uniformity of size was variable, with some cultivars receiving a good rating while others a poor rating.

Eight of the 13 cultivars evaluated had a very respectable percent marketable of 97% or greater, and the average percent marketable for all cultivars was 93%. The type of culls were equally split between rot and doubles. Skin quality varied among cultivars. Most cultivars had good skin attachment, but some skin cracking was observed. Exterior colour was dark and rich on most varieties. Most cultivars had a very low incidence of skin blemishes. Interior ring colour was good with only the dead center of the onions lacking ring colour. When onions were cut in half for interior colour evaluation, it was noted that all cultivars had lower percentages of double or multiple centers compared to 2018. The red cultivars appeared to have a higher percentage of small hollow centers then the yellow cultivars. There was limited mechanical damage found in all cultivars. Neck finishes were dry and tight and scored well. This confirmed that the onions had matured naturally by the harvest date. When evaluated for firmness in November, onions were found to be a little softer than desired. Maggot damage to onion bulbs in the evaluation samples was minimal, ranging from 0-3.5% with a trial average of 1.5%. This is almost identical to the onion maggot damage in 2018.

RED ONION TRANSPLANT CULTIVAR TRIAL – 2019

MANAGEMENT PROCEDURES

Seeded:

On 18 & 19 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 50 ppm 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 (Calcium Ammonium Nitrate 27-0-0) + 100 kg/ha Phosphorous (MESZ 10-40-0) + 200 kg/ha Potassium (ASPIRE 0-0-58) + 100 kg/ha K–Mag (0-0-22) + 35 kg/ha Manganese + 5 kg/ha Copper (99% Cu) was worked into the soil.

A side dressing blend of 12 kg/ha Nitrogen + 12 kg/ha Potassium + 6 kg/ha Manganese + 2.5 kg/ha Calcium + 13.6 kg/ha Sulphur was applied on 17 July.

Transplanted:

Three replications were planted in the field on 14 May at a spacing of 43 cm (row) and 12 cm (plant) apart.
A tray drench of Pyrinex 480 EC was applied at 1.6 ml product per 475 ml water per tray 5 days before transplanting on 10 May.

Weed Control:

1 application: **PARDNER** at 310 ml/ha and Manganese at 2.0 kg/ha on 20 May.
1 application: **PROWL H20** at 6.0 L/ha on 29 May
1 application: **PARDNER** at 140 ml/ha and **GOAL** at 210 ml/ha and Manganese at 2.0 kg/ha on 7 June.
1 application: **PARDNER** at 100 ml/ha and **GOAL** at 100 ml/ha and Manganese at 2.0 kg/ha on 12 June.
1 application: **SELECT** at 375 ml/ha and **AMIGO** at 1.5 L/ha on 21 June.
1 application: **PARDNER** at 140 ml/ha and **GOAL** at 140 ml/ha and Manganese at 2.0 kg/ha on 26 June.

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RED ONION TRANSPLANT CULTIVAR TRIAL – 2019 - continued

Minor Elements:

Eight foliar sprays: Mag Max on 16 June (2.0 L/ha), 28 June, 4, 10, 16, 22 and 31 July & 9 August (3.0 L/ha)
Eight foliar sprays: Calcimax on 16 June (2.0 L/ha), 28 June, 10, 16, 22 and 31 July, 9 & 16 August (3.0 L/ha)
Seven foliar sprays: Manganese Sulfate on 9 August (1.0 kg/ha), 16 & 28 June, 16 & 31 July (2.0 kg/ha) and 4 & 22 July (3.0 kg/ha)
Six foliar sprays: Alexin on 4, 22 & 31 July and 9, 16 & 23 August (3.0 L/ha)
Five foliar sprays: Suprafeed on 22 & 31 July and 9 & 16 August (3.0 kg/ha) and 23 August (4.0 kg/ha)
Five foliar sprays: 20-20-20 on 16 & 28 June and 4, 10 & 16 July (3.0 kg/ha)
Four foliar sprays: Zinc Max on 28 June (1.0 L/ha), 16 June and 9 August (2.0 L/ha), and 31 July (3.0L/ha)
Three foliar sprays: TruPhos on 28 June, 4 & 16 July (3.0 L/ha)
Two foliar sprays: Mancozin on 10 July (3.0 L/ha) and 16 August (4.0 L/ha)
Two foliar sprays: Epsom Salt on 23 August (1.5 kg/ha) and 16 August (3.0 kg/ha)
Two foliar sprays: Nutri Bor on 16 August (1.0 L/ha) and 23 August (1.5 L/ha)
One foliar spray: Copper Max on 22 July (1.0 L/ha)

Insect and Disease Control:

According to IPM recommendations.

PRISTINE at 1.3 kg/ha + Minor Elements on 28 June.
LUNA TRANQUILITY at 1.2 L/ha on 4 July.
DITHANE DG at 2.25 kg/ha + **LUNA TRANQUILITY** at 1.2 L/ha and Minor Elements on 10 July.
SERCADIS at 666 ml/ha + **UP-CYDE** at 280 ml/ha and Minor Elements on 22 July.
MOVENTO at 365 ml/ha + **SYLGARD** at 0.002% solution on 26 July.
QUADRIS TOP at 1.0 L/ha + **RIDOMIL MZ** 2.25 kg/ha + **MATADOR** at 188 ml/ha on 31 July.
MOVENTO at 365 ml/ha + **SYLGARD** at 0.002% solution on 2 August.
QUADRIS TOP at 1.0 L/ha + **DELEGATE** at 336 g/ha and Minor Elements on 9 August.
QUADRIS TOP at 1.0 L/ha + **RIDOMIL MZ** at 2.25 kg/ha + **AGRI-MEK SC** at 175 ml/ha and Minor Elements on 16 August.
DITHANE DG at 3.0 kg/ha and Minor Elements on 23 August.

Harvest:

The trial was pulled on 9 September and topped on 25 September. The trial was placed in a forced air and temperature controlled storage 29 October. The trial was cured for 48 hours (25ºC, minimum 65% RH). After curing the temperature was lowered 5ºC per week until 0ºC was attained.

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RED ONION TRANSPLANT CULTIVAR TRIAL – 2019 - continued

Sprout Inhibition:

Royal MH 30 XTRA at 8.63 L/ha in 550 L/ha water on 19 & 23 August.

August 19			August 23			
Red Bull	Red Mountain	Red Hawk	Rubillion	Monastrell	Red Spring	Red Nugent
Red Carpet	Red Wing	Ruby Ring	SV 4643	Blush	Red Sky	

EVALUATION PROCEDURES

The cultivars were evaluated 26-27 November and 2 December after 4 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 2½") and 64 mm to 32 mm (2½" 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

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

Neck Finish:

10.0 = Most Desirable, small tight neck 6.0 = Average, neck closed 4.0 = Poor, neck bit rough and open

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RED ONION TRANSPLANT CULTIVAR TRIAL - 2019 - continued

Overall Score:
Based on quality and general appearance.

Score:
The average of nine marks at evaluation from Uniformity of Shape to Firmness.

Firmness:
10 = Desirable solid and firm 6.0 = Average firm but some elasticity 1.0 = Poor spongy

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.

% Single Centers:
Percentage of onions with only one heart

% Double Centers:
Percentage of onions with two hearts

% Mutiple Centers:
Percentage of onions with three or more hearts

Interior & Exterior Colour:
LR = Light Red R = Red DR = Dark Red DDR = Deep Dark Red

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RED ONION TRANSPLANT CULTIVAR TRIAL - 2019 - 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 9 July.
50 cm is equal to 20 inches.

Leaf Shape:

B = Leaves are bent or hanging U = Up right leaves, straight

Leaf Colour:

LG = Light Green, G = Green, BG = Blue Green, DG = Dark Green

Irrigation:

Irrigation water was applied five times for the 2019 season:

8 July in the amount of 1 ½ inches
17 July in the amount of 5/8 inch
25 July in the amount of 1 inch
7 August in the amount of 1 inch
15 August in the amount of 1 inch

RED ONION TRANSPLANT CULTIVAR TRIAL - 2019

Cultivar	Source	# Bulbs Harvested	# Bulbs Jumbos > 100 mm	# Bulbs X-Large 89 -100 mm	# Bulbs Large 76 - 89 mm	# Bulbs Medium 64 - 76 mm	# Bulbs Small 32 - 64 mm	Stand/Foot
RED CARPET	BEJO	82 a*	0 a	6 de	43 ab	28 bc	4 b-e	5.3 a
RED MOUNTAIN	BEJO	78 a	0 a	5 de	34 bcd	33 ab	6 a-e	5.1 a
RED WING	BEJO	77 a	0 a	6 de	49 a	19 cde	2 de	5.0 a
RED SKY	BEJO	79 a	0 a	3 de	22 de	43 a	9 abc	5.2 a
RED BULL	BEJO	76 a	0 a	7 cde	30 b-e	27 bcd	11 ab	5.0 a
RUBY RING	Tak	75 a	0 a	0 e	18 e	42 a	13 a	4.9 a
RED HAWK	BEJO	73 a	1 a	15 ab	43 ab	12 e	1 e	4.8 a
BLUSH	BEJO	78 a	0 a	4 de	37 abc	26 bcd	9 a-d	5.1 a
SV 4643	Sto	80 a	1 a	14 abc	42 ab	16 de	3 cde	5.2 a
RUBILLION	Tak	79 a	0 a	1 de	24 cde	37 ab	13 a	5.1 a
RED NUGENT	Sto	76 a	2 a	18 a	34 bcd	15 de	4 b-e	5.0 a
MONASTRELL	EZ	80 a	0 a	5 de	20 e	28 bc	13 a	5.2 a
RED SPRING	BEJO	81 a	1 a	8 bcd	27 cde	12 e	1 e	5.3 a
Trial Average		**78**	**0**	**7**	**32**	**26**	**7**	**5.1**

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.

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RED ONION TRANSPLANT CULTIVAR TRIAL - 2019 - continued

Cultivar	Source	Total Harvest Weight (kg)	Wgt. Jumbo > 89 mm (kg)	Wgt. Large 76-89 mm (kg)	Wgt. Medium 76-64 mm (kg)	Wgt. Small 64-32 mm (kg)	Marketable Yield B/A	% Marketable	Majority of Culls
RED CARPET	BEJO	18.45 bcd*	2.11 cde	10.49 abc	5.24 bc	0.46 cd	1380 bcd	98.8 a	R
RED MOUNTAIN	BEJO	17.77 cde	1.60 cde	9.03 bcd	6.35 ab	0.71 a-d	1333 b-e	98.7 a	D/R
RED WING	BEJO	19.69 abc	1.93 cde	13.42 a	3.79 c-f	0.29 d	1464 abc	98.3 a	D/R
RED SKY	BEJO	15.43 efg	1.15 cde	5.45 ef	7.57 a	1.06 abc	1148 ef	97.9 a	PW
RED BULL	BEJO	15.97 def	2.37 cd	7.64 cc-f	4.69 bcd	1.08 abc	1190 de	97.8 a	R
RUBY RING	Tak	13.27 gh	0.00 e	4.37 f	7.32 a	1.28 a	978 fg	97.8 a	D/R
RED HAWK	BEJO	19.54 abc	5.20 b	11.72 ab	2.18 ef	0.13 d	1450 abc	97.7 a	D
BLUSH	BEJO	17.61 cde	1.41 cde	10.04 bc	4.82 bcd	1.03 abc	1304 cde	97.4 a	PW/D
SV 4643	Sto	20.77 ab	5.15 b	11.33 ab	3.14 def	0.39 cd	1509 ab	95.8 a	D/R
RUBILLION	Tak	13.63 fgh	0.23 de	5.62 ef	6.28 ab	1.08 abc	996 fg	95.8 a	D
RED NUGENT	Sto	22.10 a	9.60 a	7.82 cde	3.05 def	0.52 bcd	1582 a	95.2 a	D
MONASTRELL	EZ	12.87 h	1.46 cde	4.48 ef	4.21 cde	1.16 ab	852 g	82.8 b	D/R
RED SPRING	BEJO	18.39 bcd	2.51 c	6.19 def	1.86 f	0.15 d	808 g	59.4 c	SP
Trial Average		**17.35**	**2.67**	**8.28**	**4.65**	**0.72**	**1230**	**93.3**	

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.

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RED ONION TRANSPLANT CULTIVAR TRIAL - 2019 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Skin Thickness	Skin Attachment	Neck Finish	Overall Score	Score
RED CARPET	BEJO	SPG	6.0 abc	8.0 ab	7.7 a	9.2 ab	6.7 cd	7.3 a	7.28 ab
RED MOUNTAIN	BEJO	HG	5.7 bcd	6.7 a-e	7.3 ab	8.7 bc	7.7 bc	7.3 a	7.33 ab
RED WING	BEJO	MIX	7.0 ab	8.3 a	7.0 abc	9.0 ab	6.7 cd	7.7 a	7.59 a
RED SKY	BEJO	G	5.3 cdd	7.0 a-e	6.0 c	5.7 d	7.7 bc	5.7 cd	6.56 cde
RED BULL	BEJO	SPG	6.7 abc	6.0 cde	6.7 abc	7.7 c	7.0 cd	6.3 bc	6.59 cde
RUBY RING	Tak	TD	6.7 abc	7.0 a-e	7.0 abc	5.3 d	6.7 cd	5.7 cd	6.48 c-f
RED HAWK	BEJO	G	7.3 a	8.0 ab	6.0 c	7.7 c	6.3 d	7.0 ab	7.09 abc
BLUSH	BEJO	HG	6.0 abc	6.7 a-e	7.7 a	9.8 a	7.7 bc	7.2 ab	7.30 ab
SV 4643	Sto	TOP	6.0 abc	7.7 abc	6.3 bc	6.3 d	6.7 cd	6.3 bc	6.35 def
RUBILLION	Tak	TD	6.3 abc	6.3 b-e	7.3 ab	6.3 d	8.7 ab	6.0 cd	6.89 bcd
RED NUGENT	Sto	SPG	4.3 d	5.7 de	6.3 bc	6.3 d	6.7 cd	5.3 d	5.89 f
MONASTRELL	EZ	FG	6.0 abc	5.3 e	6.3 bc	2.7 e	9.3 a	3.7 e	6.26 def
RED SPRING	BEJO	SPG	5.7 bcd	7.3 a-d	6.0 c	3.0 e	8.7 ab	3.0 e	6.19 ef
Trial Average			**6.1**	**6.9**	**6.7**	**6.7**	**7.4**	**6.0**	**6.75**

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.

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RED ONION TRANSPLANT CULTIVAR TRIAL - 2019 - continued

Cultivar	Source	Firmness at Harvest	Firmness at Evaluation	Interior Colour	Interior Colour Rating	Exterior Colour	Exterior Colour Rating	Days to Harvest	% Onion Maggot Damage	Average Weight/Bulb (g)
RED CARPET	BEJO	10.0 a*	7.7 ab	R	5.7 de	DR	7.3 a	100 b	1.3 a	225.2 c
RED MOUNTAIN	BEJO	10.0 a	7.3 bc	R	8.0 ab	DR	7.3 a	95 c	1.7 a	226.6 c
RED WING	BEJO	10.0 a	8.3 a	R	6.7 cd	DR	7.7 a	108 a	0.4 a	255.8 b
RED SKY	BEJO	9.3 b	6.7 cd	R	7.7 abc	R	7.3 a	80 f	1.3 a	195.2 de
RED BULL	BEJO	9.7 ab	6.7 cd	DR	7.0 bc	R	5.3 b	96 c	0.4 a	209.9 cd
RUBY RING	Tak	9.8 a	6.3 d	DR	7.3 bc	R	6.3 ab	95 c	3.5 a	177.0 ef
RED HAWK	BEJO	9.3 b	6.5 cd	R	7.3 bc	DR	7.7 a	93 cd	1.8 a	265.6 ab
BLUSH	BEJO	10.0 a	7.3 bc	LR	5.7 de	PR	7.7 a	89 de	1.7 a	226.0 c
SV 4643	Sto	9.7 ab	6.8 bcd	R	4.7 e	R	6.3 ab	90 de	1.7 a	259.8 b
RUBILLION	Tak	9.3 b	6.3 d	R	7.7 abc	R	7.0 a	87 e	1.7 a	173.3 ef
RED NUGENT	Sto	9.3 b	6.3 d	R	6.7 cd	DR	5.3 b	90 de	1.7 a	289.7 a
MONASTRELL	EZ	9.7 ab	6.7 cd	DR	8.7 a	DR	7.7 a	77 fg	2.1 a	162.0 f
RED SPRING	BEJO	8.7 c	6.3 d	R	8.0 ab	DR	7.7 a	74 g	0.0 a	226.0 c
Trial Average		**9.6**	**6.9**		**7.0**		**7.0**	**90**	**1.5**	**222.5**

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.

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RED ONION TRANSPLANT CULTIVAR TRIAL - 2019 - continued

Cultivar	Source	Seeders	Percent Single Centres	Percent Double Centers	Percent Multiple Centers	% Jumbo > 101 mm	% Jumbo > 90 - 101 mm	% Jumbo > 76 - 90 mm	Top Heights (cm)	Leaf Shape	Leaf Colour
RED CARPET	BEJO	0.0 a	40.0 ab	60.0 a	0.0 a	0.0 a	7.3 c	52.2 abc	70.4 abc	B	LG
RED MOUNTAIN	BEJO	0.0 a	20.0 a-d	70.0 a	6.7 ab	0.0 a	6.0 c	43.0 b-e	66.2 de	U	LG
RED WING	BEJO	0.0 a	43.3 a	53.3 a	3.3 a	0.0 a	7.4 c	63.6 a	72.0 a	B	G
RED SKY	BEJO	0.0 a	20.0 a-d	60.0 a	20.0 bc	0.0 a	4.2 c	27.8 ef	71.0 ab	B	G
RED BULL	BEJO	0.0 a	30.0 abc	70.0 a	0.0 a	0.4 a	8.8 bc	39.0 c-f	67.1 cde	U	G
RUBY RING	Tak	0.0 a	30.0 abc	70.0 a	0.0 a	0.0 a	0.0 c	24.0 f	64.8 e	U	BG
RED HAWK	BEJO	0.0 a	30.0 abc	63.3 a	6.7 ab	1.8 a	20.0 a	58.6 ab	72.4 a	B	G
BLUSH	BEJO	0.0 a	6.7 cd	93.3 a	0.0 a	0.0 a	5.1 c	47.0 bcd	68.4 bcd	B	LG
SV 4643	Sto	0.0 a	40.0 ab	60.0 a	0.0 a	1.7 a	17.5 ab	52.5 abc	72.3 a	U	LG
RUBILLION	Tak	0.0 a	13.3 cd	66.7 a	20.0 bc	0.0 a	0.8 c	30.9 def	67.1 cde	U	BG
RED NUGENT	Sto	0.0 a	6.7 cd	63.3 a	30.0 c	2.6 a	23.1 a	44.1 b-e	72.7 a	B	LG
MONASTRELL	EZ	0.0 a	16.7 bcd	80.0 a	3.3 a	0.0 a	5.9 c	25.1 f	64.9 e	U	LG
RED SPRING	BEJO	0.0 a	0.0 d	40.0 a	60.0 d	0.8 a	9.8 bc	32.8 def	67.3 cde	B	BG
Trial Average		**0.0**	**22.8**	**65.4**	**11.5**	**0.6**	**8.9**	**41.6**	**69.0**		

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.

RED ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2019

Red Carpet: *Bejo sample,* Good to nice appearance, Average tight neck finish, Some neck finishes a bit rough, Medium neck size, Thicker skins, Pretty good skin quality, Odd one with skin cracking, Dark exterior colour even, Odd one with brown or white spots on skins, Interior colour uneven, Dead centers white, Good packer, Uniformity of shape a little uneven, Good firm onion, Firmness even, Medium run size, Run size uneven, Small hollowness in center (30-50%), Longer term storage onion.

Red Mountain: *Bejo sample,* Good appearance, Good tight neck finish, Small & medium neck sizes, Average skin thickness, Pretty good skin quality, Odd one with skin cracking, Exterior colour a little uneven, Odd one with brown or white spots on skins, Interior colour even, Dead centers white, Good packer, Uniformity of shape uneven, Good firm onion, Firmness even, Medium run size, Run size a little even, Small hollowness in center (20-30%), Mid-term storage onion.

Red Wing: *Bejo sample,* Nice appearance, Average but tight neck finish, Necks a bit rough, Medium sized necks, Thicker skin, Nice skin quality, Odd one with skin cracking, Darker exterior colour even, Some with white spots on skins, Interior colour average, Dead centers white, Good packer, Uniformity of shape uneven, Good firm solid onion, Firmness even, Medium to large run size, Run size even, Small hollowness in center (40-80%), Longer term storage onion.

Red Sky: *Bejo sample,* Average appearance, Good tight neck finish, Small medium sized necks, Thinner skin, Poor skin quality, A lot with skin cracking a concern, Exterior colour fairly even, Nice interior colour even, Dead centers white, Okay packer, Uniformity of shape uneven, Average firmness, Firmness uneven, Medium run size, Run size uneven, Small hollowness in center (40%), Early term storage onion.

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RED ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2019 continued

Red Bull: *Bejo sample,* Average appearance, Good tight neck finish, Small & medium sized necks, Average skin thickness, Average skin quality, Some with skin cracking, A few with basal plate rot, Exterior colour uneven, Odd one with white spots on skin, Interior colour uneven, Dead centers white, Average to good packer, Uniformity of shape a little uneven, Average firmness, Firmness a little uneven, Medium run size, Run size uneven, Small hollowness in center (20-50%), Mid-term storage onion.

Ruby Ring: *American Takii sample,* Fair appearance, Average tight neck finish, Neck finish a bit rough, Small & medium sized necks, Average skin thickness, Fair skin quality, A lot of skin cracking a concern, Exterior colour uneven, Odd one with brown spots on skins, Dark interior colour even, Dead centers white, Average to good packer, Uniformity of shape a little even, Average firmness, Firmness a little uneven, Small to medium run size, Run size a little uneven, Small hollowness in center (20-70%), Early to mid-term storage onion.

Red Hawk: *Bejo sample,* Good appearance, Average tight neck finish, Neck finish bit rough, Medium sized necks, Average skin thickness, Average skin quality, Odd one with skin cracking, Dark exterior colour even, Interior colour uneven, Dead centers yellow, Good packer, Uniformity of shape a little even, Average firmness even, Medium to large run size, Run size even, Small hollowness in center (40%), Mid-term storage onion.

Blush: *Bejo sample,* Good appearance, Good tight neck finish, Small & medium sized necks, Thicker skin, Nice skin quality, Pinkish exterior colour even, Odd one with brown spots on skin, Interior colour a pale, Interior colour a little uneven, Dead centers white, Nice packer, Uniformity of shape uneven, Good firm solid onion, Firmness even, Medium run size, Run size even, Small hollowness in center (30-60%), Longer term storage onion.

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RED ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2019 continued

SV 4643: *Stokes sample,* Average appearance, Average tight neck finish, Some necks a bit rough, Medium sized necks, Average skin thickness, Fair to average skin quality, Some with skin cracking a concern, Exterior colour a little uneven, Odd one with white or brown spots on skins, Interior colour uneven, Centers white, Okay packer, Uniformity of shape uneven, Good firmness, Firmness a little uneven, Large run size, Run size even, Small hollowness in center (60-90%), Early to mid-term storage onion.

Rubillion: *American Takii sample* , Fair appearance, Great tight neck finish, Small sized necks, Thinner skins, Poor to fair skin quality, Some skin cracking a concern, Exterior colour a little even, Odd one with brown spots on skins, Good interior colour even, Dead centers yellow, Okay packer, Uniformity of shape a little uneven, Average firmness, Firmness uneven, Small to medium run size, Run size a little uneven, Small hollowness in center (10-30%), Early term storage onion.

Red Nugent: *Stokes sample,* Fair appearance, Good tight neck finish, Medium sized necks, Average skin thickness, Average skin quality, Some skin cracking a concern, Exterior colour uneven, Odd one with brown or white spots on skins, Interior colour uneven, Dead centers white, Okay packer, Uniformity of shape very uneven, Average firmness, Firmness uneven, X-large run size, Run size a little uneven, Small hollowness in center (60-80%), Odd double onion, Early to mid-term storage onion.

Monastrell: *Enza Zaden sample,* Poor appearance, Great tight neck finish, Very small sized necks, Thinner skin, Very poor skin quality, Most with skin cracking a concern, Skin rot a concern, Dark exterior colour even, Odd one with brown spots on skins, Nice dark interior colour even, Dead centers yellow or white, Poor packer, Uniformity of shape uneven, Average firmness, Firmness even, Run size very uneven, Odd one with mechanical damage, Suspicion of doubles, Small hollowness in center (20-40%), Early to mid-term storage onion.

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RED ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2019 continued

Red Spring: *Bejo sample,* Very poor rough appearance, Great tight neck finish, Very small sized necks, Thinner skin, Very poor skin quality, Most have skin cracking a big concern, Skin rot a concern, Darker exterior colour even, Odd one with brown spots on skins, Good interior even, Colour bleeds between rings when cut, Dead centers white, Poor packer, Uniformity of shape uneven, Average firmness, Firmness a little uneven, Small to medium run size, Run size uneven, A lot of mechanical damage a concern, Suspicion of doubles a concern, Early term storage onion.

MAIN RED ONION STORAGE TRIAL 2018 - 2019

Cultivar	Source	% Marketable	% Weight Loss	% Sprouts	% Rot	% Soft	Firmness In **	Firmness Out **	% Sprouting at Base	% Sprouting at Top
BGS 335	Bejo	50.1 a*	6.1 b	39.4 ab	3.7 bcd	0.0 b	9.2 bcd	7.2 ab	42.3 a	2.0 a
RED CARPET	Bejo	43.3 a	6.6 c	45.4 ab	4.0 bcd	0.0 b	10.0 a	7.0 ab	53.3 a	15.7 cd
RED WING	Bejo	42.9 a	7.0 cd	46.0 bc	2.9 bc	0.6 b	10.0 a	5.2 ab	53.3 a	1.0 a
RED BULL	Bejo	37.9 ab	6.8 cd	49.6 cd	5.0 bcd	0.3 b	10.0 a	6.8 ab	60.0 ab	8.3 bc
RED NUGENT	Sem	37.3 ab	8.8 de	29.6 a	20.3 d	3.5 b	9.0 cd	5.0 ab	31.7 a	21.7 cd
BLUSH	Bejo	28.5 bc	7.2 cd	61.8 cd	2.1 bc	0.0 b	10.0 a	7.7 a	76.7 ab	2.2 b
RED HAWK	Bejo	25.0 bc	8.1 de	62.1 cde	4.4 bcd	0.0 b	8.7 de	6.2 ab	81.7 bcd	41.7 d
SV 4643	Sto	19.8 c	7.9 cd	63.6 cde	5.2 bcd	3.1 b	9.7 ab	6.3 ab	80.0 ab	53.33 e
RUBY RING	Tak	19.8 c	9.7 de	63.7 def	6.3 cd	0.0 a	9.7 ab	6.3 ab	81.7 abc	70.0 ef
RUBILLION	Tak	3.3 d	8.1 cde	86.5 fg	2.0 bc	0.0 a	9.2 bcd	6.3 ab	93.33 cde	75.0 ef
RED SKY	Bejo	2.7 d	5.0 a	91.9 g	0.2 a	0.0 b	9.5 abc	5.8 ab	98.8 de	54.3 ef
MONASTRELL	EZ	0.3 d	15.3 de	82.9 fg	1.2 b	0.0 b	9.3 bc	4.3 bc	99.3 e	95.0 ef
RED SPRING	Bejo	0.0 d	19.1 e	74.8 ef	5.6 bcd	0.0 b	8.3 e	1.7 c	95.7 cde	96.3 f
Trial Average		**23.9**	**8.9**	**61.3**	**4.8**	**0.6**	**9.4**	**5.8**	**72.9**	**41.3**

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 CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2018-2019

BGS 335: *Bejo sample*, Top & Root sprouts just starting 0-1cm, Mostly skin rot, A few internal rot, Basal plates just starting to push out 10-35%, Fairly firm slightly uneven, Mid to late storage onion, Stored good.

Red Carpet: *Bejo sample*, Top & Root sprouts just starting 0-1cm, Mostly internal rot, A few skin rot, Basal plates just starting & pushing out 10-60%, Fairly firm onion, Firmness slightly uneven, Mid to late storage onion, Stored good.

Red Wing: *Bejo sample*, Top & Root sprouts just starting 0-1 cm, Root sprouts are a concern, Mostly skin rot, Some internal rot, Basal plates just starting & pushing out 25-40%, Firm onion, Firmness slightly uneven, Late storage onion, Stored good.

Red Bull: *Bejo sample*, Top sprouts just starting 0-1cm, Root sprouts just starting to light 0-2.5cm, Root sprouts are a concern, Mostly skin rot, A few internal rot, Rot is a slight concern, Basal plates just starting & pushing out 25-60%, Firmness uneven, Mid to late storage onion, Stored fair.

Red Nugent: *Seminis sample*, Top sprouts just starting to moderate 0-2.5cm, Root sprouts just starting to light 0-2.5cm, Majority skin rot, Odd internal rot, Basal plates just starting to push out 15-25%, Softer onion, Firmness uneven, Early storage onion, Stored a little poor.

Blush: *Bejo sample*, Top sprouts just starting to moderate 0-2.5cm, Root sprouts moderate 1-2.5cm, Root sprouts are a concern, Mostly skin rot, Odd internal rot, Basal plates just starting & pushing out 35-90%, Fairly firm, Firmness a little uneven, Mid-term storage onion, Stored good.

Red Hawk: *Bejo sample*, Top & Root sprouts just starting to light 0-2.5cm, Root sprouts are a concern, Mostly skin rot, Odd internal rot, Basal plates just starting to push out 10-40%, Firmness okay, Firmness uneven, Mid-term storage onion, Stored okay.

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RED ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2018-2019 -- continued

SV 4643: *Stokes sample,* Top & Root sprouts moderate 1-2.5cm, Top sprouts uneven, Root sprouts are a concern, Skin & internal rot, Basal plates just starting & pushing out 15-35%, Softer onion, Firmness slightly uneven, Early to mid-term storage onion, Stored a little poor.

Ruby Ring: *American Takii sample,* Top sprouts light to moderate 1-2.5cm, Root sprouts just starting to light 0-1cm, Root sprouts are a concern, Mostly internal rot, Some skin rot, Basal plates just starting to push out 15-25%, Firmness okay, Firmness uneven, Mid-term storage onion, Stored a little poor.

Rubillion: *American Takii sample,* Top sprouts light to moderate 1-2.5cm, Root sprouts moderate 2.5-5cm, Root sprouts are a concern, Majority internal rot, Odd skin rot, Basal plates just starting & pushing out 10-35%, Okay firmness, Firmness uneven, Mid-term storage onion, Stored a little poor.

Red Sky: *Bejo sample,* Top sprouts light to moderate 1-2.5cm, Root sprouts heavy 2.5-5cm, Top sprouts uneven, Root sprouts are a concern, Skin & internal rot, Basal plates just starting to push out 35%, Firmness okay, Early storage onion, Stored poor.

Monastrell: *Enza zaden sample,* Top & Root sprouts heavy 2.5-5cm, Sprouting a big concern, Sprouts uneven, Skin & internal rot, Basal plates just starting to push out 10-20%, Fairly firm, Early to mid storage onion, Stored poor.

Red Spring: *Bejo sample,* Top sprouts heavy >5 cm, Root sprouts moderate 2.5-5cm, Top sprouts uneven, Sprouting is a big concern, Majority skin rot, Odd internal rot, Basal plates pushing out 30%, Firmness uneven, Soft onion, Early storage onion, Stored poor.

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 (1971-2019)

Research Reports

Research Documents