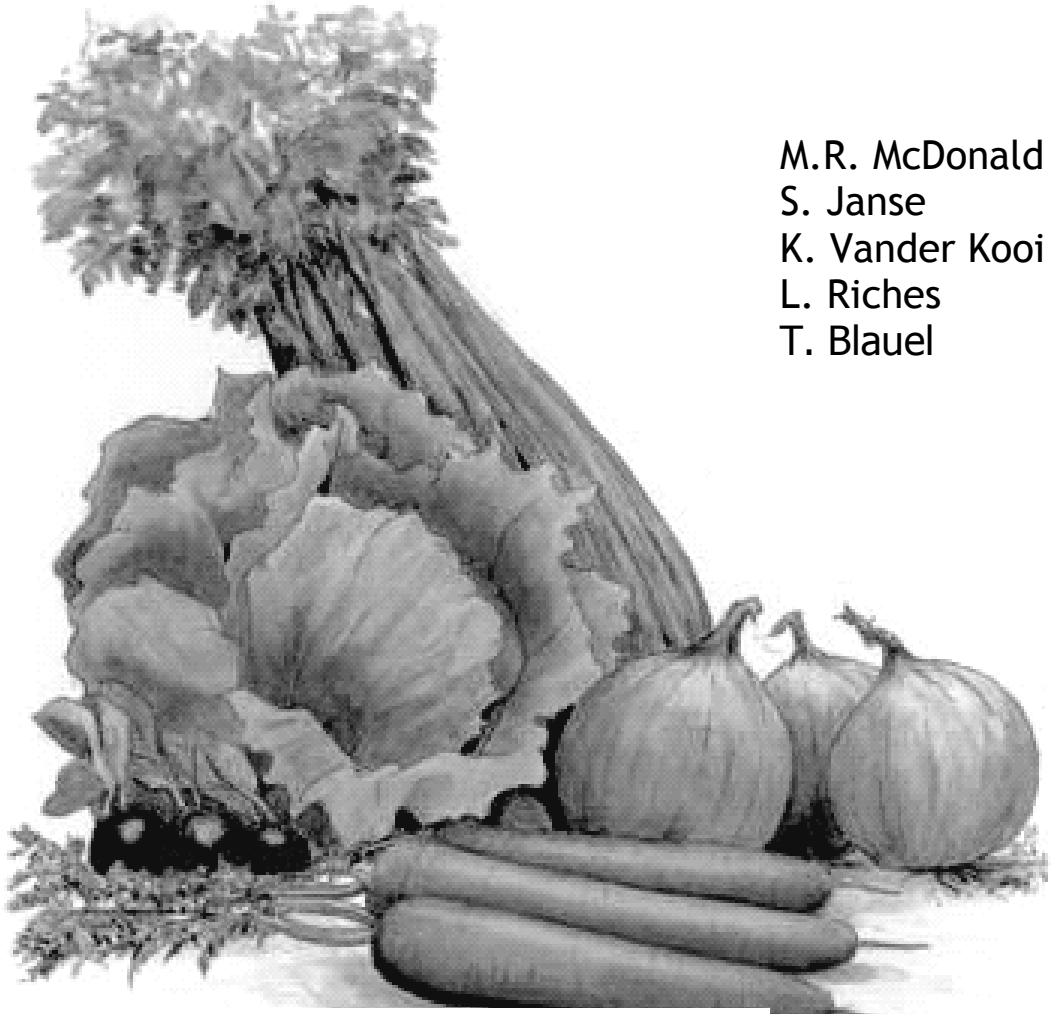
Muck Vegetable Cultivar Trial & Research Report 2020



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

UNIVERSITY of GUELPH

Office of Research &
Dept. of Plant Agriculture
Report No. 70

Muck Crops
Research Station
King, Ontario

Research and Cultivar Trial Report for 2020

University of Guelph
Ontario Crops Research Centre - Bradford
Office of Research &
Department of Plant Agriculture
Muck Crops Research Station

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Twitter Account: @MuckIPM

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Miscellaneous

Integrated Pest Management

CULTIVAR TRIALS

STAFF - 2020

UNIVERSITY OF GUELPH
Ontario Crops Research Centre - Bradford
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
Tyler Blauel	IPM Supervisor / Research Associate
Afsaneh Sedaghatkish	Post Doctoral Fellow

IPM Scouts:

Colin Anderson
John de Dreu

Seasonal Contracts:

Johanna Bronsveld	Summer Assistant
Rebekah Bronsveld	Summer Assistant
Michael Kooy	Summer Assistant
Madalena Liougas	Summer Assistant
Noah Vander Kooi	Summer Experience

Graduate Students:

Sarah Drury	Department of Plant Agriculture
Umbrin Ilyas	Department of Plant Agriculture
Sara Stricker	Department of Plant Agriculture

CO-OPERATING COMPANIES 2020

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
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
Jason Deveau	Ontario Ministry of Agriculture, Food and Rural Affairs, Simcoe, 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
Laura Smith	Corteva Agriscience, Winnipeg, MB, Canada
Tom Miedema	Fresh Vegetable Growers of Ontario, Ridgetown, ON, Canada
Colin Smith	Sylvar Technologies Inc, Fredericton, NB, Canada
Tessa de Boer	Syngenta Canada Inc., Plattsville, ON, Canada
Lorelei Hepburn	The Environmental Factor Inc., Ajax, ON, Canada

SEED SOURCES - 2020 - 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

ILL **Illinois Foundation Seeds Inc**, 1083 County Road 900N, Tolono, IL, 61880, U.S.A.
Tel: (217) 485-6260

Pure **Pure Line Seeds Inc**, 222 S Wisconsin Dr, Jefferson, WI, 53549, U.S.A.
Tel: (509) 349-2374

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 2020.

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

ILL Illinois Foundation Seeds

Pure Pure Line 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 2020, 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 2020 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 2020 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 two M.Sc. and one 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 2020

PRECIPITATION

Month	2010		2011		2012		2013		2014		2015	
	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	9*	21	15	38	39	13	36	16	28	19	0	15
February	189*	33	17	40	15	19	17	58	19	45	0	32
March	36*	0	56	21	30	2	12	6	9	16	10	5
April	12	0	75	0	51	0	82	4	82	2	48	0
May	52	0	92	0	49	0	112	0	58	0	40	0
June	170	0	68	0	55	0	94	0	88	0	171	0
July	146	0	56	0	140	0	104	0	92	0	36	0
August	74	0	113	0	69	0	87	0	63	0	79	0
September	95	0	67	0	94	0	83	0	113	0	27	0
October	60	0	83	0	123	0	92	0	67	0	54	0
November	41	0	85	1	32	0	24	15	24	5	40	0
December	61	72	49	4	35	14	29	40	11	22	39	3
Annual	**789**	**126**	**776**	**104**	**732**	**48**	**772**	**139**	**654**	**109**	**544**	**55**
Total Precip.	**901**		**880**		**780**		**911**		**763**		**599**	

LTA = Long Term Average for U of Guelph, Dept. of Plant Agriculture - Kettleby
1125 Woodchoppers Lane, King, ON, L7B 0E9 46 Years (1975-2020)

* Data collected from Egbert, ON

PRECIPITATION

Month	2016		2017		2018		2019		2020		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	23	2	61	14	34	25	14	52	84	24	22	28
February	29	12	28	23	28	32	14	43	0	44	19	26
March	80	30	54	8	21	14	39	17	42	5	31	14
April	22	18	87	12	117	12	89	0	30	0	57	4
May	45	0	120	0	82	0	77	0	38	3	73	0
June	39	0	209	0	59	0	100	0	77	0	81	0
July	51	0	74	0	104	0	93	0	58	0	84	0
August	58	0	53	0	109	0	80	0	140	0	81	0
September	25	0	38	0	20	0	61	0	65	0	78	0
October	41	0	99	0	69	0	74	0	61	0	69	1
November	40	5	22	11	63	31	27	31	27	22	51	10
December	20	65	2	32	44	10	44	40	29	39	26	28
Annual	**473**	**132**	**847**	**100**	**750**	**124**	**712**	**183**	**651**	**138**	**671**	**111**
Total Precip.	**605**		**947**		**874**		**895**		**789**		**783**	

LTA = Long Term Average for U of Guelph, Dept. of Plant Agriculture - Kettleby
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MEAN TEMPERATURE (°C)

Month	2010		2011		2012		2013		2014		2015	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
January	-3.8*	-11.6*	-3.0	-14.2	1.3	-6.9	2.1	-6.3	-3.9	-14.7	-3.2	-13.1
February	-2.4*	-8.9*	-0.8	-11.3	2.7	-5.6	-1.0	-10.3	-2.2	-17.3	-8.2	-19.8
March	7.4*	-2.9*	3.7	-5.6	12.7	-0.1	3.7	-4.3	1.9	-12.2	2.7	-7.4
April	16.2	3.4	12.7	1.2	12.5	0.0	11.4	0.7	11.9	0.3	13.0	0.8
May	22.6	7.6	19.8	8.4	23.4	8.4	21.8	7.6	20.9	6.6	23.5	8.3
June	23.9	12.9	24.8	12.0	26.9	13.2	24.2	12.8	27.1	11.6	23.8	11.8
July	29	15.6	30.1	15.5	29.7	14.7	27.5	15.1	25.9	12.5	28.1	13.3
August	27.8	14.4	26.9	13.4	27.0	13.1	26.7	12.4	25.8	12.5	25.7	13.2
September	21.1	9.8	22.6	10.6	21.7	8.0	22.4	8.1	22.8	8.5	25.9	12.1
October	15.2	3.5	15.4	4.7	14.6	4.8	16.3	4.6	15.3	5.5	14.6	3.9
November	7.9	-1	11.1	1.1	7.3	-1.4	6.6	-3.2	5.2	-1.0	10.8	0.6
December	-4.6	-6.7	3.7	-3.9	3.8	-3.4	-1.0	-9.4	2.0	-2.9	6.9	-0.1
Mean	**13.4**	**3.0**	**13.9**	**2.7**	**15.3**	**3.7**	**13.4**	**2.3**	**12.7**	**0.8**	**13.6**	**2.0**

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1125 Woodchoppers Lane, King, ON, L7B 0E9 46 Years (1975-2020)

* Data collected from Egbert, ON

MEAN TEMPERATURE (°C)

Month	2016		2017		2018		2019		2020		LTA	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
January	0.4	-7.8	0.8	-5.2	3.3	-3.2	-3.7	-12.3	0.9	-6.5	**-2.3**	**-10.8**
February	1.9	-8.3	3.7	-5.0	1.7	-7.7	-0.4	-9.9	-0.1	-8.3	**-1.2**	**-10.4**
March	6.6	-2.8	3.4	-5.0	2.9	-4.5	2.8	-6	6.6	-1.6	**3.4**	**-5.4**
April	10.3	-1.7	14.4	3.4	7.0	-1.9	5.8	1.3	10.0	0.0	**11.3**	**1.0**
May	21.2	6.3	17.3	7.2	23.4	9.0	16.5	6.3	17.4	5.7	**19.2**	**6.8**
June	26.2	11.1	24.1	12.8	25.1	12.2	23.5	11.6	26.4	12.0	**24.2**	**11.6**
July	28.8	15.3	26.4	14.9	28.4	15.0	29.3	15.4	29.6	16.9	**26.8**	**14.2**
August	29.6	15.5	25.2	12.6	27.8	16.9	26.3	12.4	26.8	14.3	**25.6**	**13.0**
September	24.8	10.0	25.0	9.6	23.7	11.3	21.6	9.6	21.3	8.7	**21.3**	**9.1**
October	15.9	5.9	17.2	5.8	12.2	3.8	14.8	4.3	12.6	3.6	**13.8**	**3.8**
November	11.5	0.9	7.3	-1.8	3.3	-3.2	4	-3.9	10.7	1.5	**6.8**	**-0.9**
December	1.3	-5.8	-2.0	-11.6	1.7	-4.3	2.2	-6.7	1.7	-4.0	**0.5**	**-6.6**
Mean	**14.9**	**3.2**	**13.6**	**3.1**	**13.4**	**3.6**	**11.9**	**1.8**	**13.7**	**3.5**	**12.5**	**2.1**

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EXTREME TEMPERATURE (°C)

Month	2010 H	2010 L	2011 H	2011 L	2012 H	2012 L	2013 H	2013 L	2014 H	2014 L	2015 H	2015 L
January	4.3*	-25.8*	11.7	-28.7	7.9	-20.3	14.0	-22.4	8.3	-30.4	5.3	-21.4
February	2.5*	-16.1*	9.7	-24.8	9.2	-17.3	6.5	-23.8	7.6	-30.2	-1.8	-30.8
March	18.7*	-10.7*	14.8	-14.8	26.4	-15.6	12.3	-10.3	12.9	-27.8	12.9	-26.3
April	26.2	-2.7	23.5	-3.0	25.7	-5.9	24.7	-7.4	23.4	-7.3	22.7	-5.1
May	32.3	-0.5	28.3	-0.2	34.9	1.1	31.3	0.0	31.9	-0.1	30.8	-1.2
June	31.1	5.2	33.4	5.2	35.5	7.6	33.4	6.1	32.7	2.8	29.1	4.1
July	35.4	7.4	36.3	6.8	35.3	9.7	35.3	7.6	31.4	6.5	34.2	7.2
August	35.1	7.0	31.5	8.5	32.6	6.4	31.7	7.3	32.6	5.7	32.8	6.9
September	33.2	4.0	30.8	5.4	29.9	1.7	35.3	-0.5	32.1	0.1	34.1	4.3
October	24.4	-2.4	29.2	-3.6	23.5	-4.7	24.7	-5.7	24.4	-1.5	23.9	-3.1
November	14.5	-5.4	19.2	-6.6	18.5	-5.8	16.0	-19.0	16.6	-10.3	22.1	-6.8
December	11.1	-5.4	14.3	-19.6	15.1	-12.7	15.9	-25.3	10.5	-11.1	15.4	-8.1
Annual High & Low	**35.4**	**-25.8**	**36.3**	**-28.7**	**35.5**	**-20.3**	**35.3**	**-25.3**	**32.6**	**-30.4**	**34.2**	**-30.8**

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

EXTREME TEMPERATURE (°C)

Month	2016		2017		2018		2019		2020		EXTREME TEMPERATURES			
	H	L	H	L	H	L	H	L	H	L	H	Year	L	Year
January	10.3	-19	7.2	-16.8	11.4	-28.6	6.6	-23.5	10.5	-24.1	15.8	2005	-36.0	1977
February	15.4	-28.8	16.7	-14.8	14.7	-21.7	11.2	-23.4	8.9	-25.4	16.7	2017	-33.0	1979
March	18.5	-14.7	14.8	-17.3	10.3	-11.7	11.6	-18.7	17.4	-18.7	26.4	2012	-29.0	1984
April	26.2	-15.3	26.6	-1.6	18.8	-8.3	14.4	-6.4	17.2	-5.6	30.0	1990	-15.3	2016
May	33.2	-1.6	31.5	1.1	30.6	-1.0	24.2	-0.3	33.3	-5.4	34.6	2006	-4.0	1983
June	34.2	3.1	32.6	4.5	33.2	5.9	31.4	2.8	33.6	3.6	35.5	1988	-2.0	1977
July	35.1	8.4	30.8	10.5	35.3	8.6	34	9.3	35.1	11.5	36.3	2011	2.5	1984
August	34.8	9.8	30.4	5.3	33.1	10.9	30.8	6.8	32.3	8.0	36.3	2001	0.5	1982
September	34.2	1.2	34.6	1.1	33.4	1.9	29.9	1.0	28.0	-1.3	35.3	2013	-6.5	1991
October	25.8	-3.5	26.0	-1.6	28.7	-3.3	27.2	-2.4	24.4	-6.1	30.0	89 & 07	-9.0	1975
November	19.1	-6.5	22.6	-14.4	14.5	-25.3	11.5	-19.1	24.0	-7.4	24.0	1990	-25.3	2018
December	9.1	-15.9	12.1	-29.0	11.0	-12.4	8.9	-21.6	8.6	-13.1	20.0	1982	-31.5	1980
Annual High & Low	**35.1**	**-28.8**	**34.6**	**-29.0**	**35.3**	**-28.6**	**31.4**	**-23.5**	**35.1**	**-25.4**	**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	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	LTA
January	0*	1	0	9	0	0	1	0	2	0	1	**1**
February	0*	0	0	0	0	0	8	8	7	2	0	**1**
March	15*	5	123	8	0	1	31	12	0	2	17	**15**
April	147	74	54	78	63	79	56	123	25	19	42	**75**
May	312	282	338	304	271	337	273	220	348	200	220	**243**
June	395	403	450	405	431	390	409	404	410	375	426	**386**
July	536	552	533	507	443	480	528	486	518	535	567	**478**
August	499	472	467	450	438	456	543	431	531	446	483	**442**
September	314	348	295	306	320	419	372	368	375	323	300	**305**
October	139	163	145	177	171	141	188	203	108	142	109	**130**
November	14	69	15	28	30	72	67	20	11	2	80	**32**
December	2	6	11	4	4	22	2	1	2	2	0	**4**
Annual	**2373***	**2375**	**2431**	**2276**	**2171**	**2397**	**2478**	**2276**	**2338**	**2048**	**2245**	**2112**

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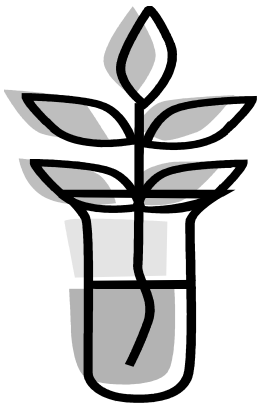
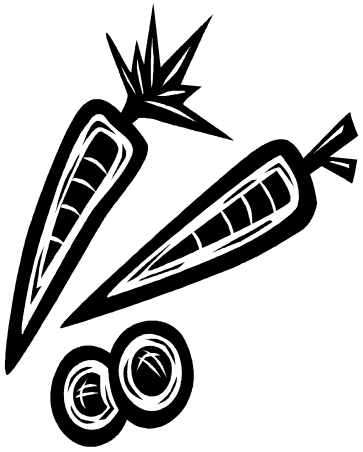
* Data collected from Egbert, ON





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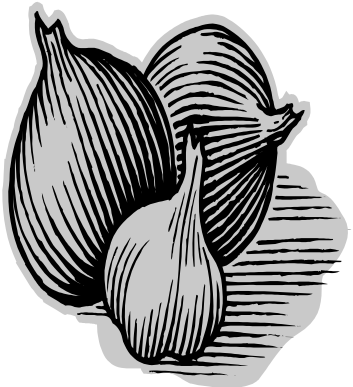

CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang.), cvs. Cellobunch and Bergen
PESTS: Carrot cyst nematode (*Heterodera carotae*) Jones, 1950; Root-lesion nematode (*Pratylenchus penetrans*) (Cobb, 1917) Filip'ev & Schuurmans Stekhoven, 1941

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

TITLE: FIELD EVALUATIONS OF NEMATICIDES FOR CARROT CYST AND ROOT-LESION NEMATODE CONTROL IN CARROTS, 2020

MATERIALS: NIMITZ (fluensulfone 480 g/L), SALIBRO (fluazaindolizine 500 g/L), VYDATE (oxamyl 240 g/L)

METHODS: Two trials were conducted in commercial fields in the Holland/Bradford Marsh, Ontario, one known to be infested with root-lesion nematode (*Pratylenchus penetrans*) (Trial 1) and the other infested with carrot cyst nematode (*Heterodera carotae*) (Trial 2). A randomized complete block design with five replicates per treatment was used. The treatments were: NIMITZ at 4.0 L/ha, SALIBRO at 0.56, 1.12, 2.24 and 4.48 L/ha, VYDATE at 4.67 and 9.3 L/ha, a low rate combination of SALIBRO at 0.56 L/ha + VYDATE 4.67 L/ha, and a high rate combination of SALIBRO at 1.12 L/ha + VYDATE 9.3 L/ha. All treatments were applied to the soil surface using a CO_2 backpack sprayer fitted with TeeJet 8003 flat fan nozzles at the rate of 200 L/ha and were incorporated into carrot hills at seeding. For Trial 1, carrots, cv. Bergen, were direct seeded in all treatments at 40 seeds/m on raised beds on 3 June. For Trial 2, carrots, cv. Cellobunch, were direct seeded at 65 seeds/m on raised beds on 1 June. Each experimental unit consisted of three rows, 66 cm apart and 7 m in length for Trial 1, and 66 cm apart and 10 m in length for Trial 2. An untreated check was also included in both trials. Twelve 15 cm soil cores were taken from each plot to create one soil sample at seeding and at 8 weeks after application (8 WAA) for nematode analysis. Nematodes were extracted at the University of Guelph Muck Crops Research Station using the Baermann pan method for motile nematodes and Fenwick method for female carrot cyst nematodes. Carrot emergence was recorded on 9 July and phytotoxicity and vigor were recorded on 29 June, 10 July, 24, July and 5 August for both trials.
In Trial 1, carrots were hand harvested from two 1.28 m sections of row on 27 October and placed in cold storage until assessment on 4 November. In Trial 2, carrots were hand harvested from two 1.5 m sections of row on 28 October, placed in cold storage, and assessment on 6 November. Carrot samples were assessed for nematode damage (stunting and forking) and sorted into the following classes: 0 = no nematode damage; 1 = few small cysts, difficult to find; 2 = small cysts only but clearly visible, main roots clean; 3 = some larger cysts visible, minimal forking on main root; 4 = larger cysts predominate, minor forking; 5 = many cysts, minor forking and stunting; 6 = cysts easily present, carrots forked or stunted; 7 = carrots forked and/or stunted, some “hairy” roots; 8 = major forking and/or stunting, “hairy” roots, few clean roots visible; 9 = significant forking and/or stunting, very “hairy” roots, plant usually dying; 10 = all roots severely damaged, no root. Marketable yield was also determined from the harvest samples. Carrots in classes 0 to 3 were considered marketable and carrots in classes 4 to 10 were considered unmarketable. 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 2020 were above average for July (23.3°C), average for June (19.2°C), August (20.6°C), and below average for May (11.6°C), September (15.0°C) and October (8.1°C). The 10-year average temperatures were: May 14.2°C, June 18.5°C, July 21.5°C, August 20.3°C, September 16.5°C and October 9.9°C.

Monthly rainfall was above the 10-year average for August (140 mm), average for September (65 mm), and below average for May (38 mm), June (77 mm), July (58 mm) and October (61 mm). The 10-year rainfall averages were: May 73 mm, June 103 mm, July 84 mm, August 76 mm, September 62 mm and October 78 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 Fisher's Protected LSD test with $P = 0.05$ level of significance.

RESULTS: Data are presented in Tables 1, 2, 3 and 4.

CONCLUSIONS: In Trial 1, where the soil was infested with root-lesion nematode, VYDATE at 9.3 L/ha and SALIBRO at 0.56, 1.12 and 4.48 L/ha treatments had significantly higher percent marketable carrots and lower nematode damage incidence and severity than the untreated check (Table 3). The combination treatment of SALIBRO at 0.56 L/ha and VYDATE at 4.67 L/ha also had significantly lower root-lesion nematode damage incidence than the untreated check. Nematode counts after application varied among treatments and there were no significant differences in the reproduction ratio among the treatments in both trials (Tables 1 and 2).
Due to localized flooding around the beginning of August, one replication from Trial 2 was discarded at harvest. In addition, high temperatures after seeding resulted in heat canker which lowered the stand in Trial 2. No significant differences were observed at harvest among the treatments in Trial 2 (Table 4). No phytotoxicity or differences in vigor were observed in either trial.

Table 1. Root-lesion nematode soil counts (nematodes/kg of soil) and reproduction ratio from carrot soil at planting and eight weeks after application of nematicides in the Holland Marsh, Ontario, 2020, Trial 1.

Treatment	Rate (L/ha)	Root-Lesion Nematode Counts (nematodes/kg soil)		Reproduction Ratio[1]
		At Planting	8 Weeks After Application	
VYDATE	9.3	288 ns[2]	600 ns	311.9 ns
NIMITZ	4.0	232	584	3.0
SALIBRO + VYDATE	0.56 + 4.67	208	512	1.8
Untreated	-	184	768	58.9
SALIBRO	2.24	160	1520	276.0
SALIBRO + VYDATE	1.12 + 9.3	128	624	5.0
SALIBRO	0.56	112	304	2.3
SALIBRO	4.48	104	656	520.4
SALIBRO	1.12	88	472	6.7
VYDATE	4.67	56	448	224.7

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

Table 2. Carrot cyst nematode soil counts (juveniles/kg of soil) and reproduction ratio from carrot soil at planting and eight weeks after treatment with nematicides in the Holland Marsh, Ontario, 2020, Trial 2.

Treatment	Rate (L/ha)	Carrot Cyst Nematode Counts (juveniles/kg soil)		Reproduction Ratio[1]
		At Planting	8 Weeks After Application	
SALIBRO	1.12	2376 ns[2]	448 ns	3.7 ns
VYDATE	9.3	2370	512	-0.8
SALIBRO + VYDATE	0.56 + 4.67	1912	672	0.4
NIMITZ	4.0	1768	360	-0.7
Untreated	-	1336	568	-0.2
SALIBRO	2.24	1240	464	0.1
VYDATE	4.67	1016	488	55.3
SALIBRO + VYDATE	1.12 + 9.3	944	712	-0.3
SALIBRO	0.56	488	376	0.1
SALIBRO	4.48	352	472	71.8

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

Table 3. Percent marketable, marketable yield, percent nematode damage and damage severity index (DSI) for carrots, cv. Bergen, grown in root-lesion nematode infested soil treated with nematicides in the Holland Marsh, Ontario, 2020, Trial 1.

Treatment	Rate (L/ha)	% Marketable Carrots	Marketable Yield (t/ha)	% Nematode Damage	DSI[1]
VYDATE	9.3	81.5 a[2]	40.9 a	35.3 a	14.3 a
SALIBRO	0.56	81.0 a	40.3 a	37.9 a	14.6 a
SALIBRO	1.12	80.1 a	37.2 ab	39.1 a	15.5 a
SALIBRO	4.48	79.9 ab	33.0 abc	33.6 a	14.9 a
SALIBRO + VYDATE	0.56 + 4.67	70.0 abc	29.7 bc	45.5 ab	21.8 ab
SALIBRO + VYDATE	1.12 + 9.3	68.9 abc	32.7 abc	51.4 abc	23.3 ab
VYDATE	4.67	61.5 abc	28.1 bc	55.3 abc	26.3 ab
NIMITZ	4.0	58.0 bc	30.8 abc	65.3 bc	30.5 b
Untreated	-	52.3 c	34.2 abc	71.4 c	33.5 b
SALIBRO	2.24	50.5 c	24.3 c	68.4 bc	32.8 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 $P = 0.05$, Fisher's Protected LSD test

Table 4. Percent marketable, marketable yield, percent nematode damage and damage severity index (DSI) for carrots, cv. Cellobunch, grown in carrot cyst nematode infested soil treated with nematicides in the Holland Marsh, Ontario, 2020, Trial 2.

Treatment	Rate (L/ha)	% Marketable Carrots	Marketable Yield (t/ha)	% Nematode Damage	DSI[1]
SALIBRO	4.48	57.1 ns[2]	14.3 ns	56.9 ns	26.0 ns
VYDATE	4.67	55.6	22.9	59.0	31.0
SALIBRO	1.12	53.6	15.8	63.8	32.2
VYDATE	9.3	52.8	15.1	65.9	32.7
SALIBRO + VYDATE	0.56 + 4.67	49.3	10.6	66.7	34.5
Untreated	-	49.1	11.3	65.0	33.7
NIMITZ	4.0	47.9	11.4	71.1	37.2
SALIBRO	2.24	45.7	13.2	72.8	36.8
SALIBRO	0.56	44.6	10.6	65.0	34.9
SALIBRO + VYDATE	1.12 + 9.3	42.5	11.2	67.1	37.6

[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 $P = 0.05$, Fisher's Protected LSD test

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PEST: Carrot cyst nematode (*Heterodera carotae*) Jones, 1950

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TITLE: NEMATICIDE EFFICACY FOR CONTROLLING CARROT CYST NEMATODE EGGS WITHIN CYSTS, 2019

MATERIALS: NIMITZ (fluensulfone 480 g/L), VELUM PRIME (fluopyram 500g/L)

METHODS: Laboratory trials were conducted to determine the efficacy of nematicides to penetrate carrot cyst nematode (CCN) cysts and kill the eggs within. Cysts were first extracted from infested soil using the Fenwick method. Five cysts were picked and placed in a 35 mm diameter petri dish for treatment, replicated 12 times. Nematicide rates were prepared and 3 mL of each treatment were pipetted into petri dishes with cysts. The treatments were relative to fields rates of: NIMITZ at 4 L/ha, 8 L/ha and 16 L/ha, and VELUM PRIME at 500 mL/ha. An untreated check using tap water was also included. Dishes were sealed with parafilm and left at room temperature for 72 hours. Cysts were then rinsed with tap water in a #200 sieve (0.074 mm pore size) and transferred to a clean 35 mm petri dish with a droplet of water. Cysts were opened with a probe to release all CCN eggs. Immediately after, 2 mL of 1% Methylene Blue stain were pipetted into the dish, directly exposing the eggs to the stain for 2 minutes. The eggs were then rinsed in a #500 sieve (0.025 mm pore size) with tap water and transferred to a counting dish. Carrot cyst nematode eggs were quantified using a compound microscope at the Muck Crops Research Station. Viable CCN eggs were clear and dead eggs were blue/green, as a result of the stain. Data were analyzed using the PROC GLIMMIX function in SAS version 9.4. Means separation was obtained using Tukey's HSD test with $P = 0.05$ level of significance.

RESULTS: Data are presented in Table 1.

CONCLUSIONS: All nematicide treatments resulted in significantly higher CCN egg mortality compared to the untreated check. The highest rate of NIMITZ resulted in approximately half the number of viable eggs after treatment compared to the untreated check. However, more than 30% of eggs within cysts were still viable after cysts were directly exposed to the nematicides. The cysts of carrot cyst nematodes protect the eggs from nematicides to a certain degree. Nematicides provide some control when cysts are exposed to the products, reducing the number of viable eggs able to hatch and parasitize.

Table 1. Percent and number of viable carrot cyst nematode (CCN) eggs after cyst exposure to nematicides in petri plates for 72 hours.

Treatment	Rate (L/ha)	% of Viable CCN Eggs	Average # of Viable CCN Eggs
NIMITZ	16	31.1 a[1]	117 a
NIMITZ	8	34.4 a	118 a
NIMITZ	4	35.8 a	130 a
VELUM PRIME	0.5	43.8 a	112 a
check	-	64.2 b	219 b

[1] Numbers in a column followed by the same letter are not significantly different at P = 0.05, Tukey's HSD 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.), cv. Cellobunch
PESTS: Alternaria leaf blight (*Alternaria dauci* (Kühn) Groves & Skolko)
Cercospora leaf blight (*Cercospora carotae* (Pass.) Solheim))

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TITLE: EVALUATION OF FUNGICIDES FOR LEAF BLIGHT CONTROL IN CARROTS, 2020

MATERIALS: Product A (experimental), FLINT (trifloxystrobin 50%)

METHODS: The trial was conducted on mineral soil (pH ≈ 7.8, organic matter ≈ 2.7 %) near the Muck Crops Research Station, Holland Marsh, Ontario. Carrots, cv. Cellobunch, were direct seeded (82 seeds/m) into raised beds using a Stanhay precision seeder on 19 May. A randomized complete block design with four replicates per treatment was used. Each experimental unit consisted of two rows, 86 cm apart, and 6 m in length. Treatments were Product A at 1000, and 1500 mL/ha, Product A at 1,000, 1,500 and 3,000 mL/ha + AGRAL 90 at 0.02% v/v and FLINT at 210 g/ha. An untreated check was also included. Treatments were applied on 30 July, 11, 20, 28 August and 9 September using a CO_2 backpack sprayer equipped with four TeeJet 8002 VS fan nozzles spaced 40 cm apart and calibrated to deliver 400 L/ha at 275 kPa. On 10, 18, 25 August, 1 and 14 September, carrot foliage in every replicate was rated for leaf blight symptoms, not differentiating between Alternaria and Cercospora, using a 0-10 scale where 0= no disease, 2= some lesions mainly on leaves, 4= many lesions, few on petioles, 6= numerous lesions on leaves and petioles, 8= 50% leaves dead and 10= 100% leaves dead.
On 17 September, the leaves of ten carrots per replicate were removed for a blight assessment. Leaves were visually assessed for the percentage of leaf area blighted, not differentiating between Alternaria and Cercospora, and sorted into the following classes: 0= 0%, 1= 1-5%, 2= 6-10%, 3= 11-25%, 4= 26-50%, 5= 51-75%, 6= >75%, 7= 100% dead. 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 28 September, carrots in three 1.16 m sections of row were pulled, topped and graded by size to determine yield.
Compared to the previous 10-year average, air temperatures in 2020 were above average for July (23.3°C), average for June (19.2°C), August (20.6°C), and below average for May (11.6°C) and September (15.0°C). The 10-year average temperatures were: May 14.2°C, June 18.5°C, July 21.5°C, August 20.3°C and September 16.5°C. Monthly rainfall was above the 10-year average for August (140 mm), average for September (65 mm), and below average for May (38 mm), June (77 mm) and July (58 mm). The 10-year rainfall averages were: May 73 mm, June 103 mm, July 84 mm, August 76 mm and September 62 mm. Data were analyzed using the General Analysis of Variance with Statistix V.10. Means separation was obtained using Tukey's HSD Test at P = 0.05 level of significance.

RESULTS & DISCUSSION: Leaf blight incidence was high in the trial with 87% incidence in untreated carrots (Table 2). Significant differences in LB plot ratings, the area under the disease progress curve (AUDPC), leaf blight incidence and severity, the percentage of dead leaves and the number of healthy leaves per plant were found among the treatments (Tables 1 & 2). All treated carrots had a lower AUDPC than untreated carrots. Carrots treated with Product A at 3,000 mL/ha + AGRAL 90 had a lower AUDPC than carrots treated with Product A at 1,000 mL/ha with or without AGRAL 90.
Carrots treated with Product A at 3,000 mL/ha + AGRAL 90 or FLINT had lower leaf blight incidence and severity than carrots treated with Product A at 1,000 mL/ha with or without AGRAL 90 and untreated carrots (Table 2). No significant differences in AUDPC, leaf blight incidence or severity were observed with the addition of AGRAL 90 to Product A at 1,000 or 1,500 mL/ha (Tables 1 & 2).

Significant differences in the percentage of marketable carrots (carrots > 2.0 cm) were observed among the treatments (Table 3). Carrots treated with Product A at 3,000 mL/ha + AGRAL 90 or FLINT had more marketable carrots than carrots treated with lower rates of Product A or untreated carrots.

CONCLUSIONS: Product A at 3,000 mL/ha + AGRAL 90 was more efficient at reducing leaf blight and increasing yield than Product A at 1,000 mL/ha and was comparable to FLINT. The addition of AGRAL 90 to the lower rates of Product A did not improve efficacy.

Table 1. Leaf blight (LB) severity plot ratings and area under the disease progress curve (AUDPC) for carrots, cv. Cellobunch, treated with fungicides and grown near Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Treatment	Product rate (mL/ha)	AUDPC[1]	LB Severity Plot Ratings[2]				
			10 Aug	18 Aug	25 Aug	1 Sept	14 Sept
Product A + NIS[3]	3,000	95.9 a[4]	1.8 ns[5]	2.8 a	2.3 a	2.6 a	3.5 a
Product A + NIS	1,500	109.7 ab	2.3	2.8 a	3.3 ab	3.4 ab	3.6 a
FLINT	210 g	110.9 ab	2.3	2.8 a	3.3 ab	3.3 ab	4.0 a
Product A	1,500	116.6 ab	1.8	3.4 a	3.4 ab	3.9 b	3.4 a
Product A +NIS	1,000	135.4 b	2.3	3.9 ab	4.1 b	4.0 b	4.4 a
Product A	1,000	137.9 b	2.5	3.6 a	4.3 b	4.3 b	4.4 a
Check	-	196.1 c	3.3	5.1 b	5.9 c	6.4 c	6.1 b

[1] Area under the disease progress curve (AUDPC) was based on the plot ratings for 10, 18, 25 August and 1, 14 September and was determined using the following equation:

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

[2] Plots were rated for leaf blight (LB) on a 0-10 scale where 0 = no disease, 2 = some lesions mainly on leaves, 4 = many lesions, few on petioles, 6 = numerous lesions on leaves and petioles, 8 = 50% leaves dead and 10 = 100% leaves dead.
[3] NIS = non ionic surfactant (AGRAL 90 at 0.02% v/v)
[4] Numbers in a column followed by the same letter are not significantly different at P = 0.05, Tukey's HSD test.
5 ns = no significant differences were found among the treatments using Tukey's HSD test.

Table 2. Leaf blight incidence and severity assessed on 17 September for carrots, cv. Cellobunch, treated with fungicides and grown near Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Treatment	Product rate (mL/ha)	Leaf blight Incidence (%)	DSI[1,2] (0-100)	Dead leaves (%)	Healthy leaves/plant
Product A + NIS[3]	3,000	57.3 a[4]	37.7 a	22.0 a	3.2 a
FLINT	210 g	60.1 a	37.8 a	24.9 ab	2.8 ab
Product A + NIS	1,500	66.5 ab	44.4 ab	27.0 ab	2.5 abc
Product A	1,500	69.6 ab	49.5 ab	38.7 b	2.3 abc
Product A +NIS	1,000	76.9 bc	52.2 b	35.7 ab	1.8 bcd
Product A	1,000	77.9 bc	52.5 b	33.6 ab	1.5 cd
Check	-	86.6 c	75.2 c	65.9 c	1.1 d

[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 17 September

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

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

[3] NIS = non ionic surfactant (AGRAL 90 at 0.02% v/v)

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

Table 3. Yield and size distribution of carrots, cv. Cellobunch, treated with various rates of GF-4536 and grown near the Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Treatment	Product rate (mL/ha)	% Marketable[1]	% Medium (2.0-4.5 cm)	% Jumbo (> 4.5 cm)	Mkb Yield (t/ha)	Wgt/mkb carrot (g)
FLINT	210 g	95.7 a[2]	91.7 ns[3]	4.0 ns	19.4 ns	63.8 ns
Product A + NIS[4]	3000	95.5 a	87.7	7.8	22.0	66.6
Product A + NIS	1000	94.8 ab	88.8	6.0	18.1	58.5
Product A	1500	93.9 ab	92.0	1.9	17.0	56.9
Product A + NIS	1500	93.1 ab	84.9	8.2	18.8	63.5
Product A	1000	90.3 ab	90.3	0.0	15.1	53.6
Check	-	83.7 b	83.7	0.0	10.0	38.0

[1] Marketability was based on size. Carrots less than 2.0 cm in diameter were classed as unmarketable.

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

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

[4] NIS = AGRAL 90 at 0.02%v/v

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

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)

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TITLE: EVALUATION OF FUNGICIDES AS SEED TREATMENTS AND DRENCHES TO CONTROL PYTHIUM DISEASES IN CARROTS, 2020

MATERIALS: RIDOMIL 1G (metalaxyl-M & S-isomer 1%), PICARBUTRAZOX 10 SC (picarbutrazox 100 g/L), VAYANTIS (picarbutrazox 400 g/L), REASON 500 SC (fenamidone 500 g/L), TORRENT 400 SC (cyazofamid 34.5%), PRESIDIO (fluopicolide 39.5%), RHIZOVITAL 42 (*Bacillus amyloliquefaciens*), ORONDIS GOLD A (oxathiapiprolin 35 g/L), ORONDIS GOLD B (metalaxyl-M & S-isomer 480 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* spp. plant pathogens 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 disease.

METHODS: The trial was conducted at the Muck Crops Research Station (MCRS) in muck soil (organic matter ≈ 71.7%, pH ≈ 5.8) known to be infested with *Pythium* spp. A randomized complete block design with four replicates per treatment was used. Each experimental unit consisted of one row, 86 cm apart and 6 m in length. Seed treatments were: VAYANTIS at 0.25, 0.5, 1.0 and 2.5 g a.i./100 kg seed (cv. Cellobunch), applied using a tabletop laboratory seed treater, six drops of methyl cellulose and 1 mL of various rates of stock solutions of VAYANTIS. Drench treatments were: ORONDIS GOLD A at 5.6 L/ha + ORONDIS GOLD B at 650 mL/ha, PICARBUTRAZOX 10 SC at 1.0, 2.0 and 3.0 L/ha, REASON 500 SC at 0.6 L/ha, TORRENT 400 SC at 0.44 L/ha, PRESIDIO at 0.29 L/ha and RIDOMIL 1G at 25 kg/ha (13 g/6 m row) and RHIZOVITAL 42 at 0.5 L/ha. An untreated check was also included. All carrot seeds, (treated and untreated) were direct seeded at 70 seeds/m into raised beds using a push cone seeder on 1 June. Drench treatments were applied on 2 June in a 13-15 cm band over the row after seeding using a CO_2 backpack sprayer fitted with a single TeeJet XR8004 nozzle in a water volume of 300 L/ha, followed by 7 mm of irrigation water. Two 1.16 m long sections of row were randomly chosen and staked out to be used as assessment and harvest plots. The number of emerged plants in the staked-out sections were recorded on a weekly basis (11 June-17 July), three weekly leaf stage assessments were conducted (1-17 July) and canopy height (soil to the tallest leaf) was measured on 23 July (results not presented). For a mid-season assessment, 25 carrots were harvested and assessed on 2 September. Carrots were hand-washed, visually examined for cavity spot lesions, and sorted into classes based on the size of the largest lesion (measured as horizontal length). The six classes were: 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).
On 20 October, carrots from the two 1.16 m staked-out sections of row were harvested by hand and placed in cold storage. On 20-30 October carrots were removed from storage, washed in a small drum washer and graded for size into the following categories: jumbo (>4.4 cm), medium (1.9-4.4 cm), and culls (<1.9 cm). One hundred carrots from the medium or jumbo categories were set aside after grading to be used for the cavity spot assessment. On 20 October - 4 November, carrots were visually examined 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 2020 were above average for July (23.3°C), average for June (19.2°C), August (20.6°C), and below average for May (11.6°C), September (15.0°C) and October (8.1°C). The 10-year average temperatures were: May 14.2°C, June 18.5°C, July 21.5°C, August 20.3°C, September 16.5°C and October 9.9°C. Monthly rainfall was above the 10-year average for August (140 mm), average for September (65 mm), and below average for May (38 mm), June (77 mm), July (58 mm) and October (61 mm). The 10-year rainfall averages were: May 73 mm, June 103 mm, July 84 mm, August 76 mm, September 62 mm and October 78 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: as presented in Tables 1 and 2.

CONCLUSION: Cavity spot pressure and percent forking was relatively low in this trial. No significant differences in the percentage of forking or cavity spot incidence or severity were found among the treatments at either the midseason or late assessment dates (Table 1).
No significant differences in total or marketable yield or in the percentage of marketable carrots were found among the treatments (Table 2).

Table 1. Cavity spot incidence, severity and percent forked for carrots, cv. Cellobunch, treated with various seed treatments and drench applications and grown in grown in muck soil infested with *Pythium* spp. in the Holland Marsh, Ontario, 2020.

Treatment	Midseason (2 Sept)			Harvest (20 Oct)		
	Incidence (%)	DSI[1]	% Forked	Incidence (%)	DSI	% Forked
PICARBUTRAZOX Low	20 ns[2]	6.2 ns	8 ns	35 ns	11.8 ns	12 ns
PICARBUTRAZOX Med	25	6.6	20	45	16.2	10
PICARBUTRAZOX High	25	5.6	6	49	18.3	7
VAYANTIS 0.25 (seed trt)	22	5.2	12	46	17.3	11
VAYANTIS 0.5 (seed trt)	32	7.2	8	41	15.1	10
VAYANTIS 1 (seed trt)	33	7.6	8	46	16.7	8
VAYANTIS 2.5 (seed trt)	30	6.8	11	39	13.3	11
REASON	25	6	11	61	21.2	12
TORRENT	31	6.8	4	47	16.5	7
PRESIDIO	35	9	8	35	13.9	8
RHIZOVITAL	34	8.6	6	36	14.2	13
ORONDIS GOLD A + B	25	5.6	17	40	14.9	8
RIDOMIL	40	10.4	5	39	14.2	7
Untreated	36	10.2	15	40	15.7	14

[1] DSI was calculated using the following equation:

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

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

Table 2. Yield and percent marketable for carrots, cv. Cellobunch, treated with VAYANTIS seed treatments or drench applications of various fungicides grown at Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Treatment	Total Yield (t/ha)	Marketable Yield (t/ha)	% Marketable
PICARBUTRAZOX Low	55.6 ns[1]	46.6 ns	83 ns
PICARBUTRAZOX Med	62.8	54.3	87
PICARBUTRAZOX High	55.0	50.1	91
VAYANTIS 0.25 (seed trt)	62.8	54.3	86
VAYANTIS 0.5 (seed trt)	51.9	47.0	90
VAYANTIS 1.0 (seed trt)	59.5	53.7	91
VAYANTIS 2.5 (seed trt)	58.8	53.2	90
REASON	53.1	45.2	85
TORRENT	56.8	51.8	91
PRESIDIO	69.2	64.7	94
RHIZOVITAL	63.6	53.1	83
ORONDIS GOLD A + B	57.7	52.2	90
RIDOMIL 1G	58.3	54.3	93
Untreated	59.4	50.1	84

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

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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)

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TITLE: EVALUATION OF CARROT BREEDING LINES FOR SUSCEPTIBILITY TO CAVITY SPOT, 2020

MATERIALS: USDA experimental carrot breeding lines, commercial cultivars Cellobunch, Envy (Seminis Vegetable Seeds), Atomic Red (OSC Seeds), Purple Haze, Nairobi (Bejo Seed Inc.), Uppercut 25, Honeysnax and Maverick (Nunhems USA)

METHODS: The trial was conducted on organic soil (pH ≈ 5.7, organic matter ≈ 70.8%) 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 28, 29 May. 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 14 July stand was rated on a 0-5 scale were 0 = ≤ 9 carrots, 1 = very poor, 2 = poor, 3 = good, 4 = very good, 5 = excellent. On 1 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 29 and 30 October, 50 carrots from each replicate were harvested, placed into cold storage, and assessed for cavity spot on 17-26 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 2020 were above average for July (23.3°C), average for June (19.2°C), August (20.6°C), and below average for May (11.6°C), September (15.0°C) and October (8.1°C). The 10-year average temperatures were: May 14.2°C, June 18.5°C, July 21.5°C, August 20.3°C, September 16.5°C and October 9.9°C. Monthly rainfall was above the 10-year average for August (140 mm), average for September (65 mm), and below average for May (38 mm), June (77 mm), July (58 mm) and October (61 mm). The 10-year rainfall averages were: May 73 mm, June 103 mm, July 84 mm, August 76 mm, September 62 mm and October 78 mm. Data were analyzed using the General Analysis of Variance function of Statistics V.10. Means separation was obtained using Tukey's HSD test with P = 0.05 level of significance.

RESULTS: as presented in Tables 1-4.

CONCLUSIONS: In 2020, rainfall in August was above average (140 mm) which created moist soil conditions favourable for cavity spot development. Cellobunch incidence was 42% in 2020 compared to 2% in 2019. Significant differences in cavity spot incidence were observed among the lines tested, ranging from 4-90%. The orange line crosses N17005-1, 18'B112-3, 19'B113-1, 15'1030-2 and 19'B108-1 all had cavity spot incidence less than 35%. Significant differences in leaf blight ratings was also observed with 15 of the crosses tested having a leaf blight rating 1.5 or less (Table 2).

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, 2020.

Field #	Pedigree/Name	Incidence (%)	DSI[1]	% Forked
CS059	Purple Haze	4.5 a[2]	1.1 a	4.0 ab
CS034	N17005-1	23.8 ab	9.0 ab	3.9 ab
CS025	18'B112-3	30.5 abc	13.2 a-d	5.0 ab
CS038	19'B113-1	31.2 abc	12.8 a-d	4.0 ab
CS014	15'1030-2	33.2 a-d	14.3 a-e	3.6 ab
CS044	19'B108-1	34.6 a-e	17.8 a-g	0.5 a
CS056	19'B112-1	35.3 a-e	14.0 a-d	1.5 a
CS063	Nairobi	36.4 a-e	14.2 a-e	2.0 ab
CS033	19'B112-3	37.0 a-e	13.8 a-d	3.5 ab
CS032	19'B112-2	37.2 a-e	13.9 a-d	3.0 ab
CS035	N17005-2	37.4 a-e	13.4 a-d	9.2 ab
CS002	855-2	38.4 a-e	11.5 abc	5.4 ab
CS039	19'B113-3	41.1 a-f	16.3 a-g	3.4 ab
CS061	Maverick	41.2 a-f	14.1 a-e	2.9 ab
CS058	**Cellobunch**	**41.6 a-f**	**15.8 a-f**	**0.5 a**
CS037	725-2	41.8 a-f	17.3 a-g	4.9 ab
CS023	789-1	43.2 a-f	21.7 a-h	13.5 ab
CS027	790-2	43.8 a-f	15.7a-f	8.0 ab
CS040	19'B113-4	44.7 a-f	18.6 a-g	1.9 ab
CS029	790-5	45.3 a-g	17.5 a-g	6.5 ab
CS013	225-2	45.4 a-g	16.8 a-g	3.7 ab
CS052	19'B111-2	45.8 a-g	20.0 a-g	6.9 ab
CS064	Honeysnax	47.2 a-g	20.7 a-h	1.0 a
CS053	19'B111-3	49.8 b-g	22.2 a-h	6.4 ab
CS018	17'B121-3	50.3 b-g	23.1 a-i	5.0 ab
CS062	Uppercut	51.47 b-g	20.1 a-g	7.7 ab
CS049	19'B110-1	52.9 b-g	31.6 b-j	2.0 ab
CS057	18'B112-6	54.8 b-g	21.9 a-h	3.0 ab
CS001	855-1	55.4 b-g	25.8 a-j	15.7 ab
CS050	19'B110-2	56.1 b-g	27.8 b-j	5.1 ab
CS060	Atomic Red	56.8 b-g	32.9 b-j	3.4 ab
CS020	19'S1433-2	58.2 b-g	25.2 a-i	5.5 ab
CS026	790-1	58.4 b-g	26.1 a-j	2.2 ab
CS030	790-6	59.6 b-g	23.8 a-i	6.7 ab
CS054	N110502a	60.4 b-g	30.3 b-j	3.0 ab
CS028	790-4	61.4 b-g	31.9 b-j	7.4 ab
CS012	814-2	62.6 b-g	29.3 b-j	3.4 ab
CS045	19'B108-2	62.8 b-g	35.5 c-j	1.7 ab
CS003	12'B1131a	63.3 b-g	29.7 b-j	
CS065	Envy	64.3 b-g	25.3 a-i	2.5 ab
CS046	13'B112-1	66.2 b-g	39.7 e-j	9.6 ab
CS005	360-2	66.9 b-g	30.3 b-j	5.6 ab
CS024	789-2	66.9 b-g	33.3 b-j	10.0 ab
CS048	13'B112-3	67.0 b-g	30.3 b-j	15.3 ab
CS043	19'B109-3	67.2 b-g	32.3 b-j	20.5 b

CS022	17'B101-2	68.3 b-g	27.3 b-j	6.4 ab
CS055	N110512a	71.4 c-g	37.5 d-j	3.0 ab
CS016	19'S1432-2	73.6 c-g	36.7 c-j	3.5 ab
CS047	13'B112-2	74.2 c-g	35.8 c-j	17.2 ab
CS008	454-2	74.2 c-g	34.4 b-j	1.7 ab
CS017	17'B121-1	74.6 c-g	40.0 f-j	7.4 ab
CS021	17'B101-1	75.2 c-g	32.4 b-j	5.4 ab
CS042	19'B109-1	77.0 d-g-	41.1 f-j	3.5 ab
CS019	19'S1433-1	79.2 efg-	41.7 g-j	3.9 ab
CS051	19'B111-1	79.5 efg-	38.0 d-j	4.7 ab
CS041	19'B109-2	87.1 fg-	45.9 hij	4.4 ab
CS007	454-1	87.9 fg	50.8 ij	0.0 a
CS015	19'S1432-1	90.0 g	51.1 j	1.5 a
CS004	360-1	-	-	-
CS006	012-3	-	-	-
CS009	012-1	-	-	-
CS010	012-7	-	-	-
CS011	012-8	-	-	-
CS031	19'B112-1	-	-	-
CS036	725-1	-	-	-

[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, Tukey's HSD test.
[3] Carrots listed below the line had very poor emergence with sample sizes <10 and therefore were not assessed for cavity spot.

Table 2. Stand (14 July), bolting and leaf blight ratings (1 October), for carrot breeding lines from University of Wisconsin grown at the Muck Crops Research Station, Holland Marsh, 2020.

Field #	Name	Stand Rating[1]	Bolting Rating[2]	Leaf Blight Rating[3,4]
CS063	Nairobi	4.9	0.0	1.6
CS048	13'B112-3	4.6	0.1	1.8
CS020	19'S1433-2	4.6	0.1	1.6
CS002	855-2	4.5	0.6	1.6
CS058	Cellobunch	4.5	0.3	**2.0**
CS064	Honey Snax	4.5	0.1	1.1
CS030	790-6	4.4	0.0	**2.0**
CS061	Maverick	4.4	0.0	1.0
CS059	Purple Haze	4.4	1.8	0.9
CS056	18'B112-1	4.3	0.0	**2.9**
CS040	19'B113-4	4.3	0.0	**2.6**
CS062	Uppercut	4.1	0.0	1.0
CS046	13'B112-1	4.0	0.0	1.8
CS043	19'B109-3	4.0	0.0	1.3
CS039	19'B113-3	4.0	0.1	**2.4**
CS027	790-2	4.0	0.1	1.4
CS028	790-4	4.0	0.1	1.0
CS018	17'B121-3	4.0	0.0	1.4
CS041	19'B109-2	4.0	0.0	1.9
CS054	N110502a	4.0	1.0	1.5
CS022	17'B101-2	3.9	0.1	1.9

CS033	19’B112-3	3.9	0.0	1.6
CS015	19’S1432-1	3.9	0.3	**3.0**
CS016	19’S1432-2	3.9	0.0	**3.1**
CS047	13’B112-2	3.9	0.0	1.8
CS057	18’B112-6	3.9	0.0	**2.0**
CS055	N110512a	3.9	0.3	1.1
CS003	12’B113-1a	3.8	0.6	**3.9**
CS065	Envy	3.8	0.3	0.8
CS025	18’B112-3	3.6	0.1	1.8
CS014	15’1030-2	3.5	1.5	**2.3**
CS051	19’B111-1	3.5	0.6	1.6
CS019	19’S1433-1	3.5	0.0	**2.6**
CS042	19’B109-1	3.4	0.4	**2.1**
CS050	19’B110-2	3.4	0.0	**2.1**
CS029	790-5	3.4	0.0	1.6
CS017	17’B121-1	3.3	0.3	**3.1**
CS053	19’B111-3	3.3	0.4	1.8
CS005	360-2	3.3	0.3	**2.5**
CS037	725-2	3.2	0.0	1.6
CS032	19’B112-2	3.1	0.0	1.4
CS013	225-2	3.1	0.3	1.8
CS035	N17005-2	3.1	0.0	1.4
CS052	19’B111-2	3.0	0.8	1.3
CS038	19’B113-1	3.0	0.1	**2.0**
CS021	17’B101-1	2.9	0.0	1.3
CS049	19’B110-1	2.9	0.1	**2.5**
CS060	Atomic Red	2.6	0.0	**2.4**
CS008	454-2	2.5	0.0	**3.0**
CS001	855-1	2.5	0.4	**2.6**
CS024	789-2	2.4	0.0	1.3
CS012	814-2	2.3	0.6	**2.4**
CS045	19’B108-2	1.9	0.0	1.9
CS034	N17005-1	1.9	0.0	1.5
CS036	725-1	1.8	0.4	1.6
CS023	789-1	1.5	0.7	1.5
CS026	790-1	1.5	0.3	1.5
CS031	19’B112-1	1.5.	0.0	1.6
CS044	19’B108-1	1.5	0.0	1.0
CS007	454-1	1.4	0.3	1.7
CS011	012-8	0.3	-	-
CS004	360-1	0.3	-	-
CS009	012-1	0.0	-	-
CS006	012-3	0.0	-	-
CS010	012-7	0.0	-	-

[1] Stand (carrot emergence) was rating on 14 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 1 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 2.0 or higher (the rating for Cellobunch) are noted in bold.

Table 3. Leaf blight ratings (1 October), for carrot breeding lines from University of Wisconsin grown at the Muck Crops Research Station, Holland Marsh, 2020.

Field #	Pedigree/Name	Leaf blight rating
CS065	Envy	0.8 a
CS059	Purple Haze	0.9 a
CS044	19'B108-1	1.0 ab
CS062	Uppercut	1.0 ab
CS028	790-4	1.0 ab
CS061	Maverick	1.0 ab
CS055	N110512a	1.1 abc
CS064	Honeysnax	1.1 abc
CS043	19'B109-3	1.3 a-d
CS052	19'B111-2	1.3 a-d
CS021	17'B101-1	1.3 a-d
CS024	789-2	1.3 a-d
CS035	N17005-2	1.4 a-d
CS018	17'B121-3	1.4 a-d
CS032	19'B112-2	1.4 a-d
CS027	790-2	1.4 a-d
CS034	N17005-1	1.5 a-d
CS054	N110502a	1.5 a-d
CS026	790-1	1.5 a-d
CS023	789-1	1.5 a-d
CS031	19'B112-1	1.6 a-d
CS036	725-1	1.6 a-d
CS037	725-2	1.6 a-d
CS033	19'B112-3	1.6 a-d
CS051	19'B111-1	1.6 a-d
CS029	790-5	1.6 a-d
CS020	19-S1433-2	1.6 a-d
CS063	Nairobi	1.6 a-d
CS002	855-2	1.6 a-d
CS048	13'B112-3	1.8 a-d
CS047	13'B112-2	1.8 a-d
CS046	13'B112-1	1.8 a-d
CS013	225-2	1.8 a-d
CS053	19-B111-3	1.8 a-d
CS025	18'B112-3	1.8 a-d
CS007	454-1	1.8 a-d
CS041	19'B109-2	1.9 a-d
CS022	17'B101-2	1.9 a-d
CS045	19-B108-2	1.9 a-e
CS058	Cellobunch	**2.0 a-e**
CS038	19'B113-1	**2.0 a-e**
CS057	18'B112-6	**2.0 a-e**
CS030	790-6	**2.0 a-e**
CS042	19'B109-1	**2.0 a-e**
CS050	19-B110-2	**2.1 a-e**

CS014	15'1030-219'B108-2	**2.2 a-e**
CS060	Atomic Red	**2.4 a-e**
CS039	19'B113-3	**2.4 a-e**
CS012	814-2	**2.4 a-e**
CS049	19'B110-1	**2.5 a-e**
CS005	360-2	**2.5 a-e**
CS040	19'B113-4	**2.6 a-e**
CS019	19'S1433-1	**2.6 a-e**
CS001	855-1	**2.6 a-e**
CS056	18'B112-1	**2.9 b-e**
CS015	19'S1432-1	**3.0 cde**
CS008	454-2	**3.0 cde**
CS016	19'S1432-2	**3.1 de**
CS017	17'B121-1	**3.1 de**
CS003	12'B113-1a	**3.9 e**
CS004	360-117	-
CS006	012-33	-
CS009	012-1	-
CS010	012-7	-
CS011	012-8	-

[1] Numbers in a column followed by the same letter are not significantly different at P= 0.05, Tukey's HSD test.
[2] Carrots listed below the line had very poor emergence with sample sizes <10 and therefore were not assessed for leaf blight.
[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 >2.0 (the rating for Cellobunch) are noted in bold.

Table 4. Bolting ratings (1 October), for carrot breeding lines from University of Wisconsin grown at the Muck Crops Research Station, Holland Marsh, 2020.

Field #	Pedigree/Name	Bolting rating
35	N17005-2	0.0
61	Maverick	0.0
63	Nairobi	0.0
24	789-2	0.0
16	19'S1432-2	0.0
50	19'B110-2	0.0
41	19'B109-2	0.0
45	19'B108-2	0.0
18	17-B121-3	0.0
44	19'B108-1	0.0
57	18'B112-6	0.0
40	19'B113-4	0.0
32	19'B112-2	0.0
60	Atomic Red	0.0
56	18'B112-1	0.0
34	N17005-1	0.0
8	454-2	0.0
33	19'B112-3	0.0

31	19'B112-1	0.0
62	Uppercut	0.0
19	19'S1433-1	0.0
30	790-6	0.0
43	19'B109-3	0.0
21	17'B101-1	0.0
37	725-2	0.0
47	13'B112-2	0.0
29	790-5	0.0
46	13'B112-1	0.0
64	Honeysnax	0.12
38	19'B113-1	0.12
49	19'B110-1	0.12
39	19'B113-3	0.12
22	17'B101-2	0.12
28	790-4	0.12
25	18'B112-3	0.12
27	790-2	0.12
20	19'S1433-2	0.12
48	13'B112-3	0.12
55	N110512a	0.25
65	Envy	0.25
58	Cellobunch	0.25
13	225-2	0.25
17	17'B121-1	0.25
15	19'S1432-1	0.25
26	790-1	0.25
5	360-2	0.25
7	454-1	0.33
53	19'B111-3	0.37
42	19'B109-1	0.37
36	725-1	0.37
1	855-1	0.37
12	814-2	0.62
3	12'B113-1a	0.62
51	19'B111-1	0.62
2	855-2	0.62
24	789-2	0.75
52	19'B111-2	0.75
54	N110502a	1.0
14	15'1030-2	1.5
59	Purple Haze	1.8

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

Funding was provided by the Plant Production Systems of the Ontario Agri-Food Innovation Alliance and the California Fresh Carrot Advisory Board.

CROP: Carrots (*Daucus carota subsp. Sativus* (Hoffm.) Arcang)
PEST: *Pythium* species

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TITLE: EVALUATION OF COMMERCIAL CARROT CULTIVARS FOR SUSCEPTIBILITY TO CAVITY SPOT, 2020

MATERIALS: commercial cultivars Purple Haze and Atomic Red (Johnny's Select Seeds), Cellobunch and Envy (Seminis Vegetable Seeds), Nairobi (Bejo Seeds Inc), Triton (Sakata Seeds America), Uppercut and Honey Snax (Nunhems USA)

METHODS: The trial was conducted on organic soils (pH ≈ 6.4, organic matter ≈ 68.3%) naturally infested with *Pythium* species at the Muck Crops Research Station, Holland Marsh, Ontario. Carrot cultivars were direct seeded (≈ 65 seeds/m) on raised beds with spacing of 66 cm on 21 May. The trial was a randomized complete block design with four replicates of each treatment. One experimental unit was two rows with the row length of 5 m. The treatments were eight carrot cultivars with varying susceptibility to cavity spot. These carrot cultivars were divided into three categories: relatively resistant: Purple Haze, moderately susceptible: Cellobunch, Uppercut, Nairobi, Honey Snax and very susceptible: Atomic red, Envy, and Triton, based on the results from previous cavity spot trials (McDonald et al. 2015 – 2019).
The incidence and severity of cavity spot on carrots was assessed at mid-season and harvest. Twenty carrots were pulled from each experimental unit (10 consecutive carrots per row) to assess cavity spot at mid-season on 20 August. On 26 October, 50 carrots were pulled out from each experimental unit (25 consecutive carrots per row) to assess cavity spot.
The carrots were placed in cold storage until the assessment of disease. Carrots were washed with water in a small rotating drum washer. The carrots were examined for the characteristic symptoms, sunken lesions horizontally arranged on the carrot root. Incidence of cavity spot was calculated as the percent of carrots in the sample with one or more cavity spot lesions. Disease severity was determined based on the length of the largest horizontal lesion on the carrot. Disease severity was divided into 6 classes: 0 = no lesions, 1= lesions up to 0.09 cm, 2= lesions of 0.1 to 0.2 cm, 3= lesions of 0.2 to 0.5 cm, 4= lesions of 0.5 to 1 cm and 5= lesions >1 cm (Saude et al. 2014). The disease severity values were transformed to an index of 0-100 using the equation of Kobriger and Hagedorn (1983) to determine disease severity index (DSI).

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

The relative disease response of the carrot cultivars was determined by comparing disease incidence and severity to pre-identified most resistant cultivar, Purple Haze, and the most susceptible cultivar, Atomic Red. The carrot cultivars that had a DSI statistically the same as Purple Haze were considered relatively resistant. Similarly, the carrot cultivars that had a disease response statistically the same as Atomic Red were considered susceptible. The cultivars shown to have an intermediate disease response were considered as moderately susceptible.
Pythium species were isolated from cavity spot lesions on the carrots. Five lesions from each experimental unit were placed on culture media to isolate *Pythium* species. These cultures were identified microscopically based on morphological characteristics including sporangia, antheridia, oospores and oogonia following the key of van der Plaats-Niterink (1981).
Data were analyzed using the General Analysis of Variance using Statistix V.10. Means separation was obtained using Tukey's test with P = 0.05 level of significance. Compared to the previous 10-year average, air temperatures in 2020 were above average for July (23.3°C), average for June (19.2°C), August (20.6°C), and below average for May (11.6°C), September (15.0°C) and October (8.1°C). The 10-year average

temperatures were: May 14.2°C, June 18.5°C, July 21.5°C, August 20.3°C, September 16.5°C and October 9.9°C. Monthly rainfall was above the 10-year average for August (140 mm), average for September (65 mm), and below average for May (38 mm), June (77 mm), July (58 mm) and October (61 mm). The 10-year rainfall averages were: May 73 mm, June 103 mm, July 84 mm, August 76 mm, September 62 mm and October 78 mm.

RESULTS: The incidence of cavity spot at the mid season assessment was lower in Purple Haze compared to other cultivars, however, there was no difference in the disease severity (Table 1). At harvest, the incidence and severity of cavity spot was again lowest in Purple Haze, and moderate in Uppercut and Cellobunch (Table 1). Both the incidence and severity were highest in Envy (Table 1).
Nineteen *Pythium* isolates were recovered from the cavity spot lesions belong to following species *P. ultimum var. ultimum, P. ultimum var. sporangiiform, P. irregulare, P salvaticum, P. intermedium,* and *P. violae*.

CONCLUSION: The cultivar Purple Haze was relatively resistant as expected, Cellobunch and Uppercut were moderately susceptible, and Envy was susceptible to cavity spot. Overall, the disease incidence was high (10 – 90 %) and severity was moderate (4 – 43 %) in the trial.

Table 1. Incidence and severity cavity spot on carrots cultivars, grown on muck soils at the Muck Crops Research Station, Holland Marsh, Ontario, 2020

Cultivars	Color	Cavity spot assessment			
		At mid-season		At harvest	
		Incidence (%)	DSI[1]	Incidence (%)	DSI
Envy	Orange	50.0 a[2]	23.7 ns[3]	89.3 a	42.8 a
Atomic Red	Red	43.8 a	22	77.0 ab	39.1 ab
Honey Snax	Orange	46.3 a	20	70.3 ab	34.5 ab
Triton	Orange	50.0 a	25.7	67.4 ab	31.9 ab
Nairobi	Orange	48.8 a	24.7	63.7 ab	26.1 ab
Uppercut	Orange	43.8 a	23	58.8 b	25.4 b
Cellobunch	Orange	40.0 ab	18	50.9 b	25.3 b
Purple Haze	Purple	23.8 b	11.7	10.2 c	4.1 c

[1] DSI indicates disease severity index calculated as

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

[2] Numbers in column followed by same letter are not significantly different at $P = 0.05$, Tukey`s Test.
[3] ns indicates no significant difference were found among these treatments.

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

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

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

TITLE: TOLERANCE OF CARROT TO PYRIDATE, 2020

MATERIALS: BCP258H (pyridate 600 g/L), BP1047H (pyridate 300 g/kg), ZIDUA (pyroxasulfone 850 g/kg), LOROX-L (linuron 480 g/L), DUAL II MAGNUM (S-metolachlor/benoxacor 915 g/L), PROWL H_2O (pendimethalin 455 g/L)

METHODS: Carrots, cv. Enterprise, were direct seeded (25 seeds per foot of row) on 21 May 2020 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 two rows (85 cm apart), 5 m in length.

Treatments were:

1. BCP258H at 900 g ai/ha applied at the 2-3 leaf stage of carrots.
2. BP1047H at 900 g ai/ha applied at the 2-3 leaf stage of carrots.
3. BP1047H at 600 g ai/ha applied at the 2-3 leaf stage of carrots.
4. BP1047H at 300 g ai/ha applied at the bunny ear stage of carrots followed by BP1047H at 300 g ai/ha applied at the 2-3 leaf stage of carrots followed by BP1047H at 600 g ai/ha applied at the 5-7 leaf stage of carrots.
5. BP1047H at 300 g ai/ha tankmixed with pyroxasulfone at 89 g ai/ha applied at the bunny ear stage of carrots followed by BP1047H at 300 g ai/ha tankmixed with linuron at 1000 g ai/ha applied at the 2-3 leaf stage of carrots followed by BP1047H at 300 g ai/ha tankmixed with linuron at 1000 g ai/ha applied at the 5-7 leaf stage of carrots.
6. BP1047H at 300 g ai/ha tankmixed with S-metolachlor at 1098 g ai/ha applied at the bunny ear stage of carrots followed by BP1047H at 300 g ai/ha tankmixed with linuron at 1000 g ai/ha applied at the 2-3 leaf stage of carrots followed by BP1047H at 300 g ai/ha tankmixed with linuron at 1000 g ai/ha applied at the 5-7 leaf stage of carrots.
7. BP1047H at 300 g ai/ha tankmixed with pendimethalin at 1680 g ai/ha applied at the bunny ear stage of carrots followed by BP1047H at 300 g ai/ha tankmixed with linuron at 1000 g ai/ha applied at the 2-3 leaf stage of carrots followed by BP1047H at 300 g ai/ha tankmixed with linuron at 1000 g ai/ha applied at the 5-7 leaf stage of carrots.

A weed free check was included. All plots were maintained weed free using standard management practices. Treatments were applied on 06 June 2020 (E-POST - bunny ear stage of carrots), 18 June 2020 (M-POST - 2-3 leaf stage of carrots) and 06 July 2020 (L-POST - 5-6 leaf stage of carrots) using a backpack sprayer fitted with AIXR 11002 spray nozzles at 206.84 kPa calibrated to deliver 200 litres/ha spray solution. On 15 October, the carrots in two 1.16 m sections of each row were pulled for a yield sample. Carrots were graded for size and weighed on 24 November to determine marketable yield.
Data were analyzed using the ARM Revision 2020.5 Analysis of Variance function. Means separation was obtained by using Tukey's HSD test at $P = 0.05$ level of significance.

RESULTS: as presented in Table 1.

CONCLUSIONS: This data is the first trial on muck soil to test the potential of pyridate as an herbicide for carrots. Both formulations of pyridate, BCP258H and BP1047H, were equally safe on carrots when applied M-POST at the 2 to 3 leaf stage of carrot growth. No visible injury with POST treatments of pyridate ranging in dose from 600 to 900 g ai/ha applied at the 2 to 3 leaf stage. BP1047H applied at 300 g ai/ha did

not cause crop injury when applied at the cotyledon (bunny ear) stage of carrot growth. Tank mixtures of BP104H plus pyroxasulfone, S-metolachlor or pendimethalin applied at the cotyledon stage of carrots did not cause crop injury. Carrot yields did not differ with herbicide treatment.

Table 1. Yield for carrots, cv. Enterprise, treated with pyridate herbicide and grown at Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Treatments	Yield – marketable (t/ha)
Weed free check	43.43[1]
BCP258H at 900 g ai/ha M-POST	37.00
BP1047H at 900 g ai/ha M-POST	39.92
BP1047H at 600 g ai/ha M-POST	39.30
BP1047H at 300 g ai/ha E-POST fb BP1047H at 300 g ai/ha M-POST fb BP1047H at 300 g ai/ha L-POST	44.70
BP1047H at 300 g ai/ha + pyroxasulfone at 89 g ai/ha E-POST fb BP1047H at 300 g ai/ha + linuron at 1000 g ai/ha M-POST fb BP1047H at 300 g ai/ha + linuron at 1000 g ai/ha L-POST	34.92
BP1047H at 300 g ai/ha + S-metolachlor at 1098 g ai/ha E-POST fb BP1047H at 300 g ai/ha + linuron at 1000 g ai/ha M-POST fb BP1047H at 300 g ai/ha + linuron at 1000 g ai/ha L-POST	34.17
BP1047H at 300 g ai/ha + pendimethalin at 1680 g ai/ha E-POST fb BP1047H at 300 g ai/ha + linuron at 1000 g ai/ha M-POST fb BP1047H at 300 g ai/ha + linuron at 1000 g ai/ha L-POST	42.72

[1] No significant differences were found among treatments at P = 0.05 Tukey's HSD test.

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 Belchim Crop Protection Canada.

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

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

TITLE: WEED MANAGEMENT IN CARROTS, 2020

MATERIALS: GESAGARD (prometryne 480 g/l), PARDNER (bromoxynil 280 g/l), ZIDUA (pyroxasulfone 850 g/Kg), BLAZER (aciflurofen 240 g/l), LOROX-L (linuron 480 g/l), GOAL 2XL (oxyfluorfen 240 g/l), DUAL II MAGNUM (S-metolachlor/benoxacor 915 g/l), PROWL H_2O (pendimethalin 455 g/l), SENCOR (metribuzin 480 g/l)

METHODS: Carrots, cv. Enterprise, were direct seeded (25 seeds per foot of row) on 21 May 2020 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 two rows (85 cm apart), 5 m in length.

Treatments were:

1. Prometryne at 3400 g ai/ha preemergence
   fb bromoxynil at 300 g ai/ha preemergence (just prior to carrot emergence)
   fb pyroxasulfone at 89 g ai.ha at the bunny ear stage of carrots
   fb aciflurofen at 18.75 g ai/ha at bunny ear – 1 leaf stage of carrots
   fb aciflurofen at 18.75 g ai/ha + linuron at 1000 g ai/ha at the 1-3 leaf stage of carrots
   fb oxyfluorfen at 60 g ai/ha + linuron at 1000 g ai/ha late post emergence

2. Prometryne at 3400 g ai/ha preemergence
   fb bromoxynil at 300 g ai/ha preemergence (just prior to carrot emergence)
   fb pendimethalin at 1680 g ai/ha at the bunny ear stage of carrots
   fb aciflurofen at 18.75 g ai/ha at bunny ear – 1 leaf stage of carrots
   fb aciflurofen at 18.75 g ai/ha + linuron at 1000 g ai/ha at the 1-3 leaf stage of carrots
   fb oxyfluorfen at 60 g ai/ha + linuron at 1000 g ai/ha late post emergence

3. Prometryne at 3400 g ai/ha preemergence
   fb bromoxynil at 300 g ai/ha preemergence (just prior to carrot emergence)
   fb S-metolachlor at 1098 g ai/ha at the bunny ear stage of carrots
   fb aciflurofen at 18.75 g ai/ha at bunny ear – 1 leaf stage of carrots
   fb aciflurofen at 18.75 g ai/ha + linuron at 1000 g ai/ha at the 1-3 leaf stage of carrots
   fb oxyfluorfen at 60 g ai/ha + linuron at 1000 g ai/ha late post emergence

4. Prometryne at 3400 g ai/ha preemergence
   fb bromoxynil at 300 g ai/ha preemergence (just prior to carrot emergence)
   fb pyroxasulfone at 89 g ai.ha at the bunny ear stage of carrots
   fb aciflurofen at 18.75 g ai/ha at bunny ear – 1 leaf stage of carrots
   fb aciflurofen at 18.75 g ai/ha + metribuzin at 140 g ai/ha at the 1-3 leaf stage of carrots
   fb oxyfluorfen at 60 g ai/ha + linuron at 1000 g ai/ha late post emergence

5. Prometryne at 3400 g ai/ha preemergence
   fb bromoxynil at 300 g ai/ha preemergence (just prior to carrot emergence)
   fb pyroxasulfone at 89 g ai.ha at the bunny ear stage of carrots
   fb aciflurofen at 18.75 g ai/ha at bunny ear – 1 leaf stage of carrots
   fb aciflurofen at 18.75 g ai/ha + linuron at 1000 g ai/ha at the 1-3 leaf stage of carrots

fb pyroxasulfone at 89 g ai.ha at the 3-4 leaf stage of carrot
fb oxyfluorfen at 60 g ai/ha + linuron at 1000 g ai/ha late post emergence

6. Prometryne at 3400 g ai/ha preemergence
   fb bromoxynil at 300 g ai/ha preemergence (just prior to carrot emergence)
   fb pyroxasulfone at 89 g ai.ha at the bunny ear stage of carrots
   fb aciflurofen at 18.75 g ai/ha at bunny ear – 1 leaf stage of carrots
   fb aciflurofen at 18.75 g ai/ha + linuron at 1000 g ai/ha at the 1-3 leaf stage of carrots
   fb S-metolachlor at 1098 g ai/ha at the 3-4 leaf stage of carrots
   fb oxyfluorfen at 60 g ai/ha + linuron at 1000 g ai/ha late post emergence

7. Prometryne at 3400 g ai/ha preemergence
   fb bromoxynil at 300 g ai/ha preemergence (just prior to carrot emergence)
   fb pendimethalin at 1680 g ai/ha at the bunny ear stage of carrots
   fb aciflurofen at 18.75 g ai/ha at bunny ear – 1 leaf stage of carrots
   fb aciflurofen at 18.75 g ai/ha + linuron at 1000 g ai/ha at the 1-3 leaf stage of carrots
   fb pyroxasulfone at 89 g ai.ha at the 3-4 leaf stage of carrots
   fb oxyfluorfen at 60 g ai/ha + linuron at 1000 g ai/ha late post emergence

Treatments were applied on 06 June 2020 (BE - bunny ear stage of carrots), 11 June 2020 (E-POST - bunny ear-1 lf carrot), 18 June 2020 (M-POST - 1-3 lf carrot) and 06 July 2020 (L-POST - 4-5 lf carrot) using a backpack sprayer fitted with AIXR 11002 spray nozzles at 206.84 KPa calibrated to deliver 200 litres/ha spray solution. Prometryne at 3400 g ai/ha preemergence, bromoxynil at 300 g ai/ha preemergence (just prior to carrot emergence) and oxyfluorfen at 60 g ai/ha + linuron at 1000 g ai/ha late post emergence were blanket treatments applied to all plots. A weed free check was included.
On 15 October, the carrots in two 1.16 m sections of each row were pulled for a yield sample. Carrots were graded for size and weighed on 24 November to determine marketable yield.
Data were analyzed using the ARM Revision 2020.5 Analysis of Variance function. Means separation was obtained by using Tukey's HSD test at $P = 0.05$ level of significance.

RESULTS: as presented in Table 1.

CONCLUSIONS: Zidua (pyroxasulfone), Prowl H_2O (pendimethalin), Dual II Magnum (S-metolachlor/benoxacor) and Blazer (acifluorfen) applied POST at the cotyledon stage (bunny ears) of carrots did not cause crop injury or reduce plant stand (data not shown). Tank mixtures of Blazer (acifluorfen) plus Sencor (metribuzin), or Lorox-L (linuron) were also found to be safe on carrots when applied POST at the 1 to 3 leaf stage. Goal 2XL (oxyfluorfen) plus Lorox-L (linuron) appled POST at growth stages of 4 to 8 leaves did not cause significant crop injury (data not shown). Marketable carrot yields in this trial did not significantly differ with treatment.

Table 1. Yield for carrots, cv. Enterprise, treated with herbicide and grown at Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Treatment	Yield (Marketable) T/ha
Weed free check	
GESAGARD (PREEMERGENCE) fb PARDNER (late PREEMERGENCE) fb GOAL 2XL + LOROX-L (4-8 lf stage)	53.3[1]
GESAGARD (PREEMERGENCE) fb PARDNER (late PREEMERGENCE) fb ZIDUA (Bunny Ear stage) fb BLAZER (E-POST stage) fb BLAZER + LOROX-L (M-POST stage) fb GOAL 2XL + LOROX-L (4-8 lf stage)	47.7
GESAGARD (PREEMERGENCE) fb PARDNER (late PREEMERGENCE) fb PROWL H_2O (Bunny Ear stage) fb BLAZER (E-POST stage) fb BLAZER + LOROX-L (M-POST stage) fb GOAL 2XL + LOROX-L (4-8 lf stage)	56.4
GESAGARD (PREEMERGENCE) fb PARDNER (late PREEMERGENCE) fb DUAL II MAGNUM (Bunny Ear stage) fb BLAZER (E-POST stage) fb BLAZER + LOROX-L (M-POST stage) fb GOAL 2XL + LOROX-L (4-8 lf stage)	53.4
GESAGARD (PREEMERGENCE) fb PARDNER (late PREEMERGENCE) fb ZIDUA (Bunny Ear stage) fb BLAZER (E-POST stage) fb BLAZER + SENCOR (M-POST stage) fb GOAL 2XL + LOROX-L (4-8 lf stage)	47.6
GESAGARD (PREEMERGENCE) fb PARDNER (late PREEMERGENCE) fb ZIDUA (Bunny Ear stage) fb BLAZER (E-POST stage) fb BLAZER + LOROX-L (M-POST stage) fb ZIDUA (L-POST stage) fb GOAL 2XL + LOROX-L (4-8 lf stage)	54.6

GESAGARD (PREEMERGENCE) fb PARDNER (late PREEMERGENCE) fb ZIDUA (Bunny Ear stage) fb BLAZER (E-POST stage) fb BLAZER + LOROX-L (M-POST stage) fb DUAL II MAGNUM (L-POST stage) fb GOAL 2XL + LOROX-L (4-8 lf stage)	54.4
GESAGARD (PREEMERGENCE) fb PARDNER (late PREEMERGENCE) fb PROWL H2O (Bunny Ear stage) fb BLAZER (E-POST stage) fb BLAZER + LOROX-L (M-POST stage) fb DUAL II MAGNUM (L-POST stage) fb GOAL 2XL + LOROX-L (4-8 lf stage)	56.4

[1] No significant differences were found among treatments at P = 0.05 Tukey's HSD test

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 The Bradford Co-operative Storage Limited

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

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TITLE: EVALUATION OF VARIOUS INSECTICIDES FOR CONTROL OF MAGGOTS IN YELLOW COOKING ONIONS, 2020

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

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 was also included. All treatments also include EVERGOL PRIME for smut control and thiram. 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 for damage plots plus a 2.32 m section for a yield sample were staked out in each replicate. Emergence counts were conducted within the 2 m staked sections on 29 May to determine initial stands. Beginning on 3 June and continuing weekly, onion plants within the 2 m sections were examined for loss due to maggot damage or damage caused by other pests. Damaged onions were removed, and numbers and the cause of damage recorded. The remaining onions within the assigned 2 m sections were removed and visually examined for maggot damage on 29 June (three weeks after the first generation peak), 29 July (three weeks after the second generation peak) and after lodging on 21 September. On 16 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 2020 were above average for July (23.3°C), average for June (19.2°C), August (20.6°C), and below average for May (11.6°C) and September (15.0°C). The 10-year average temperatures were: May 14.2°C, June 18.5°C, July 21.5°C, August 20.3°C and September 16.5°C. Monthly rainfall was above the 10-year average for August (140 mm), average for September (65 mm), and below average for May (38 mm), June (77 mm) and July (58 mm). The 10-year rainfall averages were: May 73 mm, June 103 mm, July 84 mm, August 76 mm and September 62 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 number of onions lost to maggot damage were found among the treatments at all assessments (Table 2). After the 1st generation of maggot damage, onions grown from seeds treated with SEPRESTO or REGARD + CRUISER had fewer losses due to maggot damage than the GOVERNOR treatment or the check seed. After the 2nd generation of maggot damage and at the harvest assessment, all insecticide seed treatments had statistically fewer loses than the untreated check. Significant differences in yield and onions per meter at harvest were found among the treatments (Table 3). All insecticide seed treatments resulted in higher yields than the untreated check and SEPRESTO,

REGARD+ CRUISER and REGARD alone had more onions per meter than the untreated check. No significant differences in yield or size distribution were found among the treatments.

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, 2020.

#	Treatment[1]	Insecticide Active Ingredients and Label Rates
1	Check seed	–
2	REGARD	spinosad 0.2 g ai/1,000 seeds
3	REGARD + CRUISER	spinosad 0.2 g ai + thiamethoxam 0.2 g ai/1,000 seeds
4	SEPRESTO	clothianidin 0.18 g ai + imidacloprid 0.6 g ai/1,000 seeds
5	GOVERNOR	cyromazine 49.5 g ai/kg

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

Table 2. Emergence and percentage of onions (cv. Fortress) lost due to maggot damage, treated with various insecticide seed treatments, pelleted by Incotec and grown at the Muck Crop Research Station, Holland Marsh, Ontario, 2020.

Treatment[1]	Emergence (plants/m)	% Onions lost due to maggot damage		
		1st Gen	1st & 2nd Gen	Total Season
SEPRESTO	25.9 ns[2]	3.4 a[3]	16.1 a	5.0 a
REGARD + CRUISER	26.2	5.0 a	19.2 a	13.6 a
REGARD	24.5	12.3 ab	16.3 a	8.2 a
GOVERNOR	20.1	15.5 b	8.5 a	12.5 a
Check seed	21.3	36.7 c	51.9 b	53.8 b

[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.
[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, number and size distribution for onions, cv. Fortress, treated with various insecticide seed treatments, pelleted by Incotec and grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Treatment[1]	Yield (t/ha)	Onions/ m	Size Distribution[2] (%)			
			Jumbo (>76mm)	Large (76-64 mm)	Medium (>64-45 mm)	Cull[3] (<45mm)
SEPRESTO	76.8 a[4]	21.2 a	24.2 ns[5]	48.3 ns	26.7 ns	0.8 ns
GOVERNOR	67.5 a	15.3 ab	38.0	51.9	10.0	0.1
REGARD + CRUISER	62.7 a	16.9 a	31.1	43.0	25.4	0.4
REGARD	62.3 a	17.2 a	28.9	43.0	27.4	0.7
Check seed	34.1 b	7.3 b	53.0	33.9	12.8	0.3

[1] See treatment details listed in Table 1.
[2] Size distribution was based on weights.
[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 was provided by Incotec for seed pelleting, Bayer Crop Science for the Sepresto insecticide, the Plant Production Systems of the Ontario Agri-Food Innovation Alliance and the California Garlic and Onion Research Advisory Board. Dr. Taylor's effort was supported under the United States Multi-State project, W-3168.

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

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TITLE: EVALUATION OF VARIOUS FUNGICIDES FOR CONTROL OF ONION SMUT IN YELLOW COOKING ONIONS, 2020

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%), FARMORE F300 ((APRON XL(metalaxyl-M and S-isomer 33.3%), MAXIM 4 FS (fludioxonil 40.3%), DYNASTY (azoxystrobin 9.6%))

METHODS: The trial was conducted on organic soil (pH ≈ 6.3, organic matter ≈ 69.0%) 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 and PRO-GRO + FARMORE 300 (See Table 1 for rates). A no-fungicide check was also included. Both treatments and pelleting were done by Incotec using standard methods. Three randomly chosen 2 m sections of row to be used as damage plots and a 2.32 m yield section were staked out in each replicate. Emerged onions were counted within the 2 m sections on 29 May to determine initial stands. Beginning on 3 June and continuing weekly, onion plants within the 2 m staked sections were examined for onions lose due to onion smut or damage caused by other pests. Damaged onions were removed and numbers and the cause of damage recorded. The remaining onions within the assigned 2 m sections were removed and visually examined for smut damage at the first true-leaf stage (8 June), at the 3-leaf stage (24 June) and after lodging (2 September). On 16 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 2020 were above average for July (23.3°C), average for June (19.2°C), August (20.6°C), and below average for May (11.6°C) and September (15.0°C). The 10-year average temperatures were: May 14.2°C, June 18.5°C, July 21.5°C, August 20.3°C and September 16.5°C. Monthly rainfall was above the 10-year average for August (140 mm), average for September (65 mm), and below average for May (38 mm), June (77 mm) and July (58 mm). The 10-year rainfall averages were: May 73 mm, June 103 mm, July 84 mm, August 76 mm and September 62 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 and 3.

CONCLUSIONS: Significant differences in the incidence of smut at the 1st and 3rd-leaf stages and at harvest were found among the treatments (Table 2). At the 1st-leaf stage, onions treated with any fungicide treatment had less smut than the check and onions treated with EVERGOL PRIME had less smut than the RANCONA and PRO-GRO treatments.
At the 3rd-leaf stage, onions treated with EVERGOL PRIME, PRO-GRO + F300, and PRO-GRO had less smut (0 - 6%) than onions treated with RANCONA (17%) or the check (15%). By harvest, onions grown from seeds treated with EVERGOL PRIME had less smut than onions treated with RANCONA or untreated onions and had a similar smut incidence to the PRO-GRO + FARMORE 300 and PRO-GRO treatments.

At the harvest assessment, onions treated with EVERGOL PRIME or PRO-GRO + F300 had a significantly lower incidence of smut (1.6 & 3% respectively) than the check (11%).
More smut was found in untreated onions at the 1st true leaf stage (19%), compared to smut incidence at harvest (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 harvest, smut incidence was lower but is located in the bulb and will result in an unmarketable onion.
Significant differences in yield and onions per meter were found among the treatments (Table 3). Onions treated with EVERGOL PRIME, PRO-GRO, or PRO-GRO + F300 had significantly higher yields (68 - 74 t/ha) than the check (51 t/ha). Onions treated with any fungicide had more onions per meter than the check. No differences in size distribution were found among the treatments.

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, 2020.

#	Treatment	Fungicide Active Ingredients and Label Rates
1	Check seed	–
2	EVERGOL PRIME	penflufen 0.0087 g ai/1,000 seeds
3	RANCONA	ipconazole at 100 g ai/100 g seed
4	PRO-GRO	carboxin 7.50 g ai + thiram 12.5 g ai per kg seed
5	PRO-GRO + FARMORE F300	carboxin 7.50 g ai, thiram 12.5 g ai/kg seed + APRON XL (metalaxyl-M and S-isomer 33%), MAXIM 4FS (fludioxonil 40.3%), DYNASTY (azoxystrobin 9.6%)

[1] All pellets also included the 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.

Table 2. Smut incidence for onions, cv. Fortress, treated with various fungicides and grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Treatment[1]	29 May Emergence (plants/m)	Smut Incidence (%)		
		1st True Leaf	3rd-leaf Stage	Harvest
PENFLUFEN	23.1 ns[2]	1.0 a[3]	0.0 a	1.6 a[4]
PRO-GRO + F300	23.6	5.7 ab	6.3 a	2.9 ab
PRO-GRO	23.8	6.9 b	3.8 a	5.4 abc
RANCONA	25.0	6.1 b	16.8 b	8.8 bc
Check (thiram)	23.0	19.0 c	14.9 b	11.1 c

[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.
[4] P = 0.06, but letters showing significant differences were added.

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, 2020.

Treatment[1]	Yield (t/ha)	Onions/m	Size Distribution[2] (%)			
			Jumbo (>76 mm)	Large (76-64 mm)	Medium (<64-45 mm)	Cull (<45 mm)
EVERGOL PRIME	68.2 ab[3]	19.2 b	15.0 ns[4]	59.5 ns	24.8 ns	0.6 ns
PRO-GRO + F300	71.3 ab	20.0 ab	19.0	56.9	23.7	0.3
PRO-GRO	74.3 a	22.9 a	8.1	55.8	35.0	1.1
RANCONA	65.2 b	17.9 b	22.2	53.6	23.6	0.5
Check (thiram)	51.1 c	14.0 c	25.2	54.0	19.7	1.1

[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] Percentages were determined by weight
[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 differences were found among the treatments

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

CROP: Yellow cooking onions (*Allium cepa* L.), cv. Traverse
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, 2020

MATERIALS: LUNA TRANQUILITY (fluopyram 125 g/L, pyrimethanil 375 g/L), APROVIA TOP (benzovindiflupyr 78 g/L, difenoconazole 117 g/L), QUADRIS TOP (azoxystrobin 200 g/L, difenoconazole 125 g/L), SERCADIS (fluxapyroxad 300 g/L), T-77 (*Trichoderma atroviride* strain 77B ≥ 2.5 x 10^9 spores/g), PREV-AM (sodium tetraborohydrate decahydrate 0.99%), BRAVO ZN (chlorothalonil 500 g/L), DITHANE RAINSHIELD WG (mancozeb 75.0%), EVERGOL PRIME (penflufen 22.7%), PRO-GRO (carboxin 30% + thiram 30%)

METHODS: Onions, cv. Traverse, were direct seeded (≈ 35 seeds/m) on 6 May into organic soil (organic matter ≈ 68.1%, pH ≈ 6.2) using a Stanhay precision seeder at the Muck Crops Research Station, Holland Marsh, Ontario. Treatments were arranged in a split-plot design with four replicates, fungicide treatments as the main plot factor and a penflufen seed treatment or the commercial standard (PRO-GRO pelleted + DITHANE WG at 8.8 kg/ha in-furrow) as the subplot factor. Each subplot consisted of four rows (40 cm apart), 6 m in length. Fungicide sprays were applied to side by side subplots (eight rows) on 26 June, 6, 15, 24 July and 6 August using a tractor-mounted sprayer fitted with hollow cone D-3 spray nozzles at 620 kPa to deliver 500 L solution/ha. Fungicide treatments were: LUNA TRANQUILITY at 1.2 L/ha alternated with QUADRIS TOP at 1.0 L/ha, APROVIA TOP at 767 mL/ha, T-77 at 250 g/ha, SERCADIS at 666 mL/ha, PREV-AM at 0.4% v/v, SERCADIS at 666 mL/ha and APROVIA TOP at 767 mL/ha alternated with T-77 at 250 g/ha, SERCADIS at 666 mL/ha + BRAVO ZN at 2.4 L/ha alternated with DITHANE at 2.5 kg/ha, APROVIA TOP at 767 mL/ha + BRAVO ZN at 2.4 L/ha alternated with QUADRIS TOP at 1.0 L/ha + DITHANE at 2.5 kg/ha (See Table 1). An untreated check was also included. On 26 June, 6, 13, 21, 27 July, in-field assessments were conducted using the three oldest leaves on 20 randomly chosen onions per replicate. The area of the leaf infected with Stemphylium was rated using a 0-4 scale where 0 = no symptoms, 1 = 1-10%, 2 = 11-25%, 3 = 26-50%, 4= >50%. The rating for the plant is the sum of the score of the three leaves. The number of plants in each class was used to determine the disease severity index (DSI) using the following formula:

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

and the area under the disease progress curve (AUDPC) using the following formula:

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

Where j is the order index for the times and n_j is the total number of assessments, y_j is the average OT count at day t_j, y_{j+1} is the average OT count at day t_{j+1} and (t_{j+1} - t_j) is the number of days between two assessments. On 11 August, the green leaves of 20 onion plants randomly chosen from the inner rows of every replicate were removed and sorted into classes based on the percentage of the leaf area infected with stemphylium. The 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. Dead leaves were counted separately. The number of leaves in each class were used to determine the disease severity index (DSI) using the above formula. On 10 September, the onions in two 2.32 m sections of row were pulled from the inner 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 2020 were above average for July (23.3°C), average for June (19.2°C), August (20.6°C), and below average for May (11.6°C) and September (15.0°C). The 10-year average temperatures were:

May 14.2°C, June 18.5°C, July 21.5°C, August 20.3°C and September 16.5°C.
Monthly rainfall was above the 10-year average for August (140 mm), average for September (65 mm), and below average for May (38 mm), June (77 mm) and July (58 mm). The 10-year rainfall averages were: May 73 mm, June 103 mm, July 84 mm, August 76 mm and September 62 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 2, 3 & 4.

CONCLUSIONS: Stemphylium incidence was moderate in 2020 and increased through July. Significant differences in disease severity were observed on 6 and 21 July among fungicide treatments (Table 2). Onions (with and without a penflufen seed treatment) sprayed with T-77, SERCADIS, LUNA TRANQUILITY alternated with QUADRIS TOP, SERCADIS alternated with T-77 or PREV-AM had a significantly lower area under the disease progress curve (AUDPC) than onions treated with APROVIA TOP alternated with T-77, SERCADIS + BRAVO ZN alternated with DITHANE, APROVIA TOP + BRAVO ZN alternated with QUADRIS TOP + DITHANE and onions not sprayed with a fungicide.
Onions grown from seeds treated with PENFLUFEN had a lower AUDPC than onions treated with PRO-GRO + DITHANE (Table 3). No significant differences in stemphylium severity were found among the fungicide treatments for the in-field rating on 27 July or at the 11 August destructive final assessment (Table 3). No significant differences in yield or size distribution were observed among the treatments (Table 4).

Table 1. Fungicide treatments applied to onions, cv. Traverse, with and without EVERGOL PRIME seed treatments, grown at Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Trt #	Treatment[1] abbreviations	26 Jun	6 Jul	15 Jul	24 Jul	6 Aug
1	LT or QT	LUNA TRANQUILITY	QUADRIS TOP	LUNA TRANQUILITY	QUADRIS TOP	LUNA TRANQUILITY
2	AT	APROVIA TOP	APROVIA TOP	APROVIA TOP	APROVIA TOP	APROVIA TOP
3	SERC	SERCADIS	SERCADIS	SERCADIS	SERCADIS	SERCADIS
4	T-77	T-77	T-77	T-77	T-77	T-77
5	PREV-AM	PREV-AM	PREV-AM	PREV-AM	PREV-AM	PREV-AM
6	SERC or T-77	SERCADIS	T-77	SERCADIS	T-77	SERCADIS
7	AT or T-77	APROVIA TOP	T-77	APROVIA TOP	T-77	APROVIA TOP
8	SERC+BR or DITH	SERCADIS + BRAVO ZN	DITHANE	SERCADIS + BRAVO ZN	DITHANE	SERCADIS + BRAVO ZN
9	AT+BR or QT+DITH	APROVIA TOP + BRAVO ZN	QUADRIS TOP + DITHANE	APROVIA TOP + BRAVO ZN	QUADRIS TOP + DITHANE	APROVIA TOP + BRAVO ZN
10	Check	-	-	-	-	-

[1] LT (Luna Tranquility) at 1.2 L/ha, QT (Quadris Top) at 1.0 L/ha, AT (Aprovia Top) at 767 mL/ha, SERC (Sercadis) at 666 mL/ha, T-77 at 250 g/ha, PREV-AM at 0.4% v/v, BR (Bravo Zinc) at 2.4 L/ha, DITH (Dithane Rainshield WG) at 2.5 kg/ha

Table 2. Area under the disease progress curve (AUDPC) for onions, cv. Traverse, treated with and without a penflufen seed treatment and sprayed with various fungicides at the Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Trt #	Fungicide[1]	AUDPC[2]	DSI[3]			
			6 July	21 July	27 July	11 Aug[4]
4	T-77	182.2 a[5]	1.6 a-d	4.9 ab	26.6 ns[6]	23.6 ns
3	SERC	184.4 a	1.7 a-d	4.7 ab	28.0	23.1
1	LT or QT	190.1 a	0.9 a	5.2 ab	24.7	22.4
6	SERC or T-77	190.2 a	1.0 ab	7.2 cd	26.4	21.6
5	PREV-AM	196.5 a	2.0 cd	6.1 a-d	26.7	26.8
2	AT	201.9 ab	1.1 abc	4.5 a	27.9	26.4
7	AT or T-77	231.0 bc	1.9 b-d	6.4 bcd	28.0	23.8
8	SERC+BR or DITH	235.4 c	2.3 d	7.9 d	27.6	26.2
9	AT+BR or QT+DITH	245.4 c	1.4 abc	6.3 a-d	27.6	24.4
10	check	248.4 c	1.9 b-d	5.8 abc	27.6	26.0

* Data were combined as there was no significant interaction for seed treatment by fungicide.

[1] See Table 1 for fungicide product names and rates.

[2] Area under the disease progress curve (AUDPC) was based on the disease severity index for 26 June, 6, 13, 21 & 27 July and was determined using the following equation:

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

[3] Disease severity (DSI) was calculated using the following formula:

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

[4] The 11 August DSI was not used in the AUDPC calculation and was based on the destructive assessment, sorting leaves of 20 plants into classes: 0= no disease, 1 = 1-4%, 2 = 5-10%, 3 = 11-25%, 4 = 26-50%, 5 = 51-75%, 6 > 75% based on the percentage of leaf area infected with stemphylium.

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

[6] ns = no significant differences were found among treatments at P = 0.05, Fisher's Protected LSD test.

Table 3. Area under the disease progress curve (AUDPC) for onions, cv. Traverse, treated with and without a penflufen seed treatment and sprayed with various fungicides at the Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Seed treatment	AUDPC[1]	DSI					
		26 June	6 July	13 July	21 July	27 July	11 Aug[2]
PENFLUFEN	178.6 a[3]	0.50 ns[4]	1.3 a	6.3 a[5]	5.7 ns	25.9 a	24.7 ns
PRO-GRO + DITHANE	242.5 b	0.57	1.9 b	12.7 b	6.2	28.4 b	24.1

* Data for fungicide sprays were combined as there was no significant interaction for seed treatment by fungicide.
[1] Area under the disease progress curve (AUDPC) was based on the DSI for 26 June, 6, 13, 21 & 27 July and was determined using the following equation:

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

[2] The destructive assessment, sorting leaves of 20 plants into classes: 0= no disease, 1 = 1-4%, 2 = 5-10%, 3 = 11-25%, 4 = 26-50%, 5 = 51-75%, 6 > 75% based on the percentage of leaf area infected with stemphylium, was used to calculate the 11 August DSI and was not used in the AUDPC calculation.
[3] Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fishers Protected LSD test.
[4] ns = no significant differences
[5] There was a significant seed treatment by fungicide interaction.

Table 4. Yield data for onions, cv. Traverse, treated with and without a penflufen seed treatment and sprayed with various fungicides at the Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Trt #	Fungicide[1]	Yield (t/ha)	% Mkb	Size distribution (%)			
				Jumbo (>76mm)	Large (76-64 mm)	Medium (>64-45 mm)	Cull (<45mm)
1	LT or QT	80.0 ns[2]	99.1 ns	18.3 ns	61.2 ns	19.6 ns	0.9 ns
7	AT or T-77	79.9	99.0	19.5	59.4	20.0	1.0
5	PREV AM	79.3	99.4	20.0	59.3	20.0	0.6
6	SER or T-77	78.5	99.4	26.2	55.2	18.0	0.6
8	SER+BR or DITH	78.4	98.9	11.5	61.5	25.9	1.1
2	AT	78.2	96.7	20.9	57.3	18.5	3.3
3	SER	77.8	99.2	23.6	55.6	20.0	0.8
4	T-77	77.4	97.5	16.4	60.4	20.6	2.5
9	AT+BR or QT+DITH	74.3	98.9	16.0	58.3	24.6	1.1
10	check	72.4	98.5	21.3	56.0	21.3	1.4

*Data were combined as there was no statistical interaction for seed treatment by fungicide.
[1] See Table 1 for fungicide product names and rates.
[2] ns = no significant differences at P = 0.05, Fisher's Protected LSD test.

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, the California Onion and Garlic Research Advisory Board and the Bradford Co-operative and Storage.

CROP: Yellow cooking onions (*Allium cepa* L.), cvs. Traverse, Milestone, Monastrell
PEST: Stemphylium leaf blight (*Stemphylium vesicarium* (Wallr.))

AUTHORS: MCDONALD MR & VANDER KOOI K
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TITLE: EVALUATION OF EVERGOL PRIME FOR MANAGEMENT OF STEMPHYLIUM LEAF BLIGHT ON ONIONS, 2020

MATERIALS: EVERGOL PRIME (penflufen 22.7%)

METHODS: Onions, cvs. Traverse, Milestone and Monastrell were direct seeded (≈ 35 seeds/m) on 6 May into organic soil (organic matter ≈ 65.3%, pH ≈ 6.5) at the Muck Crops Research Station, Holland Marsh, Ontario using a Stanhay precision seeder. A randomized complete block design with four replicates per treatment was used. Each experimental unit consisted of four rows (43 cm apart), 6 m in length. Treatments were: cvs. Traverse and Milestone with and without EVERGOL PRIME, and Monastrell without EVERGOL PRIME. On 26 June, 6, 13, 21, 28 July and 6 August, in-field Stemphylium assessments were conducted using the three oldest leaves on 20 randomly chosen onions per replicate. The area of the leaf infected with Stemphylium was rated using a 0-4 scale where 0 = no symptoms, 1 = 1-10%, 2 = 11-25%, 3 = 26-50%, 4= >50%. The rating for the plant is the sum of the score of the three leaves. The number of plants in each class was used to determine the disease severity index (DSI) using the following formula:

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

On 13 August, the non-senescent leaves of 20 onion plants randomly chosen from the inner rows of every replicate were removed and sorted into classes based on the percentage of the leaf area infected with stemphylium. The 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. Dead leaves were counted separately. The number of leaves in each class were used to determine the disease severity index (DSI) using the above formula. On 8 September, the onions in two 2.32 m sections of row were pulled from the inner rows for a yield sample. Onions were weighed and graded for size on 19 October to determine yield**.** Compared to the previous 10-year average, air temperatures in 2020 were above average for July (23.3°C), average for June (19.2°C), August (20.6°C), and below average for May (11.6°C) and September (15.0°C). The 10-year average temperatures were: May 14.2°C, June 18.5°C, July 21.5°C, August 20.3°C and September 16.5°C.
Monthly rainfall was above the 10-year average for August (140 mm), average for September (65 mm), and below average for May (38 mm), June (77 mm) and July (58 mm). The 10-year rainfall averages were: May 73 mm, June 103 mm, July 84 mm, August 76 mm and September 62 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 1-3.

CONCLUSIONS: When all treatments and cultivars are compared, on 6 July Monastrell had the highest stemphylium incidence compared to all other treatments. On 28 July, Traverse with EVERGOL PRIME had less stemphylium than Traverse without, but also had less stemphylium than Milestone with EVERGOL PRIME (Table 1). When data for cultivar are combined, no significant difference in stemphylium incidence was found between the EVERGOL PRIME treatment and the check (Table 2). Cultivar Traverse, with and without EVERGOL PRIME had a higher marketable yield (73 and 79 t/ha respectively) than Monastrell probably due to cultivar differences (Table 3).

Table 1. Stemphylium incidence for onions, cvs. Traverse and Milestone with and without EVERGOL PRIME and Monastrell, grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Cultivar	Fungicide	Stemphylium Incidence (%)					
		26 June	6 July	13 July	21 July	28 July	6 Aug
Traverse	EVERGOL PRIME	23.3 ns[1]	18.7 a[2]	21.2 ns	60.0 ns	92.5a	97.5 ns
Traverse	none	8.3	7.5 a	27.5	58.7	97.5 b	96.2
Milestone	EVERGOL PRIME	10.0	18.7 a	40.0	41.2	97.5 b	97.5
Milestone	none	28.3	18.7 a	35.0	68.7	93.7 ab	95.0
Monastrell	none	21.7	43.7 b	23.7	60.0	93.7 ab	98.7

[1] ns = no significant differences at P = 0.05, Fisher's Protected LSD test.
[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. Stemphylium incidence for onions, cvs. Traverse and Milestone, treated with and without EVERGOL PRIME, grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Fungicide	Stemphylium Incidence (%)				
	26 June	6 July	13 July	21 July	6 Aug
EVERGOL PRIME	16.7 ns[1]	18.7 ns	30.6 ns	50.7 ns	97.5 ns
check	18.3	13.1	31.2	50.6	95.6

*Data for fungicide were combined as there was no interaction between cultivar and fungicide.
[1] ns = no significant differences at P = 0.05, Fisher's Protected LSD test.

Table 3. Yield data for onions, cvs. Traverse and Milestone with and without EVERGOL PRIME and Monastrell, grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Cultivar	Fungicide	Yield (t/ha)	% Mkb	Plant stand (Onions/m)	Size distribution (%)			
					Jumbo (>76mm)	Large (76-64 mm)	Medium (>64-45 mm)	Cull[3] (<45mm)
Traverse	EVERGOL PRIME	73.0 ab[1]	99.0 ns[2]	22.9 ns	12.4 ab	56.6 ns	30.0 ns	1.0 ns
Traverse	-	78.8 a	99.3	24.8	6.3 b	59.2	33.7	0.8
Milestone	EVERGOL PRIME	70.1 b	98.8	25.3	4.9 b	45.4	48.5	1.2
Milestone	-	71.6 b	98.8	23.6	6.3 b	49.8	42.7	1.2
Monastrell	-	58.2 c	98.3	21.3	19.1 a	55.3	23.9	1.7

[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 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.)
PEST: Stemphylium leaf blight (*Stemphylium vesicarium* (Wallr.) E.G. Simmons)

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TITLE: SPORE TRAPPING TO ESTIMATE TIMING OF INFECTION FOR STEMPHYLIUM LEAF BLIGHT OF ONION, 2018–2020

MATERIALS: Burkard Multi-Vial Cyclone Sampler, Sporometrics impact spore traps, DNeasy PowerSoil DNA Isolation Kit, TaqMan Master Mix, rotorod spore sampler

METHODS: A Burkard Multi-Vial Cyclone Sampler was situated in the middle of onion research plots at the Muck Crops Research Station (MCRS), Holland Marsh, Ontario from June–August 2018, 2019, and 2020. Air-borne spores of *Stemphylium vesicarium* were collected into 1.5 ml tubes at an air movement rate of 16.5 L/min from 6:00 am to 12:00 noon. The time for sampling was based on previous studies at MCRS that showed that most spores were released in the morning.

The DNA of spores of *S. vescarium* was extracted using DNeasy PowerSoil DNA Isolation Kit (Qiagen, Toronto). Three primer and probe sets were designed for quantification of DNA from spores using real-time PCR. Taken together, the three primers/probes targeted the internal transcribed spacer (ITS), translational elongation factor EF-1 alpha (TEf-A), and cytochrome b (cytB) genes based on previously DNA-sequenced samples of *S. vesicarium.* Quantitative PCR reactions were performed in a StepOnePlus Real-Time PCR System (Applied Biosystems). Values were represented as spores per day (when comparing with Sporometrics, see below) or converted into spores m^{-3} of air sampled.

In 2020, the efficacy of a passive spore trap was assessed, and spore counts of *S. vescarium* were analyzed by Sporometrics Inc. (Toronto, ON) based on qPCR with their own primer and probe combination. This spore trap was placed near an onion plot at the MCRS. Spores were collected continuously between sample dates and the values are presented as spores per day by dividing the total count by number of days since the last sampling date. Additionally, rotorod samplers were used for routine monitoring of *Botrytis*, *Stemphylium*, *Peronospora*, *Alternaria*, and *Fusarium* species in 2020. The spores stuck to the rotating arms were identified and counted by a trained research assistant using a microscope.

Weekly assessments of stemphylium leaf blight (SLB) incidence and severity were made in the unsprayed control treatment of fungicide-efficacy trials at the MCRS during the growing season in 2018–2020. The onion cultivars in these trials were LaSalle (2018), Fortress (2019), and Traverse (2020). Beds were 6 m x 1.75 m, seeded with four paired rows, with 7.5 cm between paired rows and 35 cm between pairs of rows, with blocks separated by a 1.5 m-wide pathway. Each plot consisted of two adjacent beds in 2018 and 2019, and one bed in 2020. The three oldest leaves on 20 onions per replicate were visually examined for symptoms of SLB and rated on a 0–4 scale where 0 = no SLB symptoms, 1 = 1–10% of leaf, 2 = 11–25%, 3 = 26–50%, 4 =>51% of leaf area with SLB symptoms. The symptoms were mostly chlorosis and leaf dieback but included characteristic lesions. These ratings were used to a disease severity index (DSI).

Weather data were collected each year using an Onset automatic weather station at the MCRS. The correlation between spore counts (qPCR estimates of spores m^{-2} from the cytB primer set) and mean daily air temperature, precipitation, and relative humidity over the growing season was calculated (PROC CORR in SAS) for each year. Also, linear regression (PROC REG) was used to fit a model and create a line of best fit for the spore counts over time.

During the trapping period in 2018 (June 3–August 31: 90 days), air temperature was above the 10-yr average for May, August, and September and monthly rainfall was above the 10-year average for August. In 2019 (May 31–August 27:89 days), May was cooler, and July was above the 10-year average, but monthly rainfall was uncharacteristically low for June, July, and August. In 2020 (June 2–August 30: 90 days). Compared to the previous 10-year average, air temperatures in 2020 were above average for July (23.3°C), average for June (19.2°C), August (20.6°C), and below average for May (11.6°C) and September (15.0°C). The 10-year average temperatures were: May 14.2°C, June 18.5°C, July 21.5°C, August 20.3°C and September 16.5°C. Monthly rainfall was above the 10-year average for August (140 mm), average for September (65 mm), and below average for May (38 mm), June (77 mm) and July (58 mm). The 10-year rainfall averages were: May 73 mm, June 103 mm, July 84 mm, August 76 mm and September 62 mm.

RESULTS: The qPCR successfully amplified 132 samples using the primers for cytB, 129 samples for TEf-a, and 51 samples for ITS. There was a strong correlation between cytB and Tef-a (τ_b = 0.84, $P < 0.0001$), and moderate correlation between cytB and ITS (τ_b = 0.49, $P < 0.0001$) and between TEf-a and ITS (τ_b = 0.49, $P < 0.0001$). Since the cytB set was amplified most frequently, the qPCR estimates from the cytB set were used to assess the relationship between weather parameters and SLB severity.

SLB incidence increased to nearly 100% each year and SLB was severe in both 2018 and 2020 (Figure 1 and 3). However, in 2019, SLB severity stayed below 40 DSI (Figure 2). Spore concentration increased exponentially over time in 2018 and 2020 but stayed low in 2019. The low spore numbers trapped in 2019 may be related to the low severity of SLB in that year, either as cause or result.

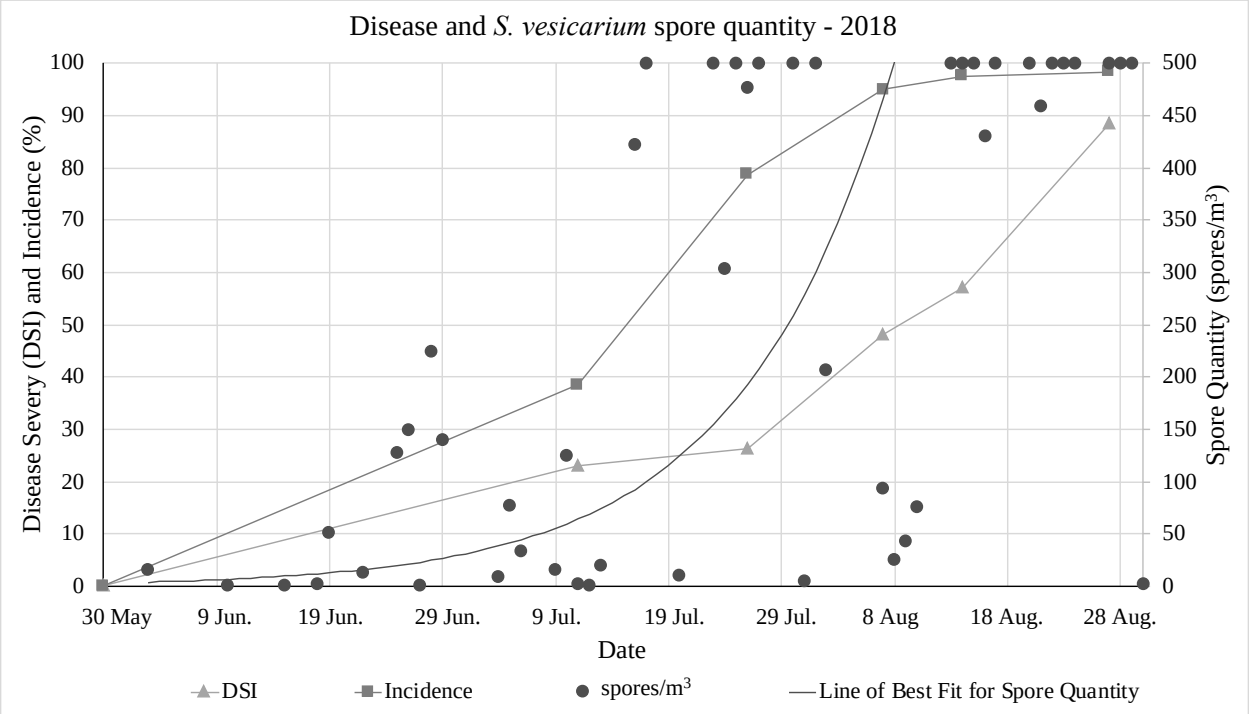


Figure 1. Stemphylium leaf blight incidence and severity plotted versus spores m^{-3} from estimates using cytB qPCR in 2019.

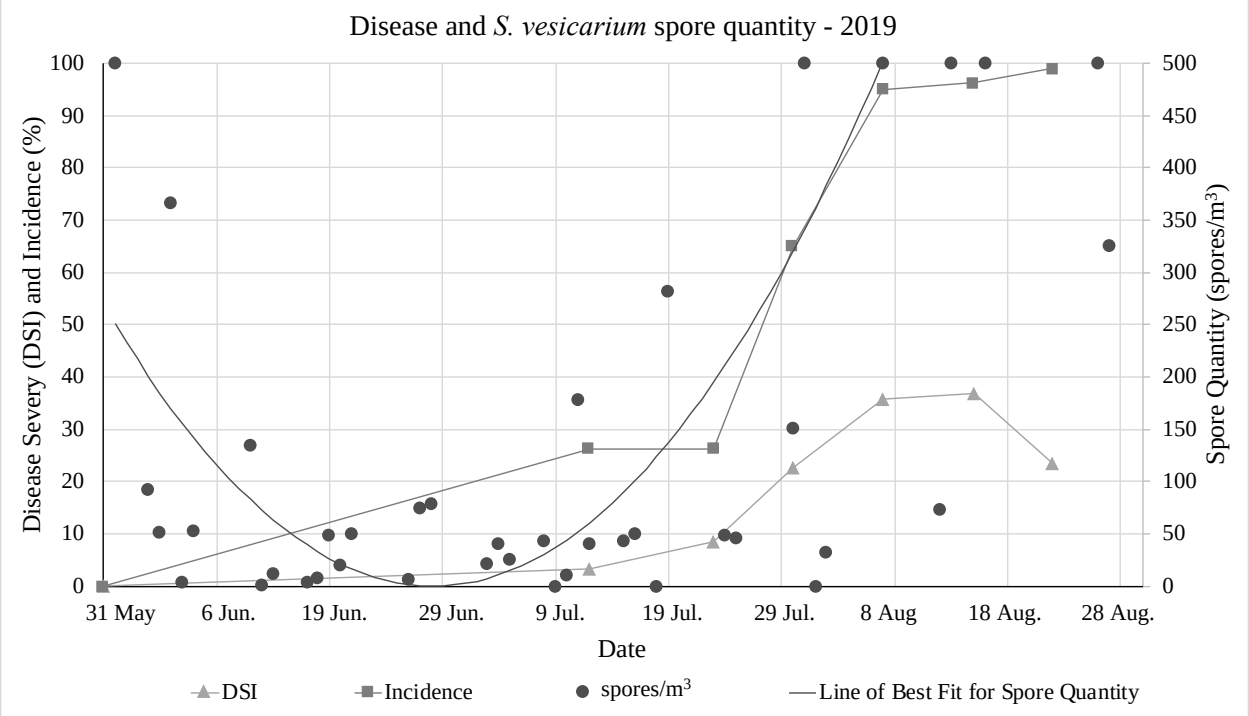


Figure 2. Stemphylium leaf blight incidence and severity plotted versus spores m^{-3} from estimates using cytB qPCR in 2019.

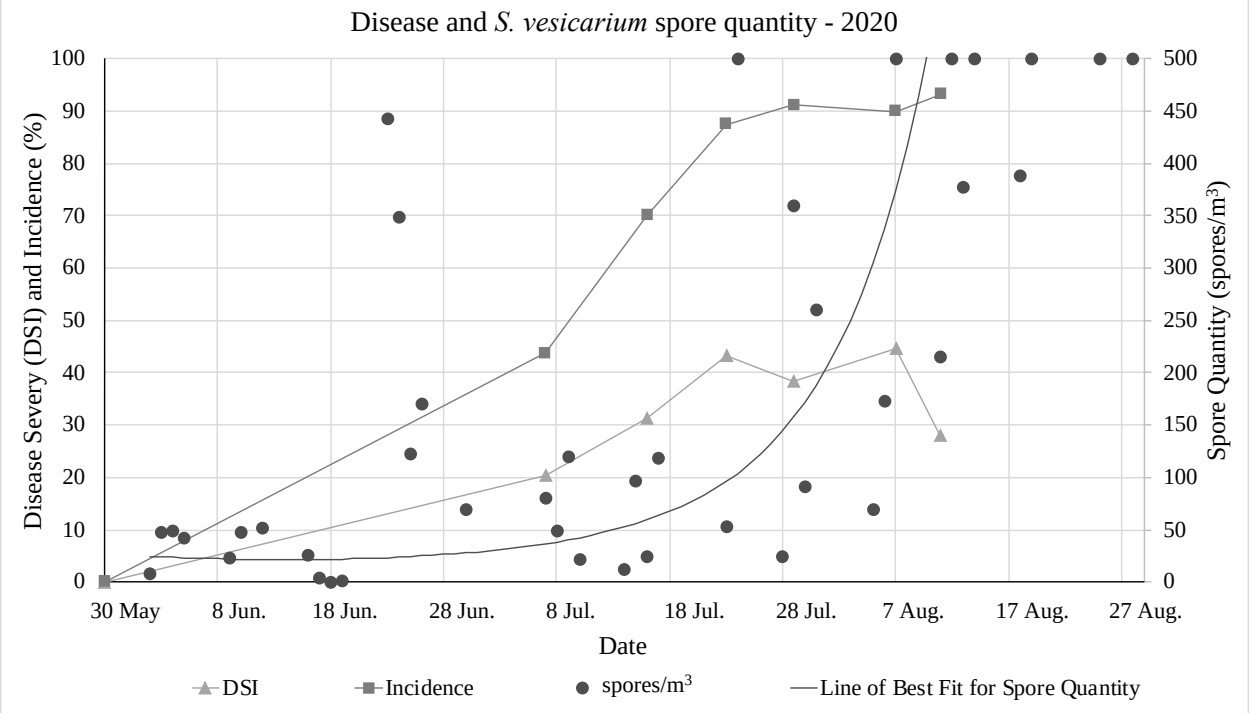


Figure 3. Stemphylium leaf blight incidence and severity plotted versus spores m^{-3} from estimates using cytB qPCR in 2020.

There was a significant positive correlation between spore counts estimated using the Burkhard sampler with Burkhard + cytB qPCR and using the Spornado cassettes with ITS qPCR (τ_b = 0.36, P = 0.006), although the relationship was not strong. Since the two sets of data were not normally distributed, a non-parametric analysis was conducted to compare the rank of the estimates from the Burkhard + cytB method

and Sporometrics methods. The line of best fit described a positive exponential relationship between the rank value of the two spore quantification methods. The Burkhardt sampler + cytB method estimated that counts ranged from 3.2 to 194,675 spores per day, whereas the Sporometrics method estimated 0.328 to 1,507 spores per day.

The two qPCR methods were compared with data collected using a rotorod sampler, which is based on a manual count of spores identified by morphology under a microscope. The spore count estimates from the rotorod sampler ranged from 0 to 307 spores per day. The Burkhard + cytB and Sporometrics estimates were significant correlated with the rotorod estimates on the same dates, but the relationship was relatively weak (τ_b = 0.56 with Burkhard +cytB and τ_b= 0.37 with Sporometrics). If the most extreme values were removed from the analysis, the relationship with cytB was still significant (τ_b = 0.48, n = 15, P = 0.005) but the relationship with Sporometrics was not (τ_b = 0.27, n = 26, P = 0.09).

The daily spore counts from the cytB method were not correlated with the total rainfall, daily temperature, or leaf wetness duration in any year (Table 1). In 2018, spore concentration was correlated with temperature during leaf wetness, the number of days with vapor pressure deficit (VPD) < 0.5 kPa, and the total rain in the 10 days prior to capture. There were no significant correlations in 2019, likely because of the overall lower disease pressure. In 2020, spore concentration was correlated with temperature during leaf wetness, the number of days with VPD < 0.5 kPa, the number of days with temperatures > 15°C prior to capture, and the total rain 10 days prior to capture. However, the correlation between temperature during leaf wetness and spore concentration was positive in 2018 and negative in 2020.

Table 1. Rank correlation (Kendall's τ_b) coefficients between weather variables and daily airborne spores quantified by cytB qPCR of air samples collected in the Holland Marsh, ON.

	Daily weather variables[1]					Weather variables 10 days before capture[2]		
Year	Rain (mm)	Temp (°C)	WTemp (°C)	LWD (h)	NVPD (h)	DTemp (days)	DLWD (days)	TRain (mm)
2018	0.02	0.16	**0.21***	0.22	**0.44***	0.20	0.15	**0.21***
2019	0.03	-0.03	-0.19	0.06	0.10	0.23	0.00	-0.19
2020	-0.10	0.00	**-0.24***	0.07	**0.46***	**0.45***	-0.02	**-0.24***

[1]Daily weather variable averaged from 24 hrs (00:00–23:00): Rain = total daily rainfall, Temp = mean air temperature, WTemp= mean temp during leaf wetness, LWD= total leaf wetness duration in one day, NVPD = # hours VPD < 0.5 KPA.
[2]Weather variables recorded 10 days prior to capture: DTemp= # Days >15°C, DLWD= # days LWD >6 h, TRain= cumulative total rainfall.

In 2018 and 2020, daily NVPD was positively correlated (τ_b=0.44 in 2018, τ_b=0.46 in 2020) with daily spore counts. In 2018, NVPD did not significantly affect spore concentration.

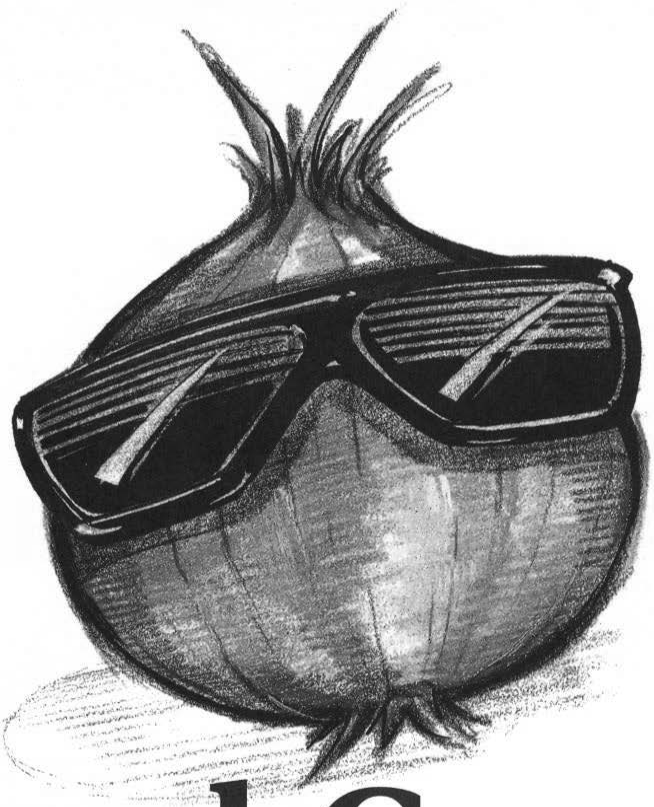
Previously, spore samples were collected from 10:00–13:00 in 2009 and 2011 using the same Burkhard multi-vial cyclone sampler and spores were counted using a microscope (McDonald, unpublished). Spore counts ranged from 10 to 6317 spores per day. In 2015 and 2016 a Burkhard-type spore trap which collected spores on sticky-tape instead of 1.5 ml tubes and the spore count values ranged from 0 to 116 spores per day.

CONCLUSIONS:

The incidence and severity of SLB, and daily spore counts increase over time in the growing season. The cytB method was the most strongly correlated (τ_b = 0.56) with manual spore counts from the rotorod

sampler. The Spornado system provided by Sporometrics is an alternative to the Burkhard method that can be operated with ease by the Pest Management Program provided by the MCRS. The spore values estimated by Spornado showed a similar trend as the Burkhard +cytB method, but it did not detect spores on 25% of days (8 days) when the Burkhard sampler detected between 71–500 *Stemphylium* spores per day, and 4% of days (1 day) when the Rotorod counted at least one spore. On the other hand, the Burkhard sampler detected 3–20,000 spores per day during the sampling period, and the Rotorod sampler did not detect Stemphylium on 54% of sampling dates (15 days). The Burkhard sampler with qPCR analysis collects a higher volume of spores due to its battery-operated vacuum. The Burkhard sampler remains the recommended method to quantify spores of *S. vesicarium* in onions.

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.



MarshGrown

Cooks!

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

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TITLE: EVALUATION OF DROPLEG BELUGA TECHNOLOGY ON SPRAY COVERAGE AND FUNGICIDE EFFICACY IN ONIONS, 2020

MATERIALS: SERCADIS (fluxapyroxad 300 g/L), DITHANE 750 F (mancozeb 75%), AGRAL90 (nonylphenoxy polyethoxy ethanol 92%)

OBJECTIVE: to evaluate the spray coverage and efficacy of Dropleg Beluga heads compared to air induction nozzles

METHODS: Onions, cv. Traverse, were direct seeded (35 seeds/m) on 6 May using a Stanhay precision seeder into organic soil (organic matter ≈ 62.0%, pH ≈ 6.8) 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), 10 m in length. TeeJet AI9503 and Beluga droplegs (Agrotop Spray Technology, Obertraubling, Germany) equipped with SprayMax SMP11003 nozzles were compared for spray efficacy and control of stemphylium leaf blight. Beluga heads are designed to spray perpendicular to the crop rows from within the crop canopy. Each dropleg was spaced 40 cm apart on the sprayer boom. Seven droplegs were used with the nozzle body positioned 20 cm into the onion canopy between the onion rows. A standard broadcast arrangement used seven TeeJet AI9503 nozzles spaced 50 cm apart on the boom positioned some 50 cm above the onion crop.

Coverage: Foliar deposition was analyzed in two locations on the onion plant, at approximately 1/3 (top) and 2/3 of the canopy depth (bottom). Plants were sprayed with a solution of rhodamine WT fluorescent dye (Cole-Parmer Fluorescent Fwt Red Dye Concentrate) in unchlorinated carrier water at a concentration of 500 ppm active ingredient (AI). Samples were drawn from the nozzle furthest from the solution tank before and after application and used to confirm the concentration. Immediately following the application, 2 cm lengths of onion leaves from 5 individual plants were excised and placed in centrifuge tubes containing 40 ml dH_2O and placed in light-excluding containers. Three replicates per treatment were used. Leaf tissue samples were removed from the tubes on the same day as collection, placed in labelled coin envelopes, dried and weighed. Solution samples were returned to the containers and stored in refrigerated conditions prior to analysis. Solution samples were analyzed using a TD-700 fluorometer equipped with a 550 nm excitation filter and 570 nm emission filter. Single point calibration confirmed a linear relationship between the absolute amount of AI and Raw Fluorescence Units (FSU) up to 0.1 mg L^{-1} (r^2=0.9821). FSU values were normalized to account for a tested 95% recovery accuracy and any dilution required to bring samples into the linear detection range. Overall dye recovery values were normalized by dividing the µL of AI by the dry leaf sample weight to arrive at µL AI g^{-1} dry weight.

Fungicide Efficacy: SERCADIS at 666 mL/ha, or SERCADIS at 666 mL/ha + DITHANE at 2.5 kg/ha + AGRAL 90 were applied on 29 July, 6, 13 August using a tractor-mounted sprayer calibrated to deliver 500 L solution/ha at 620 kPa. An untreated control was also included.
An in-field Stemphylium assessment was conducted on 28 July, using the three oldest leaves on 20 randomly chosen onions per replicate. The area of the leaf infected with Stemphylium was rated using a 0-4 scale where 0 = no symptoms, 1 = 1-10%, 2 = 11-25%, 3 = 26-50%, 4= >50%. The rating for the plant is the sum of the score of the three leaves.

The number of plants in each class was used to determine the disease severity index (DSI) using the following formula:

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

On 18 August, the green leaves of 20 onion plants randomly chosen from the inner rows of every replicate were removed and sorted into classes based on the percentage of the leaf area showing symptoms of stempylium leaf blight. The classes were: 0= no disease, 1 = 1-4%, 2 = 5-10%, 3 = 11-25%, 4 = 26-50%, 5 = 51-75%, 6 > 75% with symptoms. Dead leaves were counted separately. The number of leaves in each class was used to determine the disease severity index (DSI) using the above formula. On 11 September, the onions in two 2.32 m sections of row (2 x 1 m^2) were pulled from the middle six rows for a yield sample. Onions were weighed and graded for size on 19 October to determine yield.
Compared to the previous 10-year average, air temperatures in 2020 were above average for July (23.3°C), average for June (19.2°C), August (20.6°C), and below average for May (11.6°C) and September (15.0°C). The 10-year average temperatures were: May 14.2°C, June 18.5°C, July 21.5°C, August 20.3°C and September 16.5°C. Monthly rainfall was above the 10-year average for August (140 mm), average for September (65 mm), and below average for May (38 mm), June (77 mm) and July (58 mm). The 10-year rainfall averages were: May 73 mm, June 103 mm, July 84 mm, August 76 mm and September 62 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 Figure 1 and Tables 1-4.

CONCLUSIONS: ***Coverage:*** The amount of dye recovered from applications performed with the Beluga dropleg was significantly higher than that of the conventional broadcast application at both 1/3 and 2/3 canopy depths. This indicates that more spray reached and was retained on the leaves using droplegs. While higher residuals do not necessarily result in improved efficacy, coverage uniformity and canopy penetration are demonstrated criteria for satisfactory crop protection, particularly in the case of contact fungicides.
Fungicide Efficacy: No significant differences in Stemphylium leaf blight average ratings, incidence or severity were found among fungicide treatments applied with the standard broadcast (via AI9503 nozzles) or Beluga dropleg technology or compared to the untreated check at the in-field or final assessments (Table 1). When data for fungicide treatments are combined, the incidence of Stemphylium is significantly lower for treatments applied with the Beluga droplegs; however, there were no differences in the in-field average ratings, DSI, Stemphylium incidence or the percentage of dead leaves (Table 2). No significant differences in Stemphylium incidence or severity were found among the fungicide treatments when data for sprayer technology were combined (Table 3) and no differences in the size distribution or yield of onions at harvest were found among fungicide/spray method combinations or untreated onions (Table 4).

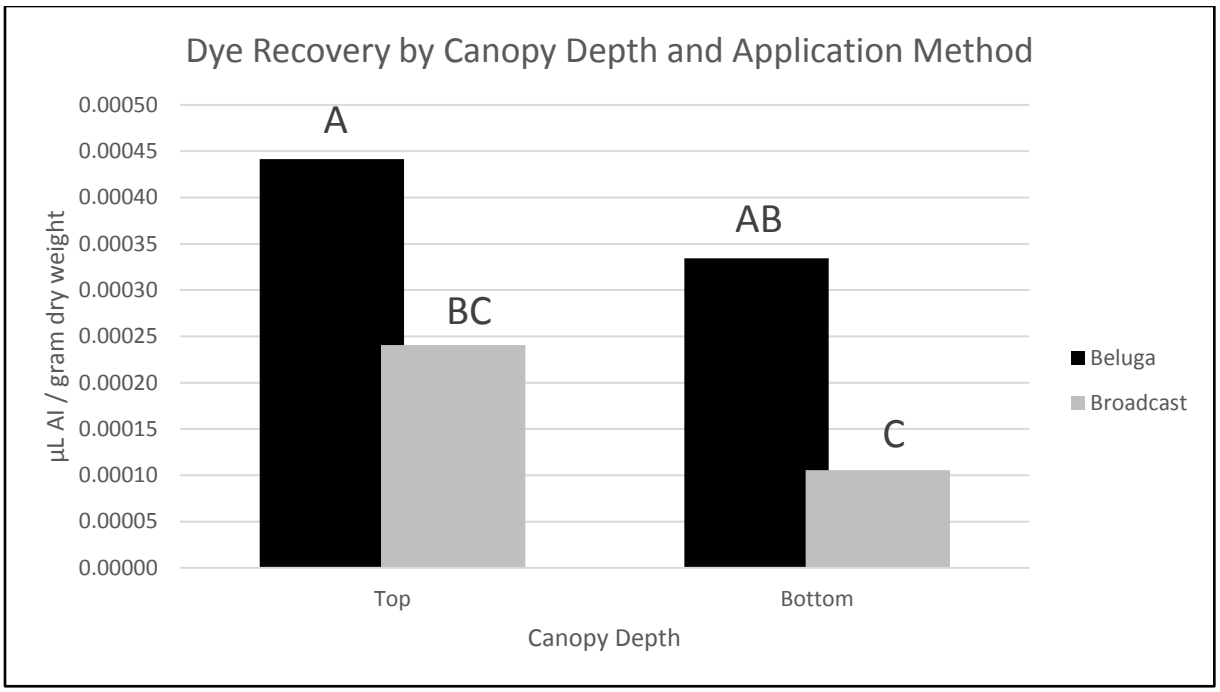

Figure 1. Distribution of dye in an onion canopy between Beluga heads and TeeJet AI9593 nozzles, Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Table 1. Stemphylium incidence and severity index (DSI) for onions, cv. Traverse, treated with fungicides using TeeJet AI9503 or Beluga heads at the Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Treatment	Sprayer Technology	28 July (In-field)[1]		18 August (Final)[2]	
		Average Rating	DSI[3]	Incidence (%)	DSI[3]
SERCADIS + DITHANE[4]	Beluga heads	3.4 ns[5]	28.2 ns	59.4 ns	27.7 ns
SERCADIS	Beluga heads	3.4	28.1	62.2	30.0
SERCADIS + DITHANE[4]	TeeJet AI9503	3.2	26.5	70.3	33.2
SERCADIS	TeeJet AI9503	3.2	26.5	69.0	30.9
Check	-	3.8	31.7	63.7	31.3

[1] On 28 July, the three oldest leaves on 20 onion plants per replicate were examined for stemphylium symptoms and rated on a 0-4 scale where 0 = no stemphylium symptoms, 1 = 1-10%, 2 = 11-25%, 3 = 26-50%, 4= >50% of leaf area infected with stemphylium symptoms. The rating for the plant is the sum of the score of the three leaves.

[2] On 18 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.

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

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

[4] These treatments include the surfactant AGRAL 90 at 0.25% v/v.

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

Table 2. Average rating, incidence and severity index (DSI) for stemphylium in onions, cv. Traverse, treated with fungicides using TeeJet AI9503 or Beluga heads at the Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Sprayer Technology	28 July (In-field)		18 August (Final)		
	Avg Stemphylium Rating	DSI	Stemphylium Incidence (%)	DSI	% Dead Leaves
Beluga heads	3.4 ns[1]	28.2 ns	60.8 a[2]	28.9 ns	17.2 ns
TeeJet AI 9503	3.2	26.5	69.7 b	32.0	15.6

* Data were combined as there was no significant interaction for fungicide by nozzle.
[1]ns indicates no significant differences were found among treatments
[2] Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD test.

Table 3. Average rating, incidence and severity index (DSI) for stemphylium in onions, cv. Traverse, treated with fungicides using TeeJet AI9503 nozzles or Beluga heads at the Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Fungicide	28 July (In-field)		18 August (Final)		
	Average Rating	DSI	Stemphylium Incidence (%)	DSI	% Dead Leaves
SERCADIS + DITHANE	3.3 ns[2]	27.3 ns	64.8 ns	30.5 ns	15.3 ns
SERCADIS	3.3	27.3	69.7	30.4	17.5

* Data were combined as there was no significant interaction for fungicide by spray technology.
[1] These treatments include the surfactant AGRAL 90 at 0.25% v/v.
[2] ns indicates no significant differences were found among treatments

Table 4. Yield and size distribution for onions, cv. Traverse, treated with fungicides using TeeJet AI9503 nozzles or Beluga heads and grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Treatment	Spray Technology	Yield (t/ha)	% Mkb	Size Distribution %[1]			
				Jumbo (>76 mm)	Large (76-64 mm)	Medium (63-45 mm)	Cull (<45 mm)
SERCADIS	Beluga heads	66.1 ns[2]	97.3 ns	26.9 ns	36.9 ns	13.8 ns	2.7 ns
SERCADIS	TeeJet AI9503	64.4	96.9	36.5	42.4	12.6	1.9
SERC + DITH	Beluga heads	63.0	96.7	26.6	43.7	17.0	3.3
SERC + DITH	TeeJet AI9503	60.3	95.3	34.8	34.8	15.7	4.7
check	--	54.8	99.1	28.8	36.9	20.6	0.9

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

Funding for this project was provided by the Ontario Agri-Food Innovation Alliance, The Fresh Vegetable Growers of Ontario, the California Garlic and Onion Research Advisory Board and the Bradford Cooperative Storage.

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

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TITLE: EVALUATION OF FUNGICIDES FOR CONTROL OF DOWNY MILDEW ON DRY BULB ONIONS, 2020

MATERIALS: ORONDIS ULTRA (oxathiapiprolin 30 g/L, mandipropamid 250 g/L), ZAMPRO SC (ametoctradin 300 g/L, dimethomorph 225 g/L), T-77 (*Trichoderma atroviride* strain 77B minimum of $2.5x10^9$ spores/g), RIDOMIL GOLD MZ 68 WG (metalaxyl-M and S-isomer 4%, mancozeb 64%), DITHANE 750 F (mancozeb 75%), SYLGARD 309 (siloxylated polyether 76%)

METHODS: Onions, cv. Traverse, were direct seeded on 6 May into organic soil, (organic matter ≈ 68.3%, pH ≈ 6.4) using a Stanhay Precision seeder at the Muck Crops Research Station, Holland Marsh, Ontario. A randomized complete block arrangement with four replicates per treatment was used. Each replicate consisted of four rows spaced 43 cm apart, and 6 m in length. Treatments were applied as foliar sprays using a CO_2 backpack sprayer equipped with four TeeJet 8002 fan nozzles calibrated to deliver 500 L/ha at 275 kPa. Treatments were: ORONDIS ULTRA at 400 mL/ha, ZAMPRO at 1.0 L/ha + Sylgard at 0.25% v/v, T-77 at 500 g/ha, ORONDIS ULTRA at 400 mL/ha alternated with ZAMPRO at 1.0 L/ha + Sylgard at 0.25% v/v, ORONDIS ULTRA at 400 mL/ha alternated with RIDOMIL MZ at 2.5 kg/ha, RIDOMIL MZ at 2.5 kg/ha and DITHANE at 3.25 kg/ha, + SYLGARD at 0.25% v/v. An untreated check was also included. Treatments were applied on 17, 24 July, and 6, and 13 August.
On 7, 17, 24 and 31 August, all onions in each replicate were visually examined for the presence of downy mildew (DM) lesions. On 9 September, onions in two, 2.32 m sections of row (2 x 1 m^2) per replicate were pulled. On 9 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 2020 were above average for July (23.3°C), average for June (19.2°C), August (20.6°C), and below average for May (11.6°C) and September (15.0°C). The 10-year average temperatures were: May 14.2°C, June 18.5°C, July 21.5°C, August 20.3°C and September 16.5°C. Monthly rainfall was above the 10-year average for August (140 mm), average for September (65 mm), and below average for May (38 mm), June (77 mm) and July (58 mm). The 10-year rainfall averages were: May 73 mm, June 103 mm, July 84 mm, August 76 mm and September 62 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 Tables 1 and 2.

CONCLUSIONS: The weather in 2020 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 onions, cv. Traverse, treated with fungicides and grown near the Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Treatment	Product rate (per ha)	DM Lesions/plot[1]			
		7 Aug	17 Aug	24 Aug	31 Aug
DITHANE	3.25 kg	0	0	0	0
ORONDIS ULTRA	400 mL	0	0	0	0
ZAMPRO+ SYLGARD	1.0 L + 0.25% v/v	0	0	0	0
RIDOMIL GOLD MZ	2.5 kg	0	0	0	0
ORONDIS ULTRA/ZAMPRO+ SYLGARD	400 mL/1.0 L + 0.25% v/v	0	0	0	0
ORONDIS ULTRA/RIDOMIL GOLD MZ	1.0 L/2.5 kg	0	0	0	0
T-77	500 g	0	0	0	0
Check	--	0	0	0	0

[1] Data was not analysed statistically

Table 2. Yield and size distribution for onions, cv. Travers, treated with fungicides and grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Treatment	Yield (t/ha)	% Mkb	Size distribution (%)[1]			
			Jumbo (>76 mm)	Large (76-64 mm)	Medium (63-45 mm)	Cull (<45 mm)
DITHANE	75.2 ns	99.6 ns	10.7	56.5 ns	32.4 ns	0.4 ns
ORONDIS ULTRA	70.5	99.0	14.3	51.0	33.8	1.0
ZAMPRO+ SYLGARD	73.7	99.2	9.6	60.0	29.6	0.8
RIDOMIL GOLD MZ	79.3	99.4	12.7	60.5	26.2	0.6
ORONDIS ULTRA/ZAMPRO+ SYLGARD	74.7	99.2	13.6	61.6	24.0	0.8
ORONDIS ULTRA / RIDOMIL GOLD MZ	75.0	98.1	10.8	59.9	27.5	1.9
T-77	69.7	99.0	9.8	58.7	30.6	1.0
Check	74.4	98.5	10.6	61.3	26.6	1.5

[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. Traverse
PEST: Onion downy mildew (*Peronospora destructor* (Berk.) Casp. in Berk.)

AUTHORS: MCDONALD MR & VANDER KOOI K
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TITLE: EVALUATION OF ORONDIS GOLD FOR CONTROL OF DOWNY MILDEW ON DRY BULB ONIONS, 2020

MATERIALS: RIDOMIL GOLD 480 SL (metalaxyl-M and S-isomer 480 g/L), ORONDIS GOLD (oxathiapiprolin 35 g/L), AGRAL 90 (nonylphenoxy polyethoxy ethanol 92%)

METHODS: Onions, cv. Traverse, were direct seeded at 35 seeds/m on 6 May into organic soil, (organic matter ≈ 68.3%, pH ≈ 6.4) at 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 5 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: RIDOMIL GOLD 480 SL at 219 mL, and ORONDIS GOLD at 1,000 mL/ha with and without AGRAL 90 at 0.25% v/v. An untreated check was also included. Treatments were applied on 17, 24 July, 6 & 13 August. On 20, 27 July and 10 & 17 August, all onions in each replicate were visually examined for the presence of downy mildew lesions and if present, the numbers were recorded. On the same dates, plots were visually rated for phytotoxicity using a 0 to 5 scale where 0 = no injury, 1 = slight yellowing, 2 = some tissue death, 3 = over 50% plant tissue brown, 4 = >75% dead tissue, 5 = plant necrosis. On 9 September, onions in two, 2.32 m sections of row per replicate were pulled. On 9 October, onions were removed from storage, sorted into Jumbo (> 76mm), Large (76-64 mm), Medium (<64-45 mm) and Small (<45 mm) size categories, weighed and counted to determine yield.
Compared to the previous 10-year average, air temperatures in 2020 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 and 2.

CONCLUSIONS: The weather in 2020 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 onions, cv. Traverse, treated with fungicides and grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Treatment	Product rate/ha	DM Lesions/plot[1]			
		20 July	27 July	10 Aug	17 Aug
ORONDIS GOLD	1,000 mL	0	0	0	0
ORONDIS GOLD+ AGRAL 90	1,000 mL + 0.25% v/v	0	0	0	0
RIDOMIL GOLD 480 SL	219 mL	0	0	0	0
Check	--	0	0	0	0

[1] Data was not analysed statistically

Table 2. Phototoxicity ratings for onions, cv. Traverse, treated with fungicides and grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Treatment	Product rate/ha	Phototoxicity Ratings[1]			
		20 July	27 July	10 Aug	17 Aug
ORONDIS GOLD	1,000 mL	0[2]	0	0	0
ORONDIS GOLD+ AGRAL 90	1,000 mL + 0.25% v/v	0	0	0	0
RIDOMIL GOLD 480 SL	219 mL	0	0	0	0
Check	--	0	0	0	0

[1] [1] Phytotoxicity rating 0-10, where 0 = no toxicity, 1 = 1-10% crop injury, 2 = 11-20% crop injury, 3 = 21-30% crop injury, 4 = 31-40% crop injury, 5 = 41-50% crop injury, 6 = 51-60% crop injury, 7 = 61-70% crop injury, 8 = 71-80% crop injury, 9 = 81-90% crop injury, 10 = 91-100% crop injury
[2] Data set consists of zeros, and therefore was not statistically analysed.

Table 3. Yield and size distribution for onions, cv. Traverse, treated with fungicides and grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Treatment	Yield (t/ha)	% Mkb	Size Distribution %[1]			
			Jumbo (>76 mm)	Large (76-64 mm)	Medium (<64-45 mm)	Cull (<45 mm)
ORONDIS GOLD	75.6 ns[2]	99.3 ns	11.3 ns	62.4 ns	25.6 ns	0.7 ns
ORONDIS GOLD+ AGRAL 90	80.1	98.9	12.0	59.1	27.9	1.1
RIDOMIL GOLD 480 SL	80.3	98.9	12.7	61.3	24.9	1.1
Check	74.9	99.0	6.5	64.1	28.3	1.0

[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 Syngenta Canada.

PESTS: Stemphylium leaf blight (*Stemphylium vesicarium* (Wallr.))
Onion downy mildew (*Peronospora destructor* (Berk.) Casp. in Berk.))

AUTHORS: BLAUEL T[1], VANDER KOOI K[1], VAN DYK D[2] and MCDONALD M R[1]
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TITLE: COMPARING THE ROTOROD AND SPORNADO SPORE TRAPPING METHODS IN THE HOLLAND MARSH, 2020

METHODS: Two spore trapping methods, the Rotorod and Spornado samplers, were compared on the ability to recover airborne *S. vesicarium* and *P. destructor* spores at the Muck Crops Research Station (MCRS) in the Holland Marsh, 2020. Both samplers were placed side by side at the edge of an onion trial on range 5 at the MCRS. The Rotorod spore sampler, also known as a rotating arm impactor, is setup close to the onion canopy and collects spores two 1.52 mm wide and 3.15 cm long polystyrene rods lined with a silicone grease. Every Monday, Wednesday and Friday from 19 June to 4 September, both rods would rotate at 2400 rpm between 06:00 to 12:00, resulting in an air sampling rate of 20.65 L/min/rod. Spores trapped on each rod were identified and counted using a compound microscope. The Spornado passively collects airborne spores in collection cassettes above the onion canopy. The number of days of spore collection varied between two to eleven days. Spores were collected between 18 June to 31 August and were analyzed using qPCR by Sporometrics Inc. (Toronto, ON).
Compared to the previous 10-year average, air temperatures in 2020 were above average for July (23.3°C), average for June (19.2°C), August (20.6°C), and below average for May (11.6°C) and September (15.0°C). The 10-year average temperatures were: May 14.2°C, June 18.5°C, July 21.5°C, August 20.3°C and September 16.5°C.
Monthly rainfall was above the 10-year average for August (140 mm), average for September (65 mm), and below average for May (38 mm), June (77 mm) and July (58 mm). The 10-year rainfall averages were: May 73 mm, June 103 mm, July 84 mm, August 76 mm and September 62 mm.
Spore counts from each trap, forecasting risk and disease severity on onions were analyzed using the Correlations function of the Linear Analysis section of Statistix V.10.

RESULTS: Data are presented in Figures 1 and 2. There was a positive correlation between Rotorod and Spornado *S. vesicarium* spore counts, but a negative correlation for *P. destructor* spore counts. Rotorod spore counts were positively correlated with high Stemphylium leaf blight risk and downy mildew sporulation-infection periods for *S. vesicarium* and *P. destructor*, respectively. However, Spornado *S. vesicarium* and *P. destructor* spore counts were negatively correlated with a high risk for Stemphylium leaf blight and downy mildew sporulation-infection events, respectively. *S. vesicarium* spore counts from both the Rotorod and Spornado were positively correlated with Stemphylium leaf blight development in onion plots on the MCRS. No onion downy mildew developed for comparisons.

CONCLUSIONS: Currently, the Rotorod spore trap is more effective than the Spornado at capturing and identifying *S. vesicarium* and *P. destructor* spores at the MCRS, especially during periods of high disease risk for disease forecasting. Interestingly, the Spornado identified *P. destructor* spores in June when there was no risk of onion downy mildew according to DOWNCAST, but did not identify any spores in August when there were numerous sporulation-infection periods. The Spornado qPCR process should be investigated further to develop more accurate results, as it is a low maintenance piece of equipment and less time consuming than the Rotorod sampling and identification process. However, the Rotorod is more cost effective. Although *P. destructor* spores were positively identified, no downy mildew developed on onions in 2020.

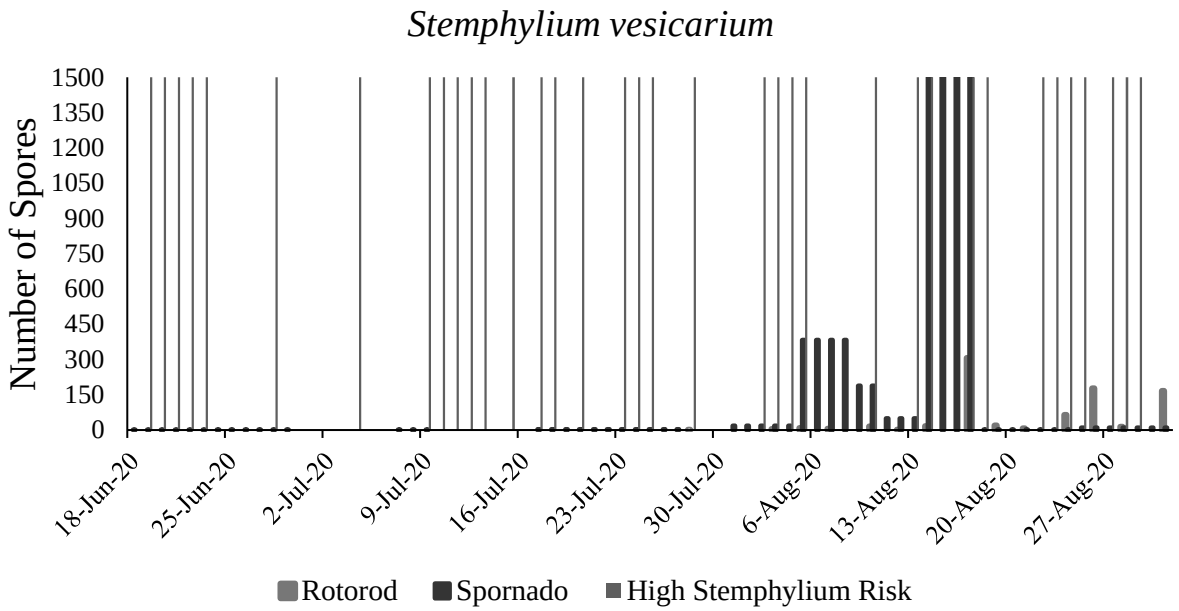

Figure 1. Number of *Stemphylium vesicarium* spores trapped in the Rotorod and Spornado, and days of high risk for Stemphylium leaf blight development on onions predicated using BSPCAST during the growing season at the Muck Crops Research Station, 2020.

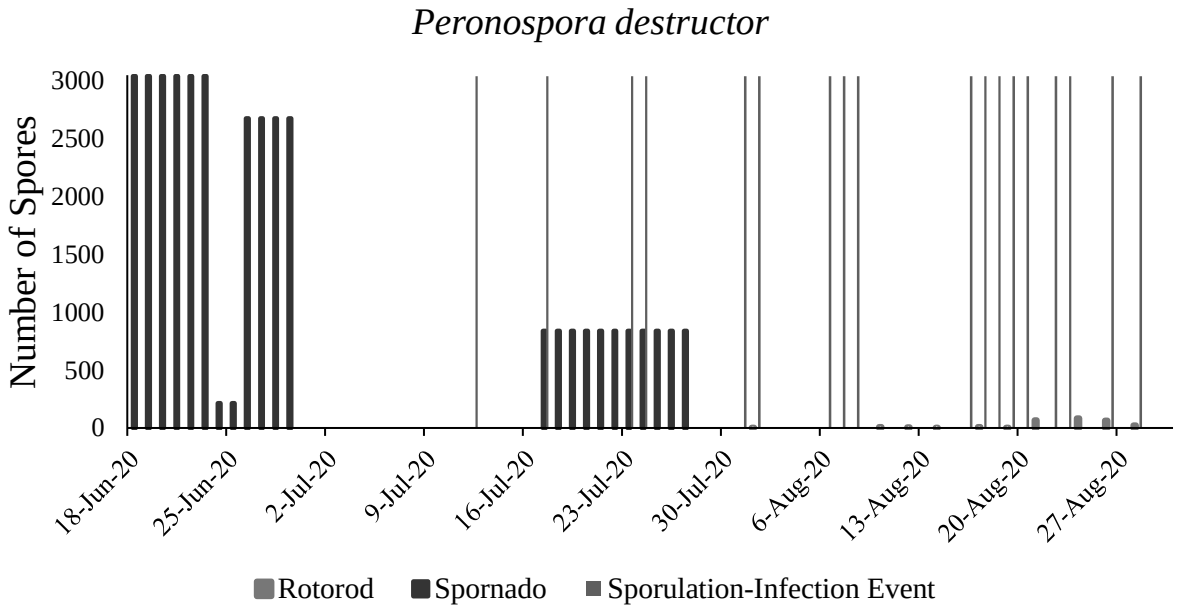

Figure 2. Number of *Peronospora destructor* spores trapped in the Rotorod and Spornado, and onion downy mildew sporulation-infection events predicated using DOWNCAST during the growing season at the Muck Crops Research Station, 2020.

CROP: Onion (*Allium cepa* L.)
PESTS: Stemphylium leaf blight (*Stemphylium vesicarium* (Wallr.))
Onion downy mildew (*Peronospora destructor* (Berk.) Casp. in Berk.))

AUTHORS: BLAUEL T, VANDER KOOI K and MCDONALD M R
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TITLE: ONION DISEASE FORECASTING MODELS IN THE HOLLAND AND KESWICK MARSHES, 2019 & 2020

METHODS: Portable weather stations (HOBO RX3000) were used to monitor several weather parameters in onion fields in the Holland Marsh in 2020 and Keswick Marsh in 2019 and 2020. These weather parameters included leaf wetness (two S-LWA-M003 sensors), temperature/humidity (S-THB-2 sensor), soil temperature (S-TMB 6 meter), soil moisture (S-SMC-M005 meter) and rainfall (S-RGB-M002 gauge). These sensors sampled data every minute and recorded mean values every hour. Data from these weather parameters were used to help predict Stemphylium leaf blight (SLB) and downy mildew (DM) development on onions using BSPCAST and DOWNCAST forecasting models, respectively. TOMCAST was also assessed to predict leaf blight risks. Different disease assessments were used in the Holland and Keswick Marsh onion plots.

In the Holland Marsh, onion field plots were established at the Muck Crops Research Station (MCRS) in 2020. Three of the oldest standing leaves from 20 random onion plants were assessed for SLB and DM in twelve plots. Each plot consisted of two, four row beds that were 6 m long and seeded at 35 seeds/m. Onion leaves were assessed six times throughout the season from 26 June to 11 August. SLB incidence and severity were assessed using a 0-6 scale, where: 0 = no disease, 1 = <5% disease, 2 = 5-10% disease, 3 = 11-25% disease, 4 = 26-50% disease, 5 = 51-75% disease, and 6 = >75% disease.

In the Keswick Marsh, ten assessment plots were established throughout a commercial onion field in 2019 and 2020. Each plot consisted of four rows of 25 onion plants. Plots were assessed six times in 2019 from 12 July to 23 August and eight times in 2020 from 9 June to 26 August. Three of the oldest standing leaves from 20 random onion plants were also assessed for SLB and DM, but a 0-4 scale was used, where: 0 = no disease, 1 = 1-10% disease, 2 = 11-25% disease, 3 = 26-50% disease, and 4 = >50% disease.

The disease severity index (DSI) was determined using the following equation for both locations:

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

Compared to the previous 10-year average at the MCRS, air temperatures in 2020 were above average for July (23.3°C), average for June (19.2°C), August (20.6°C), and below average for May (11.6°C). The 10-year average temperatures were: May 14.2°C, June 18.5°C, July 21.5°C and August 20.3°C.

Monthly rainfall was above the 10-year average for August (140 mm) and below average for May (38 mm), June (77 mm) and July (58 mm). The 10-year rainfall averages were: May 73 mm, June 103 mm, July 84 mm and August 76 mm. Monthly average air temperature and rainfall for the Holland Marsh in 2020 and Keswick Marsh in 2019 and 2020 are presented in Table 1.

Current disease forecasting and weather information were complied into reports and sent to growers in the Holland and Keswick marshes on a weekly basis.

SLB disease severity and forecasting weather factors were analyzed using the Correlations function of the Linear Analysis section of Statistix V.10.

Table 1. Monthly average air temperature (°C) and rainfall (mm) in the Holland Marsh in 2020 and Keswick Marsh in 2019 and 2020 throughout the onion growing season.

Location	Year	May		June		July		August	
		Avg Temp (°C)	Rain (mm)	Avg Temp (°C)	Rain (mm)	Avg Temp (°C)	Rain (mm)	Avg Temp (°C)	Rain (mm)
Holland Marsh	2020	11.6	38	19.2	77	23.3	58	20.6	140
Keswick Marsh	2019	N/A	N/A	N/A	N/A	22.1	36	19.4	39
Keswick Marsh	2020	18.5	6	19.3	100	22.8	70	19.9	188

RESULTS: Data are presented in Figures 1, 2, 3 and 4. Although there were a few sporulation-infection events in 2019 and several events in 2020, downy mildew was not found on onions in the Holland or Keswick Marsh.

CONCLUSIONS: SLB developed in all assessed onion fields and disease incidence and severity increased over the season in 2019 and 2020. SLB disease severity and pressure was higher closer to harvest in Keswick in 2020 compared to 2019. This may be due to more frequent and longer periods of weather conditions that were conducive for disease development. Weather conditions, in general, were more conducive for SLB development in 2020 compared to 2019. In 2020, SLB disease severity decreased on 24 July, which may be due to decreased durations leaves were ≥50% wet during that time, and increased in early August in the Holland Marsh. For both years and locations, SLB disease severity was positively correlated with total rainfall, average percent humidity and daily leaf wetness duration and negatively correlated with average air temperature. BSPCAST predicted the general time when SLB first appeared in onion fields and periods when increased disease development occurred. Periods of high leaf blight risk predicted by TOMCAST also aligned with the days BSPCAST predicted a high risk. Differences in onion cultivars and fungicide spray programs may have also influenced how the disease progressed over the season. The weather parameters BSPCAST utilize seem to be essential for SLB forecasting. BSPCAST is still being optimized for SLB forecasting on onions in Ontario.

DOWNCAST predicted multiple sporulation-infection periods in 2019 and 2020 at both locations, but disease development never occurred. This is likely due to timely application of fungicides to control disease development. Although no disease developed, *P. destructor* spores were found on a rotorod spore sampler from 7 August to 4 September, aligning with frequent sporulation-infection days predicted by DOWNCAST.

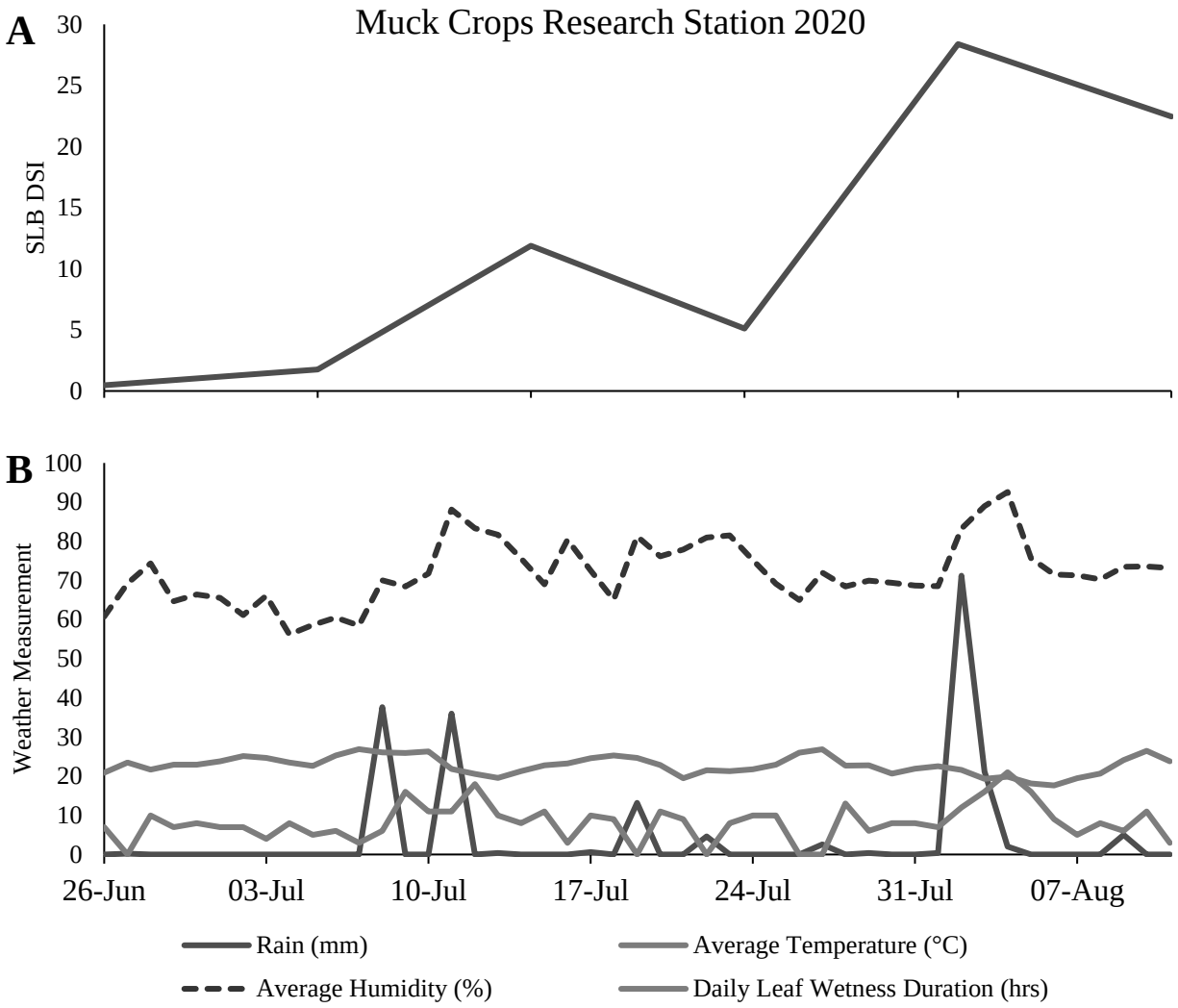

Figure 1. A) Stemphylium leaf blight (SLB) disease severity (DSI) over the season and B) daily weather factors influencing disease development from 26 June to 11 August at the Muck Crops Research Station, Ontario, 2020.

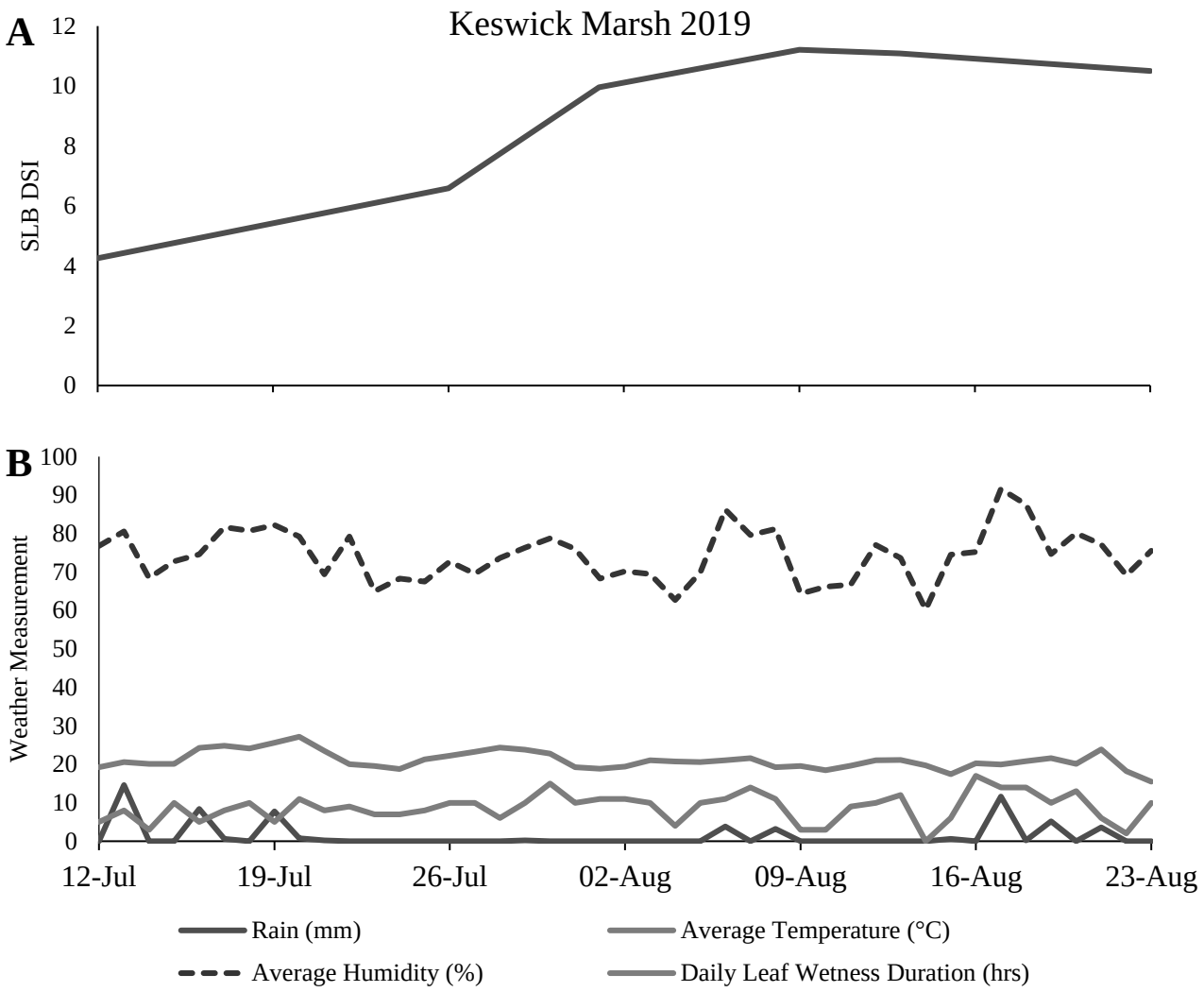

Figure 2. A) Stemphylium leaf blight (SLB) disease severity (DSI) over the season and B) daily weather factors influencing disease development from 12 June to 23 August in the Keswick Marsh, Ontario, 2019.

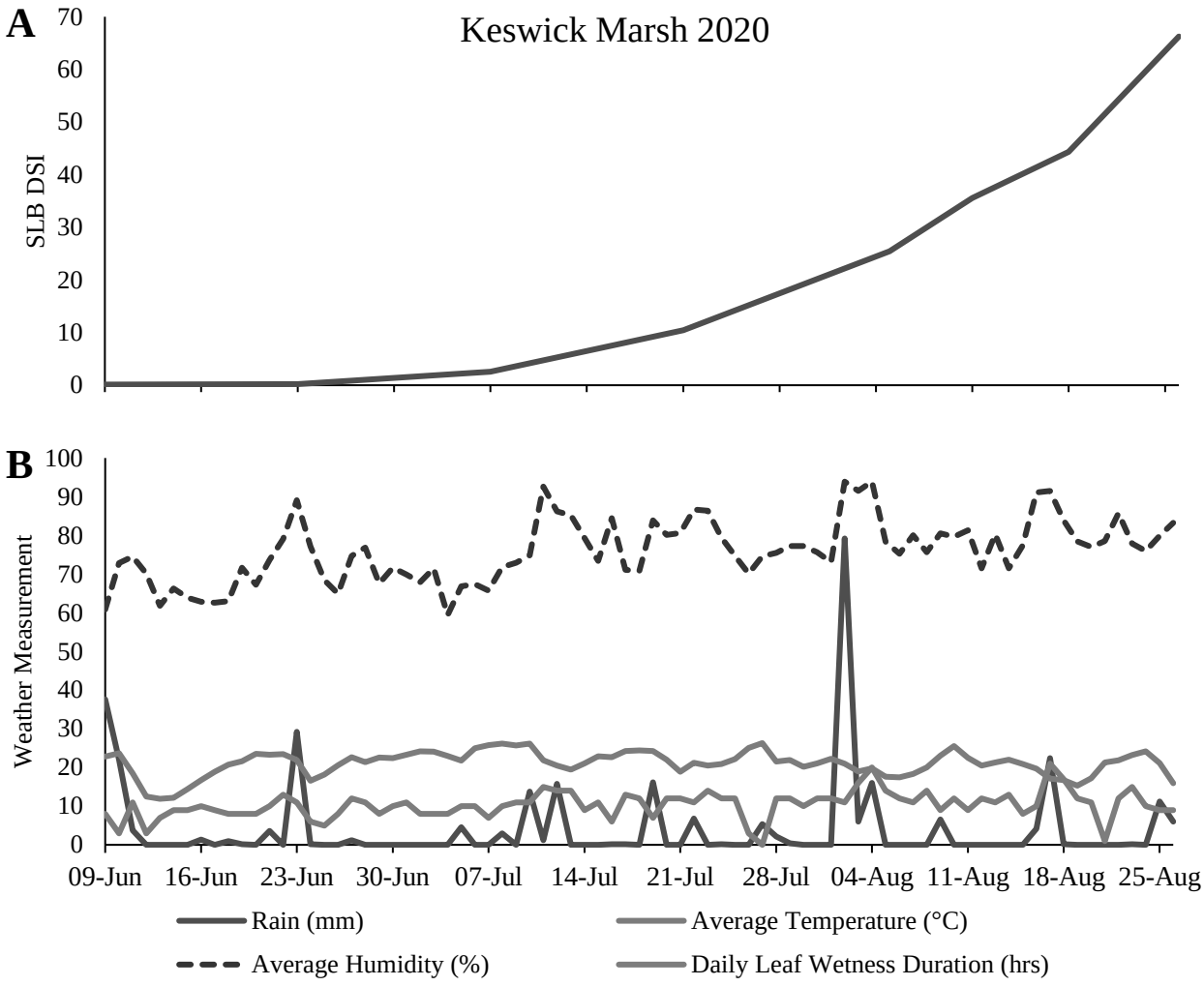

Figure 3. A) Stemphylium leaf blight (SLB) disease severity (DSI) over the season and B) daily weather factors influencing disease development from 9 June to 26 August in the Keswick Marsh, Ontario, 2020.

2019

June						
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

July						
	1	2	3	4	5	6
7	8	9	10	11	12	13
14 **K**	15 **K**	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

August						
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20 **K**	21	22	23	24
25 **K**	26	27	28	29	30	31

2020

June						
	1	2	3 **K**	4	5	6
7	8 **K**	9	10	11	12	13
14	15	16	17	18	19	20
21	22 **K**	23	24	25	26	27
28 **K**	29	30				

July						
			1	2	3	4
5	6 **K**	7	8	9	10	11
12 **H**	13	14	15 **K**	16	17 **H**	18
19	20	21	22	23 **K H**	24 **H**	25 **K**
26	27	28	29	30	31 **H**	

August						
						1 **K H**
2	3	4	5	6 **K H**	7 **K H**	8 **K H**
9	10 **K**	11	12	13 **K**	14	15
16 **K H**	17 **H**	18 **K H**	19 **K H**	20 **K H**	21	22 **K H**
23 **H**	24 **K**	25	26 **K H**	27	28 **K H**	29
30 **K**	31 **K H**					

Figure 4. Calendar months for 2019 and 2020 showing the days DOWNCAST predicted a sporulation-infection event in the Holland (**H**) and Keswick Marsh (**K**) during the growing season.

Funding for this project was provided by the Plant Production Systems of the Ontario Agri-Food Alliance of Ontario and the Ontario Fruit and Vegetable Growers' Association.

CROP: Yellow cooking onions (*Allium cepa* L.), cv. Traverse

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

TITLE: TOLERANCE OF ONION TO FIERCE APPLIED PRE OR EARLY POST, 2020

MATERIALS: FIERCE (flumioxazin 335 g/kg, pyroxasulfone 425 g/kg)

METHODS: Onions, cv. Traverse, were direct seeded (12 seeds per foot of row) on 25 May 2020 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 four rows (40 cm apart), 5 m in length. Treatments were: FIERCE at 89 g ai/ha preemergence, FIERCE at 160 g ai/ha preemergence, FIERCE at 266 g ai/ha preemergence, FIERCE at 89 g ai/ha at the loop stage, FIERCE at 160 g ai/ha at the loop stage, FIERCE at 266 g ai/ha at the loop stage, FIERCE at 89 g ai/ha at the 3-4 leaf stage, FIERCE at 160 g ai/ha at the 3-4 leaf stage and FIERCE at 266 g ai/ha at the 3-4 leaf stage. Plots were maintained weed free using standard management practices. A weed free check was also included. Treatments were applied on 20 May 2020 (preemergence), 27 May 2020 (loop stage), 22 June 2020 (3-4 leaf stage) using a backpack sprayer fitted with AIXR 11002 spray nozzles at 206.84 kPa calibrated to deliver 200 litres/ha. On 17 September, the onions in two 2.32 m sections of row were pulled from the middle two rows for a yield sample. Onions were graded for size and weighed on 10 November to determine yield.
Data were analyzed using the ARM Revision 2020.5 Analysis of Variance function. Means separation was obtained by using Tukey's HSD test at $P = 0.05$ level of significance.

RESULTS: as presented in Table 1.

CONCLUSIONS: No significant differences in marketable dry bulb onion yield, marketable yield (as a percentage of total yield) and marketable weight per bulb were observed. The mid-season stand count was significantly reduced with FIERCE (266 g ai/ha) applied preemergence compared to FIERCE applied at the loop stage (266 g ai/ha) and FIERCE applied at the 3-4 leaf stage (89 g ai/ha). The high rate of FIERCE (266 g ai/ha) when applied PRE appeared to result in temporary injury to the flag leaf. Flag leaves appeared limp and laying flat on the soil surface soon after treatment. Excellent crop tolerance was observed when FIERCE was applied POST at the 3-4 leaf stage of onions.

Table 1. Yield for onions, cv. Traverse, treated with FIERCE herbicide and grown at Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Treatments	Yield – marketable (T/ha)	Yield – marketable (% of total)	Yield – marketable (g/bulb)	Stand count (plants/metre of row)
Untreated check	36.6[1]	93.9[1]	111.3[1]	25.5 ab [2]
FIERCE @ 89 g ai/ha PRE	38.8	95.4	107.5	27.0 ab
FIERCE @ 160 g ai/ha PRE	33.4	96.2	105.2	23.8 ab
FIERCE @ 266 g ai/ha PRE	28.6	97.0	114.2	21.3 b
FIERCE @ 89 g ai/ha LOOP	40.9	96.6	114.6	26.3 ab
FIERCE @ 160 g ai/ha LOOP	31.4	91.0	98.9	25.8 ab
FIERCE @ 266 g ai/ha LOOP	34.3	96.5	111.7	28.0 a
FIERCE @ 89 g ai/ha 3-4 LF	40.8	94.2	103.1	28.0 a
FIERCE @ 160 g ai/ha 3-4 LF	39.4	94.8	111.1	26.5 ab
FIERCE @ 266 g ai/ha 3-4 LF	40.6	94.5	104.0	24.3 ab

[1] No significant differences were found among treatments at P = 0.05 Tukey's HSD test.
[2] Significant differences were found among treatments at P = 0.05 Tukey's HSD test.

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

CROP: Yellow cooking onions (*Allium cepa* L.), cv. Traverse

AUTHORS: SWANTON CJ & SMITH P
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TITLE: TOLERANCE OF ONION TO PYRIDATE, 2020

MATERIALS: BP1047H (pyridate 300 g/kg)

METHODS: Onions, cv. Traverse, were direct seeded (12 seeds per foot of row) on 25 May 2020 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 four rows (40 cm apart), 5 m in length.

Treatments were:

1. BP1047H @ 112.5 g ai/ha at the first true leaf stage on onions followed by BP1047H @ 112.5 g ai/ha 7-10 days after the first application followed by BP1047H @ 112.5 g ai/ha 7-10 days after the second application
2. BP1047H @ 225 g ai/ha at the first true leaf stage on onions followed by BP1047H @ 225 g ai/ha 7-10 days after the first application followed by BP1047H @ 225 g ai/ha 7-10 days after the second application
3. BP1047H @ 300 g ai/ha at the first true leaf stage on onions followed by BP1047H @ 300 g ai/ha 7-10 days after the first application followed by BP1047H @ 300 g ai/ha 7-10 days after the second application

A weed free check was included. All plots were maintained weed free using standard management practices. Treatments were applied on 06 June 2020 (first true leaf), 16 June 2020 (2 leaf stage of onions) and 22 June 2020 (3 leaf stage of onions) using a backpack sprayer fitted with AIXR 11002 spray nozzles at 206.84 KPa calibrated to deliver 200 litres/ha spray solution. On 17 September, the onions in two 2.32 m sections of the middle two rows were pulled for a yield sample. Onions were graded for size and weighed on 10 November to determine marketable yield.
Data were analyzed using the ARM Revision 2020.5 Analysis of Variance function. Means separation was obtained by using Tukey's HSD test at $P = 0.05$ level of significance.

RESULTS: as presented in Table 1.

CONCLUSIONS: BP1047H was applied beginning at the first true leaf stage of onion development at rates of 112.5, 225 or 300 g ai/ha. Consecutive treatments ranging in doses from 112.5 to 300 g ai/ha, separated by 7 to 10 days did not cause crop injury. Onions appear to tolerate total dose range of 337.5 to 900 g ai/ha when applied as split applications. Onion yields did not differ with herbicide treatment.

Table 1. Yield for onions, cv. Traverse, treated with BP1047H herbicide and grown at Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Treatments	Yield – marketable (t/ha)
Weed free check	37.13[1]
BP1047H @ 112.5 G AI/HA EARLY POST fb BP1047H @ 112.5 G AI/HA MID POST fb BP1047H @ 112.5 G AI/HA LATE POST	23.70
BP1047H @ 225 G AI/HA EARLY POST fb BP1047H @ 225 G AI/HA MID POST fb BP1047H @ 225 G AI/HA LATE POST	26.78
BP1047H @ 300 G AI/HA EARLY POST fb BP1047H @ 300 G AI/HA MID POST fb BP1047H @ 300 G AI/HA LATE POST	27.99

[1] No significant differences were found among treatments at P = 0.05 Tukey's HSD test.

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 Belchim Crop Protection Canada.

CROPS: Shanghai pak choi (*Brassica rapa* L. spp. *chinensis* var. *communis*) cv. Mei Qing Choi, spring wheat (*Triticum aestivum* L.) cv. AAC Connery, barley (*Hordeum vulgare* L.) cv. Trochu

PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

AUTHORS: DRURY SC[1], GOSSEN BD[2], MCDONALD MR[1]
[1]University of Guelph, Department of Plant Agriculture, Guelph
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TITLE: THE COMBINED EFFECT OF CEREAL CROPS AND LIMING ON CLUBROOT RESTING SPORE CONCENTRATIONS IN SOIL

MATERIALS AND METHODS: Controlled environment trials were conducted at the University of Guelph. Barley, cv. Trochu, was evaluated in a first run of the experiment and spring wheat, cv. AAC Connery, was evaluated in a second run. A no-plant control and the susceptible check, Shanghai pak choi, cv. Mei Qing Choi, were also included. In the barley and lime study, the three rates calcium hydroxide (hydrated lime) were: 0.3, 0.077 and 0 mg g^{-1} of soil, to target a pH of 7.2, 6.8 and 6.4, respectively. Higher rates of calcium hydroxide were targeted in the spring wheat and lime study as pH levels dropped throughout the 8-week growth period in the barley and lime study. The rates of calcium hydroxide were: 0.52, 0.24 and 0 mg g^{-1} of soil to attain a target pH of 7.6, 7.0 and 6.4, respectively. The study was arranged as a randomized complete block design, with six replicates and one pot per experimental unit. The study was arranged as a factorial, with two factors: the crop (yes or no) and the rate of calcium hydroxide.

The growing media was 2:1:1 by volume of mineral field soil from Elora, Ontario, noncalcareous coarse sand (Hutcheson Son & Mixes) and soil-less mix (Sunshine Soil Mix, L4A). For each replicate, 4,700 g of soil was prepared: a mixture of 2419 g of field soil, 2103 g of sand and 178 g of soilless mix. The soil was inoculated with pathotype 2 resting spores obtained from clubbed roots of canola, cv. ACS N39, grown for 9 weeks at the University of Guelph Muck Crops Research Station, Holland Marsh, Ontario in 2017. For each replicate, 10 mL of 2.3×10^8 spores mL^{-1} was diluted in 50 mL of deionized water and applied to attain 5×10^5 spores g^{-1} of soil. The inoculum was divided into two 50 mL falcon tubes and an EZ plant spray bottle was used to apply the inoculum to the soil. The soil was spread out in a 73.7 × 45.7 × 15.2-cm bin to a thickness of 3.8 cm. The spray was applied at a 10 cm distance from the soil to cover the soil surface once evenly. After each spray, the inoculum was mixed by hand for 30 seconds. The inoculum was sprayed and mixed the same way until all the inoculum was applied (the inoculum was sprayed and mixed 10 times).

Following inoculation, the soil from each replicate was divided to apply different rates of calcium hydroxide. In the barley and lime study, the rates of calcium hydroxide were 465 mg and 77 mg to attain a pH of 7.2 and 6.8, respectively. In the spring wheat and lime study, to attain pH 7.6, 651 mg of calcium hydroxide was added the 1,500 g of soil for each replicate. To attain pH 7.0, 0.155 mg of calcium hydroxide was added to each replicate. In both studies, no lime was applied to the negative control which had a soil pH of 6.4.

Sterilized plastic 16 oz. cups with drainage holes were filled with 500 g of soil and 20 seeds of pak choi, barley or spring wheat were planted at a depth of 3 cm in each cup. The cups were each placed in a 20.3 × 15.9 × 9.6-cm plastic container. The plants were watered from the bottom with tap water adjusted with commercial white vinegar or sodium hydroxide (NaOH) to the target pH of the limed soil. Therefore, water was adjusted to pH 7.2, 6.8 and 6.4 in the barley and lime study and to pH 7.6, 7.0 and 6.4 in the spring wheat and lime study. A fertilizer solution consisting of a 0.1% solution of nitrogen, phosphate, potassium (20-20-20), and magnesium sulfate was applied to the plastic container to fertilize from the bottom of the cups weekly. The fertilizer was adjusted with NaOH to the target soil pH. The volume of fertilizer applied increased throughout the study for barley, spring wheat and pak choi. Soil pH was tested weekly in the no-plant control in the barley and lime study. Three pots were set up with the 3 lime rates to test the pH every 5 days in the spring wheat and lime study. The growth room was set with a 17-hr photoperiod and a temperature of 24/19°C day/night.

Pak choi was extracted from soil after 6 weeks of growth to avoid the decay of clubs in the soil. The roots were assessed for clubroot disease severity 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. Clubroot incidence (CI) was determined as the percentage of plants with clubroot symptoms. A disease severity index (DSI) was calculated using the following formula:

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

The plants and soil from the barley or spring wheat and the no-plant control treatments were removed from the cups after 8 weeks of growth.

A DNeasy® PowerSoil® Kit (Qiagen) was used for extraction of *P. brassicae* DNA from samples in the barley and lime study and DNeasy® PowerSoil® Pro Kit (Qiagen) was used in the spring wheat and lime study. The samples were quantified with qPCR with a TaqMan multiplex system following the methods of Al-Daoud *et al.* (2017).

All statistical analyses were conducted in SAS 9.4 (SAS Institute, Cary, IN). A Type 1 error of $P = 0.05$ was set for all statistical tests. Concentrations of resting spores in soil were analyzed in PROC GLIMMIX based on a lognormal distribution using Tukey's test for means separation. The studies were analyzed using a factorial design where there were 2 factors: the crop treatment (yes or no) and the rate of calcium hydroxide. Concentrations of resting spores in the pak choi samples were analyzed among different lime rates. Clubroot incidence and DSI in pak choi among lime rates were analyzed based on a binomial distribution and were analyzed in PROC GLIMMIX using Tukey's test. PROC GLIMMIX using Tukey's test was used to analyze the pH values among treatments at the end of the experiment based on a normal distribution.

RESULTS: Clubroot developed in Shanghai pak choi, cv. Mei Qing Choi, at all three rates of calcium hydroxide in both studies. In both studies, clubroot incidence and disease severity in pak choi was over 90% in in the non-limed soil and was also high in the soil limed to target pH 6.8 (DSI = 86) and pH 7.0 (DSI = 99) (Table 1). Clubroot severity was lower in the treatments that received the highest rates of calcium hydroxide in both studies to target pH of 7.2 and 7.6 (DSI = 50 and 57, respectively).

Growing pak choi increased the concentration of spores in soil at all three rates of calcium hydroxide, but the concentration varied based on the rate (Table 1). In the non-limed soil, the concentration of spores was 1.0×10^8 spores g^{-1} in the barley study and 1.5×10^8 spores g^{-1} in the spring wheat study. The concentration of spores decreased to 2.2×10^7 spores g^{-1} and 7.4×10^6 spores g^{-1} in soil limed with a target pH of 6.8 and 7.2, respectively in the barley study and decreased to 3.0×10^7 spores g^{-1} in soil limed to a target pH of 7.6 in the spring wheat study.

There was no interaction between the cereal crop and lime in either study (Table 2). Spring wheat planted in soil limed to a target pH of 7.6 had lower concentration of resting spores than the no-lime treatments (no-plant and spring wheat) and the no-plant treatment at a target pH of 7.0. The concentration of resting spores was reduced by 66, 54 and 64% respectively.

CONCLUSION: No interaction was found between applying calcium hydroxide and growing barley or spring wheat. Therefore, growers can apply lime in combination with spring wheat to reduce concentrations of resting spores in soil. There were no differences between growing wheat and fallow (no-plant) treatments for any one pH level.

Table 1. Effect of three rates of calcium hydroxide ($Ca(OH)_2$) on concentration of resting spores of *Plasmodiophora brassicae* in soil based on standard qPCR analysis, clubroot incidence (CI) and disease severity index (DSI) in the susceptible control, Shanghai pak choi ,cv. Mei Qing Choi, after 6 weeks of growth in two runs (n=6).

Rate of $Ca(OH)_2$ (g^{-1})	Initial/target soil pH	Final soil pH	Resting spore concentration[1] (spores g^{-1})	CI (%)	DSI (0-100)
Run 1					
0 mg	6.4	6.8	1.0×10^8 a[2]	95 a	90 a
0.077 mg	6.8	7.0	2.2×10^7 b	93 a	86 a
0.30 mg	7.2	7.0	7.4×10^6 b	70 b	50 b
Run 2					
0 mg	6.4	6.9	1.5×10^8 a	100 a	99 a
0.24 mg	7.0	7.0	3.1×10^8 a	100 a	99 a
0.52 mg	7.6	7.1	3.0×10^7 b	83 b	57 b

[1]The soil was inoculated to attain an initial concentration of 5×10^5 resting spores g^{-1}. The actual concentration was 1.5×10^6 spores g^{-1} in run 1 and 2.3×10^5 spores g^{-1} in run 2. Resting spore concentrations were analyzed based on a lognormal distribution and are presented as back transformed least square means.
[2]Means followed by the same letter in a column do not differ based on Tukey's test at $P = 0.05$.

Table 2. Effect of barley cv. Trochu (run 1) and spring wheat cv. AAC Connery (run 2) and three rates of calcium hydroxide ($Ca(OH)_2$) on *Plasmodiophora brassicae* resting spore concentration in soil after 8 weeks of growth. Resting spore concentration was based on standard qPCR analysis (n=6).

Crop treatment	Rate of $Ca(OH)_2$ g^{-1}	Initial/target soil pH	Final pH	Resting spore concentration[1] (spores g^{-1})
Run 1				
No-plant (control)	0 mg	6.4	6.8	2.1×10^6 ns[2]
Barley	0 mg	6.4	6.9	3.0×10^6
No-plant (control)	0.077 mg	6.8	6.8	1.2×10^6
Barley	0.077 mg	6.8	7.0	2.5×10^6
No-plant (control)	0.30 mg	7.2	7.0	1.2×10^6
Barley	0.30 mg	7.2	7.1	2.4×10^6
Run 2				
No-plant (control)	0 mg	6.4	6.6	4.7×10^6 a[3]
Spring wheat	0 mg	6.4	7.0	3.4×10^6 a
No-plant (control)	0.24 mg	7.0	6.7	3.8×10^6 a
Spring wheat	0.24 mg	7.0	7.1	2.8×10^6 ab
No-plant (control)	0.52 mg	7.6	6.9	2.8×10^6 ab
Spring wheat	0.52 mg	7.6	7.2	2.1×10^6 b

[1]The soil was inoculated to attain an initial concentration of 5×10^5 resting spores g^{-1}. The actual concentration was 1.5×10^6 spores g^{-1} in run 1 and 2.3×10^5 spores g^{-1} in run 2. Resting spore concentrations were analyzed based on a lognormal distribution and are presented as back transformed least square means.
[2]ns indicates not significant based on Tukey's test at $P = 0.05$.
[3]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 Ontario Canola Growers Association.

Reference

Al-Daoud, F., Gossen, B. D., Robson, J., and McDonald, M. R. 2017. Propidium monoazide improves quantification of resting spores of *Plasmodiophora brassicae* with qPCR. Plant Disease 101:442–447.

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
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TITLE: EVALUATION OF SOIL SOLARIZATION FOR CLUBROOT CONTROL ON SHANGHAI PAK CHOI, 2020

METHODS: The trial was conducted at the Muck Crops Research Station, Holland Marsh, Ontario on muck soil (pH ≈ 7.0, organic matter ≈ 64.3%) naturally infested with *Plasmodiophora brassicae*. A randomized complete block design with six replicates per treatment was used. Each experimental unit was a 2 m x 6 m raised bed. Treatments were solarized for four, two and one week(s) before seeding by covering beds with totally impermeable film (TIF) (Raven Industries, Sioux Falls, South Dakota),. An uncovered (no TIF) check was also included. HOBO pendant dataloggers were placed 5 cm below the soil surface in the various treatments and the no TIF check. Beds were covered with TIF and the edges sealed with soil on 17, 30 June and 7 July (to solarize for four, two and one week(s) respectively). TIF was removed from all treatments on 15 July. On 16 July, each plot was seeded with four rows of Shanghai pak choi, cv. Mei Qing, spaced 43 cm apart, using an Earthway push seeder fitted with a 1002-09 seeding disc. On 31 July the number of weeds in a 1 m^2 area were counted to determine the effect of solarization on weed control. Plant stand was determined on 17 August by counting the number of plants in two randomly chosen 1 m sections of row. On 27 August, 50 plants per replicate were removed and tops cut and weighed to determine fresh top weight. Clubroot incidence and severity were assessed on the roots of these plants plus the roots of 50 additional plants (100 roots in total) using a 0 to 3 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:

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

Compared to the previous 10-year average, air temperatures in 2020 were above average for July (23.3°C), and average for August (20.6°C). The 10-year average temperatures were: July 21.5°C, and August 20.3°C. Monthly rainfall was above the 10-year average for August (140 mm), and average for July (58 mm). The 10-year rainfall averages were: July 84 m, and August 76 mm. 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 Table 1 and Figure 1.

CONCLUSIONS: Clubroot incidence in the trial was high (92-71%). Clubroot incidence was lowest in beds solarized for four and two weeks; however statistically, clubroot incidence in beds solarized for four weeks did not differ from the one-week solarization and the no TIF check. Clubroot severity was significantly less in beds solarized for two and four weeks compared to the no TIF check (Table 1). Significant differences in weed control, plants per meter, and fresh plant weight were found among the treatments (Table 1). Significantly fewer weeds and more plants per m were found in beds solarized for 2 or 4 weeks compared to the one-week solarization and the no TIF check. Top weight was significantly higher in beds solarized for one, two or four weeks compared to the no TIF check. Solarizing soil for four weeks did not improve weed or clubroot control compared to 2 weeks of solarization. Solarizing soil for 1 week did not decrease clubroot or reduce weeds compared to the check. There was no benefit from solarizing soil for four weeks compared to two weeks.

Table 1. Effects of solarization using totally impermeable film (TIF) on plants per meter, weeds per square meter, and clubroot incidence and severity for Shanghai pak choi, cv. Mei Qing, grown on muck soil naturally infested with *Plasmodiophora brassicae*, and solarized at the Muck Crops Research Station, Ontario, 2020.

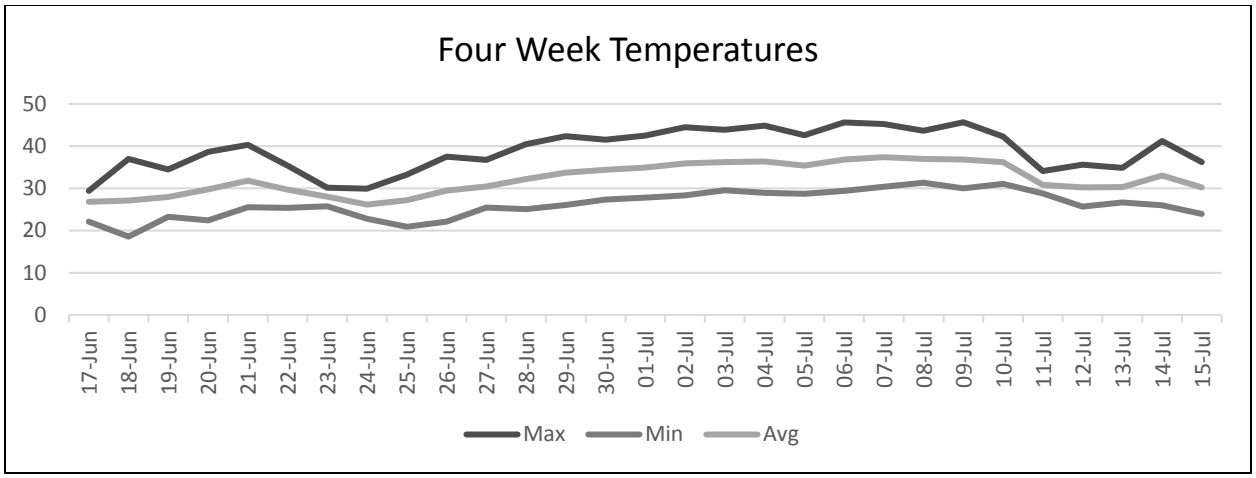
Treatment	# Plants/m	Clubroot incidence (%)	DSI[z]	Fresh top wgt/plant (g)	Weeds/m^2
TIF 4 week	19.3 a	81.8 ab	41.2 a	78.5 a	45.7 a[y]
TIF 2 week	19.3 a	70.9 a	35.8 a	101.3 a	43.7 a
TIF 1 week	16.3 ab	85.9 b	47.3 ab	70.4 a	124.8 b
No TIF check	12.3 b	91.9 b	56.5 b	10.2 b	113.2 b

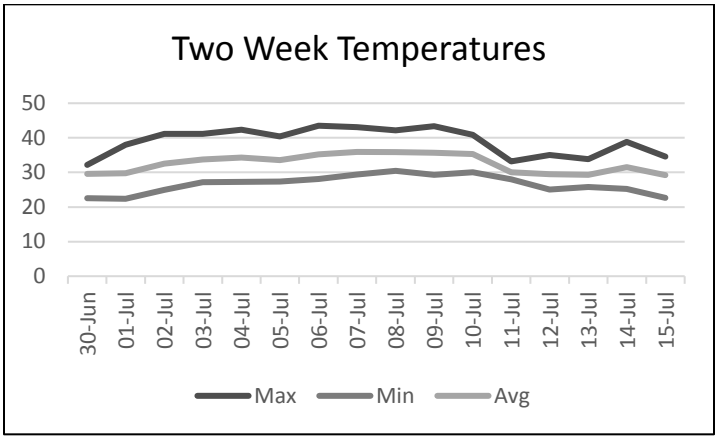
[z] Roots of 100 plants were sorted into the following classes: 0 = 0 clubbing, 0.2 = small club (<2 cm), 1 = <1/4 root clubbed, 2 = 1/4-1/2 root clubbed, 3 = >1/2 root clubbed. DSI was calculated with the following formula:

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

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

Funding was provided by the Clubroot Mitigation Initiative of Agriculture and Agri-Food Canada, the Canola Council of Canada and by the Ontario Agri-Food Innovation Alliance





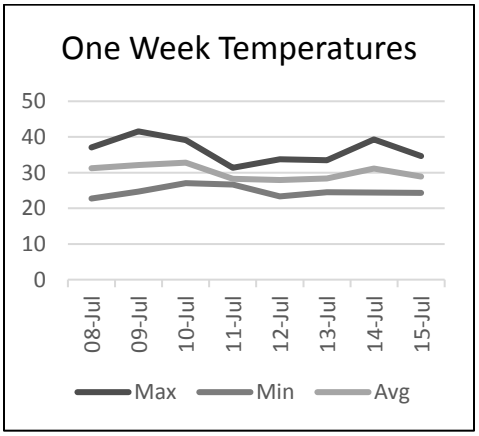


Figure 1. Maximum, Minimum and average daily soil temperatures 5 cm below totally impermeable film (TIF) covered for 4, 2 and 1 week at the Muck Crops Research Station, Ontario, June 17 – July 15, 2020.
Daily soil temperature recorded using a HOBO Pendant temperature data logger buried 5 cm below the soil

CROPS: Shanghai pak choi (*Brassica rapa* L. spp. *chinensis* var. *communis*) cv. Mei Qing Choi, spring wheat (*Triticum aestivum* L.) cv. AAC Connery, perennial ryegrass (*Lolium perenne* L.) cv. Norlea, barley (*Hordeum vulgare* L.) cv. Trochu, soybean (*Glycine max* L.) cv. PRO 26X662N, field pea (*Pisum sativum* L.) cv. CDC Meadow
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: THE EFFECT OF ROTATION CROPS ON CONCENTRATIONS OF CLUBROOT RESTING SPORES IN SOIL

MATERIALS AND METHODS: Controlled environment trials were conducted at the University of Guelph. The susceptible control, Shanghai pak choi (*Brassica rapa* L. spp. *chinensis* var. *communis*) cv. Mei Qing Choi and a no-plant (fallow/bare soil) control were also included in the study. The study was arranged as a randomized complete block design with six replicates and one pot per experimental unit. The study was conducted twice.

The growing media was 2:1:1 by volume of mineral field soil from Elora, Ontario, noncalcareous coarse sand (Hutcheson Son & Mixes) and soil-less mix (Sunshine Soil Mix, L4A). The soil for each replicate was prepared separately with 1,400 g of field soil, 1,400 g of sand and 100 g of soilless mix by weight for a total of 3,000 g per replicate. This growing media (pH 6.4) was inoculated with pathotype 2 resting spores obtained from clubbed roots of canola cv. ACS N39 grown for 9 weeks at the University of Guelph Muck Crops Research Station, Holland Marsh, Ontario in 2017.

Each replicate was inoculated separately to attain 5×10^5 spores g^{-1} of soil. To inoculate, 7.5 mL of 2.0×10^8 spores mL^{-1} were diluted in deionized water for a final spore suspension volume of 100 mL. The inoculum was divided into two 50 mL falcon tubes and an EZ plant spray bottle was used to apply the inoculum to the soil. The soil was spread out in a 73.7 × 45.7 × 15.2-cm bin to a thickness of 3.8 cm. The spray was applied at a 10 cm distance from the soil to cover the soil surface once evenly. After each spray, the inoculum was mixed by hand for 30 seconds. The inoculum was sprayed and mixed the same way until all the inoculum was applied (the inoculum was sprayed and mixed 10 times). Sterilized 16 oz. plastic cups with drainage holes were filled with 410 g of inoculated soil and 20 seeds were planted in each cup. The plants were thinned to 10 plants per cup 6 days after planting. The cups were each placed in a 20.3 × 15.9 × 9.6-cm plastic container and plants were watered from the bottom of the cups with tap water adjusted to pH 6.0 with 5% acetic acid (commercial white vinegar). The plants were watered based on field capacity. A fertilizer solution consisting of 0.1% solution of nitrogen, phosphate, potassium (20-20-20), and magnesium sulfate was applied to the plastic containers to fertilize from the bottom of the cups weekly. The growth room was set with a 17-hr photoperiod and a temperature of 24/19°C day/night.

Pak choi was harvested after 6 weeks of growth to avoid the decay of clubs in the soil. The roots were assessed for clubroot disease severity 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. Clubroot incidence (CI) was determined as the percentage of plants with clubroot symptoms. A disease severity index (DSI) was calculated using the following formula:

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

After 8 weeks of growth, the other plants and the no-plant control were removed from the pots. Roots were extracted from the soil, washed to remove excess soil, oven dried at 80ºC for 24 hours and root dry weight per pot was measured.

A DNeasy® PowerSoil® Kit (Qiagen) was used for extraction of *P. brassicae* DNA from samples following the manufacturer's instructions. The samples were quantified with qPCR with a TaqMan multiplex system following the methods of Al-Daoud *et al.* (2017).

All statistical analyses were conducted in SAS 9.4 (SAS Institute, Cary, IN). Concentrations of resting spores in soil and dry root weight were analyzed in PROC GLIMMIX using Tukey's test for means separation. A Type 1 error of $P = 0.05$ was set for all statistical tests. Concentrations of spores were analyzed based on a lognormal distribution and dry root weight among crop species was analyzed based on a normal distribution. The 2 runs could not be pooled for analysis and were therefore analyzed separately. Pearson correlations were used to examine the relationship between concentrations of resting spores and root weight among all crops and within each crop species using PROC CORR.

RESULTS: In run 1, perennial ryegrass and spring wheat reduced concentrations of resting spores in soil by 37 and 36%, respectively compared to the no-plant control (Table 1). In run 2, spring wheat reduced concentrations of resting spores compared to the no-plant control by 57%. The other crops did not change concentrations of spores compared to the no-plant control.

Perennial ryegrass had a higher root dry weight per pot than the other crops and field pea had the lowest dry root weight (Table 2). There was a positive correlation between root weight and concentrations of spores for perennial ryegrass in both runs. There was no correlation between root weight and concentrations of spores within any of the other crop species, or when all crops were assessed together.

CONCLUSION: Planting spring wheat as a rotation crop in clubroot infested soil may be effective in reducing the number of resting spores in soil.

Table 1. Effect of rotation crops and cover crop species on the concentration of resting spores of *Plasmodiophora brassicae* in soil and root dry weight after 8 weeks of growth. Resting spore concentration was based on standard qPCR analysis (n=6).

Crop	Cultivar	Resting spore concentration[1] (spores g^{-1})		Root dry weight (g pot^{-1})	
		Run 1	Run 2	Run 1	Run 2
No-plant control		6.8×10^5 ab[2]	2.1×10^5 a		
Soybean	PRO 26X662N	8.7×10^5 a	2.1×10^5 a	4.8 b	4.2 b
Barley	Trochu	3.8×10^5 bc	1.2×10^5 ab	2.9 bc	4.2 b
Field pea	Meadow	3.4×10^5 bc	1.4×10^5 a	1.9 c	1.9 c
Spring wheat	AAC Connery	3.3×10^5 c	6.6×10^4 b	3.0 bc	4.8 b
Perennial ryegrass	Norlea	3.1×10^5 c	1.2×10^5 ab	8.5 a	9.5 a

[1] The soil was inoculated to attain an initial concentration of 5×10^5 resting spores g^{-1} of soil. The actual concentration was 7.2×10^6 spores g^{-1} in run 1 and 6.1×10^4 spores g^{-1} in run 2. Resting spore concentrations were analyzed based on a lognormal distribution and are presented as back transformed least square means.

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

Table 2. Correlation between rotation or cover crop root dry weight and *Plasmodiophora brassicae* resting spore concentrations in soil after 8 weeks of growth in run 1 and 2 (n=6).

Crop	Resting spore concentration (spores g^{-1})			
	Run 1		Run 2	
	r	*p*[1]	*r*	*p*
Perennial ryegrass	0.87	0.03	0.90	0.01
Barley root	0.48	ns[1]	0.54	ns
Spring wheat	-0.29	ns	-0.42	ns
Field pea	-0.29	ns	0.52	ns
Soybean	-0.33	ns	-0.20	ns
Total	0.14	ns	0.23	ns

[1] ns indicates not significant.

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

Reference

Al-Daoud, F., Gossen, B. D., Robson, J., and McDonald, M. R. 2017. Propidium monoazide improves quantification of resting spores of *Plasmodiophora brassicae* with qPCR. Plant Disease 101:442–447.

HOST: Canola (*Brassica napus* L.), cv. L252
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 INCIDENCE ONE YEAR AFTER FUMIGATION AT MUCK CROPS RESEARCH STATION, 2020

METHODS: The trial was conducted at the Muck Crops Research Station, Holland Marsh, Ontario on organic soil (pH ≈ 6.0, organic matter ≈ 66%) naturally infested with *Plasmodiophora brassicae* pathotype 2. In 2020, susceptible canola, cv. Invigor L252, was seeded on 8 July using an Earthway Precision Garden Seeder fitted with seeding disc 1002-10 into plots that the previous year (2019) had received the following treatments: PIC PLUS at 164 and 280 kg/ha and BUSAN 1236 at 150 and 300 kg/ha covered with totally impermeable film (TIF) (Raven Industries, Sioux Falls, South Dakota). Untreated checks both tarped and untarped were also included. A randomized complete block design with five replications was used. Each experimental unit (plot) consisted of four rows, 12 m long, spaced 43 cm apart. On 27 August, 50 consecutive plants from each of the middle two rows (100 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 club≤ 2 cm, 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 2020 were above average for July (23.3°C), and average for August (20.6°C). The 10-year average temperatures were: July 21.5°C, and August 20.3°C. Monthly rainfall was above the 10-year average for August (140 mm), and below average for July (58 mm). The 10-year rainfall averages were: July 84 mm, and August 76 mm.

RESULTS: as presented in Table 1.

CONCLUSION: In 2019, clubroot incidence for susceptible canola grown in treated plots ranged from 42-64%. In 2020, clubroot incidence was 100% in all treatments (Table 1). The effects of fumigation are not carried over to the following growing season.

Treatment in 2019	Rate (kg/ha)	Incidence (%)		DSI[1]	
		2019	2020	2019	2020
PIC PLUS	164	41.6 a[2]	99.8 ns[3]	18.5 a	99.8 ns
PIC PLUS	240	46.5 a	100.0	18.1 a	100.0
TIF Check	-	47.0 a	99.4	26.1 a	99.2
BUSAN 1236	300	54.6 a	99.8	29.1 a	99.8
BUSAN 1236	150	64.0 ab	100.0	24.2 a	100.0
Uncovered Check	-	98.2 b	100.0	57.2 b	100.0

[1] Roots of 100 canola, cvs. Invigor 5030 (2019) and L252 (2020) were sorted into the following classes: 0=0%, 0.2 = 2 cm 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.
[3] ns indicated that no significant differences were found among treatments at P=0.05, Fisher's Protected LSD test.

HOST: Canola (*Brassica napus* L.), Invigor cvs. L352C, L234PC, L255 PC, L252
PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

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TITLE: EVALUATION OF CLUBROOT RESISTANCE IN CANOLA CULTIVARS FOR ONTARIO, 2020

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 L352C, L234PC, L255PC and L252 from Bayer Crop Science (Bayer). A randomized complete block design with four replicates was used. The trial was seeded on 8 July at 50 seeds per meter of row. Each experimental unit consisted of four rows, 10 m in length, with 43 cm between rows. An Earthway Precision Garden Seeder fitted with seeding disc 1002-10 was used to seed the trial.
On 19 August, six weeks after seeding, five groups of 20 consecutive plants (100 total) were pulled and visually assessed for clubroot. Clubroot symptoms were rated on a 0-3 scale and sorted into the following classes: 0 = no clubs, 0.2 = 1 club ≤ 2.0 cm, 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 was determined as the percentage of plants with clubroot symptoms. Disease severity index (DSI) was calculated using the following formula:

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

Data were analyzed with 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 Table 1.

CONCLUSION: The cultivars marketed as resistant to clubroot (L234PC, L352C, and L255) were confirmed to be resistant to pathotype 2 of *P. brassicae* in the field.

Table 1. Clubroot incidence (%) and severity (disease severity index, DSI), of clubroot susceptible and resistant canola cultivars grown at the Muck Crops Research Station, 2020.

Cultivar	Expected reaction	Clubroot incidence (%)	DSI (0-100)
L234PC	Resistant	0.5 a[1]	0.1 a
L352C	Resistant	0.8 a	0.2 a
L255PC	Resistant	3.7 a	0.4 a
L252	Susceptible	100.0 b	73.1 b

[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 Ontario Agri-Food Innovation Alliance and the Ontario Canola Growers Association.

HOSTS: Cabbage (*Brassica oleracea* L. var. *capitata*), broccoli (*B. oleracea* var. *italica*), and rutabaga (*B. napus* var. *napobrassica*)
PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

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TITLE: EVALUATION OF CLUBROOT RESISTANCE IN BRASSICA VEGETABLE CULTIVARS, 2020

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

METHODS: A field trial to evaluate the clubroot reaction of Brassica vegetable cultivars was conducted at the Muck Crops Research Station on muck soil (pH ≈ 6.4, organic matter 68.6%) naturally infested with *P. brassicae* pathotype 2. The vegetable cultivars evaluated were: Kilagreg, Kilaton, Danish Ballhead and Bronco (white cabbage), Lodero (red cabbage), Emerald Jewel (broccoli), and York (rutabaga). A randomized complete block design with four replicates per treatment was used. Each experimental unit consisted of two rows, five meters in length, spaced 86 cm apart. The cabbage and broccoli cultivars which were grown as transplants, were seeded 20 May into 128-cell plug trays filled with soilless mix and grown in a greenhouse. Rutabaga was direct seeded on 18 June using an Earthway Precision Garden Seeder fitted with seeding disc 1002-10 at ~ 50 seeds per meter of row.
On 10 August, 15 consecutive plants were pulled from each row (30 total) and the tops cut and weighed for top fresh weight. The roots were visually assessed for symptoms of clubroot and sorted into classes based on the following scale: 0 = no clubs, 0.2 = 1 very small club (≤2 cm), 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 in classes 1, 2 & 3 was used to determine clubroot incidence (CI). A disease severity index (DSI) was calculated using the following formula:

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

Compared to the previous 10-year average, air temperatures in 2020 were above average for July (23.3°C), and average for June (19.2°C). The 10-year average temperatures were: June 18.5°C and July 21.5°C. Monthly rainfall was below the 10-year average for June (77 mm) and July (58 mm). The 10-year rainfall averages were: June 103 mm, and July 84 mm. Data were analysed using the General Analysis of Variance function of the Linear Models section of Statistix V10.0. Means separation was obtained using Fisher's Protected LSD test at P = 0.05 level of significance.

RESULTS: as presented in Table 1.

CONCLUSIONS: In 2020, the resistant commercial cabbage cultivars Kilagreg and Kilaton had very low clubroot incidence. However, resistant cabbage Lodero (CI 74%) was statistically similar to susceptible cabbage Danish Ballhead. Broccoli Emerald Jewel (CI 87%), which is also listed as resistant, did not differ from the susceptible cabbage. Cultivars Kilagreg and Kilaton, which had the lowest clubroot incidence, also had significantly higher top weights compared to all other cabbage cultivars (Table 1).

Table 1. Clubroot incidence and severity (disease severity index, DSI), and fresh top weight of clubroot susceptible (S) and resistant (R) Brassica vegetables grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2020.

Cultivar	Crop	Source	Expected (S/R)	Clubroot incidence[1] (%)	DSI[2] (0-100)	Fresh top wgt/plant[3] (g)
York	rutabaga	Veseys	R	0.0 a[4]	0.0 a	-
Kilagreg	white cabbage	Syngenta	R	0.0 a	0.0 a	673.8 a
Kilaton	white cabbage	Syngenta	R	1.7 a	1.2 a	806.7 a
Lodero	red cabbage	Bejo	R	74.2 b	39.4 b	257.4 b
Emerald Jewel	broccoli	Stokes	R	87.5 bc	55.6 bc	-
Danish Ballhead	white cabbage	OSC	S	90.8 bc	62.3 c	242.8 b
Bronco	white cabbage	Bejo	S	98.2 c	70.0 c	216.2 b

[1] Clubroot incidence was determined considering only roots in classes 1, 2 & 3 as clubbed. Class 0.2 (roots with very small clubs) were grouped with class 0.

[2] Roots of 30 plants were sorted into the following classes: 0 = 0 clubbing, 0.2 =1 very small club (<2 cm), 1 = <1/4 root clubbed, 2 = 1/4-1/2 root clubbed, 3 = >1/2 root clubbed. DSI was calculated with the following formula:

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

[3] Only mean weights of the cabbage cultivars were compared statistically.

[4] 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 Ontario Agri-Food Innovation Alliance and the Fresh Vegetable Growers of Ontario.

CROPS: Mustard (*Brassica juncea*) cvs. Caliente Rojo and Caliente 199, canola (*Brassica napus* L.) cv. ACS N39 and tillage radish (*Raphanus sativus*) cv. Jackhammer

PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

AUTHORS: MCDONALD MR & VANDER KOOI K
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TITLE: EVALUATION OF CLUBROOT SUSCEPTIBILITY OF BRASSICAS USED AS BIOFUMIGANTS, 2020

METHODS: A field trial to evaluate the clubroot susceptibility of Brassica cultivars commonly used as biofumigants or cover crops was conducted on a site naturally infested with *P. brassicae* at the Muck Crops Research Station, Holland Marsh, Ontario. The cultivars evaluated were: cover crop mustard cvs. Caliente Rojo, Caliente 199, and tillage radish, cv. Jackhammer. Canola, cv. ACS N39, was included as a susceptible check. A randomized complete block design with four replicates per cultivar was used. All cultivars were direct seeded on 19 June using an Earthway Precision Garden Seeder fitted with seeding disc 1002-10 for the mustards and the canola and 1002-5 seeding disc for the tillage radish (larger seed). Each experimental unit consisted of two rows, 5 m in length, with 43 cm between rows. On 31 July, 50 plants (25 from each row) were pulled and the roots rated for clubroot using a 0-3 scale, where 0 = no clubs, 0.2 = 1 very small club (≤2 cm), 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 number of plants in each class was used to determine the disease severity index (DSI) using the following formula:

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

Compared to the previous 10-year average, air temperatures in 2020 were above average for July (23.3°C), and average for June (19.2°C). The 10-year average temperatures were: June 18.5°C and July 21.5°C. Monthly rainfall was below the 10-year average for June (77 mm) and July (58 mm). The 10-year rainfall averages were: June 103 mm, and July 84 mm. Data were analysed using the General Analysis of Variance function of the Linear Models section of Statistix V10.0. Means separation was obtained using Fisher's Protected LSD test at P = 0.05 level of significance.

RESULTS: as presented in Table 1.

CONCLUSIONS: Clubroot incidence for mustard cultivars Caliente 199 and Caliente Rojo was high (97 & 99% respectively), and statistically similar to canola ACS N39 (clubroot incidence 73%). The tillage radish Jackhammer (clubroot incidence 0%) is not susceptible to clubroot (Table 1).

Table 1. Clubroot incidence and severity for biofumigant crops and canola ACS N39 (susceptible check) grown in muck soil naturally infested with *Plasmodiophora brassicae*, at the Muck Crops Research Station, Ontario, 2020.

Cultivars	Clubroot Incidence (%)	DSI[1]
Jackhammer	0.0 a[2]	0.0 a
Canola ACS N39	73.0 b	44.8 b
Caliente 199	97.0 b	68.2 b
Caliente Rojo	98.7 b	68.8 b

[1] Roots of 100 plants were sorted into the following classes: 0 = 0 clubbing, 0.2 = 1 very small club (<2 cm), 1 = <1/4 root clubbed, 2 = 1/4-1/2 root clubbed, 3 = >1/2 root clubbed. DSI was calculated with the following formula:

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

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

Funding for this project was provided by the Ontario Agri-Food Innovation Alliance and the Fresh Vegetable Growers 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 M R
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TITLE: EVALUATION OF NEMATICIDES FOR CONTROL OF THE STEM AND BULB NEMATODE IN GARLIC IN A MINERAL SOIL FIELD, 2019-20

MATERIALS: AGRI-MEK SC (abamectin 84 g/L), PROMAX (thyme oil 3.5%), VELUM PRIME (fluopyram 500g/L)

METHODS: The field trial was conducted in a mineral soil field (organic matter 3.1%, pH 7.4) free of stem and bulb nematode (SBN) near Cookstown, Ontario. A randomized complete block design with five replicates per treatment was used. Two types of garlic cloves (seed) were included in the trial: SBN infested seed (7 SBN/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, PROMAX and VELUM PRIME applied as a soak (S) or drench (D). Treatments receiving a product soak, and the associated soaking times, were: AGRI-MEK S at 0.9 mL/L for 4-hours, PROMAX S at 37.4 mL/L for 4-, 6- and 8-hours and VELUM PRIME S at 1.7 mL/L for 1-, 2- and 4-hours. Soak treatments were applied by placing cloves in a mesh bag in 10 L of each treatment solution for each respective amount of time. After treatment, cloves were air dried before planting. The drench treatment was VELUM PRIME D at 500 mL/ha applied directly over the cloves at planting at an application rate of 40 mL/m using a 100 mL beaker. An untreated infested and clean seed checks were also included. Each experimental unit consisted of 25 garlic cloves planted ~5 cm deep and 10 cm apart in 2.5 m long single rows spaced 40 cm apart. The trial was planted on 29 October 2019. Emergence was recorded on 4 June 2020 and plant heights on 25 June. Garlic was harvested on 30 July. Bulbs were counted, weighed, assessed for basal plate rot and sorted into classes 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. These data were used to calculate a disease severity index (DSI) using the formula below.

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

Stem and bulb nematodes were extracted and quantified from a 10 g sample of cloves after harvest using the Baermann pan method.

Compared to the previous 10-year average, air temperatures in 2020 were above average for July (23.3°C), average for June (19.2°C) and below average for May (11.6°C). The 10-year average temperatures were: May 14.2°C, June 18.5°C and July 21.5°C. Average temperatures in fall 2019 were: October 9.4°C, November -0.1°C and December -3.6°C.

Monthly rainfall was below the 10-year average for May (38 mm), June (77 mm) and July (58 mm). The 10-year rainfall averages were: May 73 mm, June 103 mm and July 84 mm. Average rainfall, or precipitation, in fall 2019 were: October 2.7 mm, November 0.7 mm and December 2.2 mm.

Data were analyzed using the PROC GLIMMIX function in SAS version 9.4. Means separation was obtained using Tukey's HSD test with $P = 0.05$ level of significance. A Beta distribution was assumed in the harvest assessment analysis. SBN counts from garlic cloves at harvest were log transformed for analysis but the non-transformed counts are presented.

RESULTS: Data are presented in Tables 1 and 2.

CONCLUSIONS: The VELUM PRIME S treatment soaked for 2-hours had significantly lower SBN incidence and severity at harvest compared to all other treatments. For all VELUM PRIME S treatments, 100% of garlic bulbs were marketable at harvest while the other treatments were numerically lower. The PROMAX S treatment that soaked for 8 hours had the highest damage incidence, severity and SBN cloves counts and the lowest percent of bulbs that were marketable, numerically. No significant differences were found among treatments in terms of emergence and plant height. Stem and bulb nematode damage was low, overall, throughout the trial.

Table 1. Garlic emergence and plant heights on 4 June and 25 June, respectively, after nematicide treatments at planting near Cookstown, Ontario, 2020.

Treatment	Soaking Time (hr)	Emergence	Plant Height (cm)
Clean seed	-	24.4 ns[1]	86.6 ns
VELUM PRIME S	2	23.4	86.3
PROMAX S	4	22.6	81.0
Untreated	-	21.6	81.9
VELUM PRIME S	1	21.6	83.3
AGRI-MEK S	4	21.6	82.8
VELUM PRIME D	-	21.6	86.1
PROMAX S	6	21.6	82.1
VELUM PRIME S	4	21.6	83.6
PROMAX S	8	21.2	82.0

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

Table 2. Nematode damage incidence, disease severity index (DSI), percent marketable bulbs, marketable yield and stem and bulb nematodes (SBN) in cloves from harvested garlic treated with nematicides to control SBN in a mineral soil field trial near Cookstown, Ontario, 2019-2020.

Treatment	Soaking Time (hr)	% Nematode Damage	DSI[1]	% Marketable Bulbs	Marketable Yield (g/plot)	SBN /g of Garlic Cloves
VELUM PRIME S	2	0.0 a[2]	0.0 a	100.0 ns[3]	815.3 ns	1.6 a
VELUM PRIME S	1	2.2 b	0.6 b	100.0	870.5	0.2 a
VELUM PRIME S	4	4.0 b	1.0 b	100.0	888.2	58.4 ab
PROMAX S	4	5.4 b	2.6 b	97.4	830.5	8.8 abc
AGRI-MEK S	4	5.8 b	3.8 b	95.1	829.8	86.6 abc
PROMAX S	6	9.2 b	4.6 b	95.4	800.1	253.2 c
Clean seed	-	10.7 b	5.0 b	93.3	682.1	268.4 bc
Untreated	-	11.1 b	7.9 b	91.8	761.3	42.6 abc
VELUM PRIME D	-	12.0 b	4.6 b	95.6	804.7	199.6 bc
PROMAX S	8	16.9 b	11.1 b	88.1	763.4	862.4 c

[1] DSI was calculated using the following equation:

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

[2] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Tukey's HSD test
[3] ns indicates that no significant differences were found among the treatments at $P = 0.05$, Tukey's HSD 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, and the Fresh Vegetable Growers of Ontario representing the Ontario Garlic Growers Association.

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 M R
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TITLE: EVALUATION OF NEMATICIDES FOR CONTROL OF THE STEM AND BULB NEMATODE IN GARLIC IN MUCK SOIL, 2019-20

MATERIALS: AGRI-MEK SC (abamectin 84 g/L), PROMAX (thyme oil 3.5%), VELUM PRIME (fluopyram 500g/L)

METHODS: The trial was conducted within an enclosed muck soil plot (organic matter 64.5%, pH 7.0) that was naturally infested with a stem and bulb nematode (SBN) population of ~30 SBN/kg soil at the Muck Crops Research Station (MCRS). A randomized complete block design with four replicates per treatment was used. The garlic cloves (seed) used in the trial were clean and free of SBN. The treatments were AGRI-MEK SC, PROMAX and VELUM PRIME applied as a soak (S) or drench (D). Soak treatments were: AGRI-MEK S at 0.9 mL/L, PROMAX S at 74.8 mL/L (double the recommended rate) and VELUM PRIME S at 1.7 mL/L. Soak treatments were applied by placing cloves in a mesh bag in 10 L of each treatment solution for 4 hours. After treatment, bulbs were air dried before planting. The drench treatment was VELUM PRIME D at 500 mL/ha applied directly over the cloves at planting at an application rate of 40 mL/m using a 100 mL beaker. An untreated check was also included. Twenty garlic cloves were planted per replicate plot. Cloves were planted ~5 cm deep and 10 cm apart in 2 m long single rows spaced 40 cm apart. The trial was planted on 5 November 2019. Emergence was recorded on 12 May 2020 and plant height on 19 June. Garlic was harvested on 23 July and bulbs were counted, weighed, assessed for basal plate rot and sorted into classes 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. These data were used to calculate a disease severity index (DSI) using the formula below.

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

Stem and bulb nematodes were extracted from a 10 g sample of cloves after harvest using the Baermann pan method. Treatment plots were also soil sampled for nematode analysis by taking ten soil cores from the top 5 cm of soil. Stem and bulb nematodes were extracted from the soil using the sugar centrifugal flotation method.

Compared to the previous 10-year average, air temperatures in 2020 were above average for July (23.3°C), average for June (19.2°C), and below average for May (11.6°C). The 10-year average temperatures were: May 14.2°C, June 18.5°C and July 21.5°C. Average temperatures in fall 2019 were: October 9.4°C, November -0.1°C and December -3.6°C.

Monthly rainfall was below the 10-year average for May (38 mm), June (77 mm) and July (58 mm). The 10-year rainfall averages were: May 73 mm, June 103 mm and July 84 mm. Average rainfall, or precipitation, in fall 2019 were: October 2.7 mm, November 0.7 mm and December 2.2 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 HSD test with P = 0.05 level of significance.

RESULTS: Data are presented in Tables 1 and 2.

CONCLUSIONS: Soaking garlic cloves in VELUM PRIME (VELUM PRIME S) before planting provided excellent protection from SBN. At harvest, bulbs from the VELUM PRIME S treatment had significantly lower SBN damage incidence and severity, as well as higher marketable yield compared to the other treatments. The VELUM PRIME drench treatment (VELUM PRIME D) also provided good SBN

control and had a higher marketable yield than the PROMAX S and AGRI-MEK S treatments, but was not different from the untreated check. Garlic plants treated with AGRI-MEK S and the double rate of PROMAX S showed symptoms of SBN parasitism during the 19 June assessment as plants were smaller (Table 1) and chlorotic.

Table 1. Garlic emergence and plant heights on 12 May and 19 June, respectively, after nematicide application in a muck soil plot infested with stem and bulb nematode at the Muck Crops Research Station, 2020.

Treatment	App. Method[1]	Emergence	Plant Height (cm)
Untreated	-	20.0 ns[2]	81.0 a[3]
VELUM PRIME	D	20.0	79.9 a
VELUM PRIME	S	19.5	79.4 a
PROMAX	S	19.5	74.4 ab
AGRI-MEK	S	20.0	66.1 b

[1] Application Method: S = Soak; D = Drench
[2] ns indicates that no significant differences were found among the treatments at $P = 0.05$, Tukey's HSD test
[3] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Tukey's HSD test

Table 2. Nematode damage incidence, damage severity index (DSI), percent marketable bulbs, marketable yield and stem and bulb nematode (SBN) population in the soil from harvested garlic treated with nematicides to control soil borne SBN in muck soil at the Muck Crops Research Station, 2019-2020.

Treatment	App. Method[1]	% Nematode Damage	DSI[2]	% Marketable Bulbs	Marketable Yield (g/plot)	SBN/kg Soil
VELUM PRIME	S	10.8 a[3]	3.0 a	98.6 a	950.0 a	60 ns[4]
VELUM PRIME	D	52.7 b	24.3 b	71.7 ab	659.4 b	20
Untreated	-	73.1 bc	39.5 bc	50.1 b	398.5 bc	0
PROMAX	S	84.3 c	48.0 c	46.5 b	280.2 c	50
AGRI-MEK	S	96.3 c	54.8 c	44.0 b	135.8 c	20

[1] Application Method: S = Soak; D = Drench
[2] DSI was calculated using the following equation:

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

[3] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Tukey's HSD test
[4] ns indicates that no significant differences were found among the treatments at $P = 0.05$, Tukey's HSD 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, and the Fresh Vegetable Growers of Ontario representing the Ontario Garlic Growers Association.

CROP: Romaine Lettuce (*Lactuca sativa* L.), cv. Arroyo
PEST: Northern root-knot nematode (*Meloidogyne hapla*) Chitwood, 1949

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TITLE: A MICROPLOT EVALUATION OF AN EXPERIMENTAL NEMATICIDE FOR CONTROL OF ROOT-KNOT NEMATODE IN ROMAINE LETTUCE, 2020

MATERIALS: EXPERIMENTAL (300 g/L)

METHODS: The trial was conducted in enclosed microplots with muck soil (organic matter 76.8%, pH 6.2) infested with root-knot nematode (RKN) at the Muck Crops Research Station (MCRS). The microplot trial was arranged in a randomized complete block design with four (4) replicates. Two rates of an EXPERIMENTAL nematicide, 0.167 L/ha and 0.333 L/ha, were evaluated on the efficacy to control RKN. The treatments were applied at an application rate of 22.8 mL/m directly over the row at seeding using a 100 mL beaker. An untreated check was also included. Fifty lettuce seeds were planted per treatment (microplot) 6 cm apart in two 1.5 m long rows spaced 30 cm apart on 14 July and were thinned on 14 August. Microplots were soil sampled at seeding for nematode by taking twelve 15 cm soil cores for nematode analysis. Nematodes were extracted from the soil using the Baermann pan method and quantified at the MCRS. Lettuce emergence, phytotoxicity and vigor were recorded on 28 July and 5 August. A mid-season assessment evaluated root galling and plant weights from six plants per treatment on 1 September. The number of RKN eggs in roots were also quantified using a NaOCl egg extraction protocol. Lettuce was harvested on 18 September. Lettuce top and root weights were recorded, and roots were assessed for RKN galling. The extent of RKN galling in lettuce roots from the mid-season and harvest assessment were determined using the Bridge and Page 0-10 rating scale (1980), where: 0 = no galls on roots; 1 = very few small galls difficult to find; 2 = small galls only but clearly visible; 3 = some larger galls visible but main roots clean; 4 = larger galls predominate, but main roots clean; 5 = 50% of roots galled, galling on parts of main root system; 6 = galling on some main roots, some coalesced; 7 = majority of main roots galled; coalescing common; 8 = galling on all main roots, few clean roots visible; 9 = all roots severely galled, mostly coalesced, plant usually dying; 10 = all roots severely galled, no root. The damage severity index (DSI) was determined using the following equation:

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

Compared to the previous 10-year average, air temperatures in 2020 were above average for July (23.3°C), average for June (19.2°C), August (20.6°C), and below average for May (11.6°C) and September (15.0°C). The 10-year average temperatures were: May 14.2°C, June 18.5°C, July 21.5°C, August 20.3°C and September 16.5°C.
Monthly rainfall was above the 10-year average for August (140 mm), average for September (65 mm), and below average for May (38 mm), June (77 mm) and July (58 mm). The 10-year rainfall averages were: May 73 mm, June 103 mm, July 84 mm, August 76 mm and September 62 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 HSD test with P = 0.05 level of significance.

RESULTS: Data are presented in Tables 1 and 2.

CONCLUSIONS: The EXPERIMENTAL nematicide at 0.333 L/ha had significantly lower root-knot nematode damage incidence and severity than the same product at a lower rate and the untreated check during the mid-season assessment (Table 1). There were no significant differences among treatments at harvest although the EXPERIMENTAL at 0.333 L/ha treatment maintained lower root-knot nematode

damage incidence and severity, numerically. There were no significant lettuce emergence or vigor differences among the treatments and no phytotoxicity was observed throughout the duration of the trial.

Table 1. Nematode damage incidence, damage severity index (DSI) and lettuce top and root weight from root-knot nematode (RKN) infested microplots during the mid-season assessment at the Muck Crops Research Station, 2020.

Treatment	Rate (L/ha)	% Nematode Damage	DSI[1]	Top Weight (kg)	Root Weight (g)	RKN Eggs/g Root
EXPERIMENTAL	0.333	33.3 a[2]	3.8 a	1.5 ns[3]	88.3 ns	256.2 ns
EXPERIMENTAL	0.167	58.3 b	7.9 b	2.1	129.3	218.4
Untreated	-	62.5 b	8.3 b	1.8	117.7	581.6

[1] DSI was calculated using the following equation:

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

[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. Nematode damage incidence, damage severity index (DSI) and lettuce top and root weight at harvest from root-knot nematode (RKN) infested microplots at the Muck Crops Research Station, 2020.

Treatment	Rate (L/ha)	% Nematode Damage	DSI[1]	Top Weight (kg)	Root Weight (g)
EXPERIMENTAL	0.333	27.0 ns[2]	3.1 ns	4.1	252.5 ns
EXPERIMENTAL	0.167	37.1	4.8	4.7	247.5
Untreated	-	37.8	6.1	4.2	292.5

[1] DSI was calculated using the following equation:

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

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

Funding for this project was provided Syngenta Canada Inc.

CROP: Potato (*Solanum tuberosum* L.), cv. Superior
PEST: Root-lesion nematode (*Pratylenchus penetrans*) (Cobb, 1917) Filip'ev & Schuurmans Stekhoven, 1941

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TITLE: FIELD EVALUATIONS OF NEMATICIDES FOR ROOT-LESION NEMATODE CONTROL IN POTATO, 2020

MATERIALS: SALIBRO (fluazaindolizine 500 g/L), VELUM PRIME (fluopyram 500g/L), VYDATE (oxamyl 240 g/L)

METHODS: The trial was conducted in a commercial mineral soil field (organic matter 3.1%, pH 5.7) naturally infested with root-lesion nematode (*Pratylenchus penetrans*) near Alliston, Ontario. A randomized complete block design with five replicates per treatment was used. The treatments were: SALIBRO at 0.56 and 1.12 L/ha, VYDATE at 4.67 and 9.3 L/ha, a low rate combination of SALIBRO at 0.56 L/ha + VYDATE 4.67 L/ha, a high rate combination of SALIBRO at 1.12 L/ha + VYDATE 9.3 L/ha and VELUM PRIME at 0.5 L/ha. An untreated check was also included. All treatments were applied to the soil and potato seed surface, using a CO_2 backpack sprayer fitted with TeeJet 8003 flat fan nozzles at the rate of 250 L/ha, before potato hills were covered with soil. Potatoes, cv. Superior, were hand planted 10 cm deep in hills at 4 potatoes/m for all treatments on 14 May. Each experimental unit consisted of two rows, 91 cm apart and 7 m in length. Twelve 20 cm soil cores, discarding the top 5 cm of soil, were taken from each plot to create one soil sample at seeding, 4 weeks after application (4 WAA) and at harvest for nematode analysis. Nematodes were extracted and enumerated at the University of Guelph Muck Crops Research Station using the Baermann pan method. Potato emergence was recorded on 4 June. Phytotoxicity and vigor were recorded on 4, 12, 25 June, 15 July and 28 August. Potatoes were hand harvested from two 1.5 m middle sections of each row on 28 August and stored at room temperature. Potatoes were assessed on 31 August and graded as US #1 (marketable) or undersized and misshapen (unmarketable). Yield was also determined from the harvest sample.
Average air temperature over the 2020 season were: May 14.2°C, June 19.8°C, July 22.7°C and August 20.5°C. Monthly rainfall and irrigation averages were: May 73 mm, June 40 mm, July 127.2 mm and August 193 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 HSD test with $P = 0.05$ level of significance.

RESULTS: Data are presented in Tables 1 and 2. There were no significant differences in emergence, vigor or phytotoxicity among the treatments.

CONCLUSIONS: Root-lesion nematodes were found in all treatment plots, but there were no significant differences in nematode counts or reproduction ratios among the treatments over the season (Table 1). In addition, there were no significant differences in potato yield at harvest among nematicide treatments and the untreated check (Table 2). Overall, nematode populations for most plots were below the economic threshold (1000 root-lesion nematodes/kg soil) for the potato cultivar Superior which resulted in low damage throughout the trial. However, root-lesion nematodes are believed to contribute to the potato early dying complex, and this disease was found throughout the trial before harvest.

Table 1. Root-lesion nematode soil counts (nematodes/kg of soil) and reproduction ratios from potato, cv. Superior, soil at planting, four weeks after application (4 WAA) and after harvest after treatment with nematicides near Alliston, Ontario, 2020.

Treatment	Rate (L/ha)	At Planting	4 WAA	4 WAA Reproduction Ratio[1]	Harvest	Harvest Reproduction Ratio
SALIBRO	0.56	976 ns[2]	2000 ns	2.2 ns	5624 ns	6.1 ns
VYDATE	4.67	880	3120	3.6	5024	5.1
SALIBRO	1.12	832	3488	3.5	4944	5.7
check	-	832	2720	2.0	5200	4.8
SALIBRO + VYDATE	0.56 + 4.67	808	2544	8.4	5120	9.0
VYDATE	9.3	760	1472	1.2	5288	9.0
SALIBRO + VYDATE	1.12 + 9.3	688	1984	2.7	3760	4.8
VELUM PRIME	0.5	592	544	1.6	2928	7.1

[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

Table 2. Percent marketable and marketable yield for potatoes, cv. Superior, grown in root-lesion nematode infested soil treated with nematicides near Alliston, Ontario, 2020.

Treatment	Rate (L/ha)	% Marketable	Marketable Yield (t/ha)
VELUM PRIME	0.5	78.4 ns[1]	12.7 ns
check	-	78.3	11.9
VYDATE	9.3	77.0	11.8
SALIBRO	0.56	75.3	11.5
SALIBRO	1.12	74.8	10.5
SALIBRO + VYDATE	1.12 + 9.3	74.4	12.2
VYDATE	4.67	73.0	12.1
SALIBRO + VYDATE	0.56 + 4.67	69.1	11.9

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

Funding for this project was provided by Corteva Agriscience.

CROP: Onion (*Allium cepa* L.) cv. Highlander
Carrot (*Daucus carota* subsp. *sativus*) cv. Enterprise

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TITLE: DEMONSTRATION OF COVER CROPS FOLLOWING TRANSPLANT ONIONS AND CARROT CROPS ON ORGANIC (MUCK) SOIL, 2020

MATERIALS: Barley, Nitro Plus (5% faba bean, 10% nitro radish, 15% crimson clover, 10% Austrian peas, 10% forage peas and 50% oats), Diakon radish, Caliente 199, Caliente Rojo

METHODS: Onions, cv. Highlander, and carrots, cv. Enterprise, were mechanically transplanted (onions) and direct seeded using a Stanhay Precision seeder (carrots) into organic soil (organic matter ≈ 64.7%, pH ≈ 6.9) on 13 and 25 May respectively. Both crops were grown to maturity and mechanically harvested on 13 August (onions) and 7, 8, 14 October (carrots).
A randomized complete block design with three replicates per treatment was used. Treatment areas were 14 x 18 m for onions and 14 x 30 m for carrots. Cover crop treatments after onions were: Diakon radish at 18 kg/ha, barley at 90 kg/ha, Nitro Mix at 45 kg/ha and biofumigant mustards Caliente 199 and Caliente Rojo at 12 kg/ha. All cover crops were seeded on 20 August into lightly disked soil, cultivated to a depth of 5-8 cm after seeding and rolled to provide good soil contact.
Cover crop treatments after carrots were: Nitro Plus (5% faba bean, 10% nitro radish, 15% crimson clover, 10% Austrian peas, 10% forage peas and 50% oats) at 60 kg/ha, over seeded between carrot rows and not incorporated (17 August), and barley at 90 kg/ha both pre-harvest broadcast seeded and incorporated by harvest actions (2 October) and post-harvest seeded using a CASE 5100 seed drill to a depth of 3-4 cm into lightly disked soil (16 October).
On 6 October the green canopy cover was measured from three randomly chosen areas in each replicate using the Canopeo App developed by the Soil Physics Research Group at Oklahoma State University. On 6 October, plants in three separate 1 meter sections s in the interseeded treatment were counted and species recorded. On 28 October cover crops were cut at ground level, plants in three 1.0 m^2 areas and weighed to determine total biomass. Cover were grown until freeze up in the fall. 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: As presented in Tables 1 and 2.

CONCLUSIONS: All species of cover crops seeded following transplant onions grew well. Canopy coverage over 80% was observed in four of the five crops tested. Good ground coverage is important to minimize soil disturbance during the winter months.
In carrots, establishment and growth of the early interseeding of the Nitro Plus demonstrated that the different cover crop species will grow under and in-between carrot rows. Shallow cultivation of the soil at the time of seeding may have improved the cover crop establishment. Cover crops that were seeded prior to harvest and drilled following the carrot harvest were also able to establish and grew before freeze up in the late fall. Warm weather and adequate rainfall in October favored the establishment and growth of both late seeded cover crops. More work is needed to improve timing and placement of cover crops species in carrot fields.

Table 1. Various cover crop species following a transplant onion crop, grown near Muck Crops Research Station, Holland Marsh, 2020.

Crop	Seeding Rate kg/ha	Avg. Weight 1.0 M^2 (kg)	Canopeo Coverage %
Barley	90	1.83 ns[1]	96.3 a[2]
Nitro PLUS	45	2.22	96.3 a
Diakon Radish	17	2.20	90.4 a
Caliente 199	12	1.85	80.4 ab
Caliente Rojo	12	2.03	63.6 b

Seeded August 20

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

[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. Nitro Plus cover crop species establishment interseeded within a carrot crop on 17 August, grown near Muck Crops Research Station, Holland Marsh, 2020.

Interseeded Crop in Carrots – Nitro Plus	Percentage of 60 kg/ha Seeding Rate	Average Number of Plants/meter - 6 Oct
Oats	50	7.1
Nitro Radish	10	8.0
Crimson clover	15	8.9
Forage Pea	10	0.9
Faba bean	5	0.0
Austrian Pea	10	0.0

Funding for this project was provided by Ontario Ministry of Agriculture and Food and Ministry of Rural Affairs and by the Ontario Agri-Food Innovation Alliance

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TITLE: DEMONSTRATION OF BIOFUMIGANT COVER CROPS ON ORGANIC (MUCK) SOIL, 2020

MATERIALS: Caliente 199 (*Brassica juncea* L.), Caliente Rojo (B*rassica juncea* L.), sorghum Sudan grass (*Sorghum vulgare* var. *sudanese* Hitchcock (Marks and Townsend, 1973), Barley (*Hordeum vulgare* L. (Hitchcock, 1971) and pearl millet (*Pennisetum glaucum*)

METHODS: Cover crops of various species were seeded into organic soil (organic matter ≈ 64.7%, pH ≈ 6.9) at a site near the Muck Crops Research Station in the Holland Marsh, Ontario to determine the effect of biofumigant mustards and other cover crops on soil borne pathogens and to determine the overall benefit of cover crop use on organic soil. A randomized complete block design with three replicates per treatment was used. Treatment areas were 14 x 18 m and were seeded with a CASE 5100 grain drill. Biofumigant mustard, Caliente 199 was seeded on 1 May (early) at 12 kg/ha, worked under and reseeded on 16 July with sorghum Sudan grass, barley or pearl millet. Separate plots of Caliente 199 and Rojo were seeded on 29 June (late). When at 80-90% flowering, on 29 June for early seeded Caliente 199 and on 17 August for late seeded Caliente 199 and Rojo, plants were chopped using a flail mower and the crop residue rototilled into the soil. As the mustard plants decompose, glucosinolates are released and work as a biofumigant. Soil was left undisturbed for 14 days to allow time for the material to break down. On 16 July, cover crops of sorghum Sudan grass (56 kg/ha), barley (90 kg/ha) or pearl millet (10 kg/ha) were seeded into the early seeded biofumigant treatments using the grain drill. Fresh biomass was determined on 17 August and 11 September for the late seeded Caliente 199 and Rojo and the sorghum, barley and pearl millet reseeded treatments respectively. Plants in three 1 m^2 sections were cut at ground level and weighed. The green canopy cover was measured in three areas in each replicate using the Canopeo App developed by the Soil Physics Research Group at Oklahoma State University. Soil samples for DNA multiscan analysis were taken prior to seeding and after the fumigation process in the late seeded biofumigant treatments. 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: as presented in Tables 1 and 2.

OBSERVATIONS: Proper seeding depth of various cover crops is important to ensure good stands.
Pearl millet seeded in early September did not survive a frost when 5 cm tall.
Late seeded (17 September) daikon radish did not grow as well and were smaller in the plots that had been previously planted with sorghum Sudan grass.
Three plots seeded on 3 September with biofumigant Caliente 199 were sprayed with herbicides GOAL at 300ml/ha, PARDNER at 300 ml/ha or Chateau at 140 g/ha on 8 October. Damage was observed on 8 October on areas sprayed with GOAL but had better weed control. Caliente 199 sprayed with either PARDNER or CHATEAU had no damage .

CONCLUSIONS: All species of cover crops established well on both the early and late seeding dates. Significant differences were found among cultivars in both average weight and canopy coverage. Results were not unexpected since all crops were different plant species. All crops had good canopy coverage except for Caliente 199. The pearl millet may not be suited for cover crop use in organic soil, as it started to set seed stalks early and this may have contributed to the overall weight of the plants. The DNA multiscan testing showed varying results in plant pathogen numbers. There were few differences in the results between the two fumigation crops and between before and after levels of soilborne plant pathogens. More work is needed to help test the efficacy of these crops in organic muck soils.

Table 1. Plant growth data for various cover crop species, grown near Muck Crops Research Station, Holland Marsh, 2020.

Crop	Seeding Rate kg/ha	Avg. Weight 1.0 M^2 (g)	Average Green area Cover %	Seeding Date	Chopped
Sorghum	56	831.8 a[1]	95.7 a[1]	July 16	Sept 11
Pearl Millet	10	827.7 a	88.6 a	July 16	Sept 11
Barley	90	475.6 b	75.1 b	July 16	Sept 11
Caliente Rojo		407.8 b	74.8 b	June 29	August 17
Caliente 199		392.2 b	39.5 c	June 29	August 17

[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. DNA multiscan results showing levels of soil fungi found in soil pre- and post-biofumigation of organic soil using biofumigant mustard, cv. Caliente 199 and Rojo, near Muck Crops Research Station, Holland Marsh, Ontario, 2020.

DNA multiscan	Before Biofumigation	After Caliente 199	After Caliente Rojo
Botrytis cinerea	0[1]	0	0
Colletotrichum spp.	3	3.7	2.3
Fusarium spp	10	10	10
Fusarium oxysporum	5	3.7	3.7
Fusarium solani	3	1.3	2.3
Olpidium brassicae	0	3.0	2.3
Olpidium virulentu	7	2.3	1.7
Penicillium spp.	0	0	0
Phytophthora spp.	0	2.7	2.3
Phytophthora capsici	0	0.3	0.3
Pythium spp	10	8.0	7.7
Pythium. aphanidermatum	7	2.0	2.0
Pythium dissotocum	0	0.7	0.9
Pythium irregulare	0	0	0
Pythium intermedium	2	3.7	4.7
Pythium sylvaticum	4	4.7	4.7
Pythium ultimum	10	10	10.0
Rhizoctonia solani	0	0	0.8
Sclerotinia spp.	0	0	0
Trichoderma spp.	0	0	0
Verticillium dahliae	1	0	0

[1]Detection Levels	Result	Comments*
0	Not detected	0: < 2%
1,2,3	Low Levels	1: 2-19%, 2: 20-29%, 3: 30-39%
4,5,6	Moderate Levels	4: 40-49%, 5: 50-59%, 6:60-69%
7,8,9,10	High Levels	7: 70-79%, 8: 80-89%, 9: 90-99%, 10: 100%

*Percentage compared to the standard detection control

Funding for this project was provided by Ontario Ministry of Agriculture and Food and Ministry of Rural Affairs and by the Ontario Agri-Food Innovation Alliance

PEST: Stem and bulb nematode (*Ditylenchus dipsaci*) (Kühn, 1857) Filip'ev, 1936

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TITLE: STEM AND BULB NEMATODE EXTRACTION METHODS COMPARISON, 2020

METHODS: The sugar centrifugal flotation (SCF) and Baermann pan (BP) nematode extraction methods were compared to evaluate extraction efficacy of stem and bulb nematode (SBN) from pasteurized mineral soil. Two variations of the SCF method were compared: the standard protocol and a similar protocol with nematodes collected from the first centrifuged supernatant. Four variations of the BP method that used paper towels or tissues and an extraction time of two or seven days were also compared. Two staggered 2-ply sheets of paper towel were used for the BP paper towel methods. Three staggered 2-ply pieces of tissue were used in the BP tissue methods. All six methods were compared using 100 cm^3 of moist pasteurized soil spiked with 200 SBN. The trial was repeated, both runs with five replicates per extraction method. The final number of SBN extracted from each method were counted using a compound microscope at the Muck Crops Research Station.
Data were analyzed using the PROC GLIMMIX function in SAS version 9.4. Nematode counts from both trials were pooled for analysis. Means separation was obtained using Tukey's HSD test with $P = 0.05$ level of significance.

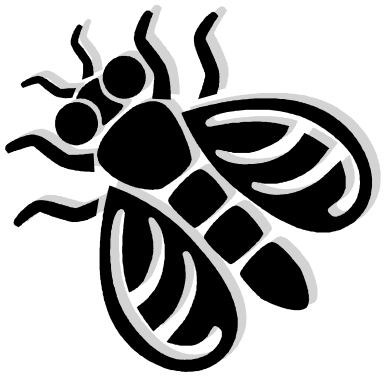
RESULTS: Data are presented in Table 1.

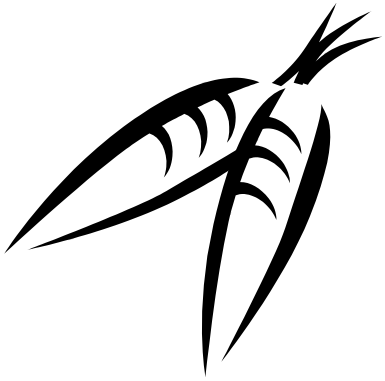
CONCLUSIONS: Both sugar centrifugal flotation methods recovered significantly more stem and bulb nematodes (> 55% of nematodes applied) than the BP methods. There were no differences in SBN recovery between the two SCF methods. Percent recovery for the SCF methods ranged from 43.5 to 77%. There were no differences in SBN recovery among the BP methods. These results indicate that the SCF extraction method should be used by laboratories and diagnostic clinics to quantify SBN in soil. Stem and bulb nematode damage can often go unnoticed during the growing season. Field soil, for garlic in particular, should be tested before planting to prevent unexpected yield losses at harvest.

Table 1. Number and percent recovery of stem and bulb nematodes (SBN) extracted from soil spiked with 200 SBN per 100 cm^3 of pasteurized soil using two sugar centrifugal flotation (SCF) and four Baermann pan (BP) methods.

Method	Extraction Time (days)	# of SBN Recovered	% Recovery
SCF Standard	-	112 a[1]	55.8 a
SCF Supernatant Collected	-	111 a	55.3 a
BP Paper Towel	7	46 b	23.1 b
BP Tissue	2	38 b	19.2 b
BP Paper Towel	2	35 b	17.7 b
BP Tissue	7	21 b	10.7 b

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





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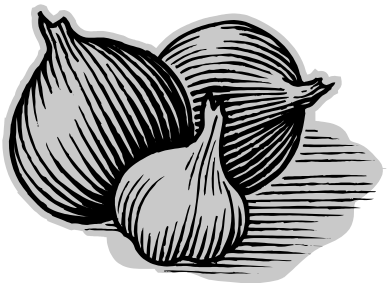

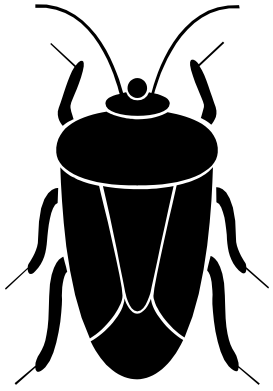

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TITLE: THE INTEGRATED PEST MANAGEMENT PROGRAM SUMMARY FOR MUCK VEGETABLE CROPS, 2020

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 (MCRS). 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 2020, 56 commercial vegetable fields, totalling 605 acres (onion 246 A., carrot 329 A., celery 20 A., potato 10 A.), were intensively scouted for 21 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 18 May to 30 October, 2020, the diagnostic laboratory of the MCRS received 67 samples for diagnosis. Of these, 63% were diagnosed with infectious diseases (42 samples), 13% with insect issues (9 samples) and 24% were diagnosed with an abiotic disorder (16 samples). These samples were associated with the following crops: carrot (48%), onion (34%), celery (10%) and other crops (8%). 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 (new site - https://bradford-crops.uoguelph.ca/), 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), BREMCAST (for lettuce downy mildew) and BSPCAST (for Stemphylium leaf blight of onion), 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 2020, 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. Insect damage at harvest was very minimal this season. Carrot rust fly counts were over threshold in most regions early in the season, but due to a lack of developed carrots and proper timing of insecticide applications very little damage was found at harvest and counts were low later in the season. The high rust fly emergence was likely due to overwintering pupae from second generation rust flies in 2019.

Table 1. Average percent carrot rust fly and carrot weevil damage on carrots at harvest in scouted fields in the Holland Marsh, 2020.

Location	% Damaged Carrots	
	Weevil damage	Rust fly damage
West HM	0.5	0.0
South HM	0.0	0.0
Central HM	0.0	0.0
North HM	0.0	0.0
East HM	0.0	0.3
Average	0.1	0.06

Carrot weevil adults were first found in wooden Boivin traps on 25 May in carrot fields (Fig. 1). The threshold of 1.5 or more weevils/trap was reached by 9 June in most regions of the Holland Marsh. Overall, 52% of fields in the IPM program reached the 1.5 weevil/trap threshold, and 21% of fields reached the 5 weevil/trap threshold.

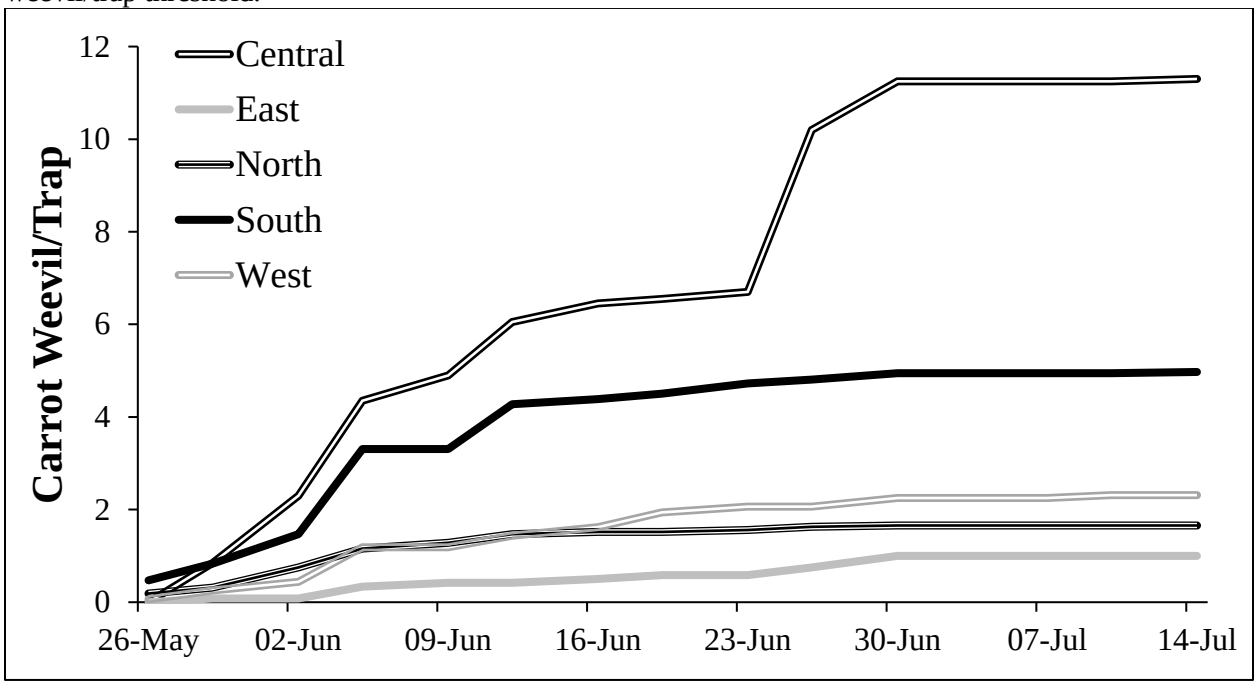


Figure 1. Average cumulative number of carrot weevils/trap in different regions of the Holland Marsh, 2020.

Carrot weevil counts were similar to counts over the past five years and damage was lower than expected. Most growers now use Rimon which is very effective at controlling carrot weevil.

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 29 May, which was exactly when the degree day model predicted first generation emergence. The highest rust fly activity during the first generation, across all regions, was on 19 June, when 48% of scouted fields had exceeded the threshold of 0.1 flies/trap/day, with the highest activity during the second generation on 25 August when 34% of scouted fields had exceeded the threshold.

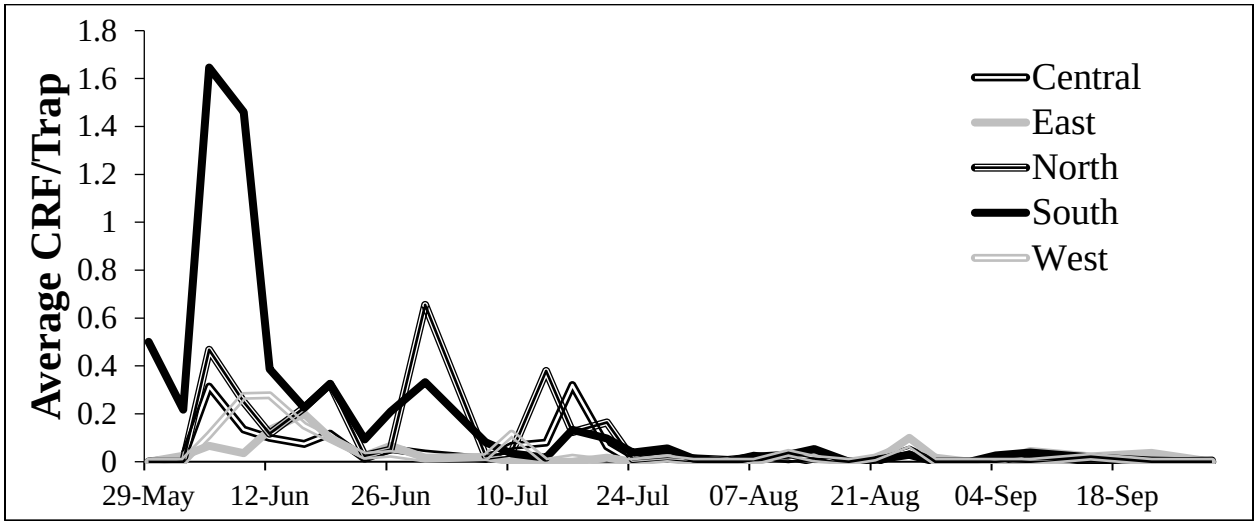


Figure 2. Average carrot rust fly (CRF) counts/trap/day in different regions of the Holland Marsh, 2020.

Aster leafhoppers are pests of carrots, celery, lettuce and leafy greens. Aster leafhopper adults were first found on orange sticky traps on 29 June in carrots and celery. Stinky traps and sweepnetting (100 sweeps per field) were used to estimate populations occurring within fields. Counts peaked around the end of July when 17% of fields were above the 20 ALH/trap threshold.

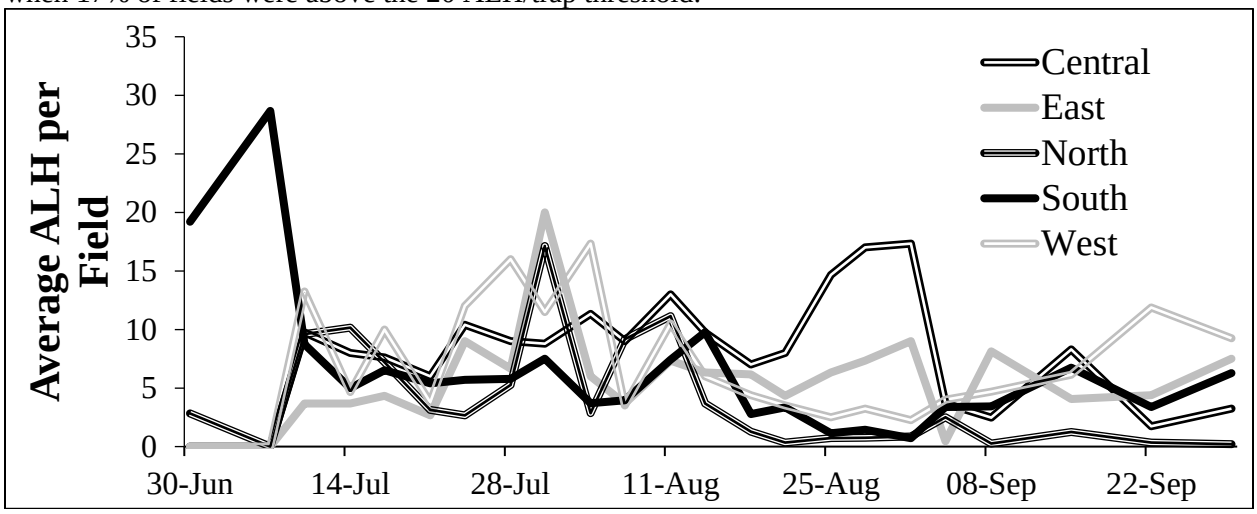


Figure 3. Average aster leafhopper counts/trap in different regions of the Holland Marsh, 2020.

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 23 July. Three scouted carrot fields reached 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 from each field often had a few disease issues, typically at low rates. Cavity spot (*Pythium* spp.) and forking/splitting (nematodes and/or *Pythium* spp.) were the most common throughout carrot

fields, similar to previous years in the Holland Marsh. Fusarium dry rot, crater rot, crown gall and aster yellows were present, but disease incidence was generally low in most fields.

Table 2. Disease incidence on carrot samples collected from commercial fields in the Holland Marsh, Ontario in 2020.

DISEASE	CAUSAL AGENT	FIELDS INFECTED (%)	INCIDENCE (%)
Cavity Spot	*Pythium* spp.	100	1-52
Forking/Split	Nematodes and/or *Pythium* spp.	100	2-42
Crown Gall	*Agrobacterium tumefaciens*	38	0-15
Crater Rot	*Rhizoctonia* spp.	19	0-2
Fusarium Dry Rot	*Fusarium* spp.	8	0-1
Aster Yellows	*Phytoplasma*	4	0-1

ONION

Insects

Onion fields were scouted for onion maggot (*Delia antiqua*) (Fig. 4), onion thrips (*Thrips tabaci*) (Fig. 5), cutworms and other insect pests. The degree day threshold for emergence of first generation onion flies was reached on 25 May. The first onion flies were also found on 25 May and counts were generally low throughout the season, which has been typical for several years in the marsh (Figure 4). There were increases in counts at the end of July in the south region and beginning of August in the central region.

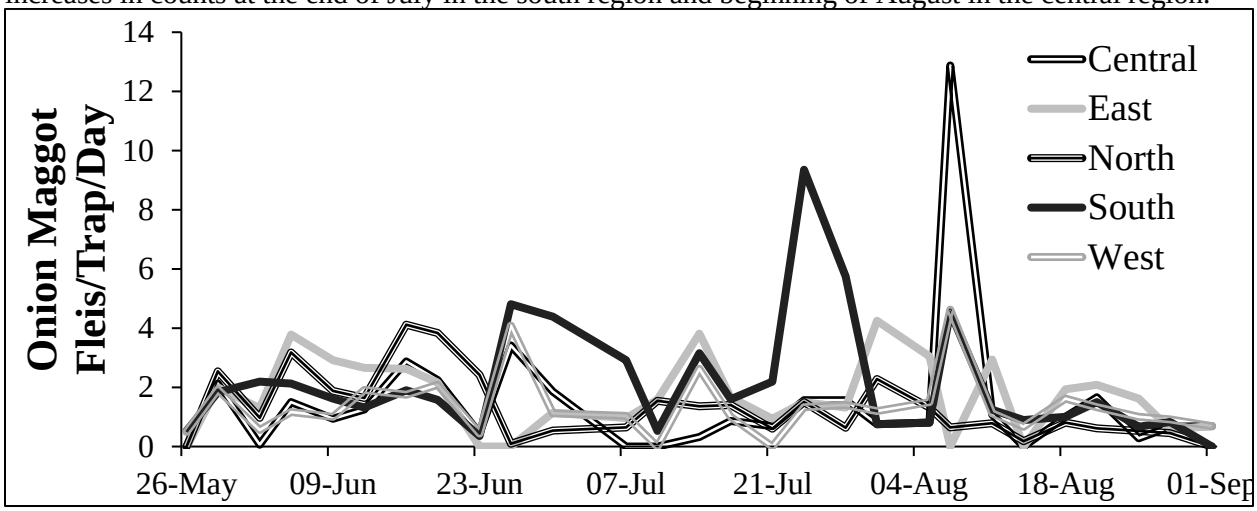


Figure 4. Average onion fly counts/trap/day in different regions of the Holland Marsh, 2020.

Thrips populations were slightly higher this year compared to 2019. Average counts increased at the beginning of July and August, but all fields stayed below the 3 thrips/leaf threshold. Thrips were first found on 16 June. Counts peaked on 10 July when 8% of fields exceeded 1 thrips/leaf.

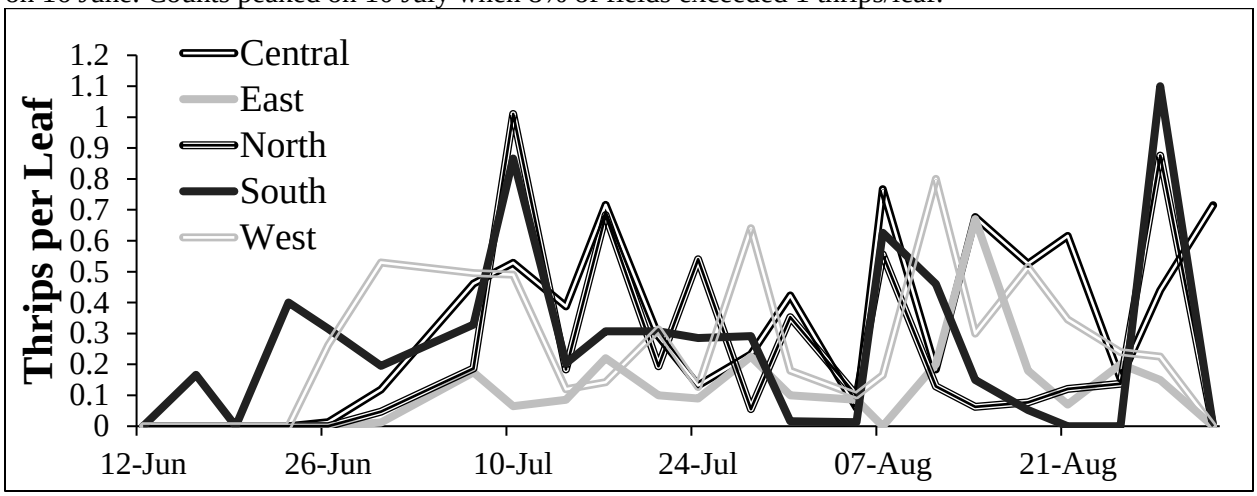


Figure 5. Average thrips counts in different regions of the Holland Marsh, 2020.

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 2020 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 25 June. There were multiple periods where conditions were favourable for downy mildew throughout the growing season, however, the disease was never found in the marsh. Disease forecasting predicted warranted sprays on 8 and 20 August. White rot was observed in <1% of fields, with the highest incidence up to 5%. Botrytis spores were detected on 10 July but 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 2020.

DISEASE	CAUSAL AGENT	FIELDS INFECTED (%)	INCIDENCE (%)
Stemphylium leaf blight	*Stemphylium vesicarium*	100	1-90
Pink root	*Setophoma terrestris*	96	0-60
Purple blotch	*Alternaria porri*	69	0-10
Smut	*Urocystis cepulae*	14	0-3
Bacterial rot/soft rot	*Erwinia carotovora*	12	0-2
White rot	*Sclerotium cepivorum*	<1	0-5

CELERY

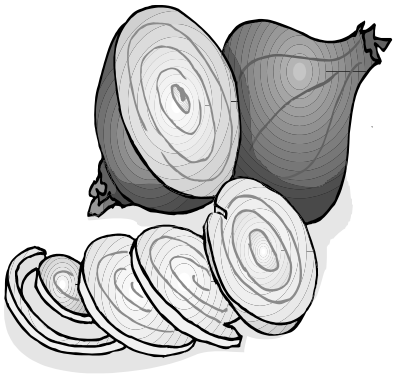
Insects

In 2020, 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 2020, tarnished plant bug and aster leaf hopper populations and damage were very low. Carrot weevil damage in celery fields was also very low. No leaf miner, aphid, caterpillar or cutworm damage was reported.

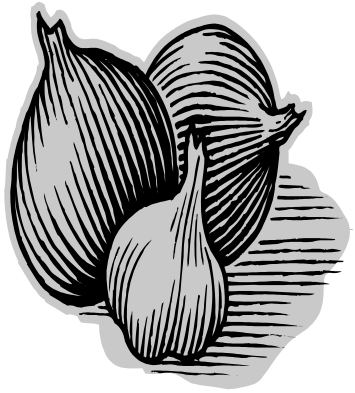
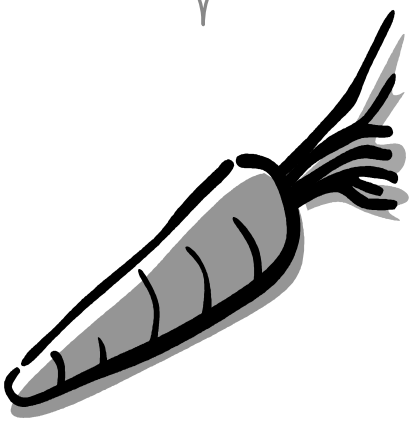
Diseases

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 and incidence was very low. Black heart was identified. Low incidences of leaf blight were identified in both celery field during the 2020 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, Corteva and Syngenta Crop Protection.


Cultivar Trials 2020


CARROT CULTIVAR TRIAL SEASON SUMMARY – 2020

Early May daytime air temperatures fluctuated from the low single digits to the mid-teens and nighttime air temperatures fluctuated from single digits to below zero. Just prior to seeding, the weather changed with daytime temperatures quickly climbing to the mid-twenties with nighttime temperatures in the mid-teens. Five days prior to seeding there was a total of 14 mm of rainfall which provided good soil conditions for carrot seeding. In the marsh, most of the carrot seeding occurred within the two-week period of 18-29 May. Compared to the previous 10-year average, air temperatures in 2020 were above average for July (23.3°C), average for June (19.2°C), August (20.6°C), and below average for May (11.6°C), September (15.0°C) and October (8.1°C). The 10-year average temperatures were: May 14.2°C, June 18.5°C, July 21.5°C, August 20.3°C, September 16.5°C and October 9.9°C. Monthly rainfall was above the 10-year average for August (140 mm), average for September (65 mm), and below average for May (38 mm), June (77 mm), July (58 mm) and October (61 mm). The 10-year rainfall averages were: May 73 mm, June 103 mm, July 84 mm, August 76 mm, September 62 mm and October 78 mm.

The carrot trial was seeded on 21 and 22 May. Soil moisture at seeding was favourable for forming the carrot hills. On 22 May, one and a half inches of irrigation water and seasonal air temperature provided good conditions for germination. Emergence and plant vigour were good. By 29 May the carrots were in the bunny ear stage. Irrigation water was applied on 5 June to help the seedlings through a dry period. On 10 June 22 mm of rain fell at an ideal time which aided the carrots through the first true leaf growth stage. Three more applications of irrigation water were applied on about two week intervals from mid-June through all of July. The carrots established well with no visible decrease in stand.

On 22 May, prior to the application of the pre-emergence herbicide Gesagard, the cultivar trial was irrigated to provide good moisture for herbicide application and activation. The pre-emergence herbicide Gesagard application provided limited weed suppression. Three applications of Lorox + Assist Oil were required on 15, 18 and 29 of June to clean up the trial. These herbicide applications provided good weed control for the balance of the growing season. The trial was hand weeded a few times to keep it free of weeds.

Carrot weevils were first found at the Muck Station on 26 May (0.5 weevils/trap/day). By 4 June weevil numbers had quickly climbed to the spray threshold of 1.5 cumulative weevils/trap and remained above threshold until mid June. Rimon was applied three times (16 June, 2 and 10 July) and no weevil damage (dead carrot seedlings), was observed in the variety trial and the trial average for

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CARROT CULTIVAR TRIAL SEASON SUMMARY – 2020 – continued

carrot weevil damage at evaluation was 4.8%. This is an increase of 4% compared to weevil damage observed in 2018 and 2019. The Rimon insecticide applications may have been poorly time. Carrot rust flies were first found on 29 May. There were three rust fly peaks occurring 8, 21 June and 13 August (5.25, 0.5, 0.3 flies/trap/day respectively). For the month of June, the rust fly population was above both the fresh market and the processing spray thresholds (0.1 and 0.2 flies/trap/day respectively). At evaluation there was very minimal rust fly damage observed with a very low trial incidence of 0.1%. Aster leaf hoppers were first found on 4 June. By 6 July leaf hopper numbers had peaked at 44 leaf hoppers/trap, with a second peak on 13 August at 13 leaf hoppers/trap. Even with these high numbers there was only one aster yellows infection found in the yield samples.

Alternaria and Cercospora leaf blights where first found on 20 July and were controlled throughout the growing season with three applications of fungicides (see Cultivar Management Procedures). In order to observe cultivar tolerances to these pathogens, regular fungicide sprays were discontinued on 26 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 leaf blight incidence among cultivars were evaluated and noted. By Grower Field Week starting on 8 September some bolting was noted in several cultivars in the trial.

Weather conditions in October were favourable for harvest which began on 19 October and continued for eight days. At harvest, carrots had good diameters and average lengths. There were some forked and split carrots in the yield samples. The carrot tops had low to moderate levels of leaf blight. Several light frosts had occurred before and during harvest which may have weakened the petiole attachment. No sclerotinia was found in the trial at harvest, but bacterial canker rot was noted. Only four of the cultivars in the trial did not produce seeders. Cultivar Extremo had the highest number of seeders with 316 seeders in 18 meters of row. Carrots samples were placed in the Filacell storage immediately after harvest.

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CARROT CULTIVAR TRIAL SEASON SUMMARY – 2020 – continued

At evaluation in late November to early December, the trial average yields for cello and jumbo cultivars were similar at 1197 and 1274 bu/A respectively. These yields were very similar to the 2019 trial average yields. The cellos were of average width, but did not have the expected length and therefore were slightly disappointing. 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 in the jumbos than last year with an increase of approximately 8% from 2019. Most of the culls were small, undersized carrots with forked and splits making up the other culls. Some canker rot was noted during evaluation with jumbo types having a higher incidence. At evaluation, the percent marketable for cello and jumbo carrots was similar (75% and 82.5% respectively). The percent marketable for cellos was significantly different between the first and the other two replicates. For cellos, the stand average was 18 carrots/foot compared to the desired trial seeding average of 25 carrots/foot. For jumbos, the stand average was 13 carrots/foot compared to the desired trial seeding average of 18 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 44.5% and this is equal to 2019 (45%). Even though cavity spot incidence was equal to the 2019 incidence, severity was a little higher with a trial average of light/moderate sized lesions. 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 good and consistent for all carrots within the samples with no marbling noticed. Most of the jumbo cultivars only had a 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 a 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 was the odd cultivar that had a small number with galls (see Carrot Management Procedures). Yields were average and quality was good for the 2020 carrot cultivar trial.

CARROT CULTIVAR TRIALS - 2020

MANAGEMENT PROCEDURES

Fertilizer:

40 kg/ha Nitrogen (Calcium Ammonium Nitrate 27-0-0) + 75 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 20 & 21 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 6.0 L/ha on 22 May.
Post-emergence:	1 application: **LOROX L** at 300 ml/ha + **ASSIST OIL** at 1.0 L/ha on 15 June.
Post-emergence:	2 applications: **LOROX L** at 500 ml/ha + **ASSIST OIL** at 1.0 L/ha on 18 & 29 June.

Minor Elements:

Six foliar sprays: Epsom Salts on 10, 23, & 31 July, 13 & 26 August (2.0 kg/ha) and 17 July (3.0 kg/ha).
Four foliar sprays: Suprafeed on 10, 23 & 31 July (2.0 kg/ha) and 17 July (3.0 kg/ha).
Two foliar sprays: Maganese Sulfate on 10 & 31 July (1.0 kg/ha).
Two foliar sprays: Alexin on 13 & 26 August (2.0 L/ha).

Insect and Disease Control:

According to IPM recommendations.

RIMON at 840 ml/ha on 16 June.
RIMON at 840 ml/ha on 2 July.
RIMON at 840 ml/ha on 10 July.
BRAVO ZN at 2.0 L/ha + **UPCYLE** at 288 ml and Minor Elements on 23 July.
BRAVO ZN at 2.0 L/ha + **MATADOR** at 83 ml and Minor Elements on 31 July.
DITHANE DG at 2.25 kg/ha + **SILENCER** 83 ml and Minor Elements on 13 August.
BRAVO ZN at 3.0 L/ha + **MATADOR** at 83 ml and Minor Elements on 26 August.

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Harvest:

The Main and Adaptation Trials were harvested on 19-26 October. All trials were immediately placed in a temperature and humidity controlled storage (1°C, 95 % RH) respectively.

Irrigation:

Irrigation water was applied five times during the 2020 growing season.

22 May in the amount of 1¼ inch
5 June in the amount of ¾ inch
17 June in the amount of ¾ inch
9 July in the amount of 1 inch
30 July in the amount of 1 inch.

EVALUATION PROCEDURES

The cultivars were evaluated on 19 – 30 and 1 & 2 December after 4 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

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CARROT CULTIVAR TRIALS - 2020 - continued

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.

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 26 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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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 cultivar yield samples.

Root Gall:
Root gall was found in the 2020 carrot cultivar trial at low levels.

No galls found					*Galls found in one replicate*	
Narvik	SV DN 5853	Belgrado	New Hall - Cello	Jackson – Jumbo	Extremo	Orange Blaze
SV 2384	Volcano	Blanes	Envy	Bentely	Speedo	Cellobunch
Naval	Istanbul	Brillyance	Baldio	Bastia	Jackson - Cello	Enterprise
Navedo	Brava	Berlin				

CARROT CULTIVAR MAIN TRIAL CELLO TYPES - 2020

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	109 c*	23 ab	72 a	18.59 c-f	6.66 ab	9.97 a	83.2	1339 a
ORANGE BLAZE	Sem	121 abc	17 bcd	68 a	14.73 f	4.49 bcd	7.69 a	60.9	981 a
ENTERPRISE	Sto	141 abc	20 abc	88 a	19.36 cde	6.03 ab	9.90 a	79.7	1282 a
NAVAL	BEJO	112 bc	25 ab	56 a	19.44 b-e	7.14 a	8.43 a	77.9	1253 a
NARVIK	BEJO	138 abc	10 d	95 a	19.62 b-e	2.78 d	12.67 a	77.2	1243 a
SV 2384	Sto	129 abc	14 cd	85 a	18.15 def	4.37 bcd	9.76 a	70.6	1137 a
BRILLYANCE	Sto	160 ab	17 bcd	98 a	23.35 ab	4.80 a-d	13.14 a	89.7	1444 a
ISTANBUL	BEJO	122 abc	17 bcd	73 a	19.45 b-e	5.33 abc	9.18 a	72.5	1168 a
NEW HALL - cello	BEJO	142 abc	22 abc	77 a	21.14 a-d	6.24 ab	9.30 a	77.7	1251 a
NAVEDO	BEJO	146 abc	17 bcd	82 a	24.32 a	5.93 ab	11.73 a	88.3	1422 a
CELLOBUNCH	Sto	163 a	17 bcd	84 a	21.07 a-d	5.34 abc	9.43 a	73.9	1189 a
JACKSON - cello	BEJO	130 abc	10 d	64 a	16.40 ef	2.94 cd	7.30 a	51.2	824 a
ENVY	Sto	162 a	26 a	57 a	22.47 abc	6.80 ab	5.87 a	63.4	1020 a
Trial Average		**137**	**18**	**77**	**19.85**	**5.30**	**9.57**	**74.3**	**1197**

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 - 2020 - continued

Cultivar	Source	% Marketable	% Oversize	Majority of Culls	Shape	Uniformity of Shape	Uniformity of Length	Uniformity of Width	Appearance	Resistance to Greening
VOLCANO	Vil	89.7 a*	35.8 ab	SM	GPN	7.3 abc	7.0 ab	7.7 a	7.7 ab	9.0 a
ORANGE BLAZE	Sem	83.0 ab	30.5 abc	SM	Imp	5.0 e	3.7 de	4.0 f	5.7 de	9.0 a
ENTERPRISE	Sto	82.2 ab	31.0 abc	SM	Imp	6.7 bcd	4.7 cde	5.0 def	6.7 bcd	9.7 a
NAVAL	BEJO	80.2 abc	38.1 a	SM	N	7.0 bcd	5.7 bc	7.0 ab	7.3 abc	9.5 a
NARVIK	BEJO	78.9 abc	14.5 e	SM	N	8.7 a	7.0 ab	6.3 bc	7.7 ab	9.7 a
SV 2384	Sto	78.1 abc	24.2 cde	F	CylImp	7.7 abc	3.7 de	5.3 cde	5.7 de	9.0 a
BRILLYANCE	Sto	76.6 bc	20.6 cde	SPL	N	7.7 abc	5.0 cd	6.3 bc	8.3 a	9.5 a
ISTANBUL	BEJO	74.3 bcd	27.2 a-d	F	Imp	6.7 bcd	4.3 cde	5.7 cd	6.3 cde	9.8 a
NEW HALL - cello	BEJO	73.2 bcd	29.1 a-d	SPL	N	5.0 e	6.7 ab	6.3 bc	7.3 abc	9.0 a
NAVEDO	BEJO	72.9 bcd	23.9 cde	SPL	Cyl	8.0 ab	4.7 cde	5.7 cd	5.7 de	8.7 a
CELLOBUNCH	Sto	67.9 cde	25.3 b-e	F	Imp	6.3 cde	3.3 e	4.3 ef	5.3 e	8.0 a
JACKSON - cello	BEJO	62.2 de	17.7 de	F	GP	5.7 de	7.7 a	7.0 ab	6.3 cde	10.0 a
ENVY	Sto	56.5 e	30.3 abc	F	GP	5.0 e	6.7 ab	6.0 bcd	6.3 cde	9.0 a
		75.1	**26.8**			**6.7**	**5.4**	**5.9**	**6.6**	**9.2**

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 CELLO TYPES - 2020 - 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	O	7.3 a*	O	6.7 ab	48.9 g	8.3 a	7.52 a	22LM a	CC
ORANGE BLAZE	Sem	DO	5.7 b	O	5.3 c	41.7 a-d	8.7 a	5.48 f	67LM de	CC
ENTERPRISE	Sto	O	6.0 ab	O	6.7 ab	40.2 abc	7.7 a	6.48 de	47L bcd	CV
NAVAL	BEJO	O	6.7 ab	O	6.7 ab	47.3 efg	9.2 a	7.12 abc	43L abc	CC
NARVIK	BEJO	LO	7.3 a	O	6.3 abc	39.2 a	8.0 a	7.57 a	40LM abc	CC
SV 2384	Sto	O	5.3 b	O	5.3 c	39.8 ab	8.7 a	6.00 ef	52LM bcd	CV
BRILLYANCE	Sto	O	6.7 ab	LO	7.0 a	52.9 h	9.2 a	7.21 ab	35LM ab	CC
ISTANBUL	BEJO	O	7.3 a	O	7.3 a	43.8 cde	7.3 a	6.79 bcd	50LM bcd	CV
NEW HALL - cello	BEJO	O	7.3 a	O	5.7 bc	47.9 fg	8.8 a	6.76 bcd	55LM bcd	CV
NAVEDO	BEJO	O	6.0 ab	LO	5.7 bc	43.6 b-e	7.7 a	6.33 de	57LM bcd	CC
CELLOBUNCH	Sto	O	5.7 b	LO	6.3 abc	49.1 gh	7.7 a	5.62 f	58LM cd	CV
JACKSON - cello	BEJO	O	6.3 ab	O	7.3 a	44.2 def	8.0 a	7.19 ab	83LM e	CV
ENVY	Sto	LO	5.3 b	LO	7.3 a	44.5 def	9.0 a	6.52 cde	58LM cd	CV
			6.4		**6.4**	**44.9**	**8.3**	**6.66**	**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 - 2020 - 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	19.7 def*	3.6 ab	20	14 a	57.9 c	G	F	0.3 a	0.8 a	0.3 a
ORANGE BLAZE	Sem	20.3 cde	3.3 ef	25	16 a	63.9 a	G	ST	7.4 bc	0.0 a	27.3 d
ENTERPRISE	Sto	22.4 a	3.3 ef	28	19 a	63.4 a	G	ST	3.7 abc	0.0 a	1.3 a
NAVAL	BEJO	18.5 fg	3.7 a	25	15 a	48.8 e	G	ST	2.4 ab	0.0 a	0.3 a
NARVIK	BEJO	18.2 g	3.5 bcd	25	18 a	43.9 f	DG	ST	1.5 ab	0.0 a	0.0 a
SV 2384	Sto	22.5 a	3.2 f	25	17 a	64.1 a	G	ST	6.0 abc	0.0 a	2.3 a
BRILLYANCE	Sto	19.2 efg	3.6 ab	25	21 a	53.7 d	LG	F	0.4 a	0.0 a	0.3 a
ISTANBUL	BEJO	22.2 ab	3.4 cde	25	16 a	59.2 bc	G	ST	6.0 abc	0.0 a	0.0 a
NEW HALL - cello	BEJO	18.6 fg	3.6 bc	25	19 a	58.4 c	G	ST	1.8 ab	0.0 a	15.7 c
NAVEDO	BEJO	21.2 bc	3.5 bcd	25	19 a	55.4 cd	G	ST	9.4 cd	0.0 a	0.3 a
CELLOBUNCH	Sto	20.6 cd	3.4 de	25	21 a	59.0 bc	G	ST	4.9 abc	0.3 a	8.0 b
JACKSON - cello	BEJO	19.3 efg	3.3 ef	25	17 a	62.4 ab	DG	C	14.7 d	0.0 a	10.7 b
ENVY	Sto	19.1 efg	3.5 bcd	25	21 a	59.2 bc	G	ST	9.6 cd	0.0 a	2.3 a
Trial Average		**20.1**	**3.4**	**25**	**18**	**57.6**			**5.2**	**0.1**	**5.3**

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.

CARROT CULTIVAR MAIN TRIAL JUMBO TYPES - 2020

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
BALDIO	BEJO	81 a*	50 ab	16 c	23.18 cd	16.54 abc	2.52 c	95.3	1535 abc
BERLIN	BEJO	96 a	57 a	15 c	27.37 ab	19.97 a	2.25 c	111.1	1789 ab
BRAVA	BEJO	91 a	46 abc	17 c	22.58 cd	15.73 bc	2.21 c	89.7	1444 bc
BELGRADO	BEJO	100 a	54 a	17 c	28.60 a	19.52 ab	2.86 bc	111.9	1802 a
BASTIA	BEJO	131 a	48 abc	45 ab	24.47 bcd	13.77 cd	5.23 ab	95.0	1529 abc
BENTLEY	Pure	90 a	40 bc	25 bc	21.45 de	12.80 cd	3.87 bc	83.3	1341 cd
SPEEDO	Vil	63 a	17 d	32 bc	15.32 f	4.41 e	7.24 a	58.3	938 e
JACKSON - jumbo	BEJO	112 a	18 d	64 a	17.00 f	5.47 e	7.16 a	63.1	1016 de
BLANES	BEJO	105 a	47 abc	20 c	26.38 abc	15.25 c	3.36 bc	93.0	1498 abc
SV DN 5853	Sem	108 a	37 c	23 bc	18.40 ef	10.11 d	2.73 bc	64.2	1034 de
NEW HALL - jumbo	BEJO	81 a	20 d	31 bc	15.67 f	6.07 e	3.96 bc	50.2	808 ef
EXTREMO	Vil	116 a	14 d	28 bc	16.57 f	3.41 e	3.43 bc	34.2	550 f
Trial Average		**98**	**37**	**28**	**21.42**	**11.92**	**3.90**	**79.1**	**1274**

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 - 2020 - continued

Cultivar	Source	% Marketable	% Oversize	Majority of Culls	Shape	Uniformity of Shape	Uniformity of Width	Uniformity of Length	Appearance	Resistance to Greening
BALDIO	BEJO	81.9 a*	70.6 ab	F	GP	6.3 bc	4.0 a	6.3 b-e	7.7 a	6.3 d
BERLIN	BEJO	81.3 a	73.3 a	SM	GPN	5.7 c	5.0 a	5.0 e	6.3 abc	8.3 abc
BRAVA	BEJO	79.5 a	69.8 ab	F	GP	6.3 bc	6.0 a	5.7 cde	6.0 bc	7.3 bcd
BELGRADO	BEJO	78.2 ab	68.1 ab	SM	D	6.3 bc	5.3 a	5.3 de	6.0 bc	8.3 abc
BASTIA	BEJO	77.5 ab	56.2 bc	SM	GP	6.7 bc	6.3 a	6.7 bcd	6.0 bc	7.7 bcd
BENTLEY	Pure	77.4 ab	59.5 ab	F	Cyl	7.3 b	6.0 a	7.0 abc	7.3 ab	7.0 cd
SPEEDO	Vil	75.9 ab	28.1 de	F	Cyl	9.0 a	6.3 a	8.3 a	5.0 c	6.7 cd
JACKSON - jumbo	BEJO	73.3 ab	31.3 de	F	Imp	6.0 bc	6.0 a	7.7 ab	7.3 ab	10.0 a
BLANES	BEJO	70.5 ab	57.7 ab	F	GPN	6.3 bc	6.0 a	6.7 bcd	7.3 ab	6.7 cd
SV DN 5853	Sem	69.7 ab	54.7 bc	SM	GP	5.7 c	4.7 a	6.3 b-e	6.7 ab	9.0 ab
NEW HALL - jumbo	BEJO	64.4 b	40.9 cd	SPL	GPN	7.3 b	6.3 a	7.0 abc	6.7 ab	7.7 bcd
EXTREMO	Vil	40.3 c	20.2 e	SEED	GP	7.3 b	6.3 a	7.3 ab	7.7 a	8.3 abc
Trial Average		**72.5**	**52.5**			**6.7**	**5.7**	**6.6**	**6.7**	**7.8**

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

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

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CARROT CULTIVAR MAIN TRIAL JUMBO TYPES - 2020 - 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
BALDIO	BEJO	LO	7.0 a*	LO	5.7 c-f	57.9 abc	9.0 a	6.19 de	83LM a	CC
BERLIN	BEJO	LO	6.7 a	O	4.7 f	61.1 ab	8.7 a	5.95 e	72M abc	CC
BRAVA	BEJO	O	5.7 a	O	6.0 b-e	60.4 ab	7.3 a	6.14 de	57LM bc	CC
BELGRADO	BEJO	LO	7.3 a	LO	6.0 b-e	56.9 bcd	7.8 a	6.38 cde	87M a	CC
BASTIA	BEJO	O	7.0 a	O	6.3 a-d	53.9 cde	8.3 a	6.67 a-e	95LM a	CC
BENTLEY	Pure	LO	8.3 a	LO	5.0 ef	44.4 g	9.0 a	6.86 a-d	50L c	CC
SPEEDO	Vil	O	7.7 a	O	5.7 c-f	48.9 f	9.2 a	6.95 abc	73M abc	CC
JACKSON - jumbo	BEJO	O	7.3 a	O	6.7 abc	55.0 cde	8.3 a	7.29 a	95M a	CV
BLANES	BEJO	LO	7.3 a	O	5.3 def	62.4 a	9.0 a	6.52 b-e	57LM bc	CC
SV DN 5853	Sem	DO	7.3 a	O	7.0 ab	48.3 fg	7.7 a	6.67 a-e	78LM ab	CV
NEW HALL - jumbo	BEJO	O	7.7 a	LO	7.3 a	52.7 def	8.0 a	7.14 ab	74LM abc	CC
EXTREMO	Vil	LO	7.3 a	O	6.3 a-d	52.1 ef	9.0 a	7.24 ab	70M abc	CC
Trial Average			**7.2**		**6.0**	**54.5**	**8.4**	**6.67**	**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 - 2020 - 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
BALDIO	BEJO	22.7 ab*	5.4 abc	18	11 a	54.2 fg	G	F	1.3 ef	0.0 a	1 b
BERLIN	BEJO	20.1 de	5.6 ab	18	13 a	56.0 ef	G	ST	7.5 b	0.0 a	1 b
BRAVA	BEJO	20.2 de	5.6 ab	18	12 a	60.8 c	LG	F	6.5 bc	0.0 a	0 b
BELGRADO	BEJO	21.2 bcd	5.7 a	18	13 a	52.0 g	G	F	2.9 c-f	0.0 a	9 b
BASTIA	BEJO	21.0 bcd	5.2 cd	20	17 a	57.8 de	LG	F	2.3 def	0.0 a	9 b
BENTLEY	Pure	22.3 abc	5.1 cde	18	12 a	56.8 ef	G	ST	0.8 f	0.0 a	1 b
SPEEDO	Vil	20.9 bcd	4.7 f	15	8 a	44.1 h	G	ST	1.4 ef	0.0 a	1 b
JACKSON - jumbo	BEJO	23.8 a	4.9 ef	18	15 a	65.8 b	G	ST	15.6 a	0.0 a	24 b
BLANES	BEJO	20.7 cd	5.4 bc	18	14 a	57.5 de	G	ST	4.6 b-e	0.0 a	0 b
SV DN 5853	Sem	18.0 f	5.2 cd	20	14 a	74.8 a	G	ST	5.4 bcd	0.0 a	1 b
NEW HALL - jumbo	BEJO	21.2 bcd	5.0 def	18	11 a	60.3 cd	DG	ST	2.5 def	0.0 a	21 b
EXTREMO	Vil	18.6 ef	5.0 de	20	15 a	68.5 b	DG	ST	2.1 def	0.0 a	316 a
Trial Average		**20.9**	**5.2**	**18**	**13**	**59.1**			**4.4**	**0.0**	**31.9**

Listed in order of % Marketable.

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

CARROT CULTIVAR MAIN TRIAL CELLO TYPES EVALUATION NOTES – 2020

Volcano: *Vilmorin sample,* Average length slightly even, Good width even, Uniformity of shape even, Odd carrot with bends and curves, Slightly tapered & full tips, Some tips still immature, Odd noticeable lenticels, Good appearance, Average to good weight, Good smoothness, Fair exterior colour slightly uneven, 1 to 2 cavity spots per root, Average interior blending even, Translucent core throughout (30-70%), Green ring around core (20-30%), Average core size, Good Packers, Good Jumbo just need bit more weight.

Orange Blaze: *Seminis sample,* Poor & average length very uneven, Uneven lengths a slight concern, Poor & average width very uneven, Uniformity of shape uneven, Odd carrot with bends and curves, Tapered tips matured, Average appearance, A touch ringy, Poor to good weight uneven, Smoothness a little rough, Fair exterior colour slightly uneven, 1 to 4 cavity spots per root, Average interior blending slightly uneven, Yellow or red ring around core (10-30%), Average core size, Okay to average Packer, A few too many with low weights and lengths, Jumbos are an oversized packer.

Enterprise: *Stokes sample,* Okay to good length uneven, Okay to good width uneven, Uniformity of shape even, Some carrots with bends and curves, Tapered tips matured, Average appearance, Slightly ringy, Poor to average weight uneven, Smoothness a little rough, Fair exterior colour slightly uneven, 2 to 3 cavity spots per root, Average interior blending a little uneven, Translucent core throughout (10%), Red ring around core (30-40%), Average core size, Average Packer, Okay Jumbo is an oversized packer.

Naval: *Bejo sample,* Nantes carrot, Average length uneven, Some a bit short, Good width slightly even, Uniformity of shape even, Full tips matured, Odd noticeable lenticels, Good appearance, Good weight, Good smoothness, Fair to good exterior colour a little uneven, 2 to 3 cavity spots per root, Good interior blending even, Translucent core throughout (20-30%), Red ring around core (10-20%), Average & large core size, Odd carrot with mouse damage, Good Packer, Jumbos are oversized nantes and a few a bit short.

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CARROT CULTIVAR MAIN TRIAL CELLO TYPES EVALUATION NOTES – 2020 - continued

Narvik: *Bejo sample,* Nantes carrot, Okay length even, Average & good width slightly even, Uniformity of shape very even, Full tips matured, Average to good appearance, Odd ringy carrot, Average to good weight slightly uneven, Good smoothness, Good exterior colour even, 1 to 2 cavity spots per root, Average interior blending even, Dead center of core translucent (20-30%), Red or green ring around core (10-20%), Average core size, Good Packer, Jumbos are oversized nantes and a few bit short.

SV 2384: *Stokes sample,* Average length but very uneven, Average & good width uneven, Uniformity of shape even, Odd carrot with bends and curves, Full tips matured, Average appearance, Some ringy carrots, Average to good weight uneven, Fairly smooth, Fair exterior colour uneven, 1 to 2 or 2 to 4 cavity spots per root, Average interior blending slightly uneven, Dead center of core translucent (10-20%), Red ring around core (40-50%), Small to average core size, Good Packer, Slicer potential, Okay Jumbo is an oversized packer.

Brillyance: *Stokes sample,* Nantes style, Average & good length uneven, Okay & average width slightly uneven, Uniformity of shape even, Odd carrot with bends and curves, Full tips matured, Odd noticeable lenticels, Good appearance, Average weight uneven, Good smoothness, Good exterior colour slightly uneven, 1 to 2 cavity spots per root, Good interior blending uneven, Dead center of core translucent (10-40%), Red or green ring around core (10-20%), White in cores (10-30%), Large core size, Good Packer, Good Jumbo but a bit short.

Istanbul: *Bejo sample,* Good length uneven, Average width uneven, Uniformity of shape even, A few carrots with bends and curves, Tapered tips matured, Average appearance, A touch ringy, Average weight a little uneven, Smoothness is a little rough, Fair exterior colour even, 2 to 3 cavity spots per root, Nice interior blending even, Red ring around core (40-50%), Average core size, Odd carrot with mouse damage, Average Packer, Average Jumbo, Jumbos are oversized packer bit thin tips.

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CARROT CULTIVAR MAIN TRIAL CELLO TYPES EVALUATION NOTES – 2020 - continued

New Hall: **Cello** *Bejo sample,* Nantes style, Okay length slightly uneven, Lengths slightly short, Average width a touch uneven, Uniformity of shape a little uneven, A few carrots with bends and curves, Full tips matured, Good appearance, Average to good weight a little uneven, Good smoothness, Fair exterior colour even, 2 to 3 cavity spots per root, Average interior blending even, Dead center of core translucent (10-60%), Yellow ring around core (30-40%), Average core size, Good Packer, Good Jumbos but some carrots too short.

Navedo: *Bejo sample,* Average & good length uneven, Average & good width uneven, Uniformity of shape even, A few carrots with bends and curves, Full tips matured, Average appearance, Odd ringy carrot, Good weight a little uneven, Fairly smooth, Fair exterior colour uneven, 1 to 2 cavity spots per root, Average interior blending a little uneven, Dead center of core translucent (20-30%), Red ring around core (20%), White in cores (20-30%), Average core size, Slicer potential, Good Packer, Good Jumbos.

Cellobunch: *Stokes sample,* Okay to good length very uneven, Poor or average width very uneven, Uniformity of shape a little uneven, A few carrot with bends and curves, Tapered tips matured, Average appearance, A touch ringy slight concern, Average weight uneven, Smoothness a little rough, Fair exterior colour uneven, 1 to 2 or 2 to 3 cavity spots per root, Average interior blending even, Yellow ring around core (10%), Large core size, Odd carrot with Galls, Okay Packer, Okay Jumbos are an oversized packer.

Jackson: **Cello** *Bejo sample,* Poor & good length even, Lengths short, Average width slightly uneven, Uniformity of shape a little uneven, Odd carrot with bends and curves, Tapered & full tips matured, Average appearance, A touch ringy, Average weight, Fairly smooth, Fair exterior colour slightly even, A few noticeable cavity spots, 2 to 3 cavity spots per root, Good interior blending even, Red ring around core (30-90%), Average to large core size, Odd carrot with Galls, Average Packer, Okay Jumbos but a bit short.

Envy: *Seminis sample,* Average length even, Average to good width slightly even, Uniformity of shape uneven, Tapered tips matured, Average appearance, Odd ringy carrot, Average weight, Fairly smooth, Fair exterior colour slightly uneven, 2 to 3 cavity spots per root, Good interior blending even, Translucent core throughout (20%), Red ring around core (20-30%), White in cores (10-20%), Average core size, Okay to average Packer, Average to good Jumbo.

CARROT CULTIVAR MAIN TRIAL JUMBO TYPES EVALUATION NOTES – 2020

Baldio: *Bejo sample*, Good length uneven, A few too short, Good width slightly uneven, Uniformity of shape a little even, Odd carrot with bends and curves, Full tips matured, Odd noticeable lenticels, Good appearance, Excellent weight a little uneven, Good smoothness, Slightly pale exterior colour, 2 to 3 or 3 to 4 cavity spots per root, Poor to average interior blending slightly uneven, Red ring around core (10-30%), White in cores (10-30%), Extra-large core size, Average Packer, Nice Jumbo.

Berlin: *Bejo sample*, Okay to average length uneven, Good width uneven, Some carrots bit short or thin, Uniformity of shape uneven, Full tips matured, A few noticeable lenticels, Good appearance, Odd ringy carrot, Good to excellent weight uneven, Good smoothness, Slightly pale exterior colour a little uneven, Some noticeable cavity spots, 3 to 4 cavity spots per root, Poor interior blending uneven, Red ring around core (10-30%), White in cores (40-70%), Extra-large core size, Poor Packer, Nice Jumbo.

Brava: *Bejo sample*, Average length slightly uneven, A few short carrots, Good width slightly uneven, Uniformity of shape a little uneven, Full tips matured, Odd noticeable lenticels, Average appearance, A touch ringy, Excellent weight a little uneven, Smoothness a little rough, Fair exterior colour slightly uneven, 2 to 3 cavity spots per root, Interior blending uneven, Red ring around core (20-30%), White in cores (20-40%), Extra large core size, Poor Packer, Nice Jumbo.

Belgrado: *Bejo sample*, Average length uneven, Good width slightly uneven, Uniformity of shape a little uneven, Full tips matured, Noticeable lenticels, Average appearance, Odd ringy carrot, Excellent weight a little uneven, Fairly smooth, Exterior colour slightly pale, Some noticeable cavity spot a little concern, 4 to 5 cavity spots per root, Good interior blending a little uneven, Dead center of core translucent (10-20%), Red ring around core (30-70%), White in cores (20-40%), Extra-large core size, Poor Packer, Good Jumbo but a bit short.

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CARROT CULTIVAR MAIN TRIAL JUMBO TYPES EVALUATION NOTES – 2020 - continued

Bastia: *Bejo sample,* Good length slightly even, Good width slightly uneven, Uniformity of shape a little uneven, Full tips matured, Heavy shoulders, A few noticeable lenticels, Average appearance, Odd carrot ringy, Good weight, Fairly smooth, Fair exterior colour slightly even, Odd noticeable cavity spot, 3 to 4 cavity spots per root, Average interior blending a little uneven, Dead center of core translucent (20-40%), Yellow, red or white ring around core (30-40%), White in cores (20-30%), Large core size, Poor Packer, Nice Jumbo.

Bentley: *Pureline sample,* Good length uneven, Good width even, Uniformity of shape a little even, Odd carrot with bends and curves, Full tips matured, A few noticeable lenticels, Good appearance, Good weight a little uneven, Good smoothness, Fair exterior colour slightly pale, 1 to 2 or 2 to 3 cavity spots per root, Poor interior blending uneven, Dead center of core translucent (10-40%), Red or green ring around core (10-20%), White in cores (20-50%), Average core size, Good Packer, Nice Jumbo.

Speedo: *Vilmorin sample,* Nantes style, Good length even, Good width very even, Uniformity of shape very even, Full tips matured, Noticeable lenticels, Average appearance, A touch ringy, Good weight even, Smoothness a little poor, Fair exterior colour even, 2 to 3 cavity spots per root, Average interior blending slightly uneven, Translucent core throughout (20-30%), Yellow ring around core (10-40%), Large core size, Odd one with Galls, Good Packer, Good Jumbo.

Jackson: *Bejo sample,* Good length uneven, Good width even, Uniformity of shape even, Odd carrot with bends and curves, Full tips matured, Good appearance, Odd ringy carrot, Good weight, Fairly smooth, Good exterior colour even, Some noticeable cavity spots slight concern, 3 to 5 cavity spots per root, Good interior blending slightly uneven, Red ring around core (30-70%), White in cores (10%), Large core size, Average Packer, Okay Jumbo an oversized packer.
Jumbo

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CARROT CULTIVAR MAIN TRIAL JUMBO TYPES EVALUATION NOTES – 2020 - continued

Blanes: *Bejo sample,* Good length uneven, A few carrots too short, Good width slightly even, Uniformity of shape even, Full tips matured, Slightly noticeable lenticels, Good appearance, Good to excellent weight, Good smoothness, Fair exterior colour slightly pale, 2 to 3 cavity spots per root, Slightly poor interior blending uneven, Red ring around core (30%), White in cores (30-40%), Extra-large core size, Okay Packer, Nice Jumbo.

SV DN 5853: *Seminis sample,* Poor to okay length uneven, Carrots a bit short, Good width slightly even, Uniformity of shape uneven, Full tips matured, Odd noticeable lenticels, Average appearance, Good weight, Fairly smooth, Fair exterior colour slightly even, Odd noticeable cavity spot, 3 to 4 cavity spots per root, Good interior blending even, Translucent cores throughout (10-20%), Red ring around cores (30-50%), Average to large core size, Odd carrot with mouse damage, Poor Packers, Okay to good Jumbo.

New Hall: *Bejo sample,* Good length even, Good width even, Uniformity of shape a little even, Full tips matured, Average
Jumbo appearance,Average weight, Good smoothness, Fair exterior colour slightly uneven, Odd noticeable cavity spot, 1 to 2 or 2 to 3 cavity spots per root, Average interior blending, Dead center of core translucent (20-30%), Red or yellow ring around core (10-60%), White in cores (10%), Large core size, Odd carrot with mouse damage, Good Packer, Good Jumbo.

Extremo: *Vilmorin sample,* Average length even, Good width even, Uniformity of shape even, Tapered & full tips matured, Odd noticeable lenticels, Good appearance, Good weight, Good smoothness, Fair exterior colour even, 2 to 3 cavity spots per root, Average interior blending even, Red ring around core (20-40%), White in cores (10-20%), Average to large core size, Odd one with Gull, Odd carrot with mouse damage, Seeders a big concern, Poor Packer, Average Jumbo.

CARROT CULTIVAR ADAPTATION TRIAL - 2020

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 bu/A	% Marketable	% Oversize	Majority of Culls
CA19 2005	ILL	78	34	39	19.25	11.37	6.48	89.3	1437	92.7	59.1	F
0283	Pure	143	15	105	18.66	3.64	12.73	81.9	1318	87.7	19.5	SM
B 3187	BEJO	95	13	66	15.42	3.56	9.24	64.0	1030	83.0	23.1	F
METRO	Pure	106	25	52	21.32	9.19	8.29	87.4	1407	82.0	43.1	SM
CA19 1002	ILL	53	25	18	15.16	8.37	3.43	59.0	950	77.8	55.2	F
B 3188	BEJO	62	23	24	17.86	9.19	3.74	64.7	1041	72.4	51.5	SPL

Listed in order of % Marketable.

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CARROT CULTIVAR ADAPTATION TRIAL - 2020 - 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
CA19 2005	ILL	Cyl	9.0	6.0	8.0	8.0	8.0	O	7.0	LO	5.0	7.29	9.5
0283	Pure	Cyl	8.0	5.0	6.0	6.0	9.0	O	6.0	O	7.0	6.71	8.0
B 3187	BEJO	Imp	8.0	7.0	6.0	5.0	10.0	DO	8.0	O	8.0	7.43	8.0
METRO	Pure	Cyl	7.0	5.0	8.0	9.0	9.0	O	7.0	LO	5.0	7.14	9.0
CA19 1002	ILL	GPN	8.0	7.0	7.0	7.0	4.0	LO	6.0	O	6.0	6.43	8.0
B 3188	BEJO	Imp	5.0	8.0	7.0	3.0	8.0	O	6.0	O	7.0	6.29	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 - 2020 - 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
CA19 2005	ILL	52.8	30LM	CC	23.2	5.0	20	10	60.5	DG	ST	3.8	0.0	6.0
0283	Pure	36.5	25LM	CC	19.3	3.4	21	19	47.4	G	ST	1.4	0.0	0.0
B 3187	BEJO	46.1	60M	CV	23.4	3.3	25	12	61.9	DG	ST	21.1	0.0	21.0
METRO	Pure	48.1	45LM	CC	23.7	5.2	21	14	50.9	DG	ST	0.0	0.0	0.0
CA19 1002	ILL	47.2	20LM	CC	22.4	5.0	25	7	42.5	G	F	0.0	0.0	0.0
B 3188	BEJO	48.4	78LM	CC	25.1	5.1	25	8	59.4	G	ST	17.7	0.0	5.0

Listed in order of % Marketable.

ADAPTATION CARROT CULTIVAR TRIAL EVALUATION NOTES - 2020

CA 19 2005: *Illinios sample,* Jumbo/Packer is a 60/40 split, Good to nice length slightly uneven, Nice width very even, Uniformity of shape very even, Odd carrots with bends and curves, Full tips matured, Odd noticeable lenticels, Nice appearance, Good weight even, Good smoothness, Exterior colour slightly pale uneven, 1 to 2 cavity spots per root, A little poor interior blending uneven, Translucent core throughout (40%), Yellow and Green ring around core (30%), White in cores (30%), Large core size, Good packer some too short, Good Jumbo.

0283: *Pureline sample,* Packer, Nantes style, Okay length uneven, Okay to average width slightly uneven, Uniformity of shape even, Some carrots with bends and curves, Full tips matured, Odd ringy carrot, Good appearance, Poor to average weight uneven, Fairly smooth, Fair exterior colour slightly uneven, 1 to 2 or 2 to 3 cavity spots per root, Nice interior blending very even, Dead center of core translucent (30%), Red ring around core (10%), Small to average core size, Okay Packer some too short and thin, Okay Jumbo a bit lacking in weight, The entire sample just a bit uneven in all categories.

3187: *Bejo sample,* Packer, Good length slightly uneven, Okay to average width slightly uneven, Uniformity of shape even, Some carrots with bends and curves, Tapered tips a few immature, Bit rough appearance, Ringy a concern, Average weight uneven, Poor smoothness, Good exterior colour even, 3 to 4 cavity spots per root, Good interior blending, Red ring around core (20%), White in cores (10%), Average core size, Okay Packer, Poor Jumbos a oversized packer, Rough sample.

Metro: *Pureline sample,* Jumbo/Packer is a 40/60 split, Good length uneven, Good width slightly even, Uniformity of shape a little even, Full tips matured, Slightly noticeable lenticels, Odd ringy carrot, Nice appearance, Good weight even, Good smoothness, Good exterior colour even, Odd noticeable cavity spot, 2 to 3 cavity spots per root, Average interior blending uneven, Translucent core throughout (30%), Yellow ring around core (30%), White in cores (10%), Average core size, Good Packer odd short one, Good Jumbo odd short one, Nice mix of Packers and Jumbos.

CA 19 1002: *Illinios sample,* Jumbo/Packer is a 70/30 split, Good length slightly uneven, Average to good width slightly even, Uniformity of shape a little even, Full tips matured, Some heavy shoulders, Odd noticeable lenticels, Good appearance, Good weight a little uneven, Good smoothness, Good exterior colour slightly uneven, 1 to 2 cavity spots per root, Average interior blending uneven, Dead center of core translucent (60%), Yellow ring around core (20%), White in cores (30%), Average to large core size, Good Packer, Nice Jumbo.

3188: *Bejo sample,* Jumbo/Packer is a 50/50 split, Good length slightly even, Good width slightly uneven, Uniformity of shape even, Some bends and curves, Tapered tips matured, Very rough appearance, Some ringy carrots, Good weight even, Poor smoothness, Good exterior colour slightly dark uneven, Odd noticeable cavity spot, 3 to 4 cavity spots per root, Good interior blending even, Translucent core throughout (10%), Red ring around core (30%), Large core size, Okay Packer, Okay Jumbo, Rough sample, Some harvest cracks

LONG TERM AVERAGES OF CARROT CULTIVAR TRIALS

CULTIVAR	SOURCE	# Years Tested	Length (cm)	Length (Inches)	Width (cm)	Marketable t/ha	Martketable bu/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
ORANGE PAK	Nor	7	23.7	9.3	3.5	85.1	1369	87.1	--
ENTERPRISE	Sto	16	23.6	9.3	3.4	79.1	1281	80.5	50.7
CANADA SUPER X	Sol	14	23.3	9.2	3.4	80.8	1376	82.7	--
SV 2384	Sem	9	23.1	9.1	3.3	75.7	1218	77.7	47.6
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	31	22.6	8.9	3.5	91.6	1501	82.7	47.6
FONTANA	Bejo	13	22.4	8.8	5.1	108.7	1750	88.5	46.9
ENVY	Sem	16	22.3	8.8	3.9	89.6	1442	81.9	51.4
JERADA	RZ	6	22.0	8.7	4.1	97.0	1564	84.6	44.0
BASTIA	Bejo	16	21.8	8.6	5.2	95.6	1539	83.6	46.9

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 bu/A	% Marketable	Avg Leaf Length (cm)
OLYMPUS	Sto	5	21.8	8.6	3.4	73.8	1188	73.9	45.8
ISTANBAL	Bejo	5	21.5	8.5	3.5	65.1	1048	70.9	48.4
ORANGE SHERBET	Sto	10	21.2	8.3	--	73.4	1310	84.0	--
BELGRADO	Bejo	13	21.1	8.3	5.3	104.9	1689	81.3	47.2
CAROPAK	Sem	8	20.9	8.2	--	74.1	1323	85.0	--
BLANES	Bejo	5	20.7	8.1	5.3	93.9	1512	80.2	48.2
PARAMOUNT	Sem	7	20.6	8.1	--	82.1	1467	85.0	--
BERLIN	Bejo	9	20.1	7.9	5.5	101.0	1626	79.5	46.1
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	9	18.7	7.4	3.5	66.6	1071	70.9	46.0
NAVAL	Bejo	10	18.0	7.1	3.5	82.0	1319	79.0	43.9

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
ORANGE PAK	Nor	7	6.9	--	6.82	--	--	--
ENTERPRISE	Sto	16	7.9	55.0	6.64	10.6	8.4	0.5
CANADA SUPER X	Sol	14	7.0	--	6.95	--	--	--
SV 2384	Sem	9	8.0	67.0	6.13	13.7	10.1	0.4
SIX PAK	HM	20	7.9	--	6.98	--	--	--
SUNRISE	Cro	15	8.4	--	6.82	--	--	--
CELLOBUNCH	Sem	31	7.1	58.3	6.52	9.0	6.5	2.1
FONTANA	Bejo	13	5.6	51.0	6.33	4.8	3.8	1.3
ENVY	Sem	16	7.5	74.6	6.53	8.7	10.4	1.1
JERADA	RZ	6	7.2	63.2	7.18	12.2	3.6	0.2
BASTIA	Bejo	16	7.4	79.2	6.80	7.3	7.1	1.5

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
OLYMPUS	Sto	5	8.3	86.0	6.31	15.8	4.5	1.1
ISTANBAL	Bejo	5	6.9	59.0	6.83	9.1	23.3	0.0
ORANGE SHERBET	Sto	10	--	--	6.75	--	--	--
BELGRADO	Bejo	13	6.7	74.0	6.36	9.3	8.5	1.7
CAROPAK	Sem	8	--	--	6.85	--	--	--
BLANES	Bejo	5	8.3	59.0	6.41	10.7	22.0	0.0
PARAMOUNT	Sem	7	--	--	6.75	--	--	--
BERLIN	Bejo	9	8.4	73.0	6.37	10.2	13.3	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	9	7.7	66.0	6.29	11.7	10.6	2.7
NAVAL	Bejo	10	7.6	53.1	6.97	11.8	10.5	0.2

Listed in order of length.

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

CARROT CULTIVAR STORAGE TRIAL - 2019 - 2020

Cultivar	Source	% Marketable	% Weight Loss	% Decay	Degree of Rot **	% Root Sprouts	% Top Sprouts
SPEEDO	Vil	97.0 a*	10.2 a-e	2.8 a	9 a	22 ab	97 a
VOLCANO Inicium	SN	96.5 a	13.1 d-g	3.1 a	7 c-f	23 abc	94 a
VOLCANO	Vil	96.3 a	10.8 a-e	3.3 a	9 ab	57 d-h	96 a
NEW HALL Jumbo	Bejo	96.2 a	9.7 a-d	3.4 a	7 a-e	17 a	96 a
CELLOBUNCH	Sto	95.2 a	9.4 abc	4.3 a	8 abc	70 fgh	97 a
NEW HALL Cello	Bejo	94.9 a	10.3 a-e	4.5 a	7 a-e	23 abc	90 a
INTREPID	Sem	93.4 ab	9.2 ab	6.2 ab	6 c-g	37 a-e	95 a
ENTERPRISE	Sto	91.3 ab	13.0 d-g	8.1 ab	7 c-f	24 a-d	93 a
PV 5041	Nor	90.6 ab	10.9 a-f	9.0 ab	8 a-d	45 a-f	92 a
SV 2384	Sto	90.3 ab	12.2 a-g	9.4 ab	7 c-f	55 c-h	93 a
ORANGE BLAZE	Sem	89.2 abc	11.2 a-f	10.6 abc	7 a-e	55 c-h	96 a
ISTANBAL	Bejo	88.3 a-d	15.4 gh	11.3 a-d	6 c-g	22 ab	95 a
NAVAL	Bejo	88.1 a-d	9.0 a	11.6 a-d	8 abc	52 b-g	94 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 - 2019 - 2020 - continued

Cultivar	Source	% Marketable	% Weight Loss	% Decay	Degree of Rot **	% Root Sprouts	% Top Sprouts
B 3136 Cello	Bejo	86.5 a-e*	18.4 h	13.1 a-e	7 b-f	32 a-e	94 a
COREO	Vil	86.1 a-e	10.3 a-e	13.6 a-e	7 a-e	60 e-h	93 a
B 3136 Jumbo	Bejo	82.1 b-f	12.5 b-g	17.5 b-f	6 d-g	57 d-h	96 a
BASTIA	Bejo	77.8 c-f	9.5 abc	21.7 c-f	6 e-h	45 a-f	96 a
NAVEDO	Bejo	77.3 c-f	8.8 a	22.2 c-f	6 e-h	22 ab	97 a
BELGRADO	Bejo	77.1 def	10.0 a-e	22.6 def	5 fgh	13 ab	96 a
ENVY	Sem	76.5 def	11.5 a-f	23.1 def	7 c-f	40 a-f	97 a
BERLIN	Bejo	76.0 ef	13.4 efg	23.8 ef	6 d-g	70 fgh	96 a
EXTREMO	Sto	75.8 ef	14.3 fg	23.9 ef	7 c-f	86 h	97 a
BRAVA	Bejo	71.6 fg	11.2 a-f	28.3 fg	5 gh	60 e-h	97 a
BLANES	Bejo	61.9 gh	12.8 c-g	37.8 gh	4 h	37 a-e	96 a
DIAMENTO	Vil	57.0 h	11.4 a-f	42.8 h	7 a-e	80 gh	97 a
Trial Average		**84.5**	**11.5**	**15.1**	**6.7**	**44.1**	**95.2**

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 2019-2020

Speedo: *Vilmorin sample,* Top sprouts light to moderate 0-2.5cm, Top sprouts lengths slightly uneven, Root sprouts just starting 0-1cm, Majority tip rot, Some canker rot, Rot is just starting to lightly established, Rot is dry, Stored excellent.

Volcano: **Inicium** *Seminova sample,* Top sprouts just starting to moderate 0-2.5cm, Top sprout lengths uneven, Root sprouts just starting 0-1cm,Tip & crown rot, Rot is slightly to moderately established, Rot is dry or moist, Stored excellent.

Volcano: *Vilmorin sample,* Top sprouts moderate 2.5 to <5cm, Top sprout lengths uneven, Root sprouts just starting to moderate 0-2.5cm, Root sprout lengths uneven, Tip & canker rot, Rot is just starting to establish, Rot is dry, Stored excellent.

New Hall: **Jumbo** *Bejo sample,* Top sprouts light to moderate 1-2.5cm, Root sprouts just starting 0-1cm, Tip & canker rot, Rot is just starting to moderately established, Rot is dry, Stored good to excellent.

Cellobunch: *Stokes sample,* Top sprouts moderate 2.5 to <5cm, Top sprout lengths uneven, Top sprouts a concern, Root sprouts just starting to moderate 0-2.5cm, Majority tip rot, A few crown rot, Rot is just starting to moderately established, Rot is moist or dry, Stored good.

New Hall: **Cello** *Bejo sample,* Top sprouts light to moderate 0-2.5cm, Root sprouts just starting 0-1cm, Majority tip rot, Some canker rot, Rot is just starting to lightly established, Rot is dry, Stored good to excellent.

Intrepid: *Seminis sample,* Top sprouts light to moderate 1-2.5cm, Top sprouts lengths are uneven, Root sprouts just starting 0-1cm, Majority tip rot, Odd canker rot, Rot is lightly to moderately established, Rot is moist or dry, Stored good.

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MAIN CARROT CULTIVAR STORAGE TRIAL EVALUATION NOTES 2019-2020 - continued

Enterprise: *Stokes sample,* Top sprouts just starting to moderate 0-2.5cm, Top sprout lengths are uneven, Root sprouts just starting 0-1cm, Majority tip rot, Odd canker & crown rot, Rot is just starting to moderately established, Rot is dry or moist, Stored fair.

PV 5041: *Norseco sample,* Top sprouts just starting to moderate 1-2.5cm, Top sprouts lengths uneven, Root sprouts just starting 0-1cm, Majority tip rot, A few crown & canker rot, Rot is just starting to heavily established, Rot is dry or moist, Stored good.

SV 2384: *Seminis sample,* Top sprouts light 1-2.5cm, Root sprouts just starting 0-1cm, Tip & canker rot, Rot is just starting to moderately established, Rot is dry or moist, Stored good.

Orange Blaze: *Seminis sample,* Top sprouts moderate 1-2.5cm, Root sprouts just starting 0-1cm, Majority tip rot, Odd canker rot, Rot is just starting to lightly established, Rot is dry or moist, Two replicates slightly dried out, Stored good.

Istanbul: *Bejo sample,* Top sprouts light to moderate 0-2.5cm, Root sprouts just starting to light 0-2.5cm, Majority tip rot, Odd canker & crown rot, Rot is just light to moderately established, Rot is dry or moist, Rot is a slight concern, Stored okay.

Naval: *Bejo sample,* Top sprouts light to moderate 1-2.5cm, Root sprouts just starting to light 0-2.5cm, Majority tip rot, Odd canker rot, Rot is just starting to lightly established, Rot is dry or moist, Stored good.

B 3136: *Bejo sample,* Top sprouts just starting to moderate 1-5cm, Top sprouts uneven, Root sprouts just starting
Cello light 0-1cm, Majority tip rot, A few canker rot, Rot is just starting to lightly established, Rot is dry, Two replicates slightly dried out, Stored good.

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MAIN CARROT CULTIVAR STORAGE TRIAL EVALUATION NOTES 2019-2020 - continued

Coreo: *Vilmorin sample,* Top sprouts moderate 1-5cm, Top sprouts lengths uneven, Root sprouts just starting to moderate 0-5cm, Root sprouting is a concern, Majority tip rot, Odd canker rot, Rot is just starting to lightly established, Rot is moist or dry, Rot is a slight concern, Stored fair to good.

B 3136: **Jumbo** *Bejo sample,* Top sprouts light to moderate 1-5cm, Top sprouting uneven, Root sprouts just starting 0-1cm, Majority tip rot, A few canker rot or crown rot, Rot is light to moderately established, Rot is moist or dry, Rot is a slight concern, Stored okay.

Bastia: *Bejo sample,* Top sprouts moderate 2.5-5cm, Top sprout lengths uneven, Root sprouts just starting 0-1cm, Majority tip rot, A few canker rot, Rot is just starting to moderately established, Rot is dry or moist, Rot is a slight concern, Stored a little poor.

Navedo: *Bejo sample,* Top sprouts moderate to heavy 2.5-5cm, Root sprouts just starting 0-1cm, Majority tip rot, A few canker rot, Rot is just starting to moderately established, Rot is moist or dry, Rot is a concern, Stored okay.

Belgrado: *Bejo sample,* Top sprouts just starting to moderate 0-5cm, Root sprouts are just starting 0-1cm, Majority tip rot, A few canker rot, Rot is just starting to moderately established, Rot is dry, Rot is a concern, Stored poor to good.

Envy: *Stokes sample,* Top sprouts light to moderate 1-2.5cm, Root sprouts just starting to light 0-2.5cm, Majority tip rot, Odd canker rot, Rot is just starting to moderately established, Rot is dry or moist, Rot is a slight concern, Stored fair.

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MAIN CARROT CULTIVAR STORAGE TRIAL EVALUATION NOTES 2019-2020 - continued

Berlin: *Bejo sample,* Top sprouts just starting to heavy 0 to <5cm, Top sprout lengths uneven, Root sprouts just starting to moderate 0-2.5cm, Tip and canker rot, Rot is slight to moderately established, Rot is dry or moist, Rot is a concern, Stored a bit poor.

Extremo: *Vilmorin sample,* Top sprouts moderate to heavy 2.5-5cm, Top sprout lengths uneven, Root sprouts moderate 1-2.5cm, Root sprout lengths uneven, Top & root sprouting is a concern, Majority tip rot, A few canker, Rot is light to moderately established, Rot is moist or dry, Rot is a concern, Stored a little poor.

Brava: *Bejo sample,* Top sprouts moderate to heavy 2.5 to <5cm, Top sprouts lengths uneven, Root sprouts light to moderate 1-2.5cm, Majority tip rot, A few canker rot, Rot is light to moderately established, Rot is dry, Stored poor to fair.

Blanes: *Bejo sample,* Top sprouts moderate 2.5-5cm, Root sprouts just starting to light 0-2.5cm, Majority tip rot, Some canker rot, Rot is moderate to heavily established, Rot is moist or dry, Rot is a concern, Stored poor.

Diamento: *Vilmorin sample,* Top sprouts moderate to heavy 2.5 to <5cm, Top sprout lengths uneven, Root sprouts moderate 2.5-5cm, Top & root sprouts are a concern, Majority tip rot, Odd canker rot, Rot is just starting to lightly established, Rot is dry or moist, Stored a little poor.

LONG TERM AVERAGES - CARROT CULTIVAR STORAGE TRIALS

CULTIVAR	SOURCE	# YEARS TESTED	% MARKETABLE	% WEIGHT LOSS IN STORAGE	% DECAY	DEGREE* OF DECAY
SPARTAN CLASSIC 80	Sto	4	97.6	6.8	2.4	5.5
BLAZE	Rog	4	95.2	10.0	4.8	4.9
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
NEW HALL	Bejo	8	86.7	11.6	4.4	7.5
ISTANBUL	Bejo	4	85.7	15.0	7.3	7.0
CROFTON	RZ	6	84.8	11.5	3.0	7.5
INFINITY	Bejo	5	83.4	11.4	4.9	7.8
2384	Sem	9	83.2	13.5	6.4	6.7
ENTERPRISE	Sem	14	82.6	10.7	8.5	6.4
BRADFORD	Bejo	5	82.1	10.0	7.9	7.8

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	9	82.1	10.8	9.3	7.9
BELGRADO	Bejo	11	80.2	10.3	11.8	7.1
SIX PAK	HM	20	79.8	11.5	8.6	5.8
COSTELLO	Sol	5	79.3	11.6	8.7	7.3
BERLIN	Bejo	8	79.1	12.0	12.4	7.0
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	28	78.5	13.0	7.1	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
ACHIEVE	Sem	8	73.0	13.0	13.6	6.4
BASTIA	Bejo	15	73.0	13.3	15.1	6.5
ENVY	Sem	16	72.2	12.7	16.6	6.6
SIX SHOOTER	HM	5	71.5	11.0	17.5	6.0
BLANES	Bejo	4	69.3	12.9	25.2	6.2
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 – 2020

Compared to the previous 10-year average, air temperatures in 2020 were above average for July (23.3°C), average for June (19.2°C), August (20.6°C), and below average for May (11.6°C) and September (15.0°C). The 10-year average temperatures were: May 14.2°C, June 18.5°C, July 21.5°C, August 20.3°C and September 16.5°C. Monthly rainfall was above the 10-year average for August (140 mm), average for September (65 mm), and below average for May (38 mm), June (77 mm) and July (58 mm). The 10-year rainfall averages were: May 73 mm, June 103 mm, July 84 mm, August 76 mm and September 62 mm.

Favourable weather conditions in mid April allowed for the ground frost to thaw and by the end of April the soil was satisfactory for seeding. Onion seeding in the Holland Marsh began the last week of April and was pretty much completed by the 10th of May. Even though soil conditions were satisfactory, the weather was less then ideal. Air temperatures were below seasonal, with a mix of sun and cloud and it was a bit windy for the first 15 days of May. The month of May recorded below average rainfall but with the cool temperatures soil moisture remained adequate. The variety trial was seeded on 5 May. During onion seed germination and emergence, daytime air temperatures fluctuated from the low teens to single digits and nighttime air temperatures dipped below 0°C several times. Onion emergence was a bit slow but vigor and plant stand were satisfactory. By 20 May the weather pattern changed to more seasonal temperatures. By 28 May the onions were in full loop to flag leaf and the herbicide Prowl was applied at the recommended rate. The heaviest weed flushes occurred in late May and early June when temperatures climbed. Two applications of Pardner + Goal reduced the weed population but hand weeding was necessary to clean the plot. Weed pressure was light for the remainder of the season and only a few hand weedings were required to keep the trial free from weeds. For the entire growing season onion growth was steady and satisfactory. When leaf lengths were recorded on 29 July, the average leaf length was almost 20 cm longer then in 2019. There were significant differences in leaf lengths among the replicates. The second replicate had the longest leaf lengths and the shortest leaf lengths were found in the third replicate.

On-station monitoring for onion maggot fly emergence began early with the first flies detected on 21 May. There were three peaks in onion maggot fly numbers during the monitoring period. Counts peaked at 3 flies/trap/day on 28 June, 4.6 flies/trap/day on 26 June and 11.8 flies/trap/day on 23 July. After the third peak, onion maggot fly numbers never reached over 2 flies/trap/day. Higher onion maggot fly counts appeared to be positively correlated to a slightly higher trial average for onion maggot damage.

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ONION CULTIVAR TRIAL SEASON SUMMARY - 2020 – continued

Thrips were first found on 26 June and were present through August. Onion thrips numbers in the variety trial reached a high of 1.2 thrips/leaf on 26 June and remained at this level for a couple of weeks. Several insecticide and irrigation water applications lowered the thrips numbers below threshold. Thrips counts climbed above threshold again to 1.2 thrips/leaf on 23 July. The second application of Movento and additional insecticides lowered thrips numbers to below threshold for the remainder of the season. Stemphylium leaf blight was found in the cultivar trial on 29 June and several fungicide applications (see Onion Management Procedures) kept severity to a minimum. Fungicide applications were applied to control downy mildew and botrytis, and environmental conditions were mainly unfavourable for these fungal diseases and neither downy mildew nor botrytis were observed in the trial. No onions with bacterial rot were found in the variety trial.

Bulb development started as expected in late July. Most bulb sizing occurred in early August. Cultivars Outlander (29 July) and Highlander (31 July) 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 24 August when at least 85% of the onions had lodged. The average days to harvest (109 days) for the 2020 season was three days longer than in 2019. 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. On 8 September a sample from each cultivar was pulled for judging and comparison during Grower Field Week. By this time, most cultivars had lodged but leaves were only 40-60% desiccated. The yield samples were harvested on 28 September. At harvest, a few cultivars still had some moisture in the neck. Harvest samples from each cultivar were placed in storage on 8 October and cured artificially for approximately 48 hours.

At evaluation on 9-18 November, quality was good in most of the cultivars and yields varied between a high of 1456 to a low of 480 bushel per acre. The trial yield average was 1037 bu/A. This is a drop of approximately 200 bu/A from last season and this average is similar to the trial average in 2017 (1093 bu/A). Significant differences in yield (bu/A) were found among the replicates. The first and second replicate were significantly higher than the third replicate. Fourteen cultivars had the highest number of onions in the 2½-3" size range and another fourteen cultivars had the highest number of onions in the 2½-1¾" size range. The remaining five cultivars were evenly split between the two size ranges. A significant difference was found between the second replicate and the third replicate in the 2½-3" size range.

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ONION CULTIVAR TRIAL SEASON SUMMARY - 2020 – continued

The trial average for the percentage of jumbos (>3" diameter) was 16%, which is equal to that of the 2019 season. Uniformity of size was a little poor and significant differences where found among cultivars and replicates. Size was the most uniform in the second replicate and the least uniform in the third replicate. The uniformity of shape rating varied among cultivars, with shapes highly variable within the individual samples. The average stand count was 6.2 plants/ft, a drop of 1 plant/ft from 2019. The third replicate was lower (5.9 plants/ft) compared to the first and second replicates (6.3 & 6.4 plants/ft). The vast majority of unmarketable onions (culls) were undersized onions (peewees). The trial average for marketable onions was 90.4% with significant variability among the replicates. Replicate two had the highest percentage of marketable onions (92%) and the lowest was in replicate three at (88.5%). Skin quality was very good among cultivars as in 2019 and 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. The third replicate of the trial had significantly thinner skins then the other replicates. Exterior colour was excellent and even in most 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. The third replicate had lower ratings then the other two replicates but not significantly. When evaluated again in November for firmness, onions were found to be quiet firm and solid. The second replicate was significantly firmer than the first and third replicates. Maggot damage to onion bulbs in the evaluation samples ranged from 1.1- 46.9% with a trial average of 8.7%. This is a 3.5% increase in average onion maggot damage for the trial compared to the 2019 season (5.0%). Cultivar Nogal had a high percentage of damage which may have skewed the trial average. The second replicate had the most onion maggot damage (9.9%) and the third replicate had the lowest (7.8%) damage. At evaluation it appeared that there were fewer multiple centers but in fact the average multiple centres had slightly increased by 1.5% compared to the trial average for 2019 and 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.

ONION CULTIVAR TRIAL – 2020

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 24 April.

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 7 July.

Seeded:

All trials were seeded on 5 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** 600 ml/ha 20 May.

Post-emergence: 2 applications: **PROWL H2O** 6.0 L/ha on 28 May and 25 June.
1 application: **PARDNER** at 70 ml/ha and **GOAL** at 70 ml/ha and Manganese at 1.0 kg/ha on 4 June.
1 application: **PARDNER** at 150 ml/ha and **GOAL** at 150 ml/ha and Manganese at 2.0 kg/ha on 8 June.
1 application: **SELECT** at 375 ml/ha + **AMIGO** at 1.5 L/ha on 16 June.

Minor Elements:

Ten foliar sprays: Mag Max on 18 & 26 June, 2 & 10 July (2.0 L/ha) and 17, 23 & 31 July, 13 & 20 August (3.0 L/ha)
Ten foliar sprays: Calcimax on 5, 12, 18 and 26 June, 2 July (2.0 L/ha) and 10, 17, 23 & 27 July, 7 August (3.0 L/ha)
Eight foliar sprays: Suprafeed on 2 July (2.0 kg/ha) and 10, 17, 23 and 27 July and 7, 13 & 20 August (3.0 kg/ha)
Seven foliar sprays: Alexin on 10, 17, 23 & 27 July and 7, 13 & 20 August (3.0 L/ha)
Four foliar sprays: Manganese Sulfate on 12 June (1.0 kg/ha) and 26 June, 2 & 10 July (2.0 kg/ha)
Four foliar sprays: 20-20-20 on 5 & 12 June (2.0 L/ha) and 18 & 26 June (2.5 kg/ha)

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ONION CULTIVAR TRIAL - 2020 - continued

Minor Elements continued:

Four foliar sprays: Zinc Max on 7 August (1.0 L/ha), June 5 & 26 (2.0 L/ha), and 27 July (3.0 L/ha)
Two foliar sprays: Nutri Bor on 20 August (1.0 L/ha) and 13 August (1.5 L/ha)
Two foliar sprays: Copper Max on 20 August (1.0 L/ha) and 13 August (2.0 L/ha)
Two foliar sprays: Mancozin on 18 June (2.0 L/ha) and 23 July (3.0 L/ha)
One foliar spray: Epsom Salts on 12 June (1.0 kg/ha)

Insect and Disease Control:

According to IPM recommendations.

DIBROOM at 500 ml/ha and Minor Elements on June 18.
LUNA TRANQUILITY at 1.2 L/ha + **UP-CYDE** at 280 ml/ha and Minor Elements on 26 June.
MOVENTO at 365 ml/ha + **AGRAL 90** at 1.0 L/ha on 29 June.
SERCADIS at 333 ml/ha + **DELEGATE** at 200 g/ha and Minor Elements on 2 July.
APROVIA at 750 ml/ha + **SILENCER** at 188 ml/ha and Minor Elements on 10 July.
MOVENTO at 365 ml/ha + **AGRAL 90** at 1.0 L/ha on 14 July.
QUADRIS TOP at 1.0 L/ha + **DITHANE DG** at 2.0 kg/ha + **SILENCER** at 188 ml/ha and Minor Elements on 17 July.
LUNA TRANQUILITY at 1.2 L/ha + **DITHANE DG** at 2.0 kg/ha + **DELEGATE** at 336 g/ha and Minor Elements on 23 July.
APROVIA at 750 ml/ha + **RIDOMIL MZ** 2.25 kg/ha + **AGRI-MEK SC** at 175 ml/ha and Minor Elements on 31 July.
QUADRIS TOP at 1.0 L/ha + **DITHANE DG** at 2.0 kg/ha and Minor Elements on 7 August.
SERCADIS at 666 ml/ha + **RIDOMIL MZ** 2.25 kg/ha and Minor Elements on 13 August.
QUADRIS TOP at 1.0 L/ha + **RIDOMIL MZ** 2.25 kg/ha and Minor Elements on 20 August.

Harvest: The Main Trial was pulled on 11 September and topped on 28 September. The trial was placed in a forced air and temperature-controlled storage on 8 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 18	August 21		August 26				September 3	
Outlander	Saddleback	SV NY 1496	Traverse	Haeckero	Y 604	Stanley	Braddock	37 121
Highlander	Sat 1	Trekker	Pocono	Trailblazer	Milestone	Safrane	Nogal	Mondella
	Frontier	Brandt	SV NY 1141	Oneida	Fortress	Catskill	Champ	Crockett
	Cartier		Almagro	Ridge Line	Patterson	Armstrong	37 120	37 118

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EVALUATION PROCEDURES

The cultivars were evaluated 9 through 18 November 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.

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 bu/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

Skin Attachment:

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 - 2020 - 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:
Percentage 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 - 2020 - continued

Top Height (cm):

The average length of 20 randomly chosen onion tops from the all three replicates from the ground to the tips as taken on 29 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 2020 season:

7 May in the amount of ¼ inch
22 May in the amount of ½ inch
27 May in the amount of ½ inch
9 June in the amount of 1 inch
8 July in the amount of 1 inch
30 July in the amount of 1 inch

ONION CULTIVAR MAIN TRIAL - 2020

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)
PATTERSON	Bejo	74 i-l*	0 fg	12 f-i	32 f-k	26 g-k	4.8 i-l	145.3 f-i
TRAVERSE	Tak	113 abc	0 g	13 f-i	60 a	36 d-i	7.4 abc	149.8 fgh
FORTRESS	Sto	113 abc	0 g	2 lm	40 c-h	66 a	7.4 abc	133.6 g-j
ARMSTRONG	CF	97 b-h	0 fg	8 h-l	45 b-f	40 d-g	6.4 b-h	149.0 f-i
TRAILBLAZER	Tak	53 lm	0 fg	9 g-k	21 klm	20 h-l	3.5 lm	147.8 f-i
CROCKETT	Bejo	107 b-f	2 d-g	27 abc	47 a-d	26 g-k	7.0 b-f	183.6 bcd
MILESTONE	Tak	118 ab	1 fg	18 def	54 ab	40 d-g	7.7 ab	166.3 c-f
SV NY 1141	Sem	93 c-i	6 bc	27 abc	36 d-j	20 i-l	6.1 c-i	193.8 b
SAFRANE	Bejo	111 a-d	1 fg	15 efg	46 a-e	43 b-g	7.3 a-d	153.7 efg
SV NY 1496	Sem	108 b-e	5 bcd	23 bcd	39 c-h	36 d-i	7.1 a-e	168.0 c-f
37-121	Haz	99 b-h	6 b	32 a	40 c-h	16 jkl	6.5 b-h	193.7 b

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 - 2020 - 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)
SADDLEBACK	Sto	113 abc*	2 efg	27 ab	51 abc	26 g-k	7.4 abc	163.3 def
RIDGE LINE	Tak	86 f-j	6 bc	27 abc	31 g-k	17 jkl	5.6 f-j	203.6 ab
TREKKER	Tak	101 b-h	0 g	5 j-m	36 d-j	53 a-d	6.6 b-h	125.6 h-l
CATSKILL	Sem	92 c-i	3 d-g	23 bcd	39 c-h	21 h-l	6.0 c-i	191.1 bc
POCONO	Sto	105 b-g	3 d-g	13 fgh	33 e-k	47 b-e	6.8 b-g	154.7 efg
BRADDOCK	Bejo	113 abc	2 d-g	25 bc	44 b-g	32 e-k	7.4 abc	167.5 c-f
Y 604	SN	71 jkl	3 c-f	21 cde	23 jkl	18 i-l	4.6 jkl	178.0 b-e
STANLEY	CF	113 abc	2 efg	13 f-i	43 b-g	45 b-f	7.4 abc	144.6 f-i
HAECKERO	Haz	91 d-j	0 g	8 h-l	26 h-l	48 a-e	5.9 d-j	126.1 h-k
37-118	Haz	84 g-k	2 efg	15 efg	31 g-k	29 f-k	5.5 g-k	156.0 efg
SAT 1	SN	99 b-h	1 fg	11 g-j	39 c-h	38 d-h	6.5 b-h	145.5 f-i

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 - 2020 - 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	81 h-k*	1 fg	8 h-l	29 h-l	34 e-j	5.3 h-k	133.4 g-j
37-120	Haz	86 f-j	7 b	23 bcd	32 f-k	15 kl	5.6 f-j	191.5 bc
ALMAGRO	Bejo	65 kl	4 b-e	13 f-i	23 jkl	16 jkl	4.2 kl	178.9 b-e
OUTLANDER	Tak	102 b-h	1 fg	3 klm	24 jkl	61 ab	6.7 b-g	100.2 lm
MONDELLA	Bejo	102 b-h	1 fg	8 h-l	38 c-i	41 d-g	6.7 b-g	123.6 i-l
HIGHLANDER	Tak	94 c-i	1 fg	7 i-m	30 g-k	41 c-g	6.1 c-i	131.4 g-k
FRONTIER	Tak	107 b-f	0 g	1 m	25 i-l	66 a	7.0 b-f	100.3 lm
ONEIDA	Bejo	130 a	2 d-g	9 g-k	38 c-i	59 abc	8.5 a	116.8 jkl
BRANDT	Sto	87 f-j	0 g	2 lm	23 jkl	48 a-e	5.7 f-j	105.9 klm
NOGAL	EZ	43 m	10 a	12 f-i	8 m	3 l	2.8 m	222.0 a
CARTIER	Bejo	88 e-j	0 fg	1 m	16 lm	47 b-f	5.8 e-j	80.7 m
Trial Average		**95**	**2**	**14**	**35**	**36**	**6.2**	**152.3**

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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ONION CULTIVAR MAIN TRIAL - 2020 - 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 bu/A	% Marketable	Majority of Culls
PATTERSON	Bejo	10.57 ijk*	0.10 fg	2.79 g-k	5.33 d-j	2.22 f-j	786 l-o	100.0 a	PW
TRAVERSE	Tak	16.85 a-e	0.00 g	3.01 f-j	10.03 a	3.60 c-h	1254 a-f	96.0 ab	PW
FORTRESS	Sto	15.03 d-g	0.00 g	0.49 mno	7.23 b-e	7.14 a	1121 c-i	95.9 ab	PW
ARMSTRONG	CF	14.48 e-h	0.10 fg	1.95 i-n	8.07 abc	4.23 cde	1082 d-j	95.7 ab	PW
TRAILBLAZER	Tak	7.79 kl	0.11 fg	2.24 g-l	3.35 jkl	1.93 h-k	575 op	95.5 ab	PW
CROCKETT	Bejo	19.60 a	0.85 d-g	7.42 ab	8.34 ab	2.70 e-j	1456 a	95.3 ab	PW
MILESTONE	Tak	19.42 ab	0.23 fg	4.62 def	9.88 a	4.44 cd	1446 a	95.3 ab	PW
SV NY 1141	Sem	17.96 a-d	2.05 bc	6.98 abc	6.49 b-f	1.90 h-k	1313 a-e	94.7 abc	R
SAFRANE	Bejo	17.12 a-e	0.53 fg	3.85 efg	8.13 abc	4.31 cde	1268 a-f	94.7 abc	PW
SV NY 1496	Sem	18.10 a-d	1.82 bcd	6.02 bcd	6.79 b-e	3.01 d-j	1330 a-d	94.7 abc	PW
37-121	Haz	19.09 abc	2.03 bc	8.05 a	7.04 b-e	1.64 ijk	1414 ab	94.7 abc	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 - 2020 - 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 bu/A	% Marketable	Majority of Culls
SADDLEBACK	Sto	18.36 abc*	0.58 efg	7.19 ab	7.47 bcd	2.61 e-j	1346 abc	94.5 abc	PW
RIDGE LINE	Tak	17.57 a-e	2.16 b	7.37 ab	6.14 b-h	1.72 ijk	1311 a-e	93.7 abc	PW
TREKKER	Tak	12.69 ghi	0.00 g	1.15 k-o	6.03 b-h	5.18 bc	931 g-l	93.4 abc	PW
CATSKILL	Sem	17.50 a-e	1.01 c-g	6.19 bcd	7.36 b-e	2.10 g-j	1256 a-f	92.3 a-d	PW
POCONO	Sto	15.99 c-f	0.99 c-g	3.66 e-i	6.38 b-f	4.55 bcd	1174 b-g	91.8 a-d	PW
BRADDOCK	Bejo	18.86 abc	0.76 d-g	6.48 abc	7.71 abc	3.09 d-j	1360 abc	91.6 a-d	PW
Y 604	SN	12.56 ghi	1.08 c-f	5.32 cde	4.15 f-k	1.64 ijk	919 i-m	91.5 bcd	PW
STANLEY	CF	16.27 c-f	0.61 efg	3.24 f-j	7.45 bcd	4.23 cde	1170 b-h	91.2 bcd	PW
HAECKERO	Haz	11.43 hij	0.00 g	2.06 h-m	4.33 f-k	4.72 bcd	838 j-n	91.2 bcd	PW
37-118	Haz	13.15 f-i	0.59 efg	3.75 e-h	5.27 d-j	2.75 e-j	933 g-l	90.5 b-e	PW
SAT 1	SN	14.47 e-h	0.35 fg	2.74 g-k	6.95 b-e	3.82 c-g	1045 f-k	89.9 b-e	PW

Listed in order of % Marketable.

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ONION CULTIVAR MAIN TRIAL - 2020 - 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 bu/A	% Marketable	Majority of Culls
CHAMP	CF	10.83 ijk*	0.21 fg	2.07 h-m	5.01 e-j	3.14 d-i	786 l-o	88.6 b-e	PW
37-120	Haz	16.44 b-e	2.31 b	6.03 bcd	5.78 c-i	1.39 jk	1170 b-h	88.4 b-e	PW
ALMAGRO	Bejo	11.37 hij	1.63 b-e	3.45 f-i	4.37 f-k	1.52 ijk	827 k-n	87.6 b-e	PW
OUTLANDER	Tak	10.26 i-l	0.22 fg	0.78 g-m	3.62 i-l	5.09 bc	732 l-o	86.2 cde	PW
MONDELLA	Bejo	12.72 ghi	0.24 fg	2.06 h-m	6.23 b-g	3.72 c-g	923 h-l	84.8 def	PW
HIGHLANDER	Tak	12.33 g-j	0.36 fg	1.70 j-o	5.13 d-j	3.87 c-f	834 j-n	84.3 def	PW
FRONTIER	Tak	10.75 ijk	0.00 g	0.15 o	3.93 g-k	6.13 ab	770 l-o	84.1 def	PW
ONEIDA	Bejo	15.04 d-g	0.80 d-g	2.13 g-m	6.20 b-g	5.14 bc	1076 e-k	82.5 ef	PW
BRANDT	Sto	9.40 jkl	0.00 g	0.60 l-o	3.80 h-k	4.50 bcd	671 m-p	82.0 ef	PW
NOGAL	EZ	9.41 jkl	3.60 a	3.03 f-j	1.36 l	0.32 k	627 nop	76.9 fg	R
CARTIER	Bejo	7.14 l	0.11 fg	0.21 no	2.21 kl	3.83 c-g	480 p	72.1 g	PW
Trial Average		**14.26**	**0.77**	**3.60**	**5.99**	**3.40**	**1037**	**90.4**	**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 - 2020 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Skin Thickness	Skin Attachment	Neck Finish	Overall Score	Score
PATTERSON	Bejo	G	7.3 a-d*	5.7 c-f	6.7 de	9.8 ab	6.7 efg	6.7 cde	7.44 b-e
TRAVERSE	Tak	G	7.8 ab	7.7 a	6.3 def	9.7 abc	7.0 ef	7.2 a-d	7.71 abc
FORTRESS	Sto	HG	7.7 abc	6.0 b-f	6.3 def	9.7 abc	6.3 fgh	6.3 def	7.04 ef
ARMSTRONG	CF	HG	7.7 abc	6.7 a-d	7.0 cd	10.0 a	7.0 ef	7.7 ab	8.00 a
TRAILBLAZER	Tak	G	6.7 b-f	5.0 efg	6.3 def	9.3 a-e	7.0 ef	7.3 abc	7.21 c-f
CROCKETT	Bejo	G	7.3 a-d	7.7 a	6.0 efg	10.0 a	6.3 fgh	7.7 ab	7.79 a
MILESTONE	Tak	HG	7.0 a-e	7.3 ab	6.7 de	8.8 def	7.0 ef	6.7 cde	7.35 c-f
SV NY 1141	Sem	G	5.0 gh	6.0 b-f	5.7 fgh	9.2 b-e	6.0 gh	6.3 def	6.48 ghi
SAFRANE	Bejo	G	5.3 fgh	6.7 a-d	6.7 de	9.7 abc	6.7 efg	7.2 a-d	7.27 c-f
SV NY 1496	Sem	HG	4.7 h	4.7 fg	6.3 def	6.7 g	6.0 gh	6.0 efg	5.75 i
37-121	Haz	G	5.7 e-h	7.2 abc	6.0 efg	9.7 abc	6.3 fgh	6.7 cde	6.98 ef

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 - 2020 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Skin Thickness	Skin Attachment	Neck Finish	Overall Score	Score
SADDLEBACK	Sto	G	5.3 fgh*	6.3 a-e	6.3 def	9.0 c-f	7.3 de	6.7 cde	6.85 fg
RIDGE LINE	Tak	HG	5.7 e-h	6.3 a-e	6.3 def	9.3 a-e	6.7 efg	6.7 cde	7.00 ef
TREKKER	Tak	HG	6.7 b-f	7.0 abc	8.3 ab	9.8 ab	7.0 ef	8.0 a	7.98 a
CATSKILL	Sem	HG	6.0 d-h	6.2 a-f	6.7 de	9.7 abc	6.7 efg	6.3 def	6.98 ef
POCONO	Sto	HG	6.0 d-h	5.7 c-f	6.3 def	9.7 abc	6.3 fgh	5.7 fg	6.83 fgh
BRADDOCK	Bejo	SPG	5.7 e-h	5.7 c-f	6.7 de	9.7 abc	6.5 e-h	6.3 def	6.96 ef
Y 604	SN	G	5.3 fgh	3.7 g	6.3 def	8.3 f	7.3 de	6.0 efg	6.33 ghi
STANLEY	CF	SPG	5.0 gh	4.7 fg	7.0 cd	9.2 b-e	6.7 efg	6.7 cde	6.98 c-f
HAECKERO	Haz	HG	5.7 e-h	5.0 efg	6.7 de	9.8 ab	6.0 gh	6.5 c-f	7.13 def
37-118	Haz	G	4.7 h	5.0 efg	5.0 hi	9.5 a-d	6.0 gh	5.3 gh	5.98 ghi
SAT 1	SN	HG	7.7 abc	6.7 a-d	6.3 def	8.7 ef	7.0 ef	7.3 abc	7.17 c-f

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ONION CULTIVAR MAIN TRIAL - 2020 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Skin Thickness	Skin Attachment	Neck Finish	Overall Score	Score
CHAMP	CF	G	7.0 a-e*	4.7 fg	6.7 de	10.0 a	6.0 gh	6.3 def	6.96 ef
37-120	Haz	G	6.7 b-f	7.0 abc	6.0 efg	9.7 abc	5.7 h	7.0 bcd	7.00 ef
ALMAGRO	Bejo	G	6.3 c-g	4.7 fg	7.7 bc	5.7 h	8.3 bc	4.7 h	6.17 i
OUTLANDER	Tak	G	7.7 abc	5.3 def	5.3 gh	5.0 h	9.0 ab	5.7 fg	6.42 hi
MONDELLA	Bejo	G	7.0 a-e	6.3 a-e	6.7 de	10.0 a	6.3 fgh	6.8 b-e	7.48 a-e
HIGHLANDER	Tak	SPG	5.7 e-h	5.3 def	4.3 i	5.7 h	9.8 a	5.3 gh	6.27 i
FRONTIER	Tak	G	7.7 abc	6.3 a-e	7.0 cd	9.2 b-e	8.3 bc	7.7 ab	7.56 a-d
ONEIDA	Bejo	G	8.2 a	5.3 def	7.0 cd	9.7 abc	8.0 cd	7.7 ab	7.60 a-d
BRANDT	Sto	HG	6.0 d-h	5.7 c-f	6.3 def	8.7 ef	7.0 ef	5.7 fg	6.46 ghi
NOGAL	EZ	FG	6.3 c-g	5.3 def	8.7 a	9.0 c-f	3.7 i	3.7 i	6.52 ef
CARTIER	Bejo	G	8.0 ab	7.0 abc	6.3 def	10.0 a	7.3 de	7.0 bcd	7.92 ab
Trial Average			**6.4**	**5.9**	**6.5**	**9.0**	**6.8**	**6.5**	**7.02**

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ONION CULTIVAR MAIN TRIAL - 2020 - continued

Cultivar	Source	Firmness at Harvest	Firmness at Evaluation	Interior Colour	Exterior Colour	Exterior Colour Rating	Days to Harvest	% Onion Maggot Damage	% Jumbo > 76 mm
PATTERSON	Bejo	10.0 a*	8.7 cde	C	G	8.0 abc	114 bcd	15.6 f-i	44.3 a
TRAVERSE	Tak	9.8 ab	7.7 f-i	MIX	G	8.3 ab	110 e-h	2.2 ab	11.5 j-m
FORTRESS	Sto	10.0 a	8.3 def	C	DG	5.7 f-j	110 d-h	6.2 a-e	1.8 pq
ARMSTRONG	CF	10.0 a	9.7 ab	G	G	8.3 ab	112 c-g	2.5 ab	8.1 l-q
TRAILBLAZER	Tak	10.0 a	9.0 bcd	G	G	7.0 b-f	113 cde	2.5 ab	17.1 f-j
CROCKETT	Bejo	10.0 a	9.0 bcd	C	G	8.3 ab	118 ab	6.5 a-e	25.1 b-e
MILESTONE	Tak	10.0 a	7.3 g-j	W	G	8.0 abc	110 d-h	4.1 abc	16.0 g-k
SV NY 1141	Sem	10.0 a	7.0 ijk	C	G	6.7 c-g	109 f-i	11.7 c-h	29.4 bc
SAFRANE	Bejo	10.0 a	9.3 abc	C	G	6.7 c-g	108 ghi	7.8 a-g	13.6 h-l
SV NY 1496	Sem	9.3 abc	6.7 jk	CG	G	5.0 hij	103 j	3.5 abc	21.3 d-h
37-121	Haz	10.0 a	7.7 f-i	MIX	DG	6.7 c-g	110 d-h	13.8 d-h	32.3 b

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ONION CULTIVAR MAIN TRIAL - 2020 - continued

Cultivar	Source	Firmness at Harvest	Firmness at Evaluation	Interior Colour	Exterior Colour	Exterior Colour Rating	Days to Harvest	% Onion Maggot Damage	% Jumbo > 76 mm
SADDLEBACK	Sto	9.8 ab*	7.2 h-k	CG	G	6.7 c-g	108 ghi	4.0 abc	24.4 b-f
RIDGE LINE	Tak	10.0 a	8.3 def	MIX	DG	6.7 c-g	110 d-h	4.9 abc	30.7 b
TREKKER	Tak	10.0 a	8.7 cde	MIX	DG	8.3 ab	105 ij	2.6 ab	4.7 m-q
CATSKILL	Sem	9.7 a	7.7 f-i	CG	G	6.7 c-g	110 d-h	14.1 e-h	25.0 b-e
POCONO	Sto	10.0 a	9.3 abc	MIX	G	5.7 f-j	108 ghi	9.5 a-h	13.2 i-l
BRADDOCK	Bejo	9.8 ab	7.8 e-i	C	G	7.3 a-e	112 c-g	4.7 abc	22.4 c-g
Y 604	SN	9.8 ab	7.0 ijk	C	G	6.7 c-g	110 e-h	16.8 hi	29.8 bc
STANLEY	CF	10.0 a	9.3 abc	MIX	G	7.3 a-e	108 hi	5.0 abc	11.5 j-m
HAECKERO	Haz	10.0 a	10.0 a	G	G	7.3 a-e	107 hi	7.7 a-f	9.2 k-p
37-118	Haz	10.0 a	7.7 f-i	C	G	4.7 ij	111 c-h	7.5 a-f	17.8 e-j
SAT 1	SN	10.0 a	7.7 f-i	W	G	6.0 e-i	107 hi	2.7 ab	10.7 j-n

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ONION CULTIVAR MAIN TRIAL - 2020 - continued

Cultivar	Source	Firmness at Harvest	Firmness at Evaluation	Interior Colour	Exterior Colour	Exterior Colour Rating	Days to Harvest	% Onion Maggot Damage	% Jumbo > 76 mm
CHAMP	CF	10.0 a*	9.0 bcd	G	DG	6.0 e-i	115 bc	9.9 b-h	10.3 j-o
37-120	Haz	9.8 a	7.3 g-j	C	G	6.7 c-g	112 d-h	16.5 ghi	27.2 bcd
ALMAGRO	Bejo	9.3 abc	7.7 f-i	W	G	4.3 j	109 e-h	23.1 i	20.3 d-i
OUTLANDER	Tak	9.3 bc	7.7 f-i	G	LG	5.7 f-j	93 k	1.6 ab	3.2 n-q
MONDELLA	Bejo	10.0 a	9.0 bcd	W	G	7.7 a-d	113 cde	2.9 ab	8.2 k-q
HIGHLANDER	Tak	9.0 d	6.3 k	W	LG	7.7 a-d	96 k	1.1 a	7.2 l-q
FRONTIER	Tak	10.0 a	8.0 e-h	MIX	DG	6.3 d-h	111 c-h	2.6 ab	0.5 q
ONEIDA	Bejo	9.7 a	7.0 ijk	W	G	8.0 abc	108 ghi	5.1 a-d	7.3 l-q
BRANDT	Sto	10.0 a	7.0 ijk	W	G	5.3 g-j	103 j	9.5 b-h	2.6 opq
NOGAL	EZ	9.2 cd	8.2 d-g	W	DG	7.3 a-e	121+ a	46.9 j	28.2 bcd
CARTIER	Bejo	10.0 a	9.0 bcd	CG	G	8.7 a	111 c-h	12.0 c-h	1.3 q
Trial Average		**9.8**	**8.1**			**6.8**	**109**	**8.7**	**16.2**

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ONION CULTIVAR MAIN TRIAL - 2020 - continued

Cultivar	Source	Seeders	% Single Centers	% Double Centers	% Multiple Centers	% Hollowness in Centers	Top Height (cm)	Leaf Shape	Leaf Colour
PATTERSON	Bejo	0.0 a*	46.7 b-g	53.3 b-h	0.0 a	30.0 b-f	64.7 k-n	B	BG
TRAVERSE	Tak	0.0 a	60.0 a-d	40.0 a-e	0.0 a	33.3 c-g	68.9 h-k	U	G
FORTRESS	Sto	0.0 a	36.7 d-i	56.7 c-i	6.7 abc	30.0 b-f	72.8 d-h	U	BG
ARMSTRONG	CF	0.0 a	46.7 b-g	53.3 b-h	0.0 a	60.0 g	71.7 e-i	B	G
TRAILBLAZER	Tak	0.0 a	30.0 e-i	66.7 f-i	3.3 ab	0.0 a	61.1 no	U	BG
CROCKETT	Bejo	0.0 a	66.7 ab	33.3 abc	0.0 a	0.0 a	81.1 a	U	G
MILESTONE	Tak	0.0 a	40.0 c-i	53.3 b-h	6.7 abc	33.3 c-g	78.1 abc	B	G
SV NY 1141	Sem	0.0 a	40.0 c-i	56.7 c-i	3.3 ab	16.7 a-e	74.4 c-f	U	BG
SAFRANE	Bejo	0.0 a	26.7 f-j	66.7 f-i	6.7 abc	16.7 a-e	74.0 c-g	B	BG
SV NY 1496	Sem	0.0 a	30.0 e-i	56.7 c-i	13.3 bcd	43.3 efg	75.4 b-e	B	G
37-121	Haz	0.0 a	63.3 abc	33.3 abc	3.3 ab	30.0 b-f	80.4 a	B	LG

Listed in order of % Marketable. 10.0 = Most Desirable, 8.0 = Good, 6.0 = Average

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ONION CULTIVAR MAIN TRIAL - 2020 - continued

Cultivar	Source	Seeders	% Single Centers	% Double Centers	% Multiple Centers	% Hollowness in Centers	Top Height (cm)	Leaf Shape	Leaf Colour
SADDLEBACK	Sto	0.0 a*	50.0 a-f	43.3 a-f	6.7 abc	26.7 a-f	79.1 ab	U	G
RIDGE LINE	Tak	0.0 a	20.0 hij	76.7 hi	3.3 ab	20.0 a-e	65.3 j-n	U	BG
TREKKER	Tak	0.0 a	30.0 e-i	70.0 ghi	0.0 a	16.7 a-e	62.0 mno	U	BG
CATSKILL	Sem	0.0 a	56.7 a-d	36.7 a-d	6.7 abc	3.3 ab	74.3 c-f	U	BG
POCONO	Sto	0.0 a	43.3 b-h	56.7 c-i	0.0 a	26.7 a-f	74.2 c-f	U	BG
BRADDOCK	Bejo	0.0 a	23.3 g-j	60.0 d-i	16.7 cd	26.7 a-f	75.1 b-e	B	G
Y 604	SN	0.0 a	26.7 f-j	63.3 e-i	10.0 a-d	26.7 a-f	68.6 ijk	U	BG
STANLEY	CF	0.0 a	16.7 ij	73.3 ghi	10.0 a-d	10.0 a-d	76.0 bcd	B	BG
HAECKERO	Haz	0.0 a	40.0 c-i	56.7 c-i	3.3 ab	16.7 a-e	68.4 ijk	B	BG
37-118	Haz	0.0 a	30.0 e-i	50.0 a-g	20.0 d	23.3 a-e	69.2 hij	B	LG
SAT 1	SN	0.0 a	43.3 b-h	53.3 b-h	3.3 ab	13.3 a-d	70.5 f-i	B	BG

Listed in order of % Marketable. 10.0 = Most Desirable, 8.0 = Good, 6.0 = Average

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ONION CULTIVAR MAIN TRIAL - 2020 - continued

Cultivar	Source	Seeders	% Single Centers	% Double Centers	% Multiple Centers	% Hollowness in Centers	Top Height (cm)	Leaf Shape	Leaf Colour
CHAMP	CF	0.0 a*	53.3 a-e	43.3 a-f	3.3 ab	20.0 a-e	64.0 lmn	U	BG
37-120	Haz	0.0 a	53.3 a-e	30.0 ab	16.7 cd	16.7 a-e	78.6 ab	B	LG
ALMAGRO	Bejo	0.0 a	23.3 g-j	66.7 f-i	10.0 a-d	6.7 abc	65.6 j-m	B	G
OUTLANDER	Tak	0.0 a	43.3 b-h	53.3 b-h	3.3 ab	36.7 d-g	58.7 o	B	G
MONDELLA	Bejo	0.0 a	73.3 a	26.7 a	0.0 a	3.3 ab	68.7 h-k	U	G
HIGHLANDER	Tak	0.0 a	3.3 j	80.0 i	16.7 cd	53.3 fg	63.5 mn	B	G
FRONTIER	Tak	0.0 a	40.0 c-i	60.0 d-i	0.0 a	20.0 a-e	67.7 i-l	B	BG
ONEIDA	Bejo	0.0 a	16.7 ij	70.0 ghi	13.3 bcd	0.0 a	69.9 ghi	B	G
BRANDT	Sto	0.0 a	53.3 a-e	43.3 a-f	3.3 ab	26.7 a-f	63.0 mn	U	BG
NOGAL	EZ	0.0 a	16.7 ij	63.3 e-i	20.0 d	3.3 ab	74.0 c-g	B	LG
CARTIER	Bejo	0.0 a	60.0 a-d	40.0 a-e	0.0 a	3.3 ab	58.4 o	U	BG
Trial Average		**0.0**	**39.5**	**54.1**	**6.4**	**21.0**	**70.2**		

Listed in order of % Marketable. 10.0 = Most Desirable, 8.0 = Good, 6.0 = Average

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2020

Patterson: *Bejo sample*, Good appearance, Average tight neck finish, Medium sized necks, Average skin thickness, Nice skin quality, Exterior colour even, Odd one with yellowing or greening on skins, Average interior blending, Good packer, Uniformity of shape a little uneven, Good firm solid onion, Firmness a little even, Run size uneven, Longer term storage onion.

Traverse: *American Takii sample*, Nice appearance, Good tight neck finish, Small to medium sized necks, Thicker skins, Nice skin quality, Exterior colour very even, Odd one with white spots on skins, Good interior blending, Good packer, Uniformity of shape even, Good firm onion, Firmness even, Medium run size a little uneven, Mid-term storage onion, Nice onion.

Fortress: *Stokes sample*, Good appearance, Average to good tight neck finish, Small to medium sized necks, Average to thicker skins, Nice skin quality, Exterior colour a little uneven, Odd one with white spots on skins, Average interior blending, Good packer, Uniformity of shape a little uneven, Good firm solid onion, Firmness even, Small to medium run size uneven, Mid to longer term storage onion.

Armstrong: *Clifton sample*, Good appearance, Good neck finish, Small to medium sized necks, Thicker skins, Nice skin quality, Exterior colour a little even, Odd one with yellowing or white spots on skins, Average interior blending, Nice packer, Uniformity of shape even, Nice firm solid onion, Firmness even, Medium run size a little uneven, Longer term storage onion, Nice onion.

Trailblazer: *American Takii sample*, Nice appearance, Good tight neck finish, Medium sized necks, Average skin thickness, Nice skin quality, Odd one with skin cracking, Exterior colour even, Odd one with white spots on skins, Poor to average interior blending, Good packer, Uniformity of shape a little uneven, Nice firm solid onion, Firmness even, Run size very uneven, Longer term storage onion, Smallish samples.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2020 - continued

Crockett: *Bejo sample*, Nice appearance, Average tight neck finish, Neck finish bit rough, Medium to large sized necks, Thicker skins, Nice skin quality, Odd one with skin or basal plate rot, Exterior colour even, Odd one with yellowing on skins, Good interior blending, Good packer, Uniformity of shape a little uneven, Good firm solid onion, Firmness even, Large run size a little uneven, Longer term storage onion, Necks a bit of a concern.

Milestone: *American Takii sample*, Good appearance, Average neck finish, Neck finish a little uneven, Medium sized necks, Average skin thickness, Pretty good skin quality, Odd one with skin cracking, Nice exterior colour even, Some white spots on skins, Good interior color, Good packer, Uniformity of shape a little even, Average firmness, Firmness even, Medium run size a little even, Mid-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, Exterior colour even, Odd one with yellowing or white spots on skins, Good interior blending, Good packer, Uniformity of shape uneven, Average firmness, Firmness a little uneven, Large run size even, Mid-term storage onion.

SV NY 1141: *Seminis sample*, Average appearance, Average tight neck finish, Neck finish a bit rough, Medium sized necks uneven, Average skin thickness, Pretty good skin quality, Odd one with skin cracking, Some skin rot, Exterior colour fairly even, Average interior blending, Average packer, Uniformity of shape uneven, Good firm onion, Firmness a little uneven, Large run size uneven, Mid-term storage onion.

Safrane: *Bejo sample*, Nice appearance, Good tight neck finish, Medium sized necks, Average skin thickness, Nice skin quality, Exterior colour even, Odd one with yellowing or white spots on skins, Average interior blending, Nice packer, Uniformity of shape uneven, Nice firm solid onion, Firmness even, Medium to large run size a little uneven, Longer term storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2020 - continued

SV NY 1496: *Seminis sample*, Average appearance, Average neck finish, Neck finish bit rough, Medium sized necks, Average skin thickness, Average skin quality, Some with skin cracking, Exterior colour slightly uneven, Odd one with white spots on skins, Poor to average interior blending, Average packer, Uniformity of shape very uneven, Average firmness, Firmness a little uneven, Medium to large run size very uneven, Mid-term storage onion.

37 121: *Hazera sample*, Average appearance, Average to good neck finish, Neck finish uneven, Small to medium sized necks, Thicker skins, Nice skin quality, Slightly dark exterior colour even, Odd one with yellowing on skins, Poor to average interior blending, Average packer, Uniformity of shape uneven, Good firm onion, Firmness even, Medium to large run size a little uneven, Mid to longer term storage onion.

Saddleback: *Stokes sample*, Average appearance, Average to good tight neck finish, Neck finish a little uneven, Small to medium sized necks, Average skin thickness, Pretty good skin quality, Odd one with skin cracking, Exterior Colour a little uneven, Odd one with yellowing on skins, Average interior blending uneven, Good packer, Uniformity of shape uneven, Average firmness, Firmness even, Medium to large run size a little uneven, Mid-term storage onion.

Ridgeline: *American Takii sample*, Good appearance, Average tight neck finish, Medium sized necks, Thicker skins, Nice skin quality, Odd one with skin cracking, Fairly dark exterior colour a little even, Odd one with white spots on skins, Average interior blending, Good packer, Uniformity of shape uneven, Good firm onion, Firmness even, Medium to larger run size a little even, Longer term storage onion.

Trekker: *American Takii sample*, Nice appearance, Good tight neck finish, Medium sized necks, Thicker skins, Nice skin quality, Fairly dark exterior colour even, Some with white spots on skins, Good interior blending, Nice packer, Uniformity of shape a little uneven, Nice firm solid onion, Firmness even, Small to medium run size a little uneven, Longer term storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2020 - continued

Catskill: *Seminis sample*, Good appearance, Good tight neck finish, Medium sized necks uneven, Average to thicker skins, Nice skin quality, Exterior colour fairly even, Average interior blending, Good packer, Uniformity of shape a little even, Good firm onion, Firmness even, Medium to large run size a little uneven, Mid to longer term storage onion.

Pocono: *Stokes sample*, Average appearance, Average to good tight neck finish, Medium sized necks, Average skin thickness, Nice skin quality, Exterior colour a little uneven, Odd one with yellowing on skins, Average interior blending, Good packer, Uniformity of shape uneven, Nice firm solid onion, Firmness even, Medium run size uneven, Longer term storage onion.

Braddock: *Bejo sample*, Good appearance, Average tight neck finish, Medium sized necks, Average skin thickness, Nice skin quality, Odd one with skin or basal plate rot, Exterior colour fairly even, Odd one with yellowing on skins, Good interior blending, Good packer, Uniformity of shape very uneven, Good firm onion, Firmness a little uneven, Medium to large run size a little uneven, Mid to longer term storage onion, Skin quality stands out.

Y 604: *Seminova sample*, Fair to average appearance, Good tight neck finish, Neck finish uneven, Small to medium sized necks, Average skin thickness, Average skin quality, A few with skin cracking, Odd one with skin rot, Exterior colour slightly uneven, Odd one with white spots on skins, Poor to average interior blending, Average packer, Uniformity of shape uneven, Average firm onion, Firmness even, Run size very uneven, Mid to longer term storage onion.

Stanley: *Clifton sample*, Good appearance, Good tight neck finish, Medium sized necks, Average skin thickness, Pretty good skin quality, Odd one with skin cracking, Exterior colour a little even, Odd one with yellowing on skins, Average interior blending, Good packer, Uniformity of shape uneven, Nice firm solid onion, Firmness even, Medium run size uneven, Longer term storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2020 - continued

Haeckero: *Hazera sample*, Good appearance, Average tight neck finish, Medium sized necks, Thicker skins, Nice skin quality, Exterior colour even, Odd one with yellowing on skins, Average interior blending, Good packer, Uniformity of shape uneven, Nice firm solid onion, Firmness even, Smaller run size uneven, Longer term storage onion.

37 118: *Hazera sample*, Average appearance, Average tight neck finish, Neck finish bit rough, Medium sized necks, Thicker skins, Nice skin quality, Odd one with basal plate rot, Exterior colour uneven, Odd one with yellowing on skins, Average to good interior blending, Okay packer, Uniformity of shape very uneven, Average firmness, Firmness a little uneven, Run size very uneven, Mid-term storage onion.

Sat 1: *Seminova sample*, Good appearance, Average to good tight neck finish, Neck finish a little uneven, Small to medium sized necks, Average skin thickness, Pretty good skin quality, Odd one with skin cracking, Exterior colour a little uneven, Some greening of scales, Average interior blending, Good packer, Uniformity of shape a little even, Good firm onion, Firmness a little uneven, Small to medium run size uneven, Mid to longer term storage onion, Nice average onion.

Champ: *Clifton sample*, Good appearance, Average neck finish, Neck finish uneven, Small to medium sized necks, Average skin thickness, Nice skin quality, Exterior colour even, Odd one with white spots on skins, Average interior blending, Good packer, Uniformity of shape a little even, Nice firm solid onion, Firmness even, Run size very uneven, Longer term storage onion.

37 120: *Hazera sample*, Good appearance, Average tight neck finish, Some neck finishes a bit rough, Medium sized necks, Average skin thickness, Nice skin quality, Odd one with skin rot, Exterior colour a little uneven, Odd one with white spots on skins, Poor to average interior blending, Good packer, Uniformity of shape a little even, Good firm onion, Firmness a little uneven, Larger run size a little uneven, Mid-term storage onion. **…/continued**

ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2020 - continued

Almagro: *Bejo sample*, Bit rough appearance, Great tight neck finish, Small sized necks, Average skin thickness, Poor to fair skin quality, A lot of skin cracking a concern, Exterior colour a little uneven, Good interior blending, Okay packer, Uniformity of shape a little uneven, Average firmness, Firmness even, Medium to large run size uneven, Mid to longer term storage onion.

Outlander: *American Takii sample*, Fair appearance, Perfect tight neck finish, Small sized necks, Thin skins, Poor to fair skin quality, A lot of skin cracking a concern, Exterior colour a little uneven, A few with greening of scales, Average interior blending, Okay packer, Uniformity of shape even, Average firmness, Firmness uneven, Small run size uneven, Early to mid-term storage onion, Early onion with skin concerns.

Mondella: *Bejo sample*, Good appearance, Average tight neck finish, Medium sized necks, Average to thicker skins, Nice skin quality, Exterior colour even, Odd one with white spots on skins, Good interior blending, Nice packer, Uniformity of shape even, Nice firm solid onion, Firmness even, Run size uneven, Longer term storage onion.

Highlander: *American Takii sample*, Fair appearance, Perfect tight neck finish, Small sized necks, Thin skins, Poor skin quality, A lot of skin cracking a concern, Lighter exterior colour even, Some greening of scales, Average interior blending, Okay packer, Uniformity of shape uneven, Softer onion, Firmness a little uneven, Large run size uneven, Suspicion of doubles, Early storage onion.

Frontier: *American Takii sample*, Good appearance, Good to great tight neck finish, Small sized necks, Average skin thickness, Nice skin quality, Odd one with skin cracking, Exterior colour a little even, Odd one with greening of scales, Average to good interior blending, Good packer, Uniformity of shape even, Good firm solid onion, Firmness even, Small run size uneven, Mid-term storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2020 - continued

Oneida: *Bejo sample*, Good appearance, Good tight neck finish, Small sized necks, Average skin thickness, Nice skin quality, Odd one with skin cracking, Exterior colour even, Good interior blending, Odd one with yellowing on skins, Average to good interior blending, Nice packer, Uniformity of shape even, Average firmness, Firmness a little uneven, Run size uneven, Mid-term storage onion.

Brandt: *Stokes sample*, Average appearance, Average to good tight neck finish, Neck finish uneven, Small to medium sized necks, Average skin thickness, Pretty good skin quality, Odd one with skin cracking, Exterior colour uneven, Some greening of scales, Good interior blending, Average packer, Uniformity of shape a little uneven, Average firmness, Firmness uneven, Small run size uneven, Mid-term storage onion.

Nogal: *Enza Zaden sample*, Poor appearance, Poor neck finish loose, rough & ripped, Large sized necks, Thicker skins, Pretty good skin quality, Skin and basal plate rot, Dark exterior colour even, Some yellowing or white spots on skins, Uneven interior blending, Okay packer, Uniformity of shape even, Good firm onion Firmness even, Extra large run size uneven, Long term storage onion, Rough samples.

Cartier: *Bejo sample*, Nice appearance, Good tight neck finish, Small to medium sized necks, Average skin thickness, Nice skin quality, Exterior colour very even, Average interior blending, Odd one with white spots on skins, Uneven interior blending, Nice packer, Uniformity of shape even, Good firm solid onion, Firmness even, Small run size a little uneven, Long term storage onion.

LONG TERM AVERAGES OF ONION CULTIVAR TRIALS

Cultivar	Source	# Years Evaluated	Yield bu/A	% Marketable	% Jumbos <3"	Days to Maturity	Firmness In*	Firmness out*	Neck Finish	Score	% Onion Maggot Damage	# of Seeders
RIDGELINE	Tak	5	1295	93.7	20.1	86	9.8	7.4	7.3	6.90	2.8	0.0
CARTIER	Bejo	5	729	78.7	3.0	88	10.0	8.7	7.7	7.55	7.1	0.0
HIGHLANDER	Tak	16	1041	86.0	13.4	93	8.5	6.0	9.3	6.22	3.6	0.0
ALPINE	Tak	11	1035	89.6	14.4	95	8.5	5.9	9.6	6.24	4.9	0.0
TREKKER	Tak	11	1084	92.9	8.8	100	9.8	8.3	7.5	7.51	3.3	0.0
NORSTAR	Tak	28	1079	91.2	12.5	102	8.2	5.9	8.6	6.34	4.2	0.0
SADDLEBACK	Sem	5	1194	93.1	21.5	104	9.6	7.1	7.3	6.56	3.2	0.2
LA SALLE	Sem	11	1153	92.4	15.6	105	9.4	7.5	7.3	6.71	6.9	0.3
RICOCHET	Sem	9	1134	96.8	30.5	105	9.6	8.0	7.5	7.11	7.8	0.5
ARSENAL	Sem	13	1232	97.6	15.0	106	9.6	8.1	7.6	7.16	5.2	1.7
FRONTIER	Tak	27	1133	93.6	9.6	106	9.8	8.1	8.0	7.60	4.2	0.0
TRAILBLAZER	Tak	13	1076	91.9	16.2	106	9.7	8.3	7.9	7.40	4.3	0.0
MOUNTAINEER	Tak	9	1084	96.9	21.3	107	9.5	8.2	7.9	7.65	6.0	0.0
TRAVERSE	Tak	5	1220	94.9	12.1	107	9.5	8.0	7.4	7.49	2.8	0.0
CATSKILL	Sem	6	1199	92.8	20.8	108	9.7	7.3	7.3	6.74	6.6	0.0

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	Yield bu/A	% Marketable	% Jumbos <3"	Days to Maturity	Firmness In*	Firmness out*	Neck Finish	Score	% Onion Maggot Damage	# of Seeders	Leaf Length (cm)
CORONA	Bejo	23	1230	86.6	20.0	108	9.5	7.1	7.1	6.26	5.8	0.0	65
PATTERSON	Bejo	14	1203	94.2	14.5	108	9.8	8.6	7.0	7.42	5.6	0.7	67
TAHOE	Bejo	9	1214	95.0	20.0	108	9.6	8.2	7.1	7.32	6.5	1.9	66
BRADDOCK	Bejo	13	1276	91.1	17.3	111	9.6	7.6	6.5	6.84	2.7	0.6	67
CHAMP	CF	7	1167	92.4	15.6	111	9.9	8.7	7.2	7.57	10.0	0.0	68
MILESTONE	Tak	19	1350	96.0	24.0	111	9.5	7.4	6.7	7.16	4.5	0.1	65
POCONO	Sem	7	1225	92.1	20.9	111	9.7	7.7	6.9	6.65	7.1	0.0	70
STANLEY	CF	22	1202	92.4	17.7	111	9.8	8.5	6.5	7.13	4.7	0.9	66
FORTRESS	Sem	27	1081	95.5	9.6	112	9.7	7.9	6.7	7.32	3.8	1.2	65
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	15	1270	93.6	21.1	113	9.8	8.5	6.7	7.22	3.4	2.7	66
PRINCE	Bejo	24	1233	93.6	22.2	115	9.8	8.6	6.2	7.20	5.4	0.4	66
CROCKETT	Bejo	9	1291	92.0	19.2	118	9.9	8.6	5.4	7.08	6.2	1.5	72

Listed in order of Days to Maturity. * 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average

* Firmness: A = Evaluated at time of Harvest B = Evaluated in December

MAIN ONION STORAGE TRIAL 2019 - 2020

Cultivar	Source	% Marketable	% Weight Loss	% Sprouts	% Rot	% Soft	Firmness In **	Firmness Out **	% Sprouting at Base	% Sprouting at Top
REDSTONE	Haz	92.4 a*	3.5 a	2.4 a	0.2 a	0.6 ab	10.0 a	7.0 b-f	0.5 a	5.7 abc
HAECKERO	Haz	90.2 ab	5.8 c-i	2.2 a	1.2 abc	0.0 a	9.8 ab	7.5 abc	1.2 a	0.5 a
HADES	SN	89.5 ab	4.8 a-e	2.4 a	2.7 a-h	0.0 a	9.3 cde	7.0 b-f	2.0 ab	1.3 a
TRAIL BLAZER MYCO + INICII	SN	88.8 abc	4.3 ab	5.1 a	2.0 a-f	0.0 a	9.8 ab	7.5 abc	2.0 ab	2.7 ab
TRAIL BLAZER INICIUM	SN	88.6 abc	4.5 a-d	3.8 a	2.0 a-f	0.1 a	10.0 a	7.0 b-f	4.2 a-d	3.3 abc
ARMSTRONG	CF	88.0 a-d	5.3 b-h	4.2 a	1.3 abc	0.2 a	10.0 a	7.0 b-f	3.2 abc	1.0 a
PATTERSON	Bejo	87.8 a-d	4.4 abc	5.7 a	1.5 abc	0.3 ab	9.8 ab	7.7 ab	2.2 ab	1.0 a
TRAIL BLAZER	Tak	87.7 a-d	4.6 a-e	6.1 a	0.8 abc	0.0 a	10.0 a	7.7 ab	8.7 a-e	6.7 abc
TREKKER	Tak	87.2 a-d	5.4 b-i	4.6 a	1.6 a-d	0.2 a	9.8 ab	6.5 d-h	4.0 a-d	3.7 abc
SAFRANE	Bejo	87.0 a-d	5.4 b-i	4.1 a	1.9 a-f	0.8 ab	10.0 a	7.2 a-e	1.3 a	1.7 a
CROCKETT	Bejo	86.3 a-d	5.3 b-i	4.3 a	3.3 a-i	0.0 a	9.5 bcd	8.0 a	1.0 a	0.8 a
Y 621	SN	85.8 a-d	5.6 b-i	2.2 a	5.3 f-j	0.2 a	9.8 ab	7.3 a-d	1.0 a	1.0 a
FORTRESS	Sto	85.7 a-d	6.3 f-i	6.1 a	1.3 abc	0.3 ab	10.0 a	7.3 a-d	32.7 f	14.7 a-e
MILESTONE	Tak	85.1 a-d	4.6 a-e	2.8 a	4.2 c-j	2.5 abc	9.5 bcd	5.0 klm	0.0 a	1.5 a
CHAMP	CF	85.0 a-d	4.9 a-f	8.3 ab	1.1 abc	0.0 a	10.0 a	7.3 a-d	6.7 a-e	1.3 a
STARTER	Haz	84.8 a-e	5.3 b-i	6.5 a	2.2 a-h	0.4 ab	9.3 cde	6.3 e-i	5.7 a-e	1.5 a

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 2019 - 2020

Cultivar	Source	% Marketable	% Weight Loss	% Sprouts	% Rot	% Soft	Firmness In **	Firmness Out **	% Sprouting at Base	% Sprouting at Top
TRAVERSE MYCO + INICIUM	SN	83.9 a-f*	5.0 b-h	8.1 ab	1.6 a-d	0.3 ab	9.5 bcd	6.5 d-h	3.7 a-d	0.5 a
LA SALLE	Sto	83.5 a-f	4.9 a-g	6.1 a	4.2 b-j	0.4 ab	9.7 abc	6.5 d-h	3.3 a-d	2.7 ab
BRADDOCK	Bejo	82.6 a-f	4.6 a-e	10.2 a-d	2.4 a-h	0.3 ab	9.8 abc	6.7 c-g	1.0 a	6.0 abc
CERESCO	Haz	82.2 a-f	5.7 b-i	5.3 a	5.7 hij	0.5 a	8.8 f	6.3 e-i	2.3 abc	1.2 a
STANLEY	CF	81.8 a-f	5.2 b-h	8.2 ab	3.3 a-i	1.3 abc	10.0 a	6.8 b-g	5.5 a-e	2.3 ab
POCONO	Sto	81.6 a-f	6.0 e-i	6.9 a	4.1 b-j	0.1 a	9.7 abc	7.0 b-f	3.3 a-d	3.7 abc
TRAIL BLAZER	SN	81.6 a-f	5.3 b-h	11.2 a-d	1.3 abc	0.3 ab	10.0 a	6.7 c-g	8.7 a-e	7.0 abc
TRAVERSE	SN	80.4 a-h	5.6 b-i	10.7 a-d	1.7 a-e	0.7 ab	9.2 def	6.3 e-i	7.5 a-e	1.0 a
FRONTIER	Tak	80.3 a-h	5.4 b-i	13.1 a-e	1.2 abc	0.1 a	9.8 ab	6.2 f-j	12.0 a-f	7.3 abc
POWELL	Bejo	80.2 a-h	6.5 hi	9.2 abc	3.3 a-i	0.2 a	9.8 ab	6.3 e-i	1.3 a	5.3 abc
TRAVERSE	Tak	80.2 a-h	5.3 b-h	13.6 a-e	0.1 a	0.0 a	9.2 def	6.8 b-g	8.0 a-e	0.5 a
37 120	Haz	79.9 a-h	6.4 ghi	10.9 a-d	2.0 a-g	0.1 a	9.8 ab	6.8 b-g	4.0 a-d	3.3 abc
RIDGE LINE	Tak	78.8 a-h	5.1 b-h	7.0 a	2.7 a-h	5.6 de	9.8 ab	4.8 klm	2.0 ab	1.2 a
CATSKILL	Sem	77.9 a-i	4.8 a-f	14.0 a-f	2.5 a-h	0.0 a	9.5 bcd	6.0 g-j	3.7 a-d	6.0 abc
37 118	Haz	77.8 b-i	5.2 b-h	8.9 ab	5.6 g-j	2.0 abc	9.7 abc	6.3 e-i	3.0 abc	6.0 abc
CARTIER	Bejo	77.1 b-j	5.6 b-i	15.5 a-f	0.6 ab	0.3 ab	10.0 a	7.3 a-d	22.3 a-f	17.7 b-f

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 2019 - 2020

Cultivar	Source	% Marketable	% Weight Loss	% Sprouts	% Rot	% Soft	Firmness In **	Firmness Out **	% Sprouting at Base	% Sprouting at Top
RIDGE LINE	SN	76.1 b-j*	5.7 b-i	7.9 ab	5.7 hij	3.9 cde	9.7 abc	5.5 i-l	4.0 a-d	5.3 abc
SADDLEBACK	Sto	74.4 c-j	5.1 b-h	14.1 a-f	5.2 d-j	0.7 ab	9.5 bcd	6.3 e-i	6.0 a-e	4.0 abc
SV NY 1141	Sem	73.9 d-j	4.6 a-d	12.9 a-e	5.2 e-j	3.2 bcd	9.3 cde	6.0 g-j	1.7 ab	6.7 abc
SV NY 1568	Sem	70.4 e-k	5.1 b-h	7.2 a	12.8 kl	3.8 cde	8.8 f	6.0 g-j	2.8 abc	4.3 abc
PROSPECTOR	Bejo	69.9 f-k	5.2 b-h	21.8 b-f	2.5 a-h	0.0 a	10.0 a	7.7 ab	25.7 c-f	11.2 a-d
DAWSON	Bejo	67.1 g-l	5.3 b-h	27.0 ef	0.2 a	0.0 a	10.0 a	7.2 a-e	14.0 a-f	18.3 c-f
RIDGE LINE INICIUM	SN	67.0 h-l	5.9 d-i	13.0 a-e	7.0 j	6.3 e	10.0 a	4.7 lm	9.3 a-f	8.3 abc
E61L 10156	EZ	63.9 i-m	6.8 h	23.5 c-f	4.2 c-j	0.1 a	9.8 abc	6.2 f-j	25.0 b-f	9.0 abc
ONEIDA	Bejo	63.0 j-m	6.4 ghi	28.0 f	1.0 abc	0.5 ab	8.8 f	6.8 b-g	25.0 b-f	26.7 efg
NORSTAR	Sto	58.5 klm	6.5 hi	26.1 ef	6.8 ij	1.6 abc	9.0 ef	5.3 jkl	28.3 ef	32.7 fg
SV NY 1496	Sem	56.0 klm	5.3 b-h	8.0 ab	15.8 l	14.1 f	9.2 def	5.7 h-k	4.0 a-d	2.2 a
A 1762	SN	54.7 lm	6.4 ghi	23.7 def	13.2 kl	1.1 abc	8.8 f	4.7 lm	26.7 def	26.0 d-g
HIGHLANDER	Tak	50.9 m	5.1 b-h	9.4 a-d	10.6 kl	23.2 g	8.8 f	4.3 m	8.7 a-e	5.3 abc
E61L 10699	EZ	30.3 n	8.3 j	58.6 g	2.4 a-h	0.0 a	9.3 cde	6.3 e-i	75.0 g	36.7 g
TRIAL AVERAGE		**77.5**	**5.4**	**11.1**	**3.6**	**1.7**	**9.6**	**6.5**	**9.2**	**6.9**

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 - 2019-2020

Redstone: *Hazera sample,* Top sprouts just starting 0-2.5 cm, Root sprouts just starting 0-1 cm, Internal & skin rot, Basal plates just starting 2-5%, Firm onion, Firmness slightly uneven, Late storage onion, Stored nice.

Haeckero: *Hazera sample,* Top sprouts just starting 0-1 cm, Root sprouts just starting 0-1 cm, Internal & skin rot, Basal plates just starting 5-25%, Firm onion, Firmness a little uneven, Late storage onion, Stored nice.

Hades: *Seminova sample,* Top sprouts just starting 0-1 cm, Root sprouts just starting 0-1 cm, All skin rot, Basal plates just starting 5-20%, Fairly firm onion, Firmness slightly uneven, Late storage onion, Stored good to nice.

Trailblazer: **Myco + Inicium** *Seminova sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, All skin rot, Basal plates just starting 5-15%, Fairly firm onion, Firmness slightly uneven, Late storage onion, Stored nice.

Trailblazer: **Inicium** *Seminova sample,* Top sprouts light 1-2.5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Odd internal rot, Basal plates just starting 5%, Fairly firm onion, Late storage onion, Stored nice.

Armstrong: *Clifton sample,* Top sprouts just starting 0-1 cm, Root sprouts just starting 0-1 cm, Skin and internal rot, Basal plates just starting & pushing out 5-65%, Fairly firm onion, Firmness uneven, Late storage onion, Stored nice.

Patterson: *Bejo sample,* Top sprouts just starting 0-1 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Some basal plate rot, Odd internal rot, Basal plates just starting & pushing out 20-40%, Fairly firm onion, Firmness slightly uneven, Late storage onion, Stored nice.

.../continued

ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2019-2020 -- continued

Trailblazer: *American Takii sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, Internal & skin rot, Basal plates just starting 20%, Firm onion, Late storage onion, Stored excellent.

Trekker: *American Takii sample,* Top sprouts just starting to moderate 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Odd internal rot, Basal plates just starting 10-15%, Fairly firm onion, Firmness slightly uneven, Mid to late storage onion, Stored good.

Safrane: *Bejo sample,* Top sprouts light 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Some internal rot, Basal plates just starting 10-15%, Fairly firm onion, Firmness uneven, Late storage onion, Stored nice.

Crockett: *Bejo sample,* Top sprouts just starting 0-1 cm, Root sprouts just starting 0-1 cm, Internal & skin rot, Odd neck rot, Basal plates just starting & pushing out 5%, Firm onion, Late storage onion, Stored excellent.

Y 621: *Seminova sample,* Top sprouts just starting 0-1 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Some internal rot, Basal plates just starting & pushing out 10-75%, Fairly firm onion, Late storage onion, Stored nice.

Fortress: *Stokes sample,* Top sprouts just starting to moderate 0-2.5 cm, Root sprouts just starting to heavy 0-2.5 cm, Root sprouts very uneven, Skin and internal rot, Basal plates just starting 10-25%, Fairly firm onion, Mid to late storage onion, Stored nice, One replicate stored poor.

Milestone: *American Takii sample,* Top sprouts just starting 0-1 cm, Majority skin rot, Some internal rot, Basal plates pushing out 40-70%, Firmness soft, Early to mid storage onion, Stored a little poor to fair.

.../continued

ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2019-2020 -- continued

Champ: *Clifton sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, Skin and internal rot, Basal plates just starting & pushing out 30-70%, Fairly firm onion, Firmness slightly uneven, Mid to late storage onion, Stored good.

Starter: *Hazera sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, Internal & skin rot, Basal plates just starting & pushing out 5-20%, Fairly firm onion, Firmness slightly uneven, Mid to late storage onion, Stored nice.

Traverse: *Seminova sample,* Top sprouts just starting 0-1 cm, Root sprouts just starting 0- 1 cm, Majority skin rot, Some internal rot, Basal plates just starting & pushing out 20-80%, Firmness okay, Mid to late storage onion, Stored okay to good.
Myco + Inicium

La Salle: *Stokes sample,* Top sprouts just starting to light 0-2.5 cm, Majority skin rot, A few internal rot, Basal plates just starting 10-25%, Fairly firm onion, Firmness slightly uneven, Mid to late storage onion, Stored good to nice.

Braddock: *Bejo sample,* Top sprouts light 1-2.5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Odd internal and neck rot, Basal plates just starting & pushing out 10-35%, Fairly firm onion, Firmness slightly uneven, Mid to late storage onion, Stored good.

Ceresco: *Hazera sample,* Top sprouts just starting to light 0-1 cm, Majority skin rot, Odd internal & neck rot, Basal plates just starting 10-15%, Firmness slightly uneven, Mid to late storage onion, Stored good.

.../continued

ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2019-2020 -- continued

Stanley: *Clifton sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Some internal rot, Basal plates just starting & pushing out 10-20%, Fairly firm onion, Firmness slightly uneven, Late storage onion, Stored good.

Pocono: *Stokes sample,* Top sprouts light 1-2.5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Odd internal rot, Basal plates just starting & pushing out 15-50%, Okay firmness, Firmness slightly uneven, Mid storage onion, Stored okay.

Trailblazer: *Seminova 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 10-60%, Fairly firm onion, Firmness slightly uneven, Mid to late storage onion, Stored good.

Traverse: *Seminova sample,* Root sprouts just starting 0- 1 cm, Majority skin rot, Some internal rot, Basal plates just starting & pushing out 20-50%, Firmness okay, Mid storage onion, Stored okay to good.

Frontier: *American Takii sample,* Top sprouts just starting to moderate 0-2.5 cm, A few root sprouts light 0-1 cm, Majority internal rot, Odd skin rot, Basal plates just starting 10-35%, Firmness okay, Firmness uneven, Mid storage onion, Stored good.

Powell: *Bejo sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, Internal & skin rot, Odd neck rot, Basal plates just starting 10-40%, Firmness slightly soft, Firmness slightly uneven, Mid storage onion, Stored okay.

.../continued

ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2019-2020 -- continued

Traverse: *American Takii sample,* Top sprouts just starting 0-1 cm, Root sprouts just starting 0-1 cm, Odd neck rot, Basal plates pushing out 40-50%, Fairly firm onion, Firmness slightly uneven, Mid storage onion, Stored good.

37 120: *Hazera sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Odd internal & neck rot, Basal plates just starting 5-15%, Firmness uneven, Mid storage onion, Stored good.

Ridgeline: *American Takii sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Odd internal rot, Basal plates pushing out 45-70%, Soft onion, Firmness uneven, Early storage onion, Stored a little poor.

Catskill: *Seminis sample,* Top sprouts just starting to moderate 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Some internal rot, Basal plates just starting & pushing out 10-45%, Okay firmness, Firmness uneven, Mid storage onion, Stored fair to good.

37 118: *Hazera sample,* Top sprouts just starting to moderate 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Odd internal rot, Basal plates just starting 15-20%, Firmness very uneven, Mid to late storage onion, Stored okay.

Cartier: *Bejo sample,* Top sprouts just starting to moderate 0-5 cm, Top sprouts slight concern Root sprouts just starting 0-1 cm, Majority internal rot, Odd neck rot, Basal plates just starting & pushing out 5-75%, Firm onion, Late storage onion, Stored nice, One replicate stored poor.

Ridgeline: *Seminova sample,* Top sprouts light to moderate 1-2.5 cm, Root sprouts just starting 0-1 cm, Internal & skin rot, Rot is a slight concern, Basal plates just starting & pushing out 25-30%, Firmness slightly soft, Firmness uneven, Early to mid storage onion, Stored a little poor.

.../continued

ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2019-2020 -- continued

Saddleback: *Stokes sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Odd internal rot, Basal plates just starting 15-30%, Firmness okay, Firmness slightly uneven, Mid storage onion, Stored good.

SV NY 1141: *Seminis sample,* Top sprouts just starting to moderate 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Odd internal rot, Basal plates just starting 30-40%, Firmness slightly soft, Firmness uneven, Early to mid storage onion, Stored okay.

SV NY 1568: *Seminis sample,* Top sprouts light 0-5 cm, Top sprouts uneven, Root sprouts just starting 0-1 cm, Majority skin rot, Odd internal rot, Basal plates pushing out 65-80%, Firmness slightly soft, Firmness uneven, Early storage onion, Stored a little poor, Internal ring rot issues.

Prospector: *Bejo sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting to moderate 0-2.5 cm, Internal & skin rot, Basal plates just starting & pushing out 5-75%, Firm onion, Late storage onion, Stored good.

Dawson: *Bejo sample,* Top sprouts light to moderate 1-2.5 cm, Root sprouts just starting 0-1 cm, Internal rot, Basal plates just starting 5-55%, Fairly firm onion, Firmness slightly uneven, Late storage onion, Stored good.

Ridgeline: *Seminova sample,* Top sprouts light 1-2.5 cm, Top sprouts uneven, Root sprouts just starting to light 0-1 cm, Majority skin rot, Some internal rot, Basal plates just starting & pushing out 20-65%, Soft onion, Firmness uneven, Early to mid storage onion, Stored a little poor.

Inicium

.../continued

ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2019-2020 -- continued

E61L 10156: *Enza Zaden sample,* Top sprouts just starting to light 1-2.5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Odd internal rot, Basal plates just starting & pushing out 15-40%, Slightly firm, Firmness uneven, Early to mid storage onion, Stored okay.

Oneida: *Bejo sample,* Top sprouts just starting to light 0-2.5 cm, Top sprouts slight concern, Root sprouts just starting 0-1 cm, Mostly internal rot, Some skin rot, Basal plates just starting 20-25%, Firmness uneven, Mid storage onion, Stored good.

Norstar: *Stokes sample,* Top sprouts light to moderate 1-2.5cm, Top sprouts uneven, Root sprouts just starting to light 0-1 cm, Top & root sprouts slight concern, Majority skin rot, Odd internal rot, Basal plates pushing out 30-70%, Firmness slightly soft, Firmness uneven, Early storage onion, Stored a little poor.

SV NY 1496: *Seminis sample,* Top sprouts just starting to light 0-2.5 cm, Majority skin rot, Odd internal rot, Basal plates pushing out 30-65%, Firmness soft, Firmness uneven, Early storage onion, Stored a little poor.

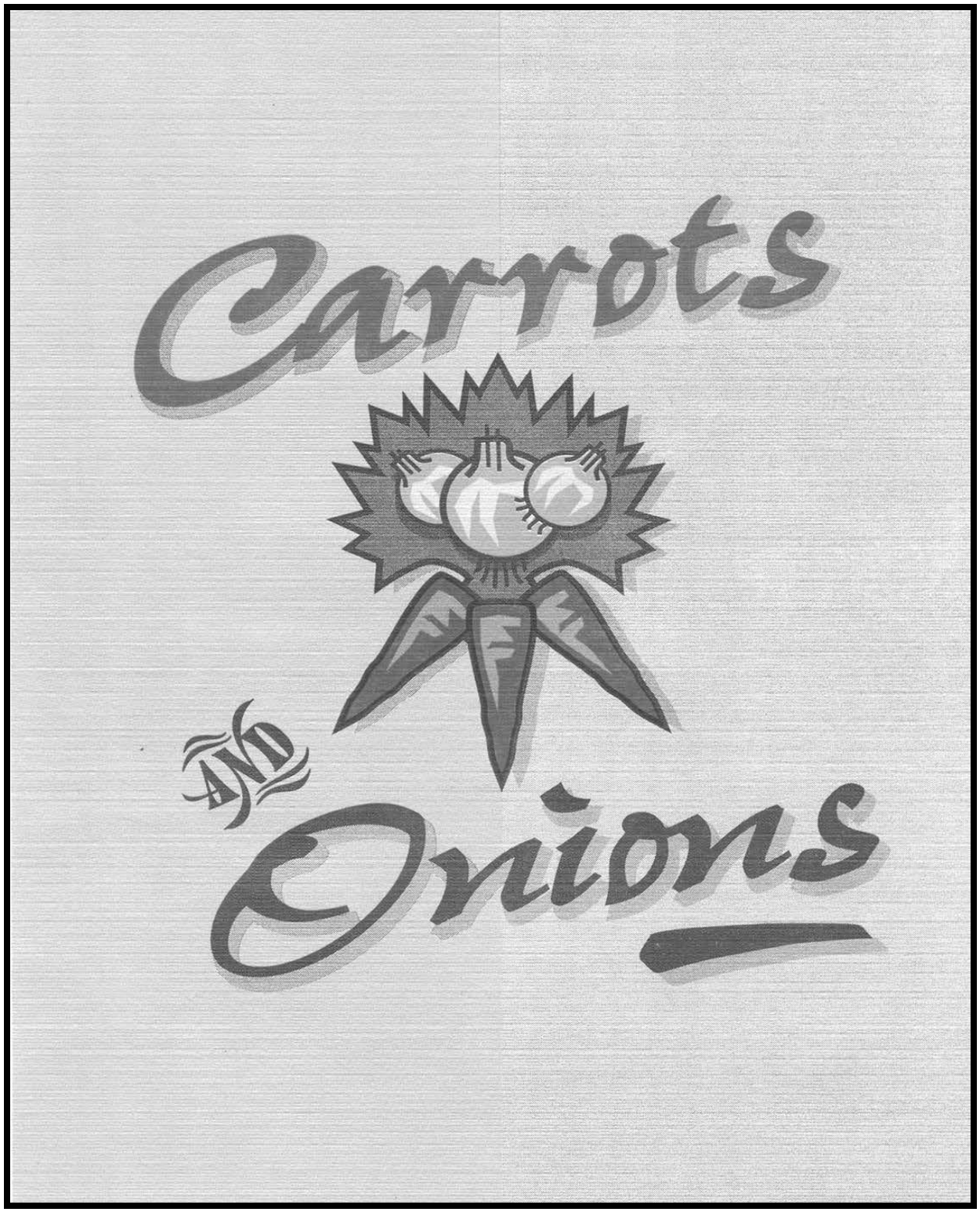
A 1762: *Seminova sample,* Top sprouts light to heavy1<5 cm, Top sprouts uneven, Top sprouts are a concern, Root sprouts light to moderate 1-2.5 cm, Majority skin rot, Odd internal rot, Rot is a concern, Basal plates just starting & pushing out 35-60%, Soft onion, Firmness slightly uneven, Early storage onion, Stored poor.

Highlander: *American Takii sample,* Top sprouts light to moderate1-5 cm, Top sprouts uneven, Root sprouts just starting to moderate 0-2.5 cm, Majority skin rot, Odd internal rot, Basal plates pushing out 35-75%, Firmness soft, Early storage onion, Not a storage onion, Stored poor.

.../continued

ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2019-2020 -- continued

E61L 10699: *Enza Zaden sample*, Top sprouts light to moderate 1-2.5 cm, Top sprouts uneven, Root sprouts just starting to moderate 0-2.5 cm, Top & root sprouts are a concern, Majority internal rot, Some skin rot, Odd neck rot, Basal plates just starting & pushing out 60-80%, Slightly firm, Firmness uneven, Early to mid storage onion, Stored poor.


Carrots
AND
Onions

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
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
TRAILBLAZER	Tak	12	82.9	5.2	11.1	9.73	7.54
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
LA SALLE	Sem	11	82.7	6.3	10.8	9.37	6.56
PATTERSON	Bejo	12	82.1	5.9	11.3	9.83	7.60
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
CHAMP	Sol	6	80.0	5.5	13.7	9.90	7.60
TRAPPS #8	E.J.	9	79.9	8.9	11.3	NA	6.35
STANLEY	Sol	21	78.8	6.8	13.7	9.84	7.21
TREKKER	Tak	10	78.2	7.1	14.1	9.87	6.55
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
BRADDOCK	Bejo	15	76.2	6.4	17.1	9.50	6.74
LIVINGSTON	Sol	13	76.1	6.9	13.8	9.70	6.90
FORTRESS	Sem	26	75.5	8.1	16.3	9.57	6.89

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
SAFRANE	Bejo	13	75.4	6.5	17.1	9.78	7.28
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
POCONO	Sem	6	73.3	6.5	19.3	9.60	6.48
TAMARA	Bejo	9	71.9	9.9	21.8	9.85	6.75
MILESTONE	Tak	18	71.2	6.3	21.6	9.54	5.82
CROCKETT	Bejo	8	70.7	7.4	21.1	9.88	7.58
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
TRAVERSE	Tak	4	69.3	6.7	23.1	9.38	6.53
CATSKILL	Sem	5	69.2	6.4	24.0	6.99	5.96
FRONTIER	Tak	25	68.5	7.6	24.7	9.82	7.09
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	28	51.7	9.8	40.1	8.26	4.71

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 – 2020

Favourable weather conditions in mid April allowed the ground frost to thaw and by the end of April the soil was satisfactory for transplanting onions. Onion transplanting in the Holland Marsh began the last week of April and was pretty much completed by 10th May. Compared to the previous 10-year average, air temperatures in 2020 were above average for July (23.3°C), average for June (19.2°C), August (20.6°C), and below average for May (11.6°C) and September (15.0°C). The 10-year average temperatures were: May 14.2°C, June 18.5°C, July 21.5°C, August 20.3°C and September 16.5°C. Monthly rainfall was above the 10-year average for August (140 mm), average for September (65 mm), and below average for May (38 mm), June (77 mm) and July (58 mm). The 10-year rainfall averages were: May 73 mm, June 103 mm, July 84 mm, August 76 mm and September 62 mm.

The red cultivar trial was seeded, two seeds/cell, into 288-cell plugs trays filled with ASB soilless mix on 19 & 20 March. The trays were placed on ebb & flow benches in the greenhouse with the daytime temperature set at 65°C and nighttime temperature set at 68°C. The onion plants were clipped regularly to a height of 8 cm to promote sturdy plants. On 8 May the transplants were placed outside on a wagon to harden off. Even though soil conditions were satisfactory, the weather was less then ideal. Air temperatures were below seasonal, with a mix of sun and cloud and it was a bit windy for the first 15 days of May. The month of May recorded below average rainfall but because the temperatures were cool, soil moisture remained adequate. During the first thirteen days of May, daytime air temperatures fluctuated from the low teens to single digits and nighttime air temperatures went below 0 °C several times. A decision was made to hold the transplants until more seasonal temperatures were forecast. The onions were transplanted on 13, 14 and 15 May which was 7 days later than would be standard. For onion maggot control a drench of Pyrinex 480 EC at 2.5 mL/5 L water per six meters of row was applied on 26 and 27 May.

For the first two weeks after transplanting, daytime air temperatures fluctuated from the high teens to the high twenties and nighttime air temperatures fluctuated from 1.2 - 16°C. The transplants established slowly and plant vigor was poor. By 28 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 late May and several herbicide sprays of Goal + Pardner were applied over a ten-day period. Weed flushes remained a problem throughout the entire season. The trial was hand-weeded several times to keep it free from weeds. For the entire growing season onion growth was steady but slightly unsatisfactory and 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.

…/continued

RED ONION CULTIVAR TRIAL SEASON SUMMARY - 2020 – continued

On-station, monitoring for onion maggot fly emergence began early with the first flies detected on 21 May. There were three peaks in onion maggot fly numbers during the monitoring period. Onion maggot fly counts peaked at 3 flies/trap/day on 28 June, 4.6 flies/trap/day on 26 June and 11.8 flies/trap/day on 23 July. After the third peak, onion maggot numbers never reached over 2 flies/trap/day. Higher onion maggot fly counts appeared to be positively correlated to a slightly higher trial average for onion maggot damage. Thrips were first found on 26 June and were present through August. Onion thrips numbers in the red onion variety trial reached a high of 1.2 thrips/leaf on 26 June and remained at this level for a couple of weeks. Several insecticide and irrigation water applications lowered the thrips numbers below threshold. Then thrips counts climb above threshold to 1.2 thrips/leaf on 23 July. The second application of Movento and additional insecticides lowered thrips numbers below threshold for the remainder of the season. Stemphylium leaf blight was found on 29 June and several fungicide applications (see Onion Management Procedures) kept severity at an acceptable level. Fungicide applications were applied to control downy mildew and botrytis, and environmental conditions were mainly unfavourable for these fungal diseases and neither downy mildew nor botrytis were observed in the trial. No onions with bacterial rot were found in the variety trial.

Bulb development started in mid July with most bulb sizing occurring in late July. Cultivars Red Spring and Monastrell were the first to lodge starting on 20 and 24 July respectively. By 5 August two thirds of the cultivars had reached full maturity with at least 85% lodged. The average days to harvest for the 2020 season was 78 days from transplant. This was twelve days sooner then in the 2019 season. The third replicate of onions matured significantly sooner then the first replicate. The onion tops dried down in a satisfactory time frame. No seeders were found. A sample from each cultivar was pulled on 8 September for judging and comparison during Grower Field Week. By this time, all cultivars had lodged, and were 90-100% desiccated. All cultivars matured naturally resulting in good neck finishes when yield samples were harvested on 16 September. Harvest samples from each cultivar were placed in storage on 8 October and were cured artificially for approximately 48 hours.

At evaluation on 2-5 November, quality was good and yields were slightly below the desired bushel per acre. For almost all the cultivars the majority of bulbs were in the 2½ - 3" size range. The average yield of 823 bu/A was 400 bu/A less than the yield in 2019 and was like the 2017 average yield. Yield was significantly different between all three replicates. The second replicate had the highest yield (925 bu/A) and the third replicate had the lowest (715 bu/A) average yield. The average percentage of jumbos (>3" diameter) was 20%. This is a drop of 30% from 2019. Cultivar SV4643, SV NT 1298 and Red Nugent had the most bulbs in the >3" category. Uniformity of shape was variable with Barolo having the best uniformity and Red Nugent the poorest. Uniformity of size was variable, with some cultivars receiving a good rating while others a poor rating. **…/continued**

RED ONION CULTIVAR TRIAL SEASON SUMMARY - 2020 – continued

Five of the 13 cultivars evaluated had a very respectable 95% percent marketable or greater, and the average percent marketable for all cultivars was 88.5%. The majority of culls were either rot or doubles. Skin quality varied among cultivars. Most cultivars had good skin attachment, with only some skin cracking 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 a higher percentage of double or multiple centers compared to 2019. 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 have maintained good firmness. Maggot damage in the evaluation samples was minimal and ranged from 0.4 - 8.6% with a trial average of 3.9%.

RED ONION TRANSPLANT CULTIVAR TRIAL – 2020

MANAGEMENT PROCEDURES

Seeded:

On 19 & 20 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 + 7 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 7 July.

Transplanted:

Three replications were planted in the field on 13, 14 and 15 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 on 11 May, 2 days before transplanting.

Weed Control:

Post-emergence:
1 application: **PROWL H2O** 6.0 L/ha on 28 May.
2 applications: **PARDNER** at 70 ml/ha and **GOAL** at 70 ml/ha and Manganese at 1.0 kg/ha on 1 and 4 June.
1 application: **PARDNER** at 150 ml/ha and **GOAL** at 150 ml/ha and Manganese at 2.0 kg/ha on 8 June.
1 application: **SELECT** at 375 ml/ha + **AMIGO** at 1.5 L/ha on 16 June.

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ONION CULTIVAR TRIAL - 2020 - continued

Minor Elements:

Ten foliar sprays: Calcimax on 5, 12, 18 and 26 June, 2 July (2.0 L/ha) and 10, 17, 23 & 27 July, 7 August (3.0 L/ha)
Nine foliar sprays: Mag Max on 18 & 26 June, 2 & 10 July (2.0 L/ha) and 17, 23 & 31 July, 13 August (3.0 L/ha)
Seven foliar sprays: Suprafeed on 2 July (2.0 kg/ha) and 10, 17, 23 and 27 July and 7, 13 August (3.0 kg/ha)
Six foliar sprays: Alexin on 10, 17, 23 & 27 July and 7, 13 August (3.0 L/ha)
Four foliar sprays: Manganese Sulfate on 12 June (1.0 kg/ha) and 26 June, 2 & 10 July (2.0 kg/ha)
Four foliar sprays: 20-20-20 on 5 & 12 June (2.0 L/ha) and 18 & 26 June (2.5 kg/ha)
Four foliar sprays: Zinc Max on 7 August (1.0 L/ha), June 5 & 26 (2.0 L/ha), and 27 July (3.0 L/ha)
Two foliar sprays: Mancozin on 18 June (2.0 L/ha) and 23 July (3.0 L/ha)
One foliar spray: Nutri Bor on 13 August (1.5 L/ha)
One foliar spray: Copper Max and 13 August (2.0 L/ha)
One foliar spray: Epsom Salt on 12 June (1.0 kg/ha)

Insect and Disease Control:

According to IPM recommendations.

DIBROM at 500 ml/ha and Minor Elements on June 18.
LUNA TRANQUILITY at 1.2 L/ha + **UP-CYDE** at 280 ml/ha and Minor Elements on 26 June.
MOVENTO at 365 ml/ha + **AGRAL 90** at 1.0 L/ha on 29 June.
SERCADIS at 333 ml/ha + **DELEGATE** at 200 g/ha and Minor Elements on 2 July.
APROVIA at 750 ml/ha + **SILENCER** at 188 ml/ha and Minor Elements on 10 July.
MOVENTO at 365 ml/ha + **AGRAL 90** at 1.0 L/ha on 14 July.
QUADRIS TOP at 1.0 L/ha + **DITHANE DG** at 2.0 kg/ha + **SILENCER** at 188 ml/ha and Minor Elements on 17 July.
LUNA TRANQUILITY at 1.2 L/ha + **DITHANE DG** at 2.0 kg/ha + **DELEGATE** at 336 g/ha and Minor Elements on 23 July.
APROVIA at 750 ml/ha + **RIDOMIL MZ** 2.25 kg/ha + **AGRI-MEK SC** at 175 ml/ha and Minor Elements on 31 July.
QUADRIS TOP at 1.0 L/ha + **DITHANE DG** at 2.0 kg/ha and Minor Elements on 7 August.
SERCADIS at 666 ml/ha + **RIDOMIL MZ** 2.25 kg/ha and Minor Elements on 13 August.
QUADRIS TOP at 1.0 L/ha + **RIDOMIL MZ** 2.25 kg/ha and Minor Elements on 20 August.

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Harvest:

The trial was pulled on 2 September and topped on 16 September. The trial was placed in a forced air and temperature controlled storage 8 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 31 July.

EVALUATION PROCEDURES

The cultivars were evaluated 2-5 November 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 bu/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

Skin Attachment:

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 - 2020 - 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 - 2020 - 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 16 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 2020 season:

7 May in the amount of ¼ inch
22 May in the amount of ½ inch
27 May in the amount of ½ inch
9 June in the amount of 1 inch
8 July in the amount of 1 inch
30 July in the amount of 1 inch

RED ONION TRANSPLANT CULTIVAR TRIAL - 2020

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
RUBY RING	Tak	77 abc*	0.0 a	1 cd	5 f	42 a	27 bc	5.0 a-d
E61L 10657	EZ	77 abc	0.0 a	2 bcd	22 bc	38 abc	13 de	5.1 a-d
RED HAWK	Bejo	76 abc	0.0 a	0 d	16 cd	32 a-e	24 bcd	5.0 bcd
RED STONE	Haz	79 ab	0.0 a	0 d	1 f	20 g	54 a	5.2 abc
RUBILLION	Tak	76 abc	0.0 a	0 d	3 f	36 abc	34 b	5.0 a-d
RED CARPET	Bejo	78 abc	0.0 a	1 cd	16 cde	33 a-d	24 bcd	5.1 a-d
SV 4643	Sto	81 a	0.0 a	4 b	31 a	32 a-f	9 e	5.3 a
RED MOUNTIAN	Bejo	73 cde	0.0 a	0 d	7 ef	36 abc	24 bcd	4.8 def
BAROLO	EZ	80 a	0.0 a	0 d	16 cde	39 ab	17 cde	5.2 abc
RED NUGENT	Sto	74 bcd	0.7 a	8 a	29 ab	19 g	10 e	4.9 cde
SV NT 1298	Sem	77 abc	0.0 a	4 b	30 ab	27 c-g	7 e	5.0 a-d
BAROLO Inicium	SN	80 ab	0.0 a	0 d	14 cde	38 abc	15 cde	5.2 abc
BLUSH	Bejo	70 de	0.0 a	0 d	3 f	21 fg	35 b	4.6 ef
RED BULL	Bejo	69 e	0.0 a	0 d	9 def	22 efg	26 bc	4.5 f
MONASTRELL	EZ	78 abc	0.0 a	0 d	5 f	29 b-g	23 bcd	5.1 a-d
RED SPRING	Bejo	80 a	0.0 a	3 bc	16 cde	24 d-g	6 e	5.3 ab
Trial Average		**77**	**0**	**1**	**14**	**31**	**22**	**5.0**

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 - 2020 - 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 bu/A	% Marketable	Majority of Culls
RUBY RING	Tak	11.19 cd*	0.23 c	1.16 fgh	6.80 a	2.76 bc	825 de	97.8 a	D
E61L 10657	EZ	13.91 b	0.69 bc	5.52 bc	6.08 a	1.33 def	1027 abc	97.4 a	R
RED HAWK	Bejo	12.45 bc	0.11 c	4.23 cd	5.57 ab	2.22 bcd	915 cd	95.6 a	MIX
RED STONE	Haz	8.11 e	0.00 c	0.15 h	2.94 e	4.86 a	599 g	95.4 ab	R
RUBILLION	Tak	8.93 de	0.00 c	0.56 h	5.23 a-d	2.97 b	661 efg	95.2 ab	PW
RED CARPET	Bejo	12.99 bc	0.40 c	4.03 cde	5.94 a	2.38 bcd	962 bcd	94.8 ab	R
SV 4643	Sto	16.44 a	1.28 b	7.86 a	5.42 abc	0.81 ef	1159 a	93.0 abc	DR
RED MOUNTIAN	Bejo	10.82 cd	0.12 c	1.86 e-h	6.38 a	2.20 bcd	797 def	92.7 abc	PW
BAROLO	EZ	13.02 bc	0.11 c	3.68 cde	6.30 a	1.64 c-f	885 cd	90.8 abc	D
RED NUGENT	Sto	16.38 a	3.17 a	7.44 ab	3.35 de	0.93 ef	1122 ab	89.2 abc	D
SV NT 1298	Sem	16.40 a	1.33 b	7.70 ab	5.02 a-d	0.77 ef	1118 ab	88.7 abc	D
BAROLO Inicium	SN	12.73 bc	0.13 c	3.21 d-g	6.00 a	1.42 def	811 de	84.5 bc	D
BLUSH	Bejo	7.91 e	0.00 c	0.66 h	3.44 de	3.15 b	547 g	83.8 c	R
RED BULL	Bejo	9.21 de	0.00 c	2.32 d-h	3.59 cde	2.37 bcd	625 fg	83.0 cd	D
MONASTRELL	EZ	8.22 e	0.00 c	1.04 gh	3.79 b-e	1.79 cde	499 g	72.8 d	R
RED SPRING	Bejo	12.60 bc	0.79 bc	3.33 c-f	3.51 cde	0.53 f	615 fg	61.0 e	SPRT
Trial Average		**11.96**	**0.52**	**3.42**	**4.96**	**2.01**	**823**	**88.5**	

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.

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RED ONION TRANSPLANT CULTIVAR TRIAL - 2020 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Skin Thickness	Skin Attachment	Neck Finish	Overall Score	Score
RUBY RING	Tak	TDHG	7.0 abc*	5.7 bcd	6.3 bc	6.3 cd	7.7 def	6.5 bc	6.76 d
E61L 10657	EZ	G	6.7 bcd	6.7 ab	6.7 b	8.7 a	8.0 cde	7.7 a	7.67 a
RED HAWK	Bejo	SPG	6.3 cd	5.0 cde	6.7 b	8.3 ab	7.0 fgh	6.7 bc	7.04 bcd
RED STONE	Haz	G	7.7 ab	7.3 a	8.0 a	5.7 d	8.7 bc	6.3 c	7.33 ab
RUBILLION	Tak	FG	6.3 cd	6.3 abc	6.3 bc	5.7 d	8.7 bc	6.3 c	6.78 cd
RED CARPET	Bejo	HGSP	6.3 cd	5.7 bcd	6.3 bc	9.0 a	6.3 h	7.0 abc	7.26 abc
SV 4643	Sto	HG	5.0 ef	7.0 ab	5.7 bc	7.3 bc	7.0 fgh	6.7 bc	6.70 d
RED MOUNTIAN	Bejo	HG	6.0 cde	5.7 bcd	6.7 b	8.0 ab	7.0 fgh	7.3 ab	7.07 bcd
BAROLO	EZ	G	8.0 a	6.0 abc	8.0 a	5.7 d	7.3 efg	6.7 bc	7.17 bcd
RED NUGENT	Sto	SPG	4.0 f	4.3 de	6.3 bc	6.7 cd	6.5 h	6.3 c	6.02 e
SV NT 1298	Sem	G	5.7 de	7.3 a	5.3 c	6.7 cd	7.3 efg	6.3 c	6.74 d
BAROLO Inicium	SN	G	7.0 abc	7.0 ab	8.0 a	5.7 d	8.3 bcd	6.7 bc	7.37 ab
BLUSH	Bejo	HG	6.3 cd	5.0 cde	6.0 bc	9.0 a	6.7 gh	7.3 ab	7.07 bcd
RED BULL	Bejo	SPG	5.7 de	4.0 e	6.3	8.7 a	6.7 gh	6.7 bc	6.96 bcd
MONASTRELL	EZ	FG	7.7 ab	6.0 abc	5.3 c	1.0 e	9.0 ab	3.0 e	5.72 e
RED SPRING	Bejo	TOP	5.7 de	4.3 de	5.7 bc	2.0 e	9.7 a	4.7 d	5.81 e
Trial Average			**6.3**	**5.8**	**6.5**	**6.5**	**7.6**	**6.4**	**6.84**

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 - 2020 - 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)
RUBY RING	Tak	10.0 a*	8.0 bc	R	7.0 a	R	6.3 def	84 ab	5.2 a	146.5 def
E61L 10657	EZ	9.5 ab	8.0 bc	DR	7.7 a	DR	9.0 a	83 b	0.4 a	180.1 bc
RED HAWK	Bejo	9.7 ab	7.7 cd	DR	8.0 a	R	7.7 a-d	83 b	3.6 a	163.2 cde
RED STONE	Haz	10.0 a	9.0 a	LR	7.7 a	LR	5.7 ef	74 c	1.3 a	102.6 h
RUBILLION	Tak	10.0 a	7.3 cd	R	7.3 a	R	6.7 c-f	75 c	7.1 a	116.8 fgh
RED CARPET	Bejo	10.0 a	9.0 a	DR	7.3 a	DR	8.3 ab	85 ab	2.5 a	166.8 cd
SV 4643	Sto	9.7 ab	7.7 cd	R	6.7 a	R	7.3 bcd	75 c	3.0 a	202.8 ab
RED MOUNTIAN	Bejo	9.8 a	8.7 ab	R	7.7 a	R	6.7 c-f	86 a	4.3 a	147.4 def
BAROLO	EZ	9.5 ab	7.2 d	DR	8.3 a	DR	7.3 bcd	75 c	4.6 a	162.8 cde
RED NUGENT	Sto	9.5 ab	7.7 cd	R	7.0 a	DR	5.3 f	84 ab	4.5 a	220.1 a
SV NT 1298	Sem	10.0 a	7.7 cd	LR	6.3 a	LR	8.0 abc	73 c	5.6 a	213.9 a
BAROLO Inicium	SN	9.5 ab	9.0 a	DR	7.7 a	DR	7.0 b-e	75 c	2.1 a	159.4 cde
BLUSH	Bejo	9.2 bc	9.0 a	LR	6.0 a	P	8.3 ab	75 c	8.6 a	112.4 gh
RED BULL	Bejo	9.8 a	9.0 a	DR	7.7 a	DR	8.0 abc	86 a	5.9 a	134.4 efg
MONASTRELL	EZ	8.7 cd	7.5 cd	DR	6.7 a	R	5.3 f	70 d	3.4 a	104.6 gh
RED SPRING	Bejo	8.3 d	7.0 d	R	8.0 a	R	5.3 f	67 d	0.8 a	156.7 cde
Trial Average		**9.6**	**8.1**		**7.3**		**7.0**	**78**	**3.9**	**155.7**

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 - 2020 - 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
RUBY RING	Tak	0.0 a*	43 bcd	50 a	7 ab	0.0 a	0.9 cd	6.5 def	70.5 cd	B	BG
E61L 10657	EZ	0.0 a	80 a	20 a	0 a	0.0 a	2.6 bcd	28.0 ab	77.8 ab	U	LG
RED HAWK	Bejo	0.0 a	33 b-e	50 a	17 b	0.0 a	0.4 cd	21.5 bc	75.7 b	U	BG
RED STONE	Haz	0.0 a	3 f	57 a	40 c	0.0 a	0.0 d	0.8 f	53.7 f	U	LG
RUBILLION	Tak	0.0 a	57 ab	43 a	0 a	0.0 a	0.0 d	3.5 ef	69.4 cd	B	BG
RED CARPET	Bejo	0.0 a	27 c-f	63 a	10 ab	0.0 a	1.3 cd	20.2 bc	74.1 bc	U	BG
SV 4643	Sto	0.0 a	33 b-e	57 a	10 ab	0.0 a	4.9 b	38.1 a	81.4 a	B	G
RED MOUNTIAN	Bejo	0.0 a	53 abc	40 a	7 ab	0.0 a	0.5 cd	10.0 c-f	70.0 cd	U	BG
BAROLO	EZ	0.0 a	0 f	60 a	40 c	0.0 a	0.4 cd	19.6 bc	68.2 de	U	G
RED NUGENT	Sto	0.0 a	40 bcd	50 a	10 ab	0.9 a	10.8 a	39.0 a	82.4 a	U	BG
SV NT 1298	Sem	0.0 a	20 def	77 a	3 ab	0.0 a	5.2 b	39.6 a	80.7 a	B	BG
BAROLO Inicium	SN	0.0 a	7 ef	77 a	17 b	0.0 a	0.4 d	18.0 bcd	69.5 cd	U	G
BLUSH	Bejo	0.0 a	33 b-e	67 a	0 a	0.0 a	0.0 d	3.8 ef	70.1 cd	B	G
RED BULL	Bejo	0.0 a	40 bcd	53 a	7 ab	0.0 a	0.0 d	13.1 cde	68.8 d	U	G
MONASTRELL	EZ	0.0 a	27 c-f	70 a	3 ab	0.0 a	0.0 d	6.8 def	58.1 f	B	G
RED SPRING	Bejo	0.0 a	0 f	33 a	67 d	0.0 a	3.3 bc	19.9 bc	63.5 e	U	BG
Trial Average		**0.0**	**31**	**54**	**15**	**0.1**	**1.9**	**18.0**	**70.9**		

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 – 2020

Ruby Ring: *American Takii sample,* Good appearance, Good tight neck finish, Neck finishes a little uneven, Small & medium sized necks, Average skin thickness, Average skin quality, Some skin cracking a little concern, Exterior colour a little uneven, Odd one with brown spots on skins, Dark interior colour a little uneven, Some dead centers white, Great interior blending, Average to good packer, Uniformity of shape a little uneven, Good firm solid onion, Firmness even, Small to medium run size, Run size a little uneven, Long term storage onion.

E61L 10657: *Enza Zaden sample,* Nice appearance, Great tight neck finish, Medium sized necks, Uneven skin thickness, Pretty good skin quality, Odd one with skin cracking, Odd one with skin rot, Nice dark exterior colour, Dark interior colour even, Dead centers white, Good interior blending, Some bleeding of colour after cutting, Nice packer, Uniformity of shape even, Good firm onion, Firmness even, Medium to large run size, Run size a little uneven, Mid to long term storage onion.

Red Hawk: *Bejo sample,* Good appearance, Average tight neck finish, Neck finish bit rough, Medium sized necks, Average skin thickness, Pretty good skin quality, Odd one with skin cracking, Exterior colour a little uneven, Odd one with brown spots on skins, Nice interior colour even, Dead centers white, Good interior blending, Average to good packer, Uniformity of shape a little even, Good firm onion, Firmness a little uneven, Run size even, Mid to long term storage onion.

Red Stone: *Hazera sample,* Average appearance, Perfect tight neck finish, Small to medium sized necks, Thicker skins, Fair skin quality, A lot of with skin cracking, Skin cracking a big concern, Lighter exterior colour uneven, Some with brown spots on skins, Light interior colour even, Dead centers white, Good interior blending uneven, Average packer, Uniformity of shape a little even, Nice firm solid onion, Firmness even, Small run size, Long term storage onion.

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RED ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2020 continued

Rubillion: *American Takii sample,* Average appearance, Great tight neck finish, Small sized necks, Average skin thickness, Average skin quality, Some skin cracking a concern, Exterior colour a little uneven, Odd one with brown spots on skins, Interior colour a little uneven, Dead centers white, Good interior blending, Average packer, Uniformity of shape a little even, Average firmness, Firmness a little uneven, Small to medium run size, Run size uneven, Mid-term storage onion.

Red Carpet: *Bejo sample,* Good appearance, Average tight neck finish, Medium sized necks, Thicker skins, Pretty good to nice skin quality, Odd one with skin cracking, Some with skin rot, Dark exterior colour even, Odd one with white spots on skins, Interior colour uneven, Dead centers white, Good interior blending, Good packer, Uniformity of shape uneven, Nice firm solid onion, Firmness even, Medium run size, Run size uneven, Long term storage onion.

SV 4643: *Stokes sample,* Good appearance, Average & good tight neck finish, Small & medium sized necks, Average skin thickness, Average skin quality, Some with skin cracking, Odd one with skin or basal plate rot, Exterior colour a little uneven, Odd one with brown spots on skins, Interior colour even, Dead centers white, Good interior blending, Average packer, Uniformity of shape uneven, Good firmness, Firmness a little uneven, Large run size, Run size a little uneven, Mid to long term storage onion.

Red Mountain: *Bejo sample,* Average appearance, Average to good tight neck finish, Neck finishes a little uneven, Medium sized necks, Average skin thickness, Pretty good skin quality, Odd one with skin cracking, Exterior colour a little even, Odd one with brown spots on skins, Interior colour a little uneven, Dead centers white, Good interior blending, Average packer, Uniformity of shape a little uneven, Good firm onion, Firmness a little uneven, Run size uneven, Long term storage onion.

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RED ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2020 continued

Barolo: *Enza Zaden sample,* Average appearance, Average & good tight neck finish, Small & medium sized necks, Thicker skins, Fair skin quality, A lot with skin cracking a concern, Odd one with skin rot, Dark exterior colour a little uneven, Dark interior colour even, Good interior blending, Some bleeding of colour after cutting, Good packer, Uniformity of shape even, Average firmness, Firmness a little uneven, Medium run size, Run size uneven, Suspicion of doubles, Mid-term storage onion.

Red Nugent: *Stokes sample,* Average appearance, Average neck finish, Some neck finishes bit rough, Medium sized necks, Average skin thickness, Fair to average skin quality, Some with skin cracking a concern, Odd one with skin or basal plate rot, Fairly dark exterior colour uneven, Odd one with brown spots on skins, Interior colour even, Dead centers white, Average interior blending, Average packer, Uniformity of shape very uneven, Good firm onion, Firmness a little uneven, Large run size, Run size uneven, Odd double onion, Mid-term storage onion.

SV NT 1298: *Seminis sample,* Average appearance, Good tight neck finish, Small sized necks, Average skin thickness, Average skin quality, Some with skin cracking a concern, Slightly light exterior colour even, Odd one with brown spots on skins, Slightly light interior colour even, Dead centers white, Average interior blending, Average packer, Uniformity of shape uneven, Average firmness, Firmness a little uneven, Large run size, Run size a little uneven, Doubles are a concern, Mid to long term storage onion.

Barolo: *Seminova sample,* Fair to average appearance, Great tight neck finish, Small sized necks, Average skin thickness, Average skin quality, A lot with skin cracking a concern, Odd one with skin or basal plate rot, Dark exterior colour a little uneven, Dark interior colour a little uneven, Good interior blending, Good packer, Uniformity of shape a little uneven, Nice firm solid onion, Firmness even, Medium run size, Run size a little uneven, Suspicion of doubles, Long term storage onion.

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RED ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2020 continued

Blush: *Bejo sample,* Nice appearance, Average tight neck finish, Medium sized necks, Average skin thickness, Nice skin quality, Odd one with skin cracking, Pinkish exterior colour even, Light interior colour, Interior colour a little uneven, Some dead centers white, Average interior blending, Good packer, Uniformity of shape a little even, Nice firm solid onion, Firmness even, Small run size, Run size uneven, Long term storage onion.

Red Bull: *Bejo sample,* Good appearance, Average tight neck finish, Medium sized necks, Average to thick skin thickness, Nice skin quality, Odd one with skin or basal plate rot, Dark exterior colour even, Dark interior colour even, Dead centers white, Good packer, Uniformity of shape a little uneven, Nice firm solid onion, Firmness even, Run size very uneven, Odd double onion, Long term storage onion.

Monastrell: *Enza Zaden sample,* Very poor appearance, Perfect tight neck finish, Extra small sized necks, Thinner skins, Very poor skin quality, Most with skin cracking a big concern, Some with skin rot, Exterior colour uneven, Fairly dark interior colour a little uneven, Dead centers yellow, Poor packer, Uniformity of shape even, Average firmness, Firmness even, Small run size, Run size uneven, Suspicion of doubles, A lot of mechanical damage, Early to mid-term storage onion.

Red Spring: *Bejo sample,* Poor rough appearance, Perfect tight neck finish, Small sized necks, Thin to average skin thickness, Poor skin quality, Most have skin cracking a big concern, Skin rot a little concern, Exterior colour uneven, Odd one with brown spots on skins, Interior colour even, Dead centers yellow, Great interior blending, Purplish interior colour, Poor packer, Uniformity of shape a little even, Average firmness, Firmness uneven, Run size very uneven, Some mechanical damage a concern, Suspicion of doubles a concern, Early term storage onion.

LONG TERM AVERAGES OF RED ONION CULTIVAR TRIALS

Cultivar	Source	# Years Evaluated	Yeild bu/A	% Marketable	% Jumbos <3"	Days to Maturity	Firmness In*	Firmness out*	Neck Finish	Score	% Onion Maggot Damage	# of Seeders
RED SPRING	Bejo	4	706	59.6	36.4	76	8.0	6.4	8.2	5.89	1.6	0.0
MONASTRELL	EZ	4	726	72.9	29.8	79	8.7	7.3	8.4	5.90	2.1	0.0
RED SKY	Bejo	6	994	90.0	34.2	81	8.6	6.7	7.8	6.53	0.9	0.0
RUBILLION	Tak	4	890	93.5	28.2	85	9.0	7.0	8.0	6.84	2.8	0.0
BLUSH	Bejo	3	1017	92.6	30.0	85	9.7	8.3	7.1	7.32	4.0	0.0
SV 4643	Sem	5	1267	88.3	59.8	85	9.5	7.0	6.7	6.13	1.2	0.5
RED NUGENT	Sto	3	1393	91.0	64.2	89	9.3	6.9	6.7	6.01	3.0	0.0
MERCURY	Sto	3	1173	86.1	47.5	91	8.8	6.8	6.7	6.07	0.0	0.2
RED HAWK	Bejo	7	1043	83.0	49.6	92	8.7	6.6	6.3	6.77	1.4	0.8
RED BULL	Bejo	6	1076	92.6	46.0	94	9.5	7.9	6.5	6.81	1.1	0.3
RUBY RING	Tak	7	953	94.4	27.2	96	9.6	7.5	6.9	6.76	1.6	0.0
RED CARPET	Bejo	4	1148	91.9	45.2	98	9.8	8.3	6.2	7.02	1.3	0.0
RED WING	Bejo	6	1325	96.7	61.1	107	9.6	8.2	6.5	7.22	0.4	0.0

All data based from 2011 season forward

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 RED ONION STORAGE TRIAL 2019 - 2020

Cultivar	Source	% Marketable	% Weight Loss	% Sprouts	% Rot	% Soft	Firmness In **	Firmness Out **	% Sprouting at Base	% Sprouting at Top
BLUSH	Bejo	92.2 a*	3.2 a	2.8 abc	1.0 ab	0.0 a	10.0 a	8.0 a	1.7 a	0.0 a
RED WINIG	Bejo	90.7 a	3.5 a	4.0 abc	0.9 ab	0.0 a	10.0 a	7.8 a	1.3 a	0.0 a
RED MOUNTAIN	Bejo	90.4 a	3.3 a	2.3 a	3.0 ab	0.0 a	10.0 a	6.8 cd	0.7 a	0.3 a
RED CARPET	Bejo	89.3 a	3.5 a	2.9 ab	3.5 b	0.0 a	10.0 a	7.7 ab	1.3 a	0.0 a
RED HAWK	Bejo	89.1 ab	3.1 a	4.1 ab	3.0 ab	0.0 a	9.3 b	5.0 e	1.3 a	1.0 a
RUBY RING	Tak	85.7 abc	3.8 a	6.1 ab	2.6 ab	1.0 abc	9.8 a	5.7 e	5.3 ab	1.3 a
SV 4643	Sem	78.2 bcd	3.4 a	12.5 abc	3.5 b	1.6 c	9.7 ab	6.7 d	5.7 abc	1.7 a
RED BULL	Bejo	75.1 cd	3.9 a	17.8 cd	2.3 ab	0.0 a	9.7 ab	6.8 cd	16.0 bc	1.7 a
RED NUGENT	Sto	72.2 d	4.0 a	13.6 cb	8.3 c	1.4 cb	9.3 b	5.3 e	4.0 ab	2.7 a
RUBILLION	Tak	69.7 d	3.6 a	25.6 d	0.3 a	0.0 a	9.3 b	6.5 d	18.3 c	2.3 a
RED SKY	Bejo	49.7 e	4.2 a	44.5 e	0.9 ab	0.4 ab	9.3 b	7.0 bcd	55.0 d	31.7 b
MONASTRELL	EZ	3.9 f	9.8 b	78.5 f	7.5 c	0.0 a	9.7 ab	7.5 abc	93.3 e	53.3 c
RED SPRING	Bejo	1.0 f	11.8 c	85.5 f	1.5 ab	0.0 a	8.7 c	5.7 e	86.7 e	89.3 d
Trial Average		**68.2**	**4.7**	**23.1**	**2.9**	**0.3**	**9.6**	**6.7**	**22.4**	**14.3**

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 - 2019-2020

Blush: *Bejo sample*, Root sprouts just starting 0-1 cm, All skin rot, Basal plates just starting to push out 10-40%, Firm onion, Firmness even, Mid to long term storage onion, Stored nice.

Red Wing: *Bejo sample*, Root sprouts just starting 0-1 cm, Majority internal rot, Some skin rot, Basal plates just starting to push out 1-5%, Firm onion, Firmness even, Long term storage onion, Stored excellent.

Red Mountain: *Bejo sample*, Top & Root sprouts just starting 0-1 cm, Majority skin rot, Odd internal rot, Basal plates just starting to push out 1-5%, Fairly firm, Mid to long term storage onion, Stored good to nice.

Red Carpet: *Bejo sample*, Root sprouts just starting 0-1 cm, Majority skin rot, A few internal rot, Basal plates just starting to push out 1-5%, Firm onion, Mid to long term storage onion, Stored nice.

Red Hawk: *Bejo sample*, Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Some neck rot, Basal plates just starting to push out 1%, Firmness slightly soft, Early to mid-term storage onion, Stored good.

Ruby Ring: *American Takii sample*, Top sprouts just starting 0-1 cm, Root sprouts just starting to light 0-1 cm, Majority skin rot, Some internal rot, Basal plates just starting to push out 1-5%, Firmness uneven, Early to mid-term storage onion, Stored fair.

SV 4643: *Stokes sample*, Top sprouts just starting 0-1 cm, Root sprouts just starting 0-1 cm, All skin rot, Basal plates just starting to push out 2-20%, Firmness okay, Firmness slightly uneven, Mid-term storage onion, Stored okay to good.

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RED ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2019-2020 -- continued

Red Bull: *Bejo sample,* Top sprouts just starting 0-1 cm, Root sprouts just starting 0-1 cm, Majority internal rot, Some skin rot, Odd one with neck rot, Basal plates just starting to push out 15-25%, Fairly firm, Mid-term storage onion, Stored good.

Red Nugent: *Seminis sample,* Top sprouts just starting to moderate 0-2.5 cm, Root sprouts just starting to light 0-1 cm, All skin rot, Basal plates just starting to push out 1-20%, Soft onion, Early storage onion, Stored a little poor.

Rubillion: *American Takii sample,* Top sprouts just starting 0-1 cm, Root sprouts just starting 1-0 cm, Root sprouts are a slight concern, Some skin rot, Basal plates just starting to push out 25%, Firmness okay, Firmness slightly uneven, Mid-term storage onion, Stored okay to good.

Red Sky: *Bejo sample,* Top sprouts just starting to heavy 1-5 cm, Root sprouts just starting to moderate 0-2.5 cm, Top sprouts a concern and uneven, Root sprouts are a concern, All skin rot, Basal plates just starting to push out 70%, Firmness okay, Early storage onion, Stored okay.

Monastrell: *Enza Zaden sample,* Top sprouts moderate to heavy 2.5-5 cm, Root sprouts light 1-2.5 cm, Sprouting a big concern, Sprouts uneven, Majority skin rot, Odd internal rot, Basal plates just starting to push out 10-30%, Fairly firm, Early to mid storage onion, Stored poor.

Red Spring: *Bejo sample,* Top sprouts heavy >5 cm, Root sprouts just starting to moderate 0-5 cm, Top sprouts uneven, Sprouting is a big concern, Skin and internal rot, Basal plates just starting to push out 10-60%, Firmness okay, Early storage onion, Stored poor.

Check out the Muck Crops Research Station's Web Page

https://bradford-crops.uoguelph.ca/

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