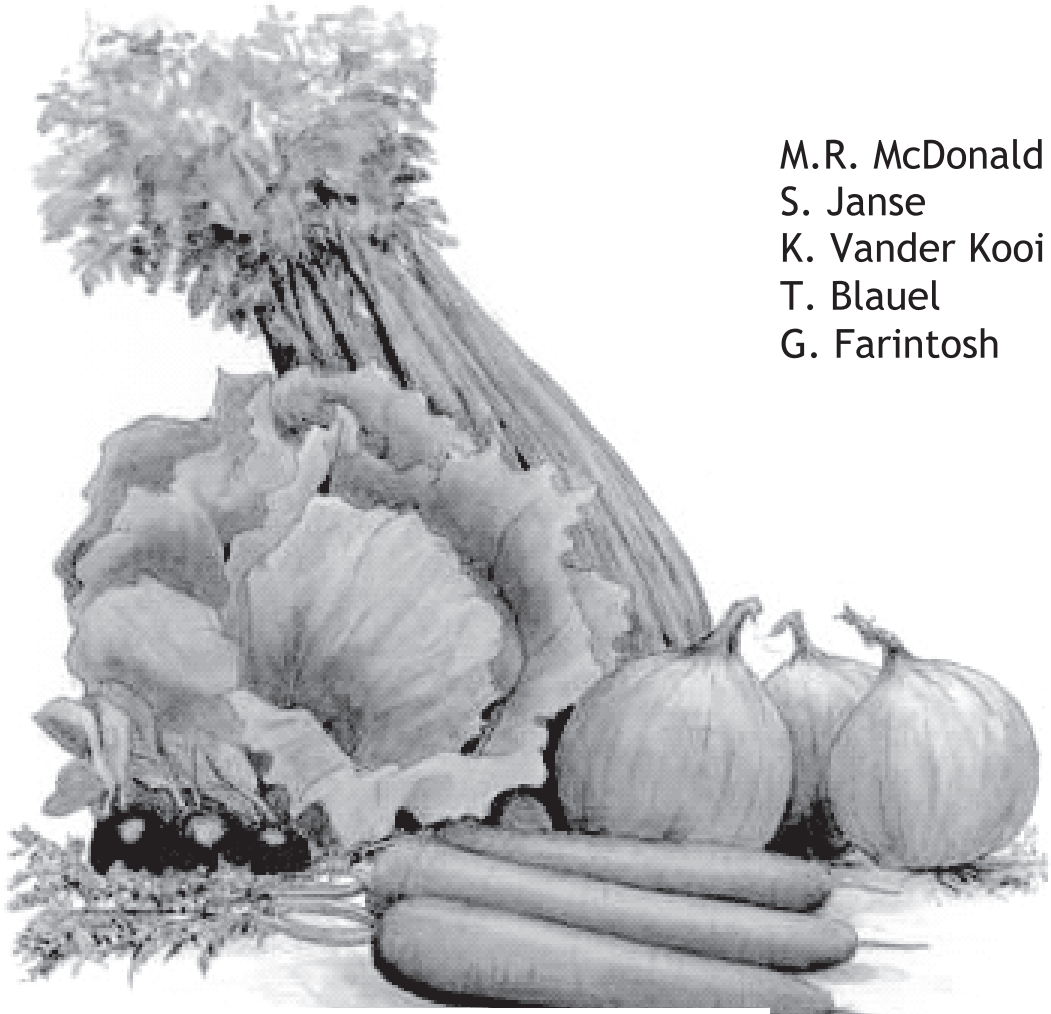
Muck Vegetable Cultivar Trial & Research Report 2022



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UNIVERSITY of GUELPH

Office of Research &
Dept. of Plant Agriculture
Report No. 72

Ontario Crops
Research Centre
Bradford, Ontario

Research and Cultivar Trial Report for 2022

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
You Tube Account: Muck Crops IPM

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Miscellaneous

Integrated Pest Management

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STAFF - 2022

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
Geoff Farintosh	Agricultural Technician
Miško Mitrović	Agricultural Assistant
Tyler Blauel	IPM Supervisor / Research Associate
Afsaneh Sedaghatkish	Post Doctoral Fellow

IPM Scouts:

David Ferguson Jessica Christie-Connolly

Seasonal Contracts:

Luke Burleigh	Summer Assistant
Thomas Jarko	Summer Assistant
Emma Searl	Summer Assistant
Jordie DiBlasio	Summer Assistant
Samantha Share	Summer Assistant

Graduate Students:

Emily McFaul	Department of Plant Agriculture
Umbrin Ilyas	Department of Plant Agriculture
Shauna Chesney	Department of Plant Agriculture
Michael Kooy	Department of Plant Agriculture
Neem Pandey	Department of Plant Agriculture

CO-OPERATING COMPANIES 2022

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
Phil Simon	USDA/ARS, Madison, WI, USA
Dennis Van Dyk	Ontario Ministry of Agriculture, Food and Rural Affairs, Guelph, ON, Canada
Kristen Obeid	Ontario Ministry of Agriculture, Food and Rural Affairs, Harrow, 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
Kevin Falk	Corteva Agriscience, Oak Bluff, MB, Canada
Tom Miedema	Fresh Vegetable Growers of Ontario, Ridgetown, ON, Canada
Jim Ye	Suntton Biochemical Ltd. Port Moody, BC, Canada
Simon Wang	Suntton Biochemical Ltd. Port Moody, BC, Canada
Colin Smith	Sylvar Technologies Inc, Fredericton, NB, Canada
Tessa de Boer	Syngenta Canada Inc., Plattsville, ON, Canada
Jen Foster	Syngenta Canada Inc., Plattsville, ON, Canada
Chuck Baresich	Haggerty Creek Ltd, Bothwell, ON, Canada
Jason Gharibo	Haggerty Creek Ltd, Bothwell, ON, Canada
Teric Greenan	Nexus Robotics, Saint-Bruno-de Montarville, PQ, Canada

SEED SOURCES - 2022 - 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

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

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

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 2022.

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 Ontario Crops Research Centre – Bradford 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 2022, Muck Crops Research Station staff conducted, and/or co-operated on research projects with researchers from the Department of Plant Agriculture at the University of Guelph; researchers from OMAFRA, Agriculture and Agri-Food Canada, the USDA, and Cornell University; research departments of the Crop Protection 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 2022 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 2022 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 five 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). While not a common muck vegetable, research also supported the registration of Velum Prime (fluopyram) for the control of stem and blub nematode on garlic.

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 2022

PRECIPITATION

Month	2012		2013		2014		2015		2016		2017	
	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	39	13	36	16	28	19	0	15	23	2	61	14
February	15	19	17	58	19	45	0	32	29	12	28	23
March	30	2	12	6	9	16	10	5	80	30	54	8
April	51	0	82	4	82	2	48	0	22	18	87	12
May	49	0	112	0	58	0	40	0	45	0	120	0
June	55	0	94	0	88	0	171	0	39	0	209	0
July	140	0	104	0	92	0	36	0	51	0	74	0
August	69	0	87	0	63	0	79	0	58	0	53	0
September	94	0	83	0	113	0	27	0	25	0	38	0
October	123	0	92	0	67	0	54	0	41	0	99	0
November	32	0	24	15	24	5	40	0	40	5	22	11
December	35	14	29	40	11	22	39	3	20	65	2	32
Annual	**732**	**48**	**772**	**139**	**654**	**109**	**544**	**55**	**473**	**132**	**847**	**100**
Total Precip.	**780**		**911**		**763**		**599**		**605**		**947**	

LTA = Long Term Average for U of Guelph, Dept. of Plant Agriculture - Kettleby
1125 Woodchoppers Lane, King, ON, L7B 0E9 48 Years (1975-2022)

PRECIPITATION

Month	2018		2019		2020		2021		2022		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	34	25	14	52	84	24	4	22	1	46	21	28
February	28	32	14	43	0	44	5	44	25	41	19	27
March	21	14	39	17	42	5	34	3	21	21	31	14
April	117	12	89	0	30	0	44	4	44	5	56	4
May	82	0	77	0	38	3	22	0	50	0	71	0
June	59	0	100	0	77	0	56	0	90	0	81	0
July	104	0	93	0	58	0	105	0	74	0	84	0
August	109	0	80	0	140	0	41	0	82	0	80	0
September	20	0	61	0	65	0	173	0	43	0	79	0
October	69	0	74	0	61	0	77	0	30	0	68	1
November	63	31	27	31	27	22	24	13	43	10	50	10
December	44	10	44	40	29	39	36	21	43	12	27	28
Annual	**750**	**124**	**712**	**183**	**651**	**138**	**621**	**107**	**546**	**135**	**668**	**112**
Total Precip.	**874**		**895**		**789**		**728**		**681**		**780**	

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

Month	2012		2013		2014		2015		2016		2017	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
January	1.3	-6.9	2.1	-6.3	-3.9	-14.7	-3.2	-13.1	0.4	-7.8	0.8	-5.2
February	2.7	-5.6	-1.0	-10.3	-2.2	-17.3	-8.2	-19.8	1.9	-8.3	3.7	-5.0
March	12.7	-0.1	3.7	-4.3	1.9	-12.2	2.7	-7.4	6.6	-2.8	3.4	-5.0
April	12.5	0.0	11.4	0.7	11.9	0.3	13.0	0.8	10.3	-1.7	14.4	3.4
May	23.4	8.4	21.8	7.6	20.9	6.6	23.5	8.3	21.2	6.3	17.3	7.2
June	26.9	13.2	24.2	12.8	27.1	11.6	23.8	11.8	26.2	11.1	24.1	12.8
July	29.7	14.7	27.5	15.1	25.9	12.5	28.1	13.3	28.8	15.3	26.4	14.9
August	27.0	13.1	26.7	12.4	25.8	12.5	25.7	13.2	29.6	15.5	25.2	12.6
September	21.7	8.0	22.4	8.1	22.8	8.5	25.9	12.1	24.8	10.0	25.0	9.6
October	14.6	4.8	16.3	4.6	15.3	5.5	14.6	3.9	15.9	5.9	17.2	5.8
November	7.3	-1.4	6.6	-3.2	5.2	-1.0	10.8	0.6	11.5	0.9	7.3	-1.8
December	3.8	-3.4	-1.0	-9.4	2.0	-2.9	6.9	-0.1	1.3	-5.8	-2.0	-11.6
Mean	**15.3**	**3.7**	**13.4**	**2.3**	**12.7**	**0.8**	**13.6**	**2.0**	**14.9**	**3.2**	**13.6**	**3.1**

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1125 Woodchoppers Lane, King, ON, L7B 0E9 48 Years (1975-2022)

MEAN TEMPERATURE (°C)

Month	2018		2019		2020		2021		2022		LTA	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
January	3.3	-3.2	-3.7	-12.3	0.9	-6.5	-0.5	-6.9	-4.1	-16.0	-2.3	-10.8
February	1.7	-7.7	-0.4	-9.9	-0.1	-8.3	-1.6	-11.6	-0.5	-10.5	-1.2	-10.5
March	2.9	-4.5	2.8	-6.0	6.6	-1.6	8.7	-3.7	4.3	-3.4	3.5	-5.3
April	7.0	-1.9	5.8	1.3	10.0	0.0	12.6	2.3	11.0	1.0	11.3	1.0
May	23.4	9.0	16.5	6.3	17.4	5.7	19.9	5.2	22.1	8.0	19.3	6.8
June	25.1	12.2	23.5	11.6	26.4	12.0	27.0	15.2	25.7	10.8	24.3	11.6
July	28.4	15.0	29.3	15.4	29.6	16.9	25.2	14.2	27.7	12.6	26.8	14.1
August	27.8	16.9	26.3	12.4	26.8	14.3	28.9	15.5	27.3	13.9	25.7	13.1
September	23.7	11.3	21.6	9.6	21.3	8.7	22.1	9.5	22.3	10.7	21.3	9.2
October	12.2	3.8	14.8	4.3	12.6	3.6	16.8	8.7	16.9	2.1	14.0	3.9
November	3.3	-3.2	4.0	-3.9	10.7	1.5	7.5	-1.6	9.8	-0.1	6.9	-0.9
December	1.7	-4.3	2.2	-6.7	1.7	-4.0	3.8	-3.0	1.7	-4.7	0.6	-6.5
Mean	**13.4**	**3.6**	**11.9**	**1.8**	**13.7**	**3.5**	**14.2**	**3.7**	**13.7**	**2.0**	**12.5**	**2.1**

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

Month	2012		2013		2014		2015		2016		2017	
	H	L	H	L	H	L	H	L	H	L	H	L
January	7.9	-20.3	14.0	-22.4	8.3	-30.4	5.3	-21.4	10.3	-19	7.2	-16.8
February	9.2	-17.3	6.5	-23.8	7.6	-30.2	-1.8	-30.8	15.4	-28.8	16.7	-14.8
March	26.4	-15.6	12.3	-10.3	12.9	-27.8	12.9	-26.3	18.5	-14.7	14.8	-17.3
April	25.7	-5.9	24.7	-7.4	23.4	-7.3	22.7	-5.1	26.2	-15.3	26.6	-1.6
May	34.9	1.1	31.3	0.0	31.9	-0.1	30.8	-1.2	33.2	-1.6	31.5	1.1
June	35.5	7.6	33.4	6.1	32.7	2.8	29.1	4.1	34.2	3.1	32.6	4.5
July	35.3	9.7	35.3	7.6	31.4	6.5	34.2	7.2	35.1	8.4	30.8	10.5
August	32.6	6.4	31.7	7.3	32.6	5.7	32.8	6.9	34.8	9.8	30.4	5.3
September	29.9	1.7	35.3	-0.5	32.1	0.1	34.1	4.3	34.2	1.2	34.6	1.1
October	23.5	-4.7	24.7	-5.7	24.4	-1.5	23.9	-3.1	25.8	-3.5	26.0	-1.6
November	18.5	-5.8	16.0	-19.0	16.6	-10.3	22.1	-6.8	19.1	-6.5	22.6	-14.4
December	15.1	-12.7	15.9	-25.3	10.5	-11.1	15.4	-8.1	9.1	-15.9	12.1	-29.0
Annual High & Low	**35.5**	**-20.3**	**35.3**	**-25.3**	**32.6**	**-30.4**	**34.2**	**-30.8**	**35.1**	**-28.8**	**34.6**	**-29.0**

Extreme Temperatures for U of Guelph, Dept. of Plant Agriculture - Kettleby
1125 Woodchoppers Lane, King, ON, L7B 0E9 48 Years (1975-2022)

EXTREME TEMPERATURE (°C)

Month	2018 H	2018 L	2019 H	2019 L	2020 H	2020 L	2021 H	2021 L	2022 H	2022 L	EXTREME TEMPERATURES H	Year	L	Year
January	11.4	-28.6	6.6	-23.5	10.5	-24.1	7.3	-22.3	3.7	-28.4	15.8	2005	-36.0	1977
February	14.7	-21.7	11.2	-23.4	8.9	-25.4	6.4	-24.9	9.3	-19.9	16.7	2017	-33.0	1979
March	10.3	-11.7	11.6	-18.7	17.4	-18.7	21.0	-15.8	19.2	-12.2	26.4	2012	-29.0	1984
April	18.8	-8.3	14.4	-6.4	17.2	-5.6	23.0	-5.5	20.2	-3.9	30.0	1990	-15.3	2016
May	30.6	-1.0	24.2	-0.3	33.3	-5.4	32.2	-0.8	33.7	-0.3	34.6	2006	-5.4	2020
June	33.2	5.9	31.4	2.8	33.6	3.6	34.0	4.6	36.1	3.8	36.1	2022	-2.0	1977
July	35.3	8.6	34	9.3	35.1	11.5	31.3	7.9	32.9	6.7	36.3	2011	2.5	1984
August	33.1	10.9	30.8	6.8	32.3	8.0	33.1	7.9	33.6	5.8	36.3	2001	0.5	1982
September	33.4	1.9	29.9	1.0	28.0	-1.3	26.7	4.6	31.7	1.5	35.3	2013	-6.5	1991
October	28.7	-3.3	27.2	-2.4	24.4	-6.1	27.0	-0.6	29.2	-3.4	30.0	89 & 07	-9.0	1975
November	14.5	-25.3	11.5	-19.1	24.0	-7.4	19.2	-13.2	24.5	-8	24.5	2022	-25.3	2018
December	11.0	-12.4	8.9	-21.6	8.6	-13.1	16.9	-14.9	11.5	-17.5	20.0	1982	-31.5	1980
Annual High & Low	**35.3**	**-28.6**	**31.4**	**-23.5**	**35.1**	**-25.4**	**33.1**	**-24.9**	**36.1**	**-28.4**	**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	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	LTA
January	0	9	0	0	1	0	2	0	1	0	0	**1**
February	0	0	0	0	8	8	7	2	0	0	0	**1**
March	123	8	0	1	31	12	0	2	17	41	15	**15**
April	54	78	63	79	56	123	25	19	42	102	62	**75**
May	338	304	271	337	273	220	348	200	220	234	310	**244**
June	450	405	431	390	409	404	410	375	426	483	397	**388**
July	533	507	443	480	528	486	518	535	567	455	470	**477**
August	467	450	438	456	543	431	531	446	483	533	484	**445**
September	295	306	320	419	372	368	375	323	300	324	344	**306**
October	145	177	171	141	188	203	108	142	109	240	141	**133**
November	15	28	30	72	67	20	11	2	80	20	78	**33**
December	11	4	4	22	2	1	2	2	0	10	5	**4**
Annual	**2431**	**2276**	**2171**	**2397**	**2478**	**2276**	**2338**	**2048**	**2245**	**2442**	**2306**	**2123**

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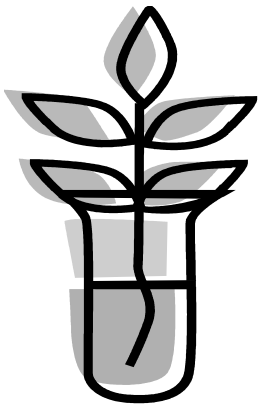

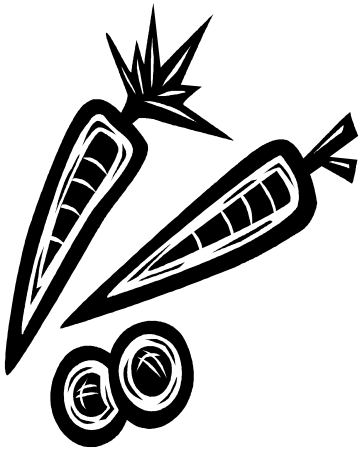

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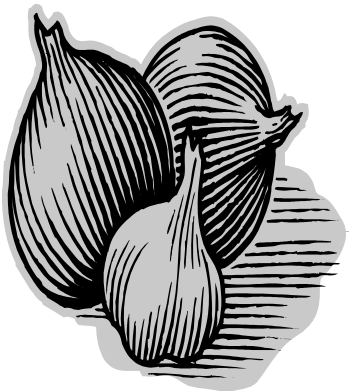

CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang.), cv. Cellobunch
PEST: Carrot cyst nematode (*Heterodera carotae* Jones)

AUTHORS: BLAUEL T, VANDER KOOI K and MCDONALD M R
U of Guelph, Dept. of Plant Agriculture, Ontario Crops Research Centre – Bradford

TITLE: FIELD EVALUATIONS OF NEMATICIDES FOR CARROT CYST NEMATODE CONTROL IN CARROTS, 2022

MATERIALS: EXPERIMENTAL (EXP 300g/L), VELUM PRIME (fluopyram 500g/L)

METHODS: The trial was conducted in a commercial field known to be infested with carrot cyst nematode (*Heterodera carotae*) in the Holland/Bradford Marsh, Ontario. A paired plot design with four replicates per treatment was used. The treatments were: EXPERIMENTAL at 0.333, 0.667 and 0.833 L/ha and VELUM PRIME at 0.5 L/ha. An untreated check plot was paired with each nematicide treatment plot. Carrots, cv. Cellobunch, were direct seeded at 65 seeds/m on raised beds on 2 June. Each experimental unit consisted of three rows, 66 cm apart and 11 m in length. Treatments were applied over the seed at seeding using StreamJet nozzles SJ3-03-VP to apply the solution at 254 L/ha. Twelve 15 cm soil cores were taken from each plot to create one soil sample before treatment and at harvest for nematode analysis. Nematodes were extracted at the University of Guelph Ontario Crops Research Centre - Bradford using the Baermann pan method. Carrot emergence, phytotoxicity and vigor were recorded on 17 June and 4 July.
Carrots were hand harvested from two 1.5 m sections of row on 27 October and placed in cold storage until assessment on 2 November. Carrot samples were assessed for nematode damage (stunting and forking) and sorted using 0-5 rating scale, where: 0 = no cysts or forking (healthy); 1 = very minor cysts or forking with no noticeable cysts; 2 = minor stunting and forking with no noticeable cysts; 3 = moderate stunting and forking with visible cysts; 4 = moderate to severe stunting and forking with visible cysts; 5 = very severe stunting and forking with visible cysts. Carrots in classes 0 and 1 were considered marketable and carrots in classes 2 to 5 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 2022 were above average for May (15.1°C), average for June (18.3°C), August (20.6°C), September (16.5C) and October (9.5°C), and below average for July (20.2°C). The 10-year average temperatures were: May 13.7°C, June 18.9°C, July 21.4°C, August 20.4°C, September 16.3°C and October 9.5°C.
Monthly rainfall was below the 10-year average for May (50 mm), September (43 mm) and October (30 mm) and average for June (90 mm), July (74 mm) and August (82 mm). The 10-year rainfall averages were: May 64 mm, June 97 mm, July 78 mm, August 79 mm, September 59 mm and October 77 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 - 3

CONCLUSIONS: There were no significant differences observed among the treatments for each assessment in the trial. No phytotoxicity was observed in the trial. Overall, carrot cyst nematode populations were unusually low which contributed to lower damage in the trial.

Table 1. Carrot, cv. Cellobunch, emergence and phytotoxicity and vigor ratings on 17 June and 4 July 2022 after carrot cyst nematode infested soil was treated with nematicides in the Holland Marsh, Ontario.

Treatment	Rate (L/ha)	Emergence (1.5m)		Phytotoxicity (%)		Vigor (%)	
		17 June	4 July	17 June	4 July	17 June	4 July
Check (EXP 0.333 Rate)	-	51.3 ns[1]	52.8 ns	0 ns	0 ns	100 ns	100 ns
EXPERIMENTAL	0.667	50.0	51.0	0	0	100	100
VELUM PRIME	0.5	49.3	51.5	0	0	100	100
EXPERIMENTAL	0.833	46.0	47.8	0	0	100	100
Check (EXP 0.667 Rate)	-	46.0	48.3	0	0	100	100
Check (EXP 0.833 Rate)	-	45.3	47.5	0	0	100	100
Check (VELUM PRIME)	-	45.0	46.0	0	0	100	100
EXPERIMENTAL	0.333	44.5	46.5	0	0	100	100

[1] ns indicates no significant differences were found among the treatments at $P = 0.05$.

Table 2. Carrot cyst nematode (CCN) soil counts and reproduction ratios from carrot soil prior to treatment and at harvest in the Holland Marsh, Ontario, 2022.

Treatment	Rate (L/ha)	Carrot Cyst Nematodes (CCN/500cm^3 soil)		Reproduction Ratio[1]
		Pre-plant	Harvest	
EXPERIMENTAL	0.333	11.3 ns[2]	26.3 ns	2.9 ns
Check (EXP 0.667 Rate)	-	11.3	68.8	8.0
Check (VELUM PRIME)	-	11.3	140.0	12.1
VELUM PRIME	0.5	7.5	80.0	13.0
Check (EXP 0.333 Rate)	-	7.5	142.5	14.8
EXPERIMENTAL	0.833	5.3	317.5	43.0
EXPERIMENTAL	0.667	4.0	320.0	197.0
Check (EXP 0.833 Rate)	-	4.0	68.8	13.8

[1] Reproduction ratio: (final population – initial population)/initial population

[2] ns indicates no significant differences were found among the treatments at $P = 0.05$.

Table 3. Percent marketable, marketable yield and damage severity index (DSI) for carrots, cv. Cellobunch, grown in carrot cyst nematode infested soil treated with nematicides in the Holland Marsh, Ontario, 2022.

Treatment	Rate (L/ha)	% Marketable Carrots	Marketable Yield (t/ha)	DSI[1]
EXPERIMENTAL	0.667	88.3 ns[2]	38.9 ns	8.8 ns
VELUM PRIME	0.5	88.0	44.6	9.0
EXPERIMENTAL	0.833	87.9	36.6	9.3
EXPERIMENTAL	0.333	87.8	39.0	9.7
Check (EXP 0.833 Rate)	-	86.6	34.5	11.3
Check (EXP 0.333 Rate)	-	86.1	35.7	10.2
Check (EXP 0.667 Rate)	-	84.6	43.6	11.8
Check (VELUM PRIME)	-	84.5	36.7	11.7

[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 $P = 0.05$.

Funding for this project was provided by Syngenta.

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

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TITLE: RISK OF CAVITY SPOT ON CARROTS CAN BE RELATED TO THE SOIL MICROBIOME, 2021

MATERIALS: Muck soil collected from carrot fields: low-risk fields were the research trial at Jane St (SJ), and two growers' fields (SGL1 & SGL2), and high-risk fields, the research trial at OCRC-Bradford (SU), and two growers' fields (SGH1 & SGH2).

RATIONAL: Cavity spot is an economically important disease caused by several soil-borne *Pythium* species. Lesions develop on carrot roots, making them unmarketable. There are no diagnostic tools to identify the fields at high risk of cavity spot before carrot seeding. Many studies have shown that disease risk is not related to the total quantity of *Pythium* in soil. The hypothesis is that components of the soil microbiome, along with pathogen presence, influence the development of cavity spot and can be identified to provide growers with an indication of risk of cavity spot in a field.

METHODS: Six fields with high organic matter (40 – 70%) soils in the Holland Marsh, Bradford, Ontario, were identified as low or high risk of cavity spot, based on disease history data collected from crop scouting in the past five years. Three fields with high-risk of disease and three with low-risk were selected. The fields with high risk were the field trial at the OCRC-B, and two grower`s fields. The fields with low risk include the Jane Street research site and two grower`s fields. The soil was sampled soon after seeding of carrots in the fields on 28 – 31 May 2021. Soil samples were collected using a soil core sampler (2.45 cm of diameter) to a depth of ~ 20 cm. The soil was collected from four different sites of each field. Each site was marked using the google map app. The field trial at the OCRC-B was divided horizontally into four sites and 20 cores of soil were sampled from each site. Four sites (each was 10 x 10 m^2) were selected from growers' fields. Sixteen soil cores were sampled per site from each field. To avoid contamination between sites, the soil sampler was cleaned with ethanol (70%) and the first soil core was discarded before sampling a new site. The soil samples collected from all of four sites were hand homogenized. Soon after sampling, 200 g (fresh weight) of soil from four sites of each field were taken out and one composite soil sample per field was made. That composite sample was sent to SGS laboratories, Guelph and Harvest Genomics, Quebec for nutrient and metagenomic analysis. The samples were kept in a refrigerator until they were sent to the laboratories for analysis.

In early October, carrots were harvested from all of four sites from each field and the disease was assessed to confirm the categorization of fields as low and high-risk. One hundred carrots (50 consecutive carrots from two rows) from each site were pulled from the research trial at the OCRC-Bon 6 October to assess cavity spot. On 7 October, 25 carrots (12 consecutive carrots from two rows) from each site were pulled from research trial at Jane St. and 4 growers' fields. The carrots were placed in cold storage until disease assessment. Carrots were washed with water in a small rotating drum washer. Carrots were examined for the characteristic symptoms, sunken lesions horizontally arranged on the carrot root. Incidence of cavity spot was the percent of carrots in the sample with one or more cavity spot lesions. Disease severity was determined based on the horizontal length of the largest horizontal lesion on the carrot. Disease severity was divided into six 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).

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

The data were analyzed using R software as a completely randomized design. The means were separated using Tukey-Test at $P = 0.05$ level of significance. The variation in the composition of microbial communities in low and high-risk soils was analyzed by PERMANOVA via Adonis function of vegan R. Principal component analysis (PCA) was used to plot the variations between microbial communities in multivariate space.

Compared to the previous 10-year average, air temperatures in 2021 were above average for June (21.1°C), August (22.2°C) and October (12.8°C), average for September (15.8°C), and below average for May (12.6°C) and July (19.7°C). The 10-year average temperatures were: May 13.9°C, June 18.6°C, July 21.7°C, August 20.2°C, September 16.4°C and October 9.8°C. Monthly rainfall was above the 10-year average for July (105 mm) and September (173 mm) and below average for May (22 mm), June (56 mm), August (41 mm) and October (30 mm). The 10-year rainfall averages were: May 71 mm, June 94 mm, July 75 mm, August 83 mm, September 59 mm and October 78 mm.

RESULTS: Disease assessment of carrots at harvest confirmed the categorization of fields as low and high risk of cavity spot. Cavity spot severity in the low-risk fields was 15–21% and 25–55% in the high-risk fields (Table 1).

Non-metric multidimensional scaling (NMDS) of the metagenomic data shown different plots of fungal and bacterial communities in low and high-risk soil, although, the plots of oomycetes communities overlap with each other (Figure 1A – 1C). Based on NMDS, fungal (liner model, P=0.0232), and bacterial (liner model, P=0.0205), communities varied between low and high-risk soil but there was no difference in oomycetes (liner model, P=0.547) communities. Due to low replicate, PERMANOVA analysis could not find differences in fungal, bacterial and oomycetes communities in low and high-risk soils.

The differential abundance analysis revealed that 63 fungal taxa, 517 bacterial taxa, and 33 oomycetes taxa were differently abundant between high and low risk soils. The relative abundance of the following taxa was greater in low-risk soils compared to high-risk: fungi *Mortierella, Tetracladium, Penicillium,* and *Fusarium*; bacteria *Bauldia* and *Rhizobium*, and oomycetes *Phytophthora* and *Albugo* (Figure 2A – 2C).

Furthermore, the low-risk soils had a higher soil pH ~7 and soil calcium content ~8400 ppm compared to high-risk soils with an average pH 5.8 and calcium content ~3800 ppm (Table 2). There was no effect of soil organic matter and other nutrients including P, K, Mg, Cl, Zn, Mn, S, Na, Cu, Fe, B, K/Mg (Table 2).

CONCLUSION: A comparative metagenomic analysis showed that microbial communities were different in the soils with high and low risk of cavity spot. The microbial taxa which were differentially abundant between low and high-risk soil are important and can be associated with disease risk. Based on the data (2021), the greater abundance of fungi *Mortierella, Tetracladium, Penicillium*, and *Fusarium*; bacteria *Bauldia* and *Rhizobium*, and oomycetes *Phytophthora* and *Albugo* was related to low risk of cavity spot. The low-risk soils had high soil pH, and calcium content. Assessment of additional fields is continuing to verify these results.

Table 1. Incidence and severity of cavity spot on carrots collected from low and high-risk fields, Bradford, Ontario, 2021.

Risk	Label	Field	Cultivar	Mefenoxam application	Cavity spot assessment	
					Incidence (%)	DSI[1] (%)
High	SGH2-21	Grower`s field	Envy	Yes	96 a [2]	55 a
High	SGH1-21	Grower`s field	Cellobunch	No	83 a	49 a
High	SU-21	Research trial at station	Multiple [3]	No	55 b	25 b
Low	SGL1-21	Grower`s field	Enterprise	No	39 b	16 b
Low	SGL2-21	Grower`s field	Navedo	Yes	38 b	15 b
Low	SJ-21	Jane St.	Navedo	No	29 c	12 b

[1] DSI indicates disease severity index calculated as

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

[2] Numbers in column followed by same letter are not significantly different at P =0.05, Tukey`s Test

[3] Seven carrot cultivars : Envy, Nairobi, Cellobunch, Red Sun, Upper cut, Honey Snax, and Atomic Red. DSI was calculated as an average of DSI of all cultivars from each block

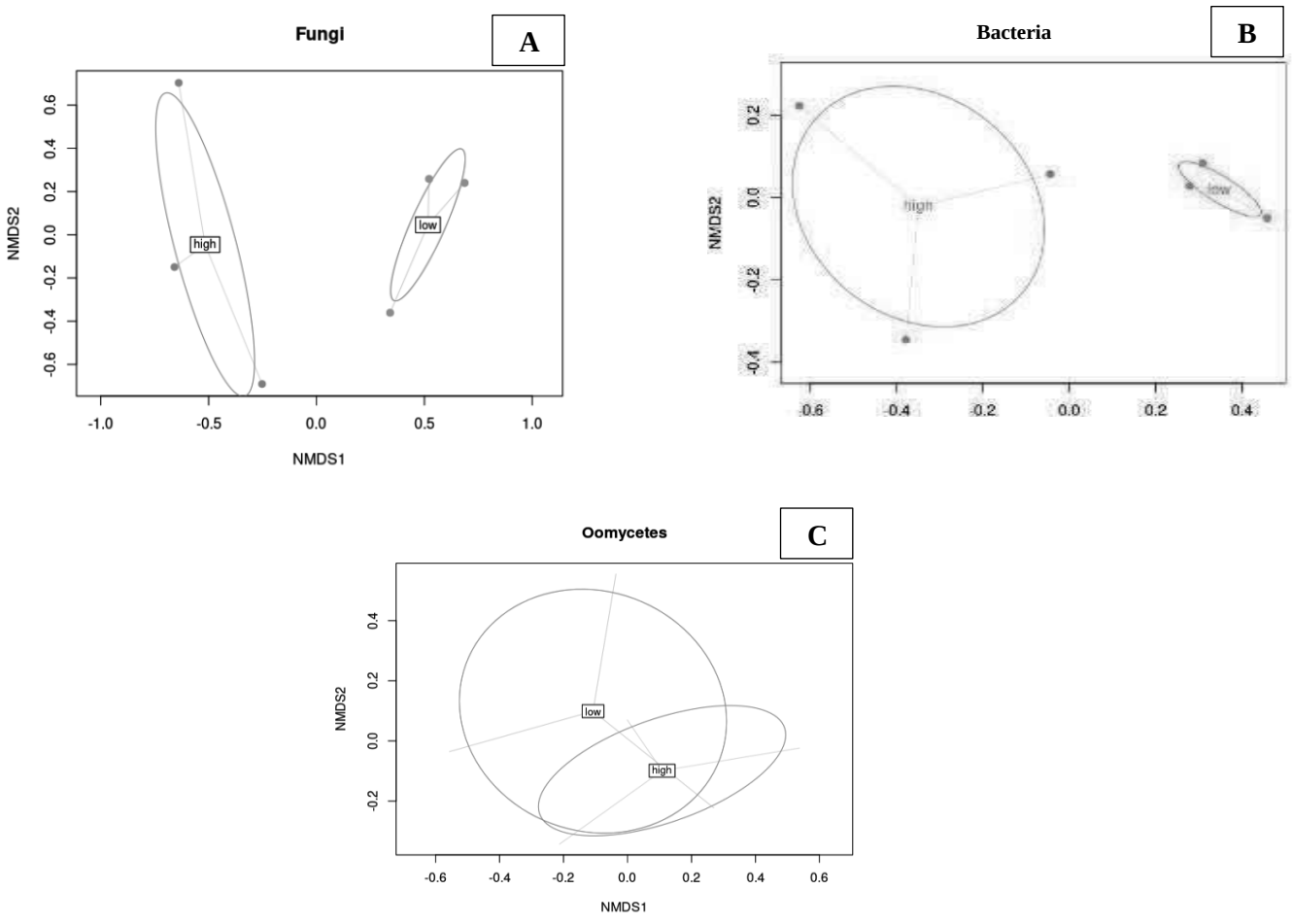

Figure 1. NMDS plots of fungal communities (A), bacterial communities (B), oomycetes communities (C)
Samples were coloured based on their disease risk: red: high risk, blue: low risk.

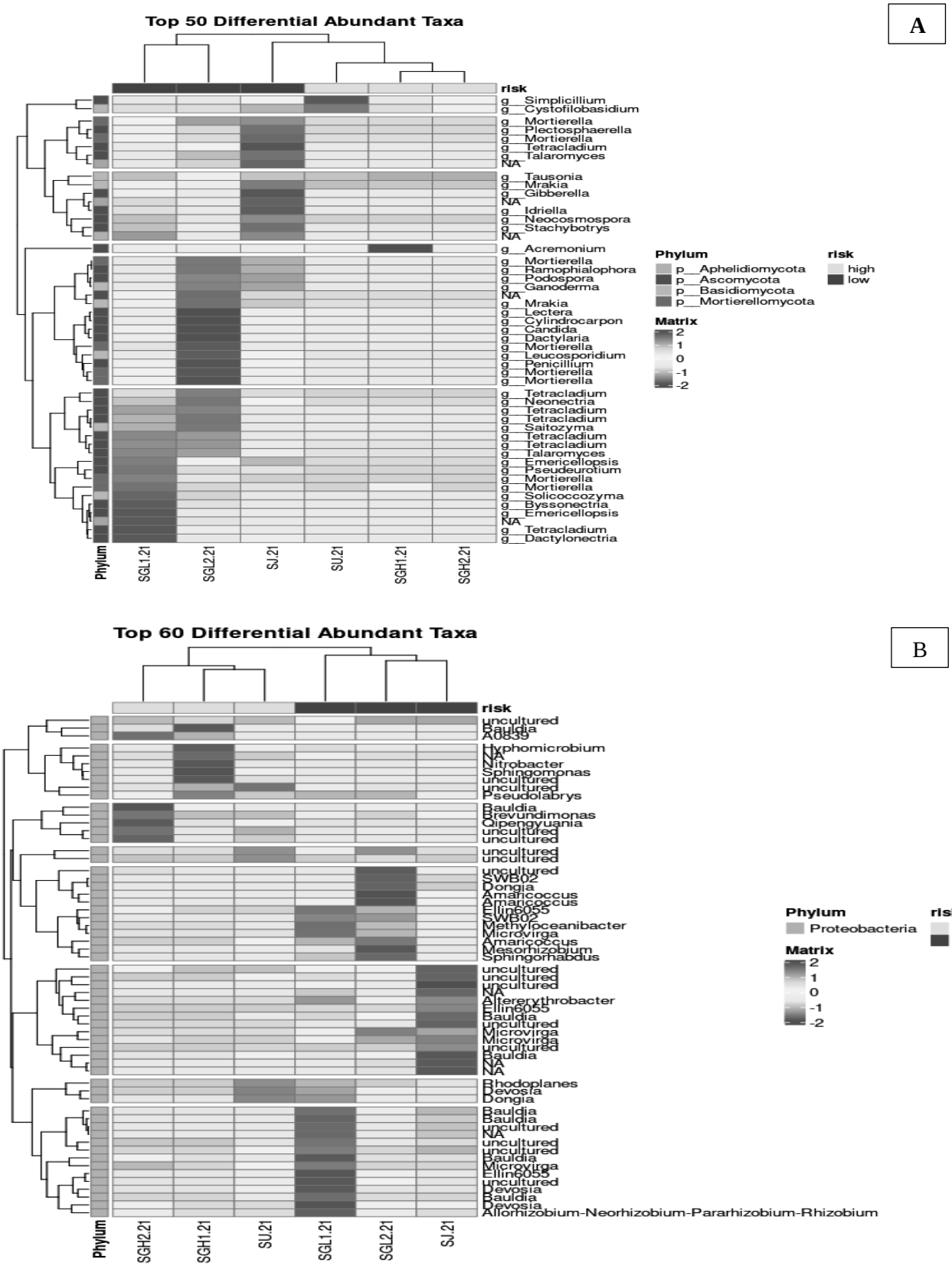

Figure 2. Differently abundant fungal taxa (A), and bacterial taxa (B) between low and high-risk soils. The columns under purple bar represented low risk fields and under yellow bar were high-risk fields. Y axis are taxonomic annotations at the Genus rank.

C

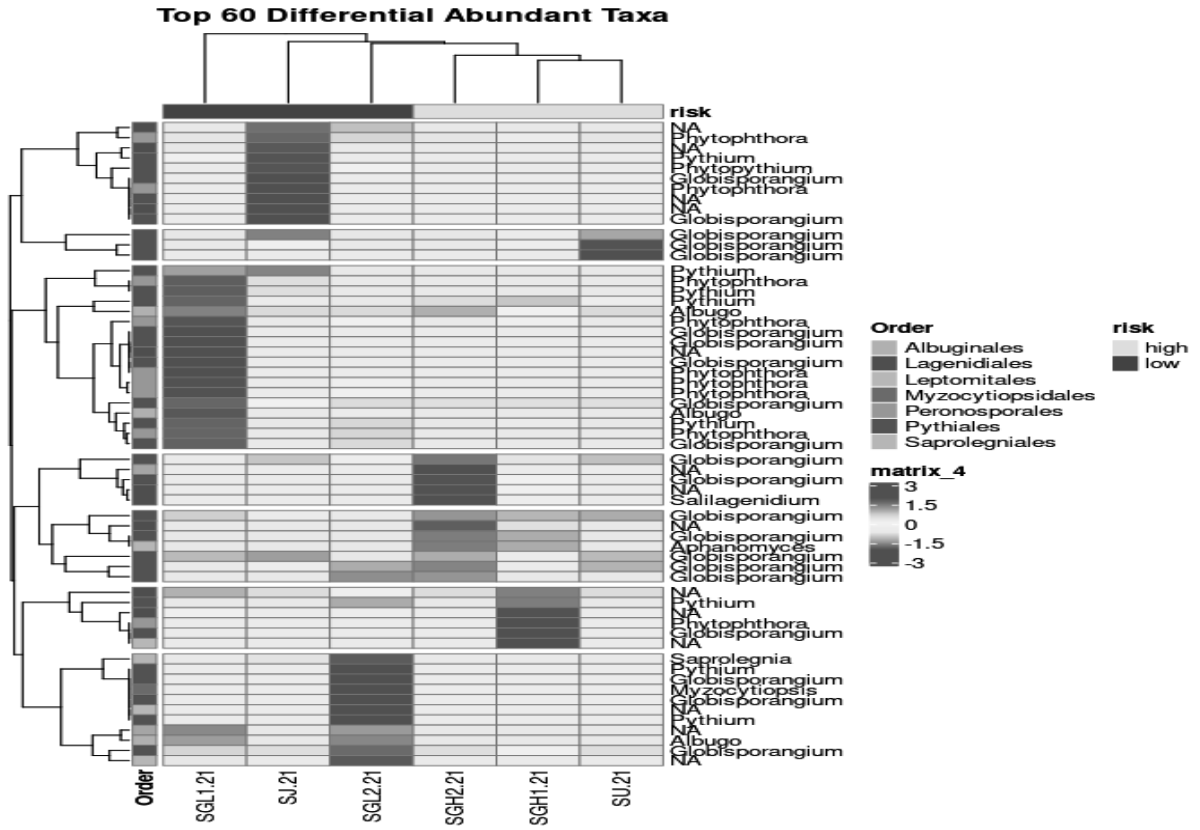

Figure 2C. Differently abundant oomycetes taxa between low and high-risk soils.
The columns under purple bar represented low risk fields and under yellow bar were high-risk fields. Y axis are taxonomic annotations at the Genus rank.

Table 2. Soil properties in relation to risk of cavity spot in the soil, Bradford, Ontario, 2021.

	Soil properties				
Disease risk	Organic matter (%)	Cation exchange capacity (MEQ)	pH	Calcium (ppm)	Base saturation calcium (%)
High-risk soils [1]	77 a[3]	28 b	5.8 b	3817 b	68 b
Low-risk soils [2]	61 b	49 a	7.0 a	8402 a	87 a

[1] Soil collected from three fields SU, SGH1, and SGH2 with high risk of cavity spot
[2] Soil collected from three fields SU, SGH1, and SGH2 with low risk of cavity spot
[3] Numbers in column followed by same letter are not significantly different at P =0.05, T-Test

Funding was provided by the California Fresh Carrot Marketing Board, the Ontario Agri-Food Innovation Alliance, the Fresh Vegetable Growers of Ontario and Bradford Cooperative Storage Ltd.

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, 2022

MATERIALS: Commercial cultivars Deep Purple, Atomic Red, Red Sun (Johnny's Select Seeds), Cellobunch, Pro Peel and Envy (Seminis Vegetable Seeds), Nairobi, Navedo (Bejo Seeds Inc)

METHODS: The trial was conducted on organic soils (pH ≈ 6.4, organic matter ≈ 68.3%) naturally infested with *Pythium* species at the Ontario Crops Research Centre - Bradford, Ontario. Carrot cultivars were direct seeded (≈ 65 seeds/m) on raised beds with spacing of 66 cm on 08 June. The trial was a randomized complete block with four replicates per treatment. One experimental unit was three rows 6 m in length. The eight carrot cultivars were chosen because they had varying susceptibility to cavity spot. These carrot cultivars were divided into three categories: relatively resistant: Deep Purple, moderately susceptible: Cellobunch, Nairobi, Pro Peel, Navedo, and very susceptible: Atomic Red, Envy, and Red Sun, 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. Fitty carrots were pulled from each experimental unit (25 consecutive carrots from two rows) to assess cavity spot at mid-season on 31 August. On 14 October, 100 carrots were pulled from two rows of each experimental unit (50 consecutive carrots from each row) to assess cavity spot. The two rows with the highest stand count were chosen for harvest.

The carrots were placed in cold storage until assessment. Carrots were washed with water in a small rotating drum washer and examined for the characteristic symptoms, sunken lesions horizontally arranged on the carrot root. Incidence of cavity spot was determined for each rep. Disease severity was determined based on the horizontal length of the largest lesion on the carrot. Disease severity was divided into six 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).

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

The relative disease response of the carrot cultivars was determined by comparing disease incidence and severity to pre-identified most resistant cultivar, Deep Purple, and the most susceptible cultivar, Atomic Red. The carrot cultivars that had a DSI statistically the same as Deep Purple were considered relatively resistant. Similarly, the carrot cultivars had disease response statistically the same as Atomic Red were considered susceptible.

The data were analyzed using General Analysis of Variances by SAS v9.4 as a randomized complete block design. The means were separated using Tukey`s Test at P = 0.05 level of significance. Compared to the previous 10-year average, air temperatures in 2022 were above average for May (15.1°C), average for June (18.3°C) August (20.6°C), September (16.5°C) and October (9.5°C), and below average for July (20.2°C). The 10-year average temperatures were: May 13.7°C, June 18.9°C, July 21.4°C, August 20.4°C, September

16.3°C and October 9.5°C. Monthly rainfall was below the 10-year average for May (50 mm), September (43 mm) and October (30 mm) and average for June (90 mm), July (74 mm) and August (82 mm). The 10-year rainfall averages were: May 64 mm, June 97 mm, July 78 mm, August 79 mm, September 59 mm and October 77 mm.

RESULTS: Deep Purple was very resistant, as expected. No disease was found in Deep Purple both at the mid-season and at harvest (Table 1). At mid-season, the disease was significantly lower only in Cellobunch compared to Atomic Red. Although the disease was numerically lower in Nairobi, Pro Peel and Navedo compared Atomic Red. At harvest, all orange cultivars had statistically same disease compared to Atomic Red. However, Cellobunch and Pro Peel had numerically, lowest disease compared to all other orange cultivars. Overall, Cellobunch, Pro Peel and Navedo were considered as moderately susceptible. Disease incidence was higher in Red Sun, Atomic Red, and Envy, compared to Cellobunch (6 %) at the mid-season disease assessment (Table 1). The disease severity was higher in Red Sun (48 %) compared to Navedo (23 %) Cellobunch (20 %) and Pro Peel (17 %) at harvest (Table 1).

CONCLUSION: The cultivar Deep Purple was very resistant as expected. Cellobunch, Pro Peel, and Navedo were moderately susceptible while Red Sun, Atomic Red and Envy were very susceptible to cavity spot. The disease severity at harvest in 2022 (17 – 43 %) was comparable to 2021 (14 – 44 %), and 2020 (25 – 42 %), but was moderate compared to some years.

Table 1. Incidence and severity cavity spot on carrots cultivars, grown on muck soils at the Ontario Crops Research Centre - Bradford, Ontario, 2022.

Cultivars	Color	Cavity spot assessment			
		Mid-season (31 August)		Harvest (14 October)	
		Incidence (%)	DSI[1]	Incidence (%)	DSI
Red Sun	Red	50.5 a[2]	19.7 ab	66.2 a	43.8 a
Atomic Red	Red	47.5 ab	21.2 a	46.7 ab	30.0 ab
Envy	Orange	42.0 ab	14.2 abc	51.5 ab	28.9 ab
Nairobi	Orange	30.0 bc	11.0 bc	44.7 ab	25.8 ab
Navedo	Orange	36.0 abc	12.5 abc	43.7 ab	23.9 b
Cellobunch	Orange	21.0 c	6.5 cd	35.7 b	20.3 b
Pro Peel	Orange	32.5 abc	12.0 bc	32.0 b	17.5 bc
Deep Purple	Purple	0.0 c	0.0 d	0.0 c	0.0 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.

Funding was provided by the California Fresh Carrot Marketing Board, the Ontario Agri-Food Innovation Alliance, the Bradford Cooperative Storage Ltd. and the Fresh Vegetable Growers of Ontario.

CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang.)
PEST: 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, 2022

MATERIALS: USDA experimental carrot breeding lines, commercial cultivars Cellobunch, Envy, Propeel, CV2384 (Seminis Vegetable Seeds), Atomic Red (OSC Seeds), Navedo, Deep Purple, Nairobi (Bejo Seed Inc.), CrispyCut, Maverick, UpperCut (Nunhems USA), Brillyance, Triton (Stokes Seeds), Imperial Cuts (Integra Hydrids)

METHODS: The trial was conducted on organic soil (pH ≈ 5.7, organic matter ≈ 70.8%) naturally infested with *Pythium* spp. at the Ontario Crops Research Centre - Bradford, Holland Marsh, Ontario. Carrots were direct seeded (≈70 seeds/m) onto raised beds using a push cone seeder on 2 June. A randomized complete block design with four replicates per treatment was used. Each experimental unit consisted of one row, 6 m in length, spaced 66 cm apart. On 20 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 24 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 1-3 November, 50 carrots from each replicate were harvested, placed into cold storage. Carrots were assessed for cavity spot on 28-30 November and 1-3 December. 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 2022 were above average for May (15.1°C), average for June (18.3°C) August (20.6°C), September (16.5C) and October (9.5°C), and below average for July (20.2°C). The 10-year average temperatures were: May 13.7°C, June 18.9°C, July 21.4°C, August 20.4°C, September 16.3°C and October 9.5°C. Monthly rainfall was below the 10-year average for May (50 mm), September (43 mm) and October (30 mm) and average for June (90 mm), July (74mm) and August (82 mm). The 10-year rainfall averages were: May 64 mm, June 97 mm, July 78 mm, August 79 mm, September 59 mm and October 77 mm.
Data were analyzed using the General Analysis of Variance function of Statistics V.10. Means separation was obtained using Fisher's Protected LSD test with P = 0.05 level of significance.

RESULTS: as presented in Tables 1 and 2

CONCLUSIONS: In 2022, rainfall in August and September was below average, irrigation was applied in early August to assist in disease development. Drier and warmer soil conditions in September and October was not favourable for cavity spot development. Overall disease development in the trial was lower than in previous years. The incidence of cavity spot in cv. Cellobunch was 16% in 2022 compared to 33% in 2021. Significant differences in cavity spot incidence were observed among the lines tested, ranging from 0 - 53%. Disease severity ranged from 0 - 23%. The orange line crosses 21'B123-3, 21'B120-3 and 17'766-5 all had cavity spot incidence less than 7.0% and these contained parental line F7738B or F7737B. Leaf blight was also low in 2022 compares to previous years. Many carrot lines had leaf blight ratings of 2.0 or less (Table 2). Very little bolting was observed in the trial, only four carrot lines had carrots with seeders (data not shown).

Table 1. Cavity spot incidence and severity index (DSI) and percent forked for carrot breeding lines from the University of Wisconsin grown at the Ontario Crops Research Centre -Bradford, Holland Marsh, Ontario, 2022.

Name/Seed source	Pedigree	Incidence (%)	DSI[1]	% Forked
Deep Purple		0.0 a[2]	0.0 a[2]	14.0 lmn
21'B123-3	(B2144A×F5494B)×F7738B	4.5 ab	1.8 ab	3.5 a-f
21'B120-3	(6274A×F7737B)×F7385B	6.0 abc	1.7 ab	2.5 a-e
17'766-5	(5280A×Nbh2306B)×F7738B	7.0 a-d	2.2 abc	6.0 a-i
21'B120-5	(Nbh2306×Nb8524)×F7385B	7.2 a-d	1.8 ab	4.5 a-h
19'B110-1	L9786B	8.2 a-e	2.2 abc	3.6 a-f
21'B119-4	(6274A×F7737B)×Nbh2306B	9.0 a-e	3.2 abc	4.5 a-h
	Brillyance	9.0 a-e	3.3 a-d	0.5 a
21'B119-2	(F7738×F9924)×Nbh2306B	9.0 a-e	2.5 abc	10.5 h-n
18'B112-6	(9304A×F7738B) × F7738B	9.2 a-f	3.5 a-d	5.5 a-i
17'791-5	(L1406A×L0567B)×Nbh2306B	9.5 a-g	2.7 abc	8.0 d-l
19'B108-1	L2575B	10.5 a-g	3.6 a-e	3.0 a-f
21'B119-5	(B2144A×F5494B)×Nbh2306B	10.5 a-g	2.5 abc	5.5 a-i
18'B111-6	(L1408A×Nbh2306B) × F7737B	10.5 a-g	3.6 a-d	8.6 f-l
18'B112-3	(2566A×F7738B) × F7738B	11.0 a-g	3.4 a-d	3.5 a-f
21'B119-3	(Nb2159×Nbh2306)×Nbh2306B	11.1 a-g	4.4 a-h	8.0 d-l
	Navedo	12.0 a-g	3.5 a-d	1.5 abc
21'B120-4	(F7738×Nbh2306)×F7385B	12.5 a-h	4.3 a-g	3.0 a-f
18'B111-7	(2566A×F7738B) × F7737B	12.5 a-h	3.7 a-e	1.5 abc
17'790-5	(L1406A×L0567B)×Nbh2306B	12.6 a-i	4.1 a-g	7.5 c-k
	CrispyCut	13.0 a-i	4.4 a-h	7.0 b-k
	Propeel	13.1 a-i	3.6 a-e	1.3 abc
21'B123-4	(6274A×F7737B)×F7738B	13.5 b-i	4.5 a-h	2.5 a-e
21'B120-2	(B2144A×F5494B)×F7385B	13.5 b-i	3.8 a-f	2.3 a-e
18'B112-5	(2566A×F7738B) × F7738B	13.5 b-i	4.0 a-g	5.0 a-h
	Triton	14.0 b-i	4.2 a-g	4.5 a-h
	Nairobi	14.5 b-i	5.0 a-h	1.0 ab
18'B111-1	F7737B	14.7 b-i	4.8 a-h	3.5 a-f
21'B123-2	F7738A	14.9 b-i	4.8 a-h	3.0 a-f
21'B119-1	Nbh2306B	15.0 b-i	5.3 a-i	4.0 a-g
N17005-1	Nbh2306B	15.0 b-i	4.2 a-g	13.0 k-n
17'791-4	(L9785A×L2576B)×Nbh2306B	15.5 b-j	4.6 a-h	7.0 b-k

	Cellobunch	**16.0 b-k**	**5.9 a-j**	**3.0 a-f**
19'B112-2	Nbh2306A	16.1 b-k	5.6 a-i	6.5 a-j
18'B112-8	(9304A×F7738B) × F7738B	16.5 b-k	5.2 a-h	3.5 a-f
21'B123-1	F7738B	16.7 b-l	6.2 a-j	3.5 a-f
	CV2384	18.0 c-m	5.8 a-j	4.5 a-h
18'B112-1	F7738B	18.5 c-n	5.3 a-i	2.0 a-d
18'B112-7	(2566A×F7738B) × F7738B	19.0 c-n	6.6 a-k	2.5 a-e
21'B120-1	F7385B	19.1 c-n	6.9 b-l	2.0 a-d
	Maverick	20.0 d-o	7.5 b-l	4.5 a-h
17'B121-3	L2574A X L1408B	20.0 d-o	8.1 b-m	9.0 f-m
18'B112-4	(9304A×F7738B) × F7738B	21.0 e-o	7.2 b-l	3.0 a-f
19'B110-3	(L2574XL1408) X L9786B	22.5 f-p	8.0 b-l	4.5a-h
17'766-4	(1111A×2226B)×F7738B	22.9 g-p	7.4 b-l	2.5 a-e
	UpperCut	25.8 h-q	8.8 c-m	10.0 g-n
N17005-2	Nbh2306A	26.0 i-q	7.9 b-l	11.5 g-n
19'B112-1	Nbh2306B	28.8 j-r	10.6 g-n	15.0 mn
19'B110-2	L9786A	29.1 k-r	13.1 i-q	4.5 a-h
	Maverick	30.0 l-r	10.0 d-m	3.5 a-f
19'S1433-1	L1408B	30.0 l-r	12.2 j-p	9.0 f-m
19'S1433-2	L1408A	30.1 l-r	10.5 f-n	15.5 n
17'789-2	(L1406A×L0567B)×Nbh2306B	31.0 m-r	8.8 c-m	8.5 e-l
19'B108-3	(L1408XL7553) X L2575B	31.9 n-r	11.1 c-m	4.0 a-g
17'790-6	(L9793A×L3726B)×Nbh2306B	32.7 o-r	10.4 e-n	12.5 j-n
N171692	L9793A	34.7 pqr	12.0 i-p	5.5 a-i
19'B108-2	L2575A	34.9 p-s	14.8 n-q	3.5 a-f
17'791-6	(L9793A×L3726B)×Nbh2306B	35.4 p-s	12.5 k-p	10.0 g-n
N151792	L9793A	35.5 p-s	13.6 m-q	8.0 d-l
	Imperial Cuts	36.7 q-t	17.5 p-s	9.0 f-m
17'B121-1	L1408B	42.2 r-u	19.5 rs	10.5 h-n
N151791	L9793B	48.3 stu	16.9 o-s	8.5 e-l
N171691	L9793B	49.2 tu	18.2 qrs	5.5 a-i
	Atomic Red	53.3 u	22.8 s	6.5 a-j

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

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

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

Table 2. Stand (20 July) and leaf blight ratings (24 October), for carrot breeding lines from University of Wisconsin grown at the Ontario Crops Research Centre -Bradford, Holland Marsh, Ontario, 2022.

Name/Seed source	Pedigree	Stand Rating[1]	Leaf Blight Rating[2,3]
	Brillyance	4.8	0.0
21'B123-3	(B2144A×F5494B)×F7738B	4.3	**2.0**
21'B119-5	(B2144A×F5494B)×Nbh2306B	4.3	0.8
	Navedo	4.3	**2.0**
18'B111-6	(L1408A×Nbh2306B) × F7737B	4.0	1.8
21'B119-4	(6274A×F7737B)×Nbh2306B	4.0	1.8
18'B112-5	(2566A×F7738B) × F7738B	3.8	1.3
21'B123-4	(6274A×F7737B)×F7738B	3.8	**3.3**
21'B120-2	(B2144A×F5494B)×F7385B	3.8	**3.5**
17'B121-1	L1408B	3.5	0.3
17'B121-3	L2574A X L1408B	3.5	0.0
18'B112-8	(9304A×F7738B) × F7738B	3.5	**2.8**
	Maverick	3.5	0.8
	Propeel	3.5	0.5
21'B120-4	(F7738×Nbh2306)×F7385B	3.5	**3.5**
	CrispyCut	3.3	0.0
	UpperCut	3.3	0.8
18'B112-3	(2566A×F7738B) × F7738B	3.3	**3.8**
18'B112-4	(9304A×F7738B) × F7738B	3.3	1.8
19'B110-3	(L2574XL1408) X L9786B	3.3	1.8
21'B119-2	(F7738×F9924)×Nbh2306B	3.3	0.8
	Deep Purple	3.3	1.0
	CV2384	3.3	0.3
18'B111-7	(2566A×F7738B) × F7737B	3.3	**2.0**
N17005-2	Nbh2306A	3.0	1.3
18'B112-6	(9304A×F7738B) × F7738B	3.0	0.5
N151792	L9793A	3.0	1.5
21'B120-3	(6274A×F7737B)×F7385B	3.0	**3.8**
	Nairobi	3.0	1.5
	Maverick	3.0	0.3
19'S1433-1	L1408B	2.8	1.0
19'S1433-2	L1408A	2.8	0.5
17'791-5	(L1406A×L0567B)×Nbh2306B	2.8	0.5
18'B112-7	(2566A×F7738B) × F7738B	2.8	2.8
21'B123-2	F7738A	2.8	**3.9**
19'B110-2	L9786A	2.8	0.8
21'B120-5	(Nbh2306×Nb8524)×F7385B	2.8	**2.8**
17'790-6	(L9793A×L3726B)×Nbh2306B	2.8	1.0
	Triton	2.8	0.5
19'B112-2	Nbh2306A	2.5	0.8
17'791-4	(L9785A×L2576B)×Nbh2306B	2.5	0.3
18'B112-1	F7738B	2.5	**3.3**
17'766-5	(5280A×Nbh2306B)×F7738B	2.5	0.8
19'B108-3	(L1408XL7553) X L2575B	2.5	0.5
21'B119-3	(Nb2159×Nbh2306)×Nbh2306B	2.5	1.3
21'B123-1	F7738B	2.5	**3.8**
17'791-6	(L9793A×L3726B)×Nbh2306B	2.5	1.0
N151791	L9793B	2.3	0.8

19'B110-1	L9786B	2.3	**3.5**
	Cellobunch	2.3	**2.0**
18'B111-1	F7737B	2.0	**3.5**
N171692	L9793A	2.0	1.3
21'B120-1	F7385B	2.0	3.5
	Atomic Red	2.0	**3.3**
17'790-5	(L1406A×L0567B)×Nbh2306B	2.0	0.8
N17005-1	Nbh2306B	1.5	1.0
19'B112-1	Nbh2306B	1.5	1.3
17'789-2	(L1406A×L0567B)×Nbh2306B	1.5	0.8
N171691	L9793B	1.5	**2.0**
19'B108-1	L2575B	1.5	1.0
17'766-4	(1111A×2226B)×F7738B	1.5	**3.0**
	Imperial Cuts	1.3	0.8
19'B108-2	L2575A	1.3	0.8
21'B119-1	Nbh2306B	1.3	1.3
	Envy	1.0	--

[1] Stand (carrot emergence) was rating on 28 July using a 0-5 scale where 0 = <5 carrots, 1 = very poor, 2 = poor, 3 = good, 4 = very good, 5 = excellent.

[2] Leaf blight was rated on a 0-5 scale where 0 = no blight, 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.

[3] Leaf blight ratings 2.0 or higher (the rating for Cellobunch) are noted in bold.

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

CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang.), cv. Envy
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 APPLIED IN-FURROW TO CONTROL PYTHIUM DISEASES IN CARROTS, 2022

MATERIALS: RIDOMIL GOLD 480 SL (metalaxyl-M & S-isomer 480g/L), PICARBUTRAZOX 10 SC (picarbutrazox 100 g/L) HICAL Grade F LIMESTONE (calcium oxide 54.5 %)

METHODS: The trial was conducted at the Ontario Crops Research Centre – Bradford, Ontario in muck soil (organic matter ≈ 71.7%, pH ≈ 5.8) known to be infested with *Pythium* spp. The trial was arranged as a factorial in a randomized complete block with six replicates per treatment. One factor was limestone and the other factor was fungicide. Each experimental unit consisted of six rows, 66 cm apart and 8 m in length. Treatments were between treatments containing HICAL LIMESTONE at 5 t/ha (factor one), and RIDOMIL GOLD at 0.65 L/ha and PICARBURAZOX at 3 L/ha and an untreated check (factor two). Carrots, cv. Envy, were direct seeded at 70 seeds/m into raised beds using a Stanhay Precision seeder on 30 May. HICAL LIMESTONE was broadcast over the treatment plots and incorporated into the soil prior to seeding. RIDOMIL GOLD, PICARBUTRAZOX were applied directly over the seed using StreamJet nozzles SJ3-030VP on the seeder using a water volume of 254 L/ha. Two assessment plots 1.5 m in length were set up in the middle of the three rows of each replicate. Stand counts were done in each assessment plot once the carrots were established. On 2 September, a mid-season assessment sample of 25 consecutive carrots was harvested, hand washed and 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 18 October, carrots from the two staked out 1.5 m sections of row were harvested by hand and placed into storage. On 24 November, carrots were removed from storage and graded for size into the following categories: jumbo (>4.4 cm), medium (1.9-4.4 cm), and forked/stunted (<1.9 cm). Fifty carrots that were not forked or stunted were set aside for the cavity spot assessment, washed in a small drum washer, 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:

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

Compared to the previous 10-year average, air temperatures in 2022 were average for June (18.3°C) August (20.6°C), September (16.5°C) and October (9.5°C), and below average for July (20.2°C). The 10-year average temperatures were: June 18.9°C, July 21.4°C, August 20.4°C, September 16.3°C and October 9.5°C. Monthly rainfall was below the 10-year average for September (43 mm) and October (30 mm) and average for June (90 mm), July (74 mm) and August (82 mm). The 10-year rainfall averages were: June 97 mm, July 78 mm, August 79 mm, September 59 mm and October 77 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: data are presented in Tables 1 and 2

CONCLUSIONS: Cavity spot incidence and severity were relatively low in this trial and percent forking was moderate. No significant differences in cavity spot incidence or severity were found among the treatments at the midseason assessments (Table 1). At harvest, there was a significant interaction between lime and fungicide, so the interaction effects were examined separately. Significant differences were found among the treatments in cavity spot incidence and DSI. All treatments had lower incidence and DSI than the check with no LIMESTONE. Carrots treated with RIDOMIL had lower incidence and DSI without LIMESTONE than the same treatments with LIMESTONE. LIMESTONE had no effect on incidence or DSI of carrots treated with PICARBUTRAZOX (Table 1). There was lower disease incidence and DSI in the untreated check with LIMESTONE than without. There were no differences in percent of forked or stunted carrots and no interaction. There were no significant differences in marketable yield among the treatments and no interaction among treatments (Table 2).

Table 1. Cavity spot incidence, severity (DSI) and percent forked for carrots, cv. Envy, grown in muck soil infested with *Pythium* spp. at the Ontario Crops Research Centre – Bradford, Ontario, 2022.

Treatment	Calcium	Mid-season[1]		Harvest[2]	
		Incidence (%)	DSI[3]	Incidence (%)	DSI
RIDOMIL		22.3 ns[4]	7.7 ns	24.2 a[5]	7.6 a
RIDOMIL	Yes	17.0	5.1	36.1 b	13.0 b
PICARBUTRAZOX		13.7	4.1	25.1 ab	7.6 a
PICARBUTRAZOX	Yes	12.0	3.8	29.6 ab	9.2 ab
Untreated		17.3	4.9	48.4 c	18.0 c
Untreated	Yes	12.6	3.9	29.6 ab	9.6 ab

[1] Mid-season assessments were conducted on a 25 carrot sample harvested on 2 September.
[2] Harvest assessments were conducted on a 50 carrot sample harvested on 24 November.
[3] DSI was calculated using the following equation:

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

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

Table 2. Marketable yield and size distribution for carrots, cv. Envy, treated with fungicides applied in-furrow and grown at the Ontario Crops Research Centre - Bradford, Ontario, 2022.

Treatment	Calcium	Marketable Yield (t/ha)	Size Distribution[1] (%)		
			% Jumbo (>4.4 cm)	% Medium (1.9 – 4.4 cm)	% Forked or stunted (<1.9 cm)
RIDOMIL		51.4 ns[2]	18.5 ns	64.0 ns	17.4 ns
RIDOMIL	Yes	49.7	20.7	53.6	25.7
PICARBUTRAZOX		41.3	20.3	55.1	24.6
PICARBUTRAZOX	Yes	50.3	25.3	60.8	14.0
Untreated		49.0	26.9	56.9	16.2
Untreated	Yes	45.6	16.5	64.1	19.5

[1] Size distribution was based on the total weight of each yield sample.
[2] ns indicates no significant differences were found among the treatments.

Funding for this project was provided by the Ontario Agri-Food Innovation Alliance, the Bradford Cooperative and 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 SUNERGIST FUNGICIDE FOR LEAF BLIGHT CONTROL IN CARROTS, 2022

MATERIALS: Sunergist (experimental), FLINT (trifloxystrobin 50%)

METHODS: The trial was conducted on muck soil (pH ≈ 7.0, organic matter ≈ 65.5 %) near the Ontario Crops Research Centre - Bradford, Holland Marsh, Ontario. Carrots, cv. Cellobunch, were direct seeded (82 seeds/m) into raised beds using a Stanhay precision seeder on 2 June. 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 SUNERGIST at 0.5ml/L and AGRAL 90 applied at 4 different leaf stages, every 7-10 days, and every 7-10 days with the addition of FLINT at 210g/ha. An untreated check was also included. Treatments were applied on 20 July, 9, 16, 23, 31 August and 9, 15 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 12 October, 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:

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

On 12 October, carrots in two 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 2022 were above average for May (15.1°C), average for June (18.3°C) August (20.6°C), September (16.5°C) and October (9.5°C), and below average for July (20.2°C). The 10-year average temperatures were: May 13.7°C, June 18.9°C, July 21.4°C, August 20.4°C, September 16.3°C and October 9.5°C.
Monthly rainfall was below the 10-year average for May (50 mm) and September (43 mm) and October (30 mm) and average for June (90 mm), July (74 mm) and August (82 mm). The 10-year rainfall averages were: May 64 mm, June 97 mm, July 78 mm, August 79 mm, September 59 mm and October 77 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: as presented in Tables 1 and 2

CONCLUSIONS: Leaf blight incidence was high in the trial with 86% incidence in untreated carrots (Table 1). Significant differences in leaf blight incidence, severity, and the percentage of dead leaves were found among the treatments (Table 1). Carrots treat with SUNERGIST + FLINT every 7–10 days had lower incidence of leaf blight and fewer dead leaves than the other treatments. SUNERGIST + FLINT every 7–10 days also had significantly lower disease severity than the untreated check and the SUNERGIST applied at 4 leaf stages. SUNERGIST applied at the 4 leaf stages and at every 7-10 days had numerically lower DSI than the check (44.4% and 37.8% respectively vs 75.2%), but the difference was not statistically significant.
There were no significant differences in marketable yield, marketable percent, or size distribution among treatments (Table 2).

Table 1. Leaf blight incidence and severity assessed on 17 September for carrots, cv. Cellobunch, treated with SUNERGIST and FLINT grown near Ontario Crops Research Centre - Bradford, Holland Marsh, Ontario, 2022.

Treatment[1]	Product rate (ml/L)	Application timing	Leaf blight Incidence (%)	DSI[2 3] (0-100)	Dead leaves (%)
SUNERGIST[4] + FLINT	0.5 + 210g/ha	7-10 days[4]	57.8 a[5]	14.6 a	7.3 a
SUNERGIST	0.5	7-10 days	89.2 b	37.8 ab	12.9 b
SUNERGIST	0.5	Leaf stages[6]	82.2 b	44.4 b	12.6 b
Check	-	-	86.1 b	75.2 b	16.0 b

[1] SUNGERGIST treatments were applied with a non-ionic surfactant (AGRAL 90 at 0.02% v/v)

[2]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 12 October

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

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

[4] Treatment applied at a 7-10 day interval between July 20th to September 15th for 7 applications total.

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

[6] Treatments applied at 2-4 leaf stage, 5-8 leaf stage, canopy 50% closed, and canopy closed 90% for 4 applications total.

Table 2. Yield and size distribution of carrots, cv. Cellobunch, treated with SUNERGIST and FLINT grown near the Ontario Crops Research Centre - Bradford, Holland Marsh, Ontario, 2022.

Treatment[1]	Product rate (ml/L)	Application timing	% Marketable[2]	% Medium (2.0-4.5 cm)	% Jumbo (> 4.5 cm)	Marketable Yield (t/ha)
SUNERGIST[4] + FLINT	0.5 + 210g/ha	7-10 days[3]	88.7 ns[4]	73.0 ns	15.7 ns	60.0 ns
SUNERGIST	0.5	7-10 days	90.9	79.6	15.4	58.8
SUNERGIST	0.5	Leaf stages[5]	93.0	77.6	11.3	60.6
Check	-	-	90.0	78.1	12.0	62.6

[1] SUNGERGIST treatments were applied with a non-ionic surfactant (AGRAL 90 at 0.02% v/v)

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

[3] Treatment applied at a 7-10 day interval between July 20th to September 15th for 7 applications total.

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

[5] Treatments applied at 2-4 leaf stage, 5-8 leaf stage, canopy 50% closed, and canopy closed for 4 applications total.

Funding for this project was provided by Suntton Biochemical Ltd.

CROP: Carrot (*Dauca carota*, subsp sativus), cv. Cellobunch
PEST: Weed control data was not recorded in this trial.

AUTHORS: SWANTON C AND SMITH P
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TITLE: TOLERANCE OF CARROT TO SELECTED WEED MANAGEMENT STRATEGIES ON MUCK SOIL, 2022

MATERIALS: DUAL II MAGNUM (S-metolachlor/benoxacor 915 g/l), LOROX-L (linuron 480 g/l), ZIDUA (pyroxasulfone 85% w/w), BLAZER (aciflurofen 240 g/l), GOAL (oxyfluorfen 120 g/l), PROWL H_20 (pendimethalin 455 g/l), TOUGH 600 EC (pyridate 600 g/l)

METHODS: Carrots, cv. Cellobunch, were direct seeded (25 seeds per 30 cm of row) on June 3rd , 2022 into muck soil (organic matter ≈ 55.6%, pH ≈ 7.3) at the Ontario Crops Research Centre - Bradford, Holland Marsh, Ontario. A randomized complete block arrangement with four replicates per treatment was used. Each replicate consisted of two raised beds spaced 85 cm apart and 6 m in length. Herbicide treatments were applied using a backpack mounted sprayer fitted with AIXR110-02 spray tips calibrated to deliver 200 L/ha at 206.84 kPa. Herbicide treatments are listed in Table 1.

Treatments were applied to carrots on 19 June, 02 July, 08 July and 26 July 2022. Carrots were grown using best agronomic practices for nutrients and pest management in order to isolate crop tolerance to herbicide treatments. Stand counts were recorded on July 11, 2022. Carrots were harvested on October 28, 2022 from two 1.16 m sections of row per plot. Yield samples were graded on November 22 for size and weight to determine marketable yield. Marketable yield was determined to be a combination of medium and jumbo carrots (1.75" diameter and greater).

Yield data were analyzed using ARM Version 2022.5 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: Visual tolerance of carrots, cv. Cellobunch, was excellent in all treatments (data not presented). Pyridate tank mixtures with pyroxasulfone, metolachlor or pendimethanlin applied post emergence at the BE (cotyledon) to 1leaf stage or at the 5 to 7 leaf stage of carrot growth was highly selective, resulting in no observed crop injury. In addition, pyridate tank mixed with Select +Amigo applied at the 5 to 7 leaf stage of carrots did not result in crop injury. No significant differences in carrot seedling stand counts or crop yield were detected among treatments compared to the weed free check (see Table 1.)

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, Belchim Crop Protection Canada, and the Bradford Co-operative.

Table 1. Stand counts and yield of carrots, cv. Cellobunch

Treatment	Rate (g ai/ha)	Crop stage at application	Carrot Stand Count #/m row[1]	Yield T/ha[1]
S-Metolachlor (Dual II Magnum)	1098	BE-1 lf	54.1	60.9
Linuron (Lorox-L)	300	BE-1 lf		
Linuron (Lorox-L)	300	1-3 lf		
S-Metolachlor (Dual II Magnum)	1098	3-5 lf		
Linuron (Lorox-L)	300	3-5 lf		
Linuron (Lorox-L)	300	5-7 lf		
Pyroxasulfone (Zidua)	89	BE-1 lf	51.0	55.3
Pyridate (Tough 600 EC)	450	BE-1 lf		
Acifluorfen (Blazer)	18.75	1-3 lf		
Oxyflurofen (Goal)	60	3-5 lf		
Pyridate (Tough 600 EC)	450	3-5 lf		
Oxyflurofen (Goal)	60	5-7 lf		
S-Metolachlor (Dual II Magnum)	450	BE-1 lf	58.2	56.9
Pyridate (Tough 600 EC)	450	BE-1 lf		
Acifluorfen (Blazer)	18.75	1-3 lf		
Oxyflurofen (Goal)	60	3-5 lf		
Pyridate (Tough 600 EC)	450	3-5 lf		
Oxyflurofen (Goal)	60	5-7 lf		
Pendimethalin (Prowl H_20)	1680	BE-1 lf	51.2	59.0
Pyridate (Tough 600 EC)	450	BE-1 lf		
Acifluorfen (Blazer)	18.75	1-3 lf		
Oxyflurofen (Goal)	60	3-5 lf		
Pyridate (Tough 600 EC)	450	3-5 lf		
Oxyflurofen (Goal)	60	5-7 lf		
Pyroxasulfone (Zidua)	89	BE-1 lf	49.2	67.6
Acifluorfen (Blazer)	18.75	1-3 lf		
Oxyflurofen (Goal)	60	3-5 lf		
Pyroxasulfone (Zidua)	89	5-7 lf		
Pyridate (Tough 600 EC)	450	5-7 lf		
S-Metolachlor (Dual II Magnum)	1098	BE-1 lf	48.0	58.5
Acifluorfen (Blazer)	18.75	1-3 lf		
Oxyflurofen (Goal)	60	3-5 lf		
S-Metolachlor (Dual II Magnum)	1098	5-7 lf		
Pyridate (Tough 600 EC)	450	5-7 lf		
Pendimethalin (Prowl H_20)	1680	BE-1 lf	49.4	52.3
Acifluorfen (Blazer)	18.75	1-3 lf		
Oxyflurofen (Goal)	60	3-5 lf		
Pendimethalin (Prowl H_20)	1680	5-7 lf		
Pyridate (Tough 600 EC)	450	5-7 lf		
Pyroxasulfone (Zidua)	89	BE-1 lf	55.2	59.8
Acifluorfen (Blazer)	18.75	1-3 lf		
Pyridate (Tough 600 EC)	450	1-3 lf		
Oxyflurofen (Goal)	60	3-5 lf		
Pyridate (Tough 600 EC)	450	5-7 lf		

[1] - No significant differences were found among the treatments compared to the weed free check

Data were analyzed using ARM Version 2022.5 Analysis of Variance function. Means separation was obtained by using Tukey's HSD test at P = 0.05 level of significance. All treatments received a pre emergence treatment of prometryne followed by a post emergence treatment of bromoxynil to ensure all emerging weed seedlings were controlled prior to emergence of the carrot seedlings. Crop growth stage BE-1 lf refers to bunny ear (cotyledon) to first true leaf stage of carrot growth.

CROP: Carrot (*Dauca carota*, subsp sativus), cv. Cellobunch
PEST: Weed control data was not recorded in this trial.

AUTHORS: SWANTON C AND SMITH P
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TITLE: TOLERANCE OF CARROT TO BLAZER APPLIED WITH OR WITHOUT ASSIST SURFACTANT, 2022

MATERIALS: BLAZER (aciflurofen 240 g/l), ASSIST OIL CONCENTRATE (paraffin base mineral oil 83% v/v)

METHODS: Carrots, cv. Cellobunch, were direct seeded (25 seeds per 30 cm of row) on June 3rd , 2022 into muck soil (organic matter ≈ 55.6%, pH ≈ 7.3) at the Muck Crops Research Station, Holland Marsh, Ontario. A randomized complete block arrangement with three replicates per treatment was used. Each replicate consisted of two raised beds spaced 85 cm apart and 6 m in length. Herbicide treatments were applied using a backpack mounted sprayer fitted with AIXR110-02 spray tips calibrated to deliver 200 L/ha at 206.84 kPa. Herbicide treatments are listed in Table 1. Treatments were applied to carrots on 19 June 2022. Carrots were grown using best agronomic practices for nutrients and pest management in order to isolate crop tolerance to Blazer +/- Assist. Stand counts were recorded on July 19, 2022. Carrots were harvested on November 07, 2022 from two 1.16 m sections of row per plot. Yield samples were graded on November 22 for size and weight to determine marketable yield. Marketable yield was determined to be a combination of medium and jumbo carrots (1.75" diameter and greater).
Yield data were analyzed using ARM Version 2022.5 Analysis of Variance function. Means separation was obtained by using Tukey's HSD test at P = 0.05 level of significance.

RESULTS: See Table 1

CONCLUSIONS: Visual tolerance of carrots, cv. Cellobunch, to acifluorfen was excellent in all treatments (data not presented). No significant differences in stand counts or crop yield were detected among treatments compared to the weed free check (see Table 1.) The addition of Assist Oil Concentrate to Blazer, at 18.75, 23 or 50 g ai/ha, had no significant effect on carrot stand counts or carrot yield.

Table 1. Stand counts and yield of carrots, cv. Cellobunch, treated with Blazer +/- Assist Oil Concentrate applied early post emergence.

Treatment	Rate (g ai/ha)	Crop stage at application	Stand Count #/m row[1]	Yield T/ha[1]
WEED FREE CHECK			42.5	43.3
Acifluorfen	18.75	Bunny ear – 1 lf	52.2	48.6
Acifluorfen + Assist	18.75	Bunny ear – 1 lf	61.5	41.6
Acifluorfen	23	Bunny ear – 1 lf	55.7	43.6
Acifluorfen + Assist	23	Bunny ear – 1 lf	48.7	43.1
Acifluorfen	50	Bunny ear – 1 lf	50.0	41.3
Acifluorfen + Assist	50	Bunny ear – 1 lf	48.0	46.1

[1] - No significant differences were detected among treatments compared to the weed free check.
Data were analyzed using ARM Version 2022.5 Analysis of Variance function. Means separation was obtained by using Tukey's HSD test at P = 0.05 level of significance. Crop growth stage bunny ear-1 lf refers to bunny ear (cotyledon) to first true leaf stage of carrot growth. Assist Oil Concentrate was added to the herbicide solution at a rate of 0.5%v/v.

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, Belchim Crop Protection Canada, and the Bradford Co-operative and Muck Crop Vegetable Growers.

CROP: Carrot (*Dauca carota*, subsp sativus), cv. Cellobunch
PEST: Weed control data was not recorded in this trial.

AUTHORS: SWANTON C AND SMITH P
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TITLE: TOLERANCE OF CARROT TO VARYING RATES OF DIFLUFENICAN APPLIED POST EMERGENCE ON MUCK SOIL, 2022

MATERIALS: Diflufenican 500 g/l

METHODS: Carrots, cv. Cellobunch, were direct seeded (25 seeds per 30 cm of row) on June 3rd, 2022 into muck soil (organic matter ≈ 55.6%, pH ≈ 7.3) at the Jane Street research location, near the Ontario Crops Research Centre - Bradford, Holland Marsh, Ontario. A randomized complete block arrangement with four replicates per treatment was used. Each replicate consisted of two raised beds spaced 85 cm apart and 6 m in length. Herbicide treatments were applied using a backpack mounted sprayer fitted with AIXR110-02 spray tips calibrated to deliver 200 L/ha at 206.84 kPa. Herbicide treatments are listed in Table 1. Treatments were applied to carrots on 19 June and 02 July 2022. Carrots were grown using best agronomic practices for nutrients and pest management in order to isolate crop tolerance to diflufenican. Stand counts were recorded on July 19, 2022. Carrots were harvested on November 07, 2022 from two 1.16 m sections of row per plot. Yield samples were graded on November 22 for size and weight to determine marketable yield. Marketable yield was determined to be a combination of medium and jumbo carrots (1.75" diameter and greater).
Yield data were analyzed using ARM Version 2022.5 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: Visual tolerance of carrots, cv. Cellobunch, to diflufenican applied post emergence at the bunny ear (cotyledon) to the 3rd true leaf stage was excellent in all treatments (data not presented). No significant differences in stand counts or crop yield were detected among treatments compared to the weed free check.

Table 1. Stand counts and yield of carrots, cv. Cellobunch, treated with varying rates of diflufenican and applied early post emergence.

Treatment	Rate (g ai/ha)	Crop stage at application	Stand Count #/m row[1]	Yield T/ha[1]
WEED FREE CHECK			51.8	67.9
Diflufenican	60	Bunny ear – 1 lf	53.9	65.2
Diflufenican	90	Bunny ear – 1 lf	57.5	66.0
Diflufenican	120	Bunny ear – 1 lf	54.9	68.3
Diflufenican	60	1-3 lf	53.3	67.5
Diflufenican	90	1-3 lf	51.5	78.1
Diflufenican	120	1-3 lf	53.5	73.4
Diflufenican	180	1-3 lf	53.6	74.9

[1] - No significant differences were found among the treatments compared to the weed free check.

Data were analyzed using ARM Version 2022.5 Analysis of Variance function. Means separation was obtained by using Tukey's HSD test at P = 0.05 level of significance. Crop growth stage Bunny ear-1 lf refers to bunny ear (cotyledon) to first true leaf stage of carrot growth.

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, Belchim Crop Protection Canada, and the Bradford Co-operative.

CROP: Carrot (*Dauca carota*, subsp sativus), cv. Cellobunch
PEST: Weed control data was not recorded in this trial.

AUTHORS: SWANTON C AND SMITH P
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TITLE: TOLERANCE OF CARROT TO VARYING RATES OF PYRIDATE (TOUGH 600 EC) AND METOBROMURON (PRAXIM) APPLIED PRE AND EARLY POST EMERGENCE ON MUCK SOIL, 2022

MATERIALS: TOUGH 600 EC (pyridate 600 g/l), PRAXIM (metobromuron 500 g/l)

METHODS: Carrots, cv. Cellobunch, were direct seeded (25 seeds per 30 cm of row) on June 3rd , 2022 into muck soil (organic matter ≈ 55.6%, pH ≈ 7.3) at the Ontario Crops Research Centre - Bradford, Holland Marsh, Ontario. A randomized complete block arrangement with four replicates per treatment was used. Each replicate consisted of two raised beds spaced 85 cm apart and 6 m in length. Herbicide treatments were applied using a backpack mounted sprayer fitted with AIXR110-02 spray tips calibrated to deliver 200 L/ha at 206.84 kPa. Herbicide treatments are listed in Table 1. Treatments were applied to carrots on 09 June and 19 June 2022. Neither pyridate or metobromuron were applied to the weed free treatment. Carrots were grown using best agronomic practices for nutrients and pest management in order to isolate crop tolerance to pyridate or metobromuron. Stand counts were recorded on July 11, 2022. Carrots were harvested on October 30, 2022 from two 1.16 m sections of row per plot. Yield samples were graded on November 22 for size and weight to determine marketable yield. Marketable yield was determined to be a combination of medium and jumbo carrots (1.75" diameter and greater).
Yield data were analyzed using ARM Version 2022.5 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: Visual tolerance of carrots, cv. Cellobunch, to pyridate, applied preemergence or post emergence at the bunny ear (cotyledon) to 1 leaf stage of carrot growth at rates of 300 to 1200 g ai/ha was excellent (data not presented). As well, carrot tolerance to metobromuron, applied at 1000 g ai/ha preemergence or 500 g ai/ha post emergence was also highly selective, resulting in no observed crop injury. No significant differences in carrot seedling stand counts or crop yield were detected among treatments compared to the weed free check (see Table 1.)

Table 1. Stand counts and yield of carrots, cv. Cellobunch, treated with pyridate (Tough 600 EC) or metobromuron (Praxim) preemergence or early post emergence.

Treatment	Rate (g ai/ha)	Crop stage at application	Carrot Stand Count #/m row[1]	Yield T/ha[1]
WEED FREE CHECK			69.6	57.2
Pyridate	300	PRE	69.1	59.6
Pyridate	450	PRE	62.1	57.2
Pyridate	600	PRE	62.5	60.5
Pyridate	1200	PRE	59.3	58.9
Metobromuron	1000	PRE	55.8	58.3
Pyridate	300	Bunny ear – 1 lf	54.1	59.9
Pyridate	450	Bunny ear – 1 lf	63.9	59.3
Pyridate	600	Bunny ear – 1 lf	68.6	56.0
Pyridate	1200	Bunny ear – 1 lf	61.6	54.2
Metobromuron	500	Bunny ear – 1 lf	57.4	54.5

[1] - No significant differences were found among the treatments compared to the weed free check.

Data were analyzed using ARM Version 2022.5 Analysis of Variance function. Means separation was obtained by using Tukey's HSD test at P = 0.05 level of significance. Crop growth stage Bunny ear-1 lf refers to bunny ear (cotyledon) to first true leaf stage of carrot growth.

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, Belchim Crop Protection Canada, and the Bradford Co-operative.

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

AUTHORS: MCDONALD MR, VANDER KOOI K & FARINTOSH G
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TITLE: EVALUATION OF CIMEGRA INSECTICIDE FOR CONTROL OF MAGGOTS IN YELLOW COOKING ONIONS, 2022

MATERIALS: SEPRESTO 75 WS (clothianidin 56.25%, imidacloprid 18.75%), CIMEGRA (broflanilide 9.51%)

METHODS: The trial was conducted on organic soil (pH ≈ 6.1, organic matter ≈ 69.8%) naturally infested with *Delia antiqua* and *D. platura* pupae at the Ontario Crops Research Centre - Bradford, 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. Trailblazer, were seeded (≈ 32 seeds/m) on 11 May using a Stanhay precision seeder. Insecticide seed treatments were: SEPRESTO at 0.21 g per 100 seeds, CIMEGRA applied in-furrow at 125 and 250 mL/ha in 250 L/ha of water, CIMEGRA applied at 250 mL/ha as an over the row band spray following seeding, and a combination of in-furrow followed by an over the row spray. A no-insecticide check was also included. The over the row spray was applied on 26 May after the onions had emerged. Treatments were applied in a 10 cm band over the row using a CO_2 backpack sprayer equipped with four TeeJet 8002 fan nozzles calibrated to deliver 250 L/ha at 275 kPa. All treatments included EVERGOL PRIME (penflufen 0.0087 g ai/1,000 seeds) for smut control and 42-S THIRAM (thiram 12.5 g ai/kg seed) to prevent damping off. 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 3 June to determine initial stands. Beginning on 13 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 counted and removed, with the cause of damage recorded. The remaining onions within the assigned 2 m sections were removed and visually examined for maggot damage on 7 July (first generation damage), 11 Aug (second generation damage) and after lodging on 15 September (total season assessment). On 27 September, onions from the 2.32 m yield section of row were pulled, allowed to dry and placed in cold storage. On 11 November, onions were sorted by size and weighed to determine yield. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.10. Means separation was obtained using Fisher's Protected LSD Test at P = 0.05 level of significance.

RESULTS: as presented in Tables 1 and 2

CONCLUSIONS: Onion maggot damage was relatively low in this trial. Significant differences in the number of onions lost to maggot damage were found among the treatments in the second generation and season total losses (Table 1). Damage caused by first generation maggots was variable, all treatments had numerically lower maggot damage than the check. The combined 250 mL/ha in-furrow and 250 mL/ha over the row spray CIMEGRA treatment had lower maggot damage over the entire season than the half rate of CIMEGRA or the untreated check, but not significantly different from the full rate of CIMEGRA applied as a drench or over the row spray. SEPRESTO seed treatment was also effective in protecting onions from maggot damage. No significant differences in yield of onions per meter at harvest were found among the treatments (Table 2). No significant differences in size distribution were found among the treatments.

Table 1. Percentage of onions, cv. Trailblazer, lost due to maggot damage, treated with CIMEGRA insecticide, and grown at the Ontario Crops Research Centre - Bradford, Ontario, 2022.

Treatment	Rate & application method	% Onions lost due to maggot damage		
		1st Generation	1st and 2nd Generation	Total Season
SEPRESTO	0.21g 100 seeds	2.9 ns[1]	5.4 ab[2]	2.0 a
CIMEGRA	250 mL./ha in-furrow	1.8	3.9 ab	5.6 ab
CIMEGRA	250 g/ha over row spray	7.3	2.0 a	2.8 ab
CIMEGRA	250 mL/ha in-furrow +250 mL/ha over row spray	9.3	9.3 ab	0.6 a
CIMEGRA	125 g/ha over row spray	11.0	14. 5 bc	12.6 bc
Check seed	-	16.2	21.3 c	21.8 c

[1] ns = 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 2. Yield, number and size distribution for onions, cv. Trailblazer, treated with CIMEGRA insecticide and grown at the Ontario Crops Research Centre - Bradford, Ontario, 2022.

Treatment[1]	Rate & application method	Onions/m	Yield (t/ha)	Size Distribution[1] (%)		
				Med (>64-45 mm)	Large (76-64 mm)	Jumbo (>76mm)
SEPRESTO	0.21 g 100 seeds	17.5 ns[2]	24.8 ns	46.5 ns	26.1 ns	14.0 ns
CIMEGRA	250 mL/ha in-furrow	13.2	30.6	27.3	38.7	27.6
CIMEGRA	250 g/ha over row spray	12.0	31.7	32.0	28.9	34.8
CIMEGRA	250 mL/ha in-furrow +250 mL/ha over row spray	11.5	24.2	37.8	30.7	24.0
CIMEGRA	125 g/ha over row spray	10.2	25.1	23.8	32.8	34.5
Check seed	-	7.7	19.3	25.6	38.7	25.0

[1] Size distribution was based on weights.
[2] ns = no significant differences were found among the treatments.

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

CROP: Onion (*Allium cepa* L.), cv. Milestone
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, 2022

MATERIALS: ORONDIS ULTRA (oxathiapiprolin 30 g/L, mandipropamid 250 g/L), ZAMPRO SC (ametoctradin 300 g/L, dimethomorph 225 g/L), RIDOMIL GOLD MZ 68 WG (metalaxyl-M and S-isomer 4%, mancozeb 64%), SYLGARD 309 (siloxylated polyether 76%), DIPLOMAT (polyoxin D zinc salt 5%), PICARBUTRAZOX 10SC (picarbutrazox), SERIFEL (Bacillus amyloliquefaciens strain mbi 600), T-77 (*Trichoderma atroviride* strain 77B $\geq 2.5 \times 10^9$ spores/g)

METHODS: Onions, cv. Milestone, were direct seeded on 10 May into organic soil, (organic matter ≈ 68.3%, pH ≈ 6.4) using a Stanhay Precision seeder at the Ontario Crops Research Centre - Bradford, 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, ORONDIS ULTRA at 400 mL/ha alternated with RIDOMIL MZ at 2.5 kg/ha, DIPLOMAT at 926 mL/ha, PICARBUTRZOX at 880 mL/ha, T-77 at 250 g/ha, and SERIFIL at 1.0 kg/ha. An untreated check was also included. Treatments were applied on 27 July, and 5 and 11 August based on disease forecasting. On 24 July, 9 and 16 August, all onions in each replicate were visually examined for the presence of downy mildew (DM) lesions. On 27 September, onions in two, 2.32 m sections of row (2 x 1 m^2) per replicate were pulled. On 15 November, 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 2022 were above average for May (15.1°C), average for June (18.3°C) August (20.6°C) and September (16.5°C), and below average for July (20.2°C). The 10-year average temperatures were: May 13.7°C, June 18.9°C, July 21.4°C, August 20.4°C and September 16.3°C. Monthly rainfall was below the 10-year average for May (50 mm) and September (43 mm) and average for June (90 mm), July (74 mm) and August (82 mm). The 10-year rainfall averages were: May 64 mm, June 97 mm, July 78 mm, August 79 mm and September 59 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 2022 was not conducive to the development of downy mildew in onions but no lesions were detected during the trial. No significant differences in the number of downy mildew lesions between treatments were 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. Milestone, treated with fungicides and grown at the Ontario Crops Research Centre - Bradford, Holland Marsh, Ontario, 2022.

Treatment[1]	Rate (per ha)	DM Lesions/plot[2]			Total lesions
		24 Jul	9 Aug	16 Aug	
RIDOMIL MZ alt/w ORONDIS ULTRA[3]	2.5 kg	0 ns[4]	0 ns	0 ns	0 ns
PICARBUTRAZOX	880 mL	0	0	0	0
ZAMPRO + SYLGARD	1.0 L + 0.25% v/v	0	0	0	0
T-77	250 g/ha	0	0	0	0
SEREFIL	1.0 kg	0	0	0	0
PREV-AM	2.0 L	0	0	0	0
DIPLOMAT	926 mL	0	0	0	0
Check	-	0	0	0	0

[1] Treatments were applied on 27 July, 5, 11 August
[2] The entire plot was visually examined for DM lesions and numbers recorded.
[3] RIDOMIL MZ was applied on 27 July, 11 August. ORONDIS ULTRA was applied on 5 August.
[4] ns = no significant differences were found among the treatments

Table 2. Yield and size distribution for onions, cv. Milestone, treated with fungicides and grown at the Ontario Crops Research Centre – Bradford, Holland Marsh, Ontario, 2022.

Treatment	Yield (t/ha)	% Mkb	Size distribution (%)[1]		
			Medium (63-45 mm)	Large (76-64 mm)	Jumbo (>76 mm)
T-77	96.0 ns[2]	99.7 ns	10.3 ns	44.8 ns	44.6 ns
SEREFIL	95.6	99.5	15.2	45.4	38.9
RIDOMIL MZ alt/w ORONDIS ULTRA[3]	92.1	99.7	13.8	49.7	36.1
Check	91.5	99.5	11.0	43.8	44.7
ORONDIS ULTRA	91.1	99.5	11.6	45.8	42.0
PICARBUTRAZOX	85.1	99.3	13.1	49.4	36.8
ZAMPRO + SYLGARD	84.6	99.3	14.4	47.3	37.6
DIPLOMAT	83.8	99.3	13.7	47.7	38.0

[1] Percentage was determined by weight.
[2] ns = no significant differences were found among the treatments.
[3] RIDOMIL MZ was applied on 27 July, 11 August. ORONDIS ULTRA was applied on 5 August.

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

PEST: Stemphylium leaf blight (*Stemphylium vesicarium* (Wallr.))

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TITLE: COMPARING ROTOROD AND BURKARD 7-DAY VOLUMETRIC SPORE SAMPLER METHODS IN THE HOLLAND MARSH FOR STEMPHYLIUM LEAF BLIGHT, 2022

METHODS: Two spore trapping methods, the Rotorod and Burkard 7-day volumetric spore samplers, were compared for the ability to recover airborne *S. vesicarium* spores at the Ontario Crops Research Centre - Bradford in the Holland Marsh, 2022. The Rotorod spore sampler, also known as a rotating arm impactor, was setup and adjusted to be just above the onion canopy throughout the season and collected spores on two 1.52 mm wide and 3.15 cm long polystyrene rods lined with a silicone grease. Every Monday, Wednesday and Friday from 24 June to 1 September the rotorod would rotate at 2400 rpm between 06:00 to 12:00 with an air sampling rate of 20.65 L/min/rod. Spores trapped on each rod were identified to genus and counted using a compound microscope. The Burkard 7-day volumetric spore sampler was set up so the suction orifice is at 0.7m above the soil surface facing the direction of prevailing wind. The sampling airflow rate was 10 L min^{-1} and ran 24 hours a day. Airborne spores were collected on a clear Melinex tape affixed to a 7 day rotating drum lined with a silicone grease. Spores were collected between 18 April to 24 August and were identified to genus and counted using a compound microscope.

Both spore trapping methods were compared to Stemphylium Leaf Blight (SLB) weather risk, and in field disease ratings. STEMcast is a modification of TOMcast more specific to SLB disease pressure in Ontario. This means higher temperatures and longer leaf wetness durations are required for STEMcast to give the same Daily Severity Value (DSV) as TOMcast. High risk STEMcast are all days with a DSV of a 3 or higher which means temperatures above 13˚C with at least 21 hours of high leaf wetness. In field ratings used disease severity index weekly value averages from the non-treated check in the fungicide timing trial for SLB.
Air temperature in 2021 was above the previous 10-year average in June (21.1°C) and August (22.2°C), normal for September (15.8°C) and below average in May (12.6°C) and July (19.7°C) relative. Monthly rainfall was above the 10-year average for July (105 mm) and September (173 mm) and below average for May (22 mm), June (56 mm) and August (41 mm). The 10-year average temperatures were: May 13.9°C, June 18.6°C, July 21.7°C, August 20.2°C and September 16.4°C. The 10-year rainfall averages were: May 71 mm, June 94 mm, July 75 mm, August 83 mm and September 59 mm.
RESULTS: Data are presented in Figure 1. There was a strong positive correlation between Burkard volumetric spore sampler and Rotorod ($r=0.88$, $P<0.0001$) on shared sampling dates. The earliest spores were identified in the middle of April from the Burkard spore trap. No spores were identified after the end of April until the middle of June for both Burkard and Rotorod.

CONCLUSIONS: Spore concentrations were low for both spore trapping methods in June and then increased through the end of July and into August. Disease severity increased from the end of June until the middle of August when final assessments were completed. An increase in spore concentrations followed disease severity showing how spore trapping might serve as a prediction of disease severity rather than a predictor. High risk STEMcast values started at the end of May and were sporadic through June. Multiple high risk events correlated with the increase in spore concentration towards the end of July and into the beginning of August. Further research is needed to determine if spore trapping can improve disease forecasting for the management of SLB on onions.

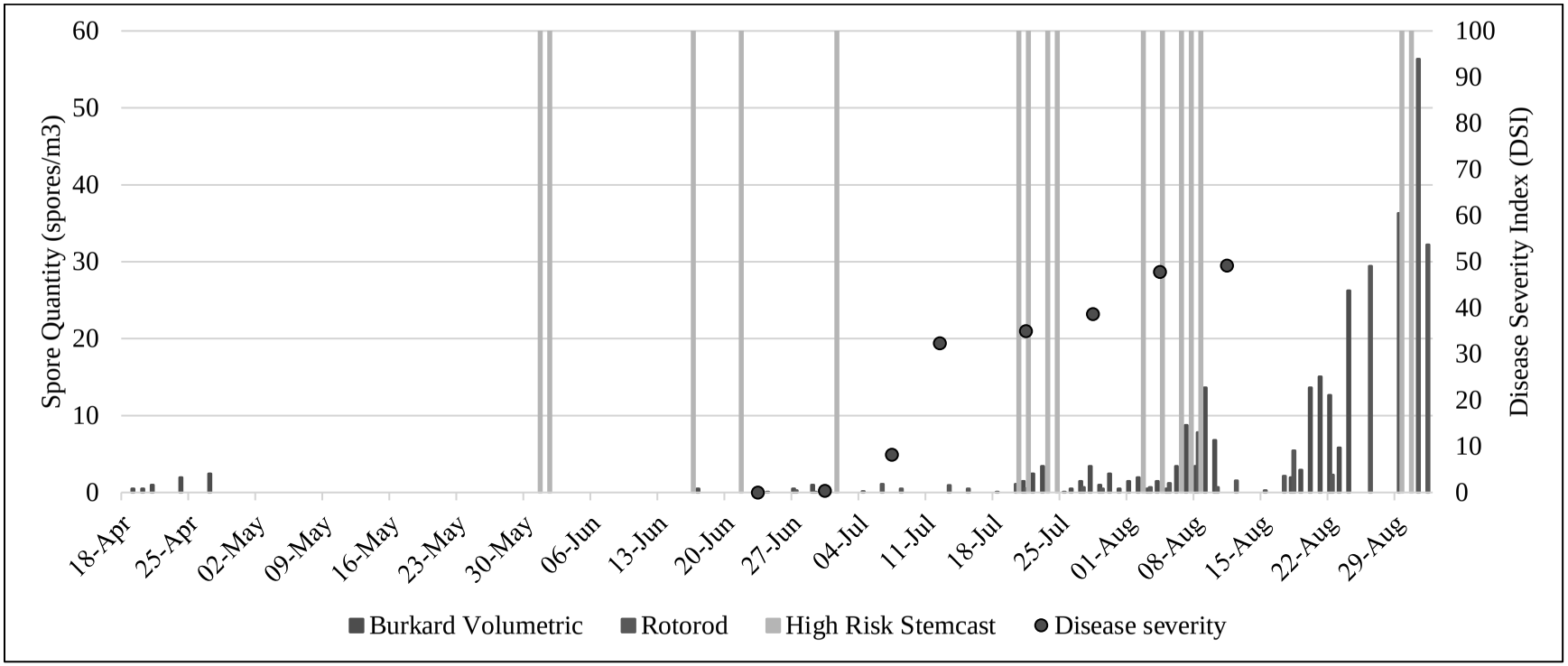

Figure 1. Spore quantities (spores/m^3) of *Stemphylium vesicarium* trapped and identified in the Burkard volumetric spore sampler and Rotorod compared to days with high risk for Stemphylium leaf blight development on onions predicted using STEMcast and disease severity values using averages of all treatments in SLB spray timing trial during the growing season at the Ontario Crops Research Centre – Bradford, 2022.

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

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

AUTHORS: KOOY M[1], GOSSEN BD[2] & MCDONALD MR[1]
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TITLE: EVALUATION OF FUNGICIDE TIMING MODELS FOR MANAGEMENT OF STEMPHYLIUM LEAF BLIGHT ON YELLOW COOKING ONION, 2022

MATERIALS: DITHANE RAINSHIELD WG (mancozeb 75% a.i.), MIRAVIS DUO (pydiflumetofen 7.5%, difenoconazole 12.5%), EVERGOL PRIME (penflufen 22.7%)

METHODS: Seed of onion cv. Traverse with penflufen as a seed treatment was planted at ≈ 35 seeds/m into organic soil (organic matter ≈ 68%, pH ≈ 6.2) using a Stanhay precision seeder at the Ontario Crops Research Centre - Bradford, Holland Marsh, Ontario on 09 May, 2022. Several disease forecasting models were used to trigger foliar fungicide application based on weather conditions. The disease forecasting models were TOMcast with threshold 15, Stemcast (a modification of TOMCast) with threshold 15, BSPcast (developed for *S. vesicarium* on pear), treatment based on conidia counts threshold of 50 spores in a day (inoculum threshold) and a calendar based spray program (7–10 day interval starting at the fourth true leaf stage). An untreated check was included as well as an untreated check without penflufen as a seed treatment. The trial was arranged in a randomized complete block design with four replicates. Each experimental unit consisted of two, 6 m long beds of onion, each with four rows per bed and 40 cm row spacing.

The fungicides MIRAVIS DUO at 1 L/ha and DITHANE at 2.5 kg/ha were applied in alternation, starting with MIRAVIS DUO. The fungicides were applied using a tractor-mounted sprayer fitted with hollow cone D-3 spray nozzles at 620 kPa to deliver 500 L/ha. On 30 June, 7, 12, 21, 28 July and 4, 11 August, blight severity was rated on the three oldest leaves of 10 onion plants in a row for two rows per replicate. The area of the leaf infected with *S. vesicarium* was rated and divided into classes based on the percent of leaf length with symptoms of SLB, using a 0-4 scale where class 0 = no symptoms, 1 = 1–10%, 2 = 11–25%, 3 = 26–50%, and class 4 >50%. The rating for each plant was 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:

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

Also, area under the disease progress curve (AUDPC) was calculated 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 16 August, the green leaves of 20 onion plants from the inner rows of each experimental unit (10 plants per row) were removed and sorted into classes based on the percentage of the leaf length with symptoms of *S. vesicarium*. 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 *S. vesicarium* and DSI was calculated. Dead leaves were counted separately. On 8 September, the onion plants in two 2.3 m sections of row from the inner rows from each plot were pulled for a yield sample. Onions were weighed and graded for size on 8 October to determine yield**.**

Air temperature in 2021 was above the previous 10-year average in June (21.1°C) and August (22.2°C), normal for September (15.8°C) and below average in May (12.6°C) and July (19.7°C) relative. Monthly rainfall was above the 10-year average for July (105 mm) and September (173 mm) and below average for May (22 mm), June (56 mm) and August (41 mm). The 10-year average temperatures were: May 13.9°C, June 18.6°C, July 21.7°C, August 20.2°C and September 16.4°C. The 10-year rainfall averages were: May 71 mm, June 94 mm, July 75 mm, August 83 mm and September 59 mm.

Data were analyzed using a mixed model analysis of variance (PROC GLIMMIX) in SAS. Means were separated using Tukey's Honest Significant Difference (HSD) at $P = 0.05$ level of significance.

RESULTS: as presented in Tables 2, 3 & 4

CONCLUSIONS: Stemphylium blight severity was low in 2022, with only 24% DSI in the nontreated control at the end of the season. There were no differences among the treatments for any assessment date, AUDPC (Table 2) or for yield (Table 4). The lack of differences is likely due to low disease levels. The Calendar treatment received six spray applications, TOMcast with threshold 15 received five, Stemcast with threshold 15 received three sprays, and Inoculum threshold received two sprays (Table 1). Research is continuing to develop an improved disease forecasting model for SLB on onion, especially aimed at reducing application in years of low disease.

Table 1: Timing of fungicide application and fungicide sequence in a field trial of onion at Ontario Crops Research Centre - Bradford, Ontario, 2022.

Treatment	28 Jun	07 Jul	15 Jul	25 Jul	3 Aug	10 Aug
Calendar	MIRAVIS DUO	DITHANE	MIRAVIS DUO	DITHANE	MIRAVIS DUO	DITHANE
TOMcast 15	MIRAVIS DUO	DITHANE	-	MIRAVIS DUO	DITHANE	MIRAVIS DUO
Stemcast 15	MIRAVIS DUO	-	DITHANE	-	MIRAVIS DUO	-
Inoculum threshold	-	-	-	-	MIRAVIS DUO	DITHANE
Control w/o ST	-	-	-	-	-	-
Control ST	-	-	-	-	-	-

ST – Seed treatment. All of the treatments received seed treatment with penflufen except the negative control.

Table 2. Effect of alternating fungicides applied according to selected forecasting models for stemphylium leaf blight on area under the disease progress curve (AUDPC) and disease severity index (DSI) on onion at the Ontario Crops Research Centre - Bradford, Ontario in 2022.

Treatment[1]	DSI							AUDPC[2]
	30 Jun	7 July	12 July	21 July	28 July	4 Aug	11 Aug	
Control ST	0.3 ns	7.9 ns	33.4 ns	35.8 ns	40.5 ns	50.7 ns	47.6 ns	1375 ns[3]
TOMcast 15	0.4	9.9	33.9	34.8	36.1	49.0	50.5	1345
Stemcast 15	0.3	9.3	33.5	35.1	39.8	45.6	49.6	1344
Calendar	0.2	6.9	32.3	34.8	39.8	47.6	48.5	1328
Inoculum threshold	0.5	8.9	32.6	35.8	36.8	45.4	52.0	1327
Control w/o ST	0.4	6.5	28.5	33.3	39.0	48.5	46.9	1283

[1] See Table 1 for fungicide application dates.
[2] Area under the disease progress curve (AUDPC) was based on assessments on, 13, 20, 27 July & 3, 10 August
[3] ns = no significant differences were found among the treatments.

Table 3. Stemphylium leaf blight (SLB) incidence and severity for onions, cv. Traverse, alternating fungicides when forecasting models triggered sprays and destructively sampled on Aug. 16, at the Ontario Crops Research Centre - Bradford, Holland Marsh, Ontario, 2022.

Treatment[1]	# Sprays	DSI	SLB incidence	% Leaves rated 0 or 1[2]	Green leaves/plant
Inoculum threshold	2	32.2 ns[3]	71.5 ns	46.9 ns	7.4 ns
Control ST	0	29.6	70.1	49.6	7.6
Calendar	6	28.3	70.7	51.4	7.1
Stemcast 15	3	26.4	64.2	57.0	7.5
TOMcast 15	5	24.9	65.4	58.2	7.6
Control w/o ST	0	24.3	59.4	58.6	8.3

[1]See Table 1 for fungicide application dates
[2] On 16 August the leaves of 20 plants were sorted 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.
[3] ns = no significant differences were found among the treatments.

Table 4. Yield of onion cv. Traverse, sprayed based on disease forecasting programs at the Ontario Crops Research Centre – Bradford, Ontario, 2022.

Treatment[1]	Yield (t/ha)	% Mkb	Size distribution (%)			
			Jumbo (>76mm)	Large (76–64 mm)	Medium (>64–45 mm)	Cull
Calendar	67 ns[2]	99 ns	39 ns	45 ns	16 ns	1 ns
Control w/o ST	67	99	39	45	15	1
TOMcast 15	65	99	32	49	18	1
Stemcast 15	65	99	25	53	20	1
Inoculum threshold	60	99	34	46	18	1
Control ST	59	99	29	51	19	1

[1]See Table 1 for fungicide application dates
[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 and the Bradford Cooperative Storage Ltd.

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

AUTHORS: MCFAUL E[1], DEVEAU J[2], VANDERKOOI K[1]GOSSEN BD[3] & MCDONALD MR[1]
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TITLE: EVALUATION OF BELUGA DROPLEG NOZZLES ON SPRAY COVERAGE AND FUNGICIDE EFFICACY IN ONIONS, 2022

MATERIALS: MIRAVIS DUO (pydiflumetofen 75 g/L, difenoconazole 125 g/L) and bio fungicide T-77 (*Trichoderma atroviride* strain 77B @ 2.5 x 10^9 spores/g)

METHODS: Onion cv. Traverse was direct seeded at ~35 seeds/m at an organic soil site (organic matter ~68%, pH ~ 6.2) at the Ontario Crops Research Centre – Bradford, Ontario on 09 May 2022. Treatments were arranged in a split-plot design where the main plots were assigned to nozzle type and subplots to fungicide treatment, with two replicates. Each experimental unit consisted of two beds, each consisting four 6-m-long rows with 40 cm inter-row spacing. The main plot treatments were dropleg nozzle head mounts and conventional spray nozzle arrangements. Dropleg Beluga heads (Agrotop Spray Technology, Obertraubling, Germany) were positioned to penetrate 20 cm into the onion canopy between the rows at 40 cm centers (seven nozzles per spray boom). Each dropleg mount was fitted with SprayMax SMP110015 nozzles. The Beluga heads position the spray nozzles within the crop canopy to apply fungicides horizontally onto the onion plants, The conventional spray application used seven D-3 hollow cone nozzles, positioned at 50 cm centers along the boom, 50 cm above the onion canopy. MIRAVIS DUO (MD) fungicide at 1.0 L/ha or MIRAVIS DUO at 1.0 L/ha alternated with T-77 at 250 g/ha were applied using a tractor-mounted sprayer fitted with each nozzle type. There was also an untreated control. Spray coverage, canopy deposition and fungicide efficacy for reduction of stemphylium leaf blight (SLB) were assessed.

Coverage: Application of rhodamine WT fluorescent dye (Fluorescent Fwt Red Dye Concentrate, Cole-Parmer) was used to estimate deposition efficacy. The crop was sprayed with rhodamine WT solution @ 500 ppm active ingredient (a.i.), when onions were generally at the 5-leaf stage on 14 July and again at the 8-leaf stage on 03 August. The spray nozzles were primed with dye solution and a sample from the furthest nozzle of the spray boom was taken prior to application to confirm the dye concentration. Spray deposition was estimated in the upper 1/3 (top) and lower 2/3 (bottom) portions of the canopy. Water sensitive paper was used to assess spray penetration. Two minutes after spray application or once spray had settled, 2–3 cm sections of onion leaves were collected from the top and bottom portions of the canopy from each of five plants from the innermost two rows of each plot. Three replicates of leaf samples were collected for each nozzle arrangement. Each leaf section was placed in a centrifuge tube with 40 mL of deionized water and placed in an opaque Tupperware container to minimize photodegradation of the dye. Each leaf sample was removed from dye-water solution, then placed into a paper envelope, dried for 5 days at 32°C and weight determined.

Aqueous dye-water solutions were kept in the dark at 5°C prior to analysis. Solutions were analyzed with a TD-700 fluorimeter using the Turner Designs 10-041R Rhodamine WT optical kit (Turner Designs, San Jose CA) fitted with a 550 nm excitation filter and a 570 nm emission filter. A dilution series of known concentration was developed and used to calibrate the fluorimeter; there is a linear relationship between dye concentration and Raw Fluoresce Units (FSU). FSU were normalized to account for 95% Rhodamine

WT recovery accuracy. Overall dye recovery values (µL a.i.) were adjusted based on sample dry weight using the following equation:

$$\text{Dye recovery} = \frac{\mu\text{L of a. i.}}{\text{weight of dry leaf sample (g)}}$$

Fungicide efficacy: The fungicide treatments (MIRAVIS DUO at 1.0 L/ha, MIRAVIS DUO at 1.0 L/ha alternated with T-77 at 250 g/ha) were applied on 28 June, 05, 15, 26 July and 09 August 2022 using a tractor-mounted sprayer fitted with D-3 hollow-cone spray nozzles or beluga dropleg heads fitted with SprayMax SMP110015 nozzles calibrated to deliver 500 L/ha at 620 kPa. On 30 June, 07, 12, 22, 28 July, and 11 August, the three oldest leaves from each of 10 randomly selected plants per bed were examined for SLB symptoms, with a total of 20 onion plants per plot. The mean ratings of leaf length affected (%) on the three leaves per plant was used to represent the plant. Each plant rating was then classified on a 0–4 scale, where: 0 = no disease; 1 = 1–10%, 2 = 11–25%, 3 = 26–50% and 4 > 50% of leaf length affected and this scale was used to calculate a disease severity index (DSI) value per plot using the following equation:

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

Additionally, the area under the disease progress curve (AUDPC) was calculated using the equation:

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

where $_j$ is the order index for the times, n_j is the total number of assessments, y_j is the average rating counts at day t_j, y_{j+1} is the average rating at day t_{j+1} and $(t_{j+1} - t_j)$ is the number of days between the two assessments evaluated.

When the crop was nearing maturity (18 August), 10 randomly selected plants were pulled from the inner rows of each bed for a total of 20 plants per plot. Leaves were removed and sorted into seven classes: 0 = no symptoms, 1 = 1–4%, 2 = 5–10%, 3 = 11–25%, 4 = 26–50%, 5 = 51–75% and 6 > 75% based on leaf length affected with *S. vesicarium*. On 08 September, 2.3 m sections of onion plants from the inner rows of each plot were pulled for yield assessment. The onion bulbs were allowed to air-dry, and then weighed and graded for size on 08 October to estimate yield.

Compared to the previous 10-year average, air temperatures in 2022 were above average for May (15.1°C), June (18.3°C), August (20.6°C) and September (16.5°C), and below average for July (20.2°C). The 10-year average temperatures were: May 13.7°C, June 18.9°C, July 21.4°C, August 20.4°C and September 16.3°C. Monthly rainfall was below the 10-year average for May (50 mm) and September (43 mm) and above average for June (90 mm), July (74 mm) and August (82 mm). The 10-year rainfall averages were: May 64 mm, June 97 mm, July 78 mm, August 79 mm and September 59 mm. Data was analyzed using PROC GLIMMIX function of SAS 9.4. Means separation was achieved using Tukey's HSD test at P=0.05 level of significance.

RESULTS: as presented in Tables 1 – 7

CONCLUSIONS: *Coverage:* There were minimal differences in dye recovery between Beluga dropleg heads and conventional broadcast nozzle arrangement (D-3 hollow cone). No differences were seen among the first (14 July) and second dye application (03 August) timings. Dye recovered was an order-of-magnitude less than in a previous study at the same site in 2020. These results are inconsistent with previous results reported in 2020.

Fungicide efficacy: SLB severity was low and there were no differences among the treatments in 2022 (Table 1). When data for fungicide treatments was combined, there remained no significant differences but MIRAVIS DUO + T-77 had lower DSI and AUDPC in field then MIRAVIS DUO applied alone (Table 1). This was also seen with the destructive rating (Table 2). No significant differences were seen among treatments and application methods for the destructive rating (Table 2) and no differences were found among fungicide/application method combinations or untreated checks for final yield evaluation (Table 3). When nozzle types were combined, no significant differences were observed among any evaluation (Table 1-3).

Table 1. Effect of foliar fungicide and nozzle arrangement / type (Beluga dropleg system vs. D-3 hollow cone nozzles) on severity of stemphylium leaf blight (disease severity index, DSI, for each rating date and area under the disease progress curve, AUDPC) on onion at the Ontario Crops Research Centre – Bradford, ON, 2022.

Fungicide	Nozzle type	DSI						AUDPC[2]
		30-Jun	07-Jul	12-Jul	21-Jul	28-Jul	11-Aug	
Miravis	D-3	1.0 ns[1]	9.4 ns	14 ns	17 ns	15 ns	12 ns	533 ns
Duo	Beluga	0.6	6.7	16	14	14	13	503
MD+T-77	D-3	0.4	9.8	16	13	10	15	486
	Beluga	0.2	8.3	18	13	16	10	516
Control	-	0.7	8.3	15	14	14	9	482

[1] ns = no significant differences were found among the treatments.
[2]AUDPC calculated based on the DSI assessed on 30 June, 07, 12, 22, 28 July and 11 August.

Table 2. Effect of foliar fungicide and nozzle arrangement / type (Beluga dropleg vs. D-3 hollow cone nozzles) on final stemphylium leaf blight (SLB) incidence and severity (disease severity index, DSI and green leaves per plant) on mature onions at the Ontario Crops Research Centre - Bradford, ON in 2022.

Fungicide	Nozzle type	Incidence (%)	DSI	Leaves rated 0 or 1 (%)[1]	Green leaves per plant
MD+T-77	Beluga	62 ns[2]	24 ns	64 ns	7.4 ns
	D-3	66	30	53	7.6
Miravis Duo	Beluga	64	26	54	7.0
	D-3	67	29	51	7.7
Control	-	65	26	57	7.1

[1] Incidence and DSI were calculated based on assessment percentage leaf length with SLB symptoms on Leaves of 20 plants per plot.
[2] ns = no significant differences were found among the treatments.

Table 3. Yield, proportion marketable (Mkb) and size distribution of onion bulbs from crop treated with fungicides using Beluga heads or D-3 hollow cone nozzles at the Ontario Crops Research Centre – Bradford, ON, 2022.

Fungicide	Nozzle type	Yield (t/ha)	Mkb (%)	Size distribution (%)			
				Medium (45–64 mm)	Large (64–76mm)	Jumbo (>76 mm)	Cull (<45 mm)
Miravis Duo	D-3	65.5 ns[1]	93 ns	18 ns	39 ns	41 ns	2 ns
	Beluga	61.6	96	26	41	33	1
MD+T-77	D-3	65.2	92	13	38	47	2
	Beluga	58.7	94	24	47	27	2
Control	-	55.9	93	31	41	26	3

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

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

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

AUTHORS: MCFAUL E[1], VANDERKOOI K[1], GOSSEN BD[2] & MCDONALD MR[1]
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TITLE: EVALUATION OF SELECTED FUNGICIDES / BIOFUNGICIDES FOR REDUCTION OF STEMPHYLIUM LEAF BLIGHT ON ONION, 2022

MATERIALS: Fungicides MERIVON (pyraclostrobin 250 g/L, fluxapyroxad 250 g/L), MIRAVIS DUO (pydiflumetofen 75 g/L, difenoconazole 125 g/L REVYSOL (mefentrifluconazole 400 g/L), SERCADIS (fluxapyroxad 300 g/L), and biofungicides SERIFEL (*Bacillus amyloliquefaciens* strain MBI 600 @ 5.5 x 10^{10} spores/g), SUNERGIST (24-epibrassinolide 0.01%), and T-77 (*Trichoderma atroviride* strain 77B @ 2.5 x 10^9 spores/g)

METHODS: Onion cv. Traverse was direct seeded at ~35 seeds/m into organic soil (organic matter ~68.1%, pH ~ 6.2) at the Ontario Crops Research Centre – Bradford, Ontario on 09 May 2022. The study was arranged in a randomized complete block design with four replicates. Each experimental unit consisted of two beds. Each bed had four 6-m-long rows, 40 cm apart. The treatments were MERIVON fungicide applied at 600 mL/ha, MIRAVIS DUO at 1.0 L/ha, REVYSOL at 350 g/ha, SERCADIS at 666 mL/ha, and the biofungicides SERIFEL at 1120 g/ha, SUNERGIST at 250 mL/ha and T-77 at 250 g/ha, plus a combination of MIRAVIS DUO at 1.0 L/ha alternated with T-77 at 250 g/ha, and an untreated control.

Fungicides were applied bi-weekly (on 28 June, 05, 15, 26 July and 09 August 2022) using a tractor-mounted sprayer fitted with D-3 hollow-cone nozzles at 620 kPa to deliver 500 L/ha. On 30 June, 07, 12, 22, 28 July, and 11 August, the three oldest leaves on 10 randomly selected plants per bed were evaluated, for a total of 20 onions per plot, and visually examined for stemphylium leaf blight (SLB) symptoms. The mean ratings of leaf length affected (%) on the three leaves per plant was used to represent the plant. Each plant rating was then classified on a 0–4 scale, where: 0 = no disease; 1 = 1–10%, 2 = 11–25%, 3 = 26–50% and 4 > 50% of leaf length affected. which were used to calculate a disease severity index (DSI) value per plot using the following equation:

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

Also, the area under the disease progress curve (AUDPC) was calculated using the equation:

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

where $_j$ is the order index for the times, n_j is the total number of assessments, y_j is the average rating at day t_j, y_{j+1} is the average rating at day t_{j+1} and $(t_{j+1} - t_j)$ is the number of days between the two assessments evaluated.

On 18 August, 10 randomly selected plants were pulled from the inner rows of each bed for a total of 20 plants per plot. Leaves were removed and sorted into seven classes: 0 = no SLB symptoms, 1 = 1–4%, 2 = 5–10%, 3 = 11–25%, 4 = 26–50%, 5 = 51–75% and 6 > 75% leaf length affected. On 08 September, 2.3 m sections of onion plants from the inner rows of each plot were pulled for yield assessment. On 08 October, the onion bulbs were weighed and graded for size to determine yield. Compared to the previous 10-year average, air temperatures in 2022 were above average for May (15.1°C), June (18.3°C), August (20.6°C) and September (16.5°C), and below average for July (20.2°C). The 10-year average temperatures were: May 13.7°C, June 18.9°C, July 21.4°C, August 20.4°C and September 16.3°C. Monthly rainfall was below

the 10-year average for May (50 mm) and September (43 mm) and above average for June (90 mm), July (74 mm) and August (82 mm). The 10-year rainfall averages were: May 64 mm, June 97 mm, July 78 mm, August 79 mm and September 59 mm. Data was analyzed using ANOVA in PROC GLIMMIX of SAS 9.4. Means separation was conducted using Tukey's HSD test at $P = 0.05$ level of significance.

RESULTS: as presented in Tables 1–3

CONCLUSIONS: SLB severity was low in 2022 and there were no differences in severity among the treatments at any date (Table 1). However, all treatments reduced AUDPC (numerically but not significantly) compared to the control, with the largest reduction (22%) from application of MERIVON fungicide. MERIVON also produced a numerical reduction of SLB incidence by 21% and DSI by 44% relative to the untreated control in the destructive sampling assessment at the end of the season (Table 2). There were no differences in yield among the treatments. However, MIRAVIS DUO had the numerically highest yield (62.2 t/ha) and produced a numerically higher proportion of marketable bulbs (91%) than to the control (Table 3).

Table 1. Effect of foliar application of fungicides / biofungicides on area under the disease progress curve (AUDPC) and the disease severity index (DSI) for SLB on onion at the Ontario Crops Research Centre – Bradford, ON in 2022.

Treatment	DSI						AUDPC[2]
	June 30	July 7	July 12	July 22	July 28	Aug 11	
Merivon	2.0 ns[1]	7.8 ns	20 ns	23 ns	31 ns	38 ns	115.2 ns
Revysol	1.9	9.7	23	13	32	38	117.4
T-77	0.7	7.8	21	23	32	40	119.8
Sunergist	1.9	8.5	27	19	32	38	119.9
Serifel	1.0	7.3	25	26	36	39	128.2
Miravis Duo	1.0	8.3	28	26	35	38	129.9
Sercadis	2.4	8.9	24	23	31	40	120.7
MD + T-77	0.9	10.3	30	22	34	43	132.8
Control	0.7	6.7	29	29	43	45	148.1

[1] ns = no significant differences were found among the treatments.
[2]AUDPC calculated based on the DSI assessed on 30 June, 07, 12, 22, 28 July and 11 August.

Table 2. Effect of foliar application of selected fungicides / biofungicides on stemphylium leaf blight (SLB) incidence and disease severity index (DSI) on a mature onion crop at the Ontario Crops Research Centre – Bradford, ON in 2022.

Treatment	Incidence (%)	DSI	Leaves rated 0 or 1 (%)[1]	Total green leaves
Merivon	65 ns[2]	27 ns	57 ns	153 a[3]
Sercadis	75	40	41	126 ab
Sunergist	77	37	40	133 ab
MD + T-77	85	43	33	125 ab
Revysol	85	43	33	123 b
T-77	86	45	31	120 b
Miravis Duo	85	45	29	131 ab
Serifel	84	47	27	134 ab
Control	83	49	27	131 ab

[1] SLB incidence and DSI were calculated based on percentage leaf length with symptoms on all leaves of each plant on 20 plants per plot.
[2] ns = no significant differences were found among the treatments.
[3] Numbers in a column followed by the same letter do not differ at $P = 0.05$.

Table 3. Effect of foliar application of fungicides on yield, marketable yield (Mkb), and size distribution of onion at the Ontario Crops Research Centre – Bradford, ON in 2022.

Fungicide/ biofungicide	Yield (t/ha)	Mkb (%)	Size distribution, by diameter (%)			
			Medium (45–64 mm)	Large (64–76 mm)	Jumbo (>76 mm)	Cull (<45 mm)
Miravis Duo	62.2 ns[1]	91 ns	37 ns	45 ns	15 ns	3 ns
Serifel	59.1	87	36	47	13	4
T-77	58.3	82	47	41	8	5
MD + T-77	58.1	89	48	36	11	4
Sercadis	55.0	88	42	40	14	4
Sunergist	53.8	88	44	43	9	4
Merivon	53.2	84	44	40	11	5
Revysol	49.0	83	50	38	6	6
Control	58.2	86	45	39	10	5

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

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

CROP: Green onions (*Allium fistulosum*.), cv. Tokyo Long White
PEST: Onion thrips, (*Thrips tabaci* Lindeman)

AUTHORS: MCDONALD MR, VANDER KOOI K & FARINTOSH G
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TITLE: EVALUATION OF NEW INSECTICIDES FOR CONTROL OF THRIPS IN GREEN ONIONS, 2022

MATERIALS: A21377, A24185, DELEGATE (spinetoram 25%), AGRAL 90 (nonylphenoxy polyethoxy ethanol 92%)

METHODS: Green onions, cv. Toyko Long White, were direct seeded (≈ 70 seed/m) on 14 July using a modified 1002-24 seeding disc for an Earthway push-seeder into organic soil (organic matter ≈ 58.7%, pH ≈ 7.2) at the Ontario Crops Research Centre - Bradford, Ontario. A randomized complete block arrangement with four replicates per treatment was used. Each replicate consisted of four rows (40 cm apart), 6 m in length. Treatments were: A21377 applied at 150 mL/ha, 300 mL/ha, and 375 mL/ha with AGRAL 90 at 0.25% v/v, A21377 at 375 mL/ha without AGRAL 90, A24185 at 750 mL/ha and DELEGATE at 336 g/ha. An untreated check was also included. Treatments were applied on 26 August and 1 September over 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. Adult and larval thrips were counted on the inside surface of the three innermost leaves of 10 randomly selected onions per replicate on 16 and 23 August (pre-spray), 2, 13 and19 September. The average number of thrips on the various count dates were used to calculate the area under the thrips population curve (AUTPC) using the following formula:

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

On 4 October, 10 randomly selected plants in the inner two rows were harvested and assessed for visible onion thrips damage Onions were assessed on a 0 – 100% damage scale, 0 = no visible feeding damage and 100% = 100% of leaf area with visible thrips damage. Data where analysed using the General Analyses of Variance function of the Linear Models section of Statistix V.10. Means separation was obtained using Fisher's Protected LSD test with $P = 0.05$ level of significance.

RESULTS: as presented in Tables 1 and 2

CONCLUSIONS: The numbers of thrips per plant was low throughout the season. However, significant differences were found following the insecticide applications (Table 1). All insecticide treatments had significantly fewer thrips than the check. Significant differences were also found among the treatments in the season total of thrips/plant. All treated onions had fewer thrips/plant than the untreated check. (Table 2). Significant differences were also found among the treatments in thrips damage, all treatments had less damage the check. There were no signs of phytotoxicity caused by the products.

Table 1. Onion thrips per plant for onions treated with Isocyoseram grown at the Ontario Crops Research Centre - Bradford, Ontario, 2022.

Treatment	Product Rate	Onion Thrips/Plant				
Larval		16 Aug[1]	23 Aug[1]	2 Sep	13 Sep	19 Sep
A21377 + AGRAL 90	150 mL/ha + 0.25% v/v	0.3 ns[2]	1.2 ns	1.4 a[3]	0.7 a	0.3 a
A21377 + AGRAL 90	300 mL/ha + 0.25% v/v	0.2	1.2	1.0 a	0.4 a	0.4 a
A21377 + AGRAL 90	375mL/ha + 0.25% v/v	0.3	0.6	1.3 a	0.3 a	0.3 a
A21377	375 ml/ha	0.1	2.5	1.4 a	0.1	0.2 a
A24185	750mL/ha	0.3	1.2	1.4 a	0.2 a	0.1 a
DELEGATE	336 g/ha	0.1	1.1	1.0 a	0.2 a	0.3 a
Check	--	0.2	1.9	8.9 b	6.2 b	4.3a
Adult						
A21377 + AGRAL 90	150 mL/ha + 0.25% v/v	0.6 ns	0.5 ns	0.2 ns	0.0 a	0.1 a
A21377 + AGRAL 90	300 mL/ha + 0.25% v/v	0.9	1.0	0.6	0.0 a	0.1 a
A21377 + AGRAL 90	375mL/ha + 0.25% v/v	1.0	0.4	0.7	0.0 a	0.2 a
A21377	375 ml/ha	0.7	0.8	0.4	0.0 a	0.1 a
A24185	750mL/ha	0.8	0.4	0.3	0.0 a	0.1 a
DELEGATE	336 g/ha	0.4	0.3	0.5	0.0 a	0.2 a
Check	--	0.4	0.5	0.7	1.3 b	1.4 b
Combined						
A21377 + AGRAL 90	150 mL/ha + 0.25% v/v	0.9 ns	1.7 ns	1.6 a	0.7 a	0.4 a
A21377 + AGRAL 90	300 mL/ha + 0.25% v/v	1.1	2.2	1.6 a	0.4 a	0.4 a
A21377 + AGRAL 90	375mL/ha + 0.25% v/v	1.3	1.0	2.0 a	0.3 a	0.4 a
A21377	375 ml/ha	0.7	3.3	1.8 a	0.1 a	0.2 a
A24185	750mL/ha	1.0	1.5	1.7 a	0.2 a	0.1 a
DELEGATE	336 g/ha	0.5	1.4	1.6 a	0.2 a	0.4 a
Check	--	0.5	2.4	10.0 b	7.5 b	5.6 b

[1] The date of the pre-spray thrips count.

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

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

Table 2. Season total onion thrips per plant and plant damage ratings for onions treated with Isocyoseram grown at the Ontario Crops Research Centre - Bradford, Ontario, 2022.

Treatment	Product Rate	Season Total Thrips/plant[1]	Thrips Damage Rating[2]
A21377 + AGRAL 90	150 mL/ha + 0.25% v/v	10.3 a[3]	2.6 a
A21377 + AGRAL 90	300 mL/ha + 0.25% v/v	11.5 a	2.9 a
A21377 + AGRAL 90	375mL/ha + 0.25% v/v	9.8 a	2.5 a
A21377	375 ml/ha	12.1 a	2.4 a
A24185	750mL/ha	9.0 a	2.6 a
DELEGATE	336 g/ha	8.3 a	3.1 a
Check	--	51.1 b	5.6 b

[1] This is the sum of the number of thrips found on every count date

[2] Damage rating based on 0-10 scale 0 = 0 % damage to leaf area, 10 = 100% damage to leaf area.

[3] 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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CROP: Multiplier onions (*Allium cepa* L. *var. aggregatum*), cv. CO5

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TITLE: EVALUATION OF ROYAL MH ON MULTIPLIER ONION (*ALLIUM CEPA* L. *VAR. AGGREGATUM*) PRODUCTION IN ORGANIC SOIL IN THE HOLLAND MARSH, 2022

MATERIALS: ROYAL MH (maleic hydrazide 270 g/L)

METHODS: Small multiplier onions, sometimes called potato onions, cv. CO5 were evaluated. The seed was obtained from India and provided by Dr. Jay Subramanian, Dept. of Plant Agriculture, Univ. of Guelph. The onions were seeded into 288 cell plug trays (3 seeds/cell) on 12 April. On 17 May, plugs were transplanted by hand 10 cm apart into organic soil (organic matter ≈ 72.1%, pH ≈ 5.9) at the Ontario Crops Research Centre – Bradford, 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. Onions were grown using standard growing practices for weed, insect and disease management. ROYAL MH was applied at 8.3 L/ha in 400 L/ha of water on 11 August (early application) and 18 August (late application) as the onions were beginning to lodge. An untreated check was also included. On 9 September, onions in two, 1 m section of row were pulled from a middle row for a yield/storage sample. Onions were windrowed and allowed to cure for 14 days. On 26 September, onions were sorted into marketable and unmarketable (top sprouted) categories. Unmarketable onions were weighed and removed, marketable onions were weighed and placed in storage for 78 days. On 13 December, onions were removed from storage and regraded into the same categories. Compared to the previous 10-year average, air temperatures in 2022 were above average for May (15.1°C), average for June (18.3°C) August (20.6°C) and September (16.5°C), and below average for July (20.2°C). The 10-year average temperatures were: May 13.7°C, June 18.9°C, July 21.4°C, August 20.4°C and September 16.3°C. Monthly rainfall was below the 10-year average for May (50 mm) and September (43 mm) and average for June (90 mm), July (74 mm) and August (82 mm). The 10-year rainfall averages were: May 64 mm, June 97 mm, July 78 mm, August 79 mm and September 59 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 Table 1

CONCLUSIONS: There were significant differences in marketable yield and sprouted onions at harvest. (Table 1). Onions treated with ROYAL MH had significantly more marketable onions than the check. After storage, onions treated with ROYAL MH had fewer sprouted onions than the check. More work needs to be done to reduce sprouting in these onions.

Table 1. Yield and storage data for small onions, cv. CO5, grown in organic soil near the Ontario Crops Research Centre – Bradford, Ontario, 2022.

Treatment	Marketable Yield (t/ha)	% Sprouted at Harvest[1]	% Marketable after Storage[1]
ROYAL MH - 11 Aug	23.0 a[2]	15.1 a	38.7 a
ROYAL MH - 18 Aug	24.9 a	17.6 a	26.2 ab
Check	17.2 b	40.8 b	1.4 b

[1] Percentage was determined by weight

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

CROPS: Canola (*Brassica napus*) cv. InVigor L233P
PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

AUTHORS: CHESNEY SG[1], GOSSEN BD[2] & MCDONALD MR[1]
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TITLE: GROWTH ROOM STUDY OF THE INTERACTION OF BORON AND LIME ON THE SEVERITY OF CLUBROOT IN CANOLA

MATERIALS: HYDRATED LIME (calcium hydroxide), SOLUBOR (20.5% B, disodium octaborate tetrahydrate)

METHODS: A study was conducted to examine the interaction between lime and boron for management of clubroot in a growth room set at set to 24°/21°C day night cycle, a 17-hour photoperiod and 50% humidity. Two runs of the study were conducted. The trials were conducted as a three-way factorial study in a replicated complete block design with four replicates and 10 plants per experimental unit. The factors were boron x lime x inoculation. The treatments were as follows: boron (B) applied at a rate of 0 or 4 kg B/ha as SOLUBOR in run 1 and 0 and 12 kg B/ha as SOLUBOR in run 2; HYDATED LIME applied to achieve the targets of pH 7.0 and pH 7.5 plus a control at pH 6.4 and inoculated with resting spores of *P. brassicae* pathotype 2 vs. non-inoculated control.

To ensure that the pH of the soil was a stable and uniform as possible prior at the start of the study, all of the LA4 Sunshine Mix (Sungro; pH 5.6 in Run 1 and pH 5.3 in Run 2) required for each individual treatment was placed in a plastic bin, and a weighed amount of HYDRATED LIME was applied to reach the target pH of 7.0 and 7.5 (Run 1: pH 7.0 - 0.84 t/ha = 27.7 g/bin and pH 7.5 - 1.14 t/ha = 37.6 g/bin; Run 2: pH 7.0 – 1.15 t/ha = 37.6 g/bin and pH 7.5 – 1.3 t/ha = 43.51 g/bin). No lime was added for the pH 6.4 control. The lime was thoroughly incorporated into the soilless mix and 4 L of deionized water was incorporated into the soil. After one week, the pH of the soil was tested to ensure each target pH levels had been achieved. The mix was then placed into tall, narrow plastic pots (conetainer, Steuve & Sons, OR) and compressed firmly to provide a soil density conducive for clubroot. Boron was applied as a solution of SOLUBOR (10 mL of solution with 0.25 g SOLUBOR/L = 4 kg B/ha in Run 1 and 5 mL of solution with 1.5 g SOLUBOR/L = 12 kg/ha in Run 2) to the soil of each pot, one day before seeding with canola cv. L233P from BASF (two seeds). Three days after germination, the seedlings were thinned to one seedling per pot. Inoculum was extracted from clubbed canola roots collected from the Ontario Crops Research Centre-Bradford in 2018 using standard procedures. Seven and twelve days after seeding, each plant was inoculated with 5 mL of $1x10^6$ resting spores/mL. Plants were top watered with water adjusted to pH 6.4, 7.0 and 7.5 with pH lowered with commercial vinegar or raised with sodium hydroxide. Plants were fertilizer twice a week with a 0.1% solution of 20-20-20 and magnesium sulfate.

Roots were assessed for clubroot symptoms at 6 weeks after inoculation using a 0 - 3 scale, where 0 = no clubbing, 1 = clubs on 1/3 of the root, 2 = clubs on 1/3 to 2/3 of the root and 3 = clubs on more than 2/3 of the root. A disease severity index (DSI) was calculated using the following equation:

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

In addition, fresh and dry weight was measured on the above-ground portions of each experimental unit. Data was analyzed using ANOVA in PROC GLIMMIX and means were separated using Tukey's test at $P = 0.05$ in SAS 9.4 (SAS Institute, Cary, IN). Data for clubroot severity and incidence were analyzed as a two-way factorial (boron x lime) while fresh and dry weights were analyzed as a three-way factorial (inoculation x boron x lime)

RESULTS: as presented in Tables 1 and 2 and Figures 1 and 2

CONCLUSIONS: In both runs of the experiment there was no effect of boron and no interaction between lime and boron for clubroot incidence or severity. However, clubroot incidence and severity decreased as pH increased (Table 1 and 2). Inoculation reduced plant fresh and dry weight except in soil amended with lime (Figure 1 and 2). This growth room trial supports previous results that there is no interaction between boron and lime. Using lime to increase the soil pH is an effective management strategy to decrease clubroot severity. The use of boron for clubroot management requires further study.

Table 1: Effect of boron (applied as SOLUBOR) and lime (applied as HYDRATED LIME) on clubroot incidence and severity (disease severity index, DSI) on canola inoculated with *P. brassicae* pathotype 2 in Run 1

Treatment	Incidence (%)	Severity (DSI; %)
Lime (pH target)		
pH 6.4 (control)	100 a[1]	97 a
pH 7.0	79 b	43 b
pH 7.5	14 c	5 c
Boron (kg B/ha)		
0 (control)	68 ns[2]	51 ns
4	60	46

[1] Means followed by the letter do not differ at P=0.05 based on Tukey's Test
[2]ns = no significant differences were found among the treatments.

Table 2: Effect of boron (applied as SOLUBOR) and lime (applied as HYDRATED LIME) on clubroot incidence and severity (disease severity index, DSI) on canola inoculated with *P. brassicae* pathotype 2 in Run 2

Treatment	Incidence (%)	Severity (DSI; %)
Lime (pH target)		
pH 6.4 (control)	100 a[1]	85 a
pH 7.0	41 b	18 b
pH 7.5	13 c	5 c
Boron (kg B/ha)		
0 (control)	54 ns[2]	38 ns
12	48	34

[1] Means followed by the letter do not differ at P=0.05 based on Tukey's Test
[2] ns = no significant differences were found among the treatments.

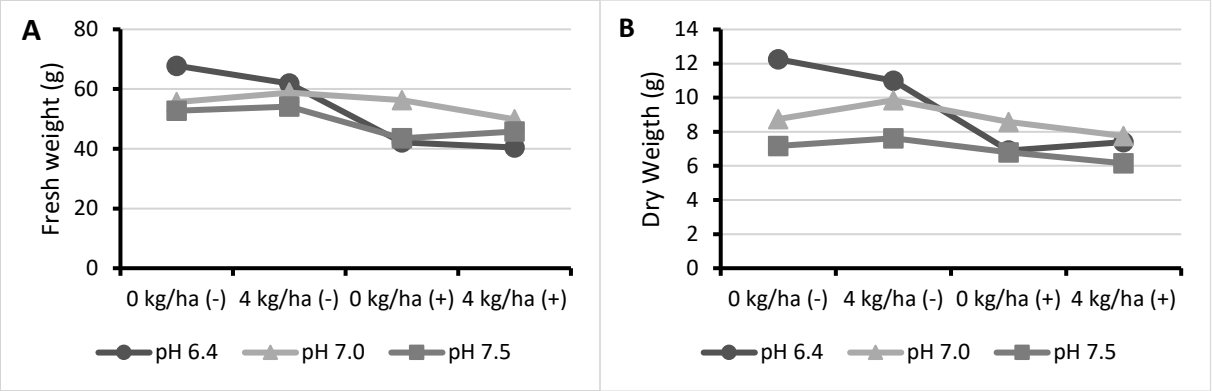

Figure 1. Effect of lime (applied as HYDRATED LIME), boron (applied as SOLUBOR at 0 and 4 kg B/ha) and inoculation with *Plasmodiophora brassicae* pathotype 2 (-/+) on fresh (A) and dry (B) weight of canola (10 plants per plot) in Run 1.

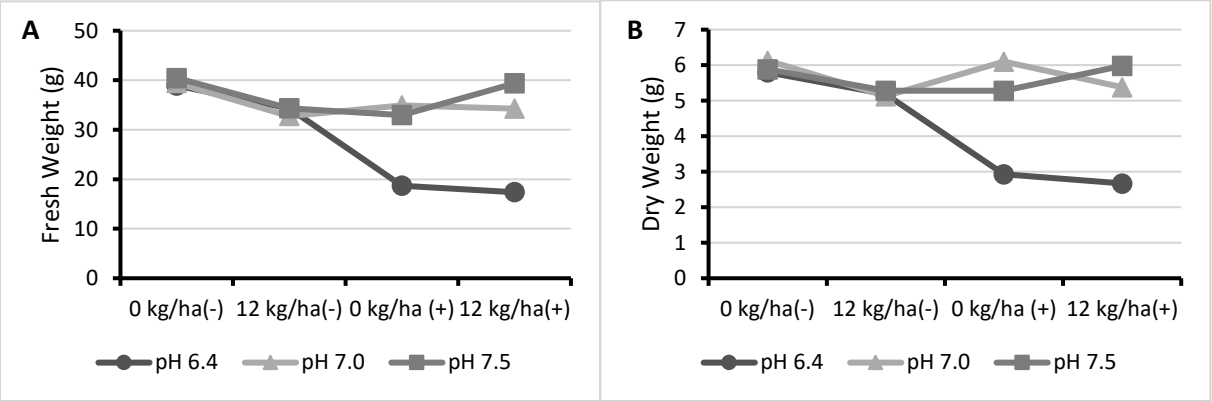

Figure 2. Effect of lime (applied as HYDRATED LIME), boron (applied as SOLUBOR at 0 and 12 kg B/ha) and inoculation with *Plasmodiophora brassicae* pathotype 2 (-/+) on fresh (A) and dry (B) weight of canola (10 plants per plot) in Run 2.

Funding for this project was provided by the Ontario Agri-Food Innovation Alliance, the Agriculture Development Fund of the Province of Saskatchewan, the Canadian Agri-Food Partnership through AAFC and the Canola Council of Canada, the Fresh Vegetable Growers of Ontario, the Ontario Canola Growers and the Ontario Ministry of Agriculture and Food through the Ontario Agricultural and Food Research initiative.

CROPS: Alyssum (*Lobularia maritima*) cvs. Snow Crystals and Clear Crystals
Stocks (*Matthiola incana*) cvs. Vintage Red and Vintage Burgundy

PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

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TITLE: EVALUATION OF ALYSSUM AND STOCKS FLOWERS FOR CLUBROOT RESISTANCE, 2022

METHODS: A field trial to evaluate the clubroot reaction of flower species Stocks and Alyssum was conducted on a site naturally infested with *P. brassicae* pathotype 2 at the Ontario Crops Research Centre -Bradford, Ontario. Flowers were seeded into plug trays on 2 May and grown in a greenhouse until transplanting. Flowers were transplanted on 17 June, each plot consisted of two rows, 3 m in length, plants were spaced 25 cm apart, with 40 cm between rows. The trial was arranged in a randomized complete block design with four replicates. Clubroot was assessed on 22 plants per plot at 6 weeks after transplanting on 4 August. Symptoms of clubroot were assessed on the roots of each plant and sorted into classes using a 0-3 scale, where 0 = no clubs, 1 = small clubs on less than 1/3 of roots, 2 = small or intermediate clubs on 1/3 to 2/3 of roots, and 3 = intermediate or large clubs on over 2/3 of roots. The proportion of plants with clubroot symptoms was used to determine clubroot incidence (CI). A disease severity index (DSI) was calculated using the following formula:

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

Compared to the previous 10-year average, air temperatures in 2022 were average for June (18.3°C) and August (20.6°C) The 10-year average temperatures were: June 18.9°C and July 21.4°C. Monthly rainfall was average for June (90 mm) and July (74mm). The 10-year rainfall averages were: June 97 mm and July 78 mm. Data were analyzed using the General Analysis of Variance function of Statistics V.10. Means separation was obtained using Fisher's Protected LSD test at P = 0.05 level of significance.

RESULTS: as presented in Table 1

CONCLUSIONS: No differences in clubroot incidence and severity were found among the treatments. Both varieties of Alyssum had low incidence of clubroot. No clubroot was found among the Stocks flower varieties (Table 1).

Table 1. Clubroot incidence (%) and severity (disease severity index, DSI) of flower species in a field trial at the Ontario Crops Research Centre -Bradford, 2022.

Flower	Cultivar	Incidence (%)	DSI (0-100)
Stocks	Vintage Red	0.0 ns[1]	0.0 ns
Stocks	Burgundy	0.0	0.0
Alyssum	Snow Crystals	8.0	1.0
Alyssum	Clear Crystals	17.0	4.0

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

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

CROPS: Canola (*Brassica napus*) cv. InVigor L233P & cv. ACS N39
PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

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TITLE: THE INTERACTION OF BORON AND LIME ON THE SEVERITY OF CLUBROOT IN CANOLA, 2022

MATERIALS: CALCITIC LIME (calcium carbonate), HYDRATED LIME (calcium hydroxide), KALIME, SOLUBOR (20.5% B, disodium octaborate tetrahydrate)

METHODS: Two field trials were conducted at the Ontario Crops Research Centre – Bradford, Ontario (OCRC) on high organic matter soil (muck soil, pH 6.4, organic matter 70%) naturally infested with *Plasmodiophora brassicae* pathotype 2. A third field trial was conducted on mineral soil (Burford loam, pH 7.3) naturally infested with *P. brassicae* pathotype 6 near Milton, ON. All trials were arranged in a randomized complete block design with four replicates at the OCRC and six replicates at Milton. Plot size differed for each trial, determined based on available space for each experiment (Trial 1 at the OCRC: 4.5 m x 3.5 m; Trial 2 at OCRC: 3.0 m x 1.75 m; Trial 3 at Milton: 4.0 m x 1.75 m).

There was a factorial arrangement of treatments with rates/types of lime to reach the target pH of 7.0 and 7.5 as one factor and application of boron as 16 kg B/ha (SOLUBOR) vs. an untreated control as the second factor. CALCITIC LIME was applied to Trial 1 at 8.9 and 15.1 t/ha by hand as a broadcast and incorporated with a cultivator to about 15 cm depth on 29 October 2021. Soil samples (0-15 cm depth) were taken from each plot in the spring of 2022 using a soil corer. They showed that the treatments had not achieved the pH targets of 7.0 and 7.5, so HYDRATED LIME was applied at 1.4 and 4.9 t/ha by hand and incorporated to about 10 cm depth with a rototiller on 21 June 2022. On 04 July, SOLUBOR was applied using a backpack sprayer in 1500 L/ha water. Trial 2 received a spring application of HYDRATED LIME at 5.6 and 9.7 t/ha. The application, timing and incorporation of lime and boron was the same as Trial 1 in 2022. Trial 3 received two types of lime, HYDRATED LIME (0.6 t/ha) and KALIME (1.1 t/ha) to achieve the pH target of 7.5 on 03 August and incorporated with a rototiller. SOLUBOR was applied on 17 August. After boron application, the trials were immediately seeded with canola (Trials 1 and 2 cv. InVigor L233P from BASF, susceptible to pathotype 2; Trial 3 – line ACS N39 from Dr. S Vail of Saskatoon Research and Development Center of AAFC, clubroot susceptible) using an Earthway push seeder with a 1002-10 seeding disc. Soil samples were taken from each plot in all three trials to determine soil pH. Weeds were managed through applications of LIBERTY (BASF) at the OCRC and hand-seeding at Milton.

On 16-17 August, 100 (Trial 1) or 50 (Trial 2) plants per plot were pulled and assessed for clubroot symptoms and 50 plants per plot were assess in Trial 3 on 06 October. Each plant was assessed using a 0 to 3 scale, where 0 = no clubbing, 0.25 = small club on lateral roots, 1 = clubs on 1/3 of the root, 2 = clubs on 1/3 to 2/3 of the root and 3 = clubs on more than 2/3 of the root. The category of 0.25 for small clubs on lateral roots was added because this symptom, which was common in some treatments, would not affect plant development and have little impact on spore numbers in soil. We concluded that allocating of a rating as 1 would overstate the impact of this symptom on clubroot intensity in the field. Disease severity index (DSI) was calculated using the following equation:

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

In addition, fresh and dry weight was measured on the above-ground portions of 10 plants per plot. The size and weight or roots were not assessed because clubroot symptoms are confounded with plant growth. At the OCRC, compared to the previous 10-year average, air temperatures in 2022 were average for June (18.3°C) August (20.6°C) and below average for July (20.2°C). The 10-year average temperatures were: June 18.9°C, July 21.4°C, August 20.4°C. Monthly rainfall was for June (90 mm), July (74mm) and August (82 mm). The 10-year rainfall averages were: June 97 mm, July 78 mm, August 79 mm. Data was analyzed using ANOVA in PROC GLIMMIX and PROC CORR using Kendall Spearman (P=0.001) in SAS 9.4 (SAS Institute, Cary, IN). Means were separated using Tukey's test at $P = 0.05$

RESULTS: as presented in Tables 1 and 2 and Figure 1

CONCLUSIONS: There was no interaction between lime and boron in any trial. In both trials at the OCRC, raising the soil pH with lime reduced clubroot incidence and severity (Table 1). There was no difference in clubroot level between the treatments with lime added, but there was a negative correlation between pH and clubroot severity in both trials (Figure 1). In Trial 2, adding lime increased plant fresh and dry weights, but there was no difference in Trial 1 (Table 1). Clubroot levels at Milton were extremely low and there were no differences in this study (Table 2). These results support previous reports that raising the soil pH is an effective management strategy in decreasing clubroot severity. The use of boron for clubroot management requires further study.

Table 1: Effect of boron (applied as SOLUBOR) and lime (applied as CALCITIC LIME in the fall and HYDRATED LIME in the spring to reach the target pH of 7.0 and 7.5) on clubroot incidence and severity (disease severity index; DSI) and fresh and dry weights for canola cv. L233P grown on muck soil naturally infested with *Plasmodiophora brassicae* at the Ontario Crops Research Centre – Bradford, Ontario, 2022.

Treatment	Incidence[1] (%)	DSI[1] (%)	Fresh Weight[2] (kg)	Dry Weight[2] (g)	Actual pH
Trial 1					
pH target					
Control	85 a[3]	64 a	0.28 ns	33.24 ns	6.5
pH 7.0	48 b	21 b	0.31	34.20	7.1
pH 7.5	53 b	24 b	0.26	33.24	7.3
Boron (kg/ha)					
0	56 ns	32 ns	0.293 ns	33.41 ns	
16	69	41	0.27	34.12	
Trial 2					
pH target					
Control	93 a	73 a	0.16 b	20 b	6.8
pH 7.0	74 b	40 b	0.37 a	41 a	7.6
pH 7.5	74 b	41 b	0.45 a	50 a	7.4
Boron (kg/ha)					
0	84 ns	58 a	0.33 ns	36 ns	
16	77	45 b	0.32	38	

[1]Roots of 100 plants (Trial 1) or 50 plants (Trial 2) per plot assessed using a 0-3 scale; DSI was calculated
[2]Weight of 10 plants per plot
[3]Values with different letter represent statistically significant at P=0.05, Tukey's Test. ns = not significant

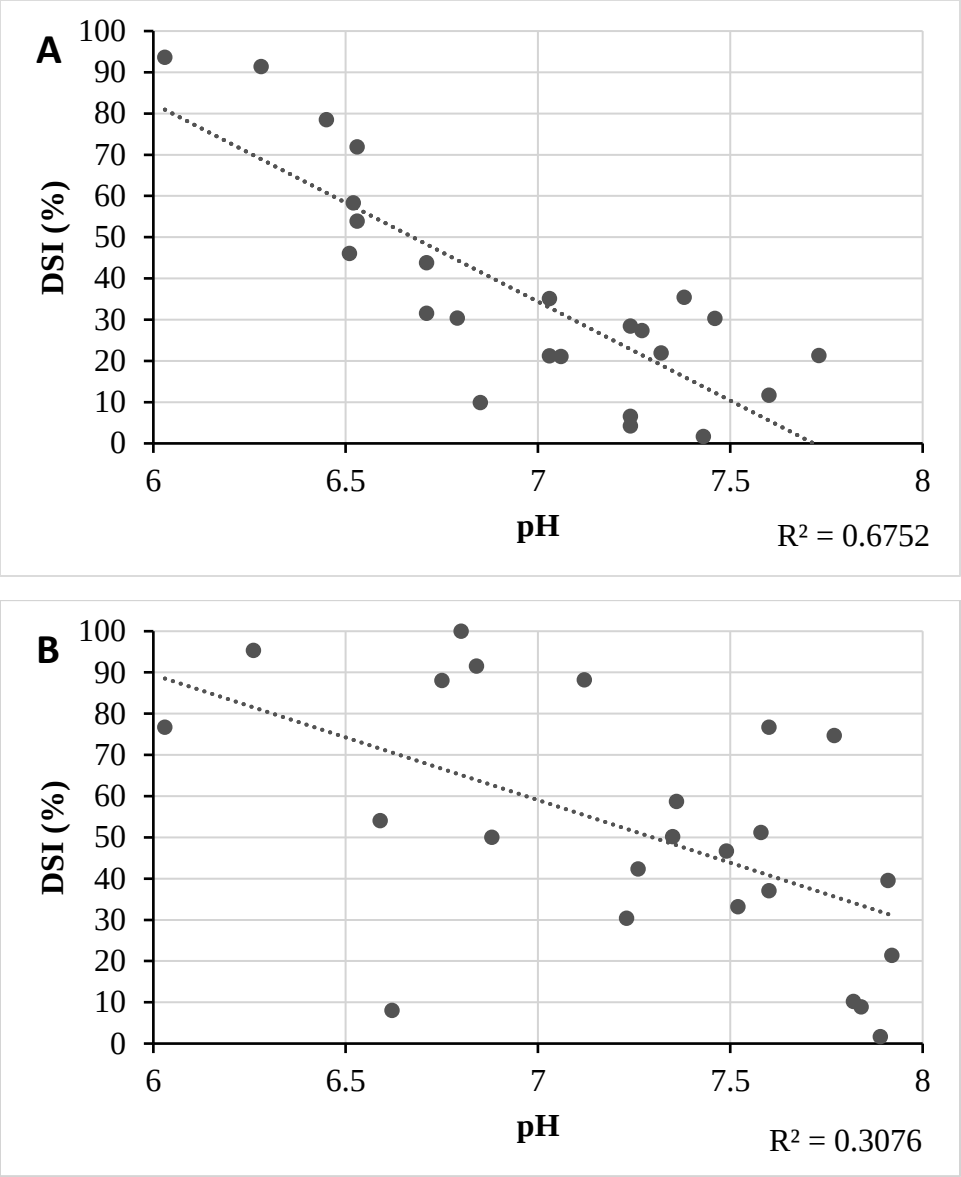

Figure 1: Correlation of pH and clubroot severity (disease severity index, DSI) in Trials 1 (A) and 2 (B) on canola grown on soil naturally infested with *Plasmodiophora brassicae* at the Ontario Crops Research Centre-Bradford in 2022.

Table 2: Effect of boron and lime (Target pH of 7.5) on clubroot incidence and severity (disease severity index; DSI) and fresh and dry weights for canola cv. L233P grown on mineral soil naturally with *Plasmodiophora brassicae* at Milton, ON

Treatment	Incidence[1] (%)	DSI[1] (%)	Fresh Weights[2] (kg)	Dry Weights[2] (g)
Lime				
Control	0 ns[3]	0 ns	0.27 ns	25 ns
Calcium hydroxide	0.005	0.17	0.31	29
KaLime	0	0	0.34	31
Boron (kg/ha)				
0	0.002 ns	0.07 ns	0.33 ns	30 ns
16	0.001	0.03	0.29	27

[1]Roots of 50 plants per plot assessed using a 0-3 scale; DSI was calculated
[2]Weight of 10 plants per plot
[3] ns = no significant differences were found among the treatments.

Funding for this project was provided by the Ontario Agri-Food Innovation Alliance, the Agriculture Development Fund of the Province of Saskatchewan, the Canadian Agri-Food Partnership through AAFC and the Canola Council of Canada, the Fresh Vegetable Growers of Ontario, the Ontario Canola Growers and the Ontario Ministry of Agriculture and Food through the Ontario Agricultural and Food Research initiative.

CROPS: *Brassica napus* cv. Prota, Mytnickij, Westar and ACS N39
PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

AUTHORS: CHESNEY SG[1], GOSSEN BD[2] & MCDONALD MR[1]
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TITLE: GROWTH ROOM STUDY OF THE EFFECT OF BORON AND B-SENSITIVITY ON THE SEVERITY OF CLUBROOT ON CANOLA, 2022

MATERIALS: SOLUBOR (20.5% B, disodium octaborate tetrahydrate)

METHODS: A study was conducted to examine the effect of boron on clubroot severity in canola in a growth room set to 24°/21°C day night cycle, a 17-hour photoperiod and 50% humidity. Two runs of the study were conducted. The study was conducted as a three-way factorial (boron x cultivar x inoculation) arranged as a randomized complete block design with four replicates and 12 plants (replicate 1, 2 and 3) or 10 plants (replicate 4) per experimental unit. Boron sensitive (Westar, ACS N39) and insensitive (Prota and Mytnickij) cultivars of canola were treated with boron and applied at rates of 0, 4 or 8 kg B/ha as SOLUBOR in run 1 and 0, 8 and 16 kg B/ha as SOLUBOR in run 2. The last treatment was inoculated with resting spores of *P. brassicae* pathotype 2 vs. non-inoculated control.
Soilless mix (LA4 Sunshine mix, Sungro) was pressed into tall, narrow plastic pots (conetainer, Steuve & Sons, OR) and compressed firmly to provide a soil density conducive for clubroot. In run 1, boron was applied as a solution of SOLUBOR (10 mL of solution with 0.25 g SOLUBOR/L = 4 kg B/ha, 10 mL of solution with 0.49 g SOLUBOR/L = 8 kg/ha) to the soil of each pot. In run 2, boron was applied at higher rates and in less solution (5 mL of solution with 0.98 g of SOLUBOR/L = 8 kg/ha, 5 ml of solution with 1.96 g of SOLUBOR/L = 16 kg/ha). One day after boron application, trials were seeded with the canola cultivars (2 seeds per pot).
Seven days after germination, seedlings were thinned to one seedling per pot. Ten days after seeding, plants were assessed for boron toxicity symptoms using a 0 to 3 scale with 0: no symptoms, 1: light marginal burning of leaves, 2: marginal burning and cupping, and 3: severe marginal burning and cupping. Toxicity was calculated using the following equation:

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

Inoculum was extracted from clubbed canola roots collected from the Ontario Crops Research Centre-Bradford in 2018 using standard procedures. Ten and eighteen days (Run 1) and seven and twelve days (Run 2) after seeding, each plant was inoculated with 5 ml of $1x10^6$ resting spores/mL. Plants were top watered in Run 1 and bottom watered in Run 2 with water adjusted to pH 6.4 using commercial vinegar and fertilized twice a week with a 0.1% solution of 20-20-20 and magnesium sulfate. Roots were assessed for clubroot symptoms at 6 weeks after inoculation using a 0-3 scale, where 0 = no clubbing, 1 = clubs on 1/3 of the root, 2 = clubs on 1/3 to 2/3 of the root and 3 = clubs on more than 2/3 of the root. Disease severity index (DSI) was calculated using the following equation:

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

In addition, fresh and dry weight was measured on the above-ground portions of each experimental unit. Data was analyzed using ANOVA in PROC GLIMMIX and means were separated using Tukey's test at $P = 0.05$ in SAS 9.4 (SAS Institute, Cary, IN). Data for toxicity and clubroot severity and incidence were analyzed as a two-way factorial (boron x cultivar) while fresh and dry weights were analyzed as a three-way factorial (inoculation x boron x cultivar)

RESULTS: In the first run of the experiment, clubroot incidence was high, and symptoms were severe, but there were no differences among the cultivars or rate of boron for clubroot severity and incidence (Table 1). Application of increasing levels of boron increased toxicity symptoms but there were no differences among the cultivars (Table 1). Also, inoculated plants had lower fresh and dry weights compared to non-inoculated plants. Non-inoculated plants of Myntickij had a higher dry weight compared to other cultivars and the high rate of boron (8 kg B/ha) reduced the biomass fresh and dry weight of Westar compared to the non-treated control (Figure 1).
In the second run of the experiment, the high rate of boron (16 kg/ha) decreased clubroot severity while 8 kg/ha did not (Table 2). Myntickij had significantly lower DSI than other cultivars and lower incidence when treated with a high rate of boron (Tables 2 and 3). There was no difference in toxicity between the different cultivars or 8 and 16 kg/ha rates of boron (Table 2). Fresh and dry weights decreased with rate of boron when non-inoculated but increased when inoculated (Figure 2).

CONCULSIONS: Only high rates of boron (16 kg/ha) decreased clubroot severity. In both runs of the experiment there was no difference in reaction to boron in the sensitive and insensitive cultivars. More research is needed to determine what rates of boron are effective in decreasing clubroot severity and the tolerance of sensitive and sensitive lines.

Table 1. Effect of boron (applied as SOLUBOR) on boron toxicity and clubroot incidence and severity (disease severity index, DSI) on boron sensitive (ACS N39 and Westar) and insensitive (Prota and Myntickij) lines of canola inoculated with *Plasmodiophora brassicae* pathotype 2 in Run 1

Treatment	Incidence (%)[1]	DSI (%)	Toxicity (%)
Cultivar			
Prota	88 ns[2]	81 ns	6 ns
Mytnickij	95	94	5
Westar	99	93	6
ACS N39	80	91	5
Boron (kg B/ha)			
0	93 ns	90 ns	0 c
4	93	91	7 b
8	89	87	10 a

[1]Roots of 10 plants per experimental unit were assessed using the standard 0-3 scale and DSI was calculated
[2] Means followed by the same letter do not differ based on Tukey's Test at $P = 0.05$. ns = not significant

Table 2. Effect of boron (applied as SOLUBOR) on boron toxicity and clubroot severity (disease severity index, DSI) on boron sensitive (Westar and ACS N39) and insensitive (Prota and Mytnickij) lines of canola inoculated with *Plasmodiophora brassicae* pathotype 2 in Run 2

Treatment	DSI (%)[1]	Toxicity (%)
Cultivar		
Prota	83 a[2]	24 ns
Mytnickij	52 b	23
Westar	81 a	27
ACS N39	74 a	25
Boron (kg B/ha)		
0	84 a	0 b
8	75 a	36 a
16	58 b	38 a

[1]Roots of 10 plants per experimental unit were assessed using the standard 0-3 scale and DSI was calculated
[2] Means followed by the same letter do not differ based on Tukey's Test at $P = 0.05$. ns = not significant

Table 3. Effect of boron (applied as SOLUBOR) on clubroot incidence on boron sensitive (Westar and ACS N39) and insensitive (Prota and Myntickij) lines of canola inoculated with *Plasmodiophora brassicae* pathotype 2 in Run 2

Cultivar	Boron (kg/ha)	Incidence (%)
Prota	0	100 a[1]
	8	100 a
	16	91 a
Mytnickij	0	87 ab
	8	71 bc
	16	59 c
Westar	0	100 a
	8	98 a
	16	100 a
ACS N39	0	100 a
	8	98 a
	16	100 a

[1] Means followed by the same letter do not differ based on Tukey's Test at $P = 0.05$. ns = not significant

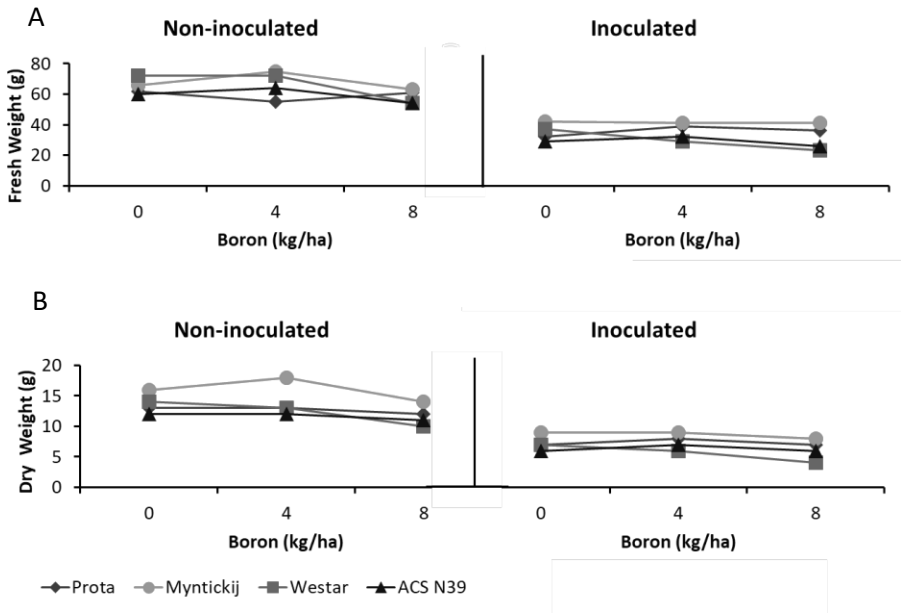

Figure 1. The effect of boron (applied as SOLUBOR) on fresh (A) and dry (B) weights of boron sensitive (Westar and ACS N39) and insensitive (Prota and Myntickij) lines of canola inoculated with *Plasmodiophora brassicae* pathotype 2 in Run 1

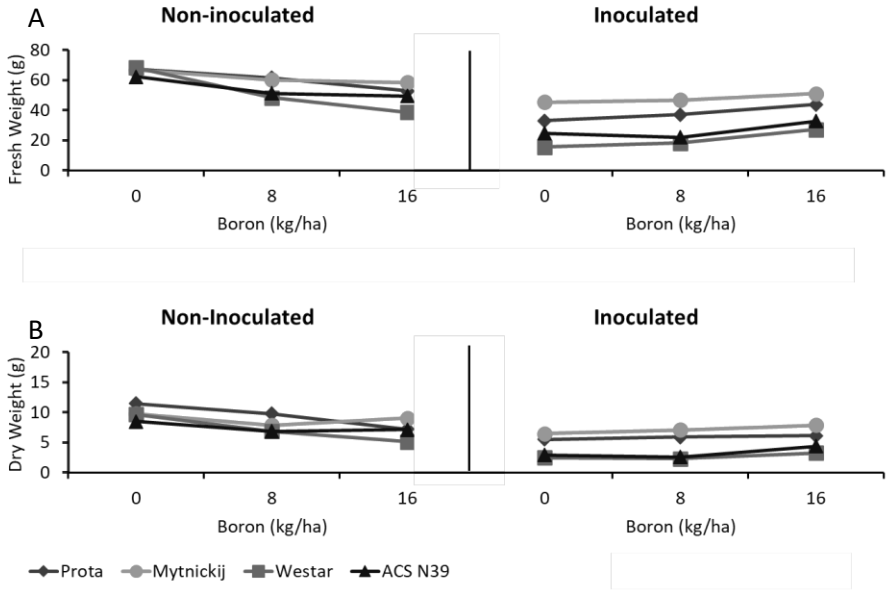

Figure 2. The effect of boron (applied as SOLUBOR) on fresh (A) and dry (B) weights of boron sensitive (Westar and ACS N39) and insensitive (Prota and Mytnickij) lines of canola inoculated with *Plasmodiophora brassicae* pathotype 2 in Run 2

Funding for this project was provided by the Ontario Agri-Food Innovation Alliance, the Agriculture Development Fund of the Province of Saskatchewan, the Canadian Agri-Food Partnership through AAFC and the Canola Council of Canada, the Fresh Vegetable Growers of Ontario, the Ontario Canola Growers and the Ontario Ministry of Agriculture and Food through the Ontario Agricultural and Food Research initiative.

CROPS: *Brassica napus* cv. InVigor L233P
PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

AUTHORS: CHESNEY SG[1], GOSSEN BD[2] & MCDONALD MR[1]
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TITLE: INDUCED RESISTANCE AND SUSCEPTIBILITY TO CLUBROOT IN SPLIT-ROOT CANOLA PLANTS UNDER CONTROLLED CONDITIONS, 2022

METHODS: Growth room studies were conducted at the University of Guelph using split-root canola plants to test the hypotheses that infection with an avirulent pathotype induces resistance to a virulent pathotype and infection with a virulent pathotype induces susceptibility to an avirulent pathotype. The treatments were avirulent/virulent (induced resistance) and virulent/avirulent (induced susceptibility). The study was arranged in a randomized complete block design with four replicates and 10 plants per experimental unit except in the fourth replicate where there were eight plants per experimental unit in the due to poor germination.

Seed of canola cv. InVigor L233P (BASF; resistant to clubroot pathotype 6 but susceptible to pathotype 2, Williams' system) was germinated in germination pouches. After seven days, the root tips of each seedling were trimmed with a sterilized scalpel. The trimmed seedlings were then transplanted into plastic pots filled with soilless mix (Sunshine Mix #4, Sungro, pH 5.3). Seeds of Shanghai pak choi were also germinated in germination pouches and transplanted at the same time as a susceptible control. Pots for the split-root system were created by taping two edgeless 8 cm x 6 cm x 6 cm plastic pots together with a bamboo skewer placed between the two pots. The pots were then filled with soilless mix and compacted. Small plastic bags were placed underneath each pot to prevent cross contamination after watering. Ten days after transplanting, the seedlings were uprooted and washed to remove the soilless mix. The roots were then divided into two sections and placed into each side of the two-pot system arrangement, with the seedling's stem supported by the bamboo skewer, to create a plant with split roots. The location of the roots in each pot was marked with a toothpick to allow inoculum to be placed directly adjacent to root.

One side of the two-pot arrangement was inoculated with 5 mL of *P. brassicae* resting spores at a concentration of $1x10^7$ resting spores/mL at 10 days after splitting the roots (day 0) with pathotype 2 (virulent) or pathotype 6 (avirulent) or water (control). The inoculum was obtained from clubbed canola roots collected at the Ontario Crops Research Centre-Bradford in 2011 (pathotype 6; inoculum increased on Shanghai pak choi in 2021) or 2018 (pathotype 2). The second side of the two-pot arrangement was inoculated with the alternate pathotype (or water control) 4 or 7 days after the first side of the system was inoculated. Untreated controls for both pathotypes on each side of the system were also included for each inoculation timing. Shanghai pak choi was used as a susceptible control at each inoculation timing to confirm the viability of inoculum and suitability of conditions for clubroot infection and development.

Roots were assessed for clubroot symptoms at six weeks after inoculation of the second side of the system of each treatment. The incidence and severity of clubroot symptoms on each side of each plant was assessed, taking care to note which side was inoculated with which pathotype. Roots were visually assessed using a standard 0-3 scale where; 0 = no clubs, 1 = clubs on 1/3 of the root, 2 = clubs on 1/3 to 2/3 of the roots and 3: clubs on > 2/3 of the root. A disease severity index (DSI) was calculated for each side of each experimental unit as the following:

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

Statistical analysis was preformed using SAS 9.4 (SAS Institute, Cary, IN). Each inoculation timing was analyzed as a factorial with inoculation treatment (pathotype x side) as one factor and timing as the other factor. Clubroot incidence and DSI was analyzed using PROC GLIMMIX and Tukey's test at $P = 0.05$ level of significance.

RESULTS: As presented in Table 1

CONLUSIONS: Clubroot incidence and severity were high throughout the study. Inoculation with *P. brassicae* on the roots of one side of the split-root plant did not affect symptom development on the roots of the other side of the plants. This demonstrated that induced resistance or susceptibility, if produced at all, were not transmitted through the plant and back down to the other side of the root system. Therefore, the hypotheses (infection with an avirulent pathotype induces resistance to a virulent pathotype and infection with a virulent pathotype induces susceptibility to an avirulent pathotype) were rejected.

Table 1: Clubroot incidence and severity (disease severity index; DSI) of canola plants with split-roots and inoculated with pathotype 2 (virulent) or pathotype 6 (avirulent) of *P. brassicae*. The roots on side A of the system were inoculated at day 0 and side B was inoculated 4 or 7 days after initial inoculation.

Treatment	Side A	Side B	Side A	Side B
	Incidence (%)	Incidence (%)	DSI (%)	DSI (%)
4-day interval				
Water / Water	0 b[2]	0 b	0 b	0 b
Avirulent / Water	0 b	0 b	0 b	0 b
Virulent / Water	100 a	0 b	92 a	0 b
Water / Virulent	0 b	98 a	0 b	90 a
Water / Avirulent	0 b	0 b	0 b	0 b
Avirulent / Virulent	0 b	98 a	0 b	85 a
Virulent / Avirulent	98 a	0 b	89 a	0 b
7-day interval				
Water / Water	0 b	0 b	0 b	0 b
Avirulent / Water	0 b	0 b	0 b	0 b
Virulent / Water	100 a	0 b	92 a	0 b
Water / Virulent	0 c	89 ab	0 c	58 b
Water / Avirulent	0 c	0 c	0 c	0 c
Avirulent / Virulent	0 c	82 b	0 c	65 b
Virulent / Avirulent	100 a	0 c	93 a	0 c

[1]Roots of 10 plants per experimental unit were assessed on a 0 - 3 scale and DSI was calculated.
[2]Means in a column and interval followed by the same letter do not differ based on Tukey test at $P < 0.05$.
[3]DSI of Shanghai pak choi at the 0-day interval (virulent: 100%; avirulent: 100%), 4-day interval (virulent: 96.67%; avirulent: 100%), 7-day interval (virulent: 80%; avirulent: 90%),

Funding provided by Canadian Agri-Food Partnership of AAFC, the Canola Council of Canada, the Fresh Vegetable Growers of Ontario, the Ontario Canola Growers and the Ontario Ministry of Agriculture and Food through the Ontario Agricultural and Food Research initiative.

HOST: Cabbage (*Brassica oleracea* L. var. *capitata*) cv. Bronco
PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

AUTHORS: MCDONALD MR & VANDER KOOI K
U of Guelph, Department of Plant Agriculture, Ontario Crops Research Centre - Bradford

TITLE: EVALUATION OF MYCOINSECTICIDES TO CONTROL CLUBROOT IN CABBAGE, 2022

MATERIAL: BOTANIGARD (*Beauveria bassiana* Strain GHA 11.3%), BIOCERES EC (*Beauveria bassiana* strain ANT-3 at least $1x10^{10}$ spores/mL)

METHODS: A field trial to evaluate the efficacy of mycoinsecticides to reduce clubroot incidence in cabbage cultivars was conducted at the Ontario Crops Research Centre – Bradford on muck soil (pH ≈ 6.3, organic matter 70.2%) naturally infested with *P. brassicae* pathotype 2. The mycoinsecticide *Beauveria bassiana* can also colonize plants as an endophyte and may reduce disease and insect damage. Treatments were: Bronco treated with BOTANIGARD or BIOCERES and untreated Bronco A randomized complete block design with four replicates per treatment was used. Each experimental unit consisted of three rows, six meters in length, spaced 55 cm apart with 30 cm in-row spacing. Cabbage was seeded 25 May into 128-cell plug trays filled with soilless mix and grown in a greenhouse. On 17 June, BOTANIGARD at 10 mL/L and BIOCERES at 8 mL/L were applied to two trays each of Bronco transplants at 500 mL/tray. On 7 July all cabbage plants were hand-transplanted into the field. On 14 September, holes caused by insect feeding were counted on the 4th oldest leaf of five consecutive plants per replicate. On 14 September, the tops were cut from 5 consecutive plants pulled from each row (10 total) and weighed to determine top fresh weight. The roots were visually assessed for symptoms of clubroot and sorted into classes based on the following scale: 0 = no clubs, 1 = small clubs on less than 1/3 of roots, 2 = small or intermediate clubs on 1/3 to 2/3 of roots, and 3 = intermediate or large clubs on over 2/3 of roots. The proportion of roots in classes 1-3 was used to calculate clubroot incidence (CI). The disease severity index (DSI) was calculated using the following formula:

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

Compared to the previous 10-year average, air temperatures in 2022 were average for August (20.6°C) and September (16.5°C), and below average for July (20.2°C). The 10-year average temperatures were: July 21.4°C, August 20.4°C and September 16.3°C. Monthly rainfall was below the 10-year average September (43 mm) and average for July (74 mm) and August (82 mm). The 10-year rainfall averages were: July 78 mm, August 79 mm and September 59 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: Treatments with endophytes did reduce clubroot incidence or severity in 2022. Plants treated with BIOCERES had significantly less clubroot than plants treated with BOTANIGARD or the untreated check. Feeding damage caused by *Lepidoptera* species was not significantly different in cabbage treated with endophytes compared than the untreated control (Table 1).

Table 1. Clubroot incidence and severity, insect damage and fresh top weight of cabbage, cv. Bronco, treated with mycoinsecticide endophytes and grown at the Ontario Crops Research Centre – Bradford, Ontario, 2022.

Endophyte	Clubroot incidence[1] (%)	DSI[2] (0-100)	Feeding Damage[3]	Fresh top wgt/plant[4] (g)
BIOCERES	9.6 a[5]	8.8 a	4.2 ns[6]	323 ns
BOTANIGARD	77.5 b	47.5 b	3.2	285
none	75.0 b	53.3 b	5.2	362

[1] Clubroot incidence was determined considering only roots in classes 1, 2 & 3 as clubbed.

[2] Roots of 10 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] Average number of holes on five leaves caused by insect larvae feeding assessed on 14 September for Bronco cabbage treatments.

[4] Average fresh top weight of 10 plants before head formation.

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

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

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

CROPS: Barsica forage rapeseed, Dwarf essex rapeseed, Forage Rapeseed, Certified brown Mustard, Supreme mustard blend, Groundbreaker radish, Tillage radish, Oilseed radish, Barkant radish, Purple top turnip, Winfred forage brassica, Tillage radish, White icicle radish, April cross Hybrid Oriental radish, Mei qing choi

PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

AUTHORS: VANDER KOOI K[1], GOSSEN BD[2], MCDONALD MR[1]
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TITLE: EVALUATION OF CLUBROOT RESISTANCE IN BRASSICA COVER CROP SPECIES, 2022

METHODS: A field trial to evaluate the clubroot reaction of Brassica cover crops species was conducted on a site naturally infested with *P. brassicae* pathotype 2 at the Ontario Crops Research Centre -Bradford, Ontario. Various brassica cover crop species were seeded into naturally infested soil on 10 June. Mei Qing Choi (Shanghai pak choi) was included as a susceptible check. Crops were seeded with an Earthway Precision Garden Seeder fitted with seeding disc 1002-10 at 50 seeds per meter of row. Each plot consisted of two rows, 5 m in length, with 40 cm between rows. The trial was arranged in a randomized complete block design with four replicates. Clubroot was assessed on 50 plants per plot at 6 weeks after seeding/transplanting on 26 and 28 July. Symptoms of clubroot were assessed on the roots of each plant on a 0-3 scale, where 0 = no clubs, 1 = small clubs on less than 1/3 of roots, 2 = small or intermediate clubs on 1/3 to 2/3 of roots, and 3 = intermediate or large clubs on over 2/3 of roots. The proportion of plants with clubroot symptoms was used to determine clubroot incidence (CI). A disease severity index (DSI) was calculated using the following formula:

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

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

RESULTS: as presented in Table 1

CONCLUSIONS: Differences in clubroot incidence and severity was found among the various crop species. Eco Till daikon, tillage radish, Winfred forage brassica and Barkant turnip had significantly lower clubroot incidence and severity than the rapeseed and mustard species (Table 1).

T able 1. Clubroot incidence (%) and severity (disease severity index, DSI), of Brassica cover crop species in a field trial at the Muck Crops Research Station, 2022.

Crop & Cultivar	Source	Incidence (%)	DSI (0-100)
Rapeseed			
Dwarf Essex	Speare Seed	98.3 d[1]	66.3 b
Barsica Forrage	Speare Seed	95.0 cd	60.4 b
Forage	Speare Seed	83.0 cd	43.1 b
Mustard			
Supreme Blend[5]	Speare Seed	93.5 cd	56.5 b
Certified Brown	Speare Seed	80.0 cd	49.7 b
Radish			
April Cross Hybrid	Stokes Seed	75.0 cd	8.4 a
Oriental Oilseed	Speare Seed	28.0 b	6.8 a
White Icicle	Stokes Seed	27.0 b	8.0 a
Tilage	Stokes Seed	15.5 ab	4.0 a
Ground Breaker	Speare Seed	7.6 ab	2.5 a
Tillage	Speare Seed	2.5 a	0.8 a
Eco-Till Daikon	Quality Seed	1.0 a	0.5 a
Turnip			
Purple Top	Speare Seed	82.0 cd	45.9 b
Barkant	Speare Seed	5.5 a	3.0 a
Brassica			
Winfred Forage	Speare Seed	2.3 a	2.0 a
Shanghai Pak choi			
Mei Qing Choi	Stokes Seed	87.0 cd	49.5 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 Fresh Vegetable Growers of Ontario.

CROP: Canola (*Brassica rapa* L.) cv. L233P
Perennial ryegrass (*Lolium perenne* L.)
Daikon radish (*Raphanus sativus* var. *longipinnatus*) cv. Eco Till
PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

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TITLE: FIELD ASSESSMENT OF COVER CROPS AND LIME ON CLUBROOT SEVERITY IN SUBSEQUENT CROP, 2022

MATERIALS: HYDRATED LIME (>94% calcium hydroxide)
ROUNDUP herbicide (7 g L^{-1} Glyphosate)

METHODS: A trial was conducted at the Ontario Crops Research Centre- Bradford, Ontario on a muck soil (pH 6.3, organic matter 70%) naturally infested with *Plasmodiophora brassicae* pathotype 2. The trial was arranged as a randomized complete block with four replicates. Each plot was 1.75 m × 4.5 m, with 1.5 m between plots and six rows with 0.35 m between rows. HYDRATED LIME was applied on 4 November 2021 by evenly distributing the powder on the soil surface at ~5.4 t ha^{-1} and incorporating it to 15-20 cm depth using a rototiller. On 2 June 2022, cover crop treatments of perennial ryegrass and daikon radish were seeded using an Earthway seeder fitted with a 1002-22 disc. The cover crops were allowed to grow for 8 weeks. The trial was hand weeded at regular intervals. ROUNDUP was applied at 3 L ha^{-1} in 400 L ha^{-1} water on 28 July 2022 and again 72 hrs later to kill the cover crops. The plots were mowed and tilled 72 hrs after the second ROUNDUP treatment.

The effect of the treatments on the inoculum potential of *P. brassicae* was assessed by seeding canola cv. L233P (susceptible to pathotype 2) across the entire trial on 11 August 2022. The canola was planted using an Earthway seeder fitted with a 1002-5 disc in three rows per plot, with 0.4 m spacing between rows. At 6 weeks after seeding (22 September 2022), plants in the center 1 m area of each plot were uprooted. Clubroot incidence and severity were assessed on each plant and sorted into classes using a standard 0–3 rating scale, where 0 = no clubbing, 1 < 1/3 clubbing of roots, 2 = 1/3 to 2/3 of root area with clubs, and 3 > 2/3 of root clubbed. A disease severity index (DSI) was calculated for each plot using the equation below:

$$DSI=\sum (\text{class \#})(\text{\# of plants in class}) / (\text{total number of plants})(\text{\# of classes } -1)$$

Data were analyzed using analysis of variance in Statistix V.10, with means separation based on LSD analysis at $P = 0.05$. A logarithmic transformation was applied prior to analysis of the disease severity index values to improve normality.

RESULTS: as presented in Table 1

CONCLUSIONS: Clubroot incidence and severity were very low in the first replicate block of the trial, so these values were omitted from the analysis. Treatment with HYDRATED LIME reduced clubroot incidence and severity, and shoot fresh weight, but did not affect shoot dry weight. Incidence was reduced to 18% compared to 44% in the untreated control, severity was reduced to 11% from 28% and fresh weight was reduced to 25.8 g from 42.8 (Table 1). Cover crop had no impact on any response variable. It is likely that cover crops require much more time to affect clubroot levels.

Table 1. Clubroot incidence and severity and mean plant topgrowth biomass (fresh and dry weight) after application of hydrated lime and cover crops in muck soil naturally infested with *Plasmodiophora*. *brassicae* at the Muck Crops Research Station, Ontario, 2022.

Lime and Cover crop	Incidence (%)	DSI (%)	Shoot weight (g)	
			Fresh	Dry
Lime				
Control	10 ns[2]	6 ns	30.8 ns	2.4 ns
Daikon	21	12	21.9	1.4
Ryegrass	22	13	24.6	1.5
Mean	***18 b***	***11 b***	***25.8 b***	***1.7 a***
No Lime				
Control	51	34	47.4	2.0
Daikon	38	25	41.3	2.9
Ryegrass	44	58	39.6	2.8
Mean	***44 a[1]***	***28 a***	***42.8 a***	***2.6 a***

[1] Means followed by a different letter are significantly different based on LSD at $P < 0.05$.
ns = no significant differences were found among treatments

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

CROP: Canola (*Brassica napus* L.) cv. L233P
PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

AUTHOR: ROBSON J[1], GOSSEN BD[2] & MCDONALD MR[1]
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TITLE: EVALUATION OF MYOINSECTICIDE BEAUVERIA BASSIANA APPLICATIONS TO REDUCE CLUBROOT SEVERITY, 2022

MATERIALS: BOTANIGARD (Beauveria bassiana Strain GHA 11.3%)
BIOCERES EC (Beauveria bassiana strain ANT-3 at least 1x1010 spores/mL)

METHODS: A trial was conducted at the Ontario Crops Research Center- Bradford, Ontario on a muck soil (pH 6.3, organic matter 70%) naturally infested with pathotype 2 of *Plasmodiophora brassicae*. The trial was arranged as a randomized complete block design with four replicates. Each experimental unit (plot) was 1.75 m × 3 m with 0.75 m between plots. Treatments consisted of an untreated check and treatments of an BIOCERES (8 mL L^{-1} H_2O) and BOTANIGARD (10 mL L^{-1} H_2O) as either a soil drench or seed treatment. Seed treatments were completed prior to seeding by adding a methyl cellulose solution (1 g methyl cellulose L^{-1} H_2O) and then mixing equal parts of the solution to BOTANIGARD or BIOCERES and adding 75 grams of L233P canola seed then continuously agitating the solution until the liquid has evaporated. Canola plants were seeded (August 18, 2022) using a Earthway seeder fitted with a 1002-5 disc creating 4 rows per plot leaving ~0.4 m between rows. Drench treatments were applied after seeding using a mixture of BIOCERES (8 mL L^{-1} H_2O) or BOTANIGARD (10 mL L^{-1} H_2O) evenly applied over the seeding rows with a band width the same width as the seeding rows (~500 mL per row) applying enough to ensure the solution is in contact with the seeds.
At 6 weeks after seeding (September 29, 2021), clubroot incidence and disease severity were assessed on plants in the center 1 m area using a 0–3 rating scale to place plants into different classes based on the amount of clubbing, where 0 = no clubbing, 1 =< 1/3 clubbing of roots, 2 = 1/3 to 2/3 of root area with clubs, and 3= > 2/3 of root clubbed. A disease severity index (DSI) was calculated as follows:

$DSI=\sum$ (class #)(# of plants in class) / (total number of plants)(# of classes -1)

Several plants were taken for the adjacent areas assessed for disease levels to determine the fresh and dry weight of canola shoots.
Compared to the previous 10-year average, air temperatures in 2022 were average for August (20.6°C) and September (16.5C). The 10-year average temperatures were 20.4°C in August and 16.3°C in September.
Monthly rainfall was below the 10-year average for September (43 mm) and average for August (82 mm). The 10-year rainfall averages were 79 mm in August and 59 mm in September.
Data were analyzed using a Kruskall-Wallis One-way AOV with a type 1 error at $P = 0.05$ for non parametric data and a Randomized Complete Block Design AOV for normally distributed data using Statistix V.10. Means separation was obtained using a Dunn's All-Pairwise Comparison with P=0.05 for non parametric data and an all comparisons LSD with P=0.05 for normally distributed data. .

RESULTS: The entire first replicate was removed from analysis due to extremely low disease pressure. Neither product choice or application type had a significant effect on any variable (Table 1). Clubroot was moderately high in the rest of the trial. A factorial analysis combining product and application choice showed no significant differences among treatments and no interaction.

CONCLUSIONS: Neither Beauveria product or application technique showed a significant effect on any variable. Weight of shoots was highly variable and may have been the result of poor germination. Beauveria products at these rates and application methods were not effective for the management of *Plasmodiophora brassicae* on canola.

Table 1. Clubroot incidence, severity, and fresh and dry weight of shoots after the application of BIOCERES and BOTANIGARD applied as a seed treatment or soil drench in muck soil naturally infested with *P. brassicae* at the Ontario Crops Research Centre - Bradford, Ontario, 2022.

Product	Application	Incidence (%)	DSI (%)	Weight (g)	
				Fresh	Dry
Check	--	87 ns[1]	67 ns	40.7 ns	3.9 ns
BIOCERES	Seed	93	55	59.7	5.5
	Drench	89	70	27.5	2.8
BOTANIGARD	Seed	83	51	29.9	2.9
	Drench	73	51	64.0	5.8

[1]ns = no significant differences among treatments

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

CROP: Pak Choy (*Brassica rapa* subsp. *hinensis*), cv. Mei Qing Choi
PEST: Flea Beetle, (*Phyllotreta cruciferae*)

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TITLE: EVALUATION OF ISOCYCLOSERAM FOR CONTROL OF FLEA BEETLE IN PAK CHOY, 2022

MATERIALS: A21377X (isocycloseram ISM 555), ACTARA 240SC (thiamethoxam 250g/kg), EXIREL (cyantraniliprole 10.2%)

METHODS: Pak choy, cv. Mei Qing Choy, were direct seeded (≈ 35 seed/m) on 10 May using a Earthway seeder fitted with a 1002-10 seeding disc into organic soil (organic matter ≈ 58.7%, pH ≈ 7.2) near the Ontario Crops Research Centre - Bradford, Ontario. A randomized complete block arrangement with four replicates per treatment was used. Each replicate consisted of four rows (40 cm apart), 6 m in length. Treatments were: ACTARA at 625mL/ha applied at seeding, A21377X at 200mL/ha (foliar spray), EXIREL at 1000mL/ha (foliar spray), ACTARA at 625mL/ha applied at seeding followed by foliar sprays of A21377X at 200mL/ha and ACTARA at 625mL/ha applied at seeding following by foliar sprays of EXIREL at 1000mL/ha. An untreated check was also included. Treatments were applied on 10 and 30 May and 6 June 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. Foliar sprays were applied once visible feeding damage was observed. Flea beetle damage was assessed as a percent of plant damaged on 20 randomly selected plants per replicate on 24, 31 May, 3, 10 June. The percent plant tissue damaged from flea beetle on the various count dates were used to calculate the area under the beetle damage curve (AUBPC) using the following formula:

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

On 14 June, pak choy in two 1 m sections of row per replicate designated for yield were harvested. On 15 June, the pak choy was sorted by marketability to determine yield. Data where analysed using the General Analyses of Variance function of the Linear Models section of Statistix V.10. Means separation was obtained using Fisher's Protected LSD test with $P = 0.05$ level of significance.

RESULTS: as presented in Tables 1 and 2

CONCLUSIONS: Significant differences in flea beetle feeding damage were found on 14 June, 7 days post application. Treatments of ACTARA followed by either EXIREL or A21377X, and EXIREL alone, had the lowest flea beetle damage compared to ACTARA alone or the check. No significant differences were found in the combined flea beetle damage over the season, the AUBPC. At harvest, significant differences were found among the treatments in percent marketable plants. All treatments except ACTARA alone had significantly more marketable plants than the check. Treatment A21377X alone had lower percent marketable plants than ACTARA followed by A21377X.

Table 1. Flea beetle damage per plant and area under the beetle damage curve (AUBDC) for pak choy treated with isocycloseram grown near Ontario Crops Research Centre - Bradford, Ontario, 2022.

Treatment	Product Rate mL/ha	Field Assessments				Combined[2]	AUBDC[3]
		May 24	May 31 1 DAA[1]	Jun 3 3 DAA	Jun10 7 DAA		
ACTARA + EXIREL	625 1000	1.2 a[4]	7.8 ns[5]	7.1 ns	4.5 a	5.1 ns	94.1 ns
ACTARA	625	1.8 ab	8.3	8.9	9.1 b	7.0	124.1
ACTARA + A21377X	625 200	2.3 ab	7.1	6.4	4.4 a	5.1	91.2
EXIREL	1000	2.3 ab	7.5	6.1	4.4 a	5.1	91.3
A21377X	200	2.7 ab	7.1	6.5	5.9 ab	5.5	98.0
Check	--	3.1 b	7.8	8.2	9.0 b	7.0	122.2

[1] DAA – Day after application

[2]This is the sum of the amount of flea beetle damage found on every count date.

[3] AUPBC (Area under the beetle damage curve) was calculated using the following equation:

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

[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 were found among the treatments.

Table 2. Yield for pak choy, cv. Mei Qing Choy, treated with isocycloseram grown near the Ontario Crops Research Centre - Bradford, Ontario, 2022.

Treatment	Product Rate mL/ha	% Marketable	Total plants	Total weight (kg)
ACTARA + EXIREL	625 1000	88.8 a[1]	38.8 ns[2]	2.9 ns
ACTARA	625	7.0 c	40.3	2.3
ACTARA + A21377X	625 200	80.1 a	47.8	2.4
EXIREL	1000	78.2 a	41.3	2.2
A21377X	200	52.7 b	49.8	3.0
Check	--	29. 1 c	44.3	2.8

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

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

Funding for this project was provided by Syngenta Canada Inc., Plattsville, ON, Canada

CROP: Tomato (*Solanum lycopersicum* L.), cv. Rutgers
PEST: Northern root-knot nematode (*Meloidogyne hapla*) Chitwood, 1949

AUTHORS: BLAUEL T, VANDER KOOI K and MCDONALD M R
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TITLE: A MICROPLOT EVALUATION OF NEMATICIDES FOR CONTROL OF ROOT-KNOT NEMATODE IN TOMATO, 2022

MATERIALS: EXPERIMENTAL (EXP 300g/L), VELUM PRIME (fluopyram 500g/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 Ontario Crops Research Centre – Bradford. The microplot trial was arranged in a completely randomized design with five (5) replicates. The treatments included: EXPERIMENTAL at 0.333, 0.667 and 0.833 L/ha and VELUM PRIME at 0.5 L/ha. Nematicide treatments were applied as a drench to each individual tomato transplant at a rate of 250 L/ha using a beaker. An untreated check was also included. Six tomato transplants (6 weeks old), cv. Rutgers, were planted per treatment (microplot) 40 cm apart in two rows spaced 30 cm apart on 10 June. The number of tomato plants, phytotoxicity and vigor were recorded on 13, 17 and 24 June. Tomato plants were destructively harvested on 10 August. Total plant weights and percent of roots with RKN galling were recorded.
Compared to the previous 10-year average, air temperatures in 2022 were average for June (18.3°C) and August (20.6°C), and below average for July (20.2°C). The 10-year average temperatures were: June 18.9°C, July 21.4°C and August 20.4°C.
Monthly rainfall compared to the 10-year average was average for June (90 mm), July (74 mm) and August (82 mm). The 10-year rainfall averages were: June 97 mm, July 78 mm and August 79 mm.
Data were analyzed using the Completely Randomized Design function of the Analysis of Variance 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: There were no significant differences observed among the treatments during the in season and harvest assessments. No phytotoxicity was observed in the trial. Root-knot nematode galling was low despite a moderate population of RKN in the soil.

Table 1. Tomato, cv. Rutgers, number of plants, phytotoxicity and vigor ratings on 13, 17 and 24 June 2022 after tomatoes were treated nematicides in root-knot nematode infested microplot soil at the Ontario Crops Research Centre – Bradford.

		# of Plants (1.5m)			Phytotoxicity (%)			Vigor (%)		
Treatment	Rate (L/ha)	13	17	24	13	17	24	13	17	24
Check	-	6 ns[1]	6 ns	6 ns	0 ns	0 ns	0 ns	100 ns	100 ns	100 ns
EXP	0.333	6	6	6	0	0	0	100	100	100
EXP	0.667	6	5.8	5.8	0	0	0	100	100	100
EXP	0.833	6	6	6	0	0	0	100	100	100
VELUM PRIME	0.5	6	5.9	5.9	0	0	0	100	100	100

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

Table 2. Weight of plants and percent of root galling for tomato plants treated with nematicides to control root-knot nematode in infested microplot soil at the Ontario Crops Research Centre – Bradford.

Treatment	Rate (L/ha)	Weight per Plant (kg)	Percent Galling (%)
EXP	0.333	2.22 ns[1]	0.7 ns
EXP	0.667	2.06	0.8
EXP	0.833	1.99	0.8
VELUM PRIME	0.5	1.99	1.1
Check	-	1.97	2.0

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

Funding for this project was provided by Syngenta.

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

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TITLE: EVALUATION OF A NOVEL ETHYL FORMATE PRECURSOR FOR ROOT-KNOT NEMATODE CONTROL IN LETTUCE, 2022

METHODS: The trial was conducted in trays of single plant cone pots, called conetainers, in the greenhouse of the Ontario Crops Research Centre – Bradford. Twenty-five kilograms of mineral soil was spiked with 4,000 second stage juvenile root-knot nematodes (RKN) to achieve a concentration of 160 nematodes/kg soil, and homogenized using a cement mixer for 10 minutes. After homogenization, soil was divided into four groups, 6.25 kg of soil each, and placed into a double layered plastic bag for treatment. Treatments included: 175 kg/ha Ethyl Formate (EF) Precursor, 220 kg/ha EF Precursor and EF Liquid (220 kg/ha EF Precursor equivalent). An untreated check was also included. Immediately after treatment, bags were sealed and shaken for 30 seconds to evenly distribute the product into the soil. Bags were then stored at room temperature (~20°C) for 7 days. After the incubation period, the soil from each treatment was placed into conetainers (~175 g soil per conetainer) in the greenhouse. Each treatment consisted of 7 conetainers organized in a randomized complete block design with four replications. Two lettuce (cv. Mighty Joe) seeds were seeded in each conetainer on 10 June. Lettuce plants were later thinned to one plant per conetainer, as necessary, and assessed for emergence on 16, 21 and 28 June. Plants were destructively harvested on 9 August, weighed and assessed for RKN parasitism. Lettuce roots were assessed for RKN galling using a 0-10 scale, where: 0 = no galls (healthy), 1 = few small galls, 2 = numerous small galls, 3 = many small galls, some coalesce, 4 = many small galls and some large galls, 5 = numerous large galls, 6 = 25% of the root severely galled, 7 = 50% of the root severely galled, 8 = 75% of the root severely galled, 9 = roots dead but plant is still green, and 10 = roots and plant are dead. These data were used to calculate a damage severity index (DSI) using the formula below:

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

Soil from each treatment was collected, homogenized and assessed for RKN populations. Root-knot nematodes were extracted from the soil using the Baermann pan method at the Ontario Crops Research Centre – Bradford.
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: as presented in Tables 1 and 2

CONCLUSIONS: The Ethyl Formate Precursor treatments had a phytotoxic effect on lettuce germination and growth (Table 1). Lettuce emergence was slightly delayed in the 175 kg/ha EF Precursor treatment and plants were noticeably smaller in both precursor treatments. Lettuce plants slowly died off over time in the precursor treatments and by harvest significantly fewer plants were alive (Figure 1). The Liquid EF treatment, however, did not seem to have a phytotoxic effect. Since there were fewer and smaller plants in the precursor treatments, above ground and root weights were significantly lower (Table 2). The Liquid EF and 175 kg/ha EF Precursor treatments had significantly lower RKN disease severity indexes compared to the untreated check. The 220 kg/ha EF Precursor treatment could not accurately be assessed for disease severity as very few plants were alive at harvest. In addition, the populations of RKN in soil after treatment were significantly lower for all EF treatments. The Liquid EF treatment had significantly higher above ground and root weight than the untreated check, which could be the result of a combination of no phytotoxicity and RKN control. Lettuce germination and growth could be improved in the EF Precursor

treatments by letting the soil volatilize for a few days to a week after treatment before seeding.

Table 1. Lettuce emergence after Ethyl Formate (EF) treatment in soil infested with root-knot nematodes, grown in the greenhouse at the Ontario Crops Research Centre – Bradford, 2022.

Treatment	Rate (kg/ha)	Emergence/Number of Plants			
		16 June	21 June	28 July	Harvest
Liquid EF	220	7.0 a[1]	7.0 a	7.0 a	6.8 a
Check	-	6.2 ab	5.8 a	6.0 a	5.4 a
EF Precursor	175	5.2 bc	6.0 a	5.2 a	2.6 b
EF Precursor	220	3.8 c	3.8 b	3.2 b	0.2 c

[1] Numbers in a column followed by the same letter are not significantly different.

Table 2. Lettuce weight, damage severity index (DSI) and number of root-knot nematodes (RKN) at harvest after treatment with Ethyl Formate (EF), grown in the greenhouse at the Ontario Crops Research Centre – Bradford, 2022.

Treatment	Rate (kg/ha)	Above Ground Weight (g)	Root Weight (g)	DSI[2]	# of RKN (RKN/50 g soil)
Liquid EF	220	11.0 a[1]	19.7 a	0.6 b	0.0 b
Check	-	7.6 b	14.5 b	6.7 a	2.4 a
EF Precursor	175	1.5 c	2.0 c	0.3 b	0.8 b
EF Precursor	220	0.1 c	0.1 c	M[3]	0.2 b

[1] Numbers in a column followed by the same letter are not significantly different.

[2] DSI was calculated using the following equation:

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

[3] M indicates that not enough plants were present to calculate an accurate DSI.

This project was conducted in collaboration with Amr Zaitoon and Loong-Tak Lim, Department of Food Science, University of Guelph. Funding for this project was supported by the University of Guelph, OMAFRA POP Fund.

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

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TITLE: EVALUATION OF NEMATICIDES FOR CONTROL OF STEM AND BULB NEMATODE IN GARLIC, 2021-2022

MATERIALS: PROMAX (thyme oil 3.5%), REKLEMEL (fluazaindolizine 500 g/L), 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 (5) replicates per treatment was used. Garlic cloves (seed) used were infested with 4 SBN/g clove. Nematode counts were determined at the University of Guelph Ontario Crops Research Centre - Bradford using the Baermann pan method. The treatments were: PROMAX, REKLEMEL and VELUM PRIME applied as a soak (S) or drench (D). Seed soak treatments, and the associated soaking times, were: PROMAX S at 37.4 mL/L for 4-hours, REKLEMEL S at 14.9 mL/L for 4-hours and VELUM PRIME S at 1.7 mL/L for 1- or 2-hours. Soak treatments were applied by placing cloves in a mesh bag in 10 L of each treatment solution for each respective time period. Garlic were air dried following the soaking treatment. The drench treatments were REKLEMEL D at 4.48 L/ha and VELUM PRIME D at 500 mL/ha using a water volume rate of 1000 L/ha. Drench treatments were applied directly over the cloves at planting at an application rate of 90 mL/m using a beaker. An untreated check was 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 9 November 2021. Emergence was recorded on 9 May and plant heights were recorded on 9 and 24 May 2022. Garlic was harvested on 4 August. 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.

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

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 2022 were above average for May (15.1°C), average for June (18.3°C) and August (20.6°C) and below average for July (20.2°C). The 10-year average temperatures were: May 13.7°C, June 18.9°C, July 21.4°C and August 20.4°C. Average temperatures in fall 2021 were: November 2.6°C and December -0.3°C.
Monthly rainfall was below the 10-year average for May (50 mm) and average for June (90 mm), July (74 mm) and August (82 mm). The 10-year rainfall averages were: May 64 mm, June 97 mm, July 78 mm and August 79 mm. Average precipitation in fall 2021 were: November 1.4 mm and December 1.5 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: as presented in Tables 1 and 2

CONCLUSIONS: All three VELUM PRIME treatments significantly reduced stem and bulb nematode damage and increased marketable yield compared to the other treatments (Table 2). The 1-hour soak with VELUM PRIME was as effective as the 2-hour soak for disease severity (8.0 and 4.1%) and percent marketable yield (88.7 and 96.1%), respectively. VELUM PRIME was very effective for management of

SBN in garlic as a soak or drench. The organic product PROMAX did not protect garlic from SBN damage. The REKLEMEL soak treatment had the highest disease severity and lowest marketable yield. In addition, the REKLEMEL soak treatment had the lowest emergence and shortest garlic on 24 May 2022 (Table 1). The low counts of SBN in the REKLEMEL soak treatment at harvest may be the result of the nematodes leaving the dead, completely desiccated bulbs before harvest (Table2).

Table 1. Garlic emergence and plant heights on 9 and 24 May after nematicide application for stem and bulb nematode infested seed cloves near Cookstown, Ontario, 2021-2022.

Treatment	App Method[1]	Soak Time (hours)	% Emergence (of 25 plants)	Plant Height (cm)	
				9 May	24 May
Check	-	-	21.2 a[2]	25.5 ns[3]	44.0 ab
VELUM PRIME	S	1	21.0 a	20.5	49.1 a
VELUM PRIME	D	-	21.0 a	19.3	44.9 ab
PROMAX	S	4	20.8 a	21.3	48.0 ab
REKLEMEL	D	-	20.6 a	19.6	42.3 ab
VELUM PRIME	S	2	17.0 ab	18.9	44.4 ab
REKLEMEL	S	4	12.8 b	16.4	39.4 b

[1] Application Method: S = Soak; D = Drench.
[2] Numbers in a column followed by the same letter are not significantly different.
[3] ns = no significant differences were found among the treatments.

Table 2. Percent marketable bulbs, nematode disease severity index (DSI), marketable yield and nematode counts from harvested garlic treated with various nematicides to control stem and bulb nematode (SBN) near Cookstown, Ontario, 2021-2022.

Treatment	App. Method[1]	Soak Time (hours)	% Marketable Bulbs	DSI[2]	Marketable Yield (g/plot)	Harvest SBN Count (SBN/g clove)
VELUM PRIME	S	2	96.1 a[3]	4.1 a	863.8 a	3.6 ns[4]
VELUM PRIME	S	1	88.7 a	8.0 a	1054.9 a	0.4
VELUM PRIME	D	-	78.5 a	18.8 a	840.2 a	78.8
REKLEMEL	D	-	40.4 b	51.2 b	335.4 b	18.3
Check	-	-	36.8 bc	56.8 bc	268.7 b	13.9
PROMAX	S	4	15.0 bc	79.2 cd	112.0 b	13.9
REKLEMEL	S	4	7.7 c	85.1 d	44.4 b	5.5

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

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

[3] Numbers in a column followed by the same letter are not significantly different.
[4] ns = no significant differences were found among the treatments.

Funding for this project was provided by the California Garlic and Onion Research Advisory Board and the Fresh Vegetable Growers of Ontario representing the Ontario Garlic Growers Association.

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TITLE: EFFECTIVENESS OF BIODIFFUSION MULCH, SOIL ARMOR, APPLIED AFTER CARROTS TO REDUCE WIND EROSION IN MUCK SOIL

MATERIALS: Soil Armor (a lignosulfonate mulch from BioDiffusion Technologies Inc.), barley (*Hordeum vulgare* L.)

METHODS: Three concentrations of Soil Armor, a by-product from the paper industry, were sprayed on to muck soil with organic matter ≈ 69.5 and pH ≈ 5.9 at Ontario Crops Research Centre - Bradford, Ontario to assess effectiveness in reducing wind erosion of the soil. A randomized complete block design with five treatments and four replications was used with a plot size of 1.5 x 2 m^2. The concentration of Soil Armor was full rate, two-thirds, and one-third rate: 850, 567 and 283 L/ha respectively. The mulch was sprayed using a CO_2 backpack-mounted sprayer equipped with four TeeJet 8002 VS fan nozzles spaced 40 cm apart and calibrated to deliver 850 L/ha at 275 kPa on 14 Oct. Barley was seeded at ≈ 90 kg/ha on the same day, as a positive control and bare soil was the negative control. Barley seeds were direct seeded at 35 seeds/m using a Earthway push cone seeder on 14 October. Wind erosion was assessed on 10 November using a wind tunnel developed at Ontario Crops Research Centre- Bradford. It was designed to measure soil eroded from a 0.5 x 2 m^2 area. A wind speed of ≈ 24.4 km/h at ground level for a time of one minute was used to assess the amount of soil eroded. Eroded soil was collected in a tray and suspended soil was captured through a MERV 7, Air Handler furnace filter (20 x 30") installed at top of the wind tunnel. The continuity of Soil Armor mulch was assessed visually every week until the final wind erosion assessment. Green canopy cover was measured using a mobile application, Canopeo, for the barley plots. Data were subjected to analysis of variance using R 4.1.0. Mean separation was carried out using Tukey's HSD test at 5% significance level.

RESULTS: as presented in Tables 1 and 2 and Figure 1

CONCLUSIONS: Weed growth was not observed in any of the plots. No crust formation was observed in plots with the one-third rate of Soil Armor; they looked similar to the nontreated controls. A crust was observed due to the application of Soil Armor in treatments with the full and two-third rate and the crust was continuous until the date of the final assessment. The crop stand was good for barley and the average canopy coverage was 9.2 percent during the assessment.

There were no significant differences in soil eroded in a tray, filter, and total soil eroded among treatments (Table 1). However, numerically the lowest soil erosion was observed in negative check plots and the highest erosion was observed in treatment with the two-third rate of Soil Armor. Large chunks of soil erosion were observed in 2 plots with the two-third rate of Soil Armor and 1 plot with the full rate of Soil Armor treatment, while such events were not seen in other treatment plots. These were determined to be outliers (Fig. 1) and the analysis was run with outliers removed (Table 2). That analysis showed that the two thirds rate had higher soil erosion than the negative (nontreated) control. The barley seeded on 14 Oct. also did not reduce soil erosion compared to the nontreated control.

The full rate of Soil Armor application did not effectively reduce wind erosion. Increasing the rate of mulch application could be effective in wind erosion control. However, the cost associated with it is also an important point to consider.

Table 1. Soil erosion data for different concentrations of Soil Armor mulch and barley assessed near the Ontario Crops Research Centre – Bradford, 2022.

Treatments	Tray (g)	Filter (g)	Total soil eroded (g)
Control	15.5 ns[1]	11.3 ns	26.3 ns
One-third Soil Armor	22.3	20.1	42.4
Barley	18.2	24.5	42.7
Full rate Soil Armor	35.0	33.3	68.3
Two-third Soil Armor	37.6	39.0	76.6

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

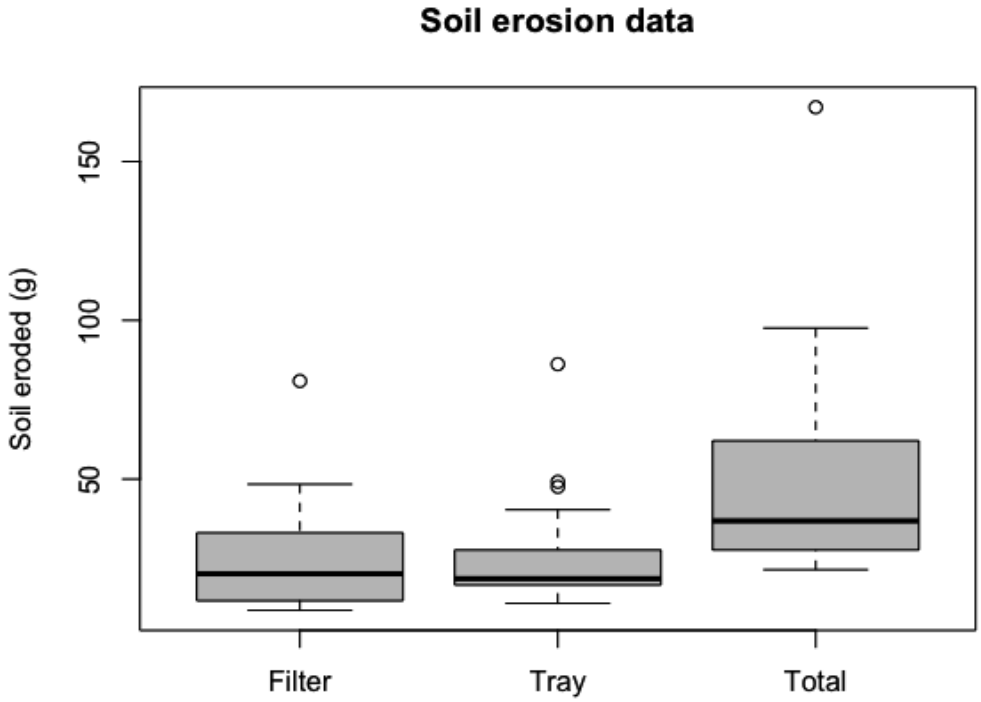

Figure 1. Soil erosion data for soil collected in filter, tray and total for different concentrations of Soil Armor mulch and barley assessed near the Ontario Crops Research Centre – Bradford, 2022. Boxplots show the median value as a bold black bar, the upper and lower limits of the box are the third and first quartile of the data, the whiskers extend up to 1.5 times the interquartile range, and open circles are outlier points.

Table 2. Soil erosion data (after removing outliers) for different concentrations of Soil Armor mulch and barley assessed near the Ontario Crops Research Centre – Bradford, 2022.

Treatments	Tray (g)	Filter (g)	Total erosion (g)
Control	15.0 ns[1]	11.3 a[2]	26.3 a
Full rate Soil Armor	17.9	19.3 a	36.3 ab
One-third Soil Armor	22.3	20.1 a	42.4 ab
Barley	18.2	24.5 ab	42.7 ab
Two-third Soil Armor	26.8	39.0 b	76.6 b

[1] ns = no significant differences were found among the treatments.
[2] Numbers in a column followed by same letter are not significantly different.

Funding for this project was provided by BioDiffusion Technologies Inc.

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TITLE: EVALUATION OF COVER CROPS SPECIES, PRIMING METHODS, AND BARLEY TRANSPLANTS FOR LATE FALL ESTABLISHMENT IN MUCK SOIL

MATERIALS: Oats (*Avena sativa* L.) cv. CDC Haymaker, barley (*Hordeum vulgare* L.), triticale (X *Triticosecale* Wittmack), hydro-primed oats, barley, and triticale, osmo-primed triticale, fall rye (*Secale cereale* L.), daikon radish (*Raphanus sativus var. longipinnatus)*, barley plugs

METHODS: A field trial was conducted to determine effective cover crops to control wind erosion when seeded or transplanted after carrot harvest in the Holland Marsh, Ontario. A randomized complete block design with ten treatments and four replications was used. The size for each experimental unit was 1.5 x 4 m^2. Treatments were: oats, barley, triticale, hydro-primed oats, barley, and triticale, osmo-primed triticale, fall rye, daikon radish, and barley plugs. Barley and rye were bought from a grower, oats and triticale from Speare Seeds and daikon radish from Quality Seeds. Barley, oats, and triticale seeds were hydro-primed for 24 hours in deionized water, drained, and left overnight to dry before seeding. For osmo-priming, potassium nitrate (KNO3 at 5 mg/L) was used instead of deionized water. Plugs of barley were grown in the greenhouse at Ontario Crops Research Centre - Bradford. Two seeds of barley were seeded in each cell of 128-cell plug trays filled with soilless mix (ASB Greenworld Seed and Plug Mix) on 19 September. Both primed and non-primed seeds of barley, oats and triticale, and rye seeds were direct seeded at ≈ 35 seeds/m using a Earthway push cone seeder on 14 October. Daikon radish was seeded at ≈ 15 seeds/m. Barley plugs were transplanted by hand at ≈ 8 cm plug-to-plug distance. Row-to-row distance was ≈ 15 cm for all treatments. One 0.25 m^2 quadrat was randomly selected within each replicate plot for sampling the aboveground biomass on 15 November. Plants were cut at ground level, and both fresh and dry weights of samples were assessed. The samples included both dead and living plant material, and plants within the quadrant were counted. The percent of green canopy cover was also measured simultaneously from two randomly chosen spots in each plot using Canopeo, a mobile application developed by Oklahoma State University. Cover crops were left to overwinter, and their survival and soil coverage will be analyzed next year in April. Data were subjected to analysis of variance using R 4.1.0. Mean separation was carried out using Tukey's HSD test at 5% significance level.

RESULTS: as presented in Table 1

CONCLUSIONS: Canopy coverage, fresh weight, and dry weight were significantly higher for the barley plugs than other treatments. Plant count was lowest for hydro-primed oats. Oats, primed triticale, and daikon radish had lower stand counts than rye and non-primed barley. Among direct seeded treatments, all barley treatments had the highest fresh weight, dry weight, and canopy coverage. Crop stand was poor for primed treatments of oats and triticale. Plant count of hydro-primed triticale was significantly lower than triticale without priming. Transplanting barley plugs could be the best option for effective late fall cover crop establishment in muck soil after carrots are harvested. However, the cost and labor required for this could be a limiting factor for its adoption.

Table 1. Canopy coverage percent, plant counts, fresh weight, and dry weight per m^2 of cover crop species trial at Holland Marsh, 2022.

Treatment	Canopy coverage (%)	Plant counts/ m2	Fresh wt. (g)/ m2	Dry wt. (g)/m^2
Oats	2.6 a[1]	98 ab	11.6 a	2.6 a
Hydro-oats	2.7 a	71 a	12.6 a	2.4 a
Hydro-triticale	4.2 abc	77 a	15.8 ab	3.4 a
Osmo-triticale	3.6 ab	96 ab	18.1 ab	3.3 a
Triticale	6.4 a-d	191 bc	33.6 abc	5.9 ab
Rye	9.8 bcd	233 c	43.6 bcd	8.1 b
Diakon radish	7.3 a-d	86 a	52.8 cd	6.2 ab
Hydro-barley	11.0 cd	182 bc	64.6 d	8.5 b
Barley	12.0 d	233 c	69.5 d	8.8 b
Barley plugs	32.0 e	137 ab	164.6 e	27.0 c

[1] Numbers in a column followed by same letter are not significantly different.

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TITLE: EVALUATION OF BIOFUMIGANT COVER CROPS ON ORGANIC (MUCK) SOIL, 2022

MATERIALS: Caliente 199 (*Brassica juncea* L.), brown mustard (*Brassica juncea* L.), sorghum Sudan grass (*Sorghum vulgare* var. *sudanese* Hitchcock (Marks and Townsend, 1973), Barley (*Hordeum vulgare* L. (Hitchcock, 1971) Fall Rye (*Secale cereale* L.) and Pearl millet (P*ennisetum glaucum* L.)

METHODS: Cover crops of various species were seeded into organic soil (organic matter ≈ 50 %, pH ≈ 6.9) at a site near the Ontario Crops Research Centre – Bradford, 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 four replicates per treatment was used. Treatment areas were 14 m x 17 m and were seeded with a CASE 5100 grain drill. Biofumigant mustard, Caliente 199 (Stokes Seeds) at 12 kg/ha (three treatment plots) and barley (bought from grower) 90 kg/ha (one treatment) were initially seeded on 6 May. On 15 July, plants in all treatments 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 10 days to allow time for the material to break down. On 2 August, cover crops of sorghum Sudan grass (56 kg/ha), pearl millet (10 kg/ha) and fall rye at 90 kg/ha were seeded into the previous seeded biofumigant treatments of Caliente 199. Sorghum and pearl millet was bought from Quality Seeds and rye from grower. The treatment area previously seeded to barley was sown to brown mustard (Speare Seeds) at 12 kg/ha. All treatments were seeded using a CASE 5100 grain drill. On 23 Sep, all treatments were chopped and rototilled into the soil. On 6 October daikon radish at 15 kg/ha was seeded into all plots with a CASE 5100 grain drill. Above ground biomass was determined on 8 and 14 July for the first phase and on 21 September for the second phase of all treatments. Plants in three 0.25 m^2 sections per rep were cut at ground level and weighed. Plant and weed counts for each section were also assessed. The green canopy cover was measured in two 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 on June 8 and 11 Nov (after bio fumigation process). Data were subjected to analysis of variance using R 4.1.0. Mean separation was carried out using Fischer's Least Significant Difference at 5% level of significance.

RESULTS: as presented in Tables 1 and 2

OBSERVATIONS: Pearl millet did not emerge uniformly throughout the plot. There were only some patches of plants leaving most part of treatment area empty without pearl millet.

CONCLUSIONS: Both Caliente 199 and barley cover crops established well during the first phase. Canopy coverage, fresh, and dry weight was better for brown mustard seeded in August when compared to May seeded Caliente 199. Barley had lower canopy coverage than Caliente 199 while the biomass was higher than that of Caliente (Table 1). Barley also seemed to be more effective to control weeds than Caliente 199 when seeded in May. Brown mustard had highest biomass of crops seeded in August. The percent of canopy coverage ranged from 94 to 98 % with no significant differences among treatments (Table 2).

Table 1. Plant growth for cover crop species grown (May to July) near the Ontario Crops Research Centre – Bradford, 2022.

Crop	Canopy coverage (%)	Plant count /m^2	Plant fresh wt./ m^2 (g)	Plant dry wt./ m^2 (g)	Weed fresh wt./ m^2 (g)	Weed dry wt./ m^2 (g)
Caliente 199	66 b[1]	137 ns[2]	595 a	82.6 a	313.3 b	48.7 b
Caliente 199	67 b	144	593 a	76.9 a	283.0 b	47.3 b
Caliente 199	60 b	163	778 a	106.8 a	263.3 b	41.3 b
Barley	32 a	220	1600 b	426.3 b	78.3 a	15.7 a

[1] Numbers in a column followed by the same letter are not significantly different.
[2] ns = no significant differences were found among the treatments.

Table 2. Plant growth data for various cover crop species, grown (Aug to Sep) near the Ontario Crops Research Centre – Bradford, 2022.

Crop	Canopy coverage %	Crop			Weeds		
		Count /m^2	Fresh wt./ m^2 (g)	Dry wt./ m^2 (g)	Count/ m^2	Fresh wt./ m^2 (g)	Dry wt./ m^2 (g)
Sorghum	98 ns[1]	124 ns	2840 b[2]	317.8 b	54 b	296.7 ns	26.2 b
Brown Mustard	94	137	3503 c	382.7 c	34 a	310.0	16.7 ab
Rye	96	93	2026 a	255.3 a	27 a	136.7	12.2 a
Pearl Millet	-	-	-	-	-	-	-

[1] ns = no significant differences were found among the treatments.
[2] Numbers in a column followed by the same letter are not significantly different.

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

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

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TITLE: EVALUATION OF COVER CROPS FOLLOWING ONIONS AND CARROT CROPS ON MUCK SOIL, 2022

MATERIALS: Daikon radish (*Raphanus sativus var. Longipinnatus)*, Nitro Plus (5% faba bean (*Vicia faba*), 10% nitro radish (*Raphanus sativus var. Longipinnatus*), 15% crimson clover (*Trifolium incarnatum)*, 10% Austrian winter peas (*Pisum sativum*), 10% forage peas (*Pisum sativum L. subsp. Sativum),* and 50% oats (*Avena sativa* L.), barley (*Hordeum vulgare* L.), fall rye (*Secale cereale* L.)

METHODS: Two field trials were conducted to determine effective cover crops after onion and carrot harvest in the Holland Marsh, Ontario. Onion, cv. Milestone was transplanted on 18 May and carrot, cv. Navedo was seeded on 26 May. Onion was mechanically harvested on 9 September and carrot on 5 and 6 October. Yield data of both crops were recorded to see the effect of previous year cover crops. Onions were transplanted into where the previous year carrot cover crop trial was conducted, and carrots were seeded into the previous year biofumigant cover crop trial field. A randomized complete block design with four treatments and four replications was used for both trials. Plot size for each experimental unit was 17 x 14 m^2. Cover crops seeded after onion harvest were daikon radish (Quality seeds) at 15 kg/ha 2, NITRO plus (General seed company) at 45 kg/ha, barley (bought from grower) and radish mix at 70 and 10 kg/ha, respectively and barley at 90 kg/ha. Cover crops were seeded using a CASE 5100 seed drill at a depth of 3-4 cm into lightly disked soil on 22 September. Treatments after carrot harvest were bare ground (check), over seeding of barley before carrot harvest at 200 kg/ha, barley seeded after carrot harvest at 100 kg/ha and fall rye (bought from grower) after harvest at 100 kg/ha. Pre-harvest seeding was done using a broadcaster on 28 September and post-harvest seeding of barley and fall rye was done using a CASE 5100 seed drill at a depth of 3-4 cm into lightly disked soil on 7 October. Cover crop biomass was sampled on 9 and 11 November for onion and carrot trials, respectively. Plants in the field were left to grow until the weather became unfavourable (severe frost). Three 0.25 m^2 quadrats in the onion trial and four quadrats in the carrot trial were randomly selected within each replicate plot for sampling the aboveground biomass. Plants were cut at ground level and both fresh and dry weight of samples were assessed. The samples included both dead and living plant material and plants within the quadrant were counted. The percent of green canopy cover was also measured simultaneously from two randomly chosen spots in each plot using Canopeo, a mobile application developed by Oklahoma State University. Cover crops were left to overwinter, and their survival and soil coverage will be analyzed next year in April. Data were subjected to analysis of variance using R 4.1.0 version. Mean separation was carried out using Fischer's Protected Least Significant Difference at 5% level of significance.

RESULTS: as presented in Tables 1, 2 and 3

CONCLUSIONS: No significant difference in the yield of onion was observed (Table 1). Carrot yield was significantly lower for the plots with fall rye as a cover crop in the previous year (Table 1).
There were significant differences among treatments for the percent of canopy coverage, plant counts, fresh weight, and dry weight among cover crops following onions. Barley/radish mix, and barley had higher canopy coverage. The plant count was significantly lower for daikon radish. Fresh weight and dry weight were highest for the barley/radish mix and lowest for the NITRO plus mix.
The crop stand was good in cover crops following carrots. There were significant differences in canopy cover percentage, plant count, and above ground fresh and dry weights among the treatments. Pre-harvest

barley had higher values for all these variables. The seeding rate for this treatment was increased to 200 kg/ha this year. Compared to the 2021 trial, canopy coverage, plant fresh weight, and dry weight were higher in 2022 for all treatments in both onion and carrot cover crops trials. The reason for the differences could be no frost and warm weather until the second week of November in 2022 compared to early November frost in 2021.

Table 1. Total and marketable yield data from onion and carrot trials in the Holland Marsh, 2022.

Onion Trial			Carrot Trial		
Previous year-Treatments	Total Yield (MT/ha)	Marketable Yield (MT/ha)	Previous year-Treatments	Total Yield (MT/ha)	Marketable Yield (MT/ha)
Barley	50.6 ns[1]	49.3 ns	Fall rye	56.4 a[2]	49.8 a
Bare ground	52.5	51.0	Sorghum	61.4 b	53.5 b
Fall rye	53.8	52.6	Pearl millet	62.7 b	55.6 b
PH Barley[3]	55.0	54.5	Caliente 199	63.6 b	55.6 b

[1] ns = no significant differences were found among the treatments.
[2] Numbers in a column followed by same letter are not significantly different.
[3] PH Barley– Preharvest broadcast barley application one week before harvest

Table 2. Average canopy coverage percent, plant count of cover crops and above ground fresh and dry mass of cover crops following onion grown at Holland Marsh, 2022.

Treatments	Canopy Coverage (%)	Avg. Plant Count m^2	Avg. Fresh Weight m^2 (g)	Avg. Dry Weight m^2 (g)
NITRO Plus	52 a[1]	165 b	425 a	49 a
Daikon Radish	55 a	75 a	628 b	59 a
Barley	70 b	174 b	773 b	89 b
Barley/Radish	76 b	176 b	959 c	97 b

[1] Numbers in a column followed by same letter are not significantly different.

Table 3. Average canopy coverage percent, plant count of cover crops and above ground fresh and dry mass of cover crops following carrot grown at Holland Marsh, 2022.

Treatments	Canopy Coverage (%)	Avg. Plant Count m^2	Avg. Fresh Weight m^2 (g)	Avg. Dry Weight m^2 (g)
Barley	7 a[1]	163 a	38 a	7 a
Fall Rye	8 a	164 a	58 a	8 a
PH Barley[2]	18 b	251 b	167 b	20 b

[1] Numbers in a column followed by same letter are not significantly different.
[2] PH Barley– Preharvest broadcast barley application one week before harvest

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

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TITLE: FIRST YEAR STUDY ON SOIL HEALTH INDICATORS OF MUCK SOIL

MATERIALS & METHODS: The study was conducted in commercial carrot fields in 2022 in the Holland/Bradford Marsh, Ontario. Soil samples were collected from 15 fields including the Ontario Crops Research Centre - Bradford. Four blocks of 10 x 10 m^2 were chosen in each field for soil sampling. The first block was approximately 50 m into the field from the road along a sprayer row. A 10 x 10 m^2 section on the left side of the sprayer row was sampled. The second block was selected 30 m ahead and on the right side of sprayer row. The third sampling area was another 50 m ahead of the second sampling area on the left side of the sprayer row and the fourth 30 m ahead of the third sampling area on the right side of sprayer row. Each block was chosen after leaving 3 rows of carrots adjacent to the sprayer row. All blocks were marked with two flags in the first 2 corners. Ten 15 cm soil cores were taken from each block. Sub-samples from blocks 1 and 2 were combined to make a composite sample and sub-samples from blocks 3 and 4 were combined to make a second composite sample. To avoid cross-contamination the first soil core taken at each new block was discarded. The soil sampler was washed with deionized water and disinfected with 70% ethanol each time before collecting samples from a new field. Composite samples were kept in labeled plastic bags and placed into an insulated container with ice packs. About 600 g of soil samples were sent to A & L lab for the VitTellus bio soil health test (SHTEST3). When the carrot crop was mature, carrots were sampled from 1m length from each block where soil samples were taken to assess yield. Four sub-samples from each field were combined to get the average yield of a field. Data were subjected to principal component analysis (PCA) using R 4.1.0 version on variables of soil health indicators from fields using a base function prcomp(). Scree plot's inflection point was used to select components that explain most of the variability and the biplot was used to plot two principal components (PCs). Highly weighed factors loading was determined by selecting absolute values within 10% of the highest factor loading. A correlation matrix for the highly weighted variables under selected PCs was run.

RESULTS: as presented in Tables 1, 2 and 3, and Figure 1

CONCLUSIONS: There were four fields in the low productivity category, eight in the moderately productivity category and three in the high productivity category, based on yield. The cumulative percent variability accounted for by the first two PCs was 46.8%. There was no clear grouping among the field types based on the variables studied. However, high-productivity soils seemed to cluster at the center when compared to the medium and low-productivity soils (Figure1). Based on the inflection point on the Scree plot, four PCs were retained to derive weighing factors. Soil health indicators with relative importance derived from the first four PCs were: Mg-ppm, CEC, Ca-ppm, and B-ppm on component one; total gram-negative bacteria, total bacteria, and pseudomonas populations on component two; nitrogen fixing bacteria on component three and Fe-ppm on component four (Table 2). Correlation analysis showed no significant correlation between the highly weighed variables under the first four PCs and productivity. The highest correlation ($r = 0.94$) was found between the Pseudomonas populations and total gram-negative bacteria, which is not surprising as Pseudomonas bacteria are gram-negative. The number of total gram-negative bacteria was also highly correlated to total bacteria. Mg-ppm had a significant positive correlation with CEC, Ca-ppm, and B-ppm, again not surprising since Mg is a cation. Similarly, CEC was positively correlated with Ca-ppm and B-ppm. There was a significant positive correlation between B-ppm and Ca-ppm. No significant correlation between soil chemical and biological indicators was observed among these variables.

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

Table 1. Fields and productivity category based on yield of carrots from fields in the Holland Marsh, 2022.

S. No.	Label	Productivity Level	Yield (tonnes/ha)	Category
1	SL5	Prod-Low	27.5	<60 ton/ha (low productivity)
2	VANM	Prod-Low	38.9	
3	SL1	Prod-Low	53.2	
4	SH4	Prod-Low	55.2	
5	SH2	Prod-Medium	62.4	60 – 80 ton/ha (medium productivity)
6	SL6	Prod-Medium	62.5	
7	SL3	Prod-Medium	63.9	
8	SL2	Prod-Medium	68.4	
9	SH3	Prod-Medium	69.7	
10	HOL	Prod-Medium	73.7	
11	SH6	Prod-Medium	74.4	
12	SH5	Prod-Medium	75.8	
13	SG	Prod-High	93.3	> 80 ton/ha (high productivity)
14	SL4	Prod-High	102.9	
15	MCRS	Prod-High	143.6	

Table 2. Results of principal component analysis of soil health indicators showing the first four principal components (PCs) with their proportion of variance (in percentage) explained and Eigen vectors for highly weighed variables in the respective PCs.

	PC1	PC2	PC3	PC4
Percentage of variance	26.3	20.5	13.6	9.1
Cumulative percentage	26.3	46.8	60.4	69.5
Eigenvectors				
Mg-ppm	0.82			
CEC	0.79			
Ca-ppm	0.77			
B-ppm	0.74			
Total gram negatives		- 0.87		
Total bacteria		- 0.83		
Pseudomonas population		- 0.81		
Nitrogen fixers			0.82	
Fe-ppm				- 0.84

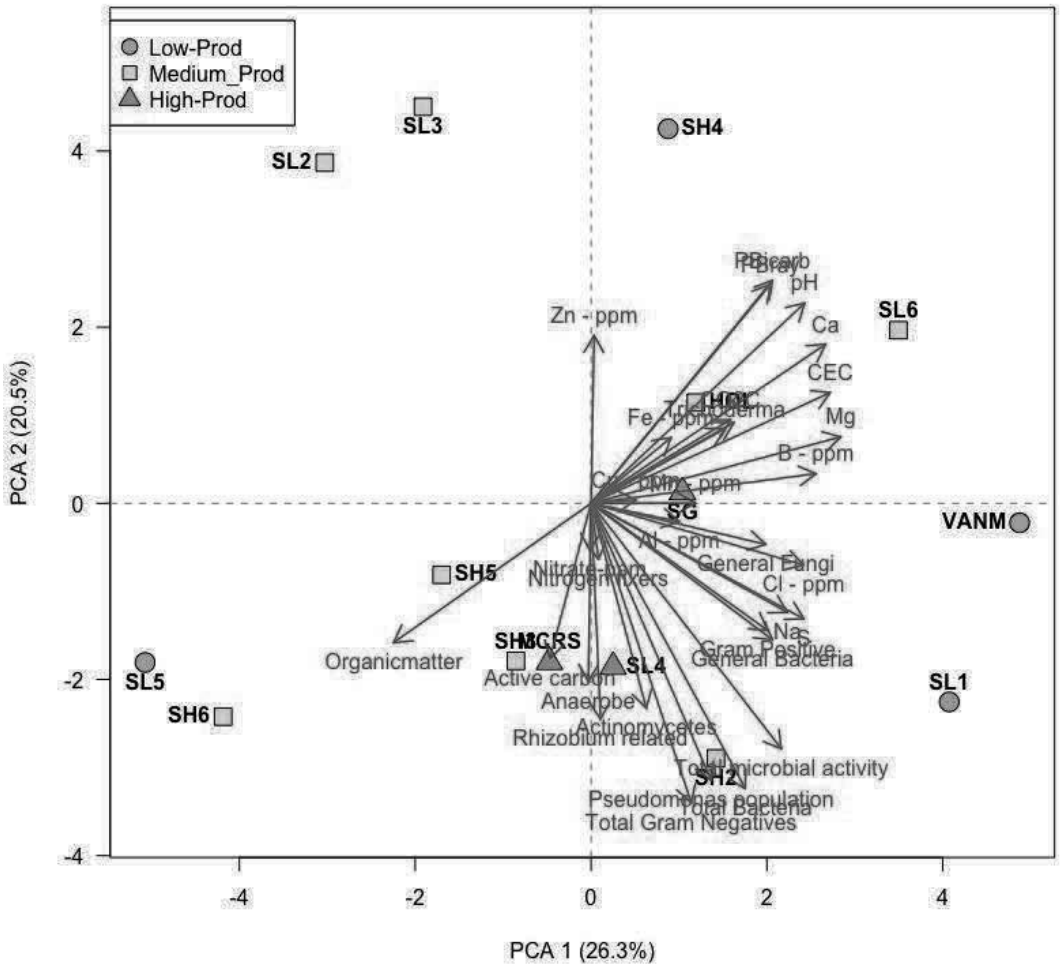
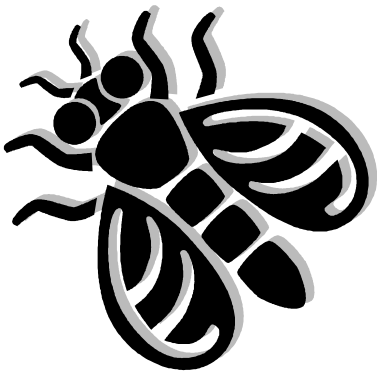


Figure 1. Principal component analysis (PCA) biplots by soil productivity. The length of the arrows in the plot represents the portion of variance contributed by the variable, whereas the cosine of the angle between pairs of arrows represents the correlation between the two variables.

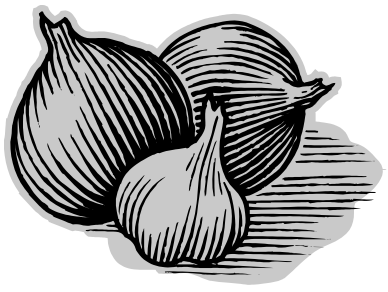
Table 3. Correlation matrix of Pearson's correlation coefficients for highly weighed variables under the first four PCs.

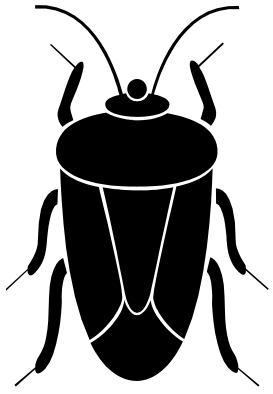
Indicators	Productivity	Mg-ppm	CEC	Ca-ppm	B-ppm	TGN	TB	PP	NF	Fe-ppm
Productivity	1.00	-0.07	-0.13	-0.18	-0.09	0.24	0.19	0.29	0.28	0.31
Mg-ppm		1.00	**0.88***	**0.78***	**0.72***	0.16	0.23	0.15	0.12	0.36
CEC			1.00	**0.91***	**0.75***	-0.04	0.07	-0.07	0.17	0.30
Ca-ppm				1.00	**0.82***	-0.16	-0.04	-0.16	0.21	0.27
B-ppm					1.00	0.12	0.21	0.14	0.15	0.07
TGN						1.00	**0.93***	**0.94***	0.29	0.12
TB							1.00	**0.92***	0.16	0.01
PP								1.00	0.10	-0.06
NF									1.00	0.25
Fe-ppm										1.00

Note- TGN = Total gram-negative bacteria, TB = Total bacteria, PP = Pseudomonas population, NF= Nitrogen fixers; values in bold followed by * are significant at p-value of 0.05



Integrated Pest Management Report - 2022





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TITLE: THE INTEGRATED PEST MANAGEMENT PROGRAM SUMMARY FOR MUCK VEGETABLE CROPS, 2022

An Integrated Pest Management (IPM) program is provided to growers in the Holland/Bradford Marsh, Ontario, by the University of Guelph Ontario Crops Research Centre - Bradford. 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 2022, 57 commercial vegetable fields, totalling 587 acres (onion 283 A., carrot 250 A., celery 40 A., parsnip 10 A. and potato 4 A.), were intensively scouted for 18 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 9 May to 13 October, 2022, the diagnostic laboratory of the OCRC-B received 70 samples for diagnosis. Of these, 73% were diagnosed with infectious diseases (51 samples), 6% with insect issues (4 samples) and 21% were diagnosed with an abiotic disorder (15 samples). These samples were associated with the following crops: carrot (44%), onion (39%), celery (11%) and other crops (6%). For extension services, data collected from growers' fields and research station 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 OCRC-B website (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) BSPCAST (for Stemphylium leaf blight of onion), an onion white rot model and a Sclerotinia white mold of carrot model, 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. The onion samples were examined by hand pulling 10 onions from 10 random locations throughout each field. The carrot samples were collected by hand pulling 20 carrots near each of the four corners and middle (5 locations total) of each field.

CARROT

Insects

In 2022, 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 caused by carrot weevil and rust fly was very minimal this season and lower than in 2021 (Table 1). High populations of aster leafhopper were found throughout the season, however, the percent of fields showing symptoms of aster yellows was lower than in 2021 as well.

Table 1. Average percent carrot weevil and carrot rust fly damage on carrots at harvest in scouted fields in the Holland Marsh, 2022.

Location within Holland Marsh	% Damaged Carrots	
	Weevil damage	Rust fly damage
West	0.0	0.0
South	0.0	0.0
Central	0.0	0.3
North	0.2	0.0
East	0.0	0.0
Average	0.04	0.06

Carrot weevil adults were first found in wooden Boivin traps on 9 May in carrot fields (Fig. 1). The threshold of 1.5 or more weevils/trap was reached by 3 June in most regions of the Holland Marsh. Overall, 40% of fields in the IPM program reached the 1.5 weevil/trap threshold, and 16% of fields reached the 5 weevil/trap threshold.

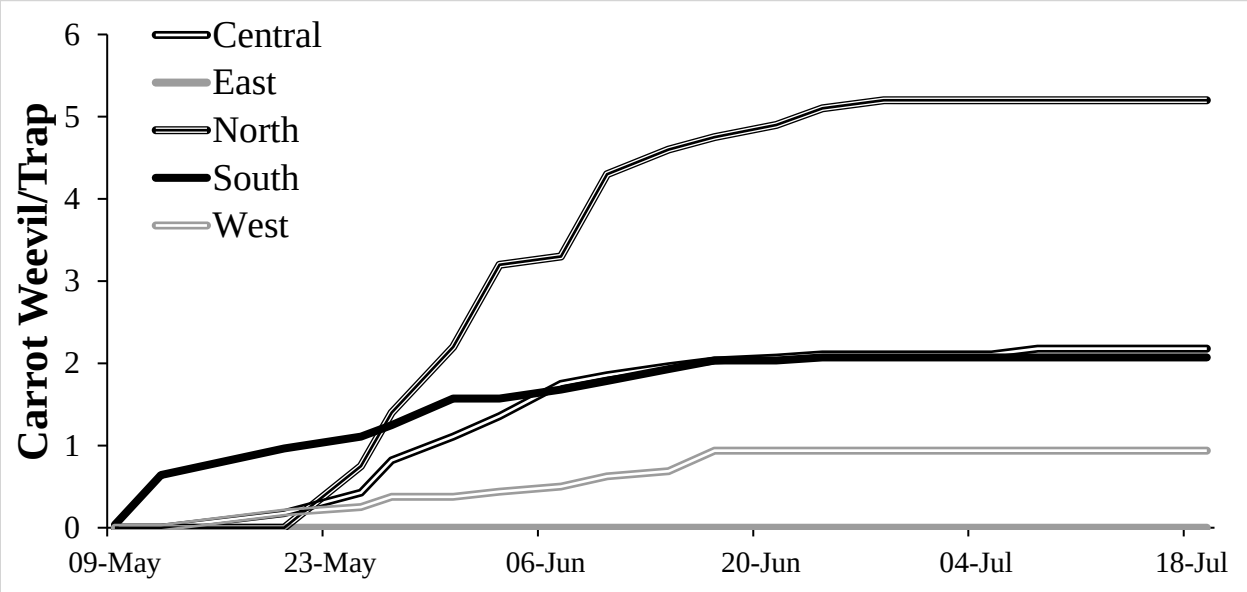


Figure 1. Average cumulative number of carrot weevils/trap in different regions of the Holland Marsh, 2022.

Populations and damage due to carrot weevil were lower than previous years. The increased uptake of growers now using Rimon and Exirel, which are very effective at controlling carrot weevil, has contributed to decreased carrot weevil damage.

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 30 May, shortly after the degree day model predicted first generation emergence (21 May). The highest rust fly activity during the first generation, across all regions, was on 3 June, when 40% of scouted fields had exceeded the threshold of 0.1 flies/trap/day. The highest activity during the second generation was on 12 August when 24% of scouted fields had exceeded the threshold.

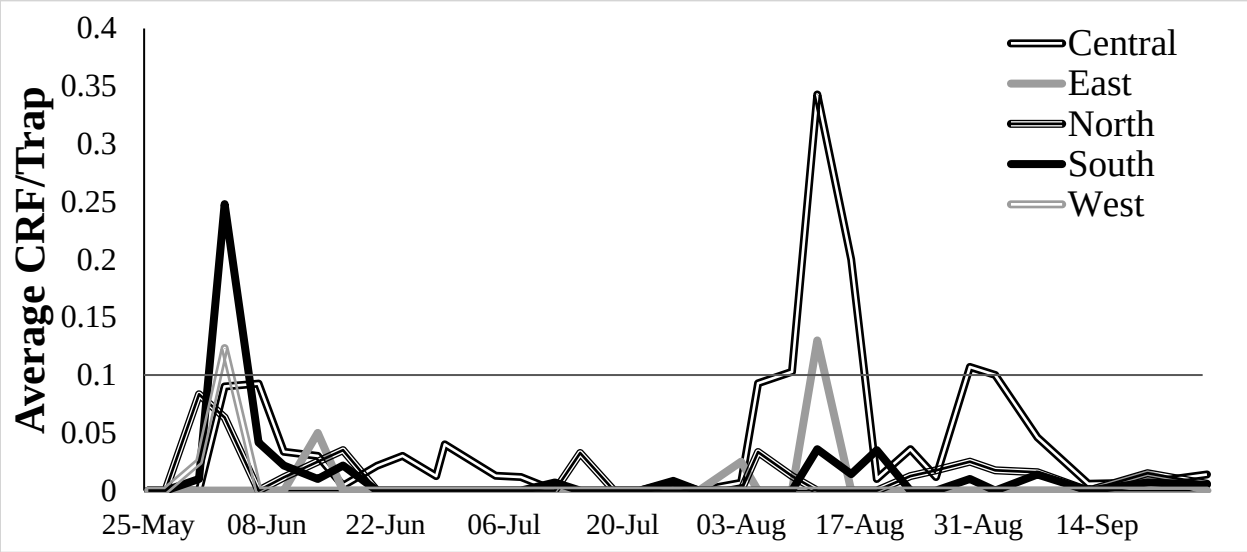


Figure 2. Average carrot rust flies (CRF)/trap/day in different regions of the Holland Marsh, 2022.

Aster leafhoppers are pests of carrots, celery, lettuce and leafy greens. Aster leafhoppers were first found on orange sticky traps on 24 May in carrots and celery (Fig. 3). Sticky traps and sweepnetting (100 sweeps per field) were used to estimate populations occurring within fields. Counts peaked around mid-June to mid-July during which 96% of fields were above the 20 ALH/trap threshold at some point.

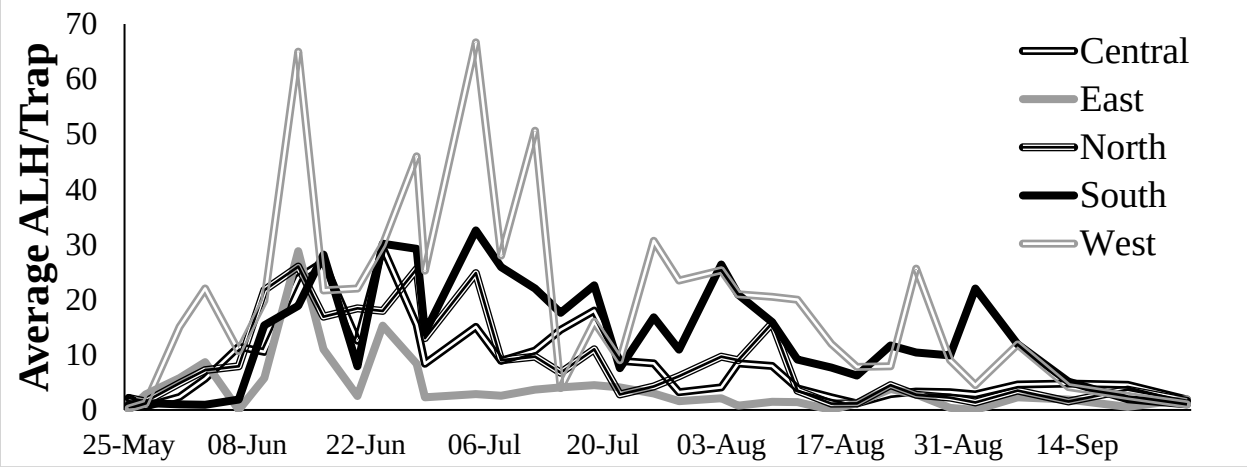


Figure 3. Average aster leafhoppers/trap in different regions of the Holland Marsh, 2022.

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 3 August. No scouted carrot fields reached the leaf blight threshold of 25% of plants infected.

Samples of 100 carrots were taken from each scouted fields and roots were assessed for diseases (Table 2). All fields had multiple diseases; however, disease severity was generally low. Cavity spot (*Pythium* spp.) and forking (nematodes and/or *Pythium* spp.) were the most common throughout carrot fields, similar to previous years in the Holland Marsh. Crater rot, Fusarium dry rot, aster yellows and crown gall were also present and disease incidence and severity were higher compared to previous years. This is likely due to the wet conditions at the end of the season and high populations of aster leafhopper.

Table 2. Disease incidence on carrot samples collected from commercial fields in the Holland Marsh, Ontario in 2022.

DISEASE	CAUSAL AGENT	FIELDS INFECTED (%)	INCIDENCE (%)
Cavity Spot	*Pythium* spp.	100	1-42
Forking/Split	Nematodes and/or *Pythium* spp.	100	3-24
Fusarium Dry Rot	*Fusarium* spp.	96	0-32
Aster Yellows	*Phytoplasma*	36	0-20
Crater Rot	*Rhizoctonia* spp.	24	0-3
Crown Gall	*Agrobacterium tumefaciens*	16	0-11

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 model predicted first generation onion fly emergence on 15 May and first onion flies were found on yellow sticky traps on 19 May. Counts remained low throughout the season, however, a few fields experienced very high numbers in the beginning of July (Fig. 4).

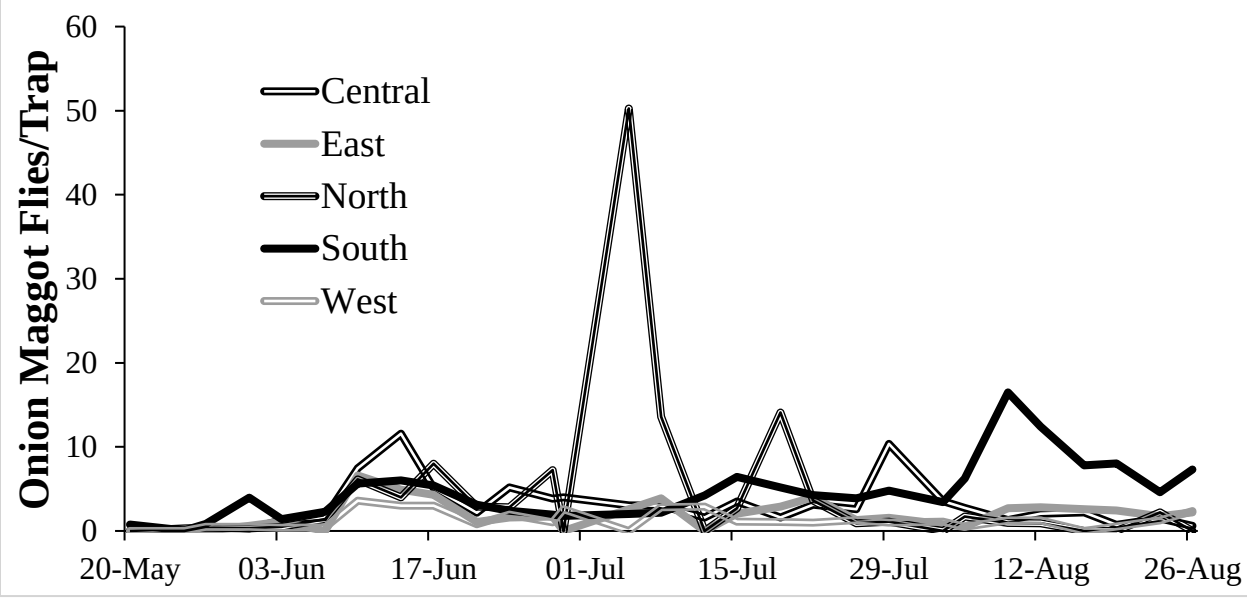


Figure 4. Average onion flies/trap/day in different regions of the Holland Marsh, 2022.

Thrips were firsts identified on 14 June and populations fluctuated throughout the season. Thrips counts peaked on 3 August. Six onion fields surpassed the 3 thrips/leaf threshold between the end of June to mid-August.

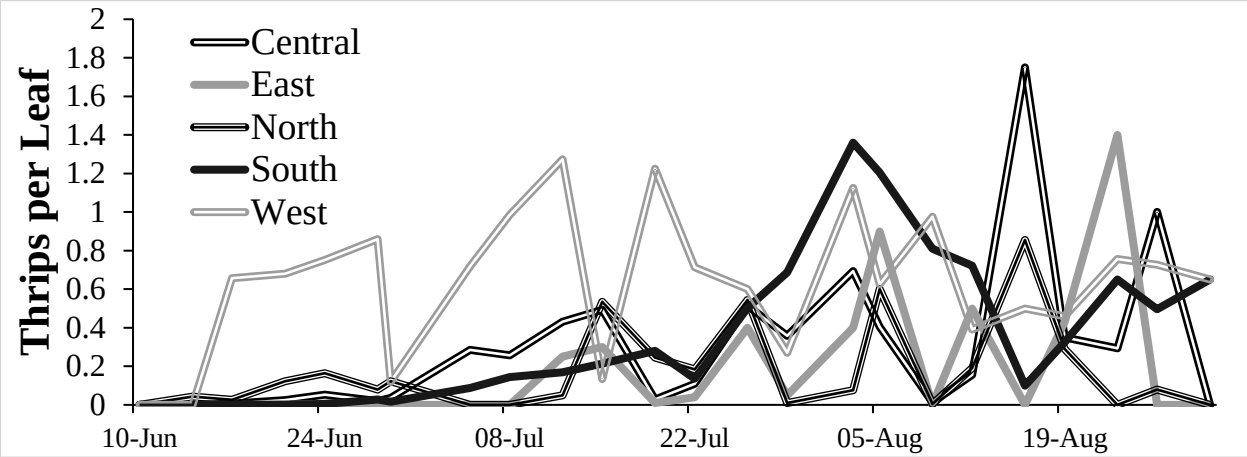


Figure 5. Average thrips/leaf in different regions of the Holland Marsh, 2022.

Diseases

Onion fields were scouted for botrytis leaf blight (*Botrytis squamosa*), downy mildew (*Peronospora destructor*), purple blotch (*Alternaria porri*), white rot (*Stromatinia cepivora*), pink root (*Setophoma terrestris*), stemphylium leaf blight (*Stemphylium vesicarium*) and other diseases.

Stemphylium leaf blight continued to be the main disease on onions in 2022, however disease severity was low this year (Table 3). First symptoms of Stemphylium leaf blight in scouted fields were seen on 24 June. All scouted onion fields showed symptoms of the disease by the end of the season. Conditions were favourable for onion downy mildew during multiple periods throughout the season, starting around the beginning to mid-July. Disease forecasting indicated a high risk of disease, known as sporulation-infection periods, and recommended sprays a few times between mid-July to mid-August. Although sporangia were identified in roto-rod spore traps on 15 July, downy mildew was not found in any scouted onion fields. This could be attributed to growers applying the proper fungicide at the right time. Pink root was found in all onion fields, but disease severity was generally low.

Table 3. Disease incidence on onion samples examined in commercial fields in the Holland/Bradford Marsh, Ontario in 2022.

DISEASE	CAUSAL AGENT	FIELDS INFECTED (%)	INCIDENCE (%)
Pink root	*Setophoma terrestris*	100	7-95
Stemphylium leaf blight	*Stemphylium vesicarium*	100	5-65
Purple blotch	*Alternaria porri*	59	0-8
White rot	*Stromatinia cepivora*	33	0-16
Bacterial rot/soft rot	*Pectobacterium carotovorum*	26	0-4
Smut	*Urocystis cepulae*	26	0-3

CELERY

Insects

In 2022, four 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. Tarnished plant bug populations and

damage were low. No carrot weevil damage was found in scouted celery fields this year. Aster yellows low in celery fields despite the higher populations of leafhoppers. No leaf miner, aphid or caterpillar damage was reported and only minor cutworm damage was seen.

Diseases

Celery leaf curl, or celery anthracnose (*Colletotrichum fioriniae*), was found in most scouted celery fields but incidence was very low overall with only a few plants per field infected with the disease. Leaf blights were common later in the season and disease severity remained low throughout the 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, FMC and Syngenta Crop Protection.

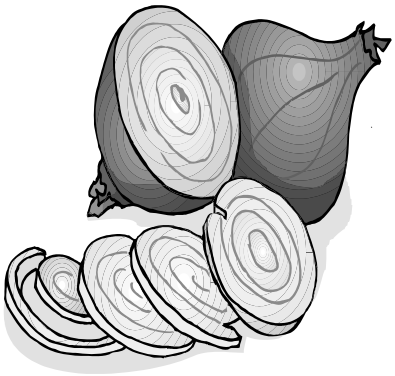
Check out the Muck Crops Research Station's You Tube Account

The Muck Crops Research Station launched a YouTube channel in 2021. The account communicates brief videos of the Station's IPM program, variety trial results, past Muck Conferences and other information to our growers, industry reps and academic personnel. We hope the information will be helpful to our followers. So take some time, check out our channel and stay informed.

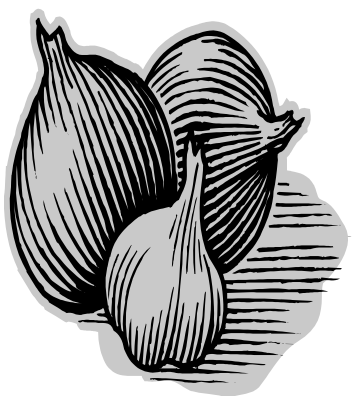
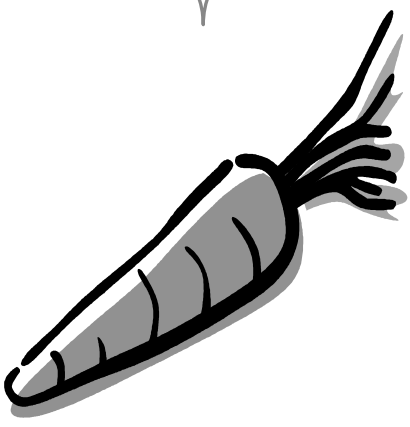
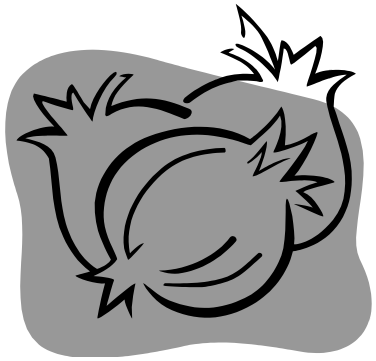
Simply type in:

"Muck Crops IPM" on YouTube to find us we're the first result.

or follow this link www.youtube.com/@muckcrops


Cultivar Trials 2022

CARROT CULTIVAR TRIAL SEASON SUMMARY – 2022

Daytime air temperatures in early May fluctuated between the teens and high twenties digits, while nighttime air temperatures fluctuated from low single digits to low teens. The month of May had below average rainfall. Half an inch of rainfall occurred four days prior to seeding which provided adequate soil moisture for carrot hill formation and seeding. In the marsh, most of the carrot seeding occurred within the two-week period of 16-27 May. Compared to the previous 10-year average, air temperatures in 2022 were above average for May (15.1°C), average for June (18.3°C), August (20.6°C), September (16.5°C) and October (9.5°C), and below average for July (20.2°C). The 10-year average temperatures were: May 13.7°C, June 18.9°C, July 21.4°C, August 20.4°C, September 16.3°C and October 9.5°C. Monthly rainfall was below the 10-year average for May (50 mm), September (43 mm) and October (30 mm) and average for June (90 mm), July (74 mm), August (82 mm). The 10-year rainfall averages were: May 64 mm, June 97 mm, July 78 mm, August 79 mm, September 59 mm and October 77 mm.

The carrot trial was seeded on 24 May. Soil moisture was sufficient in forming favourable carrot hills and provided soil moisture for seed germination. On 30 May, an additional half an inch of irrigation water was needed to provide good moisture conditions for seed germination. Emergence and plant vigour were good. On 5 June, the carrots were in the bunny ear stage. A much-needed total of 32.5 mm rainfall occurred between 7 through 11 of June. These rainfalls helped the carrots establish well with no visible decrease in stand.

The pre-emergence herbicide Gesagard was applied 28 May. The lack of rainfall meant irrigation needed to be applied to activate the Gesagard. The Gesagard gave moderate weed suppression. The rainfall events between 7 to 11 June encouraged a weed flush. Several applications of Lorox + Assist Oil were required on 14, 24 and 30 of June to clean up the trial. These herbicide applications and drier conditions provided fair weed control for the balance of the growing season. The trial was hand weeded a few times through the growing season to keep it free of weeds.

Scouting for carrots began at the station on 17 May. Carrot weevil counts on 17 May were 0.5 weevils/trap/day. By 2 June, weevil numbers had surpassed the spray threshold with 1.5 cumulative weevils/trap. The cumulative weevils/trap for the season was 6.25 when the traps were removed on 11 July. Insecticides Exirel and/or Rimon were applied three times (22 & 29 June, 13 July) to provide control for carrot weevil damage. There was limited weevil damage (dead carrot seedlings) observed in the variety trial. The trial average for carrot weevil damage at evaluation was only 0.2%. Carrot rust flies were first found on 30 May. There were two rust fly peaks

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occurring 9 June and 12 August (0.11 and 0.33 flies/trap/day, respectively). At evaluation there was a trial average of 0.6% rust fly damage observed. This was an decrease of almost 2% compared to the 2021 trial average of 2.95% rust fly damage. Aster leafhoppers were first found on 9 June. On 21 June, leafhopper numbers had peaked at 50 leaf hoppers/trap. Leafhopper numbers stayed moderate throughout the month of July. Leafhopper population significantly decreased in August to below threshold levels. The high pressure of Aster leafhoppers correlated with noticeable aster yellows infection in the field, but surprisingly low numbers found in the yield samples.

Alternaria and Cercospora leaf blights were first found on 22 August and were easily controlled throughout the growing season with three applications of fungicides (see Cultivar Management Procedures). To observe cultivar tolerances to these pathogens, regular fungicide sprays were discontinued on 24 August. Throughout the months of September & October, leaf blight incidence slightly increased in most cultivars. Leaf blight was at a low level of infection in most varieties at harvest in October. Differences in leaf blight incidence among cultivars were evaluated and noted. In the jumbo cultivars, the third replicate had a significantly higher blight rating than the other two replicates. In the cello cultivars, the first replicate had a significantly lower blight rating than the other two replicates. By Grower Field Week, starting on 6 September, some bolting was noted in a few cultivars in the trial. At harvest, twenty-five cultivars had no seeders present and in cultivars where seeders were present the total numbers were very low.

On 8 September, grower field day, most carrot roots that were pulled appeared to be progressing fair. Lengths were a bit short, weight was a little light, but smoothness was good. Unfortunately, the carrot lengths did not improve due to the below average total rainfall in September and average total rainfall in October. Weather conditions in October were very favourable for the entire harvest period which began on 17 October. At harvest, carrots had fair diameters and average lengths, but were pretty good in quality. There were moderate numbers of forked and split carrots in the yield samples. Drier conditions in the four weeks prior to harvest appeared to discourage blight development. The carrot tops had low levels of leaf blight and strong petiole attachment. No pockets of sclerotinia were found in the trial at harvest. Bacterial canker rot and tip rot was low. Carrot samples were placed in the Filacell storage immediately after harvest.

At evaluation in November, the trial average yield for cellos was a bit disappointing with only 1037 bu/A. This is a drop of approximately 100 bu/A compared to 2020. The jumbos trial yield average was 1195 bu/A, which is very similar to the 2021 trial average of 1231 bu/A. The cellos were of disappointing in width and length but were fair in quality. The jumbos were also a little disappointing in width and length, however, the quality was good. In both the cellos and jumbos, the percentage of cull carrots was high with an average of 24% of

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CARROT CULTIVAR TRIAL SEASON SUMMARY – 2022 – continued

the harvest yield. Most of the culls in the jumbos were small, undersized carrots. In the cellos, most of the culls were forked with some splits and rot making up the other culls. Some canker rot was noted during evaluation with jumbo types having a higher incidence. At evaluation, the trial percent marketable average for cellos was 75.2% and jumbos was 75.4%. The second replicate of cellos and jumbos had a 2% lower percent marketable yield compared to the first and third replicate. For cellos, the stand average was low; 16 carrots/foot compared to the desired trial seeding average of 25 carrots/foot. For jumbos, the stand average was 10 carrots/foot compared to the desired trial seeding average of 18 carrots/foot. The total number of carrots harvested in the third replicate of both the cellos and jumbos had significantly lower number then the other two replicates. The low stands for both cellos and jumbos were disappointing because in the spring the emergence and establishment of carrots appeared to be good. The trial average for cavity spot incidence was 60.5%, a drop of 22% compared to 2021 (82.5%), but still higher than 2020 (44%) and 2019 (45%). Even though cavity spot incidence was moderate, the trial average for severity remained light/moderate-sized lesions. The first replicate cello varieties had a significantly lower percentage of cavity spot compared to the other two replicates. It appeared the drier conditions in September only slightly decreased the percentage of incidence of cavity spot, but did not decrease the severity. Most of the cello cultivars had poor uniformity of length and width. The jumbos were more uniform in length and width but still were below potential. In both the cello and jumbo varieties the third replicate was significant longer and wider compared to the other two replicates. Exterior colour for all cultivars was good and consistent for all carrots within the samples. Most of the jumbo cultivars only had a few visible lenticels. The jumbos had a better average trial rating for appearance than the cellos. Most of the cello cultivars had a rougher exterior skin with some ringy surfaces. Interior colour blending was good, with only 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 were no galls found on any carrots at evaluation. Visible aster yellows infection was found throughout the trial. At evaluation, no significant differences were found in percent infected aster yellow roots.

CARROT CULTIVAR TRIALS - 2022

MANAGEMENT PROCEDURES

Fertilizer:

40 kg/ha Nitrogen (Calcium Ammonium Nitrate 27-0-0) + 75 kg/ha Phosphorous (MESZ 10-40-0) + 200 kg/ha Potassium (ASPIRE 0-0-58) + 75 kg/ha of K-Mag (0-0-22) + 35 kg/ha of Manganese Sulfate and 3.5 kg/ha Boron (10%) was worked into the soil.

Seeded:

All trials were seeded on 24 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 28 May.
Post-emergence:	1 application: **LOROX L** at 300 ml/ha + **ASSIST OIL** at 1.0 L/ha on 14 June.
	2 applications: **LOROX L** at 500 ml/ha + **ASSIST OIL** at 1.0 L/ha on 24 and 30 June.
	1 application: **LOROX L** at 750 ml/ha + **ASSIST OIL** at 1.0 L/ha on 22 July.

Minor Elements:

Four foliar sprays: Epsom Salts on 21 July and 18 & 24 August (2.0 kg/ha) and 12 August (3.0 kg/ha).
Three foliar sprays: Maganese Sulfate on 21 July and 12 August (1.0 kg/ha) and 18 August (2.0 kg/ha).
One foliar spray: 20-20-20 on 21 July (1.0 L/ha).
One foliar spray: Alexin on 18 August (3.0 L/ha).
One foliar spray: Calimax on 21 July (2.0 L/ha).
One foliar spray: Suprafeed on 24 August (2.0 kg/ha).

Insect and Disease Control:

According to IPM recommendations.

RIMON at 840 ml/ha on 22 June.
EXIREL at 1.0 L/ha on 29 June.
RIMON at 825 ml/ha on 13 July.

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CARROT CULTIVAR TRIALS - 2022 - continued

Insect and Disease Control continued:

ADMIRE 240F at 200 ml/ha + **LUNA SENSATION** at 500 ml/ha and Minor Elements on 12 August.
DITHANE DG at 2.25 kg/ha + **ALLEGRO 500F** 1.16 L/ha + **CLOSER** at 300 ml/ha and Minor Elements on 18 August.
PRISTINE WG at 735g/ha + **LUNA SENSATION** at 500 ml/ha and Minor Elements on 24 August.

Harvest:

The Main and Adaptation Trials were harvested on 17-21 October. All trials were immediately placed in a temperature and humidity controlled storage (1°C, 95 % RH) respectively.

Irrigation:

Irrigation water was applied three times during the 2022 growing season.

30 May in the amount of ½ inch
8 July in the amount of 1 inch
13 July in the amount of ¾ inch

EVALUATION PROCEDURES

The cultivars were evaluated on 6 – 24 November after 3 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").

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% 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
B = Berlicum	F = Flakkee	K = Kuroda	D = Danver	SP = Spartan Bonus

Appearance:

Appearance is based on qualities of straightness of root and smoothness.
10.0 = very straight and smooth, 6.0 = a few rough carrots in mix, 1.0 = bends and curves in root with very rough surface.

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 24 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.

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CARROT CULTIVAR TRIALS - 2022 - continued

% 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)

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

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% 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.

% Aster Yellows:

Percent of Aster yellows infected roots 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.

Zero			***One***	***Three***	***Seven***	***Eleven***
Brillyance	CA 20 2011	CK 303	SV DN 5904	Orange Blaze	Extremo	FCR 17663
SV 2384	Brava	Istanbul	Bolero	Caravel		
Naval	Belgrado	FCR 17720	Jefferson			
Navedo Jumbo	Berlin	Intrepid - Inicium	Speedo			
Enterprise	Narvik	Intrepid	Junction			
SV DN 5934	Cellobunch	Intrepid Inicium Improved				
Navedo – Cello	Baldio	Volcano				
Trophy Pak	Viper					
Siroco	Bastia					

Root Gall:

Root gall was not found in the 2022 carrot cultivar trial.

CARROT CULTIVAR MAIN TRIAL CELLO TYPES - 2022

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
BRILLYANCE	Sto	152 a*	11 de	106 a	21.14 ab	2.86 c-f	14.76 a	88.1	1419 a
NAVAL	Bejo	131 abc	21 ab	79 a-d	20.09 abc	5.72 a	10.70 bcd	82.1	1322 ab
ORANGE BLAZE	Sem	91 cde	16 bcd	53 def	14.32 fgh	5.44 ab	6.13 gh	57.9	931 c-g
TROPHY PAK	Sto	143 ab	25 a	82 a-d	17.51 b-g	5.93 a	8.18 c-h	70.5	1135 bcd
VOLCANO	Vil	115 a-d	17 bcd	68 b-f	16.30 d-h	4.38 a-e	8.69 b-g	65.3	1052 c-f
NAVEDO	Bejo	136 ab	17 bcd	84 abc	21.24 a	5.40 ab	11.19 bc	82.9	1335 ab
NARVIK	Bejo	130 abc	10 de	90 ab	18.25 a-e	2.62 def	11.51 ab	70.6	1137 bcd
CELLOBUNCH	Sto	132 abc	21 abc	78 a-e	18.98 a-d	5.85 a	8.78 b-g	73.2	1178 abc
ISTANBUL	Bejo	135 ab	16 bcd	82 a-d	19.31 a-d	4.43 a-e	10.28 b-e	73.5	1184 abc
VIPER	Ill	70 e	7 e	48 ef	14.06 gh	2.19 ef	8.30 b-h	52.4	844 efg

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 - 2022 - continued

Cultivar	Source	# Carrots Harvested	# > 4.4 cm	# 2.0 to 4.4 cm	Total Harvest Weight (kg)	Weight > 4.4 cm (kg)	Weight 2.0 to 4.4 cm (kg)	Marketable Yield t/ha	Marketable Yield B/A
SV 2384	Sto	138 ab*	9 de	97 ab	17.99 a-f	2.43 def	10.99 bcd	67.1	1080 b-e
JUNCTION	Bejo	84 de	15 bcd	48 ef	15.82 d-h	4.71 a-d	6.74 fgh	57.3	922 c-g
INTREPID	SN	135 ab	10 de	83 a-d	15.12 e-h	2.77 c-f	8.21 b-h	54.9	884 d-g
INTREPID Inicium Improved	SN	131 abc	13 cde	74 b-f	15.85 d-h	3.60 a-f	7.86 d-h	57.3	923 c-g
ENTERPRISE	Sto	153 a	11 de	96 ab	16.78 c-h	3.16 b-f	8.99 b-g	60.8	978 c-g
FCR 17720	Ill	80 de	5 e	54 c-f	13.37 h	1.74 f	7.82 d-h	47.8	770 g
SV DN 5934	Sem	132 abc	7 e	81 a-d	17.51 b-g	2.07 ef	9.98 b-f	60.2	969 c-g
INTREPID Inicium	SN	117 a-d	10 de	68 b-f	14.40 fgh	2.63 def	7.29 e-h	49.6	799 fg
JEFFERSON	Bejo	103 b-e	17 bcd	44 f	16.02 d-h	5.16 abc	5.23 h	52.0	836 efg
Trial Average		**121**	**14**	**74**	**17.06**	**3.85**	**9.03**	**64.4**	**1037**

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 - 2022 - continued

Cultivar	Source	% Marketable	% Oversize	Majority of Culls	Shape	Uniformity of Shape	Uniformity of Length	Uniformity of Width	Appearance	Resistance to Greening
BRILLYANCE	Sto	83.3 a*	13.3 f	Sm	N	6.7 efg	6.3 abc	6.7 abc	7.3 bc	9.2 cde
NAVAL	Bejo	82.2 a	29.5 a-e	F	N	9.7 ab	7.7 a	7.3 a	8.7 a	9.3 bcd
ORANGE BLAZE	Sem	81.4 a	42.7 a	F	ImpCyl	6.7 efg	6.0 bcd	6.3 a-d	6.0 def	8.7 e
TROPHY PAK	Sto	80.7 a	33.8 ab	F	Imp	7.7 cde	5.7 b-e	5.3 cde	7.3 bc	10.0 a
VOLCANO	Vil	80.2 a	27.4 a-f	F	GP	7.0 d-g	7.0 ab	7.0 ab	7.7 ab	9.0 de
NAVEDO	Bejo	78.3 a	25.1 b-f	F	Cyl	6.0 g	5.0 c-f	6.0 a-e	6.7 bcd	9.8 ab
NARVIK	Bejo	77.1 a	14.2 def	F	N	8.7 bc	6.3 abc	6.7 abc	7.7 ab	9.0 de
CELLOBUNCH	Sto	77.0 a	30.8 abc	F	Imp	6.3 fg	4.0 fg	5.0 de	6.3 cde	9.7 abc
ISTANBUL	Bejo	76.2 a	22.8 b-f	Sp	Imp	7.7 cde	4.7 d-g	6.3 a-d	5.7 d-g	9.8 ab
VIPER	Ill	74.4 a	14.4 def	F	CP	10.0 a	4.3 efg	5.7 b-e	2.7 h	10.0 a

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 - 2022 - continued

Cultivar	Source	% Marketable	% Oversize	Majority of Culls	Shape	Uniformity of Shape	Uniformity of Length	Uniformity of Width	Appearance	Resistance to Greening
SV 2384	Sto	74.1 a*	13.4 ef	F	Imp	6.0 g	4.7 d-g	4.7 e	6.3 cde	9.0 de
JUNCTION	Bejo	73.4 a	29.7 a-d	F	Imp	6.7 efg	3.3 g	5.3 cde	5.3 efg	10.0 a
INTREPID	SN	72.5 a	17.7 c-f	F	Imp	8.0 cd	5.3 c-f	6.0 a-e	5.7 d-g	9.3 bcd
INTREPID INICIUM IMPROV	SN	72.3 a	23.1 b-f	F	Imp	7.3 def	5.3 c-f	6.0 a-e	6.7 bcd	9.3 bcd
ENTERPRISE	Sto	72.1 a	18.6 b-f	F	Imp	6.3 fg	5.3 c-f	4.7 e	6.3 cde	9.5 a-d
FCR 17720	Ill	71.5 a	12.9 f	F	Cyl	10.0 a	5.3 c-f	7.3 a	4.7 g	9.3 bcd
SV DN 5934	Sem	69.6 a	11.9 f	F	Cyl	8.0 cd	4.7 d-g	5.3 cde	5.7 d-g	9.7 abc
INTREPID INICIUM	SN	68.3 a	17.9 b-f	F	Imp	7.7 cde	4.7 d-g	5.0 de	5.0 fg	9.3 bcd
JEFFERSON	Bejo	65.3 a	31.8 abc	F	ImpCyl	6.0 g	5.0 c-f	5.3 cde	5.3 efg	9.3 bcd
		75.2	**22.7**			**7.5**	**5.3**	**5.9**	**6.2**	**9.4**

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

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

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CARROT CULTIVAR MAIN TRIAL CELLO TYPES - 2022 - 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
BRILLYANCE	Sto	O	7.3 b-e*	O	7.3 a	50.7 a	8.8 a	7.26 bcd	20LM e	CC
NAVAL	Bejo	LO	8.7 a	O	6.7 abc	41.2 def	9.0 a	8.29 a	52L d	CC
ORANGE BLAZE	Sem	DO	6.0 fgh	O	5.7 cd	41.5 def	9.0 a	6.48 ef	54L cd	CV
TROPHY PAK	Sto	DO	7.3 b-e	O	7.3 a	46.3 abc	9.0 a	7.24 bcd	63LM bcd	CV
VOLCANO	Vil	O	5.7 gh	O	5.3 d	47.1 ab	9.0 a	6.95 cde	23L e	CV
NAVEDO	Bejo	O	7.3 b-e	O	6.7 abc	42.3 c-f	8.5 a	6.79 de	73LM a-d	CC
NARVIK	Bejo	O	8.3 ab	O	6.0 bcd	37.8 fg	8.7 a	7.52 b	23LM e	CC
CELLOBUNCH	Sto	O	6.0 fgh	O	6.7 abc	45.3 bcd	8.3 a	6.29 f	52LM d	CV
ISTANBUL	Bejo	O	6.7 d-g	O	7.3 a	43.4 b-e	8.7 a	6.88 de	83LM ab	CV
VIPER	Ill	DO	8.0 abc	O	7.0 ab	38.4 fg	7.5 a	6.81 de	86M ab	CV

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 - 2022 - 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
SV 2384	Sto	O	6.3 e-h*	O	7.0 ab	43.8 b-e	9.0 a	6.29 f	77M abc	CV
JUNCTION	Bejo	O	8.0 abc	O	6.7 abc	40.0 efg	8.7 a	6.48 ef	85LM ab	CV
INTREPID	SN	O	5.3 h	O	7.3 abc	40.5 efg	9.0 a	6.71 ef	72L a-d	CV
INTREPID INICIUM IMPROV	SN	O	6.7 d-g	O	7.3 a	44.3 b-e	8.7 a	6.95 cde	90LM a	CV
ENTERPRISE	Sto	O	6.3 e-h	O	7.0 ab	36.6 g	8.7 a	6.50 ef	70LM a-d	CV
FCR 17720	Ill	DO	7.7 a-d	O	7.3 a	45.7 bcd	8.3 a	7.38 bc	78MH ab	CV
SV DN 5934	Sem	O	7.0 c-f	O	5.3 d	43.7 b-e	9.0 a	6.52 ef	83M ab	CC
INTREPID INICIUM	SN	DO	7.3 b-e	O	7.0 ab	42.2 c-f	8.2 a	6.57 ef	78LM ab	CV
JEFFERSON	Bejo	DO	6.0 fgh	DO	7.0 ab	38.1 fg	8.3 a	6.29 f	88M a	CC
			6.9		**6.7**	**42.6**	**8.6**	**6.85**	**66LM**	

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 - 2022 - 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	% Aster Yellows
BRILLYANCE	Sto	19.5 ef*	3.7 abc	25	20 a	45.3 de	G	FST	0.0 a	0.6 a	0.4 a
NAVAL	Bejo	18.1 fg	3.9 a	25	17 abc	42.2 e	DG	ST	0.3 a	0.7 a	1.0 a
ORANGE BLAZE	Sem	20.9 de	3.6 a-e	25	12 cde	52.3 ab	G	STC	0.0 a	0.0 a	0.7 a
TROPHY PAK	Sto	20.6 de	3.7 a-d	25	19 ab	53.4 a	G	STC	0.0 a	0.5 a	1.2 a
VOLCANO	Vil	19.6 ef	3.8 ab	18	15 a-d	49.0 bcd	G	FST	0.0 a	0.0 a	2.9 a
NAVEDO	Bejo	20.0 ef	3.6 a-f	25	18 ab	48.1 cd	G	ST	0.0 a	0.3 a	1.2 a
NARVIK	Bejo	17.2 g	3.4 c-g	25	17 abc	38.1 f	DG	ST	0.0 a	0.0 a	0.3 a
CELLOBUNCH	Sto	20.6 de	3.5 b-f	25	17 ab	49.1 bcd	G	ST	0.0 a	0.0 a	0.3 a
ISTANBUL	Bejo	22.4 cd	3.5 b-f	25	18 ab	48.1 cd	G	ST	0.3 a	0.8 a	1.0 a
VIPER	Ill	32.2 b	3.6 a-f	23	9 e	50.4 abc	G	ST	0.0 a	0.0 a	2.8 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.

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CARROT CULTIVAR MAIN TRIAL CELLO TYPES - 2022 - 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	% Aster Yellows
SV 2384	Sto	21.6 de*	3.3 fg	25	18 ab	49.1 bcd	LG	ST	0.0 a	0.0 a	0.7 a
JUNCTION	Bejo	24.4 c	3.4 c-g	25	11 de	49.8 abc	G	ST	0.0 a	0.4 a	0.0 a
INTREPID	SN	22.3 cd	3.4 efg	18	18 ab	51.1 abc	G	ST	0.0 a	0.8 a	0.2 a
INTREPID INICIUM IMPROV	SN	21.4 de	3.5 c-g	18	17 ab	51.5 abc	G	ST	0.0 a	0.8 a	0.8 a
ENTERPRISE	Sto	20.6 de	3.2 g	25	20 a	49.5 abc	G	ST	0.0 a	0.4 a	0.2 a
FCR 17720	Ill	34.6 a	3.5 c-g	23	11 de	50.5 abc	G	STC	0.0 a	0.5 a	0.0 a
SV DN 5934	Sem	21.1 de	3.4 d-g	25	17 ab	53.4 a	G	ST	0.0 a	2.0 a	1.0 a
INTREPID INICIUM	SN	20.9 de	3.3 fg	18	15 ab	50.4 abc	G	ST	0.0 a	0.6 a	0.6 a
JEFFERSON	Bejo	21.2 de	3.6 a-e	25	13 b-e	50.4 abc	G	ST	0.0 a	1.8 a	1.6 a
Trial Average		**22.1**	**3.5**	**23**	**16**	**49.0**			**0.0**	**0.5**	**0.9**

Listed in order of % Marketable.

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

CARROT CULTIVAR MAIN TRIAL JUMBO TYPES - 2022

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
CALTONA	SN	56 f*	33 b-e	13 c-g	14.23 f	10.66 b-f	1.50 def	60.8	979 a
SPEEDO	Vil	57 ef	26 de	24 a-e	14.46 f	7.86 f	4.35 b	61.1	983 a
SIROCO	Vil	76 b-f	34 b-e	31 ab	17.55 c-f	10.83 b-f	3.88 bc	73.6	1185 a
EXTREMO	Vil	55 f	38 b-e	10 efg	19.10 b-f	14.74 ab	1.41 def	80.8	1300 a
BASTIA	Bejo	102 ab	45 abc	29 abc	21.45 a-d	13.49 abc	3.43 bcd	84.6	1362 a
CA 20 2011	Ill	80 b-f	37 b-e	26 a-d	21.54 a-d	12.84 a-e	4.04 bc	84.4	1359 a
BOLERO	Vil	65 def	24 de	27 a-d	15.67 ef	8.08 abc	3.98 bc	60.3	971 a
BELGRADO	Bejo	112 a	48 ab	25 a-e	24.95 a	15.46 ab	3.53 bcd	95.0	1529 a
BALDIO	Bejo	96 abc	48 ab	20 b-f	23.12 ab	14.24 abc	2.97 b-e	86.1	1385 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.

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CARROT CULTIVAR MAIN TRIAL JUMBO TYPES - 2022

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
CARAVEL	Ill	65 def*	24 de	20 b-f	15.81 ef	8.35 def	3.24 bcd	58.0	934 a
SV DN 5904	Sem	85 a-e	40 a-d	20 b-f	22.28 abc	12.96 a-d	3.30 bcd	81.3	1308 a
BERLIN	Bejo	101 ab	55 a	11 d-g	23.90 ab	15.92 a	1.62 def	87.7	1413 a
BRAVA	Bejo	78 b-f	43 abc	6 fg	21.12 a-d	14.09 abc	0.79 ef	74.4	1198 a
FCR 17663	Ill	68 c-f	29 cde	13 c-g	16.92 def	9.57 c-f	1.86 c-f	57.2	920 a
NAVEDO	Bejo	89 a-d	23 e	39 a	20.56 a-e	7.52 f	6.57 a	70.5	1134 a
CK 303	SN	61 def	36 b-e	0 g	24.14 a	14.45 ab	0.00 f	72.2	1163 a
Trial Average		**78**	**36**	**20**	**19.80**	**11.94**	**2.91**	**74.2**	**1195**

Listed in order of % Marketable.

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

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CARROT CULTIVAR MAIN TRIAL JUMBO TYPES - 2022 - continued

Cultivar	Source	% Marketable	% Oversize	Majority of Culls	Shape	Uniformity of Shape	Uniformity of Width	Uniformity of Length	Appearance	Resistance to Greening
CALTONA	SN	85.4 a*	75.2 a	F	SP	8.0 ab	6.0 a-d	7.0 a-d	6.0 cd	8.7 abc
SPEEDO	Vil	84.0 a	54.4 b	F	Cyl	8.3 a	7.3 a	8.0 ab	7.3 abc	5.0 f
SIROCO	Vil	83.6 a	61.3 ab	F	ImpN	8.7 a	7.3 a	8.3 a	8.7 a	8.5 abc
EXTREMO	Vil	82.8 ab	76.0 a	F	LD	6.3 cd	7.0 ab	5.0 f	6.3 cd	7.3 cde
BASTIA	Bejo	78.6 abc	62.7 ab	F	F	6.7 bcd	6.3 abc	5.3 ef	6.3 cd	9.0 ab
CA 20 2011	Ill	78.0 abc	59.0 b	F	F	5.7 d	6.0 a-d	6.3 c-f	6.7 bcd	7.7 bcd
BOLERO	Vil	76.8 abc	51.8 bc	F	F	5.3 d	4.7 cd	5.7 def	5.7 d	7.3 cde
BELGRADO	Bejo	75.2 abc	60.9 ab	Sm	B	5.7 d	4.3 d	6.7 b-e	7.0 bcd	8.0 bc
BALDIO	Bejo	74.3 abc	61.9 ab	Sm	F	6.7 bcd	5.7 a-d	6.3 c-f	7.0 bcd	8.3 abc

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 - 2022 - continued

Cultivar	Source	% Marketable	% Oversize	Majority of Culls	Shape	Uniformity of Shape	Uniformity of Width	Uniformity of Length	Appearance	Resistance to Greening
CARAVEL	Ill	73.9 abc*	53.5 b	Sp	F	5.3 d	5.3 bcd	7.0 a-d	6.3 cd	6.0 ef
SV DN 5904	Sem	73.1 a-d	57.6 b	F	B	6.7 bcd	7.3 a	8.3 a	7.3 abc	7.3 cde
BERLIN	Bejo	72.7 a-d	65.8 ab	Sm	K	6.0 d	4.3 d	6.3 c-f	8.0 ab	9.7 a
BRAVA	Bejo	69.8 bcd	66.2 ab	F	GP	5.7 d	6.7 ab	6.3 c-f	6.7 bcd	9.0 ab
FCR 17663	Ill	68.8 cd	57.4 b	Sp	B	6.7 bcd	7.0 ab	7.0 a-d	6.3 cd	6.3 def
NAVEDO	Bejo	68.8 cd	37.0 c	Sp	F	5.7 d	7.0 ab	7.7 abc	6.7 bcd	8.0 bc
CK 303	SN	60.2 d	60.2 ab	R	D	7.7 abc	6.3 abc	5.7 def	6.3 cd	5.3 f
Trial Average		**75.4**	**60.1**			**6.6**	**6.2**	**6.7**	**6.8**	**7.6**

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 - 2022 - 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
CALTONA	SN	DO	7.0 cd*	O	7.0 ab	56.7 abc	9.0 a	7.10 b	32L ghi	CV
SPEEDO	Vil	LO	7.3 abc	LO	5.7 cd	44.9 gh	8.7 ab	7.00 bc	32M ghi	CC
SIROCO	Vil	O	7.7 ab	O	8.0 a	43.3 h	8.7 ab	8.17 a	37L f-i	CC
EXTREMO	Vil	O	6.0 d	O	7.0 ab	53.3 bcd	8.5 ab	6.43 b-f	52LM d-h	CV
BASTIA	Bejo	O	7.0 a-d	O	6.7 bc	51.3 c-f	9.0 a	6.76 bcd	83LM ab	CC
CA 20 2011	Ill	O	7.0 a-d	O	5.3 d	46.6 fgh	8.3 ab	6.38 b-f	30M hi	CV
BOLERO	Vil	O	6.7 bcd	O	5.3 d	51.1 def	8.0 b	5.81 f	23L i	CV
BELGRADO	Bejo	O	6.7 bcd	O	5.3 d	53.3 bcd	8.0 b	6.24 def	58LM b-g	CC
BALDIO	Bejo	O	6.0 d	O	6.7 bc	58.4 ab	9.0 a	6.67 bcd	80L abc	CC

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

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

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CARROT CULTIVAR MAIN TRIAL JUMBO TYPES - 2022 - 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
CARAVEL	Ill	LO	6.3 cd*	O	4.7 d	52.2 cde	8.3 ab	5.86 ef	50LM e-i	CV
SV DN 5904	Sem	LO	7.0 a-d	LO	5.0 d	48.3 d-h	7.0 c	7.00 bc	88LM a	CC
BERLIN	Bejo	O	8.0 a	O	5.7 cd	58.1 ab	8.7 ab	6.86 bcd	67L a-e	CC
BRAVA	Bejo	O	6.0 d	O	5.7 cd	60.3 a	8.2 b	6.57 b-e	53L c-h	CV
FCR 17663	Ill	LO	7.0 a-d	LO	4.7 d	49.8 d-g	8.3 ab	6.43 b-f	52L d-h	CV
NAVEDO	Bejo	O	7.7 ab	O	5.3 d	46.9 e-h	8.0 b	6.86 bcd	63LM a-f	CC
CK 303	SN	LO	7.0 a-d	BO	5.7 cd	49.4 d-g	8.2 b	6.29 c-f	78M a-d	CC
Trial Average			**6.9**		**5.9**	**51.5**	**8.4**	**6.65**	**55LM**	

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 - 2022 - 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	% Aster Yellows
CALTONA	SN	26.2 a*	6.1 b	18	7 e	54.1 bc	DG	STC	1.3 a	2.4 a	1.2 a
SPEEDO	Vil	22.1 b-e	4.9 de	18	7 de	41.5 g	G	ST	0.0 a	0.0 a	1.2 a
SIROCO	Vil	23.5 bc	5.0 de	18	10 b-e	45.7 efg	G	FST	0.0 a	0.0 a	0.4 a
EXTREMO	Vil	21.1 def	6.1 b	18	7 e	58.9 a	DG	F	0.0 a	2.0 a	0.0 a
BASTIA	Bejo	21.2 def	5.4 cd	20	13 ab	47.5 def	LG	FST	0.0 a	0.3 a	2.0 a
CA 20 2011	Ill	22.5 bcd	5.3 cde	20	10 b-e	46.8 def	G	ST	0.0 a	0.4 a	1.3 a
BOLERO	Vil	21.1 def	4.8 e	18	8 cde	46.9 def	G	ST	0.7 a	0.0 a	0.0 a
BELGRADO	Bejo	20.4 def	5.5 bcd	18	15 a	46.4 ef	G	FST	0.0 a	0.2 a	1.5 a
BALDIO	Bejo	19.6 fgh	5.1 de	18	13 abc	45.7 efg	G	FST	0.0 a	1.2 a	1.7 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.

CARROT CULTIVAR MAIN TRIAL JUMBO TYPES - 2022 - 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	% Aster Yellows
CARAVEL	Ill	21.3 c-f*	5.2 de	20	8 cde	47.2 def	G	ST	0.7 a	0.7 a	3.1 a
SV DN 5904	Sem	21.5 b-f	5.1 de	18	11 a-e	59.5 a	G	ST	0.0 a	0.0 a	2.0 a
BERLIN	Bejo	19.3 fgh	5.3 cde	18	13 ab	44.1 fg	G	FST	0.0 a	0.6 a	1.0 a
BRAVA	Bejo	20.1 efg	5.9 bc	18	10 b-e	49.1 de	G	ST	0.0 a	0.8 a	4.3 a
FCR 17663	Ill	18.0 gh	5.3 cde	20	9 cde	57.8 ab	G	ST	0.0 a	0.8 a	0.5 a
NAVEDO	Bejo	23.6 b	5.0 de	18	12 a-d	51.0 cd	G	FST	0.4 a	0.0 a	3.4 a
CK 303	SN	17.4 h	7.0 a	18	8 de	49.1 de	G	ST	0.0 a	0.0 a	1.6 a
Trial Average		**21.2**	**5.4**	**18**	**10**	**49.5**			**0.2**	**0.6**	**1.6**

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 – 2022

Brillyance: *Stokes sample,* Nantes style, Average length a little uneven, Average to good width slightly even, Uniformity of shape even, Full tips matured, Odd noticeable lenticel, Good appearance, Good weight a little uneven, Good smoothness, Good exterior colour even, 1 to 2 cavity spots per root, Cavity spot not a concern, Average to good interior blending even, Translucent core dead center (20-60%), Yellow ring around core (20-50%), Average to large core size, Average Packer, Okay Jumbo, Some Jumbos a bit short.

Naval: *Bejo sample,* Nantes carrot, Average length even, Good width even, Uniformity of shape very even, Full tips matured, Odd noticeable lenticel, Nice appearance, Good weight a little even, Good smoothness, Good exterior colour even, 2 to 3 cavity spots per root, Cavity spot not a concern, Average interior blending, Translucent core dead center (30-70%), Red ring around core (20-40%), Average core size, Good Packer, Okay Jumbo, Jumbos are an oversized nantes and a bit short.

Orange Blaze: *Seminis sample,* Good length uneven, Average to good width a little uneven, Uniformity of shape even, Slightly tapered and full tips 70% matured 30% immature, Odd noticeable lenticel, Average appearance, Odd carrot a touch ringy, Good weight a little uneven, Fairly smooth, Fair exterior colour a little uneven, Odd noticeable cavity spot, 2 to 3 or 4 to 5 cavity spots per root, Average interior blending a little even, Green or red ring around core (20-40%), Average core size, Average Packer, Okay to average Jumbo slightly tapered ends.

Trophy Pak: *Stokes sample,* Average length uneven, Okay, average and good width uneven, Uniformity of shape very even, Odd carrot with bends and curves, Tapered tips 60% matured 40% immature, Average appearance, Odd ringy carrot, Average weight a little uneven, Fairly smooth, Good exterior colour even, Some noticeable cavity spots, 3 to 4 cavity spots per root, Average interior blending, Yellow in cores (10-30%), Red ring around core (60-90%), Average to large core size, Average to good Packer, Average Jumbo, Jumbos are an oversized packer.

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CARROT CULTIVAR MAIN TRIAL CELLO TYPES EVALUATION NOTES – 2022 - continued

Volcano: *Vilmorin sample,* Average length slightly uneven, Average width even, Uniformity of shape even, Tapered and full tips matured, Average appearance, Average to good weight, Good smoothness, Fair exterior colour uneven, Cavity spot not a concern, 1 to 2 cavity spots per root, Average interior blending slightly even, Yellow ring around core (20-70%), Average core size, Good Packers bit short, Average Jumbo.

Navedo: *Bejo sample,* Average to good length a little uneven, Average to good width a little uneven, Uniformity of shape even, Odd carrot with bends and curves, Full tips matured, Average appearance, Some ringy carrots, Average and good weight a little uneven, Fairly smooth, Fair exterior colour even, Noticeable cavity spots, 2 to 5 cavity spots per root, Average interior blending even, Yellow in cores (10-20%), Red ring around core (30%), Average core size, Average to good Packer, Good Jumbo with good length and weight.

Narvik: *Bejo sample,* Nantes carrot, Okay length even, Average to good width a little even, Uniformity of shape very even, Full tips matured, Good appearance, Some ringy carrots, Average to good weight a little uneven, Fairly smooth, Good exterior colour even, Cavity spot not a concern, 1 to 3 cavity spots per root, Average interior blending a little uneven, Translucent core dead center (40-60%), Red ring around core (10-60%), Average core size, Average to good Packer, Odd carrot with harvest cracks, Okay Jumbo a few bit short.

Cellobunch: *Stokes sample,* Average length uneven, Average to good width uneven, Uniformity of shape a little uneven, Odd carrot with bends and curves, Tapered and full tips matured, Average appearance, Some ringy carrots, Average weight uneven, Smoothness a little rough, Fair exterior colour a little uneven, Some noticeable cavity spots, 1 to 2 or 5 to 6 cavity spots per root, Average interior blending, Translucent core dead center (10-30%), Yellow ring around core (20-50%), Average core size, Average Packer, Good Jumbo.

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CARROT CULTIVAR MAIN TRIAL CELLO TYPES EVALUATION NOTES – 2022 - continued

Istanbul: *Bejo sample,* Average length uneven, Good width slightly uneven, Uniformity of shape even, Odd carrot with bends and curves, Tapered tips matured, Average appearance, Some ringy carrots slight concern, Good weight uneven, Smoothness is a little rough, Fair to good exterior colour, Some noticeable cavity spots some concerns, 1 to 6 cavity spots per root, Good interior blending even, Red ring around core (40-70%), Average core size, Average to good Packer, Average Jumbo, Jumbos are an oversized packer.

Viper: *Illinois sample,* Cut & Peel carrot, Okay length uneven, Lengths very long, Average width uneven, Uniformity of shape very even, A lot of carrots with bends and curves, Tapered tips matured, Rough appearance, Most carrots ringy concern, Average weight, Poor smoothness, Fair exterior colour slightly dark, Exterior colour a little pale, Some noticeable cavity spots a concern, 4 to 5 cavity spots per root, Good interior blending even, Red ring around core (60-80%), Average to large core size, Poor Packer, Odd carrots with harvest cracks, Poor Jumbo.

SV 2384: *Stokes sample,* Good length but uneven, Average width uneven, Uniformity of shape a little uneven, Some carrots with bends and curves, Tapered and full tips 70% matured 30% immature, Average appearance, Some ringy carrots, Average weight a little uneven, Smoothness a little rough, Fair exterior colour slightly uneven, Some noticeable cavity spots slight concern, 2 to 3 cavity spots per root, Average to good interior blending, Yellow in cores (10-30%), Red ring around core (20-50%), Large core size, Average Packer, Odd carrot with mouse damage, Okay Jumbo, Jumbos are an oversized packer.

Junction: *Bejo sample,* Cut & Peel blood, Good length very uneven, Average to good width uneven, Uniformity of shape very even, Some carrots with bends and curves, Tapered tips matured, Appearance a little rough, Ringy carrot concern, Average to good weight uneven, Rough smoothness, Good exterior colour even, Some noticeable cavity spots, 2 to 3 or 4 to 5 cavity spots per root, Average to good interior blending, Translucent core dead center (10-30%), Red ring around core (40-70%), Average core size, Average Packer, Carrots a bit long, Poor Jumbo. **.../continued.**

CARROT CULTIVAR MAIN TRIAL CELLO TYPES EVALUATION NOTES – 2022 - continued

Intrepid: *Seminova sample,* Average length uneven, Average width a little uneven, Uniformity of shape even, Odd carrot with bends and curves, Tapered tips 70% matured 30% immature, Appearance a little rough, Some ringy carrots, Average weight a little uneven, Fairly smooth, Good exterior colour uneven, Odd noticeable cavity spot slight concern, 2 to 3 cavity spots per root, Good interior blending even, Red ring around core (80-90%), Average core size, Average Packer, Okay Jumbo.

Intrepid: *Seminova sample,* Okay to good length uneven, Average width uneven, Uniformity of shape even, A few carrots
Inicium & Improved with bends and curves, Tapered tips matured, Average appearance, Odd ringy carrot, Average weight, Fairly smooth, Good exterior colour even, Some noticeable cavity spots, 3 to 4 cavity spots per root, Good interior blending slightly even, Red ring around core (60-100%), Average to large core size, Average Packer, Okay Jumbo, Jumbos are an oversized packer.

Enterprise: *Stokes sample,* Okay length & width uneven, Uniformity of shape a little even, Odd carrot with bends and curves, Tapered and full tips 80% matured 20% immature, Appearance a little rough, Some ringy carrots, Weight very uneven, Smoothness a little rough, Fair exterior colour a little uneven, Odd noticeable cavity spot, 2 to 3 cavity spots per root, Good interior blending even, Red ring around core (40-50%), Small to average core size, Okay to average Packer, Okay Jumbo, Jumbos are an oversized packer.

FCR 17720: *Illinois sample,* Cut & Peel carrot, Okay length uneven, Lengths very long, Okay to average width slightly even, Width slightly thin, Uniformity of shape very even, A lot of carrots with bends and curves, Tapered tips matured, Appearance a little rough, Some ringy carrots a little concern, Average weight even, Smoothness a little poor, Good exterior colour even, Slightly noticeable cavity spots a little concern, 2 to 4 cavity spots per root, Good interior blending even, Red ring around core (50-90%), Average core size, Poor Packer, Poor Jumbo.

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CARROT CULTIVAR MAIN TRIAL CELLO TYPES EVALUATION NOTES – 2022 - continued

SV DN 5934: *Seminis sample,* Average length uneven, Average width a little uneven, Uniformity of shape very even, Odd carrot with bends and curves, Full tips matured, Average appearance, A few ringy carrots, Average to good weight a little uneven, Smoothness a little uneven, Fair exterior colour even, Some noticeable cavity spots slight concern, 2 to 6 cavity spots per root, Average interior blending uneven, Translucent core throughout (20-70%), Red ring around core (20-30%), Large core size, Average to good Packer, Slicer potential, Average Jumbo bit low on weight.

Intrepid: *Seminova sample,* Average length uneven, Average width uneven, Uniformity of shape even, A few carrots with bends and curves, Tapered tips matured, Appearance a little rough, A touch ringy, Average weight uneven, Smoothness a little rough, Good exterior colour slightly dark even, Odd noticeable cavity spot, 2 to 3 cavity spots per root, Good interior blending, Translucent core throughout (10%), Red ring around core (40-90%), Average core size, Average Packer, Poor Jumbo, Jumbos are an oversized packer.

Inicium

Jefferson: *Bejo sample,* Average length uneven, Average width slightly uneven, Uniformity of shape a little uneven, Odd carrot with bends and curves, Tapered and full tips matured, Average appearance, Some ringy carrots, Average to good weight a little uneven, Smoothness uneven, Good exterior colour slightly uneven, Odd noticeable cavity spot concern, 4 to 5 cavity spots per root, Good interior blending even, Red ring around core (50-80%), Average core size, Average Packer, Okay Jumbo, Jumbos are an oversized packer needs a bit more weight.

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CARROT CULTIVAR MAIN TRIAL JUMBO TYPES EVALUATION NOTES – 2022

Caltona: *Seminova sample,* Good length a little even, Average to good width a little even, Uniformity of shape very even, Odd carrot with bends and curves, Tapered tips matured, Heavy shoulders, A few noticeable lenticels, Appearance a little rough, Some ringy carrots, Average weight even, Smoothness a little rough, Fair exterior colour slightly even, Cavity spot not a concern, 1 to 2 cavity spots per root, Average interior blending slightly even, Translucent core dead center (20%), Red ring around core (30-70%), Large to extra large core size, Okay Packer, Average Jumbo.

Speedo: *Vilmorin sample,* Nantes style, Nice length very even, Good width very even, Uniformity of shape very even, Full tips matured, A few noticeable lenticels, Good appearance, Good weight even, Fairly smooth, Fair exterior colour slightly pale, Cavity spot not a concern, 1 to 4 cavity spots per root, Average interior blending a little uneven, Translucent core dead center (20-40%), Yellow in cores (20-30%), Yellow ring around core (30-80%), Average core size, Good Packer nante style, Slicer potential, Good to nice Jumbo.

Siroco: *Vilmorin sample,* Good length even, Good width even, Uniformity of shape very even, Odd carrot with bends and curves, Full tips matured, Slightly heavy shoulders, Nice appearance, Good weight even, Good smoothness, Good exterior colour very even, Cavity spot not a concern, 1 to 3 cavity spots per root, Nice interior blending even, Red ring around core (10-40%), Average to large core size, Good Packer nante style, Slicer potential, Odd carrot with harvest cracks, Good Jumbo bit more weight.

Extremo: *Vilmorin sample,* Good length a little even, Good width uneven, Uniformity of shape even, Odd carrot with bends and curves, Slightly tapered and full tips matured, Odd noticeable lenticel, Average appearance, Good to excellent weight uneven, Good smoothness, Fair exterior colour uneven, Odd noticeable cavity spot, 1 to 2 cavity spots per root, Good interior blending even, White in cores (30%), Red ring around core (20-50%), Large core size, Odd carrot with mouse damage, Okay Packer, Good to nice Jumbo.

…/continued

CARROT CULTIVAR MAIN TRIAL JUMBO TYPES EVALUATION NOTES – 2022 - continued

Bastia: *Bejo sample,* Good length a little uneven, Good width slightly uneven, Uniformity of shape a little even, Tapered and full tips matured, Odd noticeable lenticel, Average appearance, Some ringy carrots, Average to good weight a little uneven, Smoothness a little rough, Fair exterior colour slightly uneven, Odd noticeable cavity spot, 3 to 4 cavity spots per root, Average interior blending, Translucent core dead center (20%), Yellow in cores (10-20%), Yellow ring around core (10%), Large core size, Okay Packer, Good Jumbo.

CA 20 2011: *Illinois sample,* Good length a little uneven, Average to good width, Uniformity of shape a little uneven, Full tips matured, Odd noticeable lenticel, Good appearance, Good weight a little uneven, Good smoothness, Fair exterior colour a little uneven, Cavity spot not a concern, 1 to 2 cavity spots per root, Average interior blending a little uneven, Yellow in cores (40-50%), Red ring around core (20-80%), Large core size, Average to good Packer, Good Jumbo.

Bolero: *Vilmorin sample,* Length uneven, Average width slightly uneven, Uniformity of shape uneven, Odd carrot with bends and curves, Full tips matured, Some noticeable lenticels, Appearance a little rough, Average weight even, Fairly smooth, Fair exterior colour a little uneven, Cavity spot not a concern, 1 to 3 cavity spots per root, Average interior blending, Translucent core dead center (30-80%), Translucent core dead center (30-80%), Yellow in cores (40-70%), Red or green or yellow ring around core (20-60%), Large core size, Odd carrot with mouse damage, Average Packer, Average Jumbo some need a bit more weight.

Belgrado: *Bejo sample,* Okay length uneven, Some lengths short, Good width slightly even, Uniformity of shape a little uneven, Full tips matured, A few noticeable lenticels, Average appearance, Some ringy carrots, Good to excellent weight, Fairly smooth, Good exterior colour even, Odd noticeable cavity spot, 1 to 3 cavity spots per root, Average interior blending uneven, White in cores (30-60%), Red ring around core (40-80%), Large to extra-large core size, Okay Packer, Good to nice Jumbo some a bit short.

…/continued

CARROT CULTIVAR MAIN TRIAL JUMBO TYPES EVALUATION NOTES – 2022 - continued

Baldio: *Bejo sample,* Average to good length slightly uneven, Good width slightly even, Uniformity of shape even, Full tips matured, A few noticeable lenticels, Average to good appearance, Some ringy carrots, Good to excellent weight even, Fairly smooth, Fair exterior colour a little uneven, Odd noticeable cavity spot, 2 to 3 cavity spots per root, Average interior blending even, White in cores (10-30%), Red or green ring around core (20-30%), Large core size, Good Packer nante style, Good Jumbo.

Caravel: *Illinois sample,* Average length uneven, Good width even, Uniformity of shape uneven, Full tips matured, A few noticeable lenticels, Average appearance, Good weight even, Good smoothness, Fair exterior colour even, 1 to 4 cavity spots per root, Interior blending a little poor uneven, White in cores (30-40%), Yellow or green ring around core (20-60%), Large to extra large core size, Average Packer bit short, Average Jumbo some a little short.

SV DN 5904: *Seminis sample,* Good length even, Good width even, Uniformity of shape even, Full tips matured, Odd noticeable lenticel, Good appearance, Good weight even, Good smoothness, Fair exterior colour slightly uneven, Odd noticeable cavity spot, 1 to 4 cavity spots per root, Interior blending a little poor uneven, Translucent core dead center (30-60%), Red ring around cores (20-30%), Large core size, Good Packers, Good to nice Jumbo.

Berlin: *Bejo sample,* Okay to average length uneven, Good width slightly uneven, Uniformity of shape a little uneven, Full tips matured, A few noticeable lenticels, Good to nice appearance, Good to excellent weight a little uneven, Good smoothness, Good exterior colour very even, 1 to 3 cavity spots per root, Average interior blending a little uneven, White in cores (20-50%), Red ring around core (30-40%), Large to extra-large core size, Poor Packer, Good Jumbo some a bit short.

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CARROT CULTIVAR MAIN TRIAL JUMBO TYPES EVALUATION NOTES – 2022 - continued

Brava: *Bejo sample,* Okay to average length uneven, Good to nice width even, Uniformity of shape a little even, Full tips matured, A few noticeable lenticels, Average appearance, Odd ringy carrot, Good to excellent weight even, Good smoothness, Fair exterior colour a little uneven, 2 to 3 cavity spots per root, Interior blending slightly poor, White in cores (30-40%), Red ring around core (30-50%), Extra large core size, Poor Packer, A few carrots with tip or cancker rot, Good to nice Jumbo bit short.

FCR 17663: *Illinois sample,* Okay length slightly uneven, Lengths a little short, Nice width very even, Uniformity of shape even, Full tips matured, A few noticeable lenticels, Average appearance, Excellent weight even, Fairly smooth, Fair exterior colour even, Exterior colour slightly pale, 1 to 3 cavity spots per root, Interior blending poor, Translucent core dead center (10-30%), White in cores (10-30%), Red, yellow or green ring around core (40-80%), Large core size, Poor Packer, Odd carrots with canker rot, Odd carrots with mouse damage, Good Jumbo, Some bit short.

Navedo: *Bejo sample,* Good length even, Good width even, Uniformity of shape a little even, Full tips matured, A few noticeable lenticels, Average appearance, Odd ringy carrot, Good weight even, Smoothness a little rough, Good exterior colour even, Some noticeable cavity spots, 1 to 5 cavity spots per root, Average interior blending uneven, Translucent core dead center (10-30%), Yellow or white in cores (40-80%), Red ring around core (20-60%), Large core size, Good Packer, Good Jumbo.

CK 303: *Seminova sample,* Okay length uneven, Carrot lengths short, Good width slightly uneven, Thick carrot widths, Uniformity of shape even, Tapered and full tips matured, Heavy shoulders, Noticeable lenticels, Average to good appearance, Odd ringy carrot, Excellent weight uneven, Fairly smooth, Fair exterior colour slightly uneven, Exterior colour slightly pale, Odd noticeable cavity spot, 1 to 2 or 3 to 4 cavity spots per root, Average interior blending slightly uneven, Yellow in cores (20-60%), Green ring around core (30-40%), Large to extra large core size, Very poor Packer, Some canker rot, Good Jumbo, Blocky carrot bit short.

CARROT CULTIVAR ADAPTATION TRIAL - 2022

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
FCR 17653	Ill	66	27	25	17.87	8.69	4.30	65.0	1046	72.7	48.6	Sp
NAGASAKI	Bejo	80	22	35	17.26	6.69	5.48	60.9	980	70.5	38.8	Sp
FCR 18784	Ill	67	19	18	12.99	6.00	2.34	41.7	671	64.2	46.2	Sp
FCR 20 20080	Ill	61	2	39	14.64	0.74	8.20	44.7	720	61.1	5.1	F
FCR 20 20098	Ill	39	7	16	14.37	3.11	4.94	40.3	648	56.0	21.6	F
REDSUN	Bejo	97	4	42	10.92	0.87	4.02	24.5	394	44.8	8.0	F

Listed in order of % Marketable.

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CARROT CULTIVAR ADAPTATION TRIAL - 2022 - 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
FCR 17653	Ill	B	7.0	8.0	8.0	6.0	7.0	LO	7.0	O	4.0	6.71	9.0
NAGASAKI	Bejo	N	7.0	6.0	7.0	7.0	9.0	O	7.0	O	6.0	7.00	9.0
FCR 18784	Ill	GP	4.0	4.0	8.0	7.0	7.0	O	6.0	O	5.0	5.86	9.0
FCR 20 20080	Ill	Cyl	9.0	6.0	5.0	6.0	10.0	DO	8.0	O	8.0	7.43	9.0
FCR 20 20098	Ill	Cyl	10.0	6.0	9.0	6.0	5.0	DO	8.0	O	7.0	7.29	8.0
REDSUN	Bejo	GP	6.0	8.0	8.0	5.0	10.0	R	10.0	R	6.0	7.57	9.0

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

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CARROT CULTIVAR ADAPTATION TRIAL - 2022 - 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	% Aster Yellows
FCR 17653	Ill	49.2	50LM	CC	19.9	5.0	20	9	44.4	G	ST	0.0	0.0	1.0	0.0
NAGASAKI	Bejo	47.4	75M	CC	22.2	5.0	25	11	42.6	G	ST	0.0	1.3	0.0	0.0
FCR 18784	Ill	52.1	50LM	CV	20.5	5.3	20	9	50.0	G	FST	0.0	1.5	38.0	0.0
FCR 20 20080	Ill	48.3	60M	CV	29.0	3.5	24	8	47.3	DG	ST	0.0	0.0	0.0	0.0
FCR 20 20098	Ill	40.3	70M	CV	35.5	4.0	24	5	45.9	G	STC	0.0	0.0	0.0	2.6
REDSUN	Bejo	28.6	85M	CV	16.5	3.6	25	13	45.9	LG	C	0.0	0.0	2.0	0.0

Listed in order of % Marketable.

ADAPTATION CARROT CULTIVAR TRIAL EVALUATION NOTES - 2022

FCR 17653: *Illinios sample,* Jumbo, Average to good length even, Good to nice width even, Uniformity of shape a little even, Full tips matured, A few noticeable lenticels, Good appearance, Odd ringy carrot, Good to excellent weight, Fairly smooth, Fair exterior colour slightly pale even, 2 to 3 cavity spots per root, Interior blending a little poor, White in cores (10%), Translucent core throughout (50%), Green ring around core (40%), Large core size, Good packer nantes style, Nice Jumbo odd carrot too short.

Nagaski: *Bejo sample,* Jumbo/Packer (60/40), Nantes style, Good length a little uneven, Nice width even, Uniformity of shape very even, Full tips matured, Odd noticeable lenticel, Good appearance, Good weight even, Fairly smooth, Fair exterior colour slightly even, Odd noticeable cavity spot, 2 to 3 cavity spots per root, Average interior blending a little uneven, White in cores (20%), Translucent core dead center (40%), Average and large core size mixed, Good packer some too short, Good Jumbo some could use a bit more weight.

FCR 18784: *Illinios sample,* Jumbo, Average length very uneven, Good width very even, Uniformity of shape uneven, Full tips matured, Odd noticeable lenticel, Good appearance, Good weight, Good smoothness, Fair exterior colour slightly uneven, Odd noticeable cavity spot, 2 to 3 cavity spots per root, Interior blending a little poor uneven, Yellow in core (40%), Yellow ring around core (40%), Large core size, Okay packer, Okay Jumbo, A lot of seeders big concern.

FCR 20 20080: *Illinios sample,* Cut & Peel, Good length, Average width uneven, Uniformity of shape very even, Some carrots with bends and curves, Slightly tapered tips matured, Appearance a little rough, Odd ringy carrot, Average weight, Fairly smooth, Good exterior colour slightly dark even, Odd noticeable cavity spot, 2 to 3 cavity spots per root, Nice interior blending even, Large core size, Average packer too long, Poor Jumbo.

FCR 20 20098: *Illinios sample,* Cut & Peel, Good length a little uneven, Carrots very long, Average to good width even, Uniformity of shape very even, Odd carrot with bends and curves, Tapered tips matured, Appearance a little rough, Some ringy carrots, Good weight even, Smoothness a little rough, Good exterior colour slightly dark very even, 2 to 3 cavity spots per root, Average interior blending a little uneven, Translucent core dead center (10%), Green ring around core (30%), Large core size, Good packer too long, Poor Jumbo, Odd carrot with harvest cracks.

Redsun: *Bejo sample,* Packer, Poor length (short) very even, Okay width even, Uniformity of shape very even, Tapered tips immature, Very noticeable rough lenticels, Appearance a little rough, Average weight even, Smoothness rough, Good exterior colour even, A lot of noticeable cavity spot concern, 3 to 4 cavity spots per root, Poor and good interior blending, White in cores (30%), Translucent core dead center (30%), Yellow ring around core (30%), Small core size, Okay packer some too short, A little canker rot, Poor Jumbo.

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	18	23.3	9.2	3.4	77.2	1250	79.3	51.1
CANADA SUPER X	Sol	14	23.3	9.2	3.4	80.8	1376	82.7	--
SV 2384	Sem	11	23.0	9.1	3.3	75.4	1214	77.6	48.7
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	33	22.4	8.8	3.5	90.4	1480	81.8	48.2
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
OLYMPUS	Sto	5	21.8	8.6	3.4	73.8	1188	73.9	45.8
BASTIA	Bejo	18	21.6	8.5	5.2	94.6	1522	82.5	47.5

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	Length (cm)	Length (Inches)	Width (cm)	Marketable t/ha	Martketable bu/A	% Marketable	Avg Leaf Length (cm)
ISTANBAL	Bejo	7	21.4	8.4	3.5	66.1	1065	70.3	49.6
ORANGE SHERBET	Sto	10	21.2	8.3	--	73.4	1310	84.0	--
VOLCANO	Vil	6	21.0	8.3	4.5	73.3	1181	85.9	49.3
CAROPAK	Sem	8	20.9	8.2	--	74.1	1323	85.0	--
BELGRADO	Bejo	15	20.8	8.2	5.4	101.9	1640	79.4	47.6
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	--
ORANGE BLAZE	Sem	5	20.6	8.1	3.5	62.2	1001	80.6	56.0
BERLIN	Bejo	11	19.8	7.8	5.5	99.4	1600	78.2	46.4
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	12	18.0	7.1	3.6	81.4	1310	78.5	44.4

Listed in order of length.

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

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LONG TERM AVERAGES OF CARROT CULTIVAR TRIALS - continued

CULTIVAR	SOURCE	# Years Tested	Blight Rating *	% Cavity Spots	SCORE *	% Weevil Damage	% Rust Fly Damage	Avg # of Seeders
DOMINION	Sto	5	7.3	73.0	6.82	1.3	1.3	1.1
SIX SHOOTER	HM	5	7.1	45.0	6.96	5.0	2.7	1.1
ACHIEVE	Sto	7	7.4	74.1	6.74	4.3	4.7	2.8
ORANGE PAK	Nor	7	6.9	--	6.82	--	--	--
ENTERPRISE	Sto	18	8.0	59.0	6.61	9.1	7.4	0.5
CANADA SUPER X	Sol	14	7.0	--	6.95	--	--	--
SV 2384	Sem	11	8.1	70.0	6.15	11.2	8.4	0.4
SIX PAK	HM	20	7.9	--	6.98	--	--	--
SUNRISE	Cro	15	8.4	--	6.82	--	--	--
CELLOBUNCH	Sem	33	7.3	59.2	6.50	8.1	5.9	2.0
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
OLYMPUS	Sto	5	8.3	86.0	6.31	15.8	4.5	1.1
BASTIA	Bejo	18	7.5	80.4	6.79	6.5	6.4	1.3

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
ISTANBAL	Bejo	7	7.2	66.0	6.80	6.6	17.8	0.0
ORANGE SHERBET	Sto	10	--	--	6.75	--	--	--
VOLCANO	Vil	6	8.6	28.0	7.08	12.2	13.9	0.4
CAROPAK	Sem	8	--	--	6.85	--	--	--
BELGRADO	Bejo	15	6.9	74.0	6.37	8.0	7.4	1.5
BLANES	Bejo	5	8.3	59.0	6.41	10.7	22.0	0.0
PARAMOUNT	Sem	7	--	--	6.75	--	--	--
ORANGE BLAZE	Sem	5	8.2	68.0	6.03	1.7	14.2	7.5
BERLIN	Bejo	11	8.3	74.0	6.42	8.4	11.1	0.6
DOMINATOR	Nun	13	--	--	6.80	--	--	--
NEW HALL	Bejo	9	7.7	66.0	6.29	11.7	10.6	2.7
NAVAL	Bejo	12	7.9	54.7	7.14	9.9	8.9	0.2

Listed in order of length.

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

CARROT CULTIVAR STORAGE TRIAL - 2021 - 2022

Cultivar	Source	% Marketable	% Weight Loss	% Decay	Degree of Rot **	% Root Sprouts	% Top Sprouts
ISTANBUL	Bejo	93.4 a*	18.4 a-e	6.7 g	8.7 a	30 f-i	96 abc
CELLOBUNCH	Sto	88.4 ab	19.3 a-e	11.4 fg	7.0 a-d	65 bcd	96 abc
JEFFERSON	Bejo	83.1 abc	19.8 a-e	16.9 efg	6.3 bcd	77 abc	96 abc
NAVAL	Bejo	82.9 abc	15.6 de	17.0 d-g	6.7 a-d	63 b-e	96 abc
PV 5311	Nor	81.7 a-d	15.2 de	17.8 d-g	7.7 ab	53 c-f	89 cde
SV DN 5934	Sem	81.7 a-d	20.3 a-d	17.7 d-g	6.3 bcd	50 c-g	92 a-d
ENTERPRISE	Sto	81.3 a-d	18.4 a-e	18.6 d-g	7.0 a-d	10 i	95 a-d
JACINTO	Nor	81.0 a-d	18.0 a-e	19.2 d-g	5.7 b-e	33 f-i	92 a-d
B 3187	Bejo	79.0 a-e	22.3 abc	20.9 c-g	5.7 b-e	33 f-i	92 a-d
480621	Pure	78.7 a-e	20.8 a-d	21.1 c-g	6.3 bcd	17 hi	92 a-d
480619	Pure	78.3 a-e	18.8 a-e	21.4 c-g	6.7 a-d	37 d-i	93 a-d
JACKSON Cello	Bejo	77.5 a-e	22.7 ab	22.3 c-g	6.3 bcd	52 c-g	94 a-d
INTREPID Inicium	SN	77.0 a-e	23.1 a	22.7 c-g	5.0 de	15 hi	88 de
SV 2384	Sto	76.8 a-e	17.1 a-e	23.0 c-g	6.0 b-e	42 d-h	95 a-d

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 - 2021 - 2022

Cultivar	Source	% Marketable	% Weight Loss	% Decay	Degree of Rot **	% Root Sprouts	% Top Sprouts
CARAVEL	ILL	76.6 a-e*	13.7 e	23.2 c-g	7.3 abc	30 f-i	94 a-d
480620	Pure	75.0 b-e	18.1 a-e	24.9 c-f	7.3 abc	48 c-g	90 b-e
BALDIO	Bejo	74.8 b-e	20.8 a-d	25.2 c-f	6.3 bcd	52 c-g	95 a-d
BELGRADO	Bejo	74.2 b-e	18.3 a-e	25.7 c-f	6.3 bcd	23 ghi	94 a-d
BASTIA	Bejo	73.4 b-e	18.5 a-e	26.4 c-f	5.3 cde	32 f-i	83 e
480151	Pure	72.5 b-e	15.1 de	27.5 c-f	7.3 abc	95 a	98 a
ORANGE BLAZE	Sem	72.4 b-e*	19.0 a-e	27.3 c-f	5.3 cde	33 f-i	93 a-d
VOLCANO	Vil	72.0 b-e	15.1 de	27.9 c-f	7.7 ab	48 c-g	93 a-d
BRILLYANCE	Sto	71.7 b-e	14.9 de	28.1 c-f	6.7 a-d	35 e-i	96 abc
NARVIK	Bejo	71.7 b-e	16.5 b-e	28.3 c-f	7.3 abc	87 ab	98 a
OLANCHA	Nor	69.0 cde	17.0 a-e	30.9 cde	6.0 b-e	35 e-i	92 a-d
SV DN 5904	Sem	68.9 cde	17.8 a-e	31.0 cde	7.0 a-d	73 abc	95 a-d
BRAVA	Bejo	67.9 cde	19.8 a-e	32.1 cde	7.3 abc	72 abc	97 ab
NAVEDO Jumbo	Bejo	67.8 cde	16.9 a-e	32.1 cde	5.0 de	30 f-i	95 a-d

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 - 2021 - 2022 - continued

Cultivar	Source	% Marketable	% Weight Loss	% Decay	Degree of Rot **	% Root Sprouts	% Top Sprouts
JACKSON Jumbo	Bejo	67.8 cde*	15.7 cde	32.0 cde	5.3 cde	63 b-e	96 abc
BERLIN	Bejo	67.3 cde	19.3 a-e	32.6 cde	5.7 b-e	75 abc	97 ab
NAVEDO Cello	Bejo	65.8 de	16.1 cde	19.8 d-g	6.3 bcd	15 hi	95 a-d
INTREPID Myc & Inic	SN	65.6 de	17.0 a-e	34.3 cd	4.0 e	12 i	88 de
SPEEDO	Vil	62.7 ef	19.6 a-e	37.2 bc	5.0 de	30 f-i	93 a-d
INTREPID	SN	62.4 ef	21.2 a-d	37.4 bc	4.0 e	15 hi	83 e
EXTREMO	Vil	47.9 fg	22.4 a-d	51.7 ab	5.7 b-e	75 abc	93 a-d
TROPHY PAK	Sto	43.7 g	18.2 a-e	56.3 a	4.0 e	12 i	73 f
Trial Average		**73.1**	**18.4**	**26.4**	**6.2**	**44**	**93**

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 2021-2022

Istanbul: *Bejo sample,* Top sprouts light to moderate 1-2.5cm, Top sprouts are a concern, Root sprouts just starting 0-1cm, Majority canker rot, Odd tip rot, Rot is just starting to establish, Rot is dry, Stored good to excellent.

Cellobunch: *Stokes sample,* Top sprouts moderate 1-2.5cm, Top sprouts are a concern, Root sprouts light 0-2.5cm, Majority tip rot, A few canker rot, Rot is just starting to moderately established, Rot is dry or moist, Rot is a concern, Stored good.

Jefferson: *Bejo sample,* Top sprouts moderate 1-2.5cm, Root sprouts light to moderate 1-2.5cm, Top & root sprouting is a concern, Majority tip rot, A few canker & crown rot, Rot is just starting to moderately established, Rot is dry or moist, Stored good.

Naval: *Bejo sample,* Top sprouts moderate 1-2.5cm, Root sprouts light to moderate 1-2.5cm, Top & root sprouting is a concern, Tip and canker rot, Rot is just starting to moderately established, Rot is dry, Stored good.

SV 5311: *Seminis sample,* Top sprouts light to moderate 1-2.5cm, Top sprouts are a concern, Root sprouts just starting to moderate 0-2.5cm, Majority tip rot, A few crown rot, Odd canker rot, Rot is lightly to moderately established, Rot is dry or moist, Rot is a concern, Stored fair.

SV DN 5934: *Seminis sample,* Top sprouts light to moderate 1-2.5cm, Top sprouts are a concern, Tops sprouts uneven lengths, Root sprouts just starting to light 0-2.5cm, Tip and canker rot, Odd crown rot, Rot is lightly to moderately established, Rot is moist, Rot is a concern, A few roots dried out, Stored fair to okay.

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MAIN CARROT CULTIVAR STORAGE TRIAL EVALUATION NOTES 2021-2022 - continued

Enterprise: *Stokes sample,* Top sprouts light 1-2.5cm, Top sprouts are a concern, Root sprouts just starting 0-1cm, Mostly tip rot, A few crown, Odd crown rot, Rot is lightly established, Rot is dry or moist, Rot is a slight concern, Stored good.

Jacinto: *Norseco sample,* Top sprouts light to moderate 1-5cm, Top sprouts are a concern, Top sprouts uneven lengths, Root sprouts just starting to light 1-2.5cm, Majority tip rot, A few crown rot, Rot is just starting to lightly established, Rot is moist, Rot is a concern, Stored fair.

B 3187: *Bejo sample,* Top sprouts light to moderate 1-2.5cm, Top sprouts are a concern, Root sprouts just starting to light 0-2.5cm, Majority tip rot, Odd canker or crown rot, Rot is just starting to moderately established, Rot is moist, Some sclerotinia rot found, Stored a bit poor.

480621: *Pureline sample,* Top sprouts light to moderate 1-2.5cm, Top sprouts are a concern, Top sprouts uneven lengths, Root sprouts just starting 0-1cm, Majority canker rot, Odd tip or crown rot, Rot is just starting to moderately established, Rot is dry or moist, A few roots dried out, Stored fair to good.

480619: *Pureline sample,* Top sprouts light to moderate 1-2.5cm, Top sprouts are a concern, Top sprouts uneven lengths, Root sprouts just starting 0-1cm, Majority tip rot, Odd canker rot, Rot is just starting to moderately established, Rot is moist, Stored good.

Jackson: *Bejo sample,* Top sprouts light to moderate 1-2.5cm, Root sprouts just starting to light 0-1cm, Top & root sprouting
Cello is a concern, Majority tip rot, Odd canker rot, Rot is just starting to moderately established, Rot is dry or moist, Rot is a concern, Some roots are very dried out, Stored good.

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MAIN CARROT CULTIVAR STORAGE TRIAL EVALUATION NOTES 20210-2022 - continued

Intrepid: *Seminova sample,* Top sprouts light to moderate 1-2.5cm, Top sprouts are a concern, Root sprouts just starting 0-1cm, Majority crown rot, Odd tip rot, Rot is lightly to moderately established, Rot is dry or moist, Rot is a concern, A few roots are dried out, Stored fair.

Inicium

SV 2384: *Seminis sample,* Top sprouts light to moderate 1-5cm, Top sprouts are a concern, Root sprouts just starting to moderate 0-2.5cm, Majority tip rot, A few crown rot, Odd canker rot, Rot is lightly to moderately established, Rot is dry or moist, Rot is a concern, Stored fair.

Caravel: *Illinois sample,* Top sprouts light to moderate 1-2.5cm, Top sprouts are a concern, Top sprouts uneven lengths, Root sprouts just starting 1-2.5cm, Majority tip rot, Odd canker or crown rot, Rot is just starting to moderately established, Rot is dry or moist, Rot is a concern, Stored good.

480620: *Pureline sample,* Top sprouts moderate 1-2.5cm, Top sprouts are a concern, Root sprouts just starting to moderate 0-2.5cm, Majority tip rot, A few canker rot, Rot is just starting to established, Rot is dry or moist, Rot is a concern, Stored a little poor to fair.

Baldio: *Bejo sample,* Top sprouts just starting to light 1-5cm, Top sprouts are a concern, Top sprouts uneven lengths, Root sprouts just starting to light 0-2.5cm, Tip and canker rot, Rot is just starting to moderately established, Rot is dry or moist, Rot is a concern, Stored poor to good.

Belgrado: *Bejo sample,* Top sprouts light to moderate 1-2.5cm, Top sprouts are a concern, Root sprouts are just starting to light 0-1cm, Tip and canker rot, Rot is just starting to lightly established, Rot is dry or moist, Rot is a concern, Stored poor to fair.

.../continued

MAIN CARROT CULTIVAR STORAGE TRIAL EVALUATION NOTES 2021-2022 - continued

Bastia: *Bejo sample,* Top sprouts light to moderate 1-2.5cm, Top sprouts are a concern, Root sprouts just starting to light 0-2.5cm, Tip and canker rot, Odd crown rot, Rot is lightly to heavily established, Rot is dry to liquefied, Stored poor.

480151: *Pureline sample,* Top sprouts heavy 2.5-5cm, Top sprouts uneven lengths, Root sprouts moderate to heavy 1-5cm, Top & root sprouting is a concern, Majority tip rot, A few canker rot, Rot is just starting to lightly established, Rot is dry or moist, Rot is a concern, Stored fair.

Orange Blaze: *Seminis sample,* Top sprouts moderate 1-2.5cm, Top sprouts are a concern, Root sprouts just starting 0-2.5cm, Tip, canker and crown rot, Rot is lightly established, Rot is moist, Rot is a concern, Some sclerotinia rot found, Stored fair.

Volcano: *Vilmorin sample,* Top sprouts moderate 1-2.5cm, Top sprouts are a concern, Root sprouts just starting 0-1cm, Mostly tip rot, Odd cancker rot, Rot is just starting to lightly established, Rot is dry or moist, Rot is a concern, Stored fair.

Brillyance: *Stokes sample,* Top sprouts moderate to heavy 2.5-5cm, Top sprouts are a concern, Root sprouts just starting to light 0-2.5cm, Majority tip rot, A few canker or crown rot, Rot is just starting to lightly established, Rot is dry or moist, Rot is a concern, Stored a little poor.

Narvik: *Bejo sample,* Top sprouts light to moderate 1-2.5cm, Root sprouts lightly 1-2.5cm, Top & root sprouting is a concern, Majority tip rot, Odd canker rot, Rot is just starting to lightly established, Rot is dry or moist, Rot is a concern, Stored fair.

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MAIN CARROT CULTIVAR STORAGE TRIAL EVALUATION NOTES 2021-2022 - continued

Olancha: *Norseco sample,* Top sprouts light to moderate 1-2.5cm, Top sprouts are 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, Rot is a concern, Stored poor to fair.

SV DN 5904: *Seminis sample,* Top sprouts moderate 1-5cm, Tops sprouts uneven lengths, Root sprouts light to moderate 1-2.5cm, Top & root sprouting is a concern, Majority tip rot, A few canker rot, Rot is lightly to moderately established, Rot is dry or moist, Rot is a concern, A few roots slightly dried out, Stored a little poor to fair.

Brava: *Bejo sample,* Top sprouts moderate to heavy 1-5cm, Top sprouts uneven lengths, Root sprouts just starting to moderate 1-2.5cm, Top & 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 concern, Stored a little poor to good.

Navedo: *Bejo sample,* Top sprouts light to moderate 1-5cm, Top sprouts are a concern, Top sprouts uneven lengths, Root sprouts just starting 0-1cm, Tip, crown & canker rot, Rot is lightly to heavily established, Rot is dry or moist, Rot is a concern, Some sclerotinia rot found, Stored very poor to fair.
Jumbo

Jackson: *Bejo sample,* Top sprouts moderate 1-2.5cm, Top sprouts are a concern, Root sprouts just starting to light 0-2.5cm, Majority tip rot, Odd canker or crown rot, Rot is just starting to moderately established, Rot is dry or moist, Rot is a concern, Stored a little poor to fair.
Jumbo

Berlin: *Bejo sample,* Top sprouts moderate 1-5cm, Top sprouts are a concern, Top sprouts uneven lengths, Root sprouts just starting to moderate 0-2.5cm, Tip or canker rot, Rot is lightly to moderately established, Rot is moist, Rot is a concern, Stored poor.

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MAIN CARROT CULTIVAR STORAGE TRIAL EVALUATION NOTES 2021-2022 - continued

Navedo: *Bejo sample,* Top sprouts light to moderate 1-2.5cm, Top sprouts are a concern, Root sprouts just starting 0-1cm, Majority tip rot, Odd crown rot, Rot is just starting to moderately established, Rot is moist, Rot is a concern, Stored fair to good.
Cello

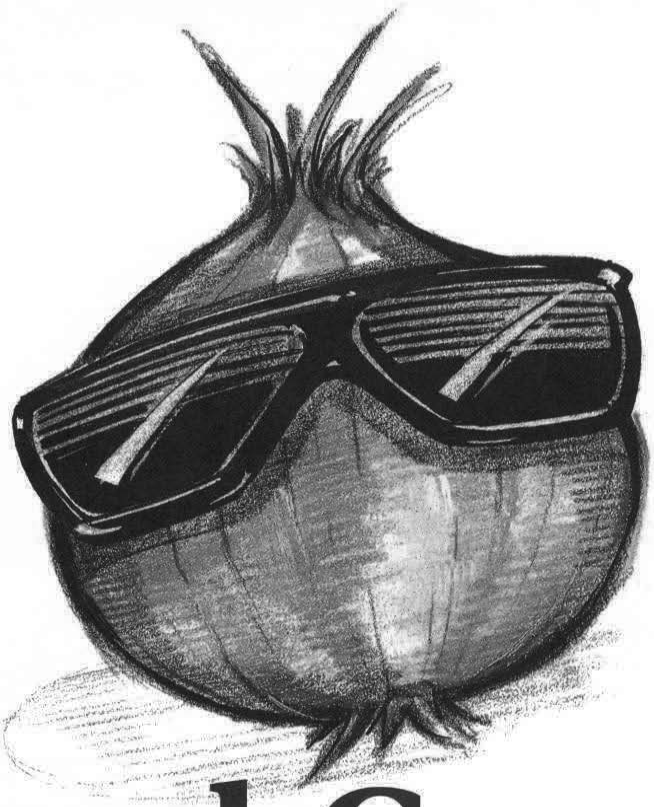
Intrepid: *Seminova sample,* Top sprouts moderate 1-2.5cm, Top sprouts are a concern, Root sprouts just starting 0-1 cm, Tip and crown rot, Odd canker rot, Rot is lightly to moderately established, Rot is moist, Rot is a concern, Some sclerotinia rot found, Stored poor.
Inicium & Mychorriza

Speedo: *Vilmorin sample,* Top sprouts moderate 1-2.5cm, Top sprouts are a concern, Top sprouts uneven lengths, Root sprouts just starting 0-1cm, Majority tip rot, Some canker rot, Odd crown rot, Rot is just starting to heavily established, Rot is moist or liquefied, Rot is a big concern, Some sclerotinia rot found, Stored very poor.

Intrepid: *Seminova sample,* Top sprouts light to moderate 1-2.5cm, Top sprouts are a concern, Top sprouts uneven lengths, Root sprouts just starting 0-1 cm, Tip and crown rot, Odd canker rot, Rot is lightly to heavily established, Rot is moist or liquefied, Rot is a big concern, Some sclerotinia rot found, Stored poor.

Extremo: *Vilmorin sample,* Top sprouts moderate 2.5-5cm, Root sprouts just starting to moderate 0-2.5cm, Top & root sprouting is a concern, Tip and canker rot, Rot is light to moderately established, Rot is moist, Rot is a big concern, Some sclerotinia rot found, Stored poor.

Trophy Pak: *Stokes sample,* Top sprouts just starting to light 0-2.5cm, Root sprouts just starting 0-1cm, Majority crown rot, A few tip or canker rot, Rot is moderately to heavily established, Rot is moist or liquefied, Rot is a major concern, Stored very poor.



MarshGrown Cooks!

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
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
ISTANBUL	Bejo	6	88.9	14.6	6.4	7.3
ORLANDO GOLD	Sto	6	87.9	12.7	12.1	4.2
NEW HALL	Bejo	10	87.8	11.5	4.2	7.6
SIX PAK II	HM	15	87.7	12.3	12.3	5.5
VOLCANO	Vil	5	87.2	12.6	10.9	8.4
CHANCELLOR	Sem	7	86.7	11.3	13.3	4.2
CROFTON	RZ	6	84.8	11.5	3.0	7.5
2384	Sem	11	83.6	13.8	7.9	6.7
INFINITY	Bejo	5	83.4	11.4	4.9	7.8
ENTERPRISE	Sem	16	83.3	11.2	8.9	6.6
NAVAL	Bejo	11	82.7	11.0	10.1	7.5

Listed in order of % Marketable.

Storage period is approximately 9 months.

* 10.0 = No Disease, 6.0 = Moderate, 1.0 = Severe (liquified)

... / continued

LONG TERM AVERAGES - CARROT CULTIVAR STORAGE TRIALS - continued

CULTIVAR	SOURCE	# YEARS TESTED	% MARKETABLE	% WEIGHT LOSS IN STORAGE	% DECAY	DEGREE * OF DECAY
BRADFORD	Bejo	5	82.1	10.0	7.9	7.8
BELGRADO	Bejo	13	81.0	10.9	12.2	7.1
SIX PAK	HM	20	79.8	11.5	8.6	5.8
BERLIN	Bejo	10	79.5	12.6	13.7	7.1
CELLOBUNCH	Sem	30	79.4	13.3	7.2	6.8
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
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
BASTIA	Bejo	17	74.1	13.6	15.3	6.5
BLANES	Bejo	5	73.4	12.3	22.1	6.3
ACHIEVE	Sem	8	73.0	13.0	13.6	6.4
ENVY	Sem	16	72.2	12.7	16.6	6.6
SIX SHOOTER	HM	5	71.5	11.0	17.5	6.0
NEVADA	Bejo	4	69.1	16.5	14.2	5.8
EXTREMO	Vil	5	65.6	16.0	31.6	5.9

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 – 2022

Compared to the previous 10-year average, air temperatures in 2022 were above average for May (15.1°C), average for June (18.3°C), August (20.6°C) and September (16.5C), and below average for July (20.2°C). The 10-year average temperatures were: May 13.7°C, June 18.9°C, July 21.4°C, August 20.4°C and September 16.3°C. Monthly rainfall was below the 10-year average for May (50 mm) and September (43 mm) and average for June (90 mm), July (74mm) and August (82 mm). The 10-year rainfall averages were: May 64 mm, June 97 mm, July 78 mm, August 79 mm and September 59 mm.

Seasonal temperatures in April allowed for the ground frost to thaw and by the end of April the soil was satisfactory for seeding. Rainfall 1 - 4 May (20.4 mm) prior to seeding created uneven soil moisture levels throughout the trial. Onion seeding in the Holland Marsh began the last week of April and was pretty much completed by the 10 May. The trial was seeded on 6 & 7 May. Daytime air temperatures were in the mid teens with a mix of sun and cloud, however nightime air temperatures were in the low single digits. Daytime air temperatures increased to the twenties four days after seeding and remained so for approximately one week, however nightime air temperatures remained in the single digits to low teens. The month of May recorded below average rainfall and half an inch of irrigation water was applied 10 days after seeding to ensure soil moisture remained adequate for seed germination. Onion emergence was good and plant vigor and stand were satisfactory. By 8 June the second true leaf was fully grown and the herbicide Frontier was applied at the recommended rate. A half inch of irrigation water was applied on 10 June to help activate the Frontier and aid the growth of the onions. Weed pressure was moderate for the entire the season. Several applications of Pardner + Goal were applied and numerous hand weeding were required to keep the trial free from weeds. Monthly average rainfall amounts from June to August allowed the onions to maintain a steady growth. When leaf lengths were recorded on 29 July, the average leaf length was 67.6 cm, comparable to the 2021 and 2020 trial average lengths. Significant differences were found in average leaf length among all three replicates. The first replicate had the longest average leaf length and the third replicate had the shortest average leaf length.

On-station monitoring for onion maggot fly emergence began on 17 May with 0.75 flies/trap/day. There were three peaks in onion maggot fly numbers during the monitoring period. Counts peaked at 6.6 flies/trap/day on 9 June, 7.0 flies/trap/day on 14 July and 28.3 flies/trap/day on 13 August. For the remainder of the monitoring period onion maggot fly numbers never reached over 4 flies/trap/day. Onion maggot population was moderately high for the first two peaks and significantly higher for the third peak. Remarkably, at evaluation there was only a trial average of 1.6 % onion maggot damage. The new seed treatments of Sepresto and Evergol appeared to give good control for the entire season.

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ONION CULTIVAR TRIAL SEASON SUMMARY - 2022 – continued

Thrips were first found on 16 June and were present throughout the growing season. Onion thrips numbers in the variety trial reached 1.2 thrips/leaf on 4 July and remained above 1.0 thrips/leaf until 8 August. On 2 August the spray threshold of 3.0 thrips/leaf was reached. A insecticide application of Delegate on 5 August reduced the thrips numbers below 1.0 thrips/leaf and remained so until monitoring stopped in September. Environmental conditions were favourable for fungal diseases to develop throughout the season. Stemphylium leaf blight was found in the cultivar trial on 4 July and several fungicide applications (see Onion Management Procedures) kept severity below 10% until 22 August. Botrytis was not observed in the trial. Fungicide applications were applied to protect from downy mildew when the downy mildew forecast was moderate to high and occurred several times in August. No downy mildew developed in the trial.

Bulb development started as expected in late July. Most bulb sizing occurred in early August. Cultivars Highlander (2 August) and SV NY 1496 (8 August) 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 17 August when at least 85% of the onions had lodged. The average days to harvest (103 days) for the 2022 season was five days shorter than in 2021 and 2020. The onion tops dried down in a satisfactory time frame. Twenty-two varieties had no seeders present and the remaining varieties had a small number of seeders. Fortress and Overlook had the highest average number of seeders, 3.3 per 20m of row. On 8 September, a sample from each cultivar was pulled for judging and comparison during Grower Field Day. By this time, most cultivars had lodged but leaves were 40-100% desiccated. All cultivars matured naturally resulting in acceptable neck finishes when yield samples were harvested on 23 September. Harvest samples from each cultivar were placed in storage on 13 October and cured artificially for approximately 48 hours.

At evaluation on 28 November through 14 December, quality was good in most of the cultivars and yields varied between a high of 1376 to a low of 383 bushels per acre. The trial yield average was 1054 bu/A. This is an increase of approximately 88 bu/A from last year and like 2020. Significant differences in yield (bu/A) were found between all three replicates. The first, second and third replicate average bu/A were 1134, 1050 and 977 bu/A, respectively. Approximately half the cultivars had the highest number of onions in the 2½-3" size range and the other half in the 2½-1¼" size range.

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ONION CULTIVAR TRIAL SEASON SUMMARY - 2022 – continued

The trial average for the percentage of jumbos (>3" diameter) was 15.9%, which is slightly up from 11% in 2021but, down 3% from the 2020 season. Uniformity of size rating was only an average of 6.1 and significant differences were found among cultivars and replicates. Cultivar SV NY 1496 received the best uniformity of size rating of 8 while fourteen other cultivars had a below average rating. Size was significantly more uniform in the first replicate compared to the other two replicates. The uniformity of shape rating varied among cultivars, with shapes highly variable within the individual samples. Cultivar Oneida had the best rating for uniformity of shape and cultivars Overlook and SV NY 1496 the poorest. The average stand count was 6.6 plants/ft, the same as 2021. The vast majority of unmarketable onions (culls) were undersized onions (peewees). The trial average for marketable onions was 89.3%. Percent marketable was significantly lower in the third replicate (85.5%) compared to the other two replicates (91.8% and 90.6% respectively). Skin quality was slightly better than the previous year. Skins were generally average and the odd skin cracking was observed in a few cultivars. There was very limited skin rot found in the trial. Although not significantly different, the first replicate of the trial had slightly poorer skin attachment compared to the second and third replicates. Exterior colour was good but a little uneven 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. When onions were cut in half for interior colour evaluation, it was noted that two thirds of the cultivars had a high percentage of double or multiple centers. Cultivars Trident and Dawson had the highest percentage of single centers at 93.3 and 90 % respectively. Neck finish was good with limited rough finishes in the longer to mature cultivars. At evaluation all cultivars had maintained good firmness and cultivar Lodestar had the best firmness with a rating of excellent, 9.5. Firmness was significantly lower in the first replicate compared to the other two replicates. Maggot damage in the evaluation samples ranged from 0-6.4%, with a trial average of 1.6%. This is a 50% decrease in average onion maggot damage for the trial compared to the 2021 season (3.0%). Cultivar Dawson had a high percentage of damage. Multiple centers were 6.4%, similar to the trial averages for 2021 and 2020. When the onions were cut in half horizontally, a very small hole was observed near the heart of the onion. Center hollowness was found in all cultivars, with a trial average of 30%. Center hollowness has not been observed this high in several years. When the onions were cut in half for single center evaluation it was noted that only a few onions had greening in the interiors.

ONION CULTIVAR TRIAL – 2022

MANAGEMENT PROCEDURES

Fertilizer:

90 kg/ha Nitrogen (Calcium Ammonium Nitrate 27-0-0) + 100 kg/ha Phosphorous (MESZ 10-40-0) + 220 kg/ha Potassium (ASPIRE 0-0-58) + 120 kg/ha K–Mag (0-0-22) + 35 kg/ha Manganese + 5 kg/ha Copper (99% Cu) was worked into the soil on 28 April.

A side dressing blend of 12 kg/ha Nitrogen + 10 kg/ha Phosphorous + 58 kg/ha Potassium was applied on 29 June.

Seeded:

All trials were seeded on 6 & 7 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 for all seed not seed treated. The Main Trial was replicated three times.

Weed Control:

Post-emergence:

1 application: **PROWL H2O** 6.0 L/ha on 23 May.
2 applications: **PARDNER** at 70 ml/ha and **GOAL** at 70 ml/ha and Manganese at 1.0 kg/ha on 30 May and 3 June.
1 application: **FRONTIER** at 1.0 L/ha on 8 June.
1 application **PARDNER** at 70 ml/ha and **GOAL** at 175 ml/ha and Manganese at 2.0 kg/ha on 14 June.
1 application **PARDNER** at 200 ml/ha and **GOAL** at 200 ml/ha and Manganese at 2.0 kg/ha on 22 June.

Minor Elements:

Eight foliar sprays: Mag Max on 10 & 29 June (2.0 L/ha), 8, 22 and 27 July and 5, 12 & 19 August (3.0 L/ha)
Seven foliar sprays: Calcimax on 2 June (1.0 L/ha), 10 & 29 June (2.0 L/ha) and 8, 22 & 27 July and 5 August (3.0 L/ha)
Six foliar sprays: Zinc Max on 2 June and 22 July (1.0 L/ha), 10 June, 8 & 27 July and 5 August (2.0 L/ha)
Six foliar sprays: Alexin on 22 & 27 July and 5, 12, 19 and 24 August (3.0 L/ha)
Five foliar sprays: Manganese Sulfate on 27 July (1.0 kg/ha) and 10 & 19 June, 8 July and 5 August (2.0 kg/ha)
Five foliar sprays: Suprafeed on 27 July (2.0 kg/ha) and 22 July and 12, 19 & 24 August (3.0 kg/ha)

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ONION CULTIVAR TRIAL - 2022 - continued

Minor Elements continued:

Four foliar sprays: Copper Max 22 & 27 July and 5 & 12 August (2.0 L/ha)
Four foliar sprays: 20-20-20 on 2 June (1.0 kg/ha), 10 & 29 June (2.0 kg/ha) and 8 July (2.5 kg/ha)
Two foliar sprays: Nutri Bor on 19 August (1.0 L/ha) and 12 August (2.0 L/ha)
One foliar spray: Epsom Salt on 24 August (2.0 kg/ha)

Insect and Disease Control:

According to IPM recommendations.

DITHANE DG at 2.25 kg/ha and Minor Elements on 8 July.
MOVENTO at 365 ml/ha + **AGRAL 90** at 1.0 L/ha on 14 July.
MIRAVIS DUO at 1.0 L/ha on 21 July.
RIDOMIL MZ 2.25 kg/ha and Minor Elements on 22 July.
SERCADIS at 333 ml/ha + **MOVENTO** at 365 ml/ha + **AGRAL 90** at 1.0 L/ha and Minor Elements on 27 July.
APROVIA TOP at 750 ml/ha + **DELEGATE** at 336 g/ha and Minor Elements on 5 August.
ORONDIS ULTRA at 400 ml/ha + **MIRAVIS DUO** at 1.0 L/ha + **UP-CYDE** at 280 ml/ha and Minor Elements on 12 August.
DITHANE DG at 3.25 kg/ha + **DELEGATE** at 336 g/ha and Minor Elements on 19 August.
DITHANE DG at 2.25 kg/ha and Minor Elements on 24 August.

Harvest:

The Main Trial was pulled on 13 and 14 September and topped on 23 September. The trial was placed in a forced air and temperature-controlled storage on 13 October. The trial was cured for 48 hours (25ºC, minimum 65% RH). After curing the temperature was lowered 5ºC per week until 0ºC was attained.

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Sprout Inhibition:

Royal MH 30 XTRA at 8.63 L/ha in 550 L/ha water on:

August 11	August 18			August 24		September 1	September 7
Highlander	Dawson	SV NY 1496	Traverse	Haeckero	SV NY 7331	Milestone	Scorpion
AG 24202	La Salle	Saddleback	Mindi	Thunderstone	Braddock	37 120	
Switchback	Oneida	Mondella	Safrane	Mountaineer	Catskill	Lodestar	
	Frontier	Stanley	Sumo	Ridge Line	Trident	Powell	
	Fortress	37 118	Haeckero Semnova			Crockett	
	Venecia	Sumo	37 120 Inicium			37 126	
	Overlook	Gunnison					

EVALUATION PROCEDURES

The cultivars were evaluated 28 November through 14 December after 9 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

.../continued

ONION CULTIVAR TRIAL - 2022 - continued

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.

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.

Seed Treatments:
SE = Sepresto & Evergol Prime SP = Spinosad FIR = FI500 & Regard LD = Lorsban & Dithane F = Fungicide

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.

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Seeders:
Average number of seeders found in each cultivar of 20 m 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.

Top Height (cm):
The average length of 20 randomly chosen onion tops from 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 three times for the 2022 season:

17 May in the amount of ½ inch
26 May in the amount of ½ inch
10 June in the amount of ½ inch

ONION CULTIVAR MAIN TRIAL - 2022

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)
CATSKILL	Sto	101 a-d*	3 de	19 a-i	49 a-d	28 g-k	6.6 a-d	176.8 b-e
TRAVERSE	Tak	95 bcd	1 e	21 a-g	47 a-e	24 h-k	6.2 bcd	163.4 d-h
La SALLE	Sto	104 abc	5 cde	16 b-l	41 a-j	38 a-i	6.8 abc	164.1 d-h
37 120	Haz	85 cde	5 b-e	24 a-d	32 c-k	20 h-k	5.6 cde	184.3 bcd
SWITCHBACK	Tak	95 bcd	4 cde	19 a-j	42 a-i	27 g-k	6.2 bcd	178.7 bcd
37 126	Haz	74 de	13 a	23 a-e	24 jkl	11 k	4.9 de	216.1 bc
SV NY 1496	Sem	111 abc	4 cde	26 ab	51 ab	24 h-k	7.3 abc	171.5 c-g
MILESTONE	Tak	60 ef	11 ab	11 g-m	21 kl	14 ijk	3.9 ef	280.3 a
SAFRANE	Bejo	108 abc	2 de	16 b-l	41 a-j	42 a-h	7.1 abc	150.2 d-j
THUNDERSTONE	SN	104 abc	2 de	19 a-i	46 a-f	31 e-k	6.8 abc	162.2 d-h
LODESTAR	Tak	111 abc	0 e	25 abc	54 a	25 g-k	7.3 abc	168.6 c-h
FRONTIER	Tak	93 bcd	0 e	9 i-m	45 a-g	34 d-k	6.1 bcd	137.4 d-j

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 - 2022 - 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)
RIDGE LINE	Tak	84 cde*	9 abc	29 a	28 f-k	12 jk	5.5 cde	226.5 b
OVERLOOK	Sem	121 ab	3 de	22 a-f	49 abc	38 a-i	7.9 ab	155.8 d-i
SADDLEBACK	Sto	110 abc	3 de	19 a-j	43 a-h	36 c-j	7.2 abc	155.1 d-i
ONEIDA	Bejo	119 ab	0 e	8 j-m	41 a-j	60 abc	7.8 ab	119.9 g-j
FORTRESS	Sto	116 ab	0 e	5 lm	45 a-g	56 a-d	7.6 ab	126.5 e-j
GUNNISON	Bejo	111 abc	0 e	6 lm	41 a-j	53 a-f	7.2 abc	117.1 hij
MOUNTAINEER	Tak	85 cde	2 de	11 f-m	30 e-k	32 d-k	5.5 ef	144.5 d-j
HAECKERO	SN	105 abc	0 e	11 f-m	28 g-k	55 a-e	6.9 abc	125.6 e-j
HAECKERO	Haz	97 bcd	1 e	10 h-m	35 b-k	41 a-h	6.4 bcd	133.9 d-j
SUMO	CF	108 abc	7 bcd	25 abc	35 b-k	29 f-k	7.0 abc	173.9 c-f
SV NY 7331	Sem	108 abc	1 de	12 e-m	45 a-g	36 c-j	7.0 abc	157.1 d-i
VENECIA	Bejo	119 ab	2 de	21 a-h	47 a-e	34 d-k	7.8 ab	156.2 d-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 - 2022 - 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)
SCORPION	Cro	31 f*	2 de	7 klm	7 l	10	2.0 f	177.4 b-e
TRIDENT	Cro	101 a-d	2 de	15 c-l	27 h-k	43	6.6 a-d	132.9 d-j
STANLEY	CF	107 abc	1 de	12 f-m	41 a-j	37	7.0 abc	135.4 d-j
MONDELLA	Bejo	115 ab	0 e	9 i-m	28 f-k	60	7.5 ab	106.9 ij
MINDI	EZ	104 abc	2 de	14 d-l	34 b-k	37	6.8 abc	137.2 d-j
CROCKETT	Bejo	129 a	2 de	13 d-m	31 d-k	61	8.5 a	124.4 f-j
HIGHLANDER	Tak	98 bcd	2 de	8 klm	34 b-k	38	6.4 bcd	141.9 d-j
BRADDOCK	Bejo	116 ab	2 de	18 b-k	35 b-k	40	7.6 ab	132.7 d-j
37 118	Haz	106 abc	1 e	11 f-m	31 d-k	43	7.0 abc	120.9 g-j
DAWSON	Bejo	94 bcd	0 e	3 m	18 kl	53	6.1 bcd	99.1 j
POWELL	Bejo	105 abc	2 de	6 lm	25 i-l	49	6.9 abc	108.3 ij
AG 24202	SN	96 bcd	1 e	8 klm	25 ijk	40	6.3 bcd	109.8 ij
TRIAL AVERAGE		**101**	**3**	**15**	**36**	**36**	**6.6**	**152.0**

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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ONION CULTIVAR MAIN TRIAL - 2022 - 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
CATSKILL	Sto	17.65 a-e*	1.02 de	5.27 a-e	8.38 ab	2.81 d-l	1318 a	97.9 a	PW
TRAVERSE	Tak	15.38 e-k	0.35 e	5.04 b-f	7.70 a-e	2.22 g-l	1154 a-g	97.5 a	PW
La SALLE	Sto	16.35 a-g	1.65 cde	3.93 b-j	6.89 a-g	3.67 a-i	1217 a-d	95.4 ab	PW
37 120	Haz	15.68 d-i	1.93 cde	6.25 abc	5.66 b-j	1.70 h-l	1172 a-f	95.4 abc	PW
SWITCHBACK	Tak	16.20 a-g	1.33 de	4.81 b-h	6.88 a-g	2.65 d-l	1182 a-f	95.3 abc	PW
37 126	Haz	15.99 b-g	4.74 a	5.88 a-d	3.87 h-k	1.01 kl	1169 a-f	95.1 abc	PW
SV NY 1496	Sem	18.96 a	1.27 de	6.35 ab	8.39 ab	2.23 g-l	1376 a	94.4 a-d	D
MILESTONE	Tak	12.54 k-n	4.43 ab	2.88 e-k	3.43 ijk	1.43 i-l	918 h-k	94.4 a-d	PW
SAFRANE	Bejo	15.76 c-h	0.89 de	3.81 b-j	6.82 a-g	3.97 a-h	1168 a-f	94.4 a-d	PW
THUNDERSTONE	SN	16.59 a-f	0.90 de	4.49 b-i	7.42 a-e	3.14 b-l	1202 a-e	94.1 a-d	PW
LODESTAR	Tak	18.71 ab	0.00 e	6.25 abc	9.40 a	2.53 f-l	1371 a	94.0 a-d	PW
FRONTIER	Tak	12.78 i-n	0.00 e	2.08 g-k	7.24 a-f	3.04 c-l	932 g-k	93.9 a-d	PW

Listed in order of % Marketable.

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

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ONION CULTIVAR MAIN TRIAL - 2022 - 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
RIDGE LINE	Tak	19.04 a*	3.52 abc	8.06 a	5.18 d-j	1.21 jkl	1355 a	93.7 a-d	D
OVERLOOK	Sem	18.65 abc	1.08 de	5.23 a-e	8.19 abc	3.63 a-i	1367 a	92.9 a-e	PW
SADDLEBACK	Sto	16.67 a-f	1.02 de	4.65 b-i	7.18 a-g	3.31 a-j	1219 a-d	91.5 a-f	PW
ONEIDA	Bejo	14.33 f-l	0.14 e	1.91 ijk	6.43 b-h	5.42 ab	1048 c-i	91.4 a-g	PW
FORTRESS	Sto	14.65 f-l	0.14 e	1.35 jk	7.19 a-g	5.48 a	1067 c-i	91.3 a-g	PW
GUNNISON	Bejo	12.88 h-n	0.00 e	1.41 jk	6.14 b-i	4.85 a-e	935 g-k	90.5 a-h	PW
MOUNTAINEER	Tak	11.73 l-o	0.70 de	2.72 e-k	4.88 e-j	3.06 c-l	856 i-l	89.6 b-h	PW
HAECKERO	SN	12.99 h-n	0.13 e	2.72 e-k	4.48 f-j	5.10 abc	937 g-k	89.3 b-h	PW
HAECKERO	Haz	12.91 h-n	0.38 e	2.52 e-k	5.82 b-i	3.72 a-i	939 g-k	89.2 b-h	PW
SUMO	CF	18.62 abc	2.57 bcd	6.40 ab	5.84 b-i	2.60 e-l	1313 ab	89.1 b-h	PW
SV NY 7331	Sem	16.65 a-f	0.45 e	3.98 b-j	7.79 a-d	3.41 a-j	1178 a-f	88.0 c-i	PW
VENECIA	Bejo	18.51 a-d	0.85 de	4.90 b-g	7.65 a-e	3.26 a-l	1256 abc	87.6 d-i	D

Listed in order of % Marketable.

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ONION CULTIVAR MAIN TRIAL - 2022 - 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
SCORPION	Cro	5.31 p*	0.92 de	1.96 h-k	1.25 k	0.95 l	383 m	86.0 e-i	PW
TRIDENT	Cro	13.47 g-m	0.59 de	3.84 b-j	4.37 g-j	4.07 a-g	970 f-j	85.0 f-j	PW
STANLEY	CF	14.41 f-l	0.50 e	2.83 e-k	7.02 a-g	3.20 a-l	1022 d-i	84.7 f-j	PW
MONDELLA	Bejo	12.31 lmn	0.00 e	2.21 f-k	4.48 f0j	4.90 a-d	874 h-k	84.3 f-j	PW
MINDI	EZ	13.99 f-m	0.85 de	3.33 d-k	5.52 c-j	3.26 a-k	977 e-j	84.1 f-j	PW
CROCKETT	Bejo	15.47 e-j	0.59 de	3.48 c-k	5.17 d-j	5.19 abc	1088 b-h	84.1 g-j	PW
HIGHLANDER	Tak	13.90 f-m	0.59 de	1.93 ijk	5.51 c-j	3.50 a-j	870 h-k	83.2 h-k	
BRADDOCK	Bejo	15.41 e-k	0.70 de	4.49 b-i	5.75 b-i	3.53 a-i	1091 b-h	81.2 ijk	PW
37 118	Haz	12.73 j-n	0.41 e	2.68 e-k	4.99 d-j	3.70 a-i	888 h-k	81.2 ijk	PW
DAWSON	BEJO	9.12 o	0.13 e	0.79 k	2.91 jk	4.63 a-f	638 l	80.9 ijk	PW
POWELL	Bejo	11.09 mno	0.76 de	1.50 jk	3.98 h-k	4.12 a-g	782 jkl	78.4 jk	PW
AG 24202	SN	10.33 no	0.24 e	1.92 ijk	3.98 h-k	3.34 a-j	715 kl	76.6 k	PW
TRIAL AVERAGE		**14.66**	**0.99**	**3.72**	**5.94**	**3.33**	**1054**	**89.3**	**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 - 2022 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Skin Thickness	Skin Attachment	Neck Finish	Overall Score	Score
CATSKILL	Sto	HG	6.3 d-g*	6.0 d-g	6.7 bcd	9.0 b-f	7.3 def	6.7 def	7.19 e-i
TRAVERSE	Tak	G	7.3 a-d	6.7 a-e	6.7 bcd	9.0 b-f	7.7 cde	7.7 abc	7.63 a-d
La SALLE	Sto	G	6.0 e-h	6.0 d-g	6.7 bcd	8.3 efg	7.7 cde	7.0 cde	7.15 e-i
37 120	Haz	HG	6.7 c-f	6.5 b-e	6.0 def	9.0 b-f	6.7 fgh	6.7 def	7.19 d-h
SWITCHBACK	Tak	G	7.3 a-d	7.8 ab	6.7 bcd	8.2 fg	7.7 cde	7.3 bcd	7.63 a-d
37 126	Haz	G	6.0 e-h	6.0 d-g	6.3 cde	10.0 a	6.0 hi	6.0 fg	7.00 e-i
SV NY 1496	Sem	T	5.0 h	8.0 a	5.0 g	6.0 h	8.3 bc	6.0 fg	6.67 hij
MILESTONE	Tak	HG	6.0 e-h	7.0 a-d	7.7 a	8.3 efg	6.7 fgh	6.7 def	7.17 d-h
SAFRANE	Bejo	G	7.7 abc	6.7 a-e	7.3 ab	9.3 a-d	7.3 def	7.7 abc	7.79 ab
THUNDERSTONE	SN	G	6.7 c-f	7.0 a-d	5.0 g	9.2 a-e	7.3 def	7.3 bcd	7.19 d-h
LODESTAR	Tak	G	8.0 ab	7.7 abc	7.3 ab	9.5 a-d	7.0 efg	7.7 abc	8.13 a
FRONTIER	Tak	G	7.0 b-e	6.0 d-g	7.0 abc	9.5 a-d	8.7 ab	8.3 a	7.96 abc

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 - 2022 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Skin Thickness	Skin Attachment	Neck Finish	Overall Score	Score
RIDGE LINE	Tak	HG	7.0 b-e*	7.0 a-d	7.0 abc	9.2 a-e	7.3 def	7.0 cde	7.33 def
OVERLOOK	Sem	G	5.0 h	6.3 c-f	5.0 g	8.8 c-g	7.7 cde	6.0 fg	6.52 ij
SADDLEBACK	Sto	HG	5.3 gh	4.7 gh	5.7 efg	8.0 g	7.3 cde	6.3 ef	6.54 ij
ONEIDA	Bejo	G	8.3 a	6.3 c-f	6.3 cde	9.8 ab	8.0 bcd	8.2 a	7.92 a-d
FORTRESS	Sto	HG	5.7 fgh	7.0 a-d	6.7 bcd	9.2 a-e	7.3 def	7.0 cde	7.44 cde
GUNNISON	Bejo	G	6.7 c-f	6.7 a-e	6.3 cde	10.0 a	7.0 efg	8.0 ab	7.67 ab
MOUNTAINEER	Tak	G	6.7 c-f	5.3 e-h	6.0 def	9.3 a-d	8.0 bcd	7.7 abc	7.46 a-d
HAECKERO	SN	G	5.3 gh	5.7 d-g	6.3 cde	9.8 ab	6.7 fgh	6.7 def	6.98 e-i
HAECKERO	Haz	HG	6.7 c-f	6.3 c-f	6.3 cde	9.7 abc	7.7 cde	7.3 bcd	7.54 b-e
SUMO	CF	G	5.7 fgh	5.3 e-h	6.7 bcd	8.3 efg	7.3 def	6.0 fg	6.54 ij
SV NY 7331	Sem	HG	5.7 fgh	6.7 a-e	5.7 efg	9.0 b-f	6.7 fgh	6.0 fg	6.83 f-j
VENECIA	Bejo	G	7.0 b-e	7.0 a-d	6.3 cde	8.7 d-g	7.7 cde	7.7 abc	7.54 b-e

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 - 2022 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Skin Thickness	Skin Attachment	Neck Finish	Overall Score	Score
SCORPION	Cro	HG	6.0 e-h*	4.0 h	6.0 def	10.0 a	5.3 i	6.3 ef	6.58 j
TRIDENT	Cro	SpG	5.3 gh	4.7 gh	5.3 fg	9.0 b-f	6.7 fgh	6.3 ef	6.25 j
STANLEY	CF	HG	5.7 fgh	6.0 d-g	6.7 bcd	9.3 a-d	6.3 gh	7.2 cd	7.06 e-i
MONDELLA	Bejo	MIX	5.7 fgh	5.0 fgh	6.3 cde	10.0 a	7.3 def	7.0 cde	7.25 d-g
MINDI	EZ	G	6.0 e-h	5.3 e-h	6.7 bcd	8.7 d-g	7.7 cde	6.7 def	6.98 e-i
CROCKETT	Bejo	G	7.0 b-e	5.7 d-g	6.3 cde	9.8 ab	6.0 hi	7.0 cde	7.27 d-g
HIGHLANDER	Tak	SpG	5.7 fgh	5.0 fgh	5.0 g	5.0 i	9.5 a	5.3 g	6.23 j
BRADDOCK	Bejo	HG	6.7 c-f	6.7 a-e	5.7 efg	9.7 abc	7.0 efg	7.0 cde	7.35 def
37 118	Haz	G	6.3 d-g	5.0 fgh	6.3 cde	9.2 a-e	7.3 def	6.3 ef	6.69 hij
DAWSON	Bejo	HG	6.7 c-f	5.3 e-h	6.7 bcd	9.0 b-f	8.3 bc	7.7 abc	7.71 a-d
POWELL	Bejo	G	5.7 fgh	5.0 fgh	5.7 efg	9.8 ab	6.7 fgh	6.3 ef	6.73 g-j
AG 24202	SN	HG	5.7 fgh	4.7 gh	5.7 efg	8.7 d-g	7.0 efg	6.0 fg	6.25 j
TRIAL AVERAGE			**6.3**	**6.1**	**6.3**	**9.0**	**7.3**	**6.9**	**7.15**

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 - 2022 - continued

Cultivar	Source	Firmness at Harvest	Firmness at Evaluation	Interior Colour	Exterior Colour	Exterior Colour Rating	Days to Harvest	Seed Treatment	% Onion Maggot Damage	% Jumbo > 76 mm
CATSKILL	Sto	9.8 a*	8.5 c-f	C	G	7.0 c-g	102 e-j	SE	1.0 cde	20.1 b-h
TRAVERSE	Tak	9.7 a	8.7 b-f	W	G	7.3 b-f	102 e-j	SE	1.3 cde	23.0 a-f
La SALLE	Sto	10.0 a	8.8 a-e	C	G	6.7 d-h	97 h-m	SE	1.0 cde	17.2 b-j
37 120	Haz	9.7 ab	8.0 fgh	C/W	G	8.0 a-d	113 bc	SPF	1.5 cde	27.9 abc
SWITCHBACK	Tak	9.8 a	8.3 d-g	W	G	7.7 a-e	94 k-n	SE	0.9 cde	22.7 a-f
37 126	Haz	10.0 a	7.7 ghi	W	DGC	8.0 a-d	119 ab	SPF	2.3 b-e	31.0 ab
SV NY 1496	Sem	8.7 d	6.3 jk	C	LG	8.7 ab	93 mn	SE	2.8 b-e	24.0 a-e
MILESTONE	Tak	10.0 a	8.0 fgh	C	G	7.0 c-g	112 bcd	SE	0.8 de	24.6 a-d
SAFRANE	Bejo	10.0 a	9.0 a-d	W	G	7.3 b-f	100 f-l	SE	1.7 cde	16.0 c-j
THUNDERSTONE	SN	10.0 a	8.3 d-g	C/G	G	6.7 d-h	102 e-i	SE	2.4 b-e	19.5 b-h
LODESTAR	Tak	10.0 a	9.5 a	W	DG	8.3 abc	113 bc	SE	0.9 cde	22.5 a-g
FRONTIER	Tak	10.0 a	8.8 a-e	C/G	G	8.3 abc	102 e-i	SE	1.3 cde	9.5 e-j

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

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

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ONION CULTIVAR MAIN TRIAL - 2022 - continued

Cultivar	Source	Firmness at Harvest	Firmness at Evaluation	Interior Colour	Exterior Colour	Exterior Colour Rating	Days to Harvest	Seed Treatment	% Onion Maggot Damage	% Jumbo > 76 mm
RIDGE LINE	Tak	10.0 a*	8.2 efg	W	G	6.0 f-i	103 e-i	SE	0.8 de	34.8 a
OVERLOOK	Sem	9.3 bc	7.0 ij	C	LG	6.3 e-i	102 e-j	S	0.6 de	18.6 b-i
SADDLEBACK	Sto	9.8 a	7.7 ghi	C	LG	7.3 b-f	94 lmn	SE	0.5 de	17.8 b-j
ONEIDA	Bejo	10.0 a	8.7 b-f	W	DG	7.7 a-e	104 efg	FIP	0.6 de	6.8 hij
FORTRESS	Sto	10.0 a	8.7 b-f	C/W	G	8.0 a-d	101 e-k	SE	1.4 cde	4.6 ij
GUNNISON	Bejo	10.0 a	8.7 b-f	W	LC	8.0 a-d	99 g-m	SE	0.6 de	5.6 hij
MOUNTAINEER	Tak	10.0 a	8.7 b-f	C	G	8.0 a-d	102 e-j	SE	0.0 e	15.2 c-j
HAECKERO	SN	10.0 a	9.0 a-d	C	G	6.3 e-i	95 j-m	SE	0.7 de	11.4 d-j
HAECKERO	Haz	10.0 a	9.3 ab	C	G	7.0 c-g	99 f-m	SPF	1.1 cde	10.7 d-j
SUMO	CF	10.0 a	7.7 ghi	C	G	5.3 hi	102 e-i	SE	0.9 cde	23.4 a-e
SV NY 7331	Sem	9.8 a	8.0 fgh	C	G	7.0 c-g	105 efg	SE	1.2 cde	11.7 d-j
VENECIA	Bejo	9.7 ab	8.3 d-g	C	G	7.7 a-e	96 i-m	SE	0.0 e	17.3 b-j

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

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

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ONION CULTIVAR MAIN TRIAL - 2022 - continued

Cultivar	Source	Firmness at Harvest	Firmness at Evaluation	Interior Colour	Exterior Colour	Exterior Colour Rating	Days to Harvest	Seed Treatment	% Onion Maggot Damage	% Jumbo > 76 mm
SCORPION	Cro	9.8 a*	8.3 d-g	C	DG	6.7 d-h	122 a	FIR	0.0 e	24.2 a-d
TRIDENT	Cro	9.8 a	7.7 ghi	W	G	5.0 i	107 cde	FIR	1.4 cde	15.1 c-j
STANLEY	CF	9.8 a	8.7 b-f	W	LG	6.7 d-h	106 def	SE	0.8 de	11.2 d-j
MONDELLA	Bejo	10.0 a	9.3 ab	C/W	G	7.3 b-f	104 e-h	LD	4.9 ab	7.5 hij
MINDI	EZ	9.8 a	8.2 efg	W/G	G	6.7 d-h	100 f-l	SE	2.1 b-e	14.3 c-j
CROCKETT	Bejo	10.0 a	9.0 a-d	W	DG	7.3 b-f	116 ab	LD	4.7 ab	11.8 d-j
HIGHLANDER	Tak	8.8 cd	6.0 k	C	LG	8.3 abc	88 n	SE	1.6 cde	7.8 g-j
BRADDOCK	Bejo	10.0 a	9.2 abc	W/G	G	7.0 c-g	108 cde	LD	3.1 bcd	15.2 c-j
37 118	Haz	10.0 a	7.3 hi	C	G	5.7 ghi	101 e-k	SPF	3.7 abc	11.4 d-j
DAWSON	Bejo	9.8 a	9.0 a-d	C	DG	9.0 a	101 e-k	LD	6.4 a	3.4 j
POWELL	Bejo	10.0 a	8.7 b-f	C	G	6.0 f-i	116 ab	LD	2.2 b-e	6.0 hij
AG 24202	SN	9.5 ab	7.0 ij	W	LG	5.3 hi	102 e-j	SE	0.8 de	8.7 f-j
TRIAL AVERAGE		**9.8**	**8.3**			**7.1**	**103**		**1.6**	**15.9**

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.

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ONION CULTIVAR MAIN TRIAL - 2022 - continued

Cultivar	Source	Seeders	% Single Centers	% Double Centers	% Multiple Centers	% Hollowness in Centers	Top Height (cm)	Leaf Shape	Leaf Colour
CATSKILL	Sto	0.0 d*	16.7 lmn	76.7 ab	6.7 bc	13.3 h-k	67.7 c-i	B	BG
TRAVERSE	Tak	0.0 d	56.7 c-h	43.3 e-j	0.0 c	60.0 a-d	67.7 c-i	U	BG
La SALLE	Sto	0.0 d	23.3 j-n	73.3 abc	3.3 c	26.7 f-k	65.7 e-j	B	BG
37 120	Haz	1.7 bc	70.0 a-e	26.7 i-l	3.3 c	30.0 f-j	74.9 ab	U	LG
SWITCHBACK	Tak	0.0 d	6.7 mn	83.3 a	10.0 bc	76.7 a	65.2 f-j	U	BG
37 126	Haz	0.7 bcd	60.0 c-g	33.3 g-k	3.3 c	16.7 h-k	61.3 ij	B	LG
SV NY 1496	Sem	0.7 bcd	20.0 k-n	70.0 a-d	10.0 bc	60.0 a-d	65.7 e-j	B	BG
MILESTONE	Tak	0.0 d	36.7 f-l	50.0 c-i	13.3 bc	43.3 c-g	69.6 a-g	B	BG
SAFRANE	Bejo	1.0 bcd	50.0 d-j	46.7 d-j	3.3 c	50.0 b-f	67.9 b-i	B	BG
THUNDERSTONE	SN	2.0 ab	73.3 a-d	23.3 jkl	3.3 c	36.7 d-h	73.4 a-d	B	LG
LODESTAR	Tak	0.0 d	40.0 f-l	56.7 b-g	3.3 c	3.3 k	72.3 a-e	U	BG
FRONTIER	Tak	0.0 d	20.0 k-n	70.0 a-d	10.0 bc	10.0 ijk	66.8 c-i	B	BG

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

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

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ONION CULTIVAR MAIN TRIAL - 2022 - continued

Cultivar	Source	Seeders	% Single Centers	% Double Centers	% Multiple Centers	% Hollowness in Centers	Top Height (cm)	Leaf Shape	Leaf Colour
RIDGE LINE	Tak	0.0 d*	20.0 k-n	70.0 a-d	10.0 bc	60.0 a-d	64.7 f-j	U	BG
OVERLOOK	Sem	3.3 a	33.3 g-m	63.3 a-e	3.3 c	33.3 e-i	73.7 abc	U	BG
SADDLEBACK	Sto	0.0 d	36.7 f-l	63.3 a-e	0.0 c	10.0 ijk	72.3 a-e	U	BG
ONEIDA	Bejo	0.7 bcd	36.7 f-l	60.0 a-f	3.3 c	10.0 ijk	65.9 e-j	U	G
FORTRESS	Sto	3.3 a	23.3 j-n	66.7 a-e	10.0 bc	30.0 f-j	69.8 a-g	B	BG
GUNNISON	Bejo	0.0 d	63.3 b-f	36.7 f-k	0.0 c	26.7 f-k	67.6 c-i	B	BG
MOUNTAINEER	Tak	0.0 d	26.7 i-n	70.0 a-d	3.3 c	56.7 a-e	65.5 e-j	U	BG
HAECKERO	SN	0.0 d	40.0 f-l	50.0 c-i	10.0 bc	16.7 h-k	62.9 g-j	B	BG
HAECKERO	Haz	0.0 d	40.0 f-l	60.0 a-f	0.0 c	10.0 ijk	64.3 f-j	B	BG
SUMO	CF	0.0 d	16.7 lmn	53.3 b-h	30.0 a	26.7 f-k	68.1 b-i	U	BG
SV NY 7331	Sem	1.3 bcd	50.0 d-j	46.7 d-j	3.3 c	30.0 f-j	75.3 a	U	G
VENECIA	Bejo	0.0 d	46.7 d-k	50.0 c-i	3.3 c	3.3 k	69.5 a-g	B	G

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

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

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ONION CULTIVAR MAIN TRIAL - 2022 - continued

Cultivar	Source	Seeders	% Single Centers	% Double Centers	% Multiple Centers	% Hollowness in Centers	Top Height (cm)	Leaf Shape	Leaf Colour
SCORPION	Cro	0.0 d*	83.3 abc	13.3 kl	3.3 c	16.7 h-k	58.9 j	B	BG
TRIDENT	Cro	0.7 bcd	93.3 a	6.7 l	0.0 c	3.3 k	66.7 c-i	B	G
STANLEY	CF	0.7 bcd	30.0 h-m	63.3 a-e	6.7 bc	20.0 g-k	68.4 a-h	B	BG
MONDELLA	Bejo	0.0 d	70.0 a-e	30.0 h-l	0.0 c	30.0 f-j	66.5 d-i	U	BG
MINDI	EZ	0.0 d	43.3 e-l	56.7 b-g	0.0 c	16.7 h-k	68.9 a-h	U	G
CROCKETT	Bejo	0.3 cd	83.3 abc	16.7 kl	0.0 c	6.7 jk	69.8 a-g	U	BG
HIGHLANDER	Tak	0.0 d	0.0 n	70.0 a-d	30.0 a	66.7 abc	62.3 hij	B	G
BRADDOCK	Bejo	1.0 bcd	26.7 i-n	63.3 a-e	10.0 bc	60.0 a-d	70.5 a-f	B	BG
37 118	Haz	0.0 d	16.7 lmn	73.3 abc	10.0 bc	36.7 d-h	67.7 c-i	B	G
DAWSON	Bejo	0.3 cd	90.0 ab	6.7 l	3.3 c	20.0 g-k	62.8 g-j	B	G
POWELL	Bejo	0.0 d	53.3 d-i	46.7 d-j	0.0 c	36.7 d-h	66.3 d-i	U	BG
AG 24202	SN	0.0 d	26.7 i-n	60.0 a-f	20.0 ab	73.3 ab	66.0 e-i	U	BG
TRIAL AVERAGE		**0.5**	**42.3**	**51.4**	**6.4**	**31.3**	**67.6**		

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

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

ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2022

Catskill: *Stokes sample*, Good appearance, Good tight neck finish, Medium sized necks, Average skin thickness, Pretty good skin quality, Odd one with skin cracking, Good exterior colour a little even, Odd one with greening or yellowing on skins, Interior colour white or cream, Average interior blending, Dead centers 25% white 75% yellow, Good packer, Uniformity of shape uneven, Good firm onion, Firmness even, Medium to large run size uneven, Mid-term storage onion.

Traverse: *American Takii sample*, Good to nice appearance, Average tight neck finish, Medium sized necks, Average to thicker skin thickness, Pretty good to nice skin quality, Exterior colour even, Odd one with greening or yellowing on skins, Interior colour white, Good interior blending, Dead centers mixture of green or yellow, Good to nice packer, Uniformity of shape uneven, Good firm onion, Firmness even, Medium run size uneven, Mid to long term storage onion.

La Salle: *Stokes sample*, Good appearance, Average to good tight neck finish, Small to medium sized necks, Average skin thickness, Pretty good skin quality, Odd one with skin cracking, Exterior colour fairly even, Odd one with greening on skins, Interior colour cream a little uneven, Average interior blending, Dead centers yellow, 20% with green rings, Good packer, Uniformity of shape a little even, Nice firm solid onion, Firmness even, Medium run size uneven, Mid to long term storage onion.

37 120: *Hazera sample*, Average to good appearance, Average tight neck finish, Odd neck finish a bit rough, Medium to large sized necks, Average to thick skin thickness, Pretty good skin quality, Exterior colour even, Odd one with greening or white spots on skins, Interior colour cream or white, Average interior blending uneven, Dead centers white, green or yellow, Average to good packer, Uniformity of shape a little uneven, Good firm onion, Firmness even, Medium to large run size a little uneven, Mid to long term storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2022 - continued

Switchback: *American Takii sample*, Good to nice appearance, Average to good tight neck finish, Small to medium sized necks, Average skin thickness, Pretty good skin quality, A few with skin cracking, Odd one with skin or basel plate rot, Good exterior colour even, Odd one with greening on skins, Interior color white, Good interior blending, Dead centers 90% white 10% green, 20% with green rings, Good to nice packer, Uniformity of shape a little even, Good firm onion, Firmness even, Medium to large run size even, Mid to long term storage onion.

37 126: *Hazera sample*, Fair to average appearance, Average tight neck finish, Neck finishes a bit rough, Medium sized necks, Average to thick skin thickness, Pretty good to nice skin quality, Exterior colour slightly dark, Skins have a copper shine, Odd one with white spots or greening on skins, Interior colour white, Average to great interior blending, Dead centers yellow or white, Average packer, Uniformity of shape a little uneven, Average firmness, Firmness a little uneven, Large run size a little uneven, Mid-term storage onion.

SV NY 1496: *Seminis sample*, Fair appearance, Great tight neck finish, Small sized necks, Thinner skins, Fair skin quality, A lot with skin cracking a concern, Lighter exterior colour even, Some with greening on skins, Interior colour white or cream, Average interior blending, Dead centers yellow, 15% with green rings, Okay packer, Uniformity of shape very uneven, Average firmness, Firmness a little uneven, Large run size a little uneven, Suspicion of doubles, Early term storage onion.

Milestone: *American Takii sample*, Average to good appearance, Average tight neck finish, Odd neck finish a bit rough, Mixed sized necks, Average to thick skin thickness, Pretty good skin quality, Odd one with skin cracking, Odd one with basal plate rot, Good exterior colour even, Odd one with greening or white spots on skins, Interior colour cream or white, Average to good interior blending, Dead centers 20% white 70% yellow, Average to good packer, Uniformity of shape a little even, Good firm onion, Firmness a little even, Medium to ex-large run size even, Mid to long term storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2022 - continued

Safrane: *Bejo sample*, Good to nice appearance, Average to good tight neck finish, Medium sized necks, Average to thick skin thickness, Pretty good to nice skin quality, Odd one with skin cracking, Good to nice exterior colour even, Odd one with greening or yellowing on skins, Interior colour cream or white, Average to good interior blending, Dead centers 70% white 30% green, Good to nice packer, Uniformity of shape a little even, Nice firm solid onion, Firmness very even, Mixed run size uneven, Long term storage onion.

Thunderstone: *Hazera sample*, Fair to good appearance, Average to good tight neck finish, Small to medium sized necks, Average skin thickness, Average to pretty good skin quality, Odd one with skin cracking, Odd one with skin rot, Exterior colour a little uneven, Odd one with greening on skins, Interior colour cream or green, Average to good interior blending, Dead centers yellow, Average packer, Uniformity of shape a little even, Good firm onion, Firmness a little uneven, Medium run size a little uneven, Mid-term storage onion.

Lodestar: *American Takii sample*, Average to nice appearance, Average tight neck finish, Odd neck finish a bit rough, Medium sized necks, Thicker skins, Pretty good to nice skin quality, Odd one with skin cracking, Slightly dark exterior colour even, Odd one with yellowing or white spots on skins, Interior color white cream, Average to good interior blending, Dead centers yellow or green, Average to nice packer uneven, Uniformity of shape very even, Nice firm solid onion, Firmness very even, Medium run size a little uneven, Long term storage onion.

Frontier: *American Takii sample*, Good to nice appearance, Good to great tight neck finish, Small sized necks, Thicker skins, Pretty good to nice skin quality, Nice exterior colour even, Odd one with greening or yellowing on skins, Interior colour cream or green, Average interior blending, Dead centers yellow, 30% with green rings, Good to nice packer, Uniformity of shape even, Nice firm solid onion, Firmness even, Small to medium run size uneven, Mid-term to long storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2022 - continued

Ridgeline: *American Takii sample*, Average to good appearance, Average to good tight neck finish, Neck sizes mixed uneven, Average skin thickness, Pretty good to nice skin quality, Odd one with skin cracking, Exterior colour uneven, Odd one with white spots on skins, Interior colour white even, Average interior blending, Dead centers white or slightly green, Good packer, Uniformity of shape a little even, Good firm onion, Firmness a little uneven, Large to ex-large run size a little uneven, Odd one with suspicion of doubles, Mid-term to long storage onion.

Overlook: *Seminis sample*, Average appearance, Average to great tight neck finish, Small to medium sized necks, Thin to average skin thickness, Fair to average skin quality, Odd one with skin cracking, Exterior colour uneven, Odd one with greening on skins, Interior colour white or cream, Average interior blending, Dead centers yellow, Okay to average packer, Uniformity of shape uneven, Average firm onion, Firmness a little uneven, Medium to large run size a little uneven, Early to mid-term storage onion.

Saddleback: *Stokes sample*, Average to good appearance, Average to good tight neck finish, Odd neck finish a bit rough, Small to medium sized necks, Skin thickness uneven, Average to pretty good skin quality, Odd one with skin cracking, Lighter exterior colour a little uneven, Odd one with greening on skins, Interior colour cream even, Average to good interior blending, Dead centers yellow, 30% green rings, Okay to good packer, Uniformity of shape uneven, Average firmness, Firmness a little even, Medium run size uneven, Mid to long term storage onion.

Oneida: *Bejo sample*, Nice appearance, Good tight neck finish, Medium sized necks, Thicker skin, Nice skin quality, Exterior colour even, Interior colour white or cream even, Average to good interior blending, Dead centers 75% yellow 25% green, Nice packer, Uniformity of shape very even, Nice firm onion, Firmness even, Small to medium run size a little uneven, Long term storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2022 - continued

Fortress: *Stokes sample,* Average to nice appearance, Average to good tight neck finish, Small to medium sized necks, Average to thick skin thickness, Average to nice skin quality, Odd one with skin cracking, Good exterior colour even, Odd one with greening on skins, Interior colour cream or white, Average to good interior blending even, Dead centers white, 25% green rings, Good packer, Uniformity of shape a little uneven, Good firm onion, Firmness a little uneven, Small to medium run size a little uneven, Long term storage onion.

Gunnison: *Bejo sample,* Nice appearance, Average to good tight neck finish, Medium sized necks, Thicker skins, Nice skin quality, Odd one with basel plate rot, Exterior colour very even, Skins have a copper shine, Odd one with green on skins, Interior colour white or cream even, Good interior blending, Dead centers white or yellow, Good to nice packer, Uniformity of shape a little uneven, Nice firm solid onion, Firmness even, Small to medium run size, Long term storage onion.

Mountaineer: *American Takii sample,* Good to nice appearance, Good tight neck finish, Small to medium sized necks, Average to thick skin thickness, Pretty good to nice skin quality, Odd one with skin cracking, Nice exterior colour even, Odd one with greening on skins, Interior colour cream or white, Average to good interior blending, Dead centers 60% green 40% yellow, Good to nice packer, Uniformity of shape a little uneven, Nice firm solid onion, Firmness even, Medium run size uneven, Long term storage onion.

Haeckero: *Seminova sample,* Average to good appearance, Average to good tight neck finish, Medium sized necks, Average skin thickness, Pretty good skin quality, Exterior colour a little uneven, Odd one with greening on skins, Interior colour cream even, Good interior blending, Dead centers white or yellow, 15% with green rings, Average to good packer, Uniformity of shape very uneven, Nice firm solid onion, Firmness even, Mixed run size uneven, Long term storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2022 - continued

Haeckero: *Hazera sample*, Good to nice appearance, Good tight neck finish, Medium sized necks, Average to thick skin thickness, Nice skin quality, Good exterior colour a little even, Odd one with greening or yellowing on skins, Interior colour cream or green, Average to good interior blending, Dead centers white or yellow, Good packer, Uniformity of shape a little uneven, Nice firm solid onion, Firmness very even, Small to medium run size a little uneven, Long term storage onion.

Sumo: *Clifton sample*, Average appearance, Good tight neck finish, Small to medium sized necks, Average skin thickness, Average to pretty good skin quality, Odd one with skin cracking, Exterior colour uneven, Some with greening on skins, Interior colour cream, Average interior blending, Dead centers white or yellow, 35% green rings, Average packer, Uniformity of shape very uneven, Average to good firmness, Firmness a little uneven, Medium to large run size uneven, Suspicion of doubles, Mid-term storage onion.

SV NY 7331: *Seminis sample*, Average appearance, Average tight neck finish, Odd neck finish a bit rough, Medium sized necks, Average skin thickness, Average to pretty good skin quality, Odd one with skin cracking, Odd one with skin or basel plate rot, Exterior colour a little uneven, Odd one with greening or yellowing on skins, Interior colour white or cream, Average interior blending, Dead centers 60% yellow 40% white, Average packer, Uniformity of shape a little uneven, Good firm onion, Firmness a little uneven, Medium run size a little uneven, Mid to long term storage onion.

Venecia: *Bejo sample*, Good to nice appearance, Good tight neck finish, Small to medium sized necks, Average to thick skin thickness, Pretty good to nice skin quality, Odd one with skin cracking, Odd one with skin or basel plate rot, Nice exterior colour even, Interior colour cream or white, Average to good interior blending even, Dead centers yellow or green, Good packer, Uniformity of shape even, Good firm onion, Firmness even, Medium run size a little uneven, Suspicion of doubles a concern, Long term storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2022 - continued

Scorpion: *Crookham sample*, Average appearance, Poor to average neck finish, Neck finishes a bit rough, Medium to large sized necks, Thicker skins, Pretty good to nice skin quality, Good exterior colour even, Odd one with yellowing or white spots on skins, Interior colour cream uneven, Interior blending uneven, Dead centers yellow to white, Okay to nice packer, Uniformity of shape uneven, Good firm onion, Firmness even, Large run size very uneven, Long term storage onion.

Trident: *Crookham sample*, Average to good appearance, Average tight neck finish, Medium sized necks, Thin to average skin thickness, Average to pretty good skin quality, Odd one with skin cracking, Exterior colour uneven, Odd one with greening on skins, Interior colour white even, Great interior blending even, Dead centers yellow, Average to good packer, Uniformity of shape very uneven, Average to good firm onion, Firmness a little uneven, Mixed run size very uneven, Mid-term storage onion.

Stanley: *Clifton sample*, Average to good appearance, Average to good tight neck finish, Medium sized necks, Average to thick skin thickness, Pretty good to nice skin quality, Odd one with skin cracking, Good exterior colour a little even, Odd one with yellowing on skins, Interior colour white even, Average to good interior blending, Dead centers mixed colours, Average to good packer, Uniformity of shape uneven, Nice firm solid onion, Firmness even, Medium run size uneven, Long term storage onion.

Mondella: *Bejo sample*, Good appearance, Average to good tight neck finish, Medium sized necks, Average to thick skin thickness, Pretty good to nice skin quality, Odd one with skin or basel plates rot, Exterior colour even, Odd one with greening or yellowing on skins, Interior colour cream or white uneven, Average interior blending, Dead centers yellow or green, Average to good packer, Uniformity of shape uneven, Good firm onion, Firmness even, Small run size uneven, Mid to long term storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2022 - continued

Mindi: *Enza Zaden sample,* Average to good appearance, Good tight neck finish, Small to medium sized necks, Average to thick skin thickness, Pretty good to nice skin quality, Odd one with skin cracking, Slightly darker exterior colour uneven, Interior colour 70% white 30% green, Average to good interior blending, Dead centers white green or yellow, 10% green rings, Good packer, Uniformity of shape a little even, Good firm onion Firmness even, Medium to large run size a little uneven, Mid to long term storage onion.

Crockett: *Bejo sample,* Average to nice appearance, Average tight neck finish, Neck finishes a bit rough, Medium sized necks, Thicker skins, Pretty good to nice skin quality, Good exterior colour even, Odd one with yellowing or greening on skins, Interior colour white even, Good interior blending even, Dead centers 60% white 40% green, Good packer, Uniformity of shape uneven, Nice firm solid onion, Firmness even, Run size mixed uneven, Long term storage onion.

Highlander: *American Takii sample,* Poor to fair appearance, Great to perfect tight neck finish, Small sized necks, Thinner skins, Poor to fair skin quality, A lot with skin cracking a concern, Lightly pale exterior colour even, A lot with greening on skins, Interior colour cream, Average interior blending uneven, Dead centers yellow, 35% green rings, Okay packer, Uniformity of shape uneven, Average firmness, Firmness a little uneven, Medium run size uneven, Suspicion of doubles a concern, Early storage onion.

Braddock: *Bejo sample,* Good appearance, Average to good tight neck finish, Small to medium sized necks, Average to thick skin thickness, Pretty good to nice skin quality, Good exterior colour even, Odd one with yellowing on skins, Interior colour 60%white 40% green, Average interior blending uneven, Dead centers yellow, Good to nice packer, Uniformity of shape a little uneven, Good firm onion, Firmness even, Small to medium run size a little uneven, Mid to long term storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2022 - continued

37 118: *Hazera sample*, Average to good appearance, Average to good tight neck finish, Medium sized necks, Average skin thickness, Pretty good skin quality, Odd one with skin cracking, Exterior colour a little uneven, A few with greening on skins, Interior colour cream or white, Average to good interior blending, Dead centers yellow or white, 30% green rings, Average to good packer, Uniformity of shape a little uneven, Average firmness, Firmness even, Small to medium run size uneven, Early to mid-term storage onion.

Dawson: *Bejo sample*, Nice appearance, Good tight neck finish, Small sized necks, Thicker skins, Nice skin quality, Odd one with skin cracking, Slightly dark nice exterior colour even, Odd one with yellowing or greening on skins, Interior colour cream or white, Average to good interior blending even, Dead centers white or yellow, 10% green rings, Good to nice packer, Uniformity of shape even, Nice firm solid onion, Firmness even, Small run size uneven, Long term storage onion.

Powell: *Bejo sample*, Average to good appearance, Average to good tight neck finish, Odd neck finish a bit rough, Medium sized necks, Average to thick skin thickness, Pretty good to nice skin quality, Exterior colour a little uneven, Odd one with yellowing on skins, Interior colour cream, Average to good interior blending even, Dead centers mixed, Average to good packer, Uniformity of shape uneven, Good firm onion, Firmness even, Mixed run size uneven, Mid to long term storage onion.

AG 24202: *Seminova sample*, Fair to average appearance, Average tight neck finish, Medium sized necks, Average skin thickness, Average skin quality, Odd one with skin cracking, Odd one with basel plate rot, Exterior colour a little uneven, Some with greening on skins, Interior colour white, Average interior blending a little uneven, Dead centers white or yellow, 25% green rings, Average packer, Uniformity of shape uneven, Average firm onion, Firmness uneven, Small to medium run size uneven, Mid-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	Leaf Length (cm)
HIGHLANDER	Tak	18	1010	85.4	13.3	93	8.5	6.0	9.3	6.23	3.5	0.0	56
ALPINE	Tak	11	1035	89.6	14.4	95	8.5	5.9	9.6	6.24	4.9	0.0	58
TREKKER	Tak	11	1084	92.9	8.8	100	9.8	8.3	7.5	7.51	3.3	0.0	61
NORSTAR	Tak	28	1079	91.2	12.5	102	8.2	5.9	8.6	6.34	4.2	0.0	59
SADDLEBACK	Sem	7	1183	92.0	19.5	103	9.6	7.2	7.3	6.55	2.7	0.1	72
ONEIDA	Bejo	5	993	81.5	5.2	104	9.3	7.8	7.5	7.35	3.8	0.1	65
LA SALLE	Sem	13	1157	92.8	15.1	105	9.5	7.7	7.3	6.78	6.8	0.3	65
RICOCHET	Sem	9	1134	96.8	30.5	105	9.6	8.0	7.5	7.11	7.8	0.5	64
ARSENAL	Sem	13	1232	97.6	15.0	106	9.6	8.1	7.6	7.16	5.2	1.7	64
FRONTIER	Tak	29	1110	93.2	9.4	106	9.8	8.1	8.0	7.59	4.1	0.0	64
TRAILBLAZER	Tak	14	1047	91.9	15.9	106	9.8	8.3	7.9	7.43	4.3	0.0	63
RIDGELINE	Tak	7	1265	93.3	22.9	107	9.9	7.7	7.2	6.96	2.8	0.0	64
MOUNTAINEER	Tak	11	1027	95.4	18.9	107	9.6	8.2	7.9	7.61	5.0	0.0	62
TRAVERSE	Tak	7	1177	95.0	13.8	107	9.5	8.2	7.4	7.49	2.5	0.0	67
CATSKILL	Sem	8	1207	93.5	18.8	107	9.7	7.5	7.3	6.82	5.2	0.0	68

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	15	1181	93.7	13.6	108	9.8	8.7	6.9	7.43	5.7	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
DAWSON	Bejo	7	858	84.0	10.4	109	9.8	7.9	7.6	7.04	7.3	0.0	61
BRADDOCK	Bejo	15	1246	90.3	16.2	110	9.6	7.8	6.6	6.91	2.6	0.6	67
MILESTONE	Tak	21	1320	95.9	24.2	111	9.6	7.5	6.7	7.18	4.4	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	24	1186	92.0	17.1	111	9.9	8.5	6.5	7.13	4.3	0.9	66
FORTRESS	Sem	29	1078	95.2	8.9	111	9.8	8.0	6.8	7.36	3.5	1.3	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	17	1248	93.3	19.9	112	9.8	8.6	6.8	7.25	3.2	2.5	67
PRINCE	Bejo	24	1233	93.6	22.2	115	9.8	8.6	6.2	7.20	5.4	0.4	66
CROCKETT	Bejo	11	1241	91.4	18.3	118	9.9	8.7	5.4	7.13	5.6	1.2	71

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

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

MAIN ONION STORAGE TRIAL 2021 - 2022

Cultivar	Source	% Marketable	% Weight Loss	% Sprouts	% Rot	% Soft	Firmness In **	Firmness Out **	% Sprouting at Base	% Sprouting at Top
LA SALLE	Sto	78.3 a*	7.0 d	9.1 mno	5.0 b-h	0.0 d	10.0 a	7.0 b-f	7.7 kl	4.7 l
SAT 1	SN	76.5 ab	6.9 d	13.6 l-o	2.3 d-h	0.0 d	9.5 bcd	6.8 b-g	14.0 jkl	11.7 i-l
STANLEY	CF	76.2 ab	8.3 cd	11.4 l-o	3.2 c-h	0.0 d	10.0 a	7.7 ab	9.2 kl	5.0 l
CROCKETT	Bejo	75.6 ab	9.6 bcd	9.2 mno	4.7 b-h	0.0 d	10.0 a	8.3 a	7.0 kl	3.7 l
SAFRANE	Bejo	75.3 ab	8.4 cd	14.0 l-o	1.6 fgh	0.0 d	10.0 a	7.2 b-e	12.0 kl	8.0 jkl
HAECKERO	Haz	71.3 abc	9.7 bcd	8.4 no	9.9 b	0.0 d	10.0 a	7.3 bcd	5.3 kl	6.7 kl
BRADDOCK	Bejo	70.2 a-d	8.9 cd	15.7 k-o	4.1 c-h	0.1 d	9.8 ab	6.5 d-h	9.0 kl	10.0 jkl
PATTERSON	Bejo	69.6 a-d	8.2 cd	17.7 j-o	3.7 c-h	0.0 d	10.0 a	7.7 ab	16.0 h-l	9.0 jkl
PREFECT	CF	69.5 a-e	8.9 cd	18.2 j-o	2.7 d-h	0.0 d	10.0 a	6.7 c-h	15.0 i-l	12.7 h-l
POWELL	Bejo	68.8 a-e	9.3 cd	17.6 j-o	3.7 c-h	0.0 d	10.0 a	7.2 b-e	14.0 jkl	8.3 jkl
SUMO	CF	68.4 a-e	7.5 d	21.3 h-o	1.8 e-h	0.2 d	9.7 abc	6.7 c-h	16.7 h-l	10.7 jkl
THUNDERSTONE	Haz	66.1 a-f	10.3 bcd	19.2 j-o	3.7 c-h	0.0 d	9.8 ab	6.7 c-h	10.7 kl	7.7 jkl
MILESTONE	Tak	64.9 a-g	9.0 cd	19.5 i-o	5.8 b-h	0.0 d	10.0 a	6.2 f-j	14.7 i-l	13.3 h-l
E61L 10240	EZ	63.6 a-h	9.3 cd	20.9 h-o	5.2 b-h	0.0 d	10.0 a	7.5 abc	15.7 i-l	12.3 i-l
SCORPION	Cro	62.2 a-i	10.0 bcd	19.6 i-o	7.1 b-f	0.2 d	9.7 abc	6.5 d-h	15.7 i-l	15.0 h-l
RIDGELINE	Tak	61.6 a-j	9.4 cd	22.7 g-o	5.6 b-h	0.0 d	10.0 a	6.0 g-j	15.7 i-l	11.7 i-l

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 2021 - 2022

Cultivar	Source	% Marketable	% Weight Loss	% Sprouts	% Rot	% Soft	Firmness In **	Firmness Out **	% Sprouting at Base	% Sprouting at Top
SV NY 1496	Sem	61.3 a-j*	8.0 cd	23.0 g-o	5.0 b-h	2.9 b	9.2 de	6.2 f-j	23.3 f-l	27.7 d-l
CATSKILL	Sem	60.4 a-j	8.1 cd	26.2 e-n	4.3 b-h	0.0 d	9.8 ab	7.3 bcd	26.7 e-l	26.7 d-l
37 120	SN	59.8 a-k	11.1 bcd	21.3 h-o	7.4 b-e	0.0 d	9.3 cde	7.0 b-f	12.7 jkl	15.0 h-l
ONEIDA	Bejo	59.7 a-k	8.7 cd	29.4 d-l	1.4 fgh	0.1 d	9.0 e	6.3 e-i	29.0 e-l	20.0 f-l
HAECKERO Inicium	SN	59.1 a-k	8.7 cd	28.0 e-l	3.5 c-h	0.0 d	10.0 a	7.7 ab	31.3 d-l	25.0 d-l
FORTRESS	Sto	58.8 b-k	9.1 cd	26.0 e-n	5.4 b-h	0.0 d	10.0 a	6.3 e-i	19.0 h-l	12.3 i-l
LODESTAR	Tak	57.9 b-k	9.6 bcd	29.1 d-l	2.4 d-h	0.0 d	10.0 a	7.2 b-e	21.7 g-l	10.3 jkl
SWITCHBACK	Tak	55.8 c-l	9.0 cd	24.1 g-o	8.9 bc	1.4 c	9.7 abc	5.5 ijk	21.7 g-l	23.7 d-l
PRELESCO	Haz	55.4 c-l	8.3 cd	34.2 c-k	1.6 fgh	0.0 d	9.7 abc	7.3 bcd	41.7 c-j	36.7 c-j
OUTLANDER	Sto	55.2 c-l	9.0 cd	25.3 f-n	7.7 bcd	2.0 bc	9.7 abc	5.0 kl	20.0 g-l	28.3 d-l
OUTLANDER	Sem	54.5 c-l	16.3 a	22.7 g-o	5.8 b-h	0.2 d	9.8 ab	6.5 d-h	15.0 i-l	14.7 h-l
TRAILBLAZER	Tak	54.4 c-l	10.6 bcd	27.3 e-m	6.5 b-g	0.0 d	10.0 a	6.5 d-h	22.3 g-l	30.7 c-l
37-120 Inicium	SN	54.0 c-l	10.7 bcd	29.0 d-l	5.9 b-h	0.0 d	9.3 cde	6.7 c-h	34.0 d-k	22.3 e-l
DAWSON	Bejo	51.1 d-l	8.8 cd	38.3 b-h	1.2 gh	0.0 d	9.7 abc	7.2 b-e	43.3 c-i	40.0 c-i
SV NY 7333	Sem	50.2 e-m	9.3 cd	38.3 b-h	1.5 fgh	0.0 d	10.0 a	6.5 d-h	48.3 c-g	35.0 c-k
FRONTIER	Tak	48.0 f-m	10.3 bcd	38.7 b-h	2.2 d-h	0.0 d	9.8 ab	6.3 e-i	43.3 c-i	41.7 c-h

Listed in Order of Percent Marketable.

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

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MAIN ONION STORAGE TRIAL 2021 - 2022

Cultivar	Source	% Marketable	% Weight Loss	% Sprouts	% Rot	% Soft	Firmness In **	Firmness Out **	% Sprouting at Base	% Sprouting at Top
37-126	Haz	47.5 f-m*	10.7 bcd	37.9 b-i	2.7 d-h	0.0 d	10.0 a	7.3 bcd	33.3 d-l	18.3 g-l
NOGAL	EZ	47.0 f-m	11.5 a-d	35.5 c-j	5.2 b-h	0.0 d	9.8 ab	7.0 b-f	32.3 d-l	25.0 d-l
TRAVERSE	Tak	47.0 f-m	9.6 bcd	40.4 b-g	2.3 d-h	0.0 d	9.7 abc	6.5 d-h	43.3 c-i	10.7 jkl
MOUNTAINEER	Tak	46.9 f-m	9.3 cd	41.2 b-g	1.9 e-h	0.0 d	10.0 a	6.7 c-h	51.7 b-f	45.0 c-g
SADDLEBACK	Sto	46.4 g-m	9.0 cd	38.2 b-h	5.6 b-h	0.1 d	9.5 bcd	6.3 e-i	45.0 c-h	47.3 c-g
HIGHLANDER	Sto	44.5 h-n	9.7 bcd	5.5 o	33.5 a	6.1 a	8.3 f	4.3 l	4.7 l	4.0 l
CAESER	CF	44.1 i-n	9.2 cd	44.0 b-e	1.8 e-h	0.0 d	10.0 a	6.7 c-h	58.3 a-d	50.0 b-e
SV NY 7331	Sem	42.7 j-n	9.1 cd	43.5 b-f	3.9 c-h	0.2 d	10.0 a	6.3 e-i	55.0 a-e	51.7 a-d
Y 604	SN	40.9 k-n	12.7 abc	44.3 b-e	1.4 fgh	0.0 d	10.0 a	7.2 b-e	63.3 abc	48.3 c-f
37 118	SN	40.7 k-n	9.6 bcd	46.8 a-d	2.4 d-h	0.0 d	9.8 ab	6.8 b-g	63.3 abc	58.3 abc
TRIDENT	Cro	36.6 lmn	10.9 bcd	50.1 abc	1.8 e-h	0.0 d	9.7 abc	5.8 h-k	58.3 a-d	50.0 b-e
MONDELLA	Bejo	31.0 mno	10.3 bcd	56.1 ab	2.1 d-h	0.0 d	10.0 a	7.7 ab	78.3 ab	46.7 c-g
VENECIA	Bejo	26.1 no	8.2 cd	64.6 a	0.5 h	0.0 d	9.8 ab	6.3 e-i	81.7 a	78.3 ab
ELYSE	EZ	16.1 o	14.3 ab	39.1 b-h	30.1 a	0.0 d	8.0 f	5.3 jk	28.3 e-l	45.0 c-g
SCOUT	Cro	13.8 o	12.5 abc	63.0 a	10.1 b	0.0 d	9.0 e	6.0 g-j	82.3 a	80.0 a
TRIAL AVERAGE		**55.0**	**9.6**	**29.1**	**5.2**	**0.3**	**9.7**	**6.7**	**30.4**	**25.9**

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 - 2021-2022

La Salle: *Stokes sample,* Top & root sprouts just starting 0-1 cm, Majority basal plate rot, Odd skin rot, Basal plates just starting to push out 15-30%, Fairly firm onion, Firmness uneven, Mid to late term storage onion, Stored nice.

Sat 1: *Seminova sample,* Top sprouts light to moderate 1-2.5cm, Root sprouts just starting to light 1-2.5 cm, Majority basal plate rot, A few internal rot, Odd skin rot, Basal plates pushing out 15-35%, Firmness slightly uneven, Mid to late term storage onion, Stored good.

Stanley: *Clifton sample,* Top & root sprouts just starting to light 0-2.5 cm, Majority basal plate rot, Some internal rot, Basal plates just starting to push out 5-20%, Firm onion, Firmness even, Late term storage onion, Stored nice.

Crockett: *Bejo sample,* Tops & root sprouts just starting 0-1 cm, All basal plate rot, Basal plates just starting to push out 5-30%, Very firm onion, Late term storage onion, Stored excellent.

Safrane: *Bejo sample,* Top sprouts light 1-2.5cm, Root sprouts just starting to light 0-2.5 cm, Majority basal plate rot, Odd neck rot, Basal plates pushing out 10-20%, Fairly firm onion, Mid to late term storage onion, Stored nice.

Haeckero: *Hazera sample,* Top sprouts just starting to moderate 0-5 cm, Top sprouts lengths uneven, Root sprouts just starting to light 0-2.5 cm, All basal plate rot, Basal plates just starting to push out 5-15%, Fairly firm onion, Late term storage onion, Stored good to excellent.

Braddock: *Bejo sample,* Top & root sprouts just starting 0-1 cm, Majority basal plate rot, Some skin rot, Basal plates pushing out 10-40%, Firmness slightly uneven, Mid to late term storage onion, Stored good to nice.

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ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2021-2022 -- continued

Patterson: *Bejo sample,* Top & root sprouts just starting to light 0-2.5 cm, Majority basal plate rot, Odd skin rot, Basal plates just starting or pushing out 10-40%, Firm onion, Late term storage onion, Stored good to nice.

Prefect: *Clifton sample,* Top sprouts just starting to moderate 0-2.5 cm, Root sprouts just starting to light 0-2.5 cm, Majority basal plate rot, Odd skin rot, Basal plates pushing out 35-60%, Fairly firm onion, Firmness slightly uneven, Mid to late term storage onion, Stored fair to good.

Powell: *Bejo sample,* Top & root sprouts just starting 0-1 cm, Majority basal plate rot, Odd internal rot, Basal plates just starting or pushing out 15-40%, Fairly firm onion, Mid to late term storage onion, Stored good to nice.

Sumo: *Clifton sample,* Top & root sprouts light 1-2.5 cm, Skin, basal plate or internal rot, Basal plates just starting or pushing out 15-20%, Fairly firm onion, Firmness slightly uneven, Mid to late term storage onion, Stored good to nice.

Thunderstone: *Hazera sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority basal plate rot, Some skin rot, Basal plates just starting to push out 5-15%, Fairly firm onion, Firmness slightly uneven, Mid to late term storage onion, Stored good to nice.

Milestone: *American Takii sample,* Top sprouts moderate to heavy 1-5 cm, Root sprouts just starting to light 0-2.5 cm, Majority skin rot, Some basal plate rot, Basal plates just starting to push out 10-25%, Firmness uneven, Early to mid-term storage onion, Stored fair.

E61L 10240: *Enza Zaden sample,* Top sprouts just starting to moderate 0-2.5 cm, Root sprouts just starting to light 0-2.5 cm, Majority basal plate rot, Odd skin rot, Basal plates just starting to push out 15-25%, Firm onion, Firmness slightly uneven, Mid to late term storage onion, Stored good.

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ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2021-2022 -- continued

Scorpion: *Crookham sample,* Top sprouts light to moderate 1-5 cm, Root sprouts just starting to light 0-2.5 cm, Majority basal plate rot, Some skin rot, Odd internal rot, Basal plates pushing out 10-50%, Fairly firm onion, Mid to late term storage onion, Stored good.

Ridgeline: *American Takii sample,* Top sprouts light to moderate 1-5 cm, Root sprouts just starting to light 0-2.5 cm, Internal and skin rot, A few basal plate rot, Basal plates just starting to push out 20-25%, Firmness uneven, Mid-term storage onion, Stored fair.

SV NY 1496: *Seminis sample,* Top sprouts just starting to moderate 0-5 cm, Root sprouts just starting to light 0-2.5 cm, Basal plate or skin rot, Odd internal rot, Basal plates pushing out 45-75%, Firmness okay, Firmness uneven, Early to mid-term storage onion, Stored fair.

Catskill: *Seminis sample,* Top sprouts light to moderate 1-2.5 cm, Root sprouts just starting to light 0-2.5 cm, Majority basal plate rot, Odd skin or internal rot, Basal plates just starting or pushing out 20-35%, Fairly firm onion, Mid to late term storage onion, Stored good to nice.

37 120: *Seminova sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority basal plate rot, Odd skin rot, Basal plates just starting or pushing out 5-25%, Fairly firm onion, Firmness slightly uneven, Mid to late term storage onion, Stored good to nice.

Oneida: *Bejo sample,* Top sprouts light 1-2.5 cm, Root sprouts just starting to light 0-2.5 cm, Basal plate or skin rot, Odd internal rot, Basal plates just starting or pushing out 10-35%, Firmness uneven, Mid-term storage onion, Stored fair to good.

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ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2021-2022 -- continued

Haeckero: *Seminova sample,* Top sprouts light to moderate 2.5-5 cm, Top sprouts lengths uneven, Root sprouts just starting to light 0-2.5 cm, Majority basal plate rot, Odd skin rot, Basal plates just starting to push out 5-20%, Firm onion, Late term storage onion, Stored good to excellent.

Inicium

Fortress: *Stokes sample,* Top sprouts light to moderate 1-2.5 cm, Root sprouts just starting to light 0-2.5 cm, Majority basal plate rot, Odd internal rot, Basal plates pushing out 10-20%, Firmness okay, Firmness slightly uneven, Mid to late term storage onion, Stored fair to good.

Lodestar: *American Takii sample,* Top sprouts just starting to moderate 0-2.5 cm, Root sprouts just starting 0-1 cm, Skin, basal plate and internal rot, Basal plates just starting or pushing out 10-30%, Fairly firm onion, Late term storage onion, Stored good to nice.

Switchback: *American Takii sample,* Top sprouts just starting to moderate 1-5 cm, Root sprouts light 1-2.5 cm, Majority skin rot, A few internal rot, Odd basal plate rot, Basal plates just starting or pushing out 15%, Slightly soft onion, Firmness uneven, Early to mid-term storage onion, Stored fair.

Prelesco: *Hazera sample,* Top sprouts moderate 2.5-5 cm, Root sprouts just starting to light 0-2.5 cm, Basal plate or skin rot, Basal plates just starting to push out 10-15%, Fairly firm onion, Firmness slightly uneven, Mid to late term storage onion, Stored good.

Outlander: *Stokes sample*, Top sprouts light to moderate 1-5 cm, Top sprouts lengths uneven, Root sprouts just starting to light 0-2.5 cm, Basal plate or skin rot, Odd internal rot, Basal plates pushing out 15-60%, Soft onion, Firmness uneven, Early to mid-term storage onion, Stored a little poor to fair.

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ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2021-2022 -- continued

Overlook: *Seminis sample,* Top sprouts light to moderate 1-5 cm, Top sprouts lengths uneven, Root sprouts just starting to light 0-2.5 cm, Majority basal rot, Some skin rot, Basal plates pushing out 20-45%, Firmness okay, Firmness uneven, Early to mid-term storage onion, Stored fair.

Trailblazer: *American Takii sample,* Top sprouts light to moderate 1-2.5 cm, Root sprouts just starting 0-1 cm, Basal plate or skin rot, Basal plates just starting to push out 5-20%, Firmness slightly uneven, Mid to late term storage onion, Stored fair to good.

37 120: **Inicium** *Seminova sample,* Top sprouts just starting to moderate 0-2.5 cm, Root sprouts just starting to light 0-2.5 cm, Majority basal plate rot, Some internal rot, Basal plates just starting to push out 5-20%, Fairly firm onion, Firmness slightly uneven, Mid to late term storage onion, Stored good.

Dawson: *Bejo sample,* Top & root sprouts just starting to light 0-2.5 cm, Majority basal plate skin rot, Some skin rot, Basal plates just starting or pushing out 15-75%, Fairly firm onion, Mid to late term storage onion, Stored good.

SV NY 7333: *Seminis sample,* Top sprouts light to moderate 1-5 cm, Top sprouts lengths uneven, Root sprouts light 1-2.5 cm, Sprouting is a concern, Majority internal rot, Odd basal plate or skin rot, Basal plates just starting to push out 10-35%, Fairly firm onion, Firmness uneven, Mid-term storage onion, Stored fair to good.

Frontier: *American Takii sample,* Top sprouts light to moderate 1-5 cm, Top sprouts lengths uneven, Top sprouts are a concern, Root sprouts just starting to light 0-2.5 cm, Majority skin rot, Some basal plate rot, Basal plates just starting to push out 10-35%, Firmness uneven, Mid-term storage onion, Stored fair.

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ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2021-2022 -- continued

37 126: *Hazera sample,* Top & root sprouts just starting to light 0-2.5 cm, Majority skin rot, Some basal plate rot, Odd internal rot, Basal plates just starting to pushing out 10%, Firmness slightly uneven, Mid to late term storage onion, Stored fair to good.

Nogal: *Enza Zaden sample,* Top sprouts just starting to moderate 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority basal plate rot, Odd internal or skin rot, Basal plates just starting to push out 5-15%, Fairly firm onion, Firmness uneven, Mid to late term storage onion, Stored fair to good.

Traverse: *American Takii sample,* Top sprouts just starting to moderate 0-5 cm, Root sprouts just starting to light 0-2.5 cm, Majority basal plate rot, Some skin or internal rot, Basal plates just starting or pushing out 15-45%, Firmness uneven, Mid-term storage onion, Stored fair to good.

Mountaineer: *American Takii sample,* Top sprouts light to moderate 1-2.5 cm, Root sprouts just starting to light 1-2.5 cm, Internal or basal plate rot, Basal plates just starting to push out 15-20%, Fairly firm onion, Firmness slightly uneven, Mid-term storage onion, Stored a little poor to good.

Saddleback: *Stokes sample,* Top sprouts moderate 2.5-5 cm, Top sprouts are a concern, Root sprouts just starting to light 0-2.5 cm, Majority basal plate rot, Some skin rot, Odd internal rot, Basal plates pushing out 35-40%, Onion slightly soft, Firmness uneven, Early to mid-term storage onion, Stored a little poor to fair.

Highlander: *American Takii sample,* Top sprouts moderate 1-5 cm, Root sprouts just starting to light 0-2.5 cm, Sprouting is a concern, Majority skin rot, Odd internal rot, Basal plates pushing out 15-65%, Soft onion, Firmness uneven, Early storage onion, Stored poor.

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ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2021-2022 -- continued

Caesar: *Clifton sample,* Top sprouts light to moderate 1-2.5 cm, Top spouts lengths uneven, Root sprouts just starting to moderate 0-2.5 cm, Sprouting is a concern, Majority basal plate rot, Some internal rot, Basal plates pushing out 15-30%, Fairly firm onion, Firmness slightly uneven, Mid to late term storage onion, Stored good.

SV NY 7331: *Seminis sample,* Top sprouts light to moderate 1-5 cm, Top sprouts lengths uneven, Root sprouts just starting to moderate 0-2.5 cm, Sprouting is a concern, Majority basal plate, Odd internal rot, Basal plates just starting to push out 15-20%, Firmness slightly uneven, Mid to late term storage onion, Stored fair to good.

Y 604: *Seminova sample,* Top sprouts light to heavy 1-2.5 cm, Root sprouts light to moderate 1-2.5 cm, Sprouting is a concern, Majority basal plate rot, Odd internal rot, Basal plates just starting to push out 20-35%, Fairly firm onion, Firmness slightly uneven, Mid to late term storage onion, Stored poor to good.

37 118: *Seminova sample,* Top sprouts light to heavy 1-5 cm, Top sprouts lengths uneven, Root sprouts light 1-2.5 cm, Root spouts a concern, Majority basal plate rot, Odd skin rot, Basal plates pushing out 10-25%, Fairly firm onion, Firmness slightly uneven, Mid to late term storage onion, Stored a little poor to good.

Trident: *Crookham sample,* Top sprouts light to moderate 1-5 cm, Top sprouts lengths uneven, Top sprouts are a concern, Root sprouts just starting to light 0-2.5 cm, Internal or basal plate rot, Basal plates pushing out 10-55%, Firmness slightly uneven, Early to mid-term storage onion, Stored poor to fair.

Mondella: *Bejo sample,* Top sprouts just starting to moderate 0-2.5 cm, Root sprouts light to moderate 1-2.5 cm, Sprouting is a concern, Majority basal plate rot, Odd internal rot, Basal plates pushing out 65-70%, Fairly firm onion, Mid to late term storage onion, Stored a little poor to good.

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ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2021-2022 -- continued

Venecia: *Bejo sample,* Top sprouts moderate 2.5-5 cm, Root sprouts light to moderate 1-2.5 cm, Sprouting is a concern, Majority skin rot, Basal plates just starting or pushing out 15-35%, Mid-term storage onion, Stored a little poor.

Elyse: *Enza Zaden sample,* Top sprouts light to heavy 1-5 cm, Root sprouts just starting to moderate 0-2.5 cm, Majority skin rot, Odd internal rot, Rot is a concern, Basal plates pushing out 35-60%, Soft onion, Firmness uneven, Early storage onion, Stored poor.

Scout: *Crookham sample,* Top sprouts light to heavy 1-5 cm, Top sprouts lengths uneven, Root sprouts just starting to light 0-2.5 cm, Majority basal plate rot, Odd skin rot, Basal plates just starting to push out 15-20%, Firmness okay, Early to mid-term storage onion, Stored a little poor.

Check out the Muck Crops Research Station's IPM Twitter Account

The Muck Crops Research Station launched a Twitter account in 2014. The account communicates brief updates of the Station's IPM program along with other information to our growers, industry reps and academic personnel. The tweets consist of important pest alerts, reminders of up and coming events and other information that we hope will be helpful to our followers. So take some time, follow us and stay informed.

@MuckIPM

twitter

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
CANADA MAPLE	Sto	9	83.3	8.3	8.3	NA	7.40
TAURUS	Sem	9	82.9	7.3	9.8	NA	5.85
MILLENNIUM	BCSVS	8	82.8	6.6	10.5	4.95	6.85
TAHOE	Bejo	9	82.8	5.0	11.9	9.70	7.68
LA SALLE	Sem	12	82.3	6.3	11.0	9.43	6.60
SCORPION	Cro	5	81.1	6.4	13.6	9.76	7.36
TRAILBLAZER	Tak	14	81.0	5.6	12.5	9.76	7.50
PATTERSON	Bejo	14	81.0	6.1	12.2	9.85	7.61
PULSAR	BCSVS	7	80.7	5.6	12.9	9.29	7.00
TRAPPS #8	E.J.	9	79.9	8.9	11.3	NA	6.35
TREKKER	Tak	11	79.1	7.0	13.2	9.88	6.64
STANLEY	CF	24	79.0	6.8	13.4	9.85	7.25
HAMLET	Sem	25	78.1	7.4	15.2	9.60	6.46
POWELL	Bejo	6	77.6	7.6	14.0	9.92	6.68
NEBULA	Nun	8	77.2	5.8	16.3	9.60	7.40
SAFRANE	Bejo	15	76.1	6.6	16.4	9.81	7.34
CHAMP	Sol	7	76.1	5.8	17.4	9.91	7.51
LIVINGSTON	Sol	13	76.1	6.9	13.8	9.70	6.90
BRADDOCK	Bejo	17	76.0	6.5	17.1	9.54	6.75

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
FORTRESS	Sem	28	75.3	8.1	16.5	9.60	6.88
ARSENAL	Sem	13	74.7	7.0	18.7	9.65	6.02
POCONO	Sem	7	74.7	6.4	18.0	9.66	6.66
PRINCE	Bejo	24	73.9	8.9	17.9	9.70	6.92
PARAGON	BCSVS	10	73.5	11.2	17.1	9.00	6.90
TAMARA	Bejo	9	71.9	9.9	21.8	9.85	6.75
MILESTONE	Tak	20	71.6	6.5	21.2	9.59	5.86
MOUNTAINEER	Tak	10	71.1	6.1	22.4	9.38	6.69
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
CROCKETT	Bejo	10	69.2	7.6	22.4	9.90	7.69
CATSKILL	Sem	7	69.1	6.7	23.7	9.69	6.37
FRONTIER	Tak	27	68.5	7.7	24.6	9.83	7.08
TRAVERSE	Tak	6	66.0	7.4	25.8	9.50	6.60
RIDGE LINE	Tak	6	65.1	6.9	27.1	9.85	5.87
HUSTLER	HM	11	64.1	9.9	27.8	8.00	5.30
SADDLEBACK	Sem	6	62.8	6.7	30.0	9.57	5.97
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 – 2022

Compared to the previous 10-year average, air temperatures in 2022 were above average for May (15.1°C), average for June (18.3°C), August (20.6°C) and September (16.5C), and below average for July (20.2°C). The 10-year average temperatures were: May 13.7°C, June 18.9°C, July 21.4°C, August 20.4°C and September 16.3°C. Monthly rainfall was below the 10-year average for May (50 mm) and September (43 mm) and average for June (90 mm), July (74mm) and August (82 mm). The 10-year rainfall averages were: May 64 mm, June 97 mm, July 78 mm, August 79 mm and September 59 mm.

Seasonal temperatures in April allowed for the ground frost to thaw and by the end of April the soil was satisfactory for seeding. Rain fall 1 - 4 May (20.4 mm) prior to seeding created uneven soil moisture levels throughout the trial. Onion seeding in the Holland Marsh began the last week of April and was pretty much completed by the 10th of May. The trial was seeded on 6 & 7 May. Day time air temperatures were in the mid teens with a mix of sun and cloud, however nightime air temperatures were in the low single digits. Day time air temperatures increased to the twenties four days after seeding and remained so for approximately one week however, nightime air temperatures remained in the single digits to low teens. The month of May recorded below average rainfall and half an inch of irrigation water was applied 10 days after seeding to ensure soil moisture remained adequate for seed germination. Onion emergence was good and plant vigor and stand were satisfactory. By 23 May the onions were in late loop and the herbicide Prowl was applied at the recommended rate. A half inch of irrigation water was applied on 26 May to help activate the Prowl and aid the growth of the onions. By 8 June the second true leaf was fully grown and the herbicide Frontier was applied at the recommended rate. A half inch of irrigation water was applied on 10 June to help activate the Frontier. Weed pressure was moderate for the entire season. Several applications of Pardner + Goal were applied, and numerous hand weeding were required to keep the trial free from weeds. Monthly average rainfall amounts from June to August allowed the onions to maintain steady growth. When leaf lengths were recorded on 28 July, the average leaf length was 73.9 cm slightly better then 2021 and 2020 at 72.4 and 70.9 cm respectively. Significant differences were found in average leaf length between the first and third replicates. The third replicate had the longest average leaf length and the first replicate had the shortest average leaf length.

On-station monitoring for onion maggot fly emergence began on 17 May with 0.75 flies/trap/day. There were three peaks in onion maggot fly numbers during the monitoring period. Counts peaked at 6.6 flies/trap/day on 9 June, 7.0 flies/trap/day on 14 July and 28.3 flies/trap/day on 13 August. For the remainder of the monitoring period onion maggot fly numbers never reached over 4 flies/trap/day. Onion maggot population was moderately high for the first two peaks and significantly high for the third peak. Remarkably at evaluation there was only a trial average of 1.8 % onion maggot damage. The new seed treatments of Sepresto and Evergol appeared to give good control for the entire season.

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RED ONION CULTIVAR TRIAL SEASON SUMMARY - 2022 – continued

Thrips were first found on 16 June and were present throughout the growing season. Onion thrips numbers in the variety trial reached 1.2 thrips/leaf on 4 July and remained above 1.0 thrips/leaf until 8 August. On 2 August the spray threshold of 3.0 thrips/leaf was reached. A insecticide application of Delegate on 5 August reduced the thrips numbers below 1.0 thrips/leaf and remained so till monitoring stopped in September. Environmental conditions were favourable for fungal diseases to develop throughout the season. Stemphylium leaf blight was found in the cultivar trial on 4 July and several fungicide applications (see Onion Management Procedures) kept severity to a minimum. Botrytis was not observed in the trial. Fungicide applications were applied to protect from downy mildew when the downy mildew forecast was moderate to high several times in August. No downy mildew developed in the trial.

Bulb development started as expected in late July. Most bulb sizing occurred in mid August. Cultivars E61D.10441 (28 July) and SV NT 1298 (8 August) were the first to lodge. It took approximately four weeks for 75% of the cultivars to reach 85% lodged. Half of the cultivars reached full maturity by 17 August when at least 85% of the onions had lodged. The average days to harvest was 107 days. On 23 September at harvest the majority of the onion tops dried down satisfactory. Eleven varieties had no seeders present and the remaining varieties had a small number of seeders. Cultivar SV 4643 NT had the highest average number of seeders 4.7 per 20m of row. On 8 September a sample from each cultivar was pulled for judging and comparison during Grower Field Day. By this time, most cultivars had lodged but leaves were 30-60% desiccated. The yield samples were harvested on 23 September. At harvest, a couple of the later maturing cultivars still had some moisture in the neck. Harvest samples from each cultivar were placed in storage on 13 October and cured artificially for approximately 48 hours.

At evaluation on 31 October through 4 November, quality was good and yields were below the desired bushel per acre. For two thirds of the cultivars the majority of bulbs were 2½-3" diameter size range. The trial average yield of 1234 bu/A was a 200 bu/A increase from last year and similar to the 2019 trial average yield of 1223 bu/A. The average percentage of jumbos (>3" diameter) was 27.7%. This is an decrease of 5% from 2021. Cultivars SV 4643 NT and SV Red Nugent had the most bulbs in the >3" category. The third replicate had significantly lower number of jumbos compared to the other two replicates. Uniformity of shape was variable with cultivars Red Stone and Comrad having the best uniformity and Red Nugent the poorest. Uniformity of size was variable, with Rubillion receiving a very good rating of 7.7 while nine other cultivars had an average or poor rating.

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RED ONION CULTIVAR TRIAL SEASON SUMMARY - 2022 – continued

Nine of the 16 cultivars evaluated had a very respectable 93% percent marketable or greater, and the average percent marketable for all cultivars was 91.6%. The majority of culls were peewee with doubles being the second most common cull. Skin quality was good at evaluation. All cultivars had good skin attachment with only the odd onion having minor cracking. The trial average for skin attachment was 8.2 the highest rating in red onion trial history. Exterior colour was satisfactory on most varieties. Most cultivars had a very low incidence of skin blemishes. Interior ring colour was acceptable, however some cultivars had several center rings lacking colour. When onions were cut in half for interior colour evaluation, it was noted that eleven cultivars had a high percentage of double or multiple centers. Cultivar Tannat had the highest percentage of single centers (90 %). There was limited mechanical damage found in all cultivars. Neck finishes were dry and tight, and most cultivars scored well. This confirmed that the onions had matured naturally by the harvest date. The neck finish was significantly better in the second replicate then the first replicate. At evaluation all cultivars had maintained good firmness and cultivar Red Stone had the best firmness with a rating of excellent, 9.2. Maggot damage to onion bulbs in the evaluation samples ranged from 0-5.2% with a trial average of 1.8%. This is a 50% increase in average onion maggot damage for the trial compared to the 2021 season (0.6%). Cultivar 8140 had no onion maggot damage and Barolo had a high percentage of damage 5.2%.

RED ONION CULTIVAR TRIAL – 2022

MANAGEMENT PROCEDURES

Fertilizer:

90 kg/ha Nitrogen (Calcium Ammonium Nitrate 27-0-0) + 100 kg/ha Phosphorous (MESZ 10-40-0) + 220 kg/ha Potassium (ASPIRE 0-0-58) + 120 kg/ha K–Mag (0-0-22) + 35 kg/ha Manganese + 5 kg/ha Copper (99% Cu) was worked into the soil on 28 April.

A side dressing blend of 12 kg/ha Nitrogen + 10 kg/ha Phosphorous + 58 kg/ha Potassium was applied on 29 June.

Seeded:

All trials were seeded on 6 & 7 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 for all seed not seed treated. The Main Trial was replicated three times.

Weed Control:

Post-emergence:

1 application: **PROWL H2O** 6.0 L/ha on 23 May.
2 applications: **PARDNER** at 70 ml/ha and **GOAL** at 70 ml/ha and Manganese at 1.0 kg/ha on 30 May and 3 June.
1 application: **FRONTIER** at 1.0 L/ha on 8 June
1 application **PARDNER** at 70 ml/ha and **GOAL** at 175 ml/ha and Manganese at 2.0 kg/ha on 14 June.
1 application **PARDNER** at 200 ml/ha and **GOAL** at 200 ml/ha and Manganese at 2.0 kg/ha on 22 June.

Minor Elements:

Eight foliar sprays: Mag Max on 10 & 29 June (2.0 L/ha), 8, 22 & 27 July and 5, 12 & 19 August (3.0 L/ha)
Seven foliar sprays: Calcimax on 2 June (1.0 L/ha), 10 & 29 June (2.0 L/ha) and 8, 22 & 27 July and 5 August (3.0 L/ha)
Six foliar sprays: Zinc Max on 2 June and 22 July (1.0 L/ha), 10 June, 8 & 27 July and 5 August (2.0 L/ha)
Six foliar sprays: Alexin on 22 & 27 July and 5, 12, 19 & 24 August (3.0 L/ha)
Five foliar sprays: Manganese Sulfate on 27 July (1.0 kg/ha) and 10 & 19 June, 8 July and 5 August (2.0 kg/ha)
Five foliar sprays: Suprafeed on 27 July (2.0 kg/ha) and 22 July and 12, 19 & 24 August (3.0 kg/ha)

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RED ONION CULTIVAR TRIAL - 2022 - continued

Minor Elements continued:

Four foliar sprays: Copper Max 22 & 27 July and 5 & 12 August (2.0 L/ha)
Four foliar sprays: 20-20-20 on 2 June (1.0 kg/ha), 10 & 29 June (2.0 kg/ha) and 8 July (2.5 kg/ha)
Two foliar sprays: Nutri Bor on 19 August (1.0 L/ha) and 12 August (2.0 L/ha)
One foliar spray: Epsom Salt on 24 August (2.0 kg/ha)

Insect and Disease Control:

According to IPM recommendations.

DITHANE DG at 2.25 kg/ha and Minor Elements on 8 July.
MOVENTO at 365 ml/ha + **AGRAL 90** at 1.0 L/ha on 14 July.
MIRAVIS DUO at 1.0 L/ha on 21 July.
RIDOMIL MZ 2.25 kg/ha and Minor Elements on 22 July.
SERCADIS at 333 ml/ha + **MOVENTO** at 365 ml/ha + **AGRAL 90** at 1.0 L/ha and Minor Elements on 27 July.
APROVIA TOP at 750 ml/ha + **DELEGATE** at 336 g/ha and Minor Elements on 5 August.
ORONDIS ULTRA at 400 ml/ha + **MIRAVIS DUO** at 1.0 L/ha + **UP-CYDE** at 280 ml/ha and Minor Elements on 12 August.
DITHANE DG at 3.25 kg/ha + **DELEGATE** at 336 g/ha and Minor Elements on 19 August.
DITHANE DG at 2.25 kg/ha and Minor Elements on 24 August.

Harvest:

The trial was pulled on 14 & 15 September and topped on 23 September. The trial was placed in a forced air and temperature controlled storage 13 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 11	August 18		August 24	September 1		September 7
E61D 10441	SV NT 1608	Red Stone	Rubillion	Red Nugent	Ruby Ring	8140
	SV NT 4643	Comrad		Red Bull	Barolo	Red Carpet
	Red Mountain	SV NT 1298		Tannat	Red Wing	

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EVALUATION PROCEDURES

The cultivars were evaluated on 31 October through 4 November after 3 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

Overall Score:

Based on quality and general appearance.

Score:

The average of nine marks at evaluation from Uniformity of Shape to Firmness.

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RED ONION CULTIVAR TRIAL - 2022 - continued

Firmness:
10 = Desirable (solid and firm) 6.0 = Average (firm but some elasticity) 1.0 = Poor (spongy)

Interior & Exterior Colour:
LR = Light Red R = Red DR = Dark Red DDR = Deep Dark Red

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.

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.

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.

Top Height (cm):
The average length of 20 random onion tops from all three replicates from the ground to the tips of the leaves as taken on 14 July.
50 cm is equal to 20 inches.

Leaf Shape:
B = Leaves are bent or hanging U = Up right leaves, straight

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Leaf Colour:

LG = Light Green, G = Green, BG = Blue Green, DG = Dark Green

Irrigation:

Irrigation water was applied three times for the 2022 season:

17 May in the amount of ½ inch
26 May in the amount of ½ inch
10 June in the amount of ½ inch

RED ONION CULTIVAR TRIAL - 2022

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
8140'	Haz	51 d*	1.7 a	5 bcd	22 d-g	15 e	7 c	3.3 d
RUBILLION	Tak	98 bc	0.3 a	1 d	22 d-g	45 abc	27 bc	6.4 bc
RUBY RING	Tak	104 bc	0.0 a	1 d	14 fgh	56 a	29 bc	6.8 bc
RED CARPET	Bejo	108 bc	0.0 a	2 cd	35 ab	45 abc	21 bc	7.1 bc
RED WING	Bejo	105 bc	0.7 a	2 cd	36 a	41 a-d	19 bc	6.9 bc
TANNAT	EZ	103 bc	0.0 a	5 bcd	27 a-e	44 abc	22 bc	6.7 bc
RED STONE	Haz	103 bc	0.0 a	0 d	4 h	52 ab	41 b	6.7 bc
SVNT 1608	Sem	118 b	1.0 a	7 abc	31 a-e	45 abc	27 bc	7.7 b
RED BULL	Bejo	119 b	0.0 a	1 d	27 a-e	52 ab	31 bc	7.8 b
SV 4643 NT	Sto	99 bc	2.7 a	11 a	33 abc	31 cde	12 c	6.5 bc
COMRAD	CF	113 b	0.0 a	2 cd	24 b-f	52 ab	25 bc	7.4 b
RED NUGENT	Sto	103 bc	2.0 a	8 ab	33 a-d	34 bcd	17 bc	6.7 bc
RED MOUNTAIN	Bejo	161 a	0.0 a	2 cd	11 gh	49 abc	79 a	10.6 a
SV NT 1298	Sem	116 b	0.0 a	2 cd	24 c-f	49 abc	25 bc	7.6 b
E61D10441	EZ	75 cd	0.0 a	2 cd	8 h	23 de	31 bc	4.9 cd
BAROLO	EZ	91 bc	0.3 a	8 ab	21 efg	24 de	16 bc	5.9 bc
TRIAL AVERAGE		**104**	**0.5**	**3.6**	**23.3**	**41.1**	**26.8**	**6.8**

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 CULTIVAR TRIAL - 2022 - 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
8140'	Haz	11.75 de*	2.53 a-d	5.65 c-f	2.66 g	0.76 c	875 d	98.0 a	PW
RUBILLION	Tak	15.19 c	0.57 de	5.05 efg	7.00 a-d	2.50 bc	1140 bc	97.3 a	PW
RUBY RING	Tak	16.85 bc	0.24 de	3.36 fgh	9.95 a	3.10 bc	1256 abc	96.8 a	PW
RED CARPET	Bejo	19.17 ab	0.76 cde	8.41 ab	7.70 a-d	1.97 bc	1420 a	95.7 ab	PW
RED WING	Bejo	19.49 ab	1.12 cde	9.14 a	7.08 a-d	1.74 bc	1439 a	94.9 abc	PW
TANNAT	EZ	16.99 bc	1.44 b-e	6.21 b-e	7.05 a-d	1.82 bc	1246 abc	94.5 abc	PW
RED STONE	Haz	13.75 cd	0.00 e	0.83 h	8.56 abc	4.03 b	1012 cd	93.5 a-d	PW
SVNT 1608	Sem	18.66 ab	2.51 a-d	7.02 a-e	6.52 b-e	2.22 bc	1377 ab	93.2 a-d	PW
RED BULL	Bejo	19.70 ab	0.31 de	6.61 a-e	9.18 ab	3.03 bc	1443 a	93.0 a-d	PW
SV 4643 NT	Sto	20.74 a	4.90 a	8.17 a-d	4.88 d-g	1.12 c	1438 a	91.2 b-e	D
COMRAD	CF	16.88 bc	0.60 de	5.53 def	8.16 abc	2.19 bc	1243 abc	90.9 b-e	PW
RED NUGENT	Sto	20.75 a	3.70 ab	8.29 abc	5.65 c-f	1.55 bc	1447 a	90.3 cde	D
RED MOUNTAIN	Bejo	18.77 ab	0.73 cde	2.74 gh	7.54 a-d	7.09 a	1365 ab	87.8 def	PW
SV NT 1298	Sem	19.61 ab	0.77 cde	5.79 b-f	8.01 abc	2.49 bc	1286 ab	86.2 ef	D
E61D10441	EZ	9.03 e	0.54 de	1.84 h	3.30 fg	2.46 bc	614 e	85.3 f	PW
BAROLO	EZ	18.78 ab	3.20 abc	6.50 a-e	3.88 efg	1.54 c	1140 bc	76.5 g	D
TRIAL AVERAGE		**17.26**	**1.49**	**5.70**	**6.70**	**2.48**	**1234**	**91.6**	

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 CULTIVAR TRIAL - 2022 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Skin Thickness	Skin Attachment	Neck Finish	Overall Score	Score
8140'	Haz	G	6.3 a-d*	7.3 ab	6.3 cde	9.5 a	6.3 d	6.7 cd	7.35 cd
RUBILLION	Tak	FG	7.3 ab	7.7 a	7.3 b	8.3 a-d	7.7 bc	7.7 ab	7.85 ab
RUBY RING	Tak	HG	6.3 a-d	7.3 ab	6.7 bcd	8.3 a-d	6.7 d	7.7 ab	7.48 bcd
RED CARPET	Bejo	SpG	6.0 bcd	4.7 f	6.0 def	9.0 ab	6.7 d	6.7 cd	6.67 fg
RED WING	Bejo	G	6.7 a-d	5.7 def	6.7 bcd	9.2 ab	6.7 d	7.0 bcd	7.00 def
TANNAT	EZ	FG	5.7 bcd	5.0 ef	5.0 g	9.2 ab	6.3 d	7.0 bcd	6.65 fg
RED STONE	Haz	HG	8.0 a	6.3 bcd	8.3 a	8.7 abc	8.0 b	8.5 a	8.15 a
SVNT 1608	Sem	FG	6.3 a-d	5.7 def	5.7 efg	7.3 de	6.7 d	6.3 d	6.59 fg
RED BULL	Bejo	SpG	5.7 bcd	6.0 cde	6.7 bcd	9.2 ab	7.0 cd	7.7 ab	7.31 cde
SV 4643 NT	Sto	T	6.0 bcd	6.3 bcd	6.0 def	8.3 a-d	7.7 bc	7.0 bcd	7.00 def
COMRAD	CF	G	8.0 a	7.0 abc	5.7 efg	9.0 ab	8.3 ab	7.7 ab	7.70 abc
RED NUGENT	Sto	HGT	5.0 d	6.7 a-d	6.0 def	8.0 b-e	7.7 bc	7.3 bc	6.76 fg
RED MOUNTAIN	Bejo	G	5.3 cd	6.0 cde	7.0 bc	8.7 abc	8.3 ab	7.7 ab	7.43 bcd
SV NT 1298	Sem	HG	6.0 bcd	5.0 ef	5.3 fg	7.0 e	8.3 ab	6.3 d	6.57 fg
E61D10441	EZ	FG	7.3 ab	5.0 ef	7.0 bc	3.7 f	9.0 a	4.7 e	6.48 g
BAROLO	EZ	G	7.0 abc	4.7 f	6.7 bcd	7.7 cde	6.3 d	6.7 cd	6.83 efg
TRIAL AVERAGE			**6.4**	**6.0**	**6.4**	**8.2**	**7.4**	**7.0**	**7.11**

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 CULTIVAR TRIAL - 2022 - 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)
8140'	Haz	10.0 a*	9.0 ab	DR	7.3 cde	DR	7.3 abc	118 ab	0.0 a	248.9 a
RUBILLION	Tak	9.3 c	7.7 de	R	8.7 ab	R	8.3 a	100 ef	1.5 a	162.9 d-h
RUBY RING	Tak	9.8 ab	9.0 ab	R	7.7 bcd	R	7.7 ab	116 abc	0.3 a	162.6 d-h
RED CARPET	Bejo	9.8 ab	8.7 abc	R	6.3 efg	R	6.0 de	119 ab	2.5 a	178.3 b-f
RED WING	Bejo	10.0 a	8.5 a-d	DR	5.3 g	DR	7.3 abc	121 a	1.6 a	185.4 b-e
TANNAT	EZ	9.5 bc	8.0 cde	DR	5.7 fg	DR	8.0 a	115 abc	1.6 a	164.8 d-h
RED STONE	Haz	10.0 a	9.2 a	LR	8.3 abc	LR	8.0 a	101 ef	2.6 a	133.9 fgh
SVNT 1608	Sem	9.8 ab	8.3 a-d	DR	5.7 fg	DR	7.3 abc	101 ef	1.7 a	158.4 e-h
RED BULL	Bejo	9.8 ab	9.0 ab	R	8.3 abc	R	6.3 cde	112 bcd	0.3 a	167.6 c-h
SV 4643 NT	Sto	9.7 abc	8.0 cde	R	7.3 cde	R	6.3 cde	106 def	1.3 a	211.4 abc
COMRAD	CF	10.0 a	8.7 abc	R	8.3 abc	R	6.7 bcd	101 ef	0.9 a	150.0 e-h
RED NUGENT	Sto	9.7 abc	8.2 b-e	R	6.3 efg	R	5.7 de	108 cde	1.2 a	204.0 a-d
RED MOUNTAIN	Bejo	10.0 a	8.5 a-d	R	7.7 bcd	R	7.7 ab	102 ef	2.3 a	123.5 h
SV NT 1298	Sem	9.8 ab	7.8 cde	LR	6.7 def	LR	6.7 bcd	99 fg	2.1 a	168.7 c-g
E61D10441	EZ	8.2 d	7.3 e	DR	9.0 a	DR	5.3 e	91 g	3.0 a	124.8 gh
BAROLO	EZ	9.8 ab	8.5 a-d	DR	6.7 def	DR	7.3 abc	106 def	5.2 a	213.8 ab
TRIAL AVERAGE		**9.7**	**8.4**		**7.2**		**7.0**	**107**	**1.8**	**172.4**

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 CULTIVAR TRIAL - 2022 - 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
8140'	Haz	0.0 a*	37 c-f	50 a-e	13 bcd	3.3 a	9.2 ab	42.5 a	75.2 b-f	B	BG
RUBILLION	Tak	0.0 a	30 def	63 a-d	7 cde	0.3 a	1.4 de	22.5 bc	71.5 g	B	BG
RUBY RING	Tak	0.0 a	60 a-d	37 c-f	3 de	0.0 a	0.6 e	13.5 cde	73.7 fg	U	BG
RED CARPET	Bejo	0.0 a	40 c-f	53 a-d	7 cde	0.0 a	2.2 de	32.4 ab	77.2 a-e	U	BG
RED WING	Bejo	0.3 a	27 def	73 a	0 e	0.6 a	2.2 de	34.5 ab	77.5 abc	U	BG
TANNAT	EZ	1.0 a	90 a	10 f	0 e	0.0 a	4.5 b-e	25.9 bc	78.4 a	B	G
RED STONE	Haz	0.0 a	7 f	73 a	20 ab	0.0 a	0.0 e	3.6 e	64.0 h	U	G
SVNT 1608	Sem	0.7 a	57 a-d	40 b-f	3 de	0.8 a	5.6 a-e	26.0 bc	78.7 a	U	BG
RED BULL	Bejo	0.0 a	33 c-f	63 a-d	3 de	0.0 a	0.8 e	23.0 bcd	78.1 ab	U	G
SV 4643 NT	Sto	4.7 a	40 c-f	50 a-e	10 b-e	2.7 a	11.1 a	33.8 ab	77.4 a-d	B	BG
COMRAD	CF	0.0 a	80 ab	20 ef	0 e	0.0 a	1.5 de	21.2 bcd	74.3 d-g	B	BG
RED NUGENT	Sto	0.7 a	47 b-e	37 c-f	17 abc	1.9 a	7.4 a-d	31.7 ab	74.5 c-g	U	BG
RED MOUNTAIN	Bejo	0.0 a	67 abc	33 def	0 e	0.0 a	1.4 de	7.0 de	77.5 abc	U	G
SV NT 1298	Sem	0.0 a	20 ef	70 ab	10 b-e	0.0 a	2.0 de	20.3 bcd	74.1 efg	U	BG
E61D10441	EZ	0.0 a	17 ef	77 a	3 de	0.0 a	2.2 cde	11.1 cde	56.4 i	U	G
BAROLO	EZ	0.0 a	7 f	67 abc	27 a	0.4 a	8.8 abc	23.5 bcd	73.3 fg	U	G
TRIAL AVERAGE		**0.5**	**41**	**51**	**8**	**0.6**	**3.8**	**23.3**	**73.9**		

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 – 2022

8140: *Hazera sample,* Good appearance, Average tight neck finish, Neck finish a bit rough, Medium to large sized necks, Average to thick skin thickness, Pretty good to nice skin quality, Dark exterior colour slightly uneven, Odd one with brown or white spots on skins, Dark interior colour even, Dead centers white, Average to good interior blending, Average to good packer, Uniformity of shape even, Good firm onion, Firmness even, Large run size, Run size a little even, Several of the inner rings pure white, Mid to long term storage onion.

Rubillion: *American Takii sample,* Good to nice appearance, Good to great tight neck finish, Small to medium sized necks, Average to thick skin thickness, Pretty good to nice skin quality, Odd one with skin cracking, Nice exterior colour very even, Odd one with brown spots on skins, Fairly dark interior colour even, Dead centers white, Great interior blending, Good to nice packer, Uniformity of shape even, Average to good firmness, Firmness even, Small to medium run size, Run size a little uneven, Mid-term storage onion.

Ruby Ring: *American Takii sample,* Good to nice appearance, Average tight neck finish, Odd neck finish a bit rough, Medium sized necks, Average to thick skin thickness, Pretty good to nice skin quality, Odd vertical skin cracking, Good exterior colour even, Odd one with brown or white spots on skins, Slightly dark interior colour even, Dead centers white, Good to great interior blending, Good to nice packer, Uniformity of shape even, Nice firm solid onion, Firmness even, Small to medium run size, Run size a little uneven, Mid to long term storage onion.

Red Carpet: *Bejo sample,* Average to good appearance, Average tight neck finish, Neck finish a bit rough, Medium sized necks, Neck sizes uneven, Thicker skins, Pretty good to nice skin quality, Fairly dark exterior colour slightly uneven, Odd one with white spots on skins, Interior colour even, Dead centers white, Good interior blending, Average to good packer, Uniformity of shape uneven, Good firm onion, Firmness even, Medium run size uneven, Mid to long term storage onion.

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RED ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2022 continued

Red Wing: *Bejo sample,* Good appearance, Average to good tight neck finish, Odd neck finish a bit rough, Medium sized necks, Average to thick skin thickness, Nice skin quality, Dark exterior colour even, Odd one with white or brown spots on skins, Dark interior colour uneven, Dead centers white, Poor to good interior blending uneven, Average to nice packer, Uniformity of shape a little uneven, Good firm onion, Firmness even, Medium to large run size, Run size a little uneven, Several of the inner rings pure white, Mid to long term storage onion.

Tannat: *Enza Zaden sample,* Good to nice appearance, Average tight neck finish, Neck finish a bit rough, Medium to large sized necks, Average skin thickness, Pretty good skin quality, Skin rot slight concern, Nice dark exterior colour even, Dark interior colour, Dead centers white, Average to good interior blending a little uneven, Good packer, Uniformity of shape a little uneven, Average firmness, Firmness even, Medium run size, Run size very uneven, Mid-term storage onion.

Red Stone: *Hazera sample,* Good to nice appearance, Good to great tight neck finish, Small to medium sized necks, Average to thick skin thickness, Nice skin quality, Odd one with skin cracking, Slightly light exterior colour even, Odd one with brown or white spots on skins, Light pale interior colour even, Dead centers white, Good interior blending, Good packer, Uniformity of shape very even, Nice firm solid onion, Firmness very even, Small to medium run size, Run size a little uneven, Long term storage onion.

SV NT 1608: *Seminis sample,* Average appearance, Average to good tight neck finish, Odd neck finish a bit rough, Medium sized necks, Average skin thickness, Fair to average skin quality, A few with skin cracking, Dark exterior colour uneven, Dark interior colour even, Dead centers white, Average to good interior blending, Okay to average packer, Uniformity of shape a little even, Average to good firmness, Firmness even, Medium run size, Run size uneven, Mid-term storage onion.

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RED ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2022 continued

Red Bull: *Bejo sample,* Good to nice appearance, Average to good tight neck finish, Odd neck finish a bit rough, Medium sized necks, Average to thick skin thickness, Pretty good to nice skin quality, Fairly dark exterior colour slightly uneven, Odd one with browning or white spots on skins, Fairly dark interior colour uneven, Dead centers white, Good to great interior blending, Good to nice packer, Uniformity of shape uneven, Nice firm solid onion, Firmness even, Medium run size, Run size a little uneven, Suspicion of doubles, Long term storage onion.

SV 4643 NT: *Stokes sample,* Average to good appearance, Average tight neck finish, Odd neck finish rough, Medium sized necks, Average skin thickness, Average to pretty good skin quality, Odd one with skin cracking, Exterior colour a little uneven, Interior colour even, Dead centers white, Average to good interior blending even, Average to good packer, Uniformity of shape uneven, Average firmness, Firmness even, Medium to large run size, Run size uneven, Doubles are a concern, Mid-term storage onion.

Comrad: *Clifton sample,* Good to nice appearance, Good tight neck finish, Small to medium sized necks, Average skin thickness, Pretty good skin quality, Odd one with skin cracking, Fairly dark exterior colour a little uneven, Some brown spots on skins, Interior colour even, Dead centers white, Good to great interior blending even, Good to nice packer, Uniformity of shape a little even, Good firm onion, Firmness even, Small to medium run size, Run size uneven, Mid to long term storage onion.

Red Nugent: *Stokes sample,* Average to good appearance, Average to good tight neck finish, Odd neck finish a bit rough, Medium sized necks, Average to thick skin thickness, Fair to pretty good skin quality, Odd one with skin cracking, Odd basal plate or skin rot, Exterior colour uneven, Some with brown or white spots on skins, Slightly dark interior colour even, Dead centers white, Average to good interior blending, Okay to good packer, Uniformity of shape very uneven, Good firm onion, Firmness even, Medium to large run size, Run size a little uneven, Suspicion of doubles, Mid-term storage onion.

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RED ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2022 continued

Red Mountain: *Bejo sample,* Good to nice appearance, Good tight neck finish, Small to medium sized necks, Average skin thickness, Pretty good to nice skin quality, Odd one with skin cracking, Fairly dark exterior colour even, Odd one with brown spots on skins, Fairly dark interior colour even, Dead centers white, Good to great interior blending even, Good to nice packer, Uniformity of shape uneven, Good firm onion, Firmness even, Small to large run size, Run size uneven, Mid to long term storage onion.

SV NT 1298: *Seminis sample,* Average to good appearance, Good tight neck finish, Small to medium sized necks, Average skin thickness, Fair to average skin quality, Odd one with skin cracking, Slightly pale exterior colour uneven, Odd one with brown spots on skins, Light interior colour slightly uneven, Dead centers white, Average to good interior blending, Average to good packer, Uniformity of shape a little uneven, Average firmness, Firmness a little uneven, Medium run size, Run size uneven, Suspicion of doubles some concern, Early to mid-term storage onion.

E61D 10441: *Enza Zaden sample,* Poor appearance, Perfect tight neck finish, Small sized necks, Thin skins, Poor skin quality, Most with skin cracking a big concern, Skin rot, Fairly dark exterior colour uneven, Odd one with brown spots on skins, Dark interior colour even, Dead centers white, Great interior blending even, Poor packer, Uniformity of shape a little uneven, Average firmness, Firmness even, Run size mixed, Run size uneven, Suspicion of doubles, Odd one with mechanical damage, Early to mid-term storage onion.

Barolo: *Enza Zaden sample,* Fair to good appearance, Average tight neck finish, Neck finish rough, Medium sized necks, Average to thick skin thickness, Fair to nice skin quality, Some with skin cracking a little concern, Odd basal plate rot, Dark exterior colour uneven, Odd one with white spots on skins, Fairly dark interior colour uneven, Dead centers white, Good interior blending, Okay to good packer, Uniformity of shape a little uneven, Good firm onion, Firmness even, Medium to large run size, Run size uneven, Suspicion of doubles concern, Mid to long 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
RED STONE	Haz	3	786	95.6	2.9	83	9.9	8.5	8.0	7.47	1.3	0.0
RUBILLION	Tak	6	901	94.4	23.3	86	9.1	7.0	8.0	6.99	2.4	0.0
SV 4643	Sem	7	1273	89.7	57.0	89	9.5	7.0	6.9	6.32	1.2	1.1
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 NUGENT	Sto	5	1344	89.4	56.5	94	9.4	6.8	6.9	6.07	2.1	0.1
RED MOUNTIAN	Bejo	4	1156	94.5	26.7	95	9.8	8.0	7.5	7.29	2.2	0.0
RED BULL	Bejo	8	1128	93.2	42.4	97	9.6	8.0	6.6	6.90	1.1	0.2
RUBY RING	Tak	9	972	95.1	23.7	98	9.7	7.5	7.0	6.81	1.4	0.0
RED CARPET	Bejo	6	1170	93.6	40.8	102	9.8	8.3	6.4	6.99	1.3	0.0
RED WING	Bejo	8	1311	96.8	54.0	109	9.7	8.2	6.6	7.20	0.5	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: In = Evaluated at time of Harvest Out = Evaluated in December

MAIN RED ONION STORAGE TRIAL 2021 - 2022

Cultivar	Source	% Marketable	% Weight Loss	% Sprouts	% Rot	% Soft	Firmness In **	Firmness Out **	% Sprouting at Base	% Sprouting at Top
RED STONE	Haz	84.4 a*	4.8 d	9.3 e	0.6 d	0.0 c	9.8 ab	6.8 ab	5 d	4 c
RUBILLION	Tak	69.0 ab	6.7 cd	17.6 cde	5.6 cd	0.2 bc	9.2 cd	6.5 bc	12 bcd	13 abc
RUBY RING	Tak	61.1 abc	10.1 ab	15.6 de	12.0 bc	0.3 bc	10.0 a	5.7 cde	14 bcd	14 abc
RED BULL	Bejo	59.1 bcd	7.7 a-d	26.4 b-e	5.4 cd	0.3 bc	10.0 a	7.8 a	27 bcd	7 bc
RED CARPET	Bejo	52.5 bcd	8.1 abc	32.8 a-e	5.9 cd	0.0 c	10.0 a	7.2 ab	36 a-d	13 abc
TANNAT	EZ	49.6 bcd	9.5 abc	31.2 a-e	8.6 cd	0.4 bc	9.0 d	6.5 bc	28 bcd	17 abc
SV 4643 NT	Sto	48.8 bcd	9.7 abc	18.6 b-e	19.7 ab	2.5 ab	9.7 abc	5.3 de	10 cd	12 abc
RED MOUNTAIN	Bejo	47.1 bcd	7.6 bcd	41.0 abc	3.6 cd	0.0 c	9.5 a-d	7.2 ab	42 abc	29 ab
SV NT 1298	Sem	45.7 bcd	9.8 abc	15.9 de	22.8 a	4.6 a	10.0 a	5.7 cde	6 d	9 bc
TANNAT Inicium	SN	45.2 bcd	9.1 abc	41.4 ab	3.7 cd	0.0 c	9.5 a-d	6.2 b-e	47 ab	21 abc
RED BERET	Cro	41.5 cd	10.2 ab	34.8 a-d	12.7 bc	0.0 c	9.5 a-d	6.3 bcd	37 a-d	32 a
RED NUGENT	Sto	39.6 cd	10.8 a	18.1 b-e	27.8 a	3.1 a	9.3 bcd	5.2 e	11 cd	14 abc
RED WING	Bejo	34.60 d	8.7 abc	51.8 a	4.2 cd	0.0 c	10.0 a	6.5 bc	68 a	12 abc
TRIAL AVERAGE		**52.2**	**8.7**	**27.3**	**10.2**	**0.9**	**9.7**	**6.4**	**26**	**15**

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 - 2021-2022

Red Stone: *Hazera sample,* Top & root sprouts just starting 0-1 cm, All skin rot, Basal plates just starting to push out 2-5%, Firm onion, Mid to late term storage onion, Stored fair to nice.

Rubillion: *American Takii sample,* Top & root sprouts just starting to light 0-1 cm, Majority skin rot, Odd internal rot, Basal plates just starting to push out 5-10%, Slightly firm, Firmness slightly uneven, Mid to late term storage onion, Stored good.

Ruby Ring: *American Takii sample,* Top sprouts light to moderate 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Some internal rot, Basal plates just starting to push out 5-40%, Firmness okay, Early to mid-term storage onion, Stored a little poor to okay.

Red Bull: *Bejo sample,* Top & root sprouts just starting to light 0-2.5 cm, Majority skin rot, Odd basal plate or internal rot, Basal plates just starting to push out 5-20%, Firmness okay to fair, Firmness slightly uneven, Mid to late term storage onion, Stored good to excellent.

Red Carpet: *Bejo sample,* Top & root sprouts just starting to light 0-2.5 cm, Skin or internal rot, Basal plates just starting or pushing out 10-35%, Fairly firm, Mid to late term storage onion, Stored okay to good.

Tannat: *Enza Zaden sample,* Top sprouts just starting to moderate 0-2.5 cm, Root sprouts just starting to light 0-1 cm, Majority skin rot, Odd internal rot, Basal plates just starting or pushing out 10-25%, Slightly firm, Mid to late term storage onion, Stored a little poor to good.

SV 4643 NT: *Stokes sample,* Top sprouts light to moderate 1-5 cm, Top sprouts lengths uneven Root sprouts just starting to light 0-2.5 cm, Majority skin rot, Odd internal rot, Basal plates just starting or pushing out 15-40%, Onion slightly soft, Firmness slightly uneven, Mid-term storage onion, Stored poor to okay. …/continued

RED ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2021-2022 - continued

Red Mountain: *Bejo sample,* Top sprouts light to moderate 1-5 cm, Root sprouts just starting to light 0-2.5 cm, Internal & skin rot, Basal plates just starting or pushing out 5-30%, Fairly firm, Mid to late term storage onion, Stored a little poor to good.

SV NT 1298: *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, Rot is a concern, Basal plates just starting or pushing out 10-20%, Onion slightly soft, Firmness uneven, Early to mid-term storage onion, Stored a little poor to okay.

Tannat: **Inicium** *Seminova sample,* Top sprouts light to moderate 1-5 cm, Top sprouts lengths uneven, Root sprouts just starting to light 0-2.5 cm, Majority skin rot, Odd internal rot, Basal plates just starting or pushing out 10-40%, Firmness okay, Firmness slightly uneven, Mid to late term storage onion, Stored a little poor to good.

Red Beret: *Crookham sample,* Top sprouts light to moderate 1-2.5 cm, Root sprouts just starting to light 0-2.5 cm, Majority skin rot, A few internal rot, Basal plates just starting or pushing out 20-35%, Firmness uneven, Mid to late term storage onion, Stored fair.

Red Nugent: *Stokes sample,* Top sprouts light to moderate 1-5 cm, Top sprouts lengths uneven, Root sprouts just starting to moderate 0-2.5 cm, Majority skin rot, A few internal rot, Rot is a concern, Basal plates just starting or pushing out 15-20%, Soft onion, Firmness uneven, Early to mid-term storage onion, Stored a little poor.

Red Wing: *Bejo sample,* Top sprouts just starting to light 1-2.5 cm, Root sprouts just starting to moderate 0-2.5 cm, Root sprouts are a concern, Majority skin rot, A few internal rot, Basal plates just starting or pushing out 15-25%, Firmness slightly uneven, Mid-term storage onion, Stored poor to fair.

LONG TERM AVERAGES OF RED ONION STORAGE TRIALS

CULTIVAR	SOURCE	# YEARS TESTED	% MARKETABLE	% WT LOSS IN STORAGE	% ROT, SOFT & SPROUT	FIRMNESS * IN	FIRMNESS * OUT
RED MOUNTAIN	Bejo	5	60.7	5.6	33.0	9.63	7.10
RED BULL	Bejo	6	56.4	6.3	37.7	9.63	7.20
RUBY RING	Tak	7	56.3	6.8	33.4	9.56	6.40
RED WING	Bejo	5	54.6	6.1	39.6	9.54	6.76
RED HAWK	Bejo	5	49.7	6.5	45.0	8.58	6.10
SV 4643 NT	Sto	4	49.6	6.6	42.1	9.70	6.00
RED CARPET	Bejo	5	48.3	6.4	45.7	9.60	7.20
RED NUGENT	Sto	4	46.0	7.3	45.3	9.28	5.30
RUBILLION	Tak	5	35.7	6.1	57.6	8.84	6.34
RED SKY	Bejo	4	30.7	5.4	64.1	8.58	6.28
RED SPRING	Bejo	4	1.0	13.7	85.1	7.75	3.10

Listed in order of % Marketable. Storage period approximately 11 months.

* 10.0 = Most Desirable, 8.0 = Good, 6.0 = Average

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 (1971-2021)
- Research Reports
- Research Documents