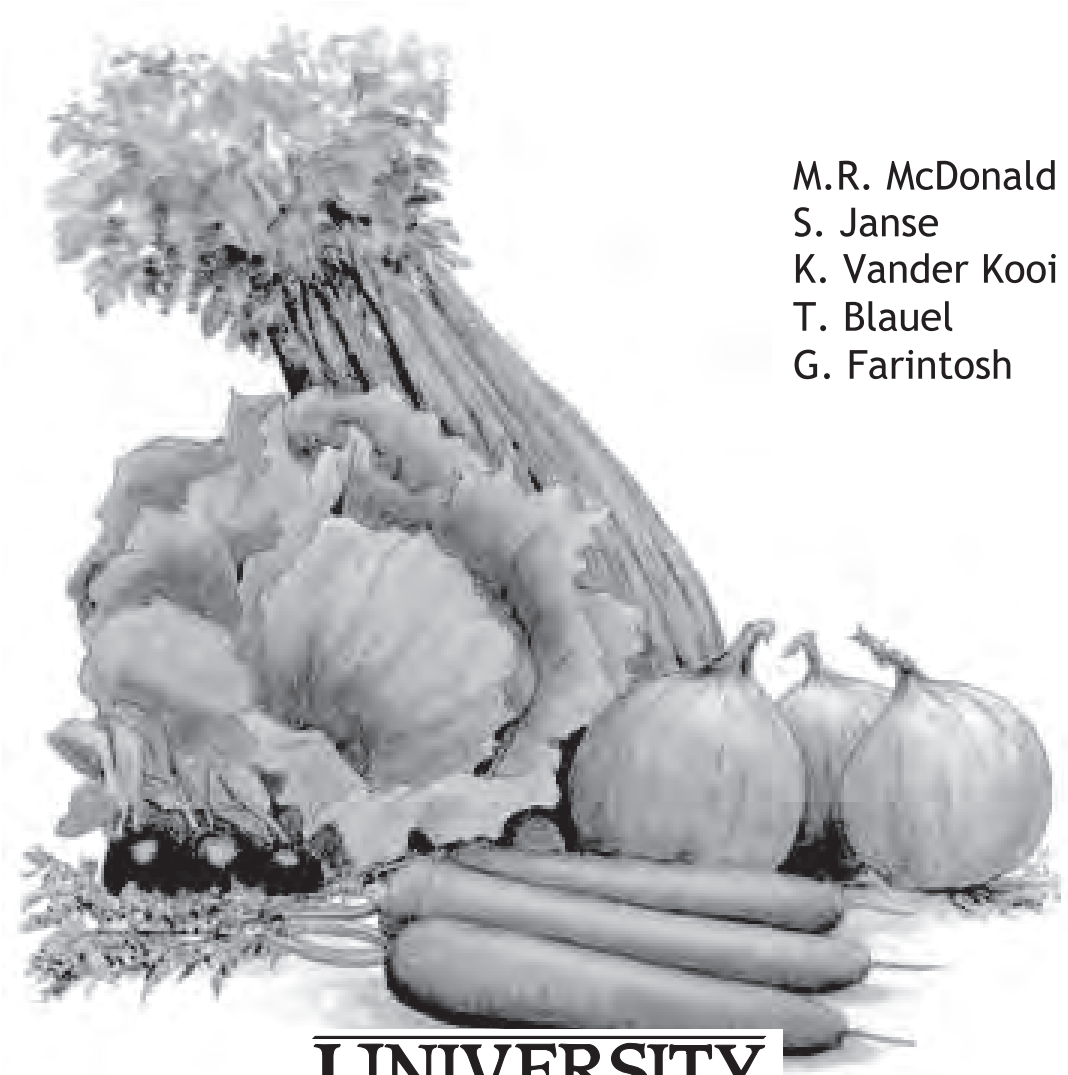
Muck Vegetable Cultivar Trial & Research Report 2023



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UNIVERSITY of GUELPH

Office of Research &
Dept. of Plant Agriculture
Report No. 73

Ontario Crops
Research Centre
Bradford, Ontario

Research and Cultivar Trial Report for 2023

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

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

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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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CULTIVAR TRIALS **Page**

STAFF - 2023

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
Tyler Blauel	IPM Supervisor / Agricultural Assistant
Afsaneh Sedaghatkish	Post Doctoral Fellow

IPM Scouts:

Olivia Heikkila	Eriel Strauch

Seasonal Contracts:

Scott Brassor	Summer Assistant
Jordie Di Blasio	Summer Assistant
Dorsa Gholibeigi	Summer Assistant
Noah Vander Kooi	Summer Assistant
Maia Davey	Summer Assistant
Adriana Verkaik	Summer Assistant

Graduate Students:

Emily McFaul	Department of Plant Agriculture
Umbrin Ilyas	Department of Plant Agriculture
Julia Scicluna	Department of Plant Agriculture
Michael Kooy	Department of Plant Agriculture
Neem Pandey	Department of Plant Agriculture
Kirsten Holy	Department of Plant Agriculture

CO-OPERATING COMPANIES 2023

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
Norm Charbonneau	Fresh Vegetable Growers of Ontario, Ridgetown, ON, Canada
Colin Smith	Sylvar Technologies Inc, Fredericton, NB, Canada
Tessa de Boer	Syngenta Canada Inc., Plattsville, ON, Canada
Jen Foster	Syngenta Canada Inc., Plattsville, ON, Canada
Chuck Baresich	Haggerty Creek Ltd, Bothwell, ON, Canada
Jason Gharibo	Haggerty Creek Ltd, Bothwell, ON, Canada
Cherly Truemen	Syngenta Canada Inc., Guelph, ON, Canada
Jessica Broe-Vayda	Bio Diffusion Technologies Inc., ON, Canada
Tyler Whale	Bio Diffusion Technologies Inc., ON, Canada

SEED SOURCES - 2023 - CULTIVAR TRIALS

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

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

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

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

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

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 2023.

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 2023, 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 2023 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 2023 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 2023

PRECIPITATION

Month	2013		2014		2015		2016		2017		2018	
	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	36	16	28	19	0	15	23	2	61	14	34	25
February	17	58	19	45	0	32	29	12	28	23	28	32
March	12	6	9	16	10	5	80	30	54	8	21	14
April	82	4	82	2	48	0	22	18	87	12	117	12
May	112	0	58	0	40	0	45	0	120	0	82	0
June	94	0	88	0	171	0	39	0	209	0	59	0
July	104	0	92	0	36	0	51	0	74	0	104	0
August	87	0	63	0	79	0	58	0	53	0	109	0
September	83	0	113	0	27	0	25	0	38	0	20	0
October	92	0	67	0	54	0	41	0	99	0	69	0
November	24	15	24	5	40	0	40	5	22	11	63	31
December	29	40	11	22	39	3	20	65	2	32	44	10
Annual	**772**	**139**	**654**	**109**	**544**	**55**	**473**	**132**	**847**	**100**	**750**	**124**
Total Precip.	**911**		**763**		**599**		**605**		**947**		**874**	

LTA = Long Term Average for U of Guelph, Dept. of Plant Agriculture - Kettleby
1125 Woodchoppers Lane, King, ON, L7B 0E9 49 Years (1975-2023)

PRECIPITATION

Month	2019		2020		2021		2022		2023		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	14	52	84	24	4	22	1	46	38	33	**21**	**28**
February	14	43	0	44	5	44	25	41	45	24	**20**	**27**
March	39	17	42	5	34	3	21	21	17	35	**31**	**14**
April	89	0	30	0	44	4	44	5	28	0	**56**	**4**
May	77	0	38	3	22	0	50	0	52	0	**71**	**0**
June	100	0	77	0	56	0	90	0	82	0	**81**	**0**
July	93	0	58	0	105	0	74	0	113	0	**85**	**0**
August	80	0	140	0	41	0	82	0	61	0	**79**	**0**
September	61	0	65	0	173	0	43	0	4	0	**78**	**0**
October	74	0	61	0	77	0	30	0	35	0	**67**	**1**
November	27	31	27	22	24	13	43	10	42	2	**50**	**10**
December	44	40	29	39	36	21	43	12	52	15	**27**	**28**
Annual	**712**	**183**	**651**	**138**	**621**	**107**	**546**	**135**	**569**	**109**	**666**	**112**
Total Precip.	**895**		**789**		**728**		**681**		**678**		**777**	

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

Month	2013		2014		2015		2016		2017		2018	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
January	2.1	-6.3	-3.9	-14.7	-3.2	-13.1	0.4	-7.8	0.8	-5.2	3.3	-3.2
February	-1.0	-10.3	-2.2	-17.3	-8.2	-19.8	1.9	-8.3	3.7	-5.0	1.7	-7.7
March	3.7	-4.3	1.9	-12.2	2.7	-7.4	6.6	-2.8	3.4	-5.0	2.9	-4.5
April	11.4	0.7	11.9	0.3	13.0	0.8	10.3	-1.7	14.4	3.4	7.0	-1.9
May	21.8	7.6	20.9	6.6	23.5	8.3	21.2	6.3	17.3	7.2	23.4	9.0
June	24.2	12.8	27.1	11.6	23.8	11.8	26.2	11.1	24.1	12.8	25.1	12.2
July	27.5	15.1	25.9	12.5	28.1	13.3	28.8	15.3	26.4	14.9	28.4	15.0
August	26.7	12.4	25.8	12.5	25.7	13.2	29.6	15.5	25.2	12.6	27.8	16.9
September	22.4	8.1	22.8	8.5	25.9	12.1	24.8	10.0	25.0	9.6	23.7	11.3
October	16.3	4.6	15.3	5.5	14.6	3.9	15.9	5.9	17.2	5.8	12.2	3.8
November	6.6	-3.2	5.2	-1.0	10.8	0.6	11.5	0.9	7.3	-1.8	3.3	-3.2
December	-1.0	-9.4	2.0	-2.9	6.9	-0.1	1.3	-5.8	-2.0	-11.6	1.7	-4.3
Mean	**13.4**	**2.3**	**12.7**	**0.8**	**13.6**	**2.0**	**14.9**	**3.2**	**13.6**	**3.1**	**13.4**	**3.6**

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1125 Woodchoppers Lane, King, ON, L7B 0E9 49 Years (1975-2023)

MEAN TEMPERATURE (°C)

Month	2019		2020		2021		2022		2023		LTA	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
January	-3.7	-12.3	0.9	-6.5	-0.5	-6.9	-4.1	-16.0	1.0	-3.6	-2.2	-10.7
February	-0.4	-9.9	-0.1	-8.3	-1.6	-11.6	-0.5	-10.5	1.8	-7.9	-1.1	-10.4
March	2.8	-6.0	6.6	-1.6	8.7	-3.7	4.3	-3.4	4.3	-4.8	3.5	-5.3
April	5.8	1.3	10.0	0.0	12.6	2.3	11.0	1.0	15.1	2.6	11.4	1.1
May	16.5	6.3	17.4	5.7	19.9	5.2	22.1	8.0	20.5	4.1	19.3	6.8
June	23.5	11.6	26.4	12.0	27.0	15.2	25.7	10.8	24.4	11.8	24.3	11.7
July	29.3	15.4	29.6	16.9	25.2	14.2	27.7	12.6	26.8	15.0	26.8	14.2
August	26.3	12.4	26.8	14.3	28.9	15.5	27.3	13.9	24.7	13.1	25.7	13.1
September	21.6	9.6	21.3	8.7	22.1	9.5	22.3	10.7	26.9	9.5	21.5	9.2
October	14.8	4.3	12.6	3.6	16.8	8.7	16.9	2.1	16.0	7.0	14.0	3.9
November	4.0	-3.9	10.7	1.5	7.5	-1.6	9.8	-0.1	6.9	-1.7	6.9	-0.9
December	2.2	-6.7	1.7	-4.0	3.8	-3.0	1.7	-4.7	4.0	-0.6	0.6	-6.3
Mean	**11.9**	**1.8**	**13.7**	**3.5**	**14.2**	**3.7**	**13.7**	**2.0**	**14.4**	**3.7**	**12.6**	**2.2**

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

Month	2013		2014		2015		2016		2017		2018	
	H	L	H	L	H	L	H	L	H	L	H	L
January	14.0	-22.4	8.3	-30.4	5.3	-21.4	10.3	-19	7.2	-16.8	11.4	-28.6
February	6.5	-23.8	7.6	-30.2	-1.8	-30.8	15.4	-28.8	16.7	-14.8	14.7	-21.7
March	12.3	-10.3	12.9	-27.8	12.9	-26.3	18.5	-14.7	14.8	-17.3	10.3	-11.7
April	24.7	-7.4	23.4	-7.3	22.7	-5.1	26.2	-15.3	26.6	-1.6	18.8	-8.3
May	31.3	0.0	31.9	-0.1	30.8	-1.2	33.2	-1.6	31.5	1.1	30.6	-1.0
June	33.4	6.1	32.7	2.8	29.1	4.1	34.2	3.1	32.6	4.5	33.2	5.9
July	35.3	7.6	31.4	6.5	34.2	7.2	35.1	8.4	30.8	10.5	35.3	8.6
August	31.7	7.3	32.6	5.7	32.8	6.9	34.8	9.8	30.4	5.3	33.1	10.9
September	35.3	-0.5	32.1	0.1	34.1	4.3	34.2	1.2	34.6	1.1	33.4	1.9
October	24.7	-5.7	24.4	-1.5	23.9	-3.1	25.8	-3.5	26.0	-1.6	28.7	-3.3
November	16.0	-19.0	16.6	-10.3	22.1	-6.8	19.1	-6.5	22.6	-14.4	14.5	-25.3
December	15.9	-25.3	10.5	-11.1	15.4	-8.1	9.1	-15.9	12.1	-29.0	11.0	-12.4
Annual High & Low	**35.3**	**-25.3**	**32.6**	**-30.4**	**34.2**	**-30.8**	**35.1**	**-28.8**	**34.6**	**-29.0**	**35.3**	**-28.6**

Extreme Temperatures for U of Guelph, Dept. of Plant Agriculture - Kettleby
1125 Woodchoppers Lane, King, ON, L7B 0E9 49 Years (1975-2023)

EXTREME TEMPERATURE (°C)

Month	2019 H	2019 L	2020 H	2020 L	2021 H	2021 L	2022 H	2022 L	2023 H	2023 L	EXTREME TEMPERATURES H	Year	L	Year
January	6.6	-23.5	10.5	-24.1	7.3	-22.3	3.7	-28.4	4.1	-18.5	15.8	2005	-36.0	1977
February	11.2	-23.4	8.9	-25.4	6.4	-24.9	9.3	-19.9	13.0	-27.4	16.7	2017	-33.0	1979
March	11.6	-18.7	17.4	-18.7	21.0	-15.8	19.2	-12.2	11.9	-16.0	26.4	2012	-29.0	1984
April	14.4	-6.4	17.2	-5.6	23.0	-5.5	20.2	-3.9	29.9	-7.7	30.0	1990	-15.3	2016
May	24.2	-0.3	33.3	-5.4	32.2	-0.8	33.7	-0.3	30.5	-3.2	34.6	2006	-5.4	2020
June	31.4	2.8	33.6	3.6	34.0	4.6	36.1	3.8	31.9	5.5	36.1	2022	-2.0	1977
July	34	9.3	35.1	11.5	31.3	7.9	32.9	6.7	33.1	9.6	36.3	2011	2.5	1984
August	30.8	6.8	32.3	8.0	33.1	7.9	33.6	5.8	29.5	6.6	36.3	2001	0.5	1982
September	29.9	1.0	28.0	-1.3	26.7	4.6	31.7	1.5	34.8	1.6	35.3	2013	-6.5	1991
October	27.2	-2.4	24.4	-6.1	27.0	-0.6	29.2	-3.4	30.6	-3.6	30.6	2023	-9.0	1975
November	11.5	-19.1	24.0	-7.4	19.2	-13.2	24.5	-8	15.8	-9.2	24.5	2022	-25.3	2018
December	8.9	-21.6	8.6	-13.1	16.9	-14.9	11.5	-17.5	12.1	-7.1	20.0	1982	-31.5	1980
Annual High & Low	**31.4**	**-23.5**	**35.1**	**-25.4**	**33.1**	**-24.9**	**36.1**	**-28.4**	**34.8**	**-27.4**	**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	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LTA
January	9	0	0	1	0	2	0	1	0	0	0	**1**
February	0	0	0	8	8	7	2	0	0	0	3	**1**
March	8	0	1	31	12	0	2	17	41	15	1	**15**
April	78	63	79	56	123	25	19	42	102	62	125	**76**
May	304	271	337	273	220	348	200	220	234	310	226	**243**
June	405	431	390	409	404	410	375	426	483	397	394	**389**
July	507	443	480	528	486	518	535	567	455	470	493	**478**
August	450	438	456	543	431	531	446	483	533	484	432	**445**
September	306	320	419	372	368	375	323	300	324	344	396	**308**
October	177	171	141	188	203	108	142	109	240	141	205	**134**
November	28	30	72	67	20	11	2	80	20	78	19	**33**
December	4	4	22	2	1	2	2	0	10	5	9	**4**
Annual	**2276**	**2171**	**2397**	**2478**	**2276**	**2338**	**2048**	**2245**	**2442**	**2306**	**2323**	**2127**

LTA = Long Term Average for U of Guelph, Dept. of Plant Agriculture - Kettleby
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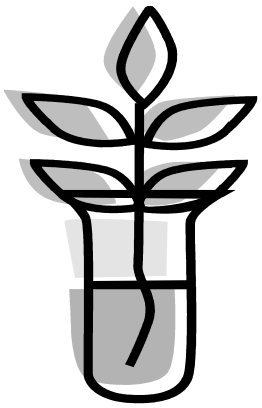

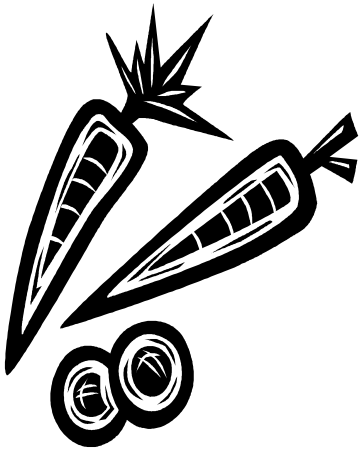

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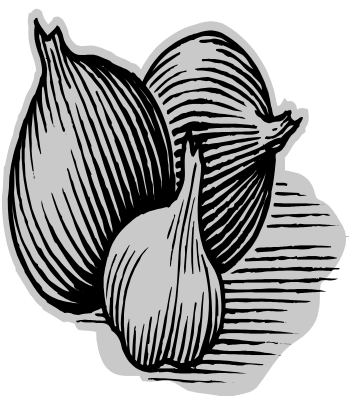

CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang.), cv. Envy
PESTS: Cavity spot, stunting, forking (*Pythium intermedium* de Bary, *Pythium irregulare* Buisman, *Pythium sulcatum* Pratt & Mitchell, *Pythium sylvaticum* W.A. Campbell & J.W. Hendrix, *Pythium ultimum* Trow and *Pythium violae*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

AUTHORS: MCDONALD MR[1], VANDER KOOI K[1], FARINTOSH G[1] and VAN DYK D[2]
[1] U of Guelph, Dept. of Plant Agriculture, Ontario Crops Research Centre - Bradford
[2] Ontario Ministry of Agriculture, Food and Rural Affairs, Guelph, ON, Canada

TITLE: EVALUATION OF FUNGICIDES APPLIED IN-FURROW TO CONTROL PYTHIUM DISEASES IN CARROTS, 2023

MATERIALS: RIDOMIL GOLD 480 SL (metalaxyl-M & S-isomer 480g/L), PICARBUTRAZOX 10 SC (picarbutrazox 100 g/L) SECURAL GYPSUM (calcium 27% sulfur 22%), LIFEGARD WG (bacillus mycoides isolate j

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 SECURAL GYPSUM at 5 t/ha (factor one), and RIDOMIL GOLD at 0.65 L/ha and PICARBURAZOX at 3 L/ha, LIFEGARD 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 8 June. SECURAL GYPSUM 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. LIFEGARD sprays were applied on 1 and 15 September using a tractor-mounted sprayer fitted with hollow cone D-3 spray nozzles at 620 kPa to deliver 500 L solution/ha. On 3 November, carrots from the two staked out 1.5 m sections of row were harvested by hand and placed into storage. On 8 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). Twenty-five carrots that were not forked or stunted were set aside for the cavity spot assessment. 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:

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

Compared to the previous 10-year average, air temperatures in 2023 were above average for September (18.2°C) and October (11.5°C), average for June (18.1°C) and July (20.9°C) and below average May (12.7°C), and August (18.9°C). The 10-year average temperatures were: May 13.6°C, June 18.7°C, July 21.2°C, August 20.5°C, September 16.5°C and October 10.0°C. Monthly rainfall was below the 10-year average for May (52 mm), June (82 mm), August (61 mm), September (4 mm) and October (35 mm) and above average for July (113 mm). The 10-year rainfall averages were: May 64 mm, June 96 mm, July 74 mm, August 77 mm, September 65 mm and October 68 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 were found among the treatments in cavity spot incidence and DSI. There were no differences in percent of forked or stunted carrots and no interaction. Significant differences in marketable yield were found among the treatments. RIDOMIL treatments with and without Gypsum had higher marketable yield than the combination treatments containing Gypsum or LIFEGARD, PICCARBUTRAZOX and untreated check (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, 2023.

Treatment	Gypsum	Harvest[1]	
		Incidence (%)	DSI[2]
RIDOMIL	Yes	55.0 ns[3]	13.0 ns
RIDOMIL		42.0	9.6
PICARBUTRAZOX	Yes	42.0	8.8
PICARBUTRAZOX		45.0	9.8
LIFEGARD	Yes	59.0	12.8
LIFEGARD		49.0	10.6
Untreated	Yes	56.0	12.2
Untreated		54.0	13.6

[1] Harvest assessments were conducted on a 25 carrot sample harvested on 8 November.

[2] DSI was calculated using the following equation:

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

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

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, 2023.

Treatment	Gypsum	Marketable Yield (t/ha)	Size Distribution[1] (%)		
			% Jumbo (>4.4 cm)	% Medium (1.9 – 4.4 cm)	% Forked or stunted (<1.9 cm)
RIDOMIL	Yes	41.7 a[2]	1.2 ns[3]	87.2 ns	11.6 ns
RIDOMIL		39.8 ab	3.3	82.8	13.9
PICARBUTRAZOX	Yes	30.4 cd	2.5	81.3	16.1
PICARBUTRAZOX		33.4 bcd	1.0	83.6	15.4
LIFEGARD	Yes	30.6 cd	1.7	83.1	15.2
LIFEGARD		36.3 abc	0.0	85.9	14.1
Untreated	Yes	27.8 d	1.5	82.0	16.5
Untreated		32.5 bcd	3.2	82.6	14.2

[1] Size distribution was based on the total weight of each yield sample.
[2] Numbers in a column followed by the same letter at not significantly different at P = 0.05, Fisher's Protected LSD test
[3] 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.)
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, 2023

MATERIALS: USDA experimental carrot breeding lines, commercial cultivars Cellobunch, Envy, Propeel, CV2384 (Seminis Vegetable Seeds), Atomic Red (OSC Seeds), Hybrid Storage Carrots (Johnny's Seed), Navedo, Deep Purple, Nairobi (Bejo Seed Inc.), Maverick, UpperCut (Nunhems USA), Bolero, Brillyance, Triton (Stokes Seeds),

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 17 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 30 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 31 October - 3 November, 50 carrots from each replicate were harvested, placed into cold storage. Carrots were assessed for cavity spot from 1 -15 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:

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

Compared to the previous 10-year average, air temperatures in 2023 were above average for September (18.2°C) and October (11.5°C), average for June (18.1°C) and July (20.9°C) and below average May (12.7°C), and August (18.9°C). The 10-year average temperatures were: May 13.6°C, June 18.7°C, July 21.2°C, August 20.5°C, September 16.5°C and October 10.0°C. Monthly rainfall was below the 10-year average for May (52 mm), June (82 mm), August (61 mm), September (4 mm) and October (35 mm) and above average for July (113 mm). The 10-year rainfall averages were: May 64 mm, June 96 mm, July 74 mm, August 77 mm, September 65 mm and October 68 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 2023, rainfall in August and September was below average and irrigation was applied in early August to assist in disease development. Overall disease development in the trial was similar to previous years. The incidence of cavity spot in cv. Cellobunch was 26% in 2023 compared to 16% in 2022. Significant differences in cavity spot incidence were observed among the lines tested, ranging from 0 - 91%. Disease severity ranged from 0 - 63%. The orange line crosses 22'B120-5 and 22'S1380-1 and 22'S1380-1had cavity spot incidence less than 20.0% and very small cavity spot lesions. These 2023 lines contain parent groups which have shown lower disease incidence in previous trials. Overall stand in the trial was lower than in previous years. Leaf blight was also low in 2023 compared 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 nine 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 USDA/U of Wisconsin breeding program, grown at the Ontario Crops Research Centre -Bradford, Ontario, 2023.

Name/Seed source	Pedigree	Incidence (%)	DSI[1]	% Forked
Deep Purple		0.0 a[2]	0.0 a	6.8 l
22'B120-5	Nbh2306A×U7393	12.0 ab	3.3 ab	3.3 c-k
22'S1380-1	F7738B	17.3 abc	6.8 abc	2.5 a-j
22'S1379-1	F7737B	18.1 a-d	6.7 abc	0.8 abc
22'S1380-5	Nbh2306A×U7393	18.7 a-d	19.5 a-k	3.8 c-k
22'B120-2	(B2144A×F5494B)×F7385B	19.7 a-d	7.0 abc	0.8 abc
	Bolero	21.3 a-d	7.1 abc	1.8 a-g
18'B111-1	F7737B	24.5 a-e	19.2 a-k	1.0 a-d
	Nairobi	24.6 a-e	8.2 abc	1.3 a-e
	Cellobunch	26.0 a-e	9.6 a-e	3.8 c-k
21'B119-5	(B2144A×F5494B)×Nbh2306B	26.7 a-f	7.9 abc	3.0 b-j
18'B111-6	(L1408A×Nbh2306B) × F7737B	26.9 a-f	9.2 a-d	3.3 c-k
21'B123-1	F7738B	27.9 a-f	16.4 a-k	0.5 ab
18'B112-4	(9304A×F7737B) × F7738B	28.4 a-g	7.3 abc	0.8 abc
22'S1380-2	F7738A	29.8 a-h	13.9 a-j	2.0 a-h
18'B112-5	(L9793A x L3276B) × F7738B	32.0 a-i	8.9 a-d	3.5 d-k
19'B110-3	(L2574XL1408) X L9786B	32.7 a-i	11.9 a-g	2.3 a-i
21'B123-3	(B2144A×F5494B)×F7738B	34.7 b-i	15.0 a-k	3.0 b-j
N17005-2	Nbh2306A	36.0 b-i	10.6 a-f	1.3 a-e
N171692	L9793A	37.3 b-j	19.4 a-k	2.0 a-h
22'B123-4	B2144A X F7142B	37.9 b-j	12.3 a-h	1.8 a-g
N17005-1	Nbh2306B	38.9 b-j	14.4 a-j	1.3 a-e
	CV 2284	39.3 b-j	23.3 c-o	2.0 a-h
22'S1379-3	B2144A X F7142B	39.3 b-j	12.6 a-i	2.3 a-i
19'B108-3	(L1408XL7553) X L2575B	40.0 b-j	15.7 a-k	1.3 a-e
	Propeel	40.0 b-j	25.2 c-q	2.0 a-h
18'B112-3	(2566A×F7737B) × F7738B	42.3 b-k	15.5 a-k	1.3 a-e
22'123-1	F8284B	43.0 b-k	23.4 c-o	0.0 a
22'B123-3	9304A×F7738B	43.4 b-l	26.8 c-q	2.5 a-j
19'B110-2	L9786A	43.6 b-l	15.8 a-k	1.5 a-f
22'S1379-4	B2144A X F5494B	43.6 b-l	31.7 h-s	2.5 a-j

18'B112-8	(9304A×F7738B) × F7738B	44.3 b-l	16.2 a-k	3.3 c-k
22'B123-5	9304A×F7738B	44.4 b-l	26.6 c-q	2.0 a-h
	Navedo	44.5 b-l	22.2 b-m	2.5 a-j
22'S1379-5	Uber-A X F7738B	44.7 b-l	27.1 c-q	2.3 a-i
	Brillyance	44.7 b-l	23.8 c-p	1.3 a-e
21'B123-2	F7738A	44.9 b-l	15.1 a-k	1.3 a-e
21'B120-1	F7385B	45.6 b-l	20.3 b-l	0.5 ab
	Triton	47.0 c-l	29.0 e-q	1.0 a-d
19'B110-1	L9786B	47.1 c-l	39.2 l-s	2.0 a-h
22'B120-3	Nb8524A	48.3 c-l	22.4 b-n	2.0 a-h
22'120-1	F7385B	48.7 c-l	29.3 f-r	1.0 a-d
18'B111-7	(2566A×F7738B) × F7737B	48.8 c-l	31.0 g-s	2.3 a-i
	Hybrid Storage Carrots	49.6 c-l	28.3 d-q	4.0 h-k
22'S1380-4	B2144A X F7142B	50.7 c-m	31.9 i-s	2.5 a-j
	Envy	50.7 c-m	32.7 j-s	2.3 a-i
17'789-2	(L1406A×L0567B)×Nbh2306B	51.3 d-m	27.1 c-q	1.8 a-g
18'B112-1	F7738B	51.7 d-m	22.8 b-o	1.0 a-d
22'B120-4	Uber-A X F7738B	53.2 d-m	34.0 k-s	1.3 a-e
22'S1379-2	F7737A	53.6 d-m	25.9 c-q	1.3 a-e
20'B111-1	F5367B	54.7 d-m	25.3 c-q	2.5 a-j
19'B108-1	L2575B	55.8 d-n	24.5 c-q	0.8 abc
22'S1380-3	B2144A X F7142B	59.3 e-n	29.7 f-r	2.0 a-h
12'310-1	Ns5154	60.1 e-n	24.9 c-q	1.5 a-f
N171691	L9793B	60.3 f-n	21.5 b-m	4.8 h-l
22'122-4	9304A×F7737B	62.0 g-n	44.5 q-t	1.5 a-f
17'790-5	(L1406A×L0567B)×Nbh2306B	62.4 h-n	40.2 m-s	0.8 abc
19'S1434-1	A-1 ALB Pool #1	64.4 i-n	41.8 n-s	4.3 i-l
	Maverick	65.6 i-n	39.9 m-s	1.5 a-f
	UpperCut	69.8 j-n	43.1 p-s	5.8 kl
17'B121-1	L1408B	75.7 k-n	43.2 o-s	4.5 j-l
06'E639-1	Brasília Embrapa	77.0 lmn	42.0 o-s	5.0 jkl
22'122-2	U8277A	83.9 mn	48.7 rst	1.5 a-f
22'122-1	U8277	91.5 n	63.5 t	1.5 a-f
	Atomic Red	91.7 n	49.7 st	3.3 c-k

[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 (17 July) and leaf blight ratings (31 October) of carrot breeding lines from USDA/U of Wisconsin breeding program grown at the Ontario Crops Research Centre - Bradford, Ontario, 2023.

Name/Seed source	Pedigree	Stand Rating[1]	Leaf Blight Rating[2,3]
22'B123-4	B1244A X F7142B	4.3	2.0
	Maverick	4.3	1.8
	Bolero	4.3	2.5
	CV 2284	4.3	2.3
19'S1434-1	A-1 ALB Pool#1	4.0	1.3
22'B120-5	Nbh2306AxU7393	3.8	**2.8**
22'S1380-3	B2144A X F7142B	3.8	**2.8**
	UpperCut	3.8	1.8
22'S1380-5	Nbh2306A×U7393	3.5	2.5
	Brillyance	3.5	1.3
21'B123-3	(B2144A×F5494B)×F7738B	3.5	**4.3**
21'B119-5	(B2144A×F5494B)×Nbh2306B	3.5	2.0
	Navedo	3.5	**3.3**
	Cellobunch	3.5	**2.8**
	Propeel	3.3	2.3
	Brasilia Embrapa	3.3	1.3
	Hybrid Storage Carrots	3.3	2.5
18'B111-6	(L1408A×Nbh2306B) × F7737B	3.0	2.0
22'B120-4	Uber-A X F7738B	3.0	**2.8**
22'120-1	F7385B	3.0	0.8
22'S1379-3	B2144A X F7142B	3.0	2.5
18'B112-5	(L9793A x L3276B) × F7738B	3.0	2.5
22'B123-5	9304A×F7738B	2.8	1.8
22'122-4	9304A×F7737B	2.8	**2.8**
	Triton	2.8	1.8
	Nairobi	2.5	2.3
19'B110-3	(L2574XL1408) X L9786B	2.5	2.0
	Deep Purple	2.5	1.8
	Envy	2.5	1.8
22'122-1	U8277	2.5	1.8
22'S1379-2	Uber-A X F7738B	2.5	2.3
20'B111-1	F5367B	2.5	2.3
22'S1379-4	B2144A X F5494B	2.5	**2.8**
22'S1379-1	F7737A	2.3	1.8
18'B112-8	(9304A×F7738B) × F7738B	2.3	**3.0**
22'B120-3	Nb8524A	2.3	**2.8**
22'S1379-2	F7737A	2.3	2.5
22'S1380-4	B2144A X F7142B	2.3	**2.8**
N17005-2	Nbh2306A	2.3	1.8
18'B111-7	(2566A×F7738B) × F7737B	2.0	**2.8**
18'B111-1	F7737B	2.0	**3.3**
22'B123-3	9304A×F7738B	2.0	2.3
22'B120-2	(B2144A×F5494B)×F7385B	2.0	2.3
21'B123-2	F7738A	1.8	**2.8**
22'S1380-2	F7738A	1.8	**3.5**
19'B110-2	L9786A	1.8	2.0
18'B112-4	(9304A×F7737B) × F7738B	1.8	**3.0**
22'S1380-1	F7738B	1.8	**2.8**

	Atomic Red	1.8	**3.0**
17'B121-1	L1408B	1.8	1.8
18'B112-1	F7738B	1.8	**3.0**
N17005-1	Nbh2306B	1.8	**3.0**
21'B120-1	F7385B	1.8	1.8
19'B108-3	(L1408XL7553) X L2575B	1.5	1.3
17-790-5	(L1406A×L0567B)×Nbh2306B	1.5	1.3
12-310-1	Ns5154	1.5	2.0
18'B112-3	(2566A×F7737B) × F7738B	1.5	**3.3**
21'B123-1	F7738B	1.5	**3.3**
22'122-2	U8277A	1.3	1.5
N171691	L9793B	1.3	1.3
N171692	L9793A	1.3	1.5
19-B110-1	L9786B	1.3	2.0
22-123-1	F8284B	1.3	2.0
19'B108-1	L2575B	1.0	1.5
17-789-2	(L1406A×L0567B)×Nbh2306B	0.8	1.3

[1] Stand (carrot emergence) was rating on 17 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 2.8 or higher (the rating for Cellobunch) are noted in bold.

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

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TITLE: **EVALUATION OF COVER CROPS SPECIES AND TECHNIQUES FOR LATE FALL ESTABLISHMENT FOLLOWING CARROT CROPS IN MUCK SOIL, 2023**

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

METHODS: Two field trials were conducted to determine effective cover crops after carrot harvest at the Jane St. site (organic matter ≈ 50 %, pH ≈ 6.9) in the Holland Marsh, Ontario. Carrot, cv. Navedo was seeded on 17 May and was mechanically harvested on 17 October. A randomized complete block design with four replications was used for both trials. Trial 1 had a large plot size of 17 × 14 m^2 while for Trial 2 a plot size of 1.5 and 4 m^2 was used. Treatments for Trial 1 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 after harvest at 100 kg/ha. Pre-harvest seeding was done 17 days before carrots were harvested using a handheld broadcast seeder on 26 September. 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 17 October. Treatments for Trial 2 were: oats, barley, triticale, hydro-primed oats, barley and triticale, osmo-primed triticale, fall rye, daikon radish and alyssum and barley in plugs transplanted at the same time as other crops were seeded. Barley and rye were bought from a grower, oats and triticale from Speare Seeds, daikon radish from Quality Seeds, and alyssum from PanAmerican Seed. Barley, oats, and triticale seeds were hydro-primed by soaking in deionized water for 24 hours, drained, and left overnight to dry at room temperature before seeding. For osmo-priming, potassium nitrate (KNO_3 at 5 mg/L) was used instead of deionized water. Plugs of alyssum and barley were grown in the greenhouse at Ontario Crops Research Centre - Bradford. One multi seed pellet of alyssum and 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 22 August and 25 September respectively. Alyssum plugs were transformed into 48-cell plug tray as they outgrew in 128-cell plug trays on 25 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. Alyssum and barley plugs were hand transplanted at ≈ 15 cm, and ≈ 8 cm plug-to-plug distance respectively. Row-to-row distance was ≈ 15 cm for all treatments. Cover crop biomass was sampled on 13 November for both trials. Plants in the field were left to grow until the weather became unfavourable (severe frost). Three 0.25 m^2 quadrats in Trial 1 and one quadrat in Trial 2 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 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 Tukey's HSD test at 5% significance level.

RESULTS: as presented in Tables 1 and 2

CONCLUSIONS: The crop stand was good in cover crops following carrots. There were significant differences among cover crop treatments for the percent of canopy coverage, plant counts, fresh weight, and dry weight in both trials. Pre-harvest barley had higher values for all these variables in trial 1. Integrating pre-harvest barley broadcasting into the standing carrot crops one to two weeks prior to the

harvest, followed by rolling the field after harvest resulted in a twofold increase in canopy coverage compared to seeding barley or fall rye after carrot harvest. There were no significant differences in results between fall rye and barley. It is important to note that the use of fall rye as a cover crop could pose a challenge in the timely seeding of onions the following year which growers want to avoid.
Percent canopy coverage and fresh weight were significantly higher for the barley plugs compared to other treatments. Plant count was lowest for alyssum plugs followed by daikon radish which reflected the low planting/seeding rate used for these species. Barley and alyssum plugs had significantly higher dry weight. Alyssum plugs produced comparatively higher dry weight as it was seeded in green house about two months earlier than other direct seeded treatments. However, it did not grow well in field after transplanting relative to barley transplants. Seed priming did not improve cover crop establishment in muck soil. Among direct seeded treatments, non-primed barley treatment had the highest fresh weight, dry weight, and canopy coverage. Direct seeded barely had relatively high emergence and growth and was significantly different from other cereals except fall rye. Barley transplants were effective as a cover crop after carrots, but associated labor and cost is a factor.

Table 1. Average canopy coverage percent, plant counts, and above ground fresh and dry weight of cover crops following carrot grown in the Holland Marsh, 2023, Trial 1.

Treatments	Canopy Coverage (%)	Avg. Plant Count/ m^2	Avg. Fresh Weight/m^2 (g)	Avg. Dry Weight/m^2 (g)
Fall Rye	4 a[1]	258 a	16.1 a	3.5 a
Barley	6 a	246 a	18.1 a	3.2 a
PreH Barley[2]	12 b	357 b	66.4 b	11.0 b

[1] Numbers in a column followed by same letter are not significantly different at P = 0.05, Tukey's HSD test
[2] PreH Barley– preharvest broadcast barley application 17 days before carrot harvest

Table 2. Canopy coverage percent, plant counts, and above ground fresh weight and dry weight of cover crop species in Trial 2 in the Holland Marsh, 2023

Treatments	Canopy Coverage (%)	Avg. Plant Counts/ m^2	Avg Fresh Weight/ m^2 (g)	Avg. Dry Weight/m^2 (g)
Alyssum plugs	1.5 a[1]	36 a	73.5 d	17.2 f
Daikon radish	1.5 a	80 ab	18.1 a	2.9 ab
Oats	2.2 a	142 bc	14.1 a	2.5 a
Triticale	3.6 ab	186 cd	17.8 a	3.4 ab
Hydro-oats	5.1 ab	196 cd	26.1 ab	5.3 ab
Hydro-triticale	5.1 ab	198 cd	28.2 ab	5.6 ab
Osmo-triticale	6.3 bc	219 de	33.6 ab	6.2 bcd
Fall rye	9.5 cd	308 f	41.9 bc	9.3 de
Hydro-barley	10.7 de	192 cd	54.4 cd	8.8 cde
Barley	13.8 e	286 ef	74.8 d	11.2 e
Barley plugs	25.1 f	132 bc	103.4 e	20.2 f

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

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

CROP: Cooking onions (*Allium cepa* L.), cv. Red Wing (red)
PESTS: Onion maggot, (*Delia antiqua* (Meigen))
Seed corn maggot, (*Delia platura* (Meigen))

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TITLE: EVALUATION OF INSECTICIDE TRAY DRENCHES FOR CONTROL OF MAGGOTS IN COOKING ONIONS, 2023

MATERIALS: VERIMARK (cyantraniliprole 200 g/L), DELEGATE WG 400 (spinetoram 25%), SUCCESS (spinosad 480 g/L)

METHODS: Various insecticide tray drenches for red cooking onion transplants, cv. Red Wing were evaluated in a field trial conducted on organic soil (pH ≈ 6.8, organic matter ≈ 67.3%) naturally infested with *Delia antiqua* and *D. platura* pupae near the Ontario Crops Research Centre - Bradford, Ontario. Red onion transplants were obtained from a local grower and treated with insecticide in the tray prior to transplanting. An untreated was also included. On 16 May, trays of red onion plants were drenched with 500 mL solution/tray of the following treatments: VERIMARK at 4.32 mL/tray, DELEGATE at 3.75 g/tray and SUCCESS at 1.8 mL/tray. A randomized complete block design with four replicates per treatment was used. Each experimental unit consisted of four rows, spaced 40 cm apart, 7 m in length. Onions were hand transplanted into the field on 16 May. Two randomly chosen 2 m sections and a 2.32 m yield section of row were staked out in each replicate. On 26 May, plants within the 2 m sections were counted and numbers recorded to determine initial stands. Beginning on 14 June, plants within the 2 m sections were examined for onion maggot losses or damage caused by other pests on a weekly basis. Damaged plants were removed, and the cause recorded. Final destructive assessments of the remaining plants within the assigned 2 m sections were conducted on 5 July (three weeks after the first generation peak), and after onions were lodged on 21 August (to assess total season damage). On 23 August, yield samples from the 2.32 m yield section of row were harvested and on 21 September samples were graded for size to determine yield.
Compared to the previous 10-year average, air temperatures in 2023 were above average for September (18.2°C), average for June (18.1°C) and July (20.9°C) and below average May (12.7°C), and August (18.9°C). The 10-year average temperatures were: May 13.6°C, June 18.7°C, July 21.2°C, August 20.5°C and September 16.5°C. Monthly rainfall was below the 10-year average for May (52 mm), June (82 mm), August (61 mm) and September (4 mm) and above average for July (113 mm). were0-year rainfall averages were: May 64 mm, June 96 mm, July 74 mm, August 77 mm and September 65 mm.
Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.10. Means separation was obtained using Fisher's Protected LSD Test at P = 0.05 level of significance.

RESULTS: as presented in Tables 1 & 2

CONCLUSIONS: Significant differences in the percentage of onions lost due to maggot damage from the first generation and for the total season were observed among the treatments (Table 1). Onion transplants treated with VERIMARK or DELEGATE had fewer losses from first generation maggot damage compared to the untreated check. Over the total season, the VERIMARK and SUCCESS treatments resulted in fewer losses compared to untreated onions. No significant differences in marketable yield or size distribution were found among treatments (Table 2).

Table 1. Onion losses caused by maggot damage for transplanted onions cv. Red Wing, treated with insecticide tray drenches and grown at the Ontario Crops Research Centre - Bradford, Ontario,2023.

Treatment	Rate/tray[1]	% Onions Lost from Maggot Damage	
		1st Gen	Total Season
DELEGATE	3.75 g	0.8 a[2]	19.8 ab
VERIMARK	4.3 mL	2.3 a	3.8 a
SUCCESS	1.8 mL	4.7 ab	6.1 a
Check	–	9.1 b	23 1 b

[1] Trays were drenched on 16 May, drenches were applied using 500 mL water per tray.
[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 and size distribution for transplanted onions, cv. Red Wing, treated with insecticide tray drenches and grown at the Ontario Crops Research Centre - Bradford, Ontario,2023.

Treatment	Rates[1]	Yield (t/ha)	Size Distribution (%)[2]			
			Jumbo (>76 mm)	Large (65-76 mm)	Medium (46 – 64 mm)	Cull (<45 mm)
SUCCESS	1.8 mL	36.0 ns[3]	2.2 ns	26.9 ns	51.6 ns	4.7 ns
VERIMARK	4.3 mL	34.0	3.0	29.2	62.9	4.8
Check		32.4	1.2	28.6	68.3	1.9
DELEGATE	3.75 g	24.5	1.6	15.9	73.1	9.4

[1] Insecticide drenches were applied using 500 mL water per tray.
[2] Percentage was determined using weight.
[3] ns = no significant differences at P = 0.05, Fisher's Protected LSD Test

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

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

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TITLE: EVALUATION OF VARIOUS INSECTICIDE SEED TREATMENTS FOR CONTROL OF MAGGOTS IN YELLOW COOKING ONIONS, 2023

MATERIALS: LUMIVERD (spinosad 80%), CRUISER 70 WS (thiamethoxam 70%), TRIGARD (cyromazine 75%), SEPRESTO 75 WS (clothianidin 56.25%, imidacloprid 18.75%), PLINAZOLIN (experimental), FARMORE F300 ((APRON XL (metalaxyl-M and S-iromer 33.3%), MAXIM 4 FS (fludioxonil 40.3%), DYNASTY (azoxystrobin 9.6%)), EVERGOL PRIME **(**penflufen)

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, 8 m in length. Onions, cv. Hamilton, were seeded (≈ 32 seeds/m) on 11 May using a Stanhay precision seeder. Insecticide seed treatments as listed in Table 1.
A no-insecticide check was also included. All treatments included EVERGOL PRIME for onion smut control and FARMORE 300 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 29 May 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 6 July (first generation damage) and after lodging on 25 September (total season assessment). On 15 September, onions from the 2.32 m yield section of row were pulled, windrowed to dry and placed in storage. On 3 October, 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 2 and 3

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 season total losses (Table 2). Treatments of LUMIVERD + CRUISER and TRIGARD alone had no maggot damage in the season total assessment. Damage caused by first generation maggots was variable, no significant differences were found in first generation damage. No significant differences in yield were found among the treatments (Table 3). No significant differences in size distribution were found among the treatments.

Table 1. Seed treatments label rates for onion seed, cv. Hamilton, pelleted by Kamterter and grown at the grown at the Ontario Crops Research Centre - Bradford, Ontario, 2023.

Treatment	Insecticide Active Ingredients and Rates
CHECK	---
TRIGARD	0.225 mg ai/seed
LUMIVERD	0.2 mg ai/seed
PLINAZOLIN TECH	0.0909 mg ai/seed
CRUISER	0.2 mg ai/seed
SEPRESTO	0.32 mg ai/seed
TRIGARD + CRUISER	0.225 mg ai/seed + 0.2 mg ai/seed
TRIGARD + SEPRESTO	0.225 mg ai/seed + 0.32 mg ai/seed
LUMIVERD + CRUISER	0.2 mg ai/seed + 0.2 mg ai/seed
LUMIVERD + SEPRESTO	0.2 mg ai/seed + 0.32 mg ai/seed
PLINAZOLIN + CRUISER	0.0909 mg ai/seed + 0.2 mg ai/seed
PLINAZOLIN + SEPRESTO	0.0909 mg ai/seed + 0.32 mg ai/seed

Table 2. Percentage of onions lost due to maggot damage, treated with various insecticides, and grown at the Ontario Crops Research Centre - Bradford, Ontario, 2023.

Treatment	Rate (mg ai/seed)	% Onions lost due to maggot damage	
		1st Generation	Total Season
LUMIVERD + CRUISER	0.2 mg + 0.2 mg	1.0 ns[1]	0.0 a[2]
TRIGARD	0.225 mg	3.4	0.0 a
LUMIVERD + SEPRESTO	0.2 mg + 0.32 mg	3.1	0.5 a
PLINAZOLIN TECH	0.0909 mg	2.1	1.7 a
PLINAZOLIN + SEPRESTO	0.0909 mg + 0.32 mg	3.9	1.9 a
TRIGARD + CRUISER	0.225 mg + 0.2 mg	4.3	2.1 a
LUMIVERD	0.2 mg	3.6	2.7 a
PLINAZOLIN + CRUISER	0.0909 mg + 0.2 mg	4.3	2.7 a
TRIGARD + SEPRESTO	0.225 mg + 0.32 mg	2.6	2.8 a
SEPRESTO	0.32 mg	2.0	2.8 a
CRUISER	0.2 mg	2.9	3.0 a
CHECK	---	3.4	8.8 b

[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 3. Yield and size distribution for onions, cv. Hamilton, treated with various insecticide seed treatments, and grown at the Muck Crops Research Station – Bradford, Ontario, 2023.

Treatment	Rate (mg ai/seed)	Yield (t/ha)	Size Distribution[1] (%)		
			Jumbo (>76 mm)	Large (76-64 mm)	Med (>64-45 mm)
PLINAZOLIN + CRUISER	0.0909 mg + 0.2 mg	61.1 ns[2]	8.7 ns	28.5 ns	60.0 ns
SEPRESTO	0.32 mg	59.7	18.9	33.9	43.5
TRIGARD + CRUISER	0.225 mg + 0.2 mg	59.2	6.5	29.0	58.1
LUMIVERD + CRUISER	0.2 mg + 0.2 mg	55.2	7.9	26.7	60.5
CRUISER	0.2 mg	54.3	7.9	36.0	52.4
PLINAZOLIN TECH –	0.0909 mg	50.0	8.5	38.6	50.3
CHECK	--	49.8	5.3	41.9	51.5
PLINAZOLIN + SEPRESTO	0.0909 mg + 0.32 mg	48.7	10.5	39.6	44.8
TRIGARD	0.225 mg	45.5	11.9	41.1	43.8
LUMIVERD	0.2 mg	44.8	3.8	24.8	64.5
LUMIVERD + SEPRESTO	0.2 mg + 0.32 mg	44.5	10.2	42.7	46.5
TRIGARD + SEPRESTO	0.225 mg + 0.32 mg	39.0	7.6	29.3	57.1

[1] Size distribution was based on weight.
[2] ns = no significant differences were found among 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: Yellow cooking onions (*Allium cepa* L.), cv. Milestone
PEST: Onion thrips, (*Thrips tabaci* Lindeman)

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TITLE: EVALUATION OF ISOCYOSERAM FOR CONTROL OF THRIPS IN YELLOW COOKING ONIONS, 2023

MATERIALS: ISOCYOSERAM (experimental), DELEGATE (spinetoram 25%)

METHODS: Onions, cv. Milestone, were direct seeded (≈ 35 seed/m) on 10 May using a Stanhay Precisions 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 at 150, 300 and 375mL/ha, treatments included AGRAL 90 at 0.25% v/v, A21377 at 300 mL/ha (no surfactant), A21377 was also applied 300mL/ha + AGRAL 90 using a low water volume of 50 L/ha. DELEGATE at 336 g/ha was used as the commercial standard. An untreated check was also included. Treatments were applied on 14 and 21 July over using a CO_2 backpack sprayer equipped with four TeeJet 8002 VS fan nozzles spaced 40 cm apart. The sprayer was calibrated to deliver 400 L/ha at 275 kPa for all treatments except the low water treatment. The low water treatment was applied at 50 L/ha. Adult and larval thrips were counted on the inside surface of the five innermost leaves of 6 randomly selected onions per replicate on 10 July (pre-spray), 20, 27, 31 July, 4, 6, 10 August. Onions plants were rated for visible thrips damage, ratings estimated the percentage of plant damage from thrips feeding on a scale of 0 – 100%.
On 13 September, onions in two 2.32 m sections of row per replicate designated for yield were harvested. On 5 October, onions were sorted by size to determine yield. Data were analysed using the General Analyses of Variance function of the Linear Models section of Statistix V.10. Means separation was obtained using Fisher's Protected LSD test with $P = 0.05$ level of significance.

RESULTS: as presented in Tables 1 - 3

CONCLUSIONS: The numbers of thrips per plant was sporadic throughout the season. Of the eight counts the two dates which showed significant differences were 13 July, before the first spray application, and on the last assessment, 20 August, when thrips numbers had fallen, with the highest average count per plant only having 4.3 thrips (Table 1). No significant differences in the cumulative total number of thrips or in the area under the thrips population curve (AUTPC) were found among the treatments (Table 1). There were no significant differences in yield among the treatments, although the untreated check had the lowest yield and lowest marketable percentage (Table 4). There were no signs of phytotoxicity caused by the products. There were no differences in insect damage on plants between treatments.

Table 1. Onion thrips per plant for onions treated with Isocyoseram grown at the Ontario Crops Research Centre - Bradford, Ontario, 2023.

Treatment	Product Rate	Onion Thrips/Plant					
Larval		10 Jul[1]	20 Jul[1]	27 Jul	31 Jul	4 Aug	10 Aug
A21377 + AGRAL 90	150 mL/ha + 0.25% v/v	9.0 ns[2]	12.8 ns	6.9 c[3]	13.1 cd	11.9 b	5.2 ab
A21377 + AGRAL 90	300 mL/ha + 0.25% v/v	10.2	11.4	5.8 bc	7.7 ab	7.3 a	3.0 a
A21377 + AGRAL 90	375 mL/ha + 0.25% v/v	7.9	5.8	1.8 a	4.7 a	7.3 a	3.5 a
A21377 + AGRAL 90 Low Water	300 ml/ha + 0.25% v/v	9.5	10.2	7.3 c	9.1 abc	6.9 a	3.6 a
A21377	300 mL/ha	10.1	10.9	8.2 c	12.4 bc	7.3 a	2.7 a
DELEGATE	336 g/ha	10.4	8.4	3.2 ab	6.0 a	5.4 a	3.4 a
Check	--	14.2	18.5	15.1 d	17.8 d	12.3 b	7.7 b
Adult							
A21377 + AGRAL 90	150 mL/ha + 0.25% v/v	1.8 a	2.5 a	1.4 ns	1.4 ns	0.1 ab	0.1 ab
A21377 + AGRAL 90	300 mL/ha + 0.25% v/v	2.8 ab	2.1 a	2.6	0.9	0.2 ab	0.0 a
A21377 + AGRAL 90	375 mL/ha + 0.25% v/v	2.0 a	1.7 a	1.7	1.1	0.3 ab	0.0 a
A21377 + AGRAL 90 Low Water	300 ml/ha + 0.25% v/v	3.8 b	2.7 a	1.8	1.3	0.1 ab	0.3 b
A21377	300 mL/ha	1.4 a	2.5 a	2.1	1.4	0.0 a	0.0 a
DELEGATE	336 g/ha	2.8 ab	2.0 a	1.4	1.8	0.4 bc	0.0 a
Check	--	4.1 b	4.3 b	3.3	2.5	0.8 c	0.5 c

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

[2] ns indicates no significant differences were found at $P = 0.05$, Fisher's Protected LSD Test.

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

Table 2. Yield and size distribution for onions, cv. Milestone, treated with insecticides and grown at the Ontario Crops Research Centre - Bradford, Ontario, 2023.

Treatment	Rate (ml/ha)	Yield (t/ha)	Size Distribution (%)[1]			
			Jumbo (>76 mm)	Large (76-64 mm)	Medium (64-45 mm)	Cull (<45 mm)
A21377 + AGRAL 90	150 mL/ha + 0.25% v/v	59.9 ns[2]	0.0 ns	10.8 ns	83.0 ns	6.3 b[3]
A21377 + AGRAL 90	300 mL/ha + 0.25% v/v	57.5	2.4	18.0	75.5	4.1 ab
A21377 + AGRAL 90	375 mL/ha + 0.25% v/v	59.3	0.8	24.8	71.5	2.9 a
A21377 + AGRAL 90 Low Water	300 ml/ha + 0.25% v/v	62.9	1.4	23.0	73.5	2.3 a
A21377	300 mL/ha	62.0	0.5	13.4	80.4	5.8 b
DELEGATE	336 g/ha	67.6	0.4	11.8	82.3	5.4 b
Check	--	56.3	0.5	9.7	83.7	6.2 b

[1] Size distribution was based on weights.
[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 3. Plant damage ratings for onions treated with Isocyoseram grown at the Ontario Crops Research Centre - Bradford, Ontario, 2023

Treatment	Product Rate	Thrips Damage Rating[1]		
		21 Jul	4 Aug	10 Aug
A21377 + AGRAL 90	150 mL/ha + 0.25% v/v	24.0 ns[2]	25.8 ab[3]	17.5 a
A21377 + AGRAL 90	300 mL/ha + 0.25% v/v	21.4	34.2 bc	15.4 a
A21377 + AGRAL 90	375 mL/ha + 0.25% v/v	15.9	24.2 ab	16.0 a
A21377 + AGRAL 90 Low Water	300 ml/ha + 0.25% v/v	21.7	23.1 ab	15.6 a
A21377	300 mL/ha	21.3	20.6 a	17.9 a
DELEGATE	336 g/ha	24.2	22.9 ab	15.0 a
Check	--	30.6	40.0 c	27.3 b

[1] Damage rating based on 0-10 scale 0 = 0 % damage to leaf area, 10 = 100% damage to leaf area.
[2] ns indicates no significant differences were found at $P = 0.05$, Fisher's Protected LSD Test
[3] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher's Protected LSD test.

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CROP: Onion (*Allium cepa* L.), cv. Catskill
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, 2023

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%), 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), SYLGARD 309 (siloxylated polyether 76%),

METHODS: Onions, cv. Catskill, 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 20, 27 July and 3 and 9 August based on disease forecasting and disease risk. On 1, 10 and 15 August, onions in a two meter section of row were visually examined for the presence of downy mildew (DM) lesions. On 18 August, 20 onions randomly chosen from the inner rows of every replicate were pulled. Leaves were removed and sorted into five classes based on the percentage of the leaf area infected with downy mildew. The five classes were: 0= no disease, 1 = 1-10%, 2 = 11-25%, 3 = 26-50%, 4 = 51-100% with symptoms of disease. These classes were used to determine the disease severity index (DSI) using the following formula:

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

On 5 September, onions in two, 2.32 m sections of row (2 x 1 m^2) per replicate were pulled. On 22 September, onions graded, sorted into size categories, weighed and counted to determine 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 & 2

CONCLUSIONS: The weather in 2023 was conducive to the development of downy mildew in onions lesions were detected in late July. Significant differences in the number of downy mildew lesions between treatments were observed in the trial (Table 1). The combination of RIMOMIL and ORONDIS ULTRA had significantly fewer lesions than all other treatments except for the ORONDIS ULTRA treatment. The ZAMPRO treatment also had significantly fewer lesions than the untreated check. The DIPLOMAT and T-77 treatments had the highest numbers of lesions. At the leaf assessment the RIDOMIL and ORONDIS ULTRA treatment had significantly lower incidence and DSI that the untreated check. No significant differences in yield or size distribution were observed among the treatments (Table 2).

Table 1. Downy mildew (DM) incidence for onions, cv. Catskill, treated with fungicides and grown at the Ontario Crops Research Centre - Bradford, Holland Marsh, Ontario, 2023.

Treatment	Rate (per ha)	DM Lesions/2 meter row[2]			Leaf Assessment	
		1 Aug	10 Aug	15 Aug	% DM	DSI
RIDOMIL alt/w ORONDIS ULTRA[3]	2.5 kg or 400 mL	0.1 ns[4]	0.1 ns	1.8 a[5]	54.4 a	43.7 a
ORONDIS ULTRA	400 mL	0.1	0.0	14.8 ab	68.4 ab	54.3 ab
ZAMPRO + Sylgard	1.0 L + 0.25% v/v	0.2	0.3	42.0 bc	84.1 bc	70.2 bc
PICARBUTRAZOX	880 mL	0.3	0.1	53.5 cde	85.5 bc	69.3 bc
SEREFIL	1.0 kg	0.3	0.2	52.3 cd	91.2 bc	84.3 c
DIPLOMAT	926 mL	0.3	0.5	84.5 e	93.9 bc	85.8 c
T-77	250g	1.4	1.1	78.5 de	96.9 c	89.9 c
Check	-	1.5	1.1	78.5 de	92.5 bc	83.0 c

[1] Two meter of row per plot was visually examined for DM lesions and numbers recorded.
[2] 20 plants per plot were chosen and assessed for Downy Mildew infection and severity on 18 August.
[3] RIDOMIL MZ was applied on 12 July, 3 August. ORONDIS ULTRA was applied on 20 July, 13 August.
[4] ns = no significant differences were found among treatments at P = 0.05, Fisher's Protected LSD test.
[5] Numbers in a column followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD test.

Table 2. Yield and size distribution for onions, cv. Catskill, treated with fungicides and grown at the Ontario Crops Research Centre – Bradford, Ontario, 2023.

Treatment	Yield (t/ha)	% Mkb	Size distribution (%)[1]		
			Jumbo (>76 mm)	Large (76-64 mm)	Medium (63-45 mm)
ORONDIS ULTRA	57.5 ns[2]	88.0 ns	0.9 ns	14.3 ns	76.5 ns
ZAMPRO + Sylgard	56.5	86.7	0.4	10.4	81.1
SEREFIL	52.3	82.7	0.0	8.3	83.4
RIDOMIL alt/w ORONDIS ULTRA[3]	51.8	80.2	0.0	11.6	76.6
DIPLOMAT	48.1	80.1	0.0	7.2	81.5
T-77	46.8	81.8	0.0	10.5	79.9
Check	44.3	72.8	0.5	6.8	75.5
PICARBUTRAZOX	39.1	67.3	0.0	5.0	66.0

[1] Percentage was determined by weight.
[2] ns = no significant differences at P = 0.05, Fisher's Protected LSD test
[3] RIDOMIL MZ was applied on 12 July, 3 August. ORONDIS ULTRA was applied on 20 July, 13 August.

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

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

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TITLE: EVALUATION OF FUNGICIDES FOR CONTROL OF STEMPHYLIUM LEAF BLIGHT ON ONIONS, 2023

MATERIALS: A24184A (experimental), A24367B (experimental), ALLEGRO 500 (fluazinam) MIRAVIS DUO (pydiflumetofen 75 g/L, difenoconazole 125 g/L)

METHODS: Onions, cv. Milestone, were direct seeded (≈ 35 seeds/m) on 10 May into organic soil (organic matter ≈ 68.1%, pH ≈ 6.2) 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 spaced 40 cm apart, and 6 m in length. Fungicide sprays were applied on 14, 21, 28 July, 4 and 10 August using a CO_2 backpack sprayer equipped with four TeeJet 8002 VS fan nozzles spaced 40 cm apart and calibrated to deliver 400 L/ha at 275 kPa. Fungicide treatments were: MIRAVIS DUO at 1.0 L/ha, ALLEGRO at 1.17 L/ha, A24184A at 375 mL/ha (Low rate), 625 mL/ha (Mid rate), 1000 L/ha (High rate) and A24367B at 1.54 L/ha. An untreated check was also included. On 22 August, 20 onions randomly chosen from the inner rows of every replicate were pulled. Leaves were removed and green leaves sorted into seven classes based on the percentage of the leaf area infected with *Stemphylium*. The seven classes were: 0= no disease, 1 = 1-4%, 2 = 5-10%, 3 = 11-25%, 4 = 26-50%, 5 = 51-75%, 6 > 75% with symptoms of SLB. These classes were used to determine the disease severity index (DSI) using the following formula:

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

On 12 September, the onions in two 2.32 m sections of row were pulled from the inner rows for a yield sample. Onions were weighed and graded for size on 5 October to determine yield**.**
Weather
Data were analyzed using the General Analysis of Variance function of Statistix V.10. Means separation was obtained by using Fisher's Protected LSD test at P = 0.05 level of significance.

RESULTS: as presented in Tables 1-2

CONCLUSIONS: Stemphylium incidence was moderate in 2023 and increased through July. Significant differences in disease severity were observed among fungicide treatments when plants were destructively sampled and assessed on Aug. 22 (Table 1). Onions sprayed with MIRAVIS DUO, ALLEGRO and A24367B had significantly lower disease severity than onion treated with A24184A or the untreated check. Onions treated with MIRAVIS DUO and A24367B had lower disease incidence than the untreated check. There were significant differences in the number of green leaves per plant, onions sprayed with MIRAVIS DUO, ALLEGRO or A24367B had the more green leaves than the untreated check and high rate of A24184A. Significant differences in yield were observed among the treatments (Table 2). Onions treated with MIRAVIS DUO or ALLEGRO had significantly higher yield (t/ha) compared to the untreated check.

Table 1. Stemphylium leaf blight (SLB) incidence and severity for onions, cv. Milestone, sprayed with various fungicides and destructively sampled on Aug. 22, at the Ontario Crops Research Centre - Bradford, Holland Marsh, Ontario, 2023.

Treatment	% Leaves rated 0 or 1[1]	SLB incidence	DSI	Green leaves/plant
MIRAVIS DUO	28.6 a[2]	86.6 a	54.6 a	6.9 a
A 24367B	27.1 a	88.4 ab	50.5 a	6.5 ab
ALLEGRO	26.4 a	90.3 abc	50.5 a	6.2 ab
A 24184 Low	8.4 b	97.5 bc	73.5 b	5.7 abc
A 24184 Mid	7.9 b	97.3 bc	73.0 b	5.5 bc
A 24184 High	3.5 b	99.2 c	82.3 b	4.8 c
Check	2.5 b	99.5 c	81.7 b	4.9 c

[1] On 22 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.
[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 of onions, cv. Milestone, sprayed with various fungicides at the Ontario Crops Research Centre - Bradford, Holland Marsh, Ontario, 2023.

Treatment	Yield (t/ha)	% Mkb	Size distribution (%)		
			Jumbo (>76mm)	Large (76-64 mm)	Medium (>64-45 mm)
MIRAVIS DUO	77.4 a[1]	98.5 ns[2]	0.8 ns	36.3 ns	61.5 ns
ALLEGRO	76.8 a	98.0	3.5	30.8	64.0
A 24367B	70.2 ab	98.3	1.2	25.8	71.0
A 24184 Mid	68.6 ab	97.7	0.0	16.7	79.6
Check	65.3 b	96.2	0.4	28.8	68.3
A 24184 Low	65.2 b	97.5	2.3	18.4	77.0
A 24184 High	64.0 b	97.4	1.2	31.3	65.0

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

Funding for this project was provided by Syngenta.

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

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TITLE: EVALUATION OF FUNGICIDES AND BIO-FUNGICIDES FOR MANAGEMENT OF STEMPHYLIUM LEAF BLIGHT ON ONION, 2023

MATERIALS: Fungicides MIRAVIS DUO (pydiflumetofen 75 g/L, difenoconazole 125 g/L CEVYA (mefentrifluconazole 400 g/L), SERCADIS (fluxapyroxad 300 g/L), DITHANE (mancozeb 479 g/L) and bio-fungicides SERIFEL (*Bacillus amyloliquefaciens* strain MBI 600 @ 5.5 x 10^{10} spores/g), T-77 (*Trichoderma atroviride* strain 77B @ 2.5 x 10^{9} spores/g).

METHODS: Onion cv. Catskill (Stokes Seeds, Thorold, ON) was direct seeded into organic soil (organic matter ~68.1%, pH ~ 6.2) at the Ontario Crops Research Centre – Bradford, Ontario on 10 May 2023. The study was arranged in a randomized complete block with four replicates. Each experimental unit consisted of two beds, wih each bed of four 6-m-long rows, 40 cm apart. The treatments were MIRAVIS DUO at 1.0 L/ha, CEVYA at 350 g/ha, SERCADIS at 666 mL/ha and DITHANE at 2.25 kg ha. Two bio-fungicides, SERIFEL at 1120 g/ha, and T-77 at 250 g/ha were also included. Rotations of fungicides and bio-fungicides were SERIFEL at 1120 g/ha alternated with CEVYA at 350 g/ha, T-77 at 250 g/ha alternated with CEVYA at 350 g/ha and DITHANE at 2.25 kg ha^{-1} alternated with CEVYA at 350 g/ha, and an untreated control.

Fungicides were applied bi-weekly (on 23 June, 05, 10, 14, 21, 28 July and 02 August) using a tractor-mounted sprayer fitted with D-3 hollow-cone nozzles at 620 kPa to deliver 500 L/ha. On 29 June, 07, 13, 20, 25 July, and 01, 08 August, the three oldest leaves of 10 representative onion plants per bed were evaluated, for a total of 20 plants per plot, and visually examined for symptoms of Stemphylium leaf blight (SLB). Leaves were rated for percent leaf length with symptoms on the three oldest leaves per plant. The mean ratings of leaf length affected (%) were used to represent each plant. Each plant rating was 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. These were used to calculate a disease severity index (DSI) value per plot using the following equation:

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

The area under the disease progress curve (AUDPC) and area under the disease progress stairs (AUDPS) were calculated using the equations:

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

$$AUDPS = AUDPC + \left[\frac{y_i + y_n}{2} \times \frac{D}{n-1}\right]$$

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. y_n is the rating at the last evaluation timepoint, and D is the length of time in days between the first and last assessment.

On 16 August, 10 plants were pulled from the inner two 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 30 August, the onion plants from 2.3 m sections of the inner rows of each plot were pulled for yield assessment. On 27 September, the onion bulbs were weighed and graded for size to determine yield. Data were 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.

Compared to the previous 10-year average, air temperatures in 2023 were above average for September (18.2°C), average for June (18.1°C) and July (20.9°C) and below average May (12.7°C), and August (18.9°C). The 10-year average temperatures were: May 13.6°C, June 18.7°C, July 21.2°C, August 20.5°C and September 16.5°C. Monthly rainfall was below the 10-year average for May (52 mm), June (82 mm), August (61 mm) and September (4 mm) and above average for July (113 mm). The 10-year rainfall averages were: May 64 mm, June 96 mm, July 74 mm, August 77 mm and September 65 mm.

RESULTS: as presented in Tables 1–3.

CONCLUSIONS: Disease pressure was high in 2023, with SLB symptoms developing early in the growing season. The calendar-based spray schedule resulted in seven fungicide applications beginning at the three-leaf stage. There were no differences in SLB severity or area under the disease progress stairs (AUDPS) among treatments throughout the growing season (Table 1). However, severity differed among treatments in the destructive rating at the end of the season, severity differed among treatments with MIRAVIS DUO exhibiting the lowest DSI (75) relative to T–77 + CEVYA, DITHANE + CEVYA, DITHANE, and SERCADIS (84). However, no treatments were different from the nontreated control (Table 2). There were no differences in yield, marketable yield, or any of the size classifications in 2023 (Table 3).

Table 1. Effect of fungicides / biofungicides on SLB severity (disease severity index, DSI) and area under the disease progress stairs (AUDPS) on onion at the Ontario Crops Research Centre – Bradford, ON in 2023.

Treatment	DSI							AUDPS[2]
	Jun 29	Jul 7	Jul 13	Jul 20	Jul 25	Aug 1	Aug 8	
MIRAVIS DUO	11 ns[1]	19 ns	36 ns	45 ns	46 ns	60 ns	79 ns	1910 ns
SERIFEL	10	20	33	47	45	60	83	1920
DITHANE + CEVYA	11	18	34	47	47	61	86	1960
SERCADIS	11	18	35	49	47	64	82	1950
DITHANE	13	18	31	47	48	64	82	1950
T–77	11	20	32	48	49	62	83	1960
CEVYA	12	18	35	51	48	60	81	1960
SERIFEL + CEVYA	12	20	32	47	47	64	83	1970
T–77 + CEVYA	11	21	36	50	50	63	87	2050
Control, untreated	11	20	35	47	52	69	83	2050

[1] ns = no significant differences among the treatments at $P = 0.05$.
[2]AUDPS calculated based on the DSI assessed on 29 June, 07, 13, 20, 25 July, 01 and 08 August.

Table 2. Effect of fungicides / biofungicides on Stemphylium leaf blight incidence and severity (disease severity index, DSI) on onion at maturity at the Ontario Crops Research Centre – Bradford, ON in 2023.

Treatment	Incidence (%)	DSI	Leaves rated 0 or 1 (%)[1]	Green leaves per plant
MIRAVIS DUO	99 ns[1]	75 a[2]	4 ns	6 ns
SERIFEL	99	77 ab	5	5
T–77	99	80 ab	3	5
CEVYA	100	81 ab	2	5
SERIFEL + CEVYA	99	82 ab	3	5
T–77+ CEVYA	100	84 b	2	4
DITHANE + CEVYA	100	84 b	1	4
DITHANE	100	84 b	1	4
SERCADIS	100	84 b	1	5
Control, untreated	98	81 ab	3	5

[1] ns = no differences among the treatments at $P = 0.05$.
[2] Numbers in a column followed by the same letter do not differ at $P = 0.05$.

Table 3. Effect of fungicides on yield, marketable yield (Mkb), and size distribution of onion at the Ontario Crops Research Centre – Bradford, ON in 2023.

Fungicide	Yield (t ha^{-1})	Mkb (%)	Size distribution (%), diam. in mm			
			Medium (45–64 mm)	Large (64–76)	Jumbo (>76)	Cull (<45 mm)
CEVYA	56 ns[1]	82 ns	83 ns	7 ns	0 ns	9 ns
MIRAVIS DUO	55	80	81	9	0	10
SERCADIS	54	81	83	8	0	10
DITHANE	52	78	83	5	0	12
SERIFEL	51	79	85	5	0	11
T–77	51	79	83	6	0	11
T–77 + CEVYA	49	77	82	6	1	12
DITHANE + CEVYA	48	75	83	3	0	14
SERIFEL + CEVYA	48	71	79	4	0	17
Control, untreated	53	78	85	4	0	12

[1]ns = no differences among the treatments at $P = 0.05$.

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.))

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TITLE: EVALUATION OF EVERGOL PRIME SEED TREATMENT FOR MANAGEMENT OF STEMPHYLIUM LEAF BLIGHT OF ONION IN CONTROLLED ENVIRONMENT STUDIES, 2023

MATERIALS: EVERGOL PRIME (penflufen 22.7%)

METHODS: Two studies examined the effect of EVERGOL PRIME seed treatment to reduce early season infection and development of Stemphylium leaf blight (SLB) on onion cv. Traverse under controlled environmental conditions (21°C night / 24°C day, 50% RH and 17 hour photoperiod). Onion seedlings were inoculated with conidia of *Stemphylium vesicarium* at the 1st true leaf stage in one study and at the 3-4 true leaf stage in the other study. Each study was arranged in a factorial design with four replicates and two factors: EVRGOL PRIME seed treatment (with or without) and inoculation (inoculated with *S. vesicarium* or water control). There were 14 plants per experimental unit in the 1st leaf study and 10 plants per experimental unit in the 3-4 leaf study. Both studies were repeated.

Three 2023 isolates of *S. vesicarium* (Ziemba 7, Ziemba 8 and Jane St 3) were cultured on V8 media (200mL of V8 juice, 3g of calcium carbonate, 15g of agar and 800mL of deionized water, 250 mg/L of ampicillin and 150 mg/L of streptomycin) and placed under UV light with a 12-hour photoperiod for 10-14 days to produce conidia. A suspension of 7.8 X 10^4 conidia/mL was made from the three isolates by adding 3 mL of sterile water mixed with a drop of Tween 20 to each fungal colony and rubbing the surface of the colony with a sterile glass rod for 1 minute to dislodge the conidia. The resulting spore suspension was filtered through cheesecloth to remove mycelia and the spore concentration was confirmed using a haemocytometer. A solution of sterile water and Tween 20 was the control. Onion leaves were damaged prior to inoculation by gently rubbing sterile cheesecloth on the leaf surface. All leaves of the plant were sprayed until runoff using a small spray bottle. The plants were misted with water and covered with plastic bags for 48 hours to maintain leaf wetness.

SLB severity was assessed as the mean number of lesions per leaf on each plant and the mean percentage leaf dieback as follows:

Leaf dieback (%) = leaf dieback (cm) / leaf length (cm) x 100

All inoculated leaves of each plant were rated for SLB severity at 4, 7, 11 and 15 days post inoculation (dpi). An additional assessment at 5 dpi was completed for only the onion cotyledons in the 1st true leaf study. At 7 dpi, the cotyledons were removed from the 1st leaf plants and surface sterilized in 70% ethanol for 30 sec and sterile water for 2 min. The cotyledons were dried on filter paper and 10 from each treatment were plated onto V8 media, placed under UV light to induce sporulation, and assessed for the presence of *S. vesicarium* colony growth 5-6 days after plating. The remaining 4 cotyledons were placed in humid chambers for 7 days and assessed for the presence of *S. vesicarium* sporulation under a compound microscope.

Data analysis was conducted in SAS using PROC GLIMMIX with a lognormal distribution and included a mixed model analysis of variance (ANOVA) and means separation using Tukey's HSD at $P = 0.05$. The repetitions of both studies were not pooled due to interactions between repetition and treatment. The

interaction may be due to the greater natural dieback seen in both the control and treatments in the first repetition of the trial.

RESULTS: as presented in Tables 1-3.

CONCLUSIONS: For both leaf stage studies, inoculation resulted in significantly more leaf dieback and lesions, but seed treatment with EVERGOL PRIME had no effect on either variable (Table 1). This demonstrated that onion seedlings can be infected with *S. vesicarium* as early as the 1st true leaf stage. Similarly, the cotyledons of inoculated onions were all infected with *S. vesicarium*, with or without EVERGOL PRIME. Symptom development at both leaf stages was consistent with symptoms typically observed in the field at later leaf stages.

Table 1: Effect of EVERGOL PRIME seed treatment on mean leaf dieback (%) and number of lesions per leaf on onion seedlings inoculated with *Stemphylium vesicarium* assessed 15 days after inoculation in two studies inoculated at the 1st true leaf stage or 3rd-4th true leaf stage. Both studies were replicated.

Inoculation	Seed treatment with EVERGOL PRIME	Leaf dieback (%)	Lesions/leaf
1st true leaf, Rep 1			
Inoculated	Yes	21 a	1.4 a
Inoculated	No	20 a	1.2 a
Control	Yes	1 b	0.0 b
Control	No	0 c	0.0 b
1st true leaf, Rep 2			
Inoculated	Yes	17 A	1.4 A
Inoculated	No	16 A	1.3 A
Control	Yes	1 B	0.0 B
Control	No	0 C	0.0 B
3rd-4th true leaf, Rep 1			
Inoculated	Yes	59 y	0.8 y
Inoculated	No	51 y	0.8 y
Control	Yes	29 z	0.0 z
Control	No	34 z	0.0 z
3rd-4th true leaf, Rep 2			
Inoculated	Yes	47 Y	1.8 Y
Inoculated	No	59 Y	1.5 Y
Control	Yes	8 Z	0.0 Z
Control	No	10 Z	0.0 Z

Table 2: Effect of EVERGOL PRIME seed treatment on mean cotyledon dieback (%) and number of lesions per cotyledon on onion seedlings inoculated with *Stemphylium vesicarium* assessed 5 days after inoculation in a study inoculated at the 1st true leaf stage. The study was replicated.

Inoculation	Seed treatment with EVERGOL PRIME	Leaf dieback (%)	Lesions/leaf
Rep 1			
Inoculated	Yes	27 a	0.6 a
Inoculated	No	32 a	0.7 a
Control	Yes	7 ab	0.0 b
Control	No	5 b	0.0 b
Rep 2			
Inoculated	Yes	18 A	0.9 A
Inoculated	No	12 A	0.8 A
Control	Yes	2 B	0.0 B
Control	No	2 B	0.0 B

Table 3: Incidence (%) of cotyledon infection from onions inoculated at the 1st true leaf stage tested by culturing or humid chambers in both runs.

Inoculation	Seed treatment with EVRGOL PRIME	Cultured Incidence (%)	Humid Chamber Incidence (%)
Inoculated	Yes	100	100
Inoculated	No	100	100

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

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

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TITLE: SUSCEPTIBILITY OF ONION CULTIVARS TO TOXINS PRODUCED BY *STEMPHYLIUM VESICARIUM*, GROWTH ROOM STUDY, 2023

MATERIALS: Yellow onion cultivars Highlander, La Salle, Milestone, Trailblazer, Traverse.

METHODS: This study evaluated methods to concentrate toxins produced by *Stemphylium vesicarium* and used the toxin to evaluate the susceptibility of onion cultivars to the toxin based on leaf dieback. The study was arranged in a two-way factorial design with four replicates. One factor were extracts of *S. vesicarium* toxin solution and controls of water or sterile potato dextrose broth (PDB) (Fig. 1). The second factor was five cultivars of yellow cooking onion (Fig. 2) selected to represent a range of susceptibility to tip dieback caused by Stemphylium leaf blight (SLB). Each experimental unit was a single onion plant. The experiment was repeated.

The five onion cultivars were seeded on 03 October, 2023 into BM6 soilless mix (All-purpose HP, Berger Peat Moss Ltd, Saint Modeste, QC) and grown in a greenhouse. Seedlings were transplanted at the three-leaf stage on 08 November and moved to a growth room set to 24°C / 21°C day night cycle, a 17-hour photoperiod and 50% humidity.

To obtain toxin solutions, four 5-mm mycelial plugs of five different *S. vesicarium* cultures were placed in sterile PDB (24 g L^{-1}) and grown on a rotary shaker at 90 rpm under diffuse light at room temperature. After three weeks, the media solution was filtered through multiple layers of cheesecloth to remove mycelial fragments. The resulting solution was concentrated via solvent separation with ethyl acetate into two liquid partitions, a solvent layer containing concentrated toxin and a water layer. A third cultural filtrate solution was autoclaved to deactivate any residual mycelium of the pathogen but not separated. Insecticides were applied to reduce thrips pressure.

When the onion plants reached the 5–6 leaf stage, the three oldest leaves per plant were injected with 3 mL of treatment solution. Leaf dieback was assessed 7, 14 and 21 days after injection of the toxin solution. The total length of the leaf and the length of dieback on the second and third oldest leaves were measured with a clear plastic ruler. The mean leaf dieback (%) for each plant and cultivar was calculated. The methods to extract toxins were evaluated and the treatment that produced the most leaf dieback (%) was used to examine the susceptibility of cultivars to the toxins.

The data were assessed using a mixed-model analysis of variance partitioned into random (block and repetition) and fixed (treatment and cultivar) effects using PROC GLIMMIX of SAS version 9.4 (SAS Institute, Cary, USA). Means were separated using Tukey's HSD at $P = 0.05$. The data were log transformed to improve the fit to a normal distribution and back-transformed values are presented. There was no repetition x treatment interaction, so the results of the two runs were pooled for analysis. Each assessment date was analyzed separately. The treatment method that produced the most leaf dieback was used to analyze cultivar susceptibility.

RESULTS: as presented in Figure 1 and 2

CONCLUSION: In the toxin extraction study, autoclaved culture filtrate (CF) produced slightly more leaf dieback (%) at 7 days after injection (DAI) relative to the water control. At 14 DAI, the solvent layer of the ethyl acetate extraction had more leaf dieback. There were no differences in leaf dieback among the treatments at 21 DAI (Fig. 1). The occurrence of leaf dieback on onion plants injected with water was consistent with the natural senescence of the plants.

The toxin solution from ethyl acetate extraction was used to evaluate cultivar susceptibility. At 7 and 14 DAI, the severity of leaf dieback increased slightly but there were no differences among cultivars (Fig. 2). At 21 DAI, leaf dieback was more severe on cv. Highlander relative to La Salle and Traverse and the other cultivars were intermediate. The lack of differences among cultivars in early evaluations indicates the time that is needed for symptom development, highlighting the importance of multiple evaluations over time.

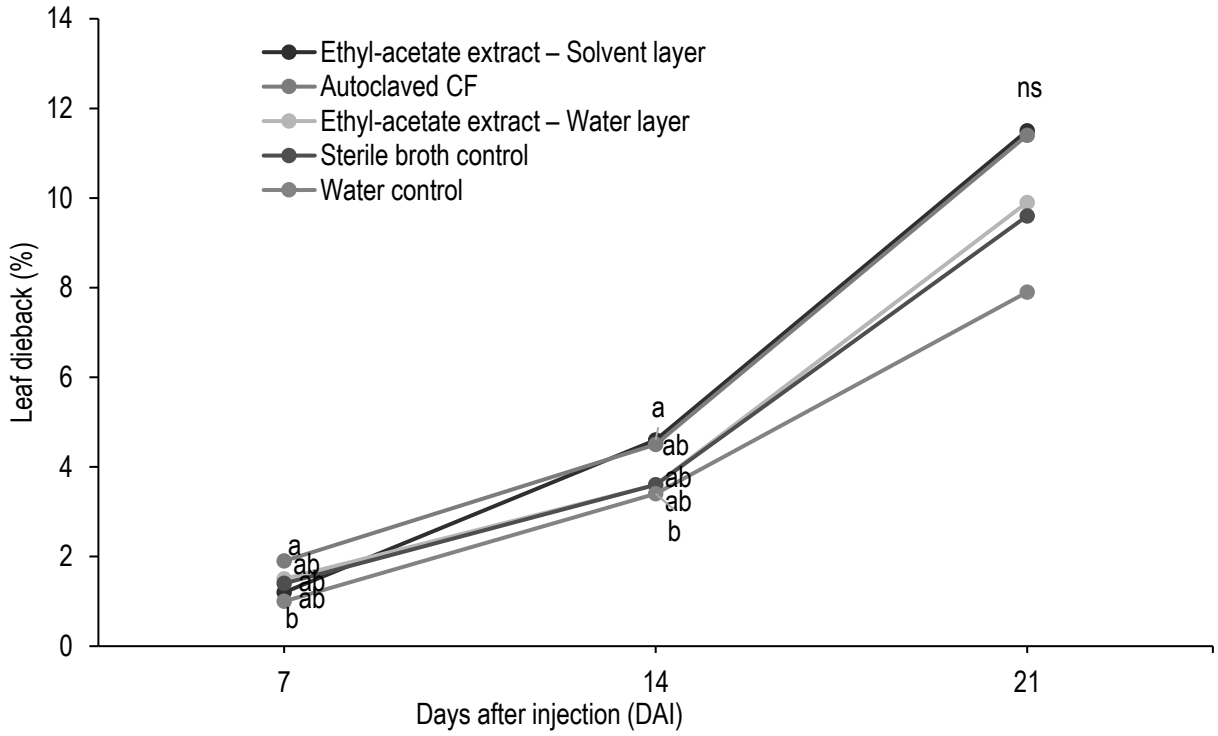

Figure 1. Effect of extraction method to concentrate toxins from culture filtrate (CF) of isolates of *Stemphylium vesicarium* grown in potato dextrose broth on leaf dieback (%) of onion. Bars topped with the same letter do not differ at *P*=0.05, Tukey's HSD.

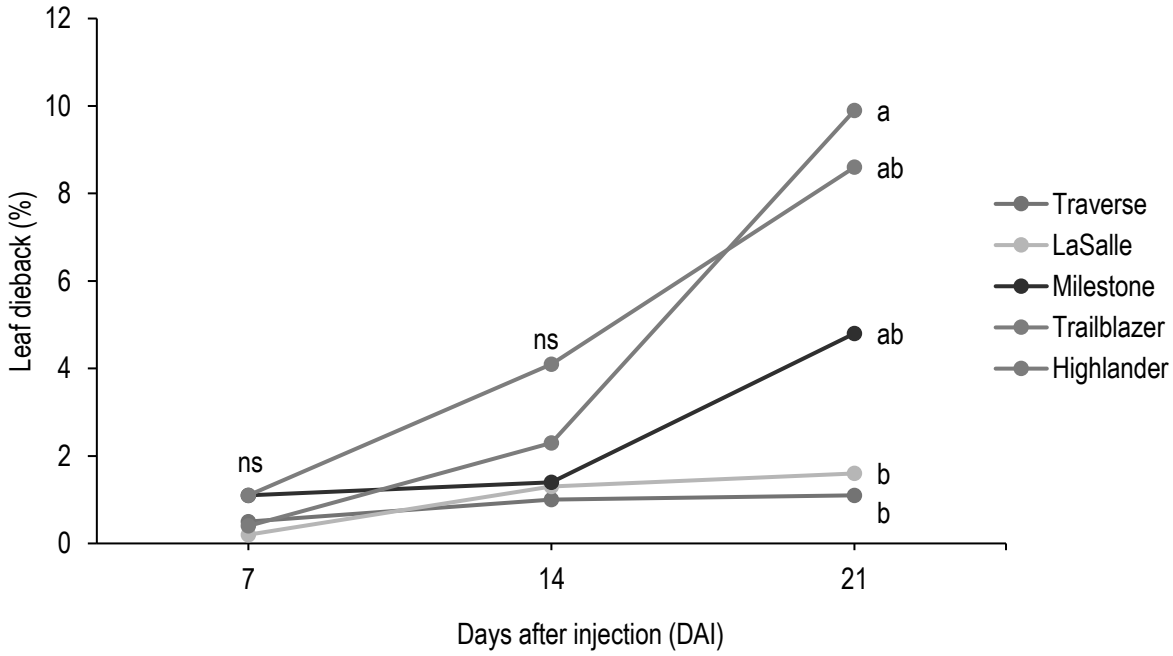

Figure 2. Effect of injection of the toxin from *Stemphylium vesicarium* in the solvent layer of ethyl acetate extraction on leaf dieback (%) on five onion cultivars in a controlled environment study. Values presented were normalized with broth and water treatments. Bars topped with the same letter are not significantly different at P=0.05, Tukey's HSD.

Funding provided by the Fresh Vegetable Growers of Ontario, the Bradford Co-operative and Storage Ltd and by the Ontario Agri-Food Innovation Alliance.

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

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TITLE: EVALUATION OF DISEASE FORECASTING MODELS FOR MANAGEMENT OF STEMPHYLIUM LEAF BLIGHT IN YELLOW COOKING ONIONS, 2023

MATERIALS: DITHANE RAINSHIELD WG (mancozeb 75.0%), MIRAVIS DUO (pydiflumetofen 7.5%, difenoconazole 12.5%), EVERGOL PRIME (penflufen 22.7%)

METHODS: Onions cv. Catskill treated with EVERGOL PRIME seed treatment were seeded on organic soil (organic matter ~68%, pH ~ 6.2) using a Stanhay precision seeder at the Ontario Crops Research Centre – Bradford on 10 May 2023. The trial was arranged in a randomized complete block design (RCBD) with seven fungicide timing treatments and one nontreated control. Each experimental unit (plot) consisted of a 6 m long segment of two adjacent beds, seeded with four double rows per bed with each double row spaced 40 cm apart. The treatments were: i) calendar sprays (applied every 7-14 days beginning at the 3-4 true leaf stage), ii) TOMcast with threshold 15, iii) conidia threshold of 20 conidia/rod per sampling date of a rotorod spore trap, iv) increasing conidia thresholds of 10 (2-5 true leaf stage), 25 (6-8 true leaf stage) and 200 (9+ true leaf stage), v) STEMcast 2.0 (a modified version of TOMcast) with a threshold of 15, vi) STEMcast 2.0 with a threshold of 15 until the 5th true leaf stage and 40 after that, vii) STEMcast 2.0 with a threshold of 20 and sprays every 7-14 days after the first spray and viii) an nontreated control. The STEMcast 2.0 model increases the leaf wetness period required to get higher disease severity values (DSVs) compared to TOMcast and eliminates DSVs for temperatures lower than 18°C. Fungicide application timing was determined using disease forecasting models based on weather data or conidia counts.

For all treatments MIRAVIS DUO (1 L/ha) and DITHANE (2.5 kg/ha) were applied alternately using a tractor-mounted sprayer with D-3 spray nozzles at 620 kPA delivering 500 L/ha. The treatments were sprayed 1-6 times throughout the season. Stemphylium leaf blight (SLB) severity was assessed in each plot on 29 June, 07, 13, 20, 25 July, and 01, 08 August. The three oldest green leaves of 20 plants per plot (10 plant from the middle rows of each bed) were rated based on a 0-4 scale for percentage leaf dieback where 0= no symptoms, 1= 1-10% dieback, 2= 11-25% dieback, 3= 26-50% dieback and 4 >50% dieback. Total SLB severity out of 12 was calculated for each plant by adding the rating of each of the three leaves. A disease severity index (DSI) was calculated with the following formula:

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

The area under the disease progress curve (AUDPC) was calculated with the following formula:

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

where $_j$ is the order index for the assessments over time, n_j is the 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 assessments. On 15 August, 10 consecutive plants within a row from the two inner rows of each bed (total of 20) were pulled. The green leaves of all 20 plants were removed and rated for percentage leaf dieback based on a 0-6 scale where 0= no symptoms, 1=1-4% dieback, 2= 5-10% dieback, 3= 11-25% dieback, 4= 26-50%

dieback, 5= 51-75% dieback and 6 >75% dieback. DSI was calculated based on this assessment. Yield was estimated by removing the onion plants from a 2.3 m section of two inner rows on 30 August. The onions were left to dry in the field. On 27 September, the onions were sorted into classes: jumbo (>76 mm), large (76-64 mm), medium (64-45 mm) and culls (<45 mm) and weighed to calculate yield.

Compared to the previous 10-year average, air temperatures in 2023 were above average for September (18.2°C), average for June (18.1°C) and July (20.9°C) and below average May (12.7°C), and August (18.9°C). The 10-year average temperatures were: May 13.6°C, June 18.7°C, July 21.2°C, August 20.5°C and September 16.5°C. Monthly rainfall was below the 10-year average for May (52 mm), June (82 mm), August (61 mm) and September (4 mm) and above average for July (113 mm). The 10-year rainfall averages were: May 64 mm, June 96 mm, July 74 mm, August 77 mm and September 65 mm.

Data analysis was conducted in SAS using PROC GLIMMIX and included a mixed model analysis of variance (ANOVA) and means separation using Tukey's HSD at a significance level of $P = 0.05$.

RESULTS: as presented in Tables 2-4.

CONCLUSIONS: In 2023, SLB severity was high (81%) in the nontreated control. There were few differences among treatments in severity in the field ratings, no differences in the destructive assessment on 15 August, and no differences in bulb yield. The only significant differences in severity were observed in the 25 July field rating and in the AUDPC, where STEMcast 2.0 15, conidia threshold 20 and the calendar spray produced a slightly lower AUDPC than the control. None of the treatments effectively suppressed SLB, but the STEMcast 2.0 15 model triggered four fewer sprays than the calendar spray without an increase in disease severity.

Table 1. Dates of application of the fungicides MIRAVIS DUO (M) and DITHANE (D) for each treatment at the Ontario Crops Research Centre – Bradford, 2023.

Treatment	16 Jun	28 Jun	10 Jul	14 Jul	20 Jul	28 Jul	2 Aug	10 Aug
Calendar	-	M	D	M	-	D	M	D
Conidia 20	-	M	D	M	-	D	M	D
TOMcast 15	-	M	D	-	M	-	D	M
Conidia IT	M	D	M	-	-	-	-	D
STEMcast 2.0 20C	-	-	-	-	M	-	D	M
STEMcast 2.0 15	-	-	-	M	-	D	-	-
STEMcast 2.0 15/20	-	-	-	-	-	-	M	-
Control	-	-	-	-	-	-	-	-

Table 2. Effect of fungicide application timing according to forecasting models for Stemphylium leaf blight (SLB) on disease severity index (DSI) and area under the disease progress (AUDPC) on onion, cv. Catskill, at the Ontario Crops Research Centre – Bradford, 2023.

Treatment	DSI							AUDPC[3]
	29 Jun	7 Jul	13 Jul	20 Jul	25 Jul	1 Aug	8 Aug	
Control	13 ns[1]	23 ns	37 ns	51 ns	51 ab[2]	67 ns	85 ns	1833 a
STEMcast 2.0 15/40	12	21	38	49	52 a	63	81	1762 ab
STEMcast 2.0 20C	11	21	38	49	52 a	62	82	1760 ab
TOMcast 15	13	21	37	46	47 abc	67	82	1752 ab
Conidia IT	13	21	37	47	50 abc	63	83	1743 ab
STEMcast 2.0 15	11	21	33	47	51 ab	62	79	1698 b
Conidia 20	12	22	35	45	46 bc	61	79	1671 b
Calendar Spray	12	23	33	47	45 c	59	78	1661 b

[1] ns = no significant differences were found among treatments.
[2] Means in a column followed by the same letter do not differ at $P = 0.05$ based on Tukey's HSD.
[3]AUDPC calculated based on the DSI for 29 Jun, 07, 13, 20, 25 Jul and 01, 08 August.

Table 3: Effect of the timing of application triggered by forecasting models for Stemphylium leaf blight (SLB) on 15 August for incidence, disease severity index (DSI), leaves rated 0 or 1 (%) and green leaves per plant on onion, cv. Catskill, at the Ontario Crops Research Centre – Bradford, 2023.

Treatment	# Sprays	Incidence (%)	DSI[2]	% Leaves rated 0 or 1	Green leaves/plant
TOMcast 15	5	100 ns[1]	82 ns	1 ns	5 ns
Control	0	100	81	3	5
STEMcast 2.0 20C	3	99	80	3	5
Conidia IT	4	99	79	3	6
STEMcast 2.0 15/40	1	100	79	4	5
Calendar Spray	6	99	77	3	5
STEMcast 2.0 15	2	99	77	3	5
Conidia 20	6	99	76	4	6

[1] ns= no significant differences were found among treatments.
[2]Incidence, DSI, % leaves rated 0 or 1 and green leaves/plant were calculated based on the destructive assessment on 15 August.

Table 4: Effect of fungicide application triggered by disease forecasting models on yield, percentage marketable (%Mkb) and size distribution of onion bulbs, cv. Catskill at the Ontario Crops Research Centre – Bradford, 2023.

Treatment	Yield (t/ha)	% Mkb	Size distribution (%)			
			Jumbo (>76mm)	Large (76-64mm)	Medium (64-45mm)	Cull (<45mm)
Conidia 20	57 ns[1]	82 ns	0 ns	9 a[2]	74 ns	18 ns
Calendar	54	80	0	9 a	71	21
STEMcast 2.0 15	53	80	0	6 ab	74	21
STEMcast 2.0 20C	50	76	0	6 ab	71	24
TOMcast 15	49	76	0	4 ab	72	24
STEMcast 2.0 15/40	49	76	0	4 ab	72	24
Control	48	75	0	4 ab	72	25
Conidia IT	47	77	0	3 b	75	23

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

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

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

AUTHORS: SCICLUNA J[1], GOSSEN BD[2] & MCDONALD MR[1]
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TITLE: EVALUATION OF SPORE TRAPS AND BARLEY AS INDICATORS FOR EARLY SEASON INFECTION OF ONION BY *STEMPHYLIUM VESICARIUM*, 2023

METHODS: Yellow cooking onion cv. Catskill and barley were seeded in a field trial with four replicates in 6 m long plots with four double rows spaced 40 cm apart at the Ontario Crops Research Centre – Bradford on 10 May 2023. Onion seedlings cv. Milestone were transplanted on 16 May 2023 in a separate trial. The 10 oldest leaves that were at least 50% green in each plot were sampled and assessed for incidence of Stemphylium leaf blight (SLB) from the flag leaf stage until the 3rd-4th true leaf stage. Seeded onions were assessed for SLB on 30 May, 06, 09, 14, 16, 20 and 23 June, and transplanted onions on 09, 14, 16, 20 and 23 June. Similarly, 10 barley leaves per plot were sampled on 06, 09, 14, 16, 20 and 23 and 26 June, until the leaves had fully senesced after being sprayed with herbicide. The collected leaves of onion and barley were placed in humid chambers for 7-14 days and assessed for the presence of *S. vesicarium* sporulation on the leaves using a dissecting microscope. Incidence (%) was calculated based on the proportion of plants that sporulated.

Two spore traps, the Burkard 7-day recording volumetric spore trap and the Rotorod (rotating arm impactor) sampler, were placed in the onion plots from April-August 2023. The Burkard trap was set facing west (into the prevailing wind) with the sampling orifice 0.7 m off the ground. It collected spores 24 hours per day on 'Melinex' tape coated with silicone grease at an air sampling rate of 10 L/min. The Rotorod trap was set directly above the onion canopy. It collected spores with an air sampling rate of 20.65 L/min/rod from 6:00 am -12:00 pm on two silicone grease coated 1.52 mm wide x 3.15 cm long polystyrene rods. The rods were collected each Monday, Wednesday and Friday. Ascospores and conidia of *S. vesicarium* were counted using a compound microscope and converted to spores/m^3 of air.

Compared to the previous 10-year average, air temperatures in 2023 were average for June (18.1°C) and July (20.9°C) and below average May (12.7°C), and August (18.9°C). The 10-year average temperatures were: May 13.6°C, June 18.7°C, July 21.2°C and August 20.5°C.
Monthly rainfall was below the 10-year average for May (52 mm), June (82 mm) and August (61 mm) and above average for July (113 mm). The 10-year rainfall averages were: May 64 mm, June 96 mm, July 74 mm, August 77 mm.

Data analysis was conducted in SAS using PROC CORR. Correlations between the spore trap counts and infection of barley and onions were calculated using Kendall's Tau-B at $P = 0.05$.

RESULTS: Data are presented in Figures 1 and 2. There was a strong positive correlation between conidia captured by the Rotorod spore trap and infection of seeded onions ($r = 0.79$, $P = 0.02$) and between conidia captured by the Burkard spore trap and infection of barley ($r = 0.77$, $P = 0.03$). There were no other significant correlations between conidial numbers and infection of onions, or infection of barley and infection of onions. There was also no correlation ($r = -0.02$, $P = 0.90$) between the two spore traps in the early season (April - June) and only a moderate correlation ($r = 0.48$, $P < 0.0001$) across the whole growing season (April - August).

CONCLUSIONS: Infection of seeded onions was initially detected at the 2nd true leaf stage (14 June), which indicated that infection of onions occurs before the 3rd-4th true leaf stage. While infection of barley was detected around the same time as infection of transplanted onions, infection of barley was not correlated with infection of onions and may not be a useful indicator of early infection of onions or SLB severity. The Rotorod counts were more strongly correlated with infection of onions than counts from the Burkard trap. The Rotorod trap also captured more conidia at lower inoculum levels, so Rotorod traps may be better for monitoring the presence of conidia early in the growing season. Research is continuing to determine if conidia captured by spore traps are a reliable indicator of disease severity later in the growing season. More research is needed to determine the impact of early season infection on SLB severity later in the season.

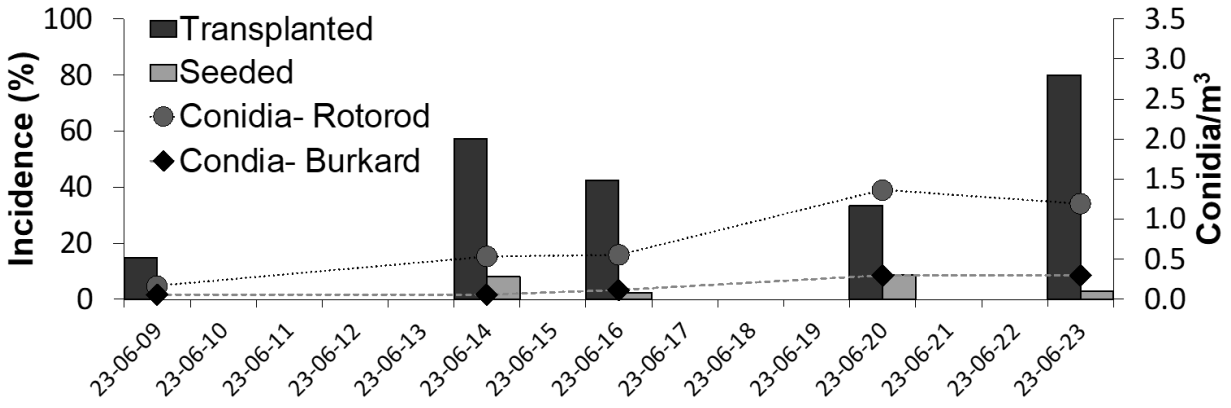

Figure 1: Incidence (%) of *Stemphylium vesicarium* sporulation in transplanted or seeded onions from 09 to 23 June and the 7-day average of conidia/m^3 captured by the Burkard and Rotorod spore traps at the Ontario Crops Research Centre – Bradford in 2023.

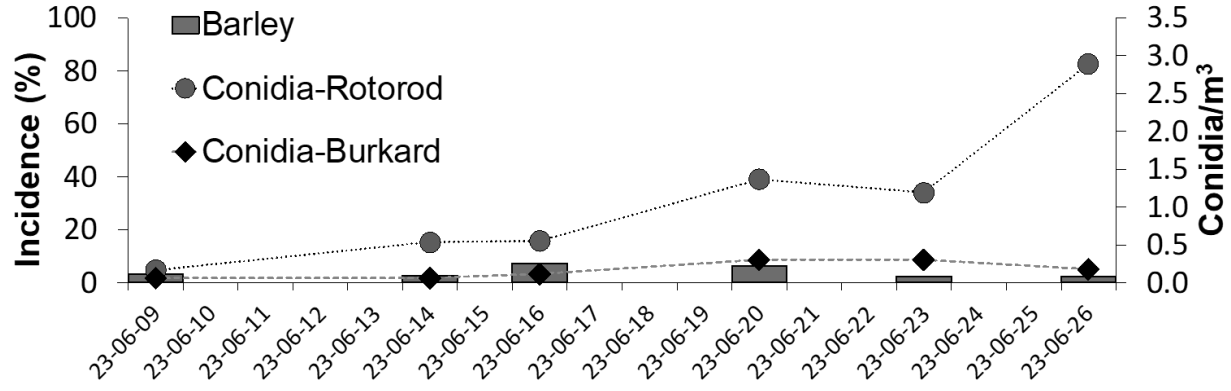

Figure 2: Incidence (%) of *Stemphylium vesicarium* sporulation in barley from 09 to 26 June and the 7-day average of conidia/m^3 captured by the Burkard and Rotorod spore traps at the Ontario Crops Research Centre – Bradford in 2023.

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

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

AUTHORS: MCDONALD MR, VANDER KOOI K & FARINTOSH G
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TITLE: EVALUATION OF THE FARMDROID FD20 SEEDING AND WEEDING IN A COMMERCIAL ONION FIELD, 2023

METHODS: The Farmdroid FD20, a solar-powered agricultural robot, was used to seed and weed 7 acres of onions in a commercial field. Onions, cv. Saddleback, were direct seeded on 9 May using a FarmDroid FD20 into organic soil in Keswick, Ontario. The robot seeded 21 beds ~800 m long, with 4 single rows in each bed (seeds 3.4 cm apart within the row) at 225 meters per hour. After seeding, the FD20 was switched into weeding mode, using metal tines to remove weeds growing between the rows it had seeded at a speed of 500 meters per hour. Yield and weeds were compared to onions seeded and weeded conventionally in a plot directly beside the FD20 plot. Weeds were identified and counted within a 0.25 m^2 wire square that was placed in 10 random locations in both plots. On 27 September, onions in two randomly selected 2.32 m sections of row were pulled from the 6 different locations from each treatment for a yield sample. Onions were weighed, graded for size, and counted on 21 October to determine yield.

Compared to the previous 10-year average, air temperatures in 2023 were above average for September (18.2°C), average for June (18.1°C) and July (20.9°C) and below average May (12.7°C), and August (18.9°C). The 10-year average temperatures were: May 13.6°C, June 18.7°C, July 21.2°C, August 20.5°C and September 16.5°C. Monthly rainfall was below the 10-year average for May (52 mm), June (82 mm), August (61 mm) and September (4 mm) and above average for July (113 mm). The 10-year rainfall averages were: May 64 mm, June 96 mm, July 74 mm, August 77 mm and September 65 mm. Data were analyzed using the General Analysis of Variance function of Statistix V.10. Means separation was obtained by using Fisher's Protected LSD test at $P = 0.05$ level of significance.

RESULTS: as presented in Tables 1 and 2

CONCLUSIONS: There were no significant differences in onions per meter, marketable yield, or size distribution of onions between the commercially grown onion and onions seeded and weeded by the FD20. The plot managed by the FD20 had significantly more weeds than the commercially managed plot, although differences in spray timing and hand-weeding may have impacted this result. The wire tines used for weeding were able to pull weeds, but they would often wrap around the tines and lose efficacy as the buildup increased, sometimes even pushing soil onto the small onion plants. Further work needs to be done to design and test improved weeding implements, and find more efficient ways to seed for commercial production.

Table 1. Yield data for onions, cv. Saddleback, seeded and weeded using a FarmDroid FD20 compared to conventional methods, grown in a commercial field in Keswick, Ontario, 2023.

Treatment	Onions/m	Marketable Yield (t/ha)	% Marketable	Size Distribution (%)[1]			
				Jumbo (>76 mm)	Large (65-76 mm)	Medium (46-64 mm)	Cull (<45 mm)
FD20	22.7 ns[2]	47.5 ns	94.0 ns	2.3 ns	27.9 ns	63.9 ns	5.9 ns
Conventional	22.0	50.0	96.2	1.4	30.4	64.4	8.8

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

Table 2. Weed counts in onions, cv. Saddleback, seeded and weeded using a FarmDroid FD20 compared to conventional methods, grown in a commercial field in Keswick, Ontario, 2023.

Treatment	Total[1] Weeds	Total Thistle	Total Pigweed	Total Marsh Cress	Weed Counts		
					May 31	June 6	June 16
FD20	25.5 b[2]	11.8 b	11.5 b	7.6 b	7.1 b	9.9 ns[3]	8.5 ns
Conventional	11.6 a	0.2 a	3.8 a	2.2 a	1.6 a	4.7	5.3

[1] Weeds counts were taken within 0.25 m^2 wire squares
[2] Means in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher's protected LSD test
[3] ns = 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.

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

AUTHORS: MCDONALD MR, VANDER KOOI K & FARINTOSH G
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TITLE: EVALUATION OF VARIOUS SEEDING TECHNIQUES AND SPEED USING THE FARMDROID FD20 IN ONIONS, 2023

METHODS: The FarmDroid FD20, a solar-powered agricultural robot, was used to seed onions with different techniques and speeds to determine the most effective seeding method and commercial viability. For the seeding technique trial, onions, cv. Saddleback, were direct seeded on 9 May using a FarmDroid FD20 into organic soil (organic matter ≈ 75.2%, pH ≈ 6.4) at the Ontario Crops Research Centre - Bradford, Holland Marsh, Ontario. The robot seeded 4 beds ~30 m long, with 4 rows in each bed, 3 of which were planted as a single row (seeded 3.4 cm apart within the row), and the fourth row seeded in clusters of 3 (12 cm apart within the row). These treatments were compared to onions planted using a conventional seeder and tractor in a double row (seeds ~5 cm apart within the row), with 4 double rows per bed. On 17 September, onions in two randomly selected 2.32 m sections of row were pulled from the 4 different beds from each treatment for a yield sample. Onions were weighed, graded for size, and counted on 21 October to determine yield.

For the speed trial, onions, cv. Saddleback, were direct seeded on 3 August using a FarmDroid FD20 into organic soil (organic matter ≈ 64.2%, pH ≈ 6.6) near the Ontario Crops Research Centre - Bradford, Holland Marsh, Ontario. A randomized complete block arrangement with four replicates per treatment was used. Each experimental unit consisted of four rows (40 cm apart), 6 m in length. Seeds were planted in a single row, (3.4 cm apart within the row) to determine if the seed valve would limit seeding accuracy when seeds were planted close together at high speeds, and if the seed beam sensor was accurate in catching seeding errors. Seeds were planted at 200, 300, 400, and 500 m/hr. On 29 August, emergence of onions was recorded from two 1 m sections from the 2 inner rows of each experimental unit.

Compared to the previous 10-year average, air temperatures in 2023 were above average for September (18.2°C), average for June (18.1°C) and July (20.9°C) and below average May (12.7°C), and August (18.9°C). The 10-year average temperatures were: May 13.6°C, June 18.7°C, July 21.2°C, August 20.5°C and September 16.5°C. Monthly rainfall was below the 10-year average for May (52 mm), June (82 mm), August (61 mm) and September (4 mm) and above average for July (113 mm). The 10-year rainfall averages were: May 64 mm, June 96 mm, July 74 mm, August 77 mm and September 65 mm. Data were analyzed using the General Analysis of Variance function of Statistix V.10. Means separation was obtained by using Fisher's Protected LSD test at $P = 0.05$ level of significance.

RESULTS: as presented in Tables 1 and 2

CONCLUSIONS: There were no significant differences in marketable yield between treatments, despite the conventional double row seeding significantly more onions per meter than the FD20, with more than double the onions per meter of the triple cluster method at harvest (Table 1). The single row and triple clusters planted by the FD20 had significantly more large onions and fewer culls compared to the conventional double row, and the triple cluster had significantly more jumbo onions than the other two treatments. Emergence was considerably higher when the FD20 seeded at the lowest speed of 200m/hr; as speed increased emergence dropped numerically (Table 2). The FD20 accurately detected seeding errors. To plant at higher speeds the seed valve would need more time to actuate by seeding further apart. This could be achieved by seeding in groups like the triple cluster, with more space between clusters than single seeds. More work needs to be done to test and optimize seeding techniques and speeds.

Table 1. Yield of onions, cv. Saddleback, seeded by a FarmDroid FD20 using various techniques and aconventional seeder, grown near the Ontario Crops Research Centre - Bradford, Holland Marsh, Ontario, 2023.

Treatment	Onion/m	Marketable Yield (t/ha)	% Marketable	Size Distribution (%)[1]			
				Jumbo (>76 mm)	Large (65-76 mm)	Medium (46-64 mm)	Cull (<45 mm)
Single Row	24.5 b[2]	75.5 ns[3]	99.2 ns	9.3 b	52.9 a	37.1 b	0.8 b
Triple Cluster	16.7 c	72.9	99.9	42.5 a	47.2 a	10.2 c	0.1 b
Double Row (Conventional)	35.1 a	72.8	96.6	0.4 b	18.5 b	77.7 a	3.4 a

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

Table 2. Emergence for onions, cv. Saddleback, planted at various speeds using the FarmDroid FD20, grown near the Ontario Crops Research Centre - Bradford, Holland Marsh, Ontario, 2023.

Treatment	Emergence (Onions/m)
200 m/hr	19.1 a[1]
300 m/hr	12.0 b
400 m/hr	11.0 b
500 m/hr	8.0 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. The FarmDroid FD20 was provided by Haggerty AgRobotics Inc.

CROP: Broccoli (*Brassica oleracea*) cv. Diplomat
PEST: Swede Midge (*Contarinia nasturtii*)

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TITLE: CONTROL OF SWEDE MIDGE IN BRASSICAS WITH ISOCYCLOSERAM, 2023

MATERIALS: A21377 (experimental), CORAGEN 200 SC (chlorantraniliprole 18.4%), HASTEN NT(Methyl and ethyl oleate (esterified vegetable oil) 75.20%)

METHODS: Broccoli plants, cv. Diplomat, were transplanted by hand on 23 May into organic soil, (pH ≈ 6.1, organic matter ≈ 69.8%) naturally infested with *Contarinia nasturtii* pupae 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 two rows, spaced 22 cm apart and 7 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: CORAGEN 200 SC at 250 mL/ha, A21377 at 100 mL/ha, 150 mL/ha, and 200 mL/ha. An untreated check was also included. Treatments were applied on 29 June, 7, 17, 25 July, and 1 August. On Aug 2, all plants in each experimental unit were visually rated on a scale from 0 to 3. Classes were: 0 = no damage, 1 = mild twisting of stem, 2 = severe twisting of stem and crumpling of leaves, 3 = death of meristem. On 25, 31 Aug and 8 September, mature broccoli heads were harvested and sorted based on marketability before being weighed. Plants without any heads (blinds) were counted and removed during harvest as well. Data were analyzed using the General Analysis of Variance function of Statistix V.10. Means separation was obtained by using Fisher's Protected LSD test at P = 0.05 level of significance.

RESULTS: as presented in Tables 1-3

CONSCLUSIONS: There were no significant differences in the visual damage assessments, but the products all reduced incidence and severity of swede midge damage numerically compared to the check (Table 1). All rates of A21377 also numerically reduced incidence and severity compared to CORAGEN also. All products significantly increased marketable yield and percent marketable yield compared to the untreated check, and numerically reduced the number of blinds (Table 2). There were no signs of phytotoxicity in the trial (Table 3).

Table 1. Swede midge damage incidence and severity for broccoli, cv. Diplomat, sprayed with various insecticides at the Muck Crops Research Station, Holland Marsh, Ontario, 2023.

Treatment	Rate (mL/ha)	Incidence (%)	DSI[1,2]
A21377 + HASTEN NT[3]	200	8.3 ns	3.0 ns[4]
A21377 + HASTEN NT	150	8.4	2.8
A21377 + HASTEN NT	100	10.1	5.0
CORAGEN + HASTEN NT	250	14.5	6.0
Check	-	18.9	7.0

[1] On 2 August, all plants were visually assessed using the following classes: 0 = no damage, 1 = mild twisting of stem, 2 = severe twisting of stem and crumpling of leaves, 3 = death of meristem.

[2] Damage severity (DSI) was calculated using the following formula:

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

[3] HASTEN NT was applied at 0.25% v/v.

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

Table 2. Yield and marketability of broccoli, cv. Diplomat, sprayed with various insecticides for control of swede midge at the Muck Crops Research Station, Holland Marsh, Ontario, 2023.

Treatment	Rate (mL/ha)	Blinds[1]	Marketable[2] Yield (%)	Marketable Weight (kg)	Unmarketable Weight (kg)
A21377 + HASTEN NT[3]	200	3.8 ns	68.8 a[4]	5.2 a	2.5 ns[5]
A21377 + HASTEN NT	150	5.8	68.6 a	5.1 a	2.4
A21377 + HASTEN NT	100	8.0	62.7 a	4.3 a	2.7
CORAGEN + HASTEN NT	250	9.2	63.9 a	4.0 a	1.9
Check	-	15.8	36.8 b	1.6 b	2.8

[1] Blinds are the number of plants per plot that did not produce any heads.

[2] Percentage values were determined using weight.

[3] HASTEN NT was applied at 0.25% v/v.

[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 treatments.

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

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, 2022-2023

MATERIALS: EXPERIMENTAL Nematicide, PROMAX (thyme oil 3.5%) + Fertigold Soil (organic fertilizer/soil health promoter), 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: EXPERIMENTAL, PROMAX and VELUM PRIME applied as a soak (S) and/or drench (D). Seed soak treatments, and the associated soaking times, were: EXPERIMENTAL S at 2.2 mL/L for 4-hours and VELUM PRIME S at 1.7 mL/L for 1-hour. Soak treatments were applied by placing cloves in a mesh bag in 10 L of each treatment solution for each respective time period. Garlic was air dried following the soaking treatment. The drench treatments were EXPERIMENTAL D low rate at 500 mL/ha, EXPERIMENTAL D high rate at 667 mL/ha, 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 a rate of 90 mL/m using a beaker. The PROMAX S+D treatment consisted of both a soak (50 mL/L for 4-hours) and drench (11.23 L/ha) at planting with two more drench applications of PROMAX on 27 April and 14 June, and Fertilgold Soil on 1 May and 21 June 2023. 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 2 November 2022 and straw was laid over the plots. Plant heights were recorded on 3 July and plant counts were recorded on 28 July 2023. Garlic was harvested on 9 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 random five clove per treatment sample after harvest using the Baermann pan method.
Compared to the previous 10-year average, air temperatures in 2023 were average for June (18.1°C) and July (20.9°C) and below average May (12.7°C), and August (18.9°C). The 10-year average temperatures were: May 13.6°C, June 18.7°C, July 21.2°C and August 20.5°C.
Monthly rainfall was below the 10-year average for May (52 mm), June (82 mm) and August (61 mm) and above average for July (113 mm). The 10-year rainfall averages were: May 64 mm, June 96 mm, July 74 mm and August 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: as presented in Tables 1 and 2.

CONCLUSIONS: The trial received an unusually high amount of precipitation in July, right before harvest, that resulted in many rotten garlic bulbs (Tables 1 & 2). As a result, conclusions cannot be drawn

from these results and the statistically significant differences among the treatments are most likely a coincidence.

Table 1. Garlic counts and plant heights after nematicide application for stem and bulb nematode infested seed cloves near Cookstown, Ontario, 2022-23.

Treatment	App Method[1]	Soak Time (hours)	% Emerged (of 25 plants)	Plant Height (cm)
EXPERIMENTAL	S	4	76.8 a[2]	68.8 a
EXPERIMENTAL LOW	D	-	60.8 ab	61.5 ab
VELUM	S	1	60.0 ab	66.2 a
VELUM	D	-	59.2 ab	61.3 ab
EXPERIMENTAL HIGH	D	-	53.6 ab	57.2 ab
Check	-	-	52.8 ab	60.3 ab
PROMAX	S+D	4	36.0 b	53.4 b

[1] Application Method: S = Soak; D = Drench.
[2] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Tukey's HSD test.

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, 2022-23.

Treatment	App. Method[1]	Soak Time (hours)	% Marketable Bulbs	DSI[2]	Marketable Yield (g/plot)	Harvest SBN Count (SBN/g clove)
EXPERIMENTAL	S	4	60.0 a[3]	36.8 a	293.9 a	293.6 ns[4]
EXPERIMENTAL LOW	D	-	52.3 ab	48.7 ab	135.8 ab	76.8
Check	-	-	46.0 abc	51.1 abc	97.4 b	95.6
VELUM	D	-	31.7 abc	67.3 abcd	70.1 b	237.6
VELUM	S	1	18.5 bc	74.6 bcd	40.2 b	153.8
PROMAX	S+D	4	13.7 c	83.6 cd	12.1 b	43.5
EXPERIMENTAL HIGH	D	-	9.5 c	87.1 d	11.5 b	49.2

[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 at $P = 0.05$, Tukey's HSD test.
[4] ns indicates that 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.

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

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TITLE: EVALUATION OF MYCOINSECTICIDES TO REDUCE CLUBROOT IN CABBAGE, 2023

MATERIAL: BOTANIGARD (*Beauveria bassiana* Strain GHA, 11.3%); BIOCERES EC (*B. bassiana* strain ANT-3, ≥1 x 10^{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%) naturally infested with *Plasmodiophora brassicae* pathotype 2. The treatments were cabbage cv. Bronco treated with BOTANIGARD or BIOCERES and untreated Bronco. Both of these products contain the mycoinsecticide *Beauveria bassiana,* which can colonize plants as an endophyte and may reduce disease and insect damage. The trial was laid out in a randomized complete block design with four replicates. Each plot consisted of three rows, 5 m in length, spaced 55 cm apart, with 30 cm between rows. Cabbage was seeded om 25 May, 2023 into 128- cell plug trays filled with soilless mix and grown in a greenhouse. On 16 June, BOTANIGARD at 10 mL/L and BIOCERES at 8 mL/L were applied to three trays each of Bronco transplants at 500 mL/tray. On 07 July, 2023, the cabbage plants were hand-transplanted into the field.

On 05 September, the tops were cut from 10 consecutive plants pulled from each row (50 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:

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

Compared to the previous 10-year average, air temperatures in 2023 were above average for September (18.2°C), average for June (18.1°C) and July (20.9°C) and below average May (12.7°C), and August (18.9°C). The 10-year average temperatures were: May 13.6°C, June 18.7°C, July 21.2°C, August 20.5°C and September 16.5°C. Monthly rainfall was below the 10-year average for May (52 mm), June (82 mm), August (61 mm) and September (4 mm) and above average for July (113 mm). The 10-year rainfall averages were: May 64 mm, June 96 mm, July 74 mm, August 77 mm and September 65 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 Tukey 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 2023. Plants treated with BIOCERES and BOTANIGARD did not differ from the untreated control. Feeding damage caused by Lepidoptera species was not observed.

Table 1. Effect of mycoinsecticide endophytes on clubroot incidence and severity (disease severity index, DSI), and fresh weight of the foliage of cabbage on a muck soil naturally infested with *Plasmodiophora brassicae* at the Ontario Crops Research Centre – Bradford, Ontario, 2023.

Endophyte	Incidence (%)	DSI (0-100)	Fresh wt / plant[1] (g)
BIOCERES	81ns[2]	57ns	5.9 ns
BOTANIGARD	80	60	6.7
Control	78	62	6.8

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

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

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

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

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TITLE: EVALUATION OF MYCOINSECTICIDE BEAUVERIA BASSIANA TO REDUCE CLUBROOT SEVERITY ON CANOLA, 2023

MATERIAL: BOTANIGARD (*Beauveria bassiana* Strain GHA, 11.3%),
BIOCERES EC (*B. bassiana* strain ANT-3, ≥ 1 x 10^{10} 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 2 m × 3 m with 0.75 m between plots. Treatments consisted of application of BIOCERES (8 mL per L water) and BOTANIGARD (10 mL per L water) as either a soil drench or seed treatment and an untreated control. Seed treatments were completed prior to seeding by adding a methyl cellulose solution (1 g methyl cellulose per L water); then the solution was mixed with equal volumes of BOTANIGARD or BIOCERES. This solution was applied to 75 g of L233P canola seed and continuously agitated until the liquid has evaporated. Canola was seeded (July 7, 2023) using a Earthway seeder fitted with a 1002-5 disc, with four rows per plot and ~0.4 m between rows. Drench treatments were applied after seeding using a mixture of BIOCERES (8 mL per L water) or BOTANIGARD (10 mL per L water) at ~500 mL per row with a band width the same width as the seeding rows. This high rate of application ensured that the solution was in contact with the seed.

At 6 weeks after seeding (September 14, 2023), 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:

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

Compared to the previous 10-year average, air temperatures in 2023 were above average for September (18.2°C), average for June (18.1°C) and July (20.9°C) and below average May (12.7°C), and August (18.9°C). The 10-year average temperatures were: May 13.6°C, June 18.7°C, July 21.2°C, August 20.5°C and September 16.5°C. Monthly rainfall was below the 10-year average for May (52 mm), June (82 mm), August (61 mm) and September (4 mm) and above average for July (113 mm). The 10-year rainfall averages were: May 64 mm, June 96 mm, July 74 mm, August 77 mm and September 65 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 Tukey test at P = 0.05 level of significance.

RESULTS: as presented in Table 1

CONCLUSIONS: Neither Beauveria product or application technique produced a significant effect on any variable. Beauveria products at these rates and application methods were not effective for management of clubroot on canola.

Table 1. Effect of BIOCERES and BOTANIGARD applied as a seed treatment or soil drench on clubroot incidence and severity (disease severity index, DSI), and fresh weight of shoots of canola in muck soil naturally infested with *P. brassicae* at the Ontario Crops Research Centre - Bradford, Ontario, 2023.

Treatment	Incidence (%)	DSI (0-100)	Fresh top wt. / plant[1] (g)
BIOCERES-Drench	33 ns[2]	25 ns	1.6 ns
BIOCERES-Seed	29	17	1.5
BOTANIGARD-Drench	26	16	1.4
BOTANIGARD-Seed	26	14	1.3
Control	18	12	1.2

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

[2] 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.

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

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TITLE: EFFECT OF SOIL PH AND CALCIUM BASE SATURATION ON SEVERITY OF CLUBROOT IN CANOLA

MATERIALS: GPYSUM (calcium: 27%, sulfur: 22%, Secural), HYDRATED LIME (calcium hydroxide: 97.9%, magnesium oxide: 0.74%, silica: 0.71%, ferric oxide: 0.13%, alumina: 0.24%, Sylvite), POTASSIUM BICARBONATE (potassium bicarbonate 99%, Rich Grow)

METHODS: A field trial was established on muck soil (pH ~ 6.4, organic matter ~ 70%), naturally infested with *Plasmodiophora brassicae* at the Ontario Crops Research Centre- Bradford. The trial was organized as a randomized complete block design with four blocks. The fourth block on the far edge of the trial was removed from data analysis because it was inconsistent for clubroot development, similar to past studies. Each replicate plot was 1.75 m x 4 m. The treatments were: gypsum (GY) to add calcium and alter the calcium base saturation (CBS%) without increasing the soil pH, potassium bicarbonate (PB) to increase the pH without adding calcium. Combination treatments (GY + PB), and a hydrated lime treatment (4.3 t/ha) were used to add calcium and increase pH. Two rates (low and high) of GY (0.86, 1.70 t/ha) PB (3.80, 5.38 t/ha), and GY (0.86, 1.70 t/ha) + PB (3.80, 5.38 t/ha) were applied. There was an untreated check included. Soil samples were taken at a depth of 10 cm from each block before treatments were applied to determine baseline soil pH and CBS. On 16 June treatments were applied in powder or granular form, and rototilled into the soil to a depth of approximately 15 cm. On 29 June InVigor L233P canola (BASF) was seeded in four rows per plot, approximately 40 cm apart, using an Earthway push-seeder with a 1002-10 seeding disk. On 7 July post treatment soil samples were taken to determine changes in soil pH and CBS. Weeds were managed through hand weeding and one application of LIBERTY (BASF) herbicide.
On 8 August, six plants per plot were assessed for wilting using a 0 - 6 scale adopted from Dr. Stanislaw Cebula. On 16 August, 50 plants per plot were assessed for clubroot disease severity using a 0 - 3 scale where 0 = no clubbing, 0.25 = small club on one or two secondary 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. A disease severity index (DSI%) was calculated with the following equation:

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

Fresh and dry shoot biomass was assessed from ten plants per plot. The fresh shoot biomass was dried at 60°C for 8 days to obtain dry shoot biomass.

Conditions after planting in the summer of 2023 were ideal for clubroot development. Elevated rainfall and temperatures occurred between planting and seedling development, which is when host plants are most susceptible to disease. Compared to the previous 10-year average, air temperatures in 2023 were average for June (18.1°C) and July (20.9°C) and below average May (12.7°C), and August (18.9°C). The 10-year average temperatures were: May 13.6°C, June 18.7°C, July 21.2°C, and August 20.5°C. Monthly rainfall was below the 10-year average for May (52 mm), June (82 mm) and August (61 mm), and above average for July (113 mm). The 10-year rainfall averages were: May 64 mm, June 96 mm, July 74 mm and August 77 mm.
Data were analyzed using RStudio (RStudio Team, Boston, MA) as a Randomized Complete Block Design using a mixed model ANOVA and Tukey's test at P = 0.05.

RESULTS: as presented below in Table 4

CONCLUSIONS: All treatments that increased soil pH reduced clubroot severity by ~40% (Table 4). These were potassium bicarbonate (high rate), gypsum + potassium bicarbonate (high rate), and hydrated lime. Both rates of potassium bicarbonate, gypsum + potassium bicarbonate, and hydrated lime also decreased plant wilting and increased fresh and dry weight of shoot biomass relative to the untreated control (Table 4). There was a significant correlation ($r = -0.62$, $p = 0.0130$) between disease severity and soil pH, but no correlation for CBS. The average CBS of the soil prior to application of treatments was 84.7 %, so the objective of elevating CBS to 80% could not be tested. Some treatments seemed to decrease CBS (Table 2), this is attributed to the addition of potassium (K^+) and large fluctuations in pH (H^+) which would cause the relative percentage of calcium (Ca^{2+}) to decrease. However, the potassium bicarbonate and hydrated lime treatments that elevated pH and had no effect on CBS, reduced clubroot severity. The gypsum treatment added calcium but did not increase pH and had no effect on clubroot (Tables 2 & 4). The trial demonstrated that soil pH over 7.4 resulted in lower clubroot. Adding calcium or a high CBS had no effect on clubroot severity. The trial will be repeated in 2024 on muck soil and mineral soil.

Table 1. Average untreated soil test results for pH and calcium base saturation (CBS%) pre-amendment application.

Pre-Amendment	
pH	6.4
CBS (%)	84.7

Table 2. Average soil test results for pH and calcium base saturation (CBS%) post-amendment application.

Post-Amendment				
Untreated	Gypsum High	Potassium Bicarbonate High	Combo High	Hydrated Lime
6.4	6.5	7.7	8.1	7.4
81.0	83.0	70.0	67.0	84.5

Table 3. Average amendment rates (t/ha) of gypsum, potassium bicarbonate and hydrated lime applied to the soil.

Treatment	Gypsum Rate (t/ha)	Potassium Bicarbonate Rate (t/ha)	Hydrated Lime Rate (t/ha)
Untreated	-	-	-
Gypsum Low	0.86	-	-
Gypsum High	1.70	-	-
Potassium Bicarbonate Low	-	3.80	-
Potassium Bicarbonate High	-	5.38	-
Combo Low	0.86	3.80	-
Combo High	1.70	5.38	-
Hydrated Lime	-	-	4.30

Table 4. The effect of gypsum, potassium bicarbonate, and hydrated lime (calcium hydroxide) on clubroot severity (disease severity index; DSI%), fresh and dry shoot weight, and wilting index for canola cv. InVigor L233P grown in muck soil naturally with *Plasmodiophora brassicae* at the Ontario Crops Research Centre - Bradford, ON, 2023.

Treatment	Wilting Index	DSI (%)	Fresh Weight (g)	Dry Weight (g)
Untreated	2.9	95.6	380.0	43.9
Gypsum Low	3.3	97.1	246.7	32.6
Gypsum High	3.2	99.1	440.0	52.0
Potassium Bicarbonate Low	0.3[1]	72.1	683.3[1]	77.0[1]
Potassium Bicarbonate High	0.4[1]	61.3[1]	703.3[1]	72.6
Combo Low	0.8[1]	82.2	520.0	62.6
Combo High	0.2[1]	60.8[1]	810.0[1]	87.5[1]
Hydrated Lime	0.0[1]	59.2[1]	1210.0[1]	134.1[1]

[1] Treatments that differed significantly from the control using Tukey's test at $p > 0.05$

Funding for this project was provided by the Ontario Agri-Food Innovation Alliance, the Agriculture Development Fund of the Province of Saskatchewan, and the Canadian Agri-Food Partnership through AAFC and the Canola Council of Canada

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

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Title: EFFECT OF TWO SOILLESS MIXES ON DEVELOPMENT OF CLUBROOT (*Plasmodiophora brassicae*) IN CANOLA IN A GROWTH ROOM STUDY

MATERIALS: Canola (InVigor L233P), Soilless mix LA4 (Sunshine mix #4, SunGro horticulture, USA), Soilless mix BM6 HP (Berger, Quebec)

METHODS: A study was conducted to assess the suitability of two soilless mixes for clubroot development in canola. It was conducted in a growth room set to 24°/21°C day/night cycle, 17-hour photoperiod and 50% humidity. The study was arranged in a three-factor randomized complete block design (RCBD with four replicates and 10 plants per experimental unit. The factors were: soilless mix (LA4 vs. BM6 HP), inoculum concentration (0, 1 x 10^6, 1 x 10^8 resting spores/mL) and compaction (dry vs. wet), For the dry compaction, dry soilless mix was compacted into tall narrow plastic pots then soaked in water overnight. For wet compaction, dry soilless mix was saturated with water, then compacted into pots by hand or with another conetainer. The hypothesis for the compaction assessment was that wet mix would compact more tightly and be more conducive for clubroot infection. One day after filling the pots with soil, the trial was seeded with InVigor L233P canola, with one seed per pot.

Inoculum was prepared following the methodology of Sharma et al., (2011). Briefly, 30 g of frozen clubs of pathotype 2 (source: Muck Crops Research Station 2022) were defrosted for two days. The clubs were placed in 300 mL of sterile water in a commercial blender and homogenized for 2 min. The suspension was filtered through eight layers of cheesecloth to remove any plant material. The concentration of resting spores in the suspension was determined using a haemocytometer and adjusted to the desired concentration. Seedlings were inoculated with 5 mL of 0 (control), 1 x 10^6 or 1 x 10^8 resting spores/mL at 7 and 12 days after seeding. Plants were top watered with water adjusted to pH 6.4 and fertilized with 20-20-20 and $MgSO_4$ once per week.

Roots were assessed for clubroot symptoms 6 weeks after inoculation and assigned to classes using a 0 to 3 scale where: 0: no clubs, 1: clubs on 1/3 of the roots, 2: clubs on 1/3 to 2/3 of the roots and 3: clubs on more than 2/3 of the roots. A disease severity index was calculated using the following equation:

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

The fresh and dry weight of the above-ground plant material in each experimental unit was assessed at 6 weeks after inoculation. Data were analyzed in a mixed-model ANOVA in PROC GLIMMIX and means were separated using Tukey's test at $P = 0.05$ in SAS 9.4 (SAS Institute, Cary, IN).

RESULTS: as presented in Tables 1, 2 and 3

CONCLUSIONS: Clubroot was severe in the LA4 mix at both concentrations of inoculum, but little to no clubroot developed in BM6 mix, especially at the low rate of inoculum (Table 1). No clubroot developed in the non-inoculated control and soil moisture at the time of compaction had no effect on any variable (Table 1). Inoculation reduced plant fresh and dry weight, which were negatively correlated with clubroot severity (-0.49, $P = 0.05$ and -0.53, $P = 0.05$, respectively). Similarly dry weight was lower in LA4 mix

than in BM6. Noninoculated plants were larger (higher dry weight) when grown in LA4 compared to BM6 mix (Table 3), which indicated that there were differences between the soils that are not related to clubroot development.

Table 1: Effect of soilless mix, resting spore concentration and compaction treatment (main effects) on clubroot incidence and severity (disease severity index, DSI) of canola v. L233P inoculated with *Plasmodiophora brassicae.*

Main effects		Incidence (%)	DSI (%)
Soilless mix	BM6	41 b[1]	31 b
	LA4	98 a	95 a
Resting spore concentration	1×10^{-6}	51 b	46 b
	1×10^{-8}	89 a	80 a
Compaction	Wet	67 a	61 a
	Dry	73 a	65 a

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

Table 2: Effect of soilless mix, compaction treatment and resting spore concentration on clubroot incidence and severity (disease severity index, DSI), and fresh and dry weight of canola inoculated with *Plasmodiophora brassicae.*

Soilless mix	Compaction	Spore concentration	Incidence (%)	DSI (%)	Fresh wt. (g)	Dry wt. (g)
LA4	Wet	1×10^{-6}	100 a[1]	93 a	29.1 def	7.2 de
		1×10^{-8}	100 a	100 a	22.0 f	4.5 f
	Dry	1×10^{-6}	93 a	88 a	49.7 ab	12.2 ab
		1×10^{-8}	100 a	99 a	36.0 cde	8.9 cd
BM6	Wet	1×10^{-6}	0 c	0 d	25.6 f	6.7 de
		1×10^{-8}	86 b	52 c	26.1 ef	5.3 ef
	Dry	1×10^{-6}	10 c	3 d	43.5 bc	9.8 c
		1×10^{-8}	88 ab	70 bc	35.6 cde	9.2 cd
LA4	Wet	0	0	0	38.2 cd	9.8 bc
	Dry	0	0	0	53.8 a	14.2 a
BM6	Wet	0	0	0	28.0 ef	5.4 ef
	Dry	0	0	0	41.0 bc	10.5 bc

[1]Means in a column followed by the same letter do not differ at $P = 0.05$ based on Tukey's test. There was no three-way interaction at $P < 0.05$.
*Soilless mix vs compaction was significant at $P < 0.05$ for DSI.
*Spore concentration vs soilless mix was significant at $P < 0.05$ for fresh and dry weights.

Table 3: Effect of soilless mix and resting spore concentration on dry weight of canola inoculated with *Plasmodiophora brassicae.*

Soilless mix	Spore concentration	Dry weight (g)
LA4	0	12.0 a[1]
BM6	0	7.9 dc
LA4	1×10^{-6}	9.7 b
LA4	1×10^{-8}	6.7 d
BM6	1×10^{-6}	8.2 c
BM6	1×10^{-8}	7.2 dc

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

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: Canola (*Brassica napus*) breeding line ACS N39
PEST: Clubroot *(Plasmodiophora brassicae* Woronin*)*

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TITLE: EFFECT OF NATURAL FREEZE-THAW CYCLES ON THE VIABILITY OF RESTING SPORES OF PLASMODIOPHORA BRASSICAE

MATERIALS: EVANS BLUE DYE (T-1824), PROPIDIUM MONOAZIDE (3-amino-8-azido-5, Biotium)

METHODS: An overwinter field trial to evaluate the survival of *Plasmodiophora brassicae* resting spores was carried out on muck soil (pH ~ 6.4, organic matter ~ 70%), at the Ontario Crops Research Centre - Bradford, ON. The trial was arranged in a randomized complete block design with four blocks. In each block there were two treatments: clubs left on the soil surface, vand clubs buried at a depth of 10–15 cm. Control clubs were maintained in a freezer at -20°C.
On 22 December, 2022, about 30 g per bag of clubbed canola root tissue (pathotype 2) was placed in bags constructed of a fine Hitex Monifil polyester mesh material (SaatiPrint Canada, Mississauga, ON). This material was selected because it allowed interaction with the soil and exposure to temperature fluctuations. One temperature sensor was placed in a bag from each treatment. On 6 April, 2023, the bags were removed from the field and maintained at -20°C until assessment. Resting spores were extracted and suspended at a concentration of 1 x 10^6 spores/mL.
Evans Blue vital stain (20mg/mL) was mixed in equal parts with resting spore suspension and left to sit for 24 hr. Spores in the solution were counted using the 60x objective of a compound microscope and the ratio of stained (non-viable) to unstained (viable) of approximately 100 resting spores was calculated.
A bioassay using ACS N39 canola (highly susceptible to clubroot, provided by Dr. S Vail, Agriculture and Agri-Food Canada, Saskatoon) was conducted in a growth room set to 24°/19°C day/night with a 17-hr photoperiod. The bioassay included four treatments: an un-inoculated control, and inoculation using spore suspensions from clubs left on the soil surface, buried at a depth of 10cm, or maintained in the freezer (-20°C). Each treatment was applied to ten plants, and four repetitions of each treatment were included. L4A Sunshine soil mix (Sun Gro Horticulture, MA) was packed tightly into plastic trays (12 x 6 cells, cell dimension 1 1/2"L & W x 2 1/4"H, William Dam Seeds, Dundas, ON) to support clubroot development. Seeds were planted just below the soil surface and covered with soil. Plants were inoculated with 5 mL of spore suspension (1 x 10^6 spores/mL) after one week of growth. Plants were watered with pH 6.0 adjusted water (maintained with acetic acid, vinegar) to promote infection, and fertilized once a week with a 0.1% solution of nitrogen, phosphate, potassium (20-20-20 Plant Products Classic, Brampton, ON) and magnesium sulfate. At six weeks post inoculation each plant was assessed for clubroot disease severity using a 0–3 scale where 0 = no clubbing, 0.25 = small club on one or two secondary 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. Percent disease severity index (DSI%) was calculated with the following equation:

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

Temperature during the 2022–2023 winter at the Ontario Crops Research Centre- Bradford fluctuated throughout the season. Temperatures below soil remained at just above 0°C for most of the season, while air temperature ranged from -10°C to 20°C. A separate assessment determined that it takes approximately 5 hours for clubs to thaw at temperatures close to 0°C. Using hourly temperature data, the number of freeze

and thaw cycles for each treatment was estimated based on the number of times temperatures were above freezing for 5+ hours, followed by freezing temperatures.
Data were analyzed using RStudio (RStudio Team, Boston, MA) as a Randomized Complete Block Design using a mixed model ANOVA and Tukey's test at $P = 0.05$.

RESULTS: as presented below in Figure 2

CONCLUSIONS: As expected, temperature fluctuated more at the soil surface than at 10 cm depth (Fig. 1). Based on temperature data it was estimated that clubs at the soil surface underwent 32 freeze and thaw cycles, while buried clubs only underwent only 2 freeze and thaw cycles. Spore viability decreased from 94% to 54% in clubs left on the surface, estimated based on Evans Blue staining (Fig. 2). In a bioassay using canola cv. ACS N39, clubroot severity produced by inoculation with spores from clubs left on the soil surface was reduced to 79% compared to clubs that were buried (91%) or left in the freezer (94%) (Fig. 2). However, DSI (%) of clubs left at the soil surface was still high (~79%). Overall, natural freeze / thaw cycles overwinter can reduce inoculum viability, but not enough to represent a single management strategy.

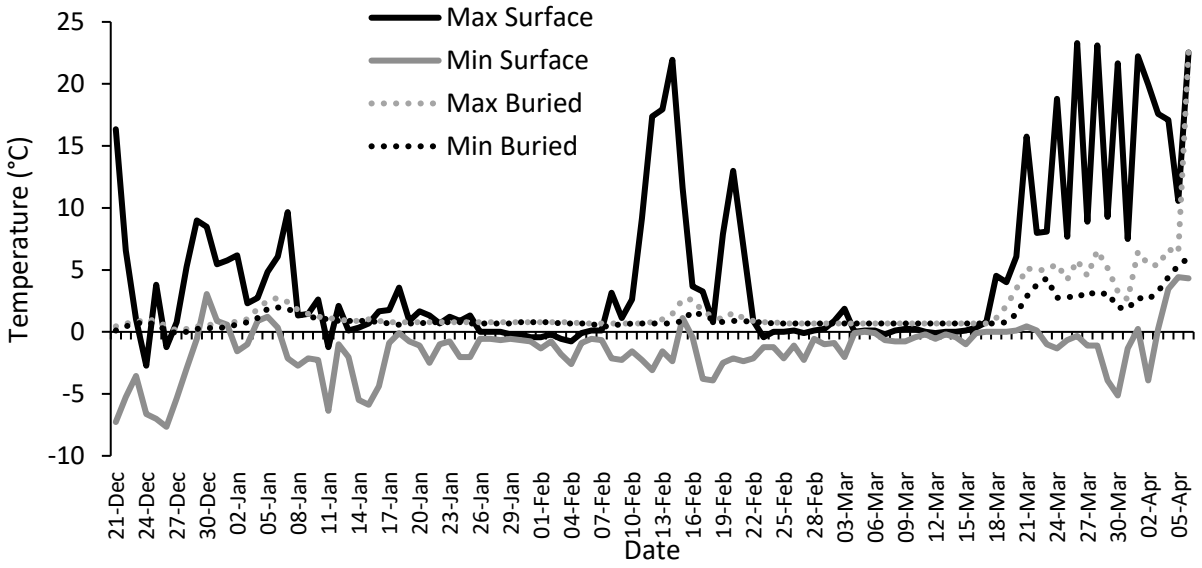

Figure 1. Maximum and minimum daily temperature (°C) at the soil surface and 10 cm below the soil surface from 21 December, 2022, to 05 April, 2023, at the Ontario Crops Research Station - Bradford, ON.

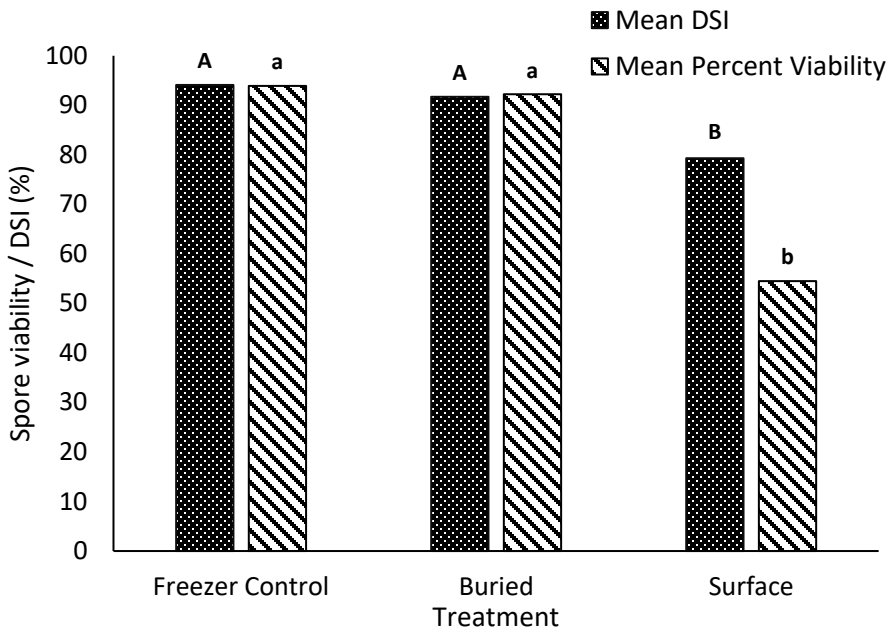

Figure 2. Mean estimates of clubroot disease severity index (DSI %) based on a bioassay of canola cv. ACS N39 and *Plasmodiophora brassicae* spore viability (%) based on Evans Blue staining from clubs on the soil surface, buried 10 cm below the soil surface, and left in the freezer (-20 °C) for 16 weeks at the Ontario Crops Research Station - Bradford, ON in the winter of 2022–2023. Bars with the same letter and capitalization are not significantly different using Tukey's test ($P = 0.05$).

Funding for this project was provided by the Ontario Agri-Food Innovation Alliance, the Agriculture Development Fund of the Province of Saskatchewan, and the Canadian Agri-Food Partnership through AAFC and the Canola Council of Canada

CROP: Canola (*Brassica napus* L.) line ACS N39
PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

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Title: **EFFECT OF REPEATED FREEZE-THAW CYCLES OF CLUBBED ROOTS OF CANOLA ON RESTING SPORE VIABILITY OF *PLASMODIOPHORA BRASSICAE***

MATERIALS: EVANS BLUE DYE (Sigma-Aldrich, CA), PROPIDIUM MONOAZIDE (Biotium, Inc., Hayward CA)

METHODS: A study was conducted to assess the effect of repeated freeze-thaw cycles on the viability of resting spores of *Plasmodiophora brassicae*. Fresh clubbed roots of canola (*Brassica napus* cv. L233P) infected with pathotype 2 collected from a field trial at the Ontario Crop Research Centre – Bradford, ON were assessed. Treatments consisted of 0, 2, 4, 6, 8 and 10 cycles of freezing and thawing and a continuously frozen control, with a cycle consisting of a 48 hr period of freezing at -20°C and 24 hr of thawing at room temperature (~ 22°C). The study was arranged in a randomized complete block design with four replicates and 12 plants per experimental unit. Each experimental unit consisted of 60 g of clubbed root sealed in a Ziplock freezer bag. To ensure that all treatments are ready for evaluation at the same time, the 10^{th} freeze-thawing cycle was started first, followed by 8^{th}, 6^{th} 4^{th} and 2^{nd} cycle. Treatments were tested at two levels of inoculum concentration: 1 x 10^5 or 1 x 10^6 resting spores mL^{-1}. The clubbed roots were stored at -20^0 C until ready for assessment and the 0 cycle treatment was continuously frozen.

Resting spore viability was assessed in a bioassay conducted in the growth room. Tall, narrow plastic pots (conetainers, Stuewe and Sons, Oregon) were filled with soilless mix (SunGro Sunshine LA4) and compressed several times to compact it. The mix was saturated with water plus fertilizer (1 g N-P-K + 1 g $MgSO_4$ L^{-1}) and lightly compacted again to produce conditions conducive for clubroot infection. One day after filling, the pots were seeded with two seeds per pot of canola line ACS N39 (AAFC Saskatoon, clubroot susceptible) and thinned to one seedling per pot at 8 days after seeding. The growth room was set to 24°/21°C day / night cycle, 17-hour photoperiod and 50% relative humidity. Plants were watered daily with water adjusted to pH 6.4 and fertilized with N-P-K and $MgSO_4$ once a week. For each experimental unit of the freeze-thaw study, 30 g of clubs were placed in 300 mL sterile water for 20 min before being homogenized in a commercial blender for 2 min at high speed. The remaining clubs of each treatment were stored at 4°C for a second inoculation. The blended solution was filtered through eight layers of cheesecloth to remove any plant material and homogenized again. The resting spore concentration of the suspension was determined using a haemocytometer and adjusted to either 1 x 10^5 or 1 x 10^6 spores mL^{-1}. Seedlings were inoculated with the resting spore suspension at 5 mL per plant at 10 days after seeding. An aliquot of the stock suspension was also saved in 50 mL Falcon tubes for assessment using Evans's Blue and PMA qPCR. Plants were inoculated for a second time at one week after the initial inoculation.

At 6 weeks after first inoculation, plants were uprooted and roots were evaluated visually for clubbing severity using a 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 as follows:

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

Fresh and dry weight of above-ground biomass was also assessed.

The viability of resting spores from the inoculation study was assessed using Evans Blue dye. A 200 µL subsample of each spore suspension was added to 200 µL of Evan's Blue solution at 20 mg mL ^{1}. The suspension was homogenized and allowed to sit for 24 hr before analysis. A 10 µL sample of the suspension was placed on a microscope slide and viewed using a compound microscope to evaluate resting spore viability; viable spores remained coluorless, while non-viable resting spores absorbed the dye and developed a dark blue colour.

A 94 µL subsample of the resting spore suspension of each treatment was transferred to a clear 2-mL centrifuge tube. The control treatment consisted of 94 µL of deionised water. A 6µl aliquot of 120 µM PMA was added and the tubes were shaken on an orbital shaker at 300 rpm for 30 min. The tubes were put on ice and exposed to a 500-W halogen light located 20 cm away for 15 min to activate the PMA. Finally, the tubes were flash frozen in liquid nitrogen and stored at −80°C prior to DNA extraction. DNA extractions was performed using DNeasy PowerSoil Pro Kit (Qiagen) on a 100 µL subsample of each suspension of PMA-treated spores. qPCR was performed using an Applied Biosystem StepOne and StepOnePlus system. The qPCR assay consisted of 2 µL of extracted genomic DNA and 18 µL of master mix. The mixture contained 10 µL of 2x TaqMan Universal PCR Master Mix (Applied Biosystems), 1.8 µL of forward primer DC1F (10 µM), 1.8 µL of reverse primer DC1mR (10 µM), 0.5 µL of *P. brassicae* probe (10 µM), and 3.9 µL of nuclease-free water. The cycling parameters were 2 min at 50°C, 10 min at 95°C, followed by 40 cycles of 15 s at 95°C, and 1 min at 60°C.

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).

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

CONCLUSIONS: Repeated freeze-thaw cycles reduced resting spore viability in proportion to the number of freeze-thaw cycles (Fig.1). Inoculum concentration had no effect on DSI. Bioassay results were comparable with viability estimates based in Evan's Blue counts and PMA qPCR. There was a strong positive correlation among the assessment methods for spore viability (Table 1, Fig. 2). Inoculation reduced plant fresh and dry weight (negative correlation, Pearson correlation coefficient ($P = 0.05$) of fresh and dry weight was -0.14 and -0.37 at $1x10^5$ resting spores/mL; -0.21 and -0.29 at $1x10^6$ resting spores/mL. Table 2).

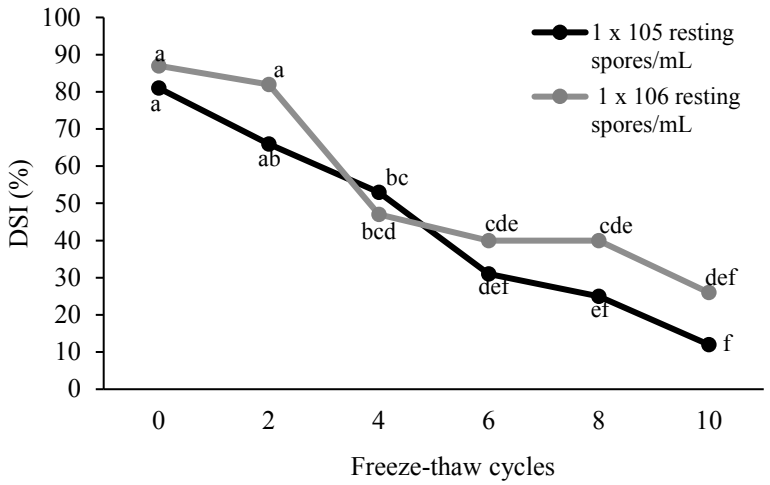

Figure 1: Effect of repeated freeze/thaw cycles of clubbed canola roots and inoculum concentrations on clubroot severity (disease severity index, DSI) on canola in a bioassay under controlled conditions. *Means in the line graph followed by the same letter are not significantly different at $P = 0.05$.

Table 1: Correlation of Evans blue spore viability and DSI and PMA qPCR resting spore concentration

	Concentration	Evans blue spore viability vs DSI	PMA qPCR vs DSI
Pearson Correlation Coefficient ($P = 0.05$)	$1x10^5$ resting spores/mL	0.86	0.75
	$1x10^6$ resting spores/mL	0.81	0.73

Table 2: Fresh weights and dry weights of canola at different resting spore concentration.

Freeze-thaw cycles	$1x10^5$ resting spores/mL		$1x10^6$ resting spores/mL	
	Fresh wt (g)	Dry wt (g)	Fresh wt (g)	Dry wt (g)
0	44.8	15.8	47.4	15.2
2	47.8	16.7	45.0	15.7
4	57.4	19.0	35.9	13.5
6	49.5	18.0	42.5	15.0
8	48.8	17.3	50.1	16.6
10	46.9	17.5	55.9	18.6

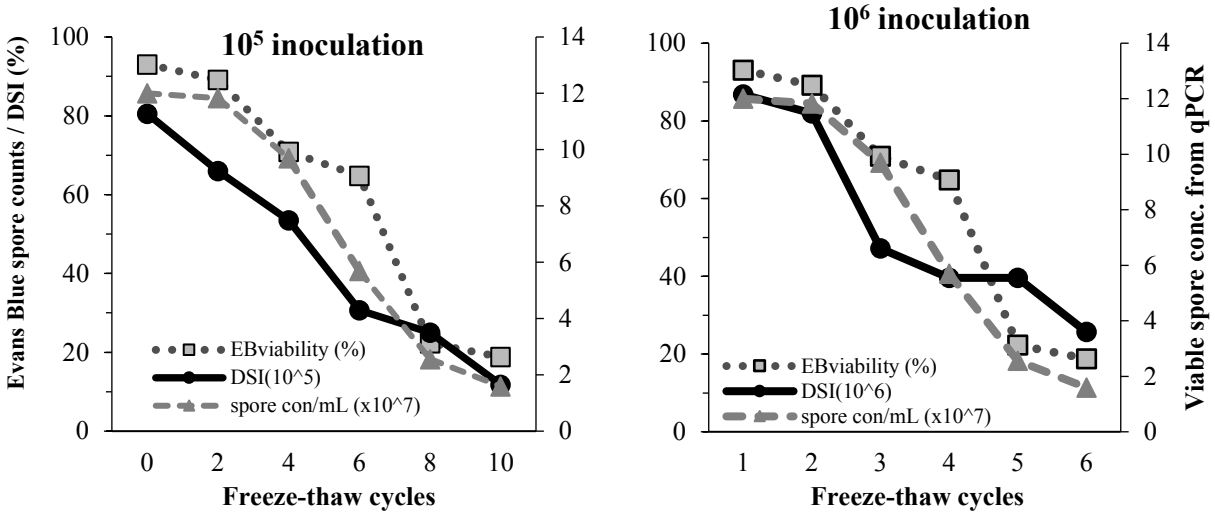

Figure 2: Relationship between assessment methods for viability of resting spore of *Plasmodiophora brassicae*: Evan's Blue spore counts, bioassay of clubroot severity (DSI) on canola from inoculation at 1 x 10^5 and 10^6 spores mL^{-1} and estimates from qPCR-PMA (x 10^7). Viable spore concentration of qPCR-PMA was estimated from the cycle threshold value (Ct) of qPCR results.

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.

Check out the Muck Crops Research Station's IPM X / Twitter Account

The Muck Crops Research Station launched a X / 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

HOST: 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: EVALUATION OF CLUBROOT RESISTANCE IN BRASSICA COVER CROP SPECIES, 2023

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 in a randomized complete block design with five replicates. Each plot was 1.5 m × 4 m, with 1.5 m between plots and six rows with 0.35 m between rows. On 15 June, cover crop treatments of perennial ryegrass and daikon radish were seeded using an Earthway seeder fitted with a 1002-22 disc. Seed was also scattered on each plot to ensure uniform coverage. 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 and again 3 days later to kill the cover crops. The plots were mowed and tilled 3 days after the second ROUNDUP treatment.

The effect of the treatments on the disease potential of *P. brassicae* was assessed by seeding canola cv. L233P (susceptible to pathotype 2) across the entire trial on 29 August. 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 2023), plants in the centre 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:

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

Compared to the previous 10-year average, air temperatures in 2023 were above average for September (18.2°C), average for June (18.1°C) and July (20.9°C) and below average May (12.7°C), and August (18.9°C). The 10-year average temperatures were: May 13.6°C, June 18.7°C, July 21.2°C, August 20.5°C and September 16.5°C. Monthly rainfall was below the 10-year average for May (52 mm), June (82 mm), August (61 mm) and September (4 mm) and above average for July (113 mm). The 10-year rainfall averages were: May 64 mm, June 96 mm, July 74 mm, August 77 mm and September 65 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 Tukey test at P = 0.05 level of significance.

RESULTS: as presented in Table 1

CONCLUSIONS: 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. Effect of cover crops on subsequent clubroot incidence and severity (disease severity index, DSI) and fresh weight of top growth of canola on muck soil naturally infested with *Plasmodiophora. brassicae* at the Ontario Crops Research Centre - Bradford, Ontario, 2023.

Cultivar	Incidence (%)	DSI (0–100)	Fresh wt. / plant[1] (g)
Perennial ryegrass	80 ns[2]	73 ns	0.99 ns
Radish	64	55	0.68
Control	93	77	0.91

[1] Mean fresh top weight of 10 plants before head formation.

[2] 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)

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[1]University of Guelph, Department of Plant Agriculture, Guelph
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TITLE: EVALUATION OF CLUBROOT RESISTANCE IN COVER CROPS IN THE FAMILY BRASSICACEAE, 2023

METHODS: A field trial to evaluate the clubroot susceptibility of cover crops cultivars and species in the Brassicaceae family was conducted on a site naturally infested with *P. brassicae* pathotype 2 at the Ontario Crops Research Centre -Bradford, Ontario. The cover crop species were seeded into naturally infested soil on 16 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 30 plants per plot at 7 weeks after seeding on 11 August. Symptoms of clubroot were assessed on the roots of each plant on a 0-3 scale, where 0 = no clubs, 1 = small clubs on less than 1/3 of roots, 2 = small or intermediate clubs on 1/3 to 2/3 of roots, and 3 = intermediate or large clubs on over 2/3 of roots. The proportion of plants with clubroot symptoms was used to determine clubroot incidence (CI). A disease severity index (DSI) was calculated using the following formula:

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

Compared to the previous 10-year average, air temperatures in 2023 were average for June (18.1°C) and July (20.9°C) and below average for August (18.9°C). The 10-year average temperatures were: June 18.7°C, July 21.2°C, August 20.5°C. Monthly rainfall was below the 10-year average for June (82 mm) and August (61 mm) and above average for July (113 mm). The 10-year rainfall averages were: June 96 mm, July 74 mm and August 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 at P = 0.05 level of significance.

RESULTS: as presented in Table 1

CONCLUSIONS: Clubroot severity was lower in 2023 than in 2022 (DSI on susceptible Shanghai pak choi 45.7). Differences in clubroot incidence and severity were found among the cover crops. Eco Till daikon, tillage radish, Winfred forage brassica and Barkant turnip had significantly lower clubroot incidence and severity than the rapeseed and mustard cultivars (Table 1). These results are similar to the 2022 trial.

T able 1. Clubroot incidence (%) and severity (disease severity index, DSI), of cover crop species in the Brassicaceae family, in a field trial at the Ontario Crop Research Centre- Bradford, 2023.

Crop & Cultivar	Source	Incidence (%)	DSI (0-100)
Rapeseed			
Dwarf Essex	Speare Seed	86.7 e[1]	49.6 cd
Barsica Forage	Speare Seed	82.5 e	47.3 cd
Forage	Speare Seed	88.3 e	55.4 cd
Mustard			
Supreme Blend	Speare Seed	97.5 e	60.3 cd
Certified Brown	Speare Seed	94.2 e	64.1 d
Radish			
April Cross Hybrid Oriental	Stokes Seed	42.5 cd	11.9 ab
Oilseed	Speare Seed	9.2 ab	1.3 a
White Icicle	Stokes Seed	24.2 bc	7.9 ab
Tilage	Stokes Seed	7.5 ab	2.0 a
Ground Breaker	Speare Seed	6.7 ab	0.8 a
Tillage	Speare Seed	2.5 a	0.6 a
Eco-Till Daikon	Quality Seed	4.2 a	1.7 a
Turnip			
Purple Top	Speare Seed	48.3 d	21.2 b
Barkant	Speare Seed	5.0 a	0.8 a
Brassica			
Winfred Forage	Speare Seed	7.5 ab	3.2 a
Shanghai Pak choi			
Mei Qing Choi	Stokes Seed	81.7 e	45.7 c

[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.

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TITLE: ACTIVITY SUMMARY OF THE FARMDROID FD20 AND THE NAÏO ORIO IN THE HOLLAND MARSH, 2023

METHODS: The activity of both the FarmDroid FD20 and Naio Orio was recorded each day to gain an understanding of their reliability and provide data to help calculate the economic return on investment. In the first year of this project, the tool-carrying Naïo Orio was used for 15 days this summer in 1.6 ha of carrots and 1 ha of beets, while the solar-powered seeding and weeding robot, the FarmDroid FD20, was used for 20 days in a 2.8 ha onion field. Tasks considered uptime for the Orio were weeding, spraying, and lining up plots for seeding. Uptime for the FD20 was seeding and weeding. The tasks classified as downtime for both robots were maintenance and troubleshooting.

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

DISCUSSION/CONCLUSIONS: Both robots had a significant amount of troubleshooting required in their first year. The FD20 required 22 hours and the Orio took 16 hours over the course of the season. For the FD20, 20 of the 22 hours were needed in the first 5 days, before it ran the remaining 15 days with just 2 hours of troubleshooting required. It was able to seed all 2.8 ha in 81 hours without needing to charge, only stopping for troubleshooting and to refill the seed hoppers. After 3 hours of maintenance to switch to weeding mode, it ran with only minor issues the rest of the season, with only 2 hours needed for maintenance or troubleshooting. Next year, the FD20 will be equipped with more robust wheels and upgraded tooling which should aid in running the robot for more days. FarmDroid has also released a greatly improved mapping system and upgraded their app which should also cut down on troubleshooting time.

The Naïo Orio was used in smaller plots and drives more than 10x the speed of the FD20, so it was not used as frequently, with just 49 hours of uptime compared to the FD20's 223 hours. It still racked up 21 hours of downtime due to issues with the wheel motors, GPS connection, and an inability to read map files from a USB. Some of these troubleshooting hours were not directly related to the Orio and were a result of the Raven spray control computer, which had a manufacturing fault and needed to be replaced. Naïo has since developed an app, engineered workarounds and backups for many of the issues the unit faced this year, and hired technicians closer to the area. The robot will see more use as reliability increases and more use cases are added, such as a wick weeder attachment, which is planned for the 2024 season.

Table 1. Season breakdown of activity hours for the FarmDroid FD20 and the Naïo Orio in the Holland Marsh and Keswick Marsh, Ontario, 2023.

Robot	**Uptime**	Seeding	Weeding	Spraying	Line Making	**Downtime**	Maintenance	Troubleshooting	**Off**
FD20	**223**	81	142	-	-	**31**	9	22	**221**
Naïo Orio	**49**	-	5	23	21	**21**	5	16	**272**

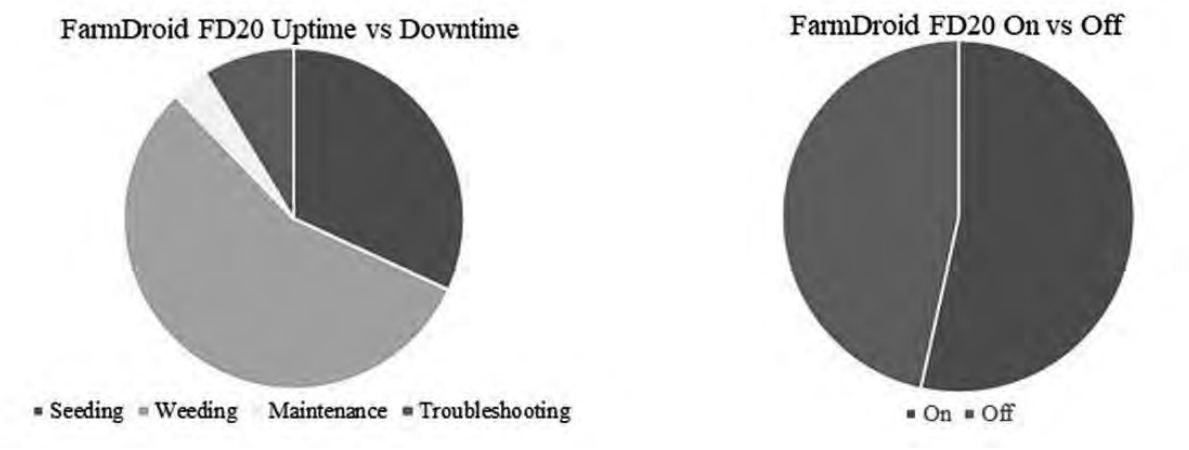

Figure 1. FarmDroid FD20 uptime vs downtime while working in the Keswick Marsh, Ontario, 2023.

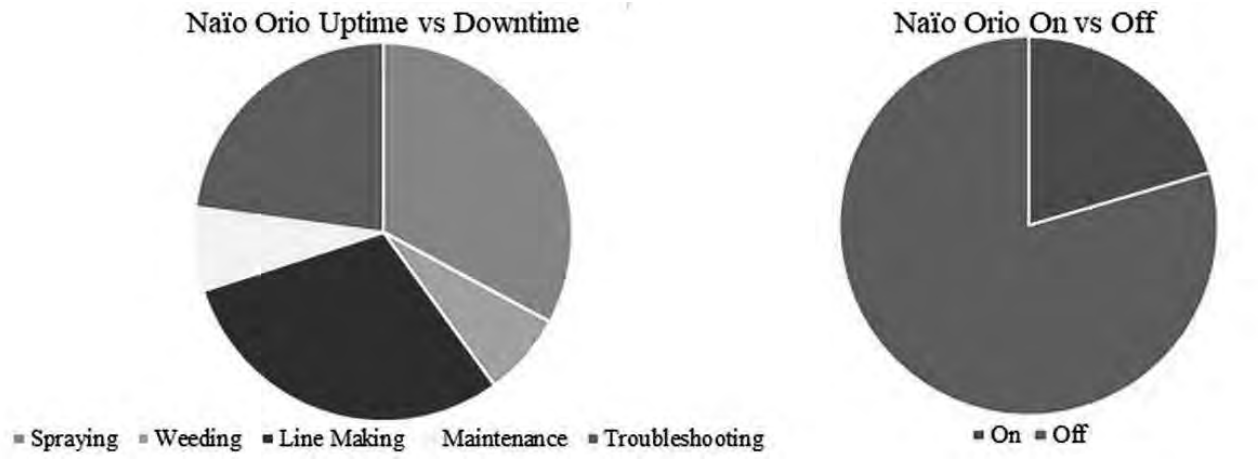

Figure 2. Naïo Orio uptime vs downtime while working in the Holland Marsh, Ontario, 2023.

Funding for this project was provided by the Ontario Agri-Food Innovation Alliance and the Fresh Vegetable Growers of Ontario. The FarmDroid FD20 and Naïo Orio were provided by Haggerty AgRobotics Inc.

CROP: Banana pepper (*Capsicum annuum*) cv. Ducado

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TITLE: **EFFECTS OF SOIL ARMOUR ON YIELD AND EROSION IN MINERAL SOIL**

MATERIALS: SOIL ARMOUR

METHODS: Two trials were conducted to evaluate the ability of SOIL ARMOUR to act as a mulch and reduce erosion in mineral soils (organic matter ≈ 2.5%, pH ≈ 7.6) near the Ontario Crops Research Centre - Bradford, Holland Marsh, Ontario. The mulch trial examined the yield of banana peppers grown with the use of SOIL ARMOUR. The trial utilized a randomized complete block design with 4 blocks and 6 treatments. Treatments were: biodegradable paper dipped in SOIL ARMOUR (diluted 3:1 in water) just once and three times (drying in between each dip), SOIL ARMOUR sprayed directly on the soil at (triple rate) 875 L/ha, biodegradable paper that was not dipped in SOIL ARMOUR, a black plastic sheet as the grower standard, and an untreated (not covered) check. The spray treatment was applied using a CO_2 backpack sprayer equipped with four TeeJet 8002 VS fan nozzles spaced 40 cm apart and calibrated to deliver 2550 L/ha at 275 kPa. On 4 July, the mulch treatments were put in place and the peppers were transplanted. Mature peppers were harvested on 4, 9, 17, 25 August, and 2, 14, 23 September, with each pepper counted and weighed.

The second trial evaluated soil erosion reduction using different rates of SOIL ARMOUR. The erosion trial was a randomized complete block design with 4 blocks and 5 treatments. Treatments were: SOIL ARMOUR at 2550 L/ha, 5100 L/ha, barley scattered randomly and raked in, barley seeding in straight rows using an EarthWay seeder, and an untreated (not covered) check. Spray treatments were applied using a CO_2 backpack sprayer equipped with four TeeJet 8002 VS fan nozzles spaced 40 cm apart and calibrated to deliver 2550 L/ha at 275 kPa. A portable wind tunnel was used to simulate wind at 25 km/h for 1 minute. Eroded soil was collected in a tray and on a furnace air filter and weighed.

Compared to the previous 10-year average, air temperatures in 2023 were above average for September (18.2°C), average for June (18.1°C) and July (20.9°C) and below average for August (18.9°C). The 10-year average temperatures were: June 18.7°C, July 21.2°C, August 20.5°C and September 16.5°C. Monthly rainfall was below the 10-year average for June (82 mm), August (61 mm) and September (4 mm) and above average for July (113 mm). The 10-year rainfall averages were: June 96 mm, July 74 mm, August 77 mm and September 65 mm. Data were analyzed using the General Analysis of Variance function of Statistix V.10. Means separation was obtained by using Fisher's Protected LSD test at $P = 0.05$ level of significance.

RESULTS: As presented in Tables 1 and 2.

CONCLUSIONS:
There were no significant differences in total yield, peppers, or average weight of peppers among treatments (Table 1). The black plastic mulch had the highest yield and average pepper weight numerically. There is some indication that SOIL ARMOUR could replace plastic mulch for the production of warm season crops such as banana peppers, but more research is needed. In the wind erosion trial, the check had significantly greater erosion than the other treatments (Table 2). Scattered barley reduced erosion the most numerically. Wind direction will affect the ability of barley in rows to suppress wind erosion.

Table 1. Weights of peppers emerged through different concentrations of SOIL ARMOUR applied to mineral soil at the Ontario Crops Research Centre – Bradford, 2023.

Treatment	Rate (L/ha)	Pepper Weights		
		Total Peppers	Total (kg)	Average weight/pepper (g)
Plastic	-	129.5 ns[1]	6.51 ns	49.5 ns
SOIL ARMOR spray	2550	130.5	5.25	47.3
Dipped paper x3	-	109.8	5.05	44.9
Dipped paper x1	-	82.2	3.65	42.7
Undipped paper	-	89.5	4.41	48.9
Check	-	102.2	4.96	46.0

[1] ns indicates no significant differences at P = 0.5, Fisher's Protected LSD test.

Table 2. Soil erosion data for different concentrations of SOIL ARMOUR applied to mineral soil near the Ontario Crops Research Centre – Bradford, 2023.

Treatment[1]	Rate (L/ha)	Tray Weight (g)
Barley (Scattered)	-	2.9 a[1]
Barley (Rows)	-	16.7 a
SOIL ARMOUR x6	5100	6.9 a
SOIL ARMOUR x3	2550	6.6 a
Check	-	54.4 b

[1] Means 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 BioDiffusion Technologies Inc.

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TITLE: STUDY ON SOIL HEALTH INDICATORS OF MUCK SOIL

MATERIALS & METHODS: The study was conducted in commercial carrot and onion fields during 2022 and 2023 in the Holland/Bradford Marsh, Ontario. Soil samples were collected from 31 grower fields and from the Ontario Crops Research Centre – Bradford, during the first week of June in 2022 and the last week of May in 2023. Soil sampling was done after the crop was fertilized and seeded. 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 three rows of carrots or four rows of onions 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 Labs, London, ON, for the VitTellus bio soil health test (SHTEST3). When the carrot or onion crop was mature they were sampled from 1m sections of row from each block where soil samples were taken to determine yield. Four sub-samples from each field were combined to get the average yield for each field. Data were subjected to principal component analysis (PCA) using R 4.1.0 version on selected variables of soil health indicators from fields using a base function prcomp(). Soil chemical properties directly affected by fertilizer application (macro and micro-nutrients) were removed from analysis before running PCA. Additionally, a single indicator was chosen among highly correlated variables where logical. Further to this, two fields with known atypical situations, one without either onion or carrots in it and one shown to be an outlier by the PCA, were removed before running final PCA. 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 Pearson's correlation test was run for all the variables measured in relation to productivity.

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

CONCLUSIONS: There were six fields in the low productivity category, 15 in the moderately productivity category and 11 in the high productivity category, based on yield (Table 1). Fields with production level below 60 Mg ha-1, between 60 to 80 Mg ha-1, and above 80 Mg ha-1 were categorized as low, moderately, and high productive fields, respectively.

The cumulative percent variability accounted for by the first four PCs was 65.5 % (Table 2). 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: soil organic carbon and ACE protein on component one; anaerobic bacteria index, *Trichoderma* index, and fungal to bacterial ratio on component two; total microbial activity index on component three and carbon to nitrogen (C:N) ratio on component four (Table 2). Although soil biological properties accounted for more variability in PC1 and PC4, soil microbial properties were weighted more heavily in PC2 and PC3 which explained 33% of total variation. This suggests that the soil microbial index is also important to assess soil health of muck soils.

All the low productive fields tended to group together based on the variables studied except one field (Figure 2(B)). That particular field had a problem of crown gall disease which caused low production (low marketable yield because diseased roots were discarded) and the farmer mentioned it was a medium productive field based on the production history. Low productive fields were associated with

higher pH and aluminium and lower soil organic carbon (SOC) as shown by PCA bi-plot (Figure 2(B)) and correlation analysis (Figure 1). An increase in the proportion of mineral material due to the loss of SOC in muck soils could be related to higher pH. Lower SOC in muck soil could be related to decreased depth of muck soil and the compacted clay layer at the base of the muck soil that could hinder plant growth making productivity lower. An outlier field spotted in PCA biplot (Figure 2(A)) had very low pH of 4.5 and low numbers of microbial indicators. Soil pH among other fields studied varied from 4.9 to 7.3. There was a field with pH of 4.9 under the category of medium productive field with production of 67 Mg ha^{-1}. Beyond that there were three fields with pH 5.2, one which had medium productivity and two that were highly productive carrot fields. The field with the highest pH, 7.3 was in the low productive category. The field with the next highest pH, 6.9, was in the high productive category. This suggests that in muck soils, pH of 4.9 to 6.9 does not negatively affect productivity of carrots.

Table 1. Fields and productivity category based on yield of carrots in the Holland Marsh, 2023.

S. No.	Label	Productivity level	Yield (tonnes/ha)	Category
1	PL1	Prod-L	27.5	
2	PL2	Prod-L	37.4	
3	PL3	Prod-L	38.9	Low productivity (<
4	PL4	Prod-L	51.7	60 tonnes/ha)
5	PL5	Prod-L	50 (Onions[1])	
6	PL6	Prod-L	55.2	
7	PM1	Prod-M	62.4	
8	PM2	Prod-M	62.5	
9	PM3	Prod-M	62.7	
10	PM4	Prod-M	63.9	
11	PM5	Prod-M	68.4	
12	PM6	Prod-M	68.5	
13	PM7	Prod-M	68.9	Moderately
14	PM8	Prod-M	69.4	productivity (60 –
15	PM9	Prod-M	69.7	80 tonnes/ha)
16	PM10	Prod-M	71.4	
17	PM11	Prod-H	73.7	
18	PM12	Prod-M	74.4	
19	PM13	Prod-M	74.9	
20	PM14	Prod-M	75.8	
21	PM15	Prod-M	77.8	
22	PH1	Prod-H	84	
23	PH2	Prod-H	93.3	
24	PH3	Prod-H	94	
25	PH4	Prod-H	94.6	
26	PH5	Prod-H	102.9	
27	PH6	Prod-H	115.4	High productivity
28	PH7	Prod-H	143.6	(> 80 ton/ha)
29	PH8	Prod-H	98.4 (Onions)	
30	PH9	Prod-H	NA[2]	
31	PH10	Prod-H	NA	
32	PH11	Prod-H	NA	

[1]Onions indicates the fields that had onions and categorization was based on yield of onions and farmer's expertise.

[2]NA means no available productivity data and fields were categorized based on farmer's expertise.

Table 2. Soil health indicators based on principal component analysis. Eigen vectors of selected variables for first four principal components (PCs) with the proportion of variance and eigen values. Bold faced eigen vectors correspond to the highly weighted indicators in each PC.

Indicators	PC1	PC2	PC3	PC4
pH	-0.58	0.56	-0.01	-0.23
Al	-0.5	0.47	0.38	0.32
CO_2- 1d incubation	-0.44	-0.43	-0.06	0.03
ACE protein	**0.87**	0.09	-0.08	-0.07
SOC	**0.87**	-0.4	-0.08	-0.06
C:N ratio	-0.2	0.23	-0.21	**-0.72**
Active carbon	0.58	-0.04	0.24	-0.03
Pseudomonas population	-0.09	-0.5	0.63	0.18
Nitrogen fixers	0.26	0.03	0.27	-0.61
Actinomycetes	0.3	0.28	0.43	0.37
Trichoderma	-0.28	**-0.66**	0.12	-0.08
Anaerobic bacteria	0.19	**0.67**	0.55	-0.15
Total microbial activity	-0.03	-0.17	**0.91**	-0.27
Fungal to bacteria ratio	-0.4	**-0.63**	0.17	-0.22
Eigenvalue	3.12	2.57	2.09	1.39
Proportion variance	22.3%	18.4%	14.9%	9.9%
Cumulative variance	22.3%	40.7%	55.6%	65.5%

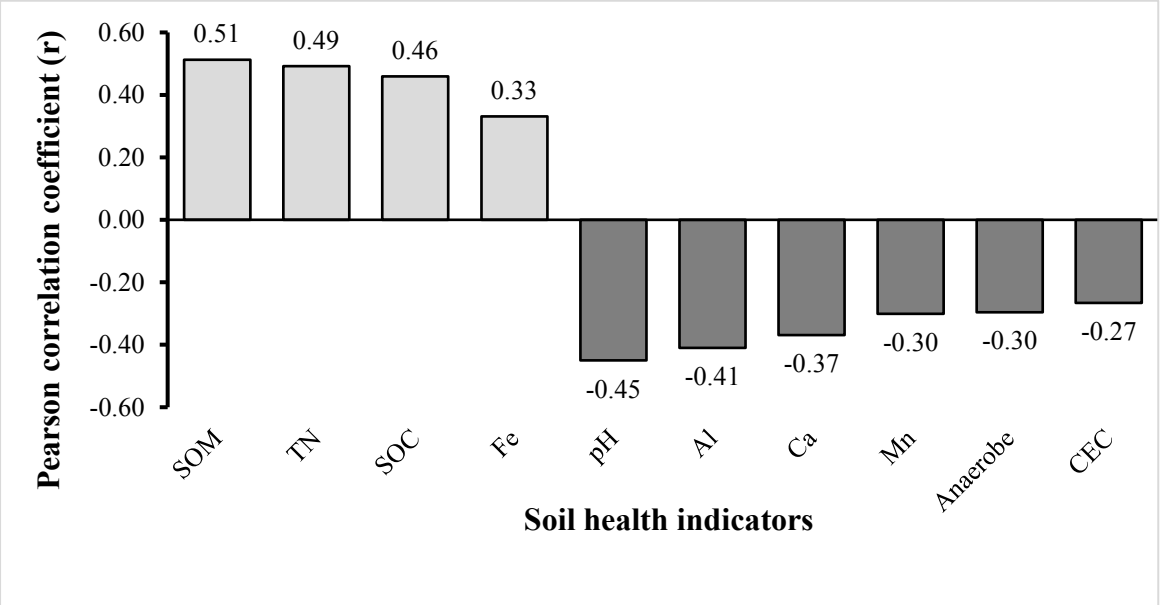

Figure 1. Pearson correlation coefficients of selected variables with productivity. All variables shown were significantly correlated with productivity at p-value of 0.1.
Note: SOM – soil organic matter, TN – total nitrogen, SOC – soil organic carbon, Fe – iron, Al – aluminum, Ca – calcium, Mn – manganese, Anaerobe – anaerobic bacteria index, CEC – cation exchange capacity

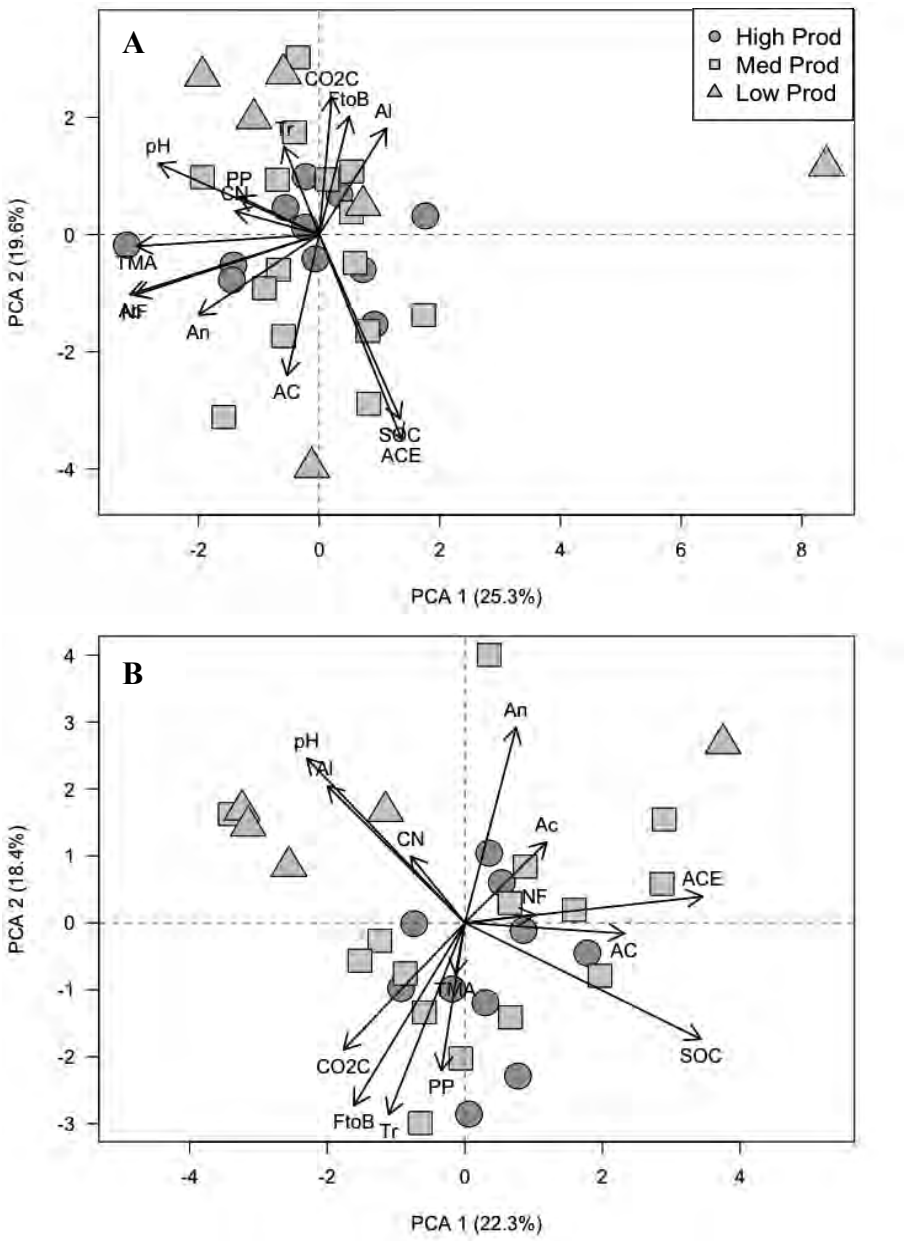

Figure 2 Principal component analysis (PCA) biplot by soil productivity on selected variables, without removing fields with known atypical situations (A) and after removing fields with known atypical situation (B), of the fields in the Holland Marsh sampled in 2022 and 2023.
Note: SOC – Soil organic carbon, CN – SOC to total nitrogen ratio, CO2C - CO2- 1d incubation, FtoB – fungal to bacterial ratio, Tr – *Trichoderma* index, PP – *Pseudomonas* population index, TMA – total microbial population index, Ac- *Actinomycetes* index, An – Anaerobic bacteria index, NF- nitrogen fixing bacteria index, ACE – ACE protein, AC- active carbon

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

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TITLE: COMPARISON OF SOIL TEST RESULTS ON MUCK SOILS FROM TWO DIFFERENT SOILS LABS IN ONTARIO

MATERIALS & METHODS: Two studies were conducted in commercial carrot and onion fields during 2023 in the Holland/Bradford Marsh, Ontario. In study one, soil samples were collected from 21 different fields including the Ontario Crops Research Centre – Bradford during last week of May. This was after broadcast fertilizer had been applied to the fields. 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 three rows of carrots or four rows of onions adjacent to the sprayer row. 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. In study two, soil samples were taken in mid November following carrot and onion harvest from 11 different fields. Each sample was a composite from a field and the soil samples were thoroughly mixed and separated in 2 sub samples. In each study a 600 g sample of thoroughly mixed composite soil samples were sent to two different labs (lab A and lab B) on the same day following similar methods. The same two labs were used for both studies. Statistical analyses were done using R 4.1.0 version for the first study. A two-sample t-test was applied to examine differences in results of individual soil properties from the two labs at 5% level of significance. A Pearson's correlation test was run on the selected variables (study one). For the second study, 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 2 and 3 and Figure 1

CONCLUSIONS: Both labs are OMAFRA accredited labs, situated in Ontario and used the same methods for soil analysis (Table 1). Although both labs used the scoop method for the soil analyses, there is no information on the scoop size they used. In study one, among the 12 tests, results on soil organic matter, pH, cation exchange capacity, phosphorous, calcium, boron, and iron were significantly higher in lab B compared to lab A. Results on potassium and zinc were higher for lab A, while there was no significant difference in the results of magnesium, manganese, and copper between the two labs. There was mean difference of 8% for soil organic matter in the results from the two labs (Table 2). Additional phosphorous fertilizer application is not recommended for carrot or onion production in muck soils if the soil phosphorous level is above 60 ppm, based on OMAFRA recommendations. Using the mean result of lab A for phosphorous, there is a need to apply 20 kg/ha P_2O_5, but based on the result of lab B, there is no need to apply phosphorous. Similarly, there was a mean difference of 0.5 for pH. Soil pH is very important characteristics of soil as it is related to nutrient availability and microbial population. It is recognized that the assessment of pH is variable and a difference of 0.2 is acceptable. OMAFRA recommends applying lime when the soil pH of muck soils is below 5.0. In study two, results on the same soil parameters were significantly different between the two labs for all parameters but soil pH and copper (Table 3).

These discrepancies in soil test results from the soil testing labs in the same region can be confusing for farmers. Valid soil test results are very important for optimum crop production, sustainable agriculture, soil health and for the environment. The strong positive correlation for the results from two labs is important to note (Figure 1). However, the differences in fertilizer recommendations from the two labs needs to be resolved in order to provide growers with the most accurate information. Future studies will send samples to three different accredited soils labs to better determine which are the most accurate.

Table 1. List of parameters measured by lab A and lab B and methods used by both labs.

Parameter	Unit	Method used
Soil organic matter	%	Loss on ignition (360 °C)
pH	-	Saturated test with distilled water
CEC	meq/100 g	Calculated based on % K, Mg, Ca, Na, and H^+ for lab A and % K, Mg, and Ca for lab B.
Phosphorous	ppm	Olsen method (Sodium bicarbonate extraction)
Potassium	ppm	
Calcium	ppm	Ammonium acetate extraction method
Magnesium	ppm	
Manganese	ppm	Phosphoric acid extraction
Boron	ppm	Hot water extraction (not accredited by OMAFRA)
Copper	ppm	
Zinc	ppm	Diethylenetriaminepentaacetic acid (DTPA, C14H23N3O10) method
Iron	ppm	

Table 2. Mean values for soil properties measured in two different labs. Soil was sampled during the last week of May 2023, after fertilizer was broadcast and incorporated, in commercial onion and carrot fields (n=42) in the Holland Marsh (study 1).

Significant at $p < 0.05$ and values greater for lab B

	Organic matter[1]	pH	CEC[2]	P	Ca	B	Fe
Lab A (mean)	**52.9**	**5.8**	**27.6**	**51.1**	**3849**	**2.9**	**117.5**
Lab B (mean)	**60.9**	**6.3**	**30.0**	**78.6**	**4626**	**5.5**	**153.0**
Mean difference	8.1	0.5	2.4	27.5	777.2	2.6	35.4

Significant at $p < 0.05$ and values greater for lab A

	K	Zn
Lab A (mean)	**257.0**	**14.0**
Lab B (mean)	**206.0**	**11.2**
Mean difference	50.7	2.7

Not significant at $p < 0.05$

	Mg	Mn	Cu
Lab A (mean)	**339.3**	**7.6**	**11.9**
Lab B (mean)	**342.5**	**7.5**	**11.7**
Mean difference	3.2	0.2	0.2

[1] Expressed as percent, [2] Expressed as meq/100 g, all other properties are expressed as ppm excluding pH. CEC – cation exchange capacity, P – phosphorous, Ca – calcium, B – boron, Fe – iron, K – potassium, Zn – zinc, Mg – magnesium, Mn – manganese, Cu – copper.

Table 3. Mean values for soil properties measured in two different labs. Soil was sampled in November 2023 from a grower cooperator following harvest, 2023 (study 2).

Significant at $p < 0.05$ and values greater for lab B

	Organic matter[1]	CEC[2]	P	K	Ca	B
Lab A (mean)	**61.5**	**34.1**	**33.1**	**128.6**	**4327**	**2.8**
Lab B (mean)	**74.9**	**50.5**	**81.4**	**186.6**	**8133**	**4.2**
Mean difference	13.4	16.4	48.3	58.0	3806	1.4

Not significant at $p < 0.05$

	pH	Cu
Lab A (mean)	**6.3**	**17.1**
Lab B (mean)	**6.3**	**24.1**
Mean difference	0.0	6.4

[1] Expressed as percent, [2] Expressed as meq/100 g, all other properties are expressed as ppm excluding pH. CEC – cation exchange capacity, P – phosphorous, Ca – calcium, B – boron, Fe – iron, K – potassium, Zn – zinc, Mg – magnesium, Mn – manganese, Cu – copper.

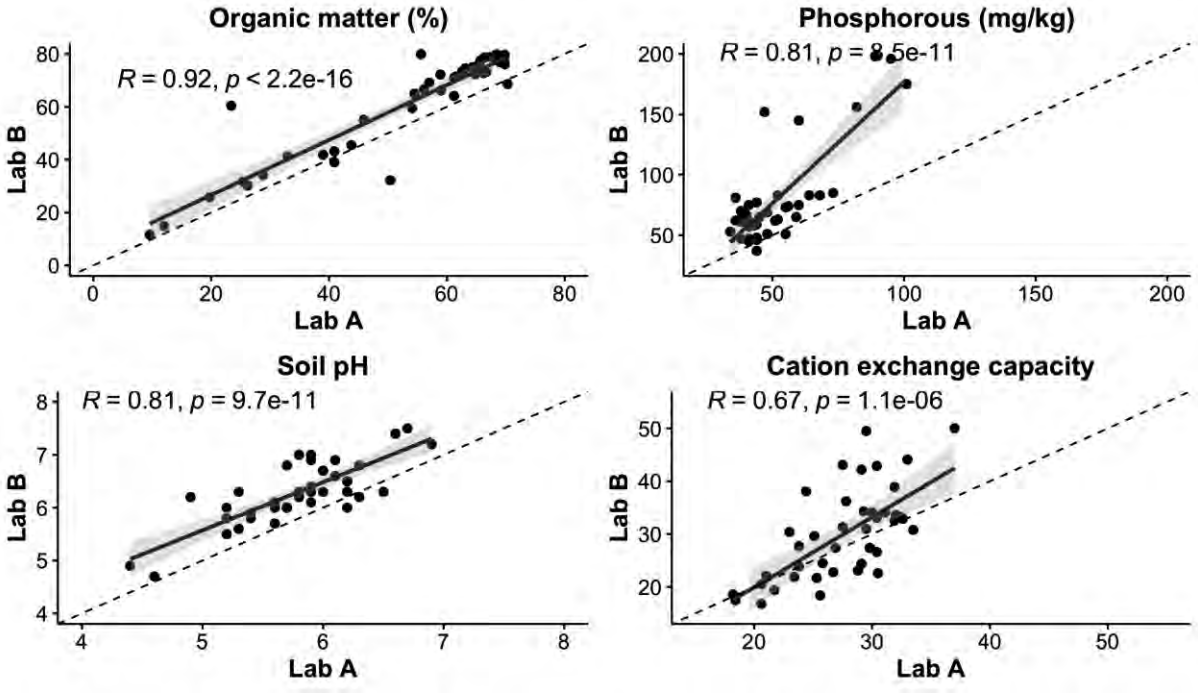
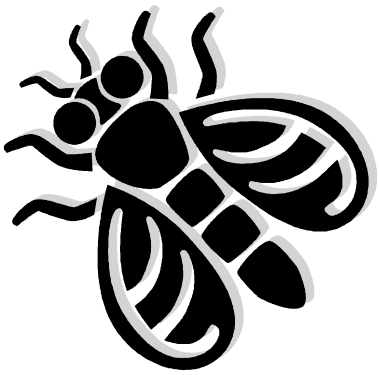
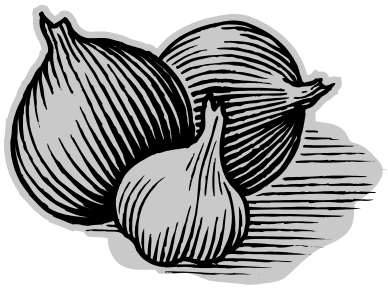


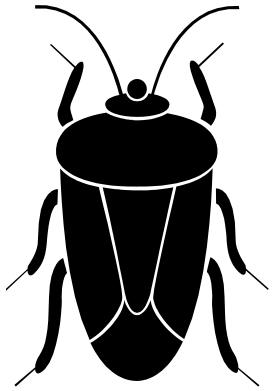
Figure 1. Comparison of soil test results from two labs on selected variables. The solid line represents linear regression between the results from the two labs and the dotted line represents 1:1 line (study 1).

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



Integrated Pest Management Report - 2023





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TITLE: THE INTEGRATED PEST MANAGEMENT PROGRAM SUMMARY FOR MUCK VEGETABLE CROPS, 2023

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 2023, 50 commercial vegetable fields, totalling 559 acres (onion 239 ac, carrot 256 ac, celery 56 ac and potato 8 ac), were intensively scouted for 17 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 14 March to 6 November, 2023, the diagnostic laboratory of the OCRC-B received 126 samples for diagnosis. Of these, 71% were diagnosed with infectious diseases (89 samples), 11% with insect issues (14 samples) and 18% were diagnosed with an abiotic disorder (23 samples). These samples were associated with the following crops: onion (46%), carrot (30%), celery (14%) and other crops (10%). 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, insect 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, samples were taken from each field for assessment. One hundred onions were examined after lodging and 100 carrot samples were collected. The samples were assessed for damage from insects, diseases and 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 2023, 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 low overall with only a few fields experiencing some damage (Table 1). Aster leafhoppers were found throughout the season; however, populations and aster yellows severity were lower than last year.

Table 1. Average percent carrot weevil and carrot rust fly damage on carrots at harvest in scouted fields in the Holland Marsh, 2023.

Location within Holland Marsh	% Damaged Carrots	
	Weevil damage	Rust fly damage
West	0.0	1.0
South	0.6	0.3
Central	0.0	1.6
North	0.0	0.0
East	0.0	5.7
Average	0.1	1.7

Carrot weevil adults were first found in wooden Boivin traps on 19 May in carrot fields (Fig. 1). Carrot weevils were only found in 64% of scouted carrot fields. Overall, 14% of fields in the IPM program reached the 1.5 weevil/trap threshold, and 5% of fields reached the 5 weevil/trap threshold.

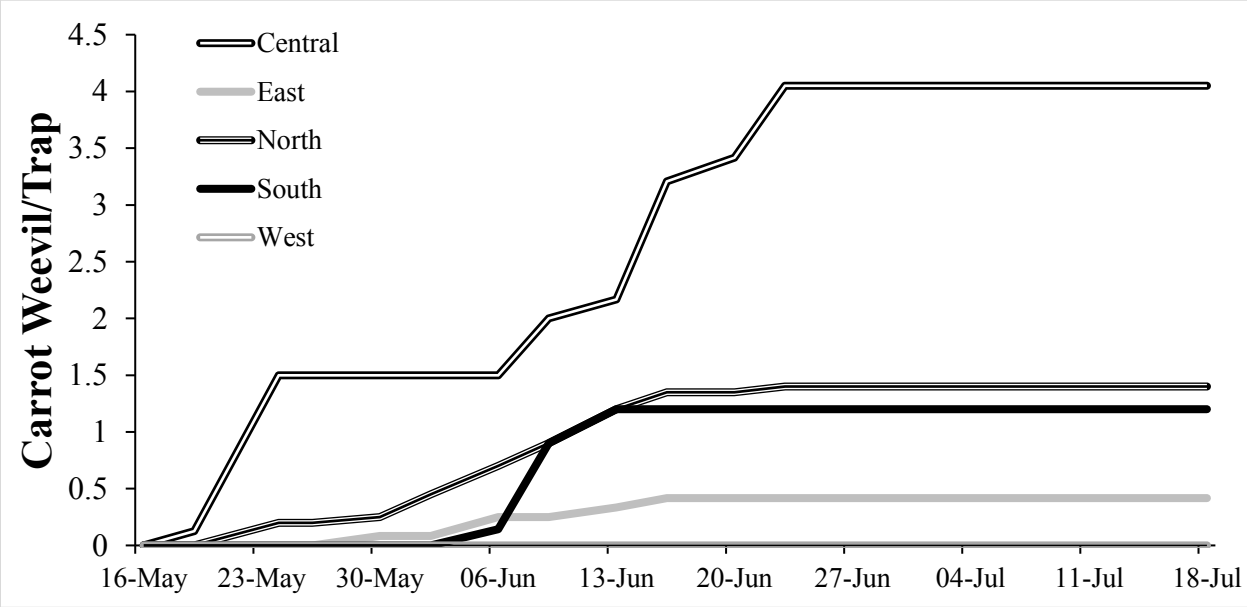


Figure 1. Average cumulative number of carrot weevils/trap in different regions of the Holland Marsh, 2023.

Populations and damage due to carrot weevil remained low, similar to the past few 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 26 May, 7 days after the degree day model predicted first

generation emergence (19 May). The highest activity during the second generation was on 11 August when 18% of scouted fields had exceeded the threshold.

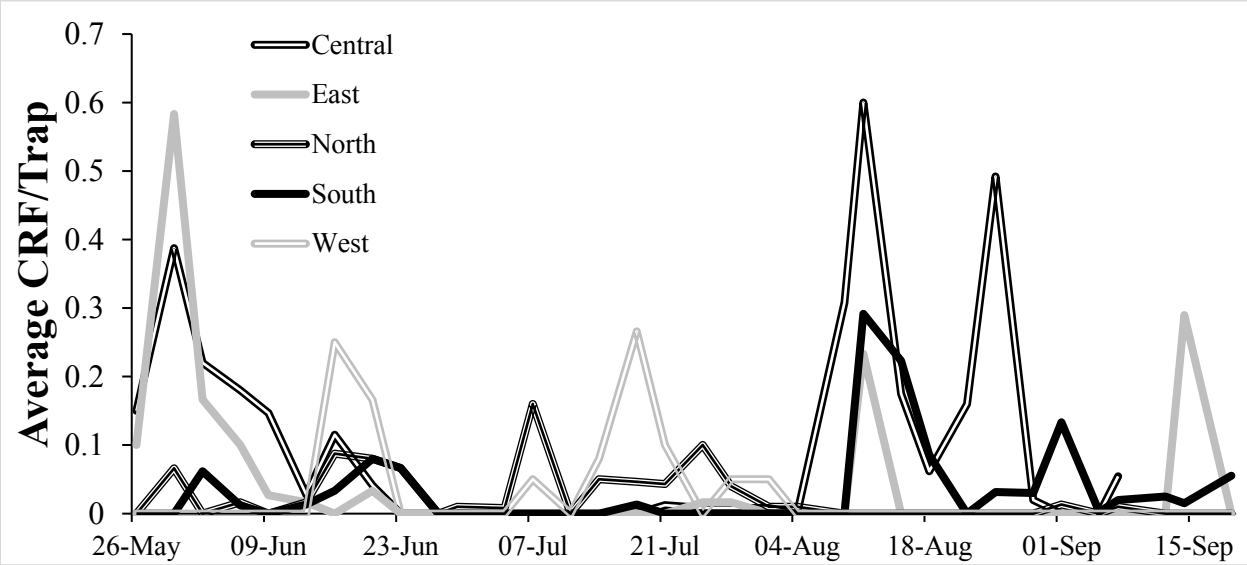


Figure 2. Average carrot rust flies (CRF)/trap/day in different regions of the Holland Marsh, 2023.

Aster leafhoppers are pests of carrots, celery, lettuce and leafy greens. Aster leafhoppers were first found on orange sticky traps on 23 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 end of June to early July during which only 14% of fields were above the 20 ALH/trap threshold at some point.

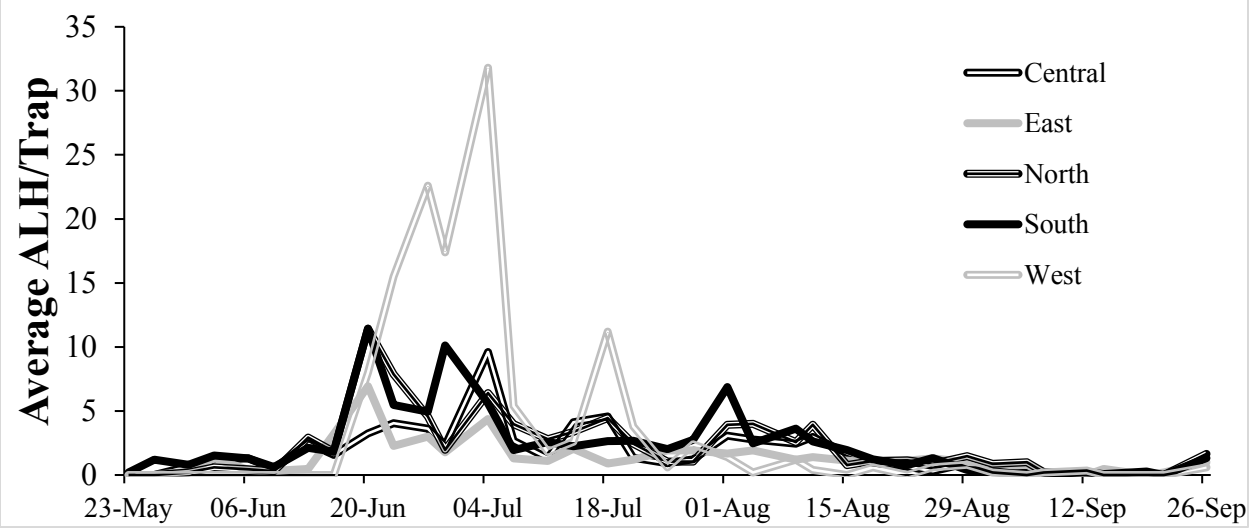


Figure 3. Average aster leafhoppers/trap in different regions of the Holland Marsh, 2023.

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 27 July. Throughout the season, 23% of scouted carrot fields reached the leaf blight threshold of 25% of plants infected.

Samples of 100 carrots were taken from each scouted field and roots were assessed for diseases (Table 2). All fields had multiple diseases; however, disease severity was generally low. Cavity spot (*Pythium* spp.)

was the most common throughout carrot fields. Crater rot, forking/stubby, lesion nematode, Fusarium dry rot, aster yellows and crown gall were also present.

Table 2. Disease incidence on carrot samples collected from commercial fields in the Holland Marsh, Ontario in 2023.

DISEASE	CAUSAL AGENT	FIELDS INFECTED (%)	INCIDENCE (%)
Cavity Spot	*Pythium* spp.	100	6-49
Crater Rot	*Rhizoctonia* spp.	95	0-30
Crown Gall	*Agrobacterium tumefaciens*	86	0-46
Forking/Stubby	Nematodes and/or *Pythium* spp.	86	0-17
Fusarium Dry Rot	*Fusarium* spp.	71	0-28
Aster Yellows	*Candidatus* Phytoplasma asteris	29	0-17

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 10 May and first onion flies were found on yellow sticky traps on 18 May. Counts remained low in general, but some fields experienced higher activity and some transplants were damaged by onion maggot feeding (Fig. 4).

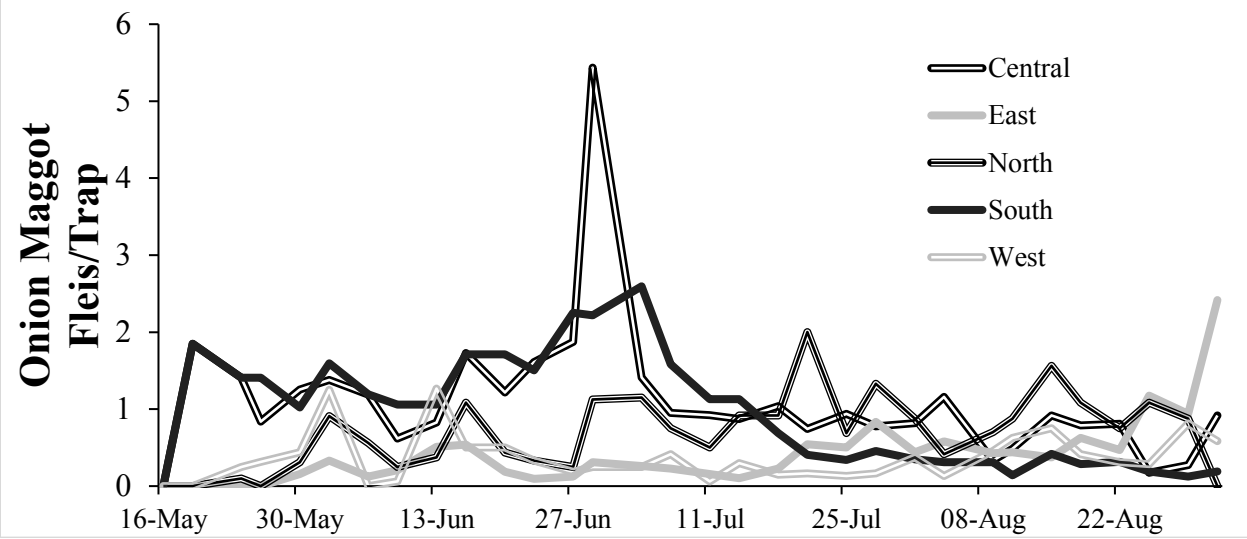


Figure 4. Average onion flies/trap/day in different regions of the Holland Marsh, 2023.

Thrips were firsts identified on 8 June and populations fluctuated throughout the season. Thrips counts peaked from mid- to late-July. Only one onion field surpassed the 3 thrips/leaf threshold during the season.

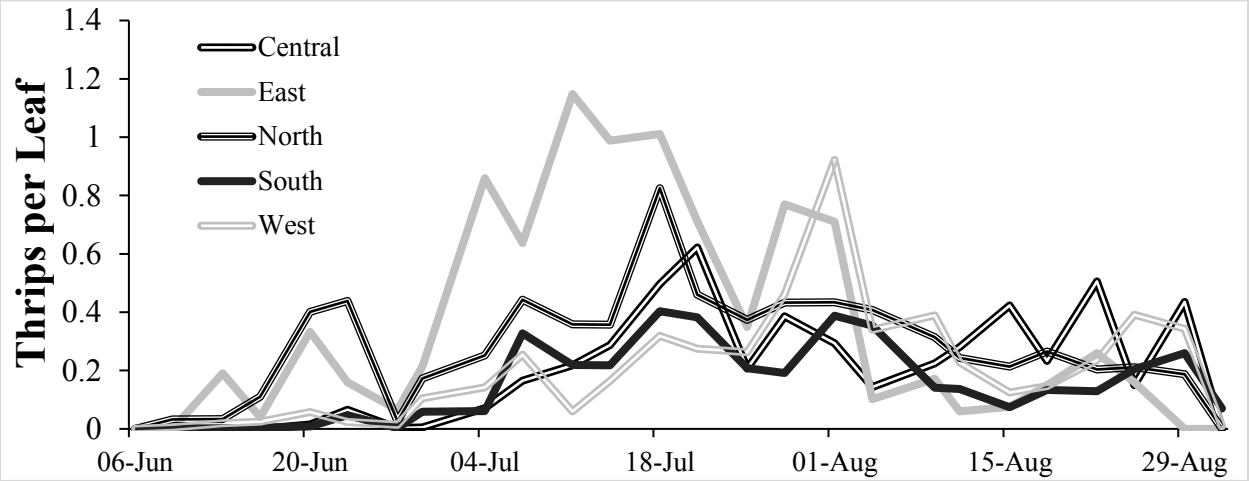


Figure 5. Average thrips/leaf in different regions of the Holland Marsh, 2023.

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.

During the growing season there were higher amounts of precipitation than usual throughout July, along with some long periods of reduced sun intensity and air quality due to smoke from forest fires during this timeframe as well. The increased precipitation resulted in longer leaf wetness periods and higher relative humidity which was favourable for disease development.

Stemphylium leaf blight continued to be the main disease on onions in 2023 (Table 3). First symptoms of Stemphylium leaf blight in scouted fields were seen on 22 June. Symptoms became severe in many fields and all scouted onion fields showed symptoms of the disease by the end of the season.

Conditions were also quite favourable for the development of onion downy mildew. Starting at the beginning of July there were multiple sporulation-infection periods and sporangia were trapped in rotorod spore traps. Symptoms were first identified on 20 July and a total of eight scouted onion fields were found to have the disease. Most fields experienced minor onion downy mildew severity; however, a couple fields in the marsh had moderate to high disease severity.

Pink root was found in all onion fields, but disease severity was generally low. Bacterial rot was found in a number of fields due to the warm and wet conditions. Smut, white rot, purple blotch and fusarium basal rot were also present.

Table 3. Disease incidence on onion samples examined in commercial fields in the Holland/Bradford Marsh, Ontario in 2023.

DISEASE	CAUSAL AGENT	FIELDS INFECTED (%)	INCIDENCE (%)
Stemphylium leaf blight	*Stemphylium vesicarium*	100	5-100
Pink root	*Setophoma terrestris*	100	7-84
Purple blotch	*Alternaria porri*	71	0-54
Bacterial rot/soft rot	*Pectobacterium carotovorum* subsp. *carotovorum*	67	0-11
Fusarium basal rot	*Fusarium oxysporum* f. sp. *cepae*	43	0-6
Downy mildew	*Peronospora destructor*	38	0-2
White rot	*Stromatinia cepivora*	33	0-18
Smut	*Urocystis cepulae*	19	0-4

CELERY

Insects

In 2023, three 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 bugs were found in all fields but populations and damage remained low. No carrot weevil damage was found. Aster yellows was very low this year. Only very minor cutworm, aphid and caterpillar damage was seen and no leaf miner damage was reported.

Diseases

Celery leaf curl, or celery anthracnose (*Colletotrichum fioriniae*), was found in two fields and severity was very low overall with only a couple plants per field infected with the disease. Leaf blights (*Cercospora apii* and *Septoria apiicola*) were common but disease severity remained low.

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.

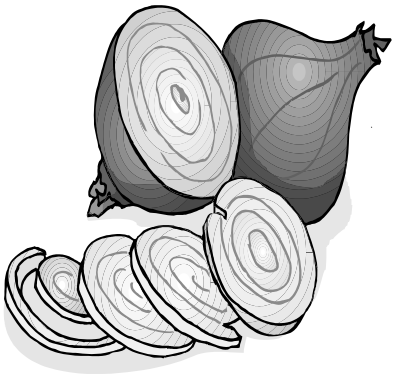
Check out the Muck Crops Research Station's You Tube Account

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.

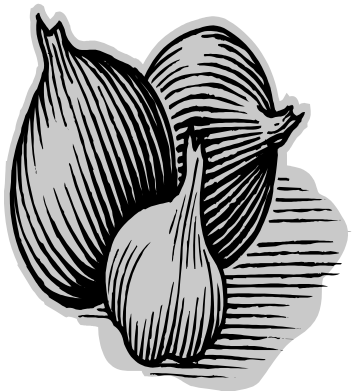
Simply type in:

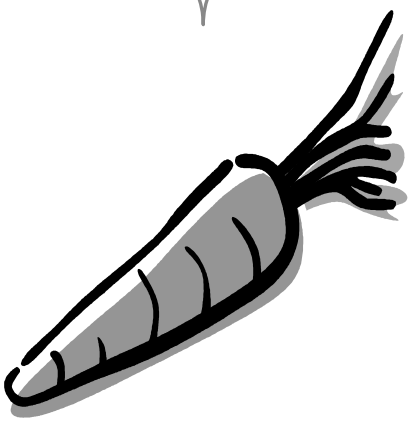
"Muck Crops IPM" on YouTube to find us we're the first result.

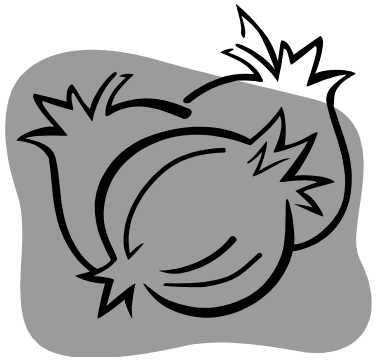
or follow this link www.youtube.com/@muckcrops



Cultivar Trials 2023







CARROT CULTIVAR TRIAL SEASON SUMMARY – 2023

Daytime air temperatures in early May fluctuated between the teens and high twenties digits and nighttime air temperatures fluctuated from low single digits. The month of May had below average rainfall. One inch of rainfall occurred five days prior to seeding which provided good soil moisture for carrot hill formation and seeding. In the marsh, most of the carrot seeding occurred within the two-week period of 15-26 May. Compared to the previous 10-year average, air temperatures in 2023 were above average for September (18.2°C) and October (11.5°C), average for June (18.1°C) and July (20.9°C) and below average May (12.7°C), and August (18.9°C). The 10-year average temperatures were: May 13.6°C, June 18.7°C, July 21.2°C, August 20.5°C, September 16.5°C and October 10.0°C. Monthly rainfall was below the 10-year average for May (52 mm), June (82 mm), August (61 mm), September (4 mm) and October (35 mm) and above average for July (113 mm). The 10-year rainfall averages were: May 64 mm, June 96 mm, July 74 mm, August 77 mm, September 65 mm and October 68 mm.

The carrot trial was seeded on 25 May. Soil moisture was sufficient in forming favourable carrot hills. Irrigation water at a rate of ½ inch was applied four times from 26 May to 6 June to aid in seed germination and plant establishment. Emergence and plant vigour were good. On the 6 June the carrots were in the bunny ear stage. A heavy rainfall event of 37.8 mm rainfall occurred on 12 June when the carrots were at the first true leaf. A couple of other rainfall events at the end of June aided the carrots to establish well with no visible decrease in stand.

The pre-emergence herbicide Gesagard was applied 26 May. The lack of rainfall meant irrigation need to be applied to activate the Gesagard. The Gesagard gave moderate weed suppression. The heavy rainfall event of 12 June encouraged a weed flush. Several applications of Lorox + Assist Oil were required on 13 and 29 June did a moderate clean up of the trial. Two more Lorox + Assist applications were applied in July to provide 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 weevils counts on 17 May were 0 weevils/trap/day. By 1 June, weevil numbers had passed the spray threshold with 2.5 cumulative weevils/trap. The cumulative weevils/trap for the season was 6.50 when the traps were removed on 6 July. Insecticide Rimon was applied once 21 June to provide control for carrot weevil damage. There was limited weevil damage (dead carrot seedlings) observed in the variety trial. Only one variety had any damage from carrot weevil at 0.3%. The trial average for carrot weevil damage at evaluation was 0%. Carrot rust flies were first found on 8 June. There were three rust fly peaks occurring 13 June, 26 June and 17 August (0.22, 0.19 and 0.05 flies/trap/day, respectively). At evaluation there was a trial average of 0.15% rust fly damage observed. This was a decrease of almost 0.4% compared to the 2022 trial average of 0.6% rust fly damage.

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CARROT CULTIVAR TRIAL SEASON SUMMARY – 2023 – continued

Aster leafhoppers were first found on 17 May when scouting began. On 3 July, leafhopper numbers had peaked at 26.4 leaf hoppers/trap. Leafhopper numbers stayed moderate for additional three weeks. Leafhoppers population significantly decreased in August to below threshold levels. The moderate pressure of Aster leafhoppers correlated with some noticeable aster yellows infection in the field, but at evaluation there were low numbers found in the yield samples.

Alternaria and Cercospora leaf blights were first found on 27 July and were controlled throughout the month of August with two 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 second replicate had a significantly higher blight rating than the other two replicates. In the cello cultivars, the third replicate had a significantly lower blight rating than the other two replicates. By Grower Field Week, starting on 7 September, some bolting was noted in a few cultivars in the trial. At harvest, twenty-one cultivars had no seeders present and in cultivars where seeders were present the total numbers were very low.

On 7 September, grower field day, most carrot roots that were pulled appeared to be progressing well. Lengths were a bit short; weight was surprisingly quite good considering the drier growing season. Unfortunately, the carrot lengths and additional weight did not improve due to the below average total rainfall in September and October. Weather conditions in October were very favourable for the entire harvest period which began on 24 October. At harvest, carrots had good diameters and average lengths, and were pretty good in quality. There were moderate numbers of forked and split carrots in the yield samples. Dryer conditions in previous eight weeks before harvest appeared to discourage blight development. The carrot tops had low levels of leaf blight and strong petiole attachment. A few pockets of sclerotinia were found in July but not at 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 January, the trial average yield for cellos was fair with 1289 bu/A. The trial average yield for jumbos was good at 1429 bu/A. This is an increase of approximately 200 bu/A for both the cellos and jumbos compared to 2022. The cellos were a little disappointing in width and length but were good in quality. The jumbos were good in width, a little poor for length and quality was good. In both the cellos and jumbos, the percentage of cull carrots was moderate with an average of 20% of the harvest yield.
This was a decrease of 4 % from the 2022 season. Most of the culls in both the cellos and jumbos were forked carrots. Canker rot was a second most cull noted during evaluation with jumbo types having slightly higher incidence. For cellos, the stand average was low 16

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CARROT CULTIVAR TRIAL SEASON SUMMARY – 2023 – continued

carrots/foot compared to the desired trial seeding average of 25 carrots/foot. For jumbos, the stand average was 12 carrots/foot compared to the desired trial seeding average of 18 carrots/foot. The total number of carrots harvested in the first replicate of the jumbos had significantly higher number of jumbos 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% identical to 2022. This is two years in a row with lower percent infection compared to the high of 2021 (82.5%) but still higher then 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 higher percentage of cavity spot compared to the other two replicates by 10%. In the jumbos the third replicate had significantly lower percentage of cavity spot compared to the second replicated by 18%. It appeared the drier conditions of the growing season only slightly decrease the percentage of incidence of cavity spot but did not decrease the severity. The uniformity of width and length rating was average for both the cellos and jumbos, however the cellos were a bit more uniform in width and length then the jumbos. Exterior colour for all cultivars was nice 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 then the cellos. Most of the cello cultivars had a rougher exterior skin with some ringy surfaces. Interior colour blending was good, with a few carrots having any translucency in the core or red/green rings around the core. Green shoulders were not present in most cello cultivars, and if found, were mostly in the jumbos and just starting to develop. There were no galls found on any carrots at evaluation. Only two carrot roots with aster yellows infection were found throughout the trial. At evaluation, no significant differences were found in percentage of weevil or rust fly damage.

CARROT CULTIVAR TRIALS - 2023

MANAGEMENT PROCEDURES

Fertilizer:

20 kg/ha Nitrogen (Calcium Ammonium Nitrate 27-0-0) + 80 kg/ha Phosphorous (MESZ 10-40-0) + 175 kg/ha Potassium (ASPIRE 0-0-58) +
100 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 25 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 26 May.
Post-emergence:	1 application: **LOROX L** at 250 ml/ha + **ASSIST OIL** at 1.0 L/ha on 13 June.
	1 application: **LOROX L** at 750 ml/ha + **ASSIST OIL** at 1.0 L/ha on 29 June.
	2 applications: **LOROX L** at 500 ml/ha + **ASSIST OIL** at 1.0 L/ha on 11 and 26 July.

Minor Elements:

Five foliar sprays: Maganese Sulfate on 23 June (0.5 kg/ha) and 21 July and 1, 11 and 17 August (1.0 kg/ha).
Four foliar sprays: Epsom Salts on 21 July and 1 & 17 August (2.0 kg/ha) and 11 August (3.0 kg/ha).
One foliar spray: 20-20-20 on 23 June (0.5 L/ha).
One foliar spray: Alexin on 11 August (3.0 L/ha).
One foliar spray: Calimax on 1 Aug (2.0 L/ha).
One foliar spray: Suprafeed on 11 August (3.0 kg/ha).
One foliar spray: Mag Max on 23 June (1.5 L/ha).
One foliar spray: Nutri Bor on 23 June (1.0 L/ha).

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CARROT CULTIVAR TRIALS - 2023 - continued

Insect and Disease Control:

According to IPM recommendations.

RIMON at 840 ml/ha on 21 June.
SLIENCER at 83 ml/ha and Minor Elements on 21 July.
DITHANE DG at 2.25 kg/ha + **CLOSER** at 300 ml/ha and Minor Elements on 1 August.
CABRIO at 1.1 kg/ha + **ALLEGRO 500F** 1.16 L/ha + **SIVANTO PRIME** at 750 ml/ha and Minor Elements on 17 August.

Harvest:

The Main and Adaptation Trials were harvested on 24-26 and 31 October. All trials were immediately placed in a temperature and humidity controlled storage (1°C, 95 % RH) respectively.

Irrigation:

Irrigation water was applied five times during the 2023 growing season.

26 May in the amount of ½ inch
29 May in the amount of ½ inch
3 June in the amount of ½ inch
6 June in the amount of ½ inch
22 June in the amount of ½ inch

EVALUATION PROCEDURES

The cultivars were evaluated on 15 – 31 January after 11 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.

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Marketable Yield t/ha + B/A:

Marketable yield includes the packaging size, 2.0 cm to 4.4 cm (¾" to 1¾") as well as the oversize > 4.4 cm (> 1¾").

% Oversize:

The percentage of carrots > 4.4 cm (> 1¾ ") and greater.

Majority of Culls:

Sp = Splits F = Forked Sm = Small (< 2.0 cm) R = Rot A = Aster Yellows

Shape:

GP = Gold Pak	N = Nantes	Imp = Imperator	Cyl = Cylindrical	LD = Long Danver
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 17 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.

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CARROT CULTIVAR TRIALS - 2023 - continued

Score:

The average of the 9 marks from Uniformity of Shape to Blight Rating. 10.0 = Most Desirable, 7.5 = Good, 6.0 = Average.

% Cavity Spot & Degree:

The number indicates the percentage of roots with cavity spots.
The letters indicate the degree to which the roots were infected.
VL = Very Light, cavity spots are few and barely visible. Lesion size < 1 mm.
L = Light, few small spots. Lesion size 1 - 2 mm.
M = Medium, roots borderline marketable. Lesion size 2 - 5 mm.
H = Heavy, large cavity spots, roots unmarketable. Lesion size 5 - 10 mm.
VH = Very Heavy, many large cavity spots, roots unmarketable. Lesion size > 10 mm.

Example: 50 H = 50% of the roots were heavily infected with cavity spots, roots unmarketable

Shape of Crown:

CV = Convex (no indentation around crown) CC = Concave (indentation around crown)

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

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CARROT CULTIVAR TRIALS - 2023 - continued

Leaf Colour:

LG = Light Green G = Green DG = Dark Green PG = Pale Green

Leaf Structure:

F = Fine leaf structure ST = Standard leaf structure C = Course heavy leaf structure

% Weevil & Rust Fly Damage:

Percent of carrot roots damaged by carrot weevil & carrot rust fly that were found in the 2.32 m harvest sample.

% 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***	***Four***	***Seven***	***Nine***
Brillyance	CA 20 2011	CA20-2008	Cellobunch	Junction	Jefferson	Caravel	ResistaFly
SV 2384	Brava	Istanbul	Fortedo				ResistaFly Improved
Naval	Belgrado	Envy					
Navedo Jumbo	Berlin	Soneto					
Enterprise	Narvik	Sirkana					
SV DN 5934	Trallyance	Caltona					
Navedo Cello	Baldio	85193					
Trophy Pak	Brillyance	Arpeggio					
Orchestro	Bastia						

Root Gall:

Root gall was not found in the 2023 carrot cultivar trial.

CARROT CULTIVAR MAIN TRIAL CELLO TYPES - 2023

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	141 a*	30 ab	85 a	23.64 a	8.88 a	11.74 a	103.1	1660 a
JUNCTION	Bejo	118 a	14 d	84 a	17.66 e	4.34 a	10.58 abc	74.6	1201 ab
ISTANBUL	Bejo	132 a	28 abc	72 ab	19.82 b-e	8.09 a	8.42 c-g	82.5	1329 abc
SV 2384	Sto	112 a	26 abc	69 abc	20.22 b-e	8.30 a	8.43 c-g	83.7	1347 abc
TROPHY PAK	Sto	116 a	31 ab	61 b-e	18.17 e	8.32 a	6.56 ghi	74.4	1198 abc
ENVY	Sto	126 a	35 a	65 a-d	21.72 a-d	9.86 a	7.80 e-h	88.3	1422 abc
SONETO	Vil	113 a	30 ab	58 b-f	20.31 b-e	7.64 a	8.84 b-f	82.4	1327 abc
NAVEDO CELLO	Bejo	151 a	23 bcd	83 a	22.74 ab	7.23 a	11.07 ab	91.5	1473 abc
ARPEGGIO	Vil	125 a	24 bc	72 ab	22.30 abc	6.83 a	11.03 ab	89.3	1438 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.

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CARROT CULTIVAR MAIN TRIAL CELLO TYPES - 2023 - 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
ENTERPRISE	Sto	137 a*	20 cd	83 a	18.71 de	5.93 a	9.00 b-e	74.7	1202 a-d
NAVAL	Bejo	127 a	28 abc	58 b-f	19.98 b-e	7.57 a	7.99 d-h	77.8	1252 a-d
CELLOBUNCH	Sto	134 a	25 bc	70 abc	20.71 a-e	7.57 a	8.30 d-g	79.4	1278 a-d
JEFFERSON	Bejo	129 a	25 abc	65 a-d	19.55 cde	7.02 a	7.93 e-h	74.8	1203 a-d
NARVIK	Bejo	130 a	23 bcd	73 ab	21.65 a-d	6.21 a	10.20 a-d	82.1	1321 a-d
SVDN 5934	Sem	103 a	25 bc	51 c-f	22.72 ab	8.89 a	7.73 e-h	83.1	1337 bcd
FORTEDO	Vil	127 a	31 ab	46 def	19.93 b-e	7.67 a	6.72 f-i	72.0	1158 cd
RESISTAFLY	SN	131 a	31 ab	44 ef	19.45 cde	7.67 a	5.80 hi	67.4	1085 de
RESISTAFLY IMPROV	SN	138 a	29 ab	39 f	19.73 b-e	7.33 a	4.80 i	60.7	976 e
Trial Average		**127**	**26**	**65**	**20.50**	**7.52**	**8.50**	**80.1**	**1289**

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 - 2023 - continued

Cultivar	Source	% Marketable	% Oversize	Majority of Culls	Shape	Uniformity of Shape	Uniformity of Length	Uniformity of Width	Appearance	Resistance to Greening
BRILLYANCE	Sto	87.0 a*	37.9 a	Sm	Cyl	7.7 abc	6.7 bc	7.3 bcd	7.7 a	9.0 bc
JUNCTION	Bejo	84.5 ab	23.9 a	F	Imp	7.7 abc	6.3 cd	6.0 efg	5.3 d	10.0 a
ISTANBUL	Bejo	83.3 abc	40.9 a	F	Imp	6.7 bcd	5.3 de	5.7 fg	5.7 cd	9.5 ab
SV 2384	Sto	82.7 abc	41.2 a	F	ImpCyl	7.3 abc	6.3 cd	6.0 efg	5.7 cd	9.0 bc
TROPHY PAK	Sto	82.5 abc	46.1 a	F	Imp	8.3 a	6.7 bc	6.7 c-f	7.7 a	10.0 a
ENVY	Sto	81.5 abc	45.4 a	FSm	Imp	5.3 d	6.8 bc	7.3 bcd	6.3 bcd	9.7 ab
SONETO	Vil	80.9 abc	37.7 a	F	CylN	8.3 a	7.0 bc	7.7 bc	5.7 cd	9.3 abc
NAVEDO CELLO	Bejo	80.4 abc	31.3 a	FSm	Cyl	5.7 d	5.0 e	5.7 fg	5.3 d	9.7 ab
ARPEGGIO	Vil	80.1 a-d	30.5 a	F	Cyl	8.3 a	6.7 bc	7.0 b-e	7.3 ab	9.2 bc

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 - 2023 - continued

Cultivar	Source	% Marketable	% Oversize	Majority of Culls	Shape	Uniformity of Shape	Uniformity of Length	Uniformity of Width	Appearance	Resistance to Greening
ENTERPRISE	Sto	79.7 a-d*	31.5 a	F	Imp	6.3 cd	5.3 de	5.0 g	5.3 d	9.3 abc
NAVAL	Bejo	77.8 a-d	37.9 a	Sm	N	7.7 abc	7.3 bc	7.0 b-e	7.3 ab	9.7 ab
CELLOBUNCH	Sto	76.9 a-d	36.6 a	F	ImpCyl	6.7 bcd	5.3 de	6.0 efg	5.7 cd	8.7 c
JEFFERSON	Bejo	76.4 a-d	35.4 a	F	ImpCyl	7.3 abc	6.3 cd	5.7 fg	6.3 bcd	9.3 abc
NARVIK	Bejo	76.2 a-d	29.2 a	Sm	Cyl	8.3 a	7.0 bc	8.0 ab	6.7 abc	9.2 bc
SVDN 5934	Sem	74.2 bcd	39.3 a	F	Cyl	7.3 abc	4.7 e	6.3 def	6.7 abc	9.0 bc
FORTEDO	Vil	72.6 cd	38.8 a	Sm	N	8.7 a	8.7 a	9.0 a	7.7 a	9.0 bc
RESISTAFLY	SN	69.4 de	39.1 a	Sm	N	5.7 d	7.7 ab	7.2 b-e	6.3 bcd	8.7 c
RESISTAFLY IMPROV	SN	61.1 e	36.8 a	Sm	N	8.0 ab	8.7 a	7.3 bcd	5.7 cd	9.0 bc
		78.2	**36.6**			**7.3**	**6.5**	**6.7**	**6.4**	**9.3**

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 - 2023 - 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	8.0 a*	O	7.7 a	49.3 ab	9.7 a	7.71 ab	65LM a-d	CC
JUNCTION	Bejo	DO	6.7 a	O	7.3 ab	41.2 de	7.7 c	7.05 cde	65L a-d	CC
ISTANBUL	Bejo	O	7.0 a	O	7.7 a	42.9 cd	8.7 abc	6.79 ef	40L e	CC
SV 2384	Sto	O	6.3 a	LO	6.3 bcd	38.8 e	9.3 ab	6.71 ef	67LM abc	CV
TROPHY PAK	Sto	O	6.7 a	O	6.3 bcd	50.6 a	8.3 bc	7.48 bc	63LM bcd	CV
ENVY	Sto	O	6.3 a	O	6.7 abc	46.2 bc	9.0 ab	6.93 de	55LM cde	CC
SONETO	Vil	O	6.7 a	O	5.3 d	38.3 ef	9.3 ab	7.14 cde	60LM cde	CC
NAVEDO CELLO	Bejo	O	7.3 a	LO	6.3 bcd	41.4 de	8.3 bc	6.43 fg	62LM cd	CV
ARPEGGIO	Vil	LO	7.3 a	O	6.3 bcd	45.2 c	9.7 a	7.45 bc	70L abc	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 - 2023 - 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
ENTERPRISE	Sto	DO	6.3 a*	O	6.0 cd	37.9 ef	9.3 ab	6.24 g	60L cde	CV
NAVAL	Bejo	O	7.0 a	LO	6.3 bcd	43.2 cd	9.0 ab	7.48 bc	45L de	CC
CELLOBUNCH	Sto	O	6.0 a	O	6.7 abc	43.6 cd	9.7 a	6.43 fg	55LM cde	CV
JEFFERSON	Bejo	O	7.3 a	O	7.7 a	38.2 ef	7.7 c	7.14 cde	57L cde	CC
NARVIK	Bejo	LO	7.0 a	LO	6.3 bcd	38.7 e	9.0 ab	7.50 bc	60L cde	CC
SVDN 5934	Sem	O	7.7 a	O	5.7 cd	42.8 cd	8.3 bc	6.76 ef	68M abc	CV
FORTEDO	Vil	O	7.7 a	LO	6.5 bc	35.0 f	8.7 abc	8.17 a	70LM abc	CC
RESISTAFLY	SN	LO	6.3 a	O	6.0 cd	43.2 cd	9.0 ab	6.83 ef	83M ab	CC
RESISTAFLY IMPROV	SN	O	7.0 a	LO	6.0 cd	42.8 cd	8.8 ab	7.38 bcd	85LM a	CC
			6.9		**6.5**	**42.2**	**8.9**	**7.09**	**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 - 2023 - 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	19.8 d-g*	3.7 a-e	25	18 a	54.4 cd	G	ST	0.0 a	0.0 a	0.5 a
JUNCTION	Bejo	24.7 a	3.3 i	25	15 ab	57.1 bc	G	ST	0.0 a	0.8 a	0.0 a
ISTANBUL	Bejo	22.1 bc	3.6 e-h	25	17 ab	57.1 bc	DG	ST	0.0 a	0.0 a	0.0 a
SV 2384	Sto	23.1 ab	3.5 ghi	23	15 ab	55.0 cd	DG	ST	0.0 a	0.0 a	0.0 a
TROPHY PAK	Sto	19.2 efg	3.7 b-f	23	15 ab	58.5 bc	G	ST	0.0 a	0.3 a	0.0 a
ENVY	Sto	19.4 efg	3.8 a-d	23	17 ab	54.8 cd	G	ST	0.0 a	1.0 a	0.3 a
SONETO	Vil	17.6 hij	3.9 a	25	15 ab	45.8 f	G	ST	0.0 a	0.0 a	0.0 a
NAVEDO CELLO	Bejo	20.7 cde	3.6 c-g	25	3 c	52.3 de	G	ST	0.0 a	0.0 a	0.0 a
ARPEGGIO	Vil	19.9 def	3.8 ab	25	16 ab	49.7 ef	LG	ST	0.0 a	0.0 a	0.3 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 - 2023 - 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
ENTERPRISE	Sto	22.7 b*	3.4 hi	25	18 ab	58.2 bc	G	ST	0.0 a	0.0 a	0.0 a
NAVAL	Bejo	18.2 ghi	3.8 abc	25	17 ab	49.5 ef	DG	ST	0.0 a	0.0 a	0.3 a
CELLOBUNCH	Sto	21.1 cd	3.5 fgh	23	18 ab	57.2 bc	DG	ST	0.0 a	0.0 a	0.0 a
JEFFERSON	Bejo	20.6 cde	3.6 d-h	25	17 ab	59.5 b	G	ST	0.0 a	0.9 a	0.0 a
NARVIK	Bejo	18.5 fgh	3.9 a	25	17 ab	48.7 ef	DG	FST	0.0 a	0.6 a	0.0 a
SVDN 5934	Sem	20.4 de	3.5 fgh	25	14 b	67.1 a	G	STC	0.0 a	0.3 a	0.0 a
FORTEDO	Vil	16.1 j	3.8 abc	25	17 ab	51.7 de	G	F	0.0 a	0.0 a	0.0 a
RESISTAFLY	SN	17.0 hij	3.9 a	40	17 ab	49.3 ef	G	ST	0.0 a	0.3 a	0.0 a
RESISTAFLY IMPROV	SN	16.7 ij	3.8 ab	40	18 a	48.3 ef	G	ST	0.0 a	0.0 a	0.5 a
Trial Average		**19.9**	**3.7**	**26**	**16**	**54.1**			**0.0**	**0.2**	**0.1**

Listed in order of % Marketable.

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

CARROT CULTIVAR MAIN TRIAL JUMBO TYPES - 2023

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
BELGRADO	Bejo	96 bcd*	53 ab	20 c-f	25.74 a	18.90 ab	2.87 d-g	108.9	1752 a
CA20-2008	ILL	90 bcd	38 ef	24 b-f	18.40 fg	10.08 f	3.08 d-g	65.8	1059 e
BASTIA	Bejo	103 abc	48 a-d	26 b-e	21.82 b-f	13.92 cde	3.11 d-g	85.2	1371 bcd
BRAVA	Bejo	92 bcd	54 a	14 def	20.97 def	15.44 bcd	2.04 efg	87.4	1407 bcd
SVDN 5904	Sem	71 d	49 a-d	9 f	25.11 ab	19.64 a	1.65 fg	106.5	1714 a
CARAVEL	ILL	89 bcd	44 cde	26 bcd	21.26 c-f	13.99 cde	3.43 def	87.1	1403 bcd
BERLIN	Bejo	85 cd	54 a	10 ef	22.08 b-e	17.20 abc	1.39 g	92.9	1496 abc
NAVEDO JUMBO	Bejo	87 cd	35 fg	36 abc	23.19 a-e	12.51 def	5.97 ab	92.4	1488 abc

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 - 2023 - 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
SIRKANA	Sto	97 a-d*	44 cde	29 bcd	20.10 ef	12.43 def	3.87 cde	81.5	1312 cde
CALTONA	SN	108 abc	39 ef	40 ab	16.45 g	9.65 f	4.19 bcd	69.2	1114 de
BALDIO	Bejo	85 cd	55 a	15 def	23.73 a-d	17.99 ab	2.21 efg	101.0	1626 ab
CA20-2011	ILL	85 cd	41 def	29 bcd	22.23 b-e	14.14 cde	4.31 bcd	92.3	1485 abc
85193	Sto	93 bcd	51 abc	19 def	22.80 a-e	16.16 a-d	2.42 d-g	92.9	1496 abc
ORCHESTRO	Vil	124 a	45 b-e	46 a	21.65 b-f	11.52 ef	5.60 abc	85.6	1378 bcd
TRALLYANCE	Sto	115 ab	29 g	50 a	24.73 abc	9.18 f	7.43 a	83.1	1337 b-e
Trial Average		**95**	**45**	**26**	**22.02**	**14.18**	**3.57**	**88.8**	**1429**

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 - 2023 - continued

Cultivar	Source	% Marketable	% Oversize	Majority of Culls	Shape	Uniformity of Shape	Uniformity of Width	Uniformity of Length	Appearance	Resistance to Greening
BELGRADO	Bejo	84.0 a*	72.4 a-d	Sm	F	7.0 bcd	5.3 cd	6.3 bc	5.7 d	7.3 cde
CA20-2008	ILL	71.7 bc	55.0 fg	F	GP	6.7 cde	8.3 a	7.3 ab	5.7 d	9.7 a
BASTIA	Bejo	78.5 ab	63.6 c-g	F	F	5.0 fg	5.3 cd	6.0 bc	6.3 cd	7.7 cde
BRAVA	Bejo	83.3 a	73.7 a-d	F	F	5.0 fg	5.0 d	6.0 bc	5.7 d	8.3 a-d
SVDN 5904	Sem	85.1 a	78.7 a	F	B	6.7 cde	6.7 a-d	7.3 ab	8.0 a	7.0 def
CARAVEL	ILL	82.2 a	66.1 b-f	Sm	GP	6.0 d-g	6.0 bcd	6.3 bc	7.3 abc	7.0 def
BERLIN	Bejo	84.3 a	78.1 ab	F	F	5.3 efg	7.0 abc	6.0 bc	6.7 bcd	8.0 bcd
NAVEDO JUMBO	Bejo	79.5 ab	53.5 g	Sp	ImpCyl	7.7 bc	6.0 bcd	7.3 ab	7.3 abc	8.7 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 - 2023 - continued

Cultivar	Source	% Marketable	% Oversize	Majority of Culls	Shape	Uniformity of Shape	Uniformity of Width	Uniformity of Length	Appearance	Resistance to Greening
SIRKANA	Sto	81.0 ab*	61.8 d-g	F	GP	5.3 efg	5.3 cd	7.3 ab	6.3 cd	9.3 ab
CALTONA	SN	84.6 a	58.7 efg	Sm	SP	9.3 a	7.0 abc	6.7 abc	6.7 bcd	8.7 abc
BALDIO	Bejo	85.2 a	75.5 abc	F	F	6.3 c-f	5.3 cd	5.3 c	6.3 cd	8.0 bcd
CA20-2011	ILL	83.0 a	63.6 c-g	F	F	5.3 efg	5.7 bcd	5.7 c	6.0 d	5.7 f
85193	Sto	81.6 ab	71.1 a-e	F	F	4.7 g	5.0 d	6.3 bc	6.0 d	7.0 def
ORCHESTRO	Vil	78.8 ab	52.4 g	F	GPN	5.7 d-g	7.3 ab	6.3 bc	7.3 abc	6.3 ef
TRALLYANCE	Sto	67.5 c	37.2 h	F	Cyl	8.3 ab	7.3 ab	8.0 a	7.7 ab	8.7 abc
Trial Average		**80.7**	**64.1**			**6.3**	**6.2**	**6.6**	**6.6**	**7.8**

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

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

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CARROT CULTIVAR MAIN TRIAL JUMBO TYPES - 2023 - 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
BELGRADO	Bejo	O	6.7 a*	O	5.3 def	54.0 bcd	9.0 abc	6.24 def	68M a	CC
CA20-2008	ILL	O	6.0 a	O	6.3 bcd	44.5 g	7.0 d	7.14 abc	58LM a	CC
BASTIA	Bejo	O	7.7 a	O	7.3 ab	52.1 cde	9.3 ab	6.48 c-f	78LM a	CV
BRAVA	Bejo	O	6.7 a	LO	5.7 cde	58.6 ab	7.3 d	6.05 ef	83L a	CV
SVDN 5904	Sem	O	7.7 a	O	5.0 ef	50.4 def	7.0 d	6.90 a-d	58M a	CC
CARAVEL	ILL	LO	6.3 a	LO	6.0 cde	48.4 efg	9.0 abc	6.43 c-f	60LM a	CC
BERLIN	Bejo	O	7.7 a	O	6.7 bc	59.7 a	9.0 abc	6.76 b-e	77LM a	CC
NAVEDO JUMBO	Bejo	O	7.3 a	O	6.0 cde	48.4 efg	9.0 abc	7.19 abc	57L a	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 - 2023 - 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
SIRKANA	Sto	O	6.7 a*	O	6.8 abc	54.9 a-d	8.7 bc	6.74 b-e	73LM a	CC
CALTONA	SN	DO	7.7 a	DO	8.0 a	55.8 abc	8.7 bc	7.71 a	63L a	CV
BALDIO	Bejo	O	7.7 a	O	6.3 bcd	56.3 abc	9.7 a	6.48 c-f	68LM a	CC
CA20-2011	ILL	LO	6.7 a	O	6.0 cde	45.6 fg	8.3 c	5.86 f	67LM a	CV
85193	Sto	DO	6.7 a	O	6.2 b-e	58.0 ab	9.3 ab	5.98 ef	90M a	CV
ORCHESTRO	Vil	O	7.3 a	LO	4.3 f	46.9 efg	9.3 ab	6.38 c-f	53L a	CV
TRALLYANCE	Sto	LO	7.3 a	LO	5.7 cde	48.1 efg	9.3 ab	7.57 ab	57LM a	CC
Trial Average			**7.1**		**6.1**	**52.1**	**8.7**	**6.66**	**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 - 2023 - 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
BELGRADO	Bejo	21.7 c-f*	5.7 ab	18	13 bcd	56.6 def	LG	FST	0.3 a	0.0 a	0.0 a
CA20-2008	ILL	20.1 efg	5.3 abc	20	12 cd	57.3 c-f	LG	ST	0.0 a	0.3 a	0.0 a
BASTIA	Bejo	21.7 c-f	5.6 ab	20	14 abc	51.6 g	LG	F	0.0 a	0.0 a	0.0 a
BRAVA	Bejo	19.9 fg	5.5 abc	18	12 bcd	60.1 bc	LG	F	0.0 a	0.0 a	0.0 a
SVDN 5904	Sem	23.8 ab	5.9 a	12	9 d	65.1 a	G	ST	0.0 a	0.0 a	0.5 a
CARAVEL	ILL	20.1 efg	5.3 abc	20	12 cd	58.8 bcd	G	FST	0.0 a	0.0 a	0.0 a
BERLIN	Bejo	20.6 def	5.8 ab	18	11 cd	60.5 b	G	FST	0.0 a	0.0 a	0.0 a
NAVEDO JUMBO	Bejo	25.7 a	5.1 bc	18	11 cd	54.7 f	G	ST	0.0 a	0.7 a	0.0 a

Listed in order of % Marketable.

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

CARROT CULTIVAR MAIN TRIAL JUMBO TYPES - 2023 - 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
SIRKANA	Sto	21.5 c-f*	5.2 abc	25	13 bcd	55.6 ef	DG	ST	0.0 a	0.0 a	0.0 a
CALTONA	SN	22.4 bcd	5.2 abc	25	14 abc	66.3 a	G	STC	0.0 a	0.3 a	0.0 a
BALDIO	Bejo	22.2 bcd	5.5 abc	18	11 cd	56.5 def	G	ST	0.0 a	0.0 a	0.0 a
CA20-2011	ILL	22.9 bc	5.3 abc	20	11 cd	57.3 c-f	G	ST	0.0 a	0.0 a	0.0 a
85193	Sto	21.9 b-e	5.7 ab	23	12 bcd	57.8 b-e	G	ST	0.0 a	0.3 a	0.0 a
ORCHESTRO	Vil	18.5 g	4.8 cd	25	16 a	54.3 fg	LG	F	0.0 a	0.0 a	0.0 a
TRALLYANCE	Sto	19.8 fg	4.2 d	23	15 ab	55.4 ef	G	ST	0.0 a	0.0 a	0.0 a
Trial Average		**21.5**	**5.3**	**18**	**12**	**57.9**			**0.0**	**0.1**	**0.0**

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.

CARROT CULTIVAR MAIN TRIAL CELLO TYPES EVALUATION NOTES – 2023

Brillyance: *Stokes sample,* Average length uneven, Average to good width slightly even, Uniformity of shape even, Odd carrot with bends and curves, Full tips matured, Good appearance, Good weight a little uneven, Good smoothness, Good exterior colour slightly uneven, 1 to 2 cavity spots per root, Odd cavity spot noticeable, Average to good interior blending even, White or green in cores (10%), Translucent core dead center (20-60%), Red ring around core (10%), Average to large core size, Average Packer a few short, Average Jumbo a few short or lacking weight.

Junction: *Bejo sample,* Cut & Peel blood, Good length slightly uneven, Average width a little uneven, Uniformity of shape very even, Some carrots with bends and curves, Tapered tips matured, Average appearance, Ringy carrot concern, Average weight a little uneven, Smoothness a little poor, Good exterior colour even, 1 to 2 or 3 to 5 cavity spots per root, Average to good interior blending even, Translucent core dead center (20%), Red ring around core (50-70%), Average core size, Average to good Packer, Poor Jumbo needs bit more weight.

Istanbul: *Bejo sample,* Average to good length uneven, Average width slightly uneven, Uniformity of shape a little uneven, Odd carrot with bends and curves, Tapered tips matured, Appearance a little rough, Some ringy carrots slight concern, Average and good weight uneven, Smoothness is a little rough, Fair to good exterior colour even, Some noticeable cavity spots, 1 to 2 cavity spots per root, Good to nice interior blending even, Red ring around core (40-50%), Average core size, Odd carrot with canker rot, Average and good Packer, Okay to average Jumbo, Jumbos are an oversized packer uneven.

SV 2384: *Stokes sample,* Good length slightly uneven, Average width uneven, Uniformity of shape even, Odd carrot with bends and curves, Full tips matured, Average appearance, Carrots a touch ringy, Average weight a little uneven, Smoothness a little rough, Fair exterior colour slightly uneven, Odd noticeable cavity spots, 1 to 3 or 3 to 4 cavity spots per root, Interior blending uneven, Yellow in cores (10%), Red ring around core (50-60%), Average core size, Average to good Packer, Odd carrot with mouse damage, Odd carrot with canker rot, Okay Jumbo, Jumbos are an oversized packer.

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CARROT CULTIVAR MAIN TRIAL CELLO TYPES EVALUATION NOTES – 2023 - continued

Trophy Pak: *Stokes sample,* Average length a little uneven, Average width even, Uniformity of shape very even, Tapered tips matured, Average to good appearance, Odd ringy carrot, Average weight a little uneven, Good smoothness, Fair to good exterior colour slightly uneven, 1 to 2 or 2 to 3 cavity spots per root, Average interior blending, Red ring around core (80-100%), Average and large core sizes, Odd carrot with canker rot, Average Packer, Average to good Jumbo, Jumbos are an oversized packer.

Envy: *Stokes sample,* Okay length a little short even, Average to good width even, Uniformity of shape a little uneven, Tapered and full tips matured, Average appearance, Some ringy carrots, Average weight even, Smoothness a little rough, Fair exterior colour slightly uneven, 1 to 2 or 3 to 4 cavity spots per root, Average to good interior blending, Translucent core dead center (10-20%), Red ring around core (30-70%), Average to large core size, Packer/Jumbo split of 70/30, Okay to average Packer some a bit short, Average Jumbo some need bit more weight and length.

Navedo: *Bejo sample,* Average to good length uneven, Average width uneven, Uniformity of shape a little uneven, Odd carrot with bends and curves, Full tips matured, Average appearance, Some ringy carrots, Average weight uneven, Smoothness uneven, Fair exterior colour even, 1 to 2 cavity spots per root, Average interior blending, Red ring around core (30-60%), Average core size, Packer/Jumbo split of 70/30, Odd carrot with canker rot, Average to good Packer bit mixed, Okay to good Jumbo bit more weight.

Arpeggio: *Vilmorin sample,* Larger carrots have slicer potential, Average to good length slightly uneven, Average to good width slightly even, Uniformity of shape very even, Odd carrot with bends and curves, Full tips matured, Average to good appearance, Odd ringy carrot, Average to good weight even, Fairly smooth, Fair exterior colour slightly pale, 1 to 2 or 2 to 3 cavity spots per root, Average to good interior blending, Translucent throughout core (10-60%), Red or yellow ring around core (10%), Average core size, Odd carrot with canker rot or mouse damage, Good Packer, Good Jumbo bit more weight.

…/continued

CARROT CULTIVAR MAIN TRIAL CELLO TYPES EVALUATION NOTES – 2023 - continued

Enterprise: *Stokes sample,* Average to good length uneven, Average width uneven, Uniformity of shape a little even, Some carrots with bends and curves, Tapered tips matured, Appearance a little rough, Some ringy carrots concern, Average weight uneven, Smoothness a little poor, Fair exterior colour a little uneven, 1 to 2 or 2 to 3 cavity spots per root, Interior blending uneven, White or yellow in core (10-30%), Translucent throughout core (10-30%), Red ring around core (60-80%), Average core size, Odd carrot with mouse damage, Average Packer, Okay Jumbo, Jumbos are an oversized packer.

Naval: *Bejo sample,* Nantes carrot, Okay length very even, Average to good width even, Uniformity of shape even, Full tips matured, Average to good appearance, Some ringy carrots, Average weight, Fairly smooth, Fair to good exterior colour even, 1 to 2 cavity spots per root, Average interior blending, Red ring around core (20-40%), Average core size, Average Packer bit short, Okay Jumbo, Jumbos are an oversized nantes and a bit short.

Cellobunch: *Stokes sample,* Average length uneven, Average to good width a little uneven, Uniformity of shape a little uneven, Some carrot with bends and curves, Tapered and full tips matured, Appearance a little rough, Carrots slightly ringy, Average weight a little uneven, Smoothness a little poor, Fair exterior colour a little uneven, 1 to 2 or 2 to 4 cavity spots per root, Average interior blending, White or yellow in core (10-30%), Red or white ring around core (10%), Average core size, Packer/Jumbo split of 70/30, Average to good Packer, Average Jumbo, Jumbos are an oversized packer.

Jefferson: *Bejo sample,* Average to good length uneven, Average width slightly uneven, Uniformity of shape even, Some carrots with bends and curves, Tapered and full tips matured, Average appearance, Some ringy carrots, Average to good weight a little uneven, Smoothness a little rough, Fair exterior colour slightly uneven, 2 to 3 cavity spots per root, Average to good interior blending even, Red ring around core (40-80%), Average core size, Packer/Jumbo split of 70/30, Average Packer, Average Jumbo, Jumbos are an oversized packer.

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CARROT CULTIVAR MAIN TRIAL CELLO TYPES EVALUATION NOTES – 2023 - continued

Narvik: *Bejo sample,* Nantes carrot, Average length even, Average to good width very even, Uniformity of shape very even, Odd carrot with bends and curves, Full tips matured, Average to good appearance, Some ringy carrots, Average to good weight even, Fairly smooth, Fair exterior colour slightly pale even, 1 to 2 or 2 to 3 cavity spots per root, Good interior blending even, Translucent core dead center (20-40%), Red ring around core (30-40%), Average core size, Odd carrot with mouse damage, Average Packer, Good Jumbo bit short.

SV DN 5934: *Seminis sample,* Larger carrots have slicer potential, Average and good length uneven, Average and good width uneven, Uniformity of shape very even, A few carrot with bends and curves, Full tips matured, Average appearance, A few ringy carrots, Average to good weight uneven, Fairly smooth, Fair exterior colour a little uneven, Some noticeable cavity spots slight concern, 3 to 4 cavity spots per root, Average interior blending, White or green in core (10%), Translucent core throughout (20-40%), Red ring around core (10-40%), Average to large core size, Odd carrot with mouse damage, Average to good Packer, Average Jumbo.

Fortedo: *Vilmorin sample,* Nantes carrot, Okay length very even but a bit short, Good width very even, Uniformity of shape very even, Full tips matured, Good to nice appearance, Good weight even, Good smoothness, Fair exterior colour even, Odd noticeable cavity spot, 1 to 2 or 2 to 3 cavity spots per root, Good interior blending, Yellow in core (30-40%), Yellow ring around core (20-30%), Average to good core size, Odd carrot with mouse damage, Average to good Packer, Good Jumbo bit short.

Resistafly: *Seminova sample,* Poor to okay length uneven, Average width even, Uniformity of shape even, Full tips matured, Odd noticeable lenticel, Appearance a little rough, Some ringy carrots, Average to good weight a little uneven, Fairly smooth, Fair exterior colour slightly pale, Some noticeable cavity spot slight concern, 1 to 5 cavity spots per root, Good interior blending a little uneven, Green or white in core (20%), Translucent core dead center (10-30%), Red ring around core (10-20%), Average core size, Some canker rot, Poor Packer to short, Okay Jumbo to short.

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CARROT CULTIVAR MAIN TRIAL CELLO TYPES EVALUATION NOTES – 2023 - continued

Resistafly:
Improved

Seminova sample, Nantes carrot, Poor length very even, Average width a little uneven, Uniformity of shape very even, Full tips matured, Average appearance, A touch ringy carrot, Average weight even, Smoothness a little poor, Fair exterior colour slightly uneven, Some noticeable cavity spots slight concern, 2 to 6 cavity spots per root, Average interior blending uneven, Translucent core dead center (20%), Red ring around core (10%), Average to large core size, Okay Packer to short, Okay Jumbo to short.

CARROT CULTIVAR MAIN TRIAL JUMBO TYPES EVALUATION NOTES – 2023

Belgrado: *Bejo sample,* Lengths uneven, Average to good width slightly uneven, Uniformity of shape even, Full tips matured, Lenticel slightly noticeable, Average appearance, Some ringy carrots, Good to excellent weight uneven, Smoothness a little rough, Fair exterior colour even, Odd noticeable cavity spot, 1 to 4 cavity spots per root, Poor to average interior blending, White in cores (20-60%), Translucent core dead center (10-30%), Red ring around core (20-60%), Large to extra-large core size, Some canker rot, Poor Packer, Good Jumbo some a bit short.

CA 20 2008: *Illinois sample,* Average to good length very even, Average width even, Uniformity of shape even, Full tips matured, Odd noticeable lenticel, Average appearance, Odd ringy carrot, Average weight even, Fairly smooth, Fair exterior colour a little uneven, Cavity spot odd one noticeable, 1 to 2 or 3 to 4 cavity spots per root, Average interior blending a little uneven, Translucent core dead center (10-20%), Red ring around core (10-20%), Average to large core size, Odd carrot with mouse damage, Odd canker rot, Okay Packer bit short, Average Jumbo.

Bastia: *Bejo sample,* Average length uneven, Average to good width slightly uneven, Uniformity of shape uneven, Odd one with bends and curves, Tapered and full tips matured, Odd noticeable lenticel, Average appearance, A few ringy carrots, Average to good weight uneven, Fairly smooth, Fair exterior colour even, Some noticeable cavity spot, 1 to 2 or 3 to 4 cavity spots per root, Average to good interior blending, White in core (10-20%), Red ring around core (10-20%), Large core size, Odd carrot with mouse damage, Poor Packer, Average to good Jumbo.

Barva: *Bejo sample,* Average length uneven, Good width uneven, Uniformity of shape uneven, Full tips matured, Odd noticeable lenticel, Appearance a little rough, Carrots a touch ringy, Average to good weight a little uneven, Smoothness a little rough, Fair exterior colour uneven, Odd noticeable cavity spot, 2 to 3 or 3 to 4 cavity spots per root, Average to good interior blending, White in core (10-40%), Red ring around core (20-60%), Extra-large core size, Odd carrot with mouse damage, Poor Packer, Average Jumbo some to short.

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CARROT CULTIVAR MAIN TRIAL JUMBO TYPES EVALUATION NOTES – 2023 - continued

SV DN 5904: *Seminis sample,* Good length a little uneven, Nice width even, Uniformity of shape a little uneven, Full tips matured, Odd noticeable lenticel, Good to nice appearance, Good to excellent weight even, Good to nice smoothness, Fair exterior colour slightly uneven, 1 to 2 or 2 to 3 cavity spots per root, Interior blending a little poor, White in core (10%), Translucent core dead center (10-30%), Red ring around cores (10%), Large core size, Average Packer, Nice Jumbo.

Caravel: *Illinois sample,* Average to good length uneven, Good width slightly uneven, Uniformity of shape uneven, Full tips matured, Odd noticeable lenticel, Average to good appearance, Odd ringy carrot, Good weight a little uneven, Fairly smooth, Fair exterior colour slightly uneven, 2 to 3 cavity spots per root, Average interior blending a little uneven, White in cores (10%), Translucent core throughout (10%), Yellow or red ring around core (10%), Large core size, Odd carrot with mouse damage, Okay Packer, Good Jumbo.

Berlin: *Bejo sample,* Average length even, Good width slightly uneven, Uniformity of shape uneven, Full tips matured, A few noticeable lenticels, Average to good appearance, Odd ringy carrot, Good weight a little uneven, Fairly smooth, Fair exterior colour even, Odd noticeable cavity spot, 1 to 3 cavity spots per root, Good interior blending a little uneven, White in cores (10-70%), Red ring around core (10-20%), Large to extra-large core size, Poor Packer, Good Jumbo some a bit short.

Navedo: *Bejo sample,* Good length slightly uneven, Good width even, Uniformity of shape even, Odd carrot with bends and curves, Full tips matured, Average to good appearance, Odd ringy carrot, Good weight even, Fairly smooth, Fair exterior colour slightly uneven, 1 to 3 cavity spots per root, Average interior blending a little uneven, Yellow or white in cores (10-40%), Translucent core dead center (10%), Red ring around core (50-60%), Large core size, Good Packer, Good Jumbo needs a bit more weight.

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CARROT CULTIVAR MAIN TRIAL JUMBO TYPES EVALUATION NOTES – 2023 - continued

Sirkana: *Stokes sample,* Average and good length uneven, Average to good width even, Uniformity of shape uneven, Odd carrot with bends and curves, Full tips matured, A few noticeable lenticel, Average appearance, Odd ringy carrot, Average to good weight, Fairly smooth, Fair exterior colour slightly uneven, Some noticeable cavity spot, 1 to 5 cavity spots per root, Average to good interior blending, Red ring around core (10-40%), Large core size, Odd carrot with canker rot, Odd carrot with mouse damage, Okay Packer a few short, Average to good Jumbo a few short.

Caltona: *Seminova sample,* Average length even, Average to good width slightly uneven, Uniformity of shape very even, Odd carrot with bends and curves, Tapered tips matured, Appearance a little rough, Some ringy carrots, Average weight a little uneven, Fairly smooth, Good exterior colour even, Odd noticeable cavity spot, 1 to 2 or 3 to 5 cavity spots per root, Good interior blending even, Yellow or white in core (20%), Red ring around core (40-80%), Large core size, Odd carrot with mouse damage, Okay Packer, Okay to average Jumbo bit more weight.

Baldio: *Bejo sample,* Average to good length uneven, Good width slightly uneven, Uniformity of shape a little uneven, Full tips matured, A few noticeable lenticels, Average appearance, Carrots a touch ringy, Good to excellent weight a little uneven, Smoothness a little rough, Fair to good exterior colour even, Odd noticeable cavity spot, 1 to 2 or 3 to 4 cavity spots per root, Average interior blending a little uneven, White in cores (10-40%), Red ring around core (10-40%), Large core size, Okay Packer, Good Jumbo a few short.

CA 20 2011: *Illinois sample,* Good length uneven, Average to good width uneven, Uniformity of shape uneven, Odd one with bends and curves, Full tips matured, Some noticeable lenticel, Appearance is little rough to average, Odd ringy carrot, Good weight a little uneven, Fairly smooth, Fair exterior colour a little pale, Some noticeable cavity spot, 1 to 2 or 3-4 cavity spots per root, Average interior blending uneven, White in cores (30-40%), Translucent core throughout (10-40%), Red or green ring around core (20-40%), Large core size, Odd carrot with mouse damage, Average to good Packer, Good Jumbo.

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CARROT CULTIVAR MAIN TRIAL JUMBO TYPES EVALUATION NOTES – 2023 - continued

85193: *Stokes sample,* Average to good length uneven, Average width uneven, Uniformity of shape uneven, Odd carrot with bends and curves, Full tips matured, A few noticeable lenticel, Appearance a little rough, Odd ringy carrot, Good to excellent weight uneven, Fairly smooth, Fair exterior colour even, Noticeable cavity spot concern, 1 to 3 or 4 to 5 cavity spots per root, Average to good interior blending uneven, White in core (20-40%), Translucent core throughout (10-20%), Red ring around core (10%), Large to extra-large core size, Odd carrot with canker rot, Mouse damage, Poor Packer, Average to good Jumbo uneven.

Orchestro: *Vilmorin sample,* Average length even, Average width uneven, Uniformity of shape uneven, Full tips matured, Nice appearance, Average to good weight a little uneven, Good smoothness, Good exterior colour, 1 to 2 cavity spots per root, Poor interior blending slightly uneven, Yellow in core (30%), Translucent core throughout (20-50%), Yellow ring around core (30-50%), Average to larger core size, Packer/Jumbo split of 40/60, Average Packer bit short, Average Jumbo bit short.

Trallyance: *Stokes sample,* Average to good length slightly uneven, Good width even, Uniformity of shape very even, Full tips matured, A few noticeable lenticel, Nice appearance, Good weight even, Good smoothness, Fair exterior colour slightly pale, Odd noticeable cavity spot, 1 to 2 or 2 to 3 cavity spots per root, Average interior blending, White in core (30-50%), Translucent core throughout (10-50%), Red ring around core (10-30%), Average to large core size, Packer/Jumbo split of 40/60, Good Packer a few to short, Good Jumbo odd one short.

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 (1971-2023)
- Research Reports
- Research Documents

CARROT CULTIVAR ADAPTATION TRIAL - 2023

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
EXP 3572	Bejo	92	1	79	10.32	0.37	8.64	45.1	725	87.3	3.6	F
FCR 20142	Ill	74	12	45	15.70	3.74	8.26	60.0	966	76.4	23.8	F
FCR 20126	Ill	109	5	85	16.19	1.60	12.30	69.5	1119	85.9	9.9	F

Listed in order of % Marketable.

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CARROT CULTIVAR ADAPTATION TRIAL - 2023 - 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
EXP 3572	Bejo	CP	9.0	5.0	6.0	7.0	10.0	O	8.0	O	8.0	7.57	8.0
FCR 20142	Ill	CP	8.0	6.0	8.0	6.0	7.0	DO	7.0	O	6.0	6.86	9.0
FCR 20126	Ill	CP	9.0	7.0	7.0	5.0	10.0	DO	7.0	O	7.0	7.43	8.0

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

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CARROT CULTIVAR ADAPTATION TRIAL - 2023 - 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
EXP 3572	Bejo	36.1	60LM	CV	31.6	2.8	30.0	12	52.4	G	ST	0.0	2.2	0.0	0.0
FCR 20142	Ill	49.2	30M	CV	29.9	3.9	23.0	10	56.0	DG	ST	0.0	0.0	0.0	0.0
FCR 20126	Ill	38.8	30M	CV	28.5	3.2	23.0	14	56.9	LG	C	0.0	1.8	0.0	0.0

Listed in order of % Marketable.

ADAPTATION CARROT CULTIVAR TRIAL EVALUATION NOTES - 2023

Exp 3572: *Bejo sample,* Cut & Peel, Good length uneven, Okay width thin uneven, Uniformity of shape very even, Some carrots have bends and curves, Tapered tips matured, Appearance a little rough, Carrots slightly ringy, Poor and average weight uneven, Smoothness a little poor, Nice exterior colour even, Odd noticeable cavity spot, 3 to 4 cavity spots per root, Good interior blending even, Red ring around core (30%), Average core size mixed, Okay to average Packer some too long & thin, Poor Jumbo.

FCR 20142: *Illinios sample,* Cut & Peel, Good length uneven, Average width uneven, Uniformity of shape very even, A lot of carrots with bends and curves, Tapered tips matured, Appearance a little rough, Some carrots ringy, Average weight a little uneven, Smoothness a little rough, Good exterior colour even, 1 to 2 cavity spots per root, Average interior blending, Red ring around core (30%), Large core size, Odd carrot with mouse damage, Average packer long, Poor to okay Jumbo, Jumbo is a oversized packer.

FCR 20126: *Illinios sample,* Cut & Peel, Good length slightly uneven, Average width slightly uneven, Uniformity of shape very even, Some carrots with bends and curves, Tapered tips matured, Appearance a little rough, Carrots a touch ringy, Average weight, Smoothness a little rough, Good exterior colour even, Slightly noticeable cavity spot, 2 to 3 cavity spots per root, Average interior blending, Red ring around core (80%), Average core size, Average packer long, Poor Jumbo, A lot of side root bumps.

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)
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	19	23.3	9.2	3.4	77.0	1247	79.3	51.6
CANADA SUPER X	Sol	14	23.3	9.2	3.4	80.8	1376	82.7	--
SV 2384	Sem	12	23.0	9.1	3.3	76.1	1225	78.1	49.2
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	34	22.4	8.8	3.5	90.1	1474	81.7	48.6
FONTANA	Bejo	13	22.4	8.8	5.1	108.7	1750	88.5	46.9
ENVY	Sem	17	22.1	8.7	3.9	89.5	1441	81.8	51.6
OLYMPUS	Sto	5	21.8	8.6	3.4	73.8	1188	73.9	45.8
BASTIA	Bejo	19	21.6	8.5	5.3	94.1	1514	82.3	47.7
ISTANBAL	Bejo	8	21.5	8.5	3.5	68.2	1098	72.0	50.5
ORANGE SHERBET	Sto	10	21.2	8.3	--	73.4	1310	84.0	--

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)
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	16	20.9	8.2	5.4	102.3	1647	79.7	48.1
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
NAVEDO	Bejo	5	20.2	8.0	3.6	87.5	1409	75.9	52.3
BRAVA	Bejo	5	20.0	7.9	5.7	85.8	1381	79.0	55.5
BERLIN	Bejo	12	19.9	7.8	5.5	98.8	1591	78.7	47.6
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	13	18.0	7.1	3.6	81.1	1306	78.4	44.8

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
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	19	8.1	59.0	6.59	8.6	6.9	0.5
CANADA SUPER X	Sol	14	7.0	--	6.95	--	--	--
SV 2384	Sem	12	8.2	69.0	6.20	10.3	7.7	0.3
SIX PAK	HM	20	7.9	--	6.98	--	--	--
SUNRISE	Cro	15	8.4	--	6.82	--	--	--
CELLOBUNCH	Sem	34	7.4	59.0	6.50	7.7	5.6	2.0
FONTANA	Bejo	13	5.6	51.0	6.33	4.8	3.8	1.3
ENVY	Sem	17	7.6	73.5	6.55	8.2	9.9	1.0
OLYMPUS	Sto	5	8.3	86.0	6.31	15.8	4.5	1.1
BASTIA	Bejo	19	7.6	80.3	6.77	6.2	6.0	1.2
ISTANBAL	Bejo	8	7.4	62.0	6.80	5.8	15.6	0.0
ORANGE SHERBET	Sto	10	--	--	6.75	--	--	--

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
VOLCANO	Vil	6	8.6	28.0	7.08	12.2	13.9	0.4
CAROPAK	Sem	8	--	--	6.85	--	--	--
BELGRADO	Bejo	16	7.0	74.0	6.37	7.6	7.0	1.4
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
NAVEDO	Bejo	5	7.6	59.4	6.65	1.9	19.0	0.1
BRAVA	Bejo	5	7.2	60.6	6.49	1.3	20.3	0.1
BERLIN	Bejo	12	8.4	75.0	6.45	7.7	10.2	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	13	8.0	53.9	7.17	9.1	8.2	0.2

Listed in order of length.

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

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)

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LONG TERM AVERAGES - CARROT CULTIVAR STORAGE TRIALS - continued

CULTIVAR	SOURCE	# YEARS TESTED	% MARKETABLE	% WEIGHT LOSS IN STORAGE	% DECAY	DEGREE * OF DECAY
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 – 2023

Compared to the previous 10-year average, air temperatures in 2023 were above average for September (18.2°C), average for June (18.1°C) and July (20.9°C) and below average May (12.7°C), and August (18.9°C). The 10-year average temperatures were: May 13.6°C, June 18.7°C, July 21.2°C, August 20.5°C and September 16.5°C. Monthly rainfall was below the 10-year average for May (52 mm), June (82 mm), August (61 mm) and September (4 mm) and above average for July (113 mm). The 10-year rainfall averages were: May 64 mm, June 96 mm, July 74 mm, August 77 mm and September 65 mm.

Above 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 on 30 April till 34 May (23.2 mm) prior to seeding slowed land preparation and created damp soil moisture levels. 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 11 May. Day time air temperatures were in the high teens to low twenties, with a mix of sun and cloud, however nightime air temperatures were in the low single digits. Seven days after seeding a heavy frost occurred just as the cotyledon leaf was just below soil surface but did not appear to damage the onions. A rainfall event on 20 May (25.8 mm) occurred as the cotyledon was just emerging. Onion emergence was good and plant vigor and stand were satisfactory. The month of May recorded below average rainfall and 3/8 of an inch of irrigation water was applied 19 days after seeding to ensure soil moisture remained adequate for seedling growth. By 5 June the second true leaf was partially grown and two small herbicide applications of Goal and Pardner were applied at the recommended rate. A heavy rainfall event on 12 June (37.8 mm) provides good moisture for the application of Prowl herbicide on 13 June. Weed pressure was low to moderate for the entire the season. Several different applications of herbicides were applied, and a couple hand weeding were required to keep the trial free from weeds. The above average rainfall amounts of July allowed the onions to maintain a steady growth. When leaf lengths were recorded on the week of 24 July, the average leaf length was 65.8 cm a 2.5 drop in length compared to the 2022 trial average heights.

On-station monitoring for onion maggot fly emergence began on 12 May with 0.71 flies/trap/day. There were two peaks in onion maggot fly numbers during the monitoring period. Counts peaked at 2.94 flies/trap/day on 29 June and 0.42 flies/trap/day on 10 August. For the remainder of the monitoring period onion maggot fly numbers never reached over 0.4 flies/trap/day. Onion maggot population was extremely low for the entire season. Surprisingly at evaluation there was a trial average of 4.8% onion maggot damage. The onions with the seed treatments of Sepresto and Evergol have lower percent onion maggot damage.

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ONION CULTIVAR TRIAL SEASON SUMMARY - 2023 – continued

Thrips were first found on 15 June and were present throughout the growing season. Onion thrips numbers in the variety trial reached 1.13 thrips/leaf on 13 July and dropped below 1.0 thrips/leaf for the rest of the season. Thrip populations never reached the spray threshold of 3.0 thrips/leaf. An insecticide application of Movento on 13 July reduced the thrips numbers below 1.0 thrips/leaf and remained so untill monitoring stopped in September. Environmental conditions were favourable for fungal diseases to develop in July with above seasonal precipitation. Stemphylium leaf blight was found in the cultivar trial on 10 July and several fungicide applications (see Onion Management Procedures) kept severity low until early August. When tip burn began in late July the percentage of leaf damage increase each week in August. A rating of tip burn was evaluated and recorded on 14 August. Tip burn was at an evaluated level for the 2023 season. 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 occurred once or twice in August. No downy mildew developed in the trial but was found on the research station.

Bulb development started as expected in late July. Most bulb sizing occurred in early August. Cultivars Switchback (4 August) and Highlander (8 August) were the first to lodge. It took approximately three weeks for 75% of the cultivars to reach 85% lodged. Approximately half of the cultivars reached full maturity by 28 August when at least 85% of the onions had lodged. The average days to harvest (110 days) an increase of 7 days compared to the 2022 season. The onion tops dried down in a satisfactory time frame. No seeders were present found in the trial. On 7 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 25 and 27 September. Harvest samples from each cultivar were placed in storage on 13 October and cured artificially for approximately 48 hours.

At evaluation in December, quality was good in most of the cultivars and yields varied between a high of 1209 to a low of 484 bushels per acre. The trial yield average was 940 bu/A. This is a decrease of approximately 100 bu/A from last year. Significant differences in yield (bu/A) were found between the third replicate (990 bu/A) and the first replicate (892.5 bu/A). The majority of the cultivars (80%) had the highest number of onions in the 2½-1¼" size range.

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ONION CULTIVAR TRIAL SEASON SUMMARY - 2023 – continued

The trial average for the percentage of jumbos (>3" diameter) was 3.8%, which is large drop from 2022 (15%). Only four cultivars had a percentage of jumbos greater then 10%. Uniformity of size rating was only average 6.1. Cultivar Gunnison received the best uniformity of size rating of 7.7 while nine other cultivars had a below average rating. The uniformity of shape rating varied among cultivars, with shapes highly variable within the individual samples. Five cultivars had a rating of 8.0 or greater for uniformity of shape and twelve cultivars had a rating below average for uniformity of shape. The average stand count was 8.4 plants/ft up from 6.6 plants/ft in 2022. Stand counts were significantly higher in the first replicate compared to the other two replicates. The vast majority of unmarketable onions (culls) were undersized onions (peewees). There was a slight concern with top sprouting occurring in several of the early maturing cultivars. The trial average for marketable onions was 87.3% which is a 2% drop from the 2022 trial. Percent marketable was significantly lower in the first replicate (85.4%) compared to the third replicate (88.7). Skin quality was slightly poorer than the previous year. Skin thickness had a below average trial rating of 5.8. Skin attachment had a good rating of 7.9 but skin cracking was observed in most cultivars. There was very limited skin rot found in the trial. The third replicate had a significantly poorer skin attachment rating compared to the second and third replicates. Exterior colour was good but uneven in most cultivars. There was very low amount of onions 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 84% of the cultivars had a high percentage of double or multiple centers. Cultivars Hamilton, Thunderstone and Crockett had the highest percentage of single centers at 86.7, 66.7 and 66.7% respectively. Neck finish was fair with limited rough finishes in the longer to mature cultivars however there was significant differences found among all three replicates. At evaluation all cultivars had maintained good firmness and cultivars Haeckero, 37 126 and 37 346B had the best firmness with a rating of excellent, 9.2. Maggot damage in the evaluation samples ranged from 0 – 24.4% with a trial average of 4.8%. This is three times higher in average onion maggot damage for the trial compared to the 2022 season (1.6%). Cultivar Haeckero had the highest percentage of onion maggot damage. 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 31.6%. Although not significantly different, the third replicate had 10% fewer onions with hollowness in the center compared to the first and second replicates. When the onions were cut in half for single center evaluation it was noted that a lot of onions had yellowing in the dead center. Possibly signalling the onions were breaking dormancy.

ONION CULTIVAR TRIAL – 2023

MANAGEMENT PROCEDURES

Fertilizer:

90 kg/ha Nitrogen (Calcium Ammonium Nitrate 27-0-0) + 100 kg/ha Phosphorous (MESZ 10-40-0) + 200 kg/ha Potassium (ASPIRE 0-0-58) + 100 kg/ha K–Mag (0-0-22) + 35 kg/ha Manganese + 5 kg/ha Copper (99% Cu) + 3.5 kg/ha Boron was worked into the soil on 4 May.

A side dressing blend of 12 -0-12 6% Mg, 2.5 Ca and 13.6 S was applied on 6 July.

Seeded:

All trials were seeded on 11 May. Pelletized onion seed was seeded with a Stanhay Precision Seeder. Raw onion seed was seeded with a V-Belt seeder equipped with a 5 cm wide scatter shoe. Row spacing was 43 cm. The Main Trial was replicated three times.

Weed Control:

Pre-emergence: 1 application: **PARDNER** at 150 ml/ha and **GOAL** at 150 ml/ha and Manganese at 1.0 kg/ha on 18 May.

Post-emergence: 2 applications: **PARDNER** at 70 ml/ha and **GOAL** at 100 ml/ha and Manganese at 1.0 kg/ha on 5 and 7 June.
1 application: **PROWL H2O** 6.5 L/ha on 13 June.
1 application: **SELECT** at 375 ml/ha and **AMIGO** at 3.0 L/ha on 15 June.
1 application: **GOAL** at 175 ml/ha and Manganese at 2.0 kg/ha on 19 June.
1 application: **CHATEAU** at 140 g/ha on 29 June.

Minor Elements:

Eleven foliar sprays: Mag Max on 10 June (1.0L/ha), 16, 23 & 30 June, 28 July and 17 & 24 Aug (2.0 L/ha), 14 and 21 July and 4and 19 August (3.0 L/ha)
Eight foliar sprays: Calcimax on 16, 23 & 30 June and 7, 14 & 28 July (2.0 L/ha) and 21 July and 4 August (3.0 L/ha)
Eight foliar sprays: Zinc Max on 14 and 28 July (1.0 L/ha), 10 &16 June, 11 & 17 July (2.0 L/ha) and 21 July and 4 Aug (3.0 L/ha)

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ONION CULTIVAR TRIAL - 2023 - continued

Minor Elements continued:

Eight foliar sprays: Manganese Sulfate on 10 &16 June (1.0 kg/ha) and 23 June, 7, 14, 21 & 28 July and 4 August (2.0 kg/ha)
Six foliar sprays: Alexin on 28 July (2.0 L/ha), 21 July and 4, 11, and 24 August (3.0 L/ha) and 17 August (4.0 L/ha)
Five foliar sprays: Suprafeed on 14 & 28 July (2.0 kg/ha) and 21 July and 4 & 24 August (3.0 kg/ha) and 11 August (4.0 kg/ha)
Four foliar sprays: Copper Max 28 July and 24 August (1.0 L/ha) and 4 & 17 August (2.0 L/ha)
Five foliar sprays: 20-20-20 on 10 June (1.5 kg/ha), 16, 23 & 30 June and 7 July (2.0 kg/ha)
Three foliar sprays: Nutri Bor on 11 & 17 August (1.5 L/ha) and 24 August (2.0 L/ha)
One foliar spray: Epsom Salt on 7 July (2.0 kg/ha)
One foliar spray: Mancozin on 30 June (2.0 L/ha)
One foliar spray: TruPhos 10 June (2.0 L/ha)

Insect and Disease Control:

According to IPM recommendations.

DITHANE DG at 2.25 kg/ha and Minor Elements on 23 June.
APROVIA TOP at 750 ml/ha and Minor Elements on 7 July.
MIRAVIS DUO at 1.0 L/ha + **MOVENTO** at 365 ml/ha and Minor Elements on 14 July.
RIDOMIL MZ 2.25 kg/ha + **SERCADIS** at 333 ml/ha and Minor Elements on 21 July.
RIDOMIL MZ 2.25 kg/ha + **MIRAVIS DUO** at 1.0 L/ha and Minor Elements on 28 July.
ORONDIS ULTRA at 400 ml/ha + **SERCADIS** at 333 ml/ha and Minor Elements on 4 August.
MIRAVIS DUO at 1.0 L/ha + **ZAMPRO** at 1.0 L/ha and Minor Elements on 11 August.
DITHANE DG at 3.25 kg/ha + **EXIREL** at 1.2 L/ha and Minor Elements on 17 August.
APROVIA TOP at 750 ml/ha and Minor Elements on 24 August.

Harvest:

The Main Trial was pulled on 25 and 27 September and topped. The trial was placed in a forced air and temperature-controlled storage on 17 October. The trial was cured for 48 hours (25^{o}C, minimum 65% RH). After curing the temperature was lowered 5^{o}C per week until 0^{o}C was attained.

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Sprout Inhibition:

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

August 14	August 18	August 22	August 24	August 31		September 5
Highlander	SV NY 1496	E61L 10957	E61L 10937	Haeckero	Ridge Line	Lodestar Tak
Switchback SN	Mountaineer	La Salle	Catskill	Frontier	Sumo	37 126
Switchback Tak	Traverse	Venecia	Fortress	Oneida	Milestone	Crockett
	37 346 B	Saddleback	Braddock	Overlook	Lodestar	TTA 782
	37 136			Sumo	Stanley	Hamilton
	Thunderstone			Safrane		37 293 C
	Gunnison					
	37 135					

EVALUATION PROCEDURES

The cultivars were evaluated 4 December through 18 December after 11 weeks in storage.

 # Bulbs Harvested:

Total number of onions harvested from 4.66 m of row.

Harvest Weight:

Weights from the harvested 4.66 m of row.

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").

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ONION CULTIVAR TRIAL - 2023 - continued

Majority of Culls:
D = Double PW = Pee Wee R = Rot OC = Off Colours S = Seeders SP = Sprouts

Shape:
HG = High Globe FG = Flattened Globe G = Globe Sp = Spindle TD = Tear Drop T = Top

Skin Thickness:
10.0 = Most Desirable 7.5 = Good 6.0 = Average

Skin Attachment:
10.0 = Most Desirable, skins well attached 7.5 = Good, skins have a few small cracks 6.0 = Average, skins have cracks but still attached

Neck Finish:
10.0 = Most Desirable, small tight neck 6.0 = Average, neck closed, 4.0 = Poor, neck bit rough and open

Overall Score:
Based on quality and general appearance.

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

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ONION CULTIVAR TRIAL - 2023 - continued

Days to Harvest:
Numbers of days from seeding until 85% of the tops were down.

Seed Treatments:

SE = Sepresto & Evergol Prime	SP = Spinosad	SF = FI400 & Spinosad	LD = Lorsban & Dithane
S = Sepresto	F = Fungicide	TP = Trigard & ProGro	

Percent Onion Maggot Damage:
Percentage of onions damaged by onion maggot ranging from pin hole to completely unmarketable that were found in the 4.66 m harvest sample.

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

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ONION CULTIVAR TRIAL - 2023 - continued

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

Tip Burn:

VL = Very light L = Low M = Moderate H = Heavy S = Severe

Irrigation:

Irrigation water was applied once for the 2023 season:

30 May in the amount of 3/8 inch

ONION CULTIVAR MAIN TRIAL - 2023

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)
SAFRANE	Bejo	145 a-e*	0 c	1 fg	41 a-d	97 a-d	9.5 a-e	107.5 e-l
CATSKILL	Sto	151 abc	0 c	1 g	35 a-g	109 ab	9.9 abc	105.3 e-m
LA SALLE	Sto	138 a-f	0 c	4 efg	41 a-e	84 b-g	9.0 a-f	115.2 d-j
SWITCHBACK	Tak	138 a-e	0 c	4 efg	39 a-e	86 b-f	9.1 abc	114.4 d-j
MILESTONE	Tak	135 b-f	0 c	2 efg	33 b-h	89 b-e	8.8 b-f	108.7 e-l
TRAVERSE	Tak	142 a-e	0 c	2 fg	34 b-g	95 a-d	9.3 a-e	103.1 f-m
LODESTAR	Tak	118 fgh	0 c	3 efg	39 a-e	67 e-h	7.7 fgh	116.0 c-i
RIDGE LINE	Tak	77 j	0 bc	11 a-d	34 b-g	25 kl	5.0 j	154.2 b
FRONTIER	Tak	86 j	0 c	1 g	26 d-i	51 hij	5.6 j	109.3 e-l
GUNNISON	Bejo	154 ab	0 c	0 g	22 g-k	119 a	10.1 ab	84.9 mno
ONEIDA	Bejo	145 a-e	0 c	4 efg	47 ab	81 c-g	9.5 a-e	109.5 e-l
STANLEY	CF	110 hi	0 c	2 fg	39 a-e	60 ghi	7.2 hi	110.4 d-k
37 136	Haz	147 a-d	0 c	0 g	38 a-f	95 a-d	9.6 a-d	94.2 j-o
OVERLOOK	Sto	140 a-e	0 bc	5 c-g	40 a-e	81 c-g	9.2 a-e	107.3 e-l

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 - 2023 - 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)
HAMILTON	Bejo	142 a-e*	0 c	1 g	32 b-h	95 a-d	9.3 a-e	99.5 f-n
LODESTAR	SN	141 a-e	0 c	4 efg	30 c-h	92 bcd	9.2 a-e	105.2 e-m
FORTRESS	Sto	136 a-f	0 c	0 g	17 h-k	105 abc	8.9 a-f	97.1 g-o
VENECIA	Bejo	147 a-d	0 bc	8 b-e	50 a	74 d-h	9.6 a-d	118.0 c-g
SUMO	CF	126 e-h	0 c	4 efg	43 abc	65 e-h	8.2 e-h	112.5 d-k
SWITCHBACK	SN	151 abc	0 c	0 g	27 d-i	108 ab	9.9 abc	95.7 i-o
THUINDERSTONE	Haz	76 j	1 b	14 a	35 a-g	18 kl	5.0 j	154.0 b
HAECKERO	Haz	87 j	0 c	2 efg	38 a-f	38 ijk	5.7 j	117.4 c-h
BRADDOCK	Bejo	155 a	0 c	3 efg	30 c-h	103 abc	10.1 a	100.4 f-n
MOUNTAINEER	Tak	144 a-e	0 c	1 g	29 c-h	97 a-d	9.4 a-e	96.3 h-o
CROCKETT	Bejo	129 d-h	0 c	1 g	22 f-j	88 b-f	8.4 d-h	98.1 f-n
37 126	Haz	88 j	0 c	11 abc	37 a-g	27 jkl	5.8 j	131.4 cd
37 346 B	Haz	133 c-f	0 c	0 g	18 h-k	93 bcd	8.7 c-g	89.0 l-o
37 293 C	Haz	151 abc	0 c	1 g	25 e-j	100 abc	9.9 abc	93.0 k-o

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 - 2023 - 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)
KILLINGTON	Sem	131 d-g*	0 bc	7 c-f	37 a-g	63 fgh	8.5 d-h	118.7 c-f
37 135	Haz	148 a-d	0 c	0 g	13 ijk	107 ab	9.7 a-d	80.4 no
SADDLEBACK	Sto	147 a-d	0 c	4 efg	28 c-i	88 b-f	9.6 a-d	94.9 i-o
TTA 782	Tak	113 gh	0 c	11 a-d	47 ab	34 jk	7.4 gh	125.1 cde
THUNDERSTONE	SN	143 j	0 c	1 g	17 h-k	96 a-d	9.3 a-e	80.9 no
HIGHLANDER	Tak	92 ij	0 c	5 d-g	32 b-h	36 ijk	6.0 ij	136.5 bc
E61L 10937	EZ	145 a-e	0 c	0 g	6 k	105 abc	9.5 a-e	76.6 o
E61L 10957	EZ	145 a-e	0 c	0 g	13 ijk	93 bcd	9.5 a-d	84.3 mno
BRADLEY	Bejo	45 k	4 a	13 ab	10 jk	3 l	2.9 k	195.0 a
TRIAL AVERAGE		**128**	**0**	**4**	**31**	**77**	**8.4**	**109.2**

Listed in order of % Marketable.

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

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ONION CULTIVAR MAIN TRIAL - 2023 - 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
SAFRANE	Bejo	15.54 abc*	0.00 c	0.28 fg	6.04 a-e	8.92 a-d	1150 a-d	96.3 a	PW
CATSKILL	Sto	15.90 ab	0.00 c	0.20 g	5.29 a-g	10.06 a	1173 ab	95.6 ab	PW
LA SALLE	Sto	15.73 ab	0.00 c	0.91 d-g	6.39 a-d	8.04 b-f	1157 a-d	93.9 abc	PW
SWITCHBACK	Tak	15.75 ab	0.00 c	0.98 d-g	6.12 a-e	8.29 ab	1161 abc	93.3 abc	PW
MILESTONE	Tak	14.32 b-g	0.00 c	0.52 efg	4.75 b-j	8.55 a-d	1042 a-h	92.6 abc	PW
TRAVERSE	Tak	14.62 b-f	0.00 c	0.35 efg	5.03 b-i	8.79 a-d	1068 a-f	92.4 a-d	PW
LODESTAR	Tak	13.45 c-l	0.00 c	0.71 efg	5.94 a-e	6.23 f-j	971 d-l	92.3 a-d	PW
RIDGE LINE	Tak	11.67 j-n	0.12 bc	2.66 ab	5.77 a-f	2.62 m	842 i-o	92.0 a-d	PW R
FRONTIER	Tak	9.25 o	0.00 c	0.20 g	3.90 d-l	4.76 jkl	668 op	91.5 a-e	PW
GUNNISON	Bejo	13.07 e-m	0.00 c	0.07 g	2.88 g-m	9.65 abc	950 e-l	91.4 a-f	PW
ONEIDA	Bejo	15.82 ab	0.00 c	0.76 efg	6.89 ab	7.26 d-i	1124 a-e	91.2 a-f	PW
STANLEY	CF	12.06 h-n	0.00 c	0.36 efg	5.77 a-f	5.44 ijk	872 g-n	90.9 a-g	PW
37 136	Haz	13.81 b-k	0.00 c	0.06 g	5.27 a-h	7.91 c-f	998 b-j	90.7 a-g	PW
OVERLOOK	Sto	14.86 b-e	0.11 bc	1.10 c-g	5.83 a-f	7.21 d-i	1075 a-f	90.4 a-g	PW

Listed in order of % Marketable.

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ONION CULTIVAR MAIN TRIAL - 2023 - 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
HAMILTON	Bejo	14.05 b-i*	0.00 c	0.23 g	4.78 b-j	8.46 a-d	1016 b-i	90.1 a-g	PW
LODESTAR	SN	14.63 b-f	0.00 c	0.87 efg	4.85 b-j	8.26 a-e	1054 a-g	89.9 a-g	PW
FORTRESS	Sto	13.18 d-m	0.00 c	0.00 g	2.75 h-m	9.87 ab	951 e-l	89.8 a-g	PW
VENECIA	Bejo	17.23 a	0.13 bc	1.69 b-e	7.68 a	6.53 e-j	1209 a	89.7 a-g	PW
SUMO	CF	14.13 b-h	0.00 c	0.83 efg	6.59 abc	5.89 g-j	1004 b-j	89.6 a-h	PW
SWITCHBACK	SN	14.40 b-g	0.00 c	0.00 g	3.87 d-l	9.92 ab	1040 a-h	89.3 a-i	PW
THUINDERSTONE	Haz	11.72 j-n	0.22 b	3.18 a	5.50 a-f	1.82 mn	808 k-o	89.3 a-i	R
HAECKERO	Haz	10.28 no	0.00 c	0.51 efg	5.63 a-f	3.55 klm	731 no	88.9 a-i	PW
BRADDOCK	Bejo	15.38 a-d	0.00 c	0.73 efg	4.73 b-j	9.13 a-d	1100 a-f	88.5 a-j	PW
MOUNTAINEER	Tak	13.88 b-j	0.00 c	0.16 g	4.31 c-k	8.81 a-d	1002 b-j	88.0 b-j	PW
CROCKETT	Bejo	12.54 f-n	0.00 c	0.14 g	3.31 f-m	8.03 b-f	866 h-n	86.0 c-k	PW
37 126	Haz	11.56 b-k	0.00 c	2.39 abc	5.63 a-f	2.43 m	788 l-o	84.6 d-l	R SP
37 346 B	Haz	11.85 i-n	0.00 c	0.00 g	2.61 i-m	8.36 a-e	827 j-o	83.7 e-l	PW
37 293 C	Haz	14.06 b-i	0.00 c	0.13 g	3.67 e-l	8.82 a-d	951 e-l	83.5 f-l	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 - 2023 - 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
KILLINGTON	Sem	15.25 a-e*	0.09 bc	1.60 b-f	5.68 a-f	5.68 hij	984 c-k	83.1 g-l	SP
37 135	Haz	11.68 j-n	0.00 c	0.00 g	1.84 klm	8.79 a-d	801 k-o	81.7 h-l	PW
SADDLEBACK	Sto	13.87 b-j	0.00 c	0.77 efg	4.21 c-k	7.56 d-h	945 e-l	81.5 i-l	PW
TTA 782	Tak	14.19 b-h	0.00 c	2.23 a-d	7.10 ab	3.07 lm	935 f-m	80.7 jkl	R
THUNDERSTONE	SN	11.53 lmn	0.00 c	0.15 g	2.48 j-m	7.80 c-g	786 l-o	79.7 klm	PW
HIGHLANDER	Tak	12.45 f-n	0.00 c	1.17 c-g	5.23 a-h	3.62 klm	755 mno	78.7 klm	D
E61L 10937	EZ	10.99 mno	0.00 c	0.00 g	0.87 m	8.50 a-d	706 no	77.3 lm	PW
E61L 10957	EZ	12.30 g-n	0.00 c	0.00 g	1.99 klm	8.44 a-d	786 l-o	72.4 mn	PW
BRADLEY	Bejo	8.73 o	1.46 a	3.10 a	1.60 lm	0.26 n	484 p	67.7 n	D
TRIAL AVERAGE		**13.40**	**0.06**	**0.78**	**4.67**	**6.95**	**940**	**87.3**	**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 - 2023 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Skin Thickness	Skin Attachment	Neck Finish	Overall Score	Score
SAFRANE	Bejo	HG	6.3 def*	6.3 a-e	6.0 bcd	9.0 a-d	7.3 cde	6.7 cde	7.15 e-i
CATSKILL	Sto	HG	7.3 a-d	6.3 a-e	6.0 bcd	6.7 hij	7.0 def	6.0 efg	6.56 j-o
LA SALLE	Sto	HG	6.7 cde	6.3 a-e	6.0 bcd	8.0 d-g	7.0 def	7.0 a-d	7.00 f-j
SWITCHBACK	Tak	HG	7.7 abc	7.0 abc	6.3 abc	7.0 g-j	8.0 bc	7.0 a-d	7.21 c-g
MILESTONE	Tak	SpG	7.3 a-d	7.3 ab	5.7 cde	6.7 hij	6.7 efg	6.3 def	6.71 h-n
TRAVERSE	Tak	G	7.3 a-d	7.3 ab	6.0 bcd	7.7 e-h	7.7 bcd	6.8 b-e	7.19 d-h
LODESTAR	Tak	G	6.7 cde	6.3 a-e	6.0 bcd	8.3 c-f	6.3 fgh	6.0 efg	6.94 f-k
RIDGE LINE	Tak	SpG	6.3 def	6.0 b-f	6.7 ab	8.3 c-f	6.5 e-h	6.0 efg	6.85 f-l
FRONTIER	Tak	G	8.3 a	6.0 b-f	6.7 ab	9.2 abc	8.0 bc	7.3 abc	7.81 a
GUNNISON	Bejo	G	7.3 a-d	7.7 a	6.0 bcd	9.3 abc	7.7 bcd	7.7 ab	7.67 a-d
ONEIDA	Bejo	G	8.3 a	6.3 a-e	6.0 bcd	9.3 abc	7.7 bcd	7.7 ab	7.69 abc
STANLEY	CF	SpG	4.7 ghi	5.3 def	6.0 bcd	9.0 a-d	6.0 ghi	6.3 def	6.67 i-n
37 136	Haz	FG	7.0 bcd	6.3 a-e	5.3 def	9.3 abc	8.3 ab	7.0 a-d	7.29 b-f
OVERLOOK	Sto	G	4.0 i	5.0 ef	5.0 efg	6.3 ij	6.3 fgh	5.7 fg	5.58 rs

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 - 2023 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Skin Thickness	Skin Attachment	Neck Finish	Overall Score	Score
HAMILTON	Bejo	G	8.3 a*	7.0 abc	5.5 de	9.7 ab	7.3 cde	7.7 ab	7.73 ab
LODESTAR	SN	HG	6.7 cde	6.3 a-e	6.7 ab	8.3 c-f	6.0 ghi	6.2 d-g	7.02 f-j
FORTRESS	Sto	HG	8.3 a	6.7 a-d	6.7 ab	7.7 e-h	7.0 def	6.7 cde	7.17 e-h
VENECIA	Bejo	G	6.7 cde	5.3 def	5.0 efg	7.7 e-h	8.0 bc	6.3 def	6.58 j-n
SUMO	CF	HG	5.7 efg	5.3 def	6.0 bcd	6.0 jk	7.0 def	5.7 fg	6.04 pqr
SWITCHBACK	SN	HG	7.0 bcd	7.7 a	5.7 cde	6.0 jk	8.3 ab	6.3 def	6.79 g-m
THUINDERSTONE	Haz	G	5.0 ghi	6.3 a-e	5.3 def	8.7 b-e	5.3 ijk	5.7 fg	6.25 n-q
HAECKERO	Haz	G	5.3 fgh	6.3 a-e	6.0 bcd	8.3 c-f	7.0 def	6.3 def	6.85 f-l
BRADDOCK	Bejo	SpG	5.3 fgh	6.3 a-e	6.7 ab	9.2 abc	7.3 cde	7.0 a-d	7.23 c-g
MOUNTAINEER	Tak	G	7.7 abc	6.0 b-f	6.5 ab	8.3 c-f	8.0 bc	7.7 ab	7.52 a-e
CROCKETT	Bejo	G	5.7 efg	6.7 a-d	5.3 def	9.7 ab	5.7 hij	6.3 def	6.98 f-k
37 126	Haz	G	5.3 fgh	6.3 a-e	5.0 efg	8.7 b-e	5.0 jk	5.3 g	6.40 l-q
37 346 B	Haz	G	8.0 ab	7.3 ab	7.0 a	8.5 cde	8.3 ab	7.8 a	7.85 a
37 293 C	Haz	G	4.3 hi	6.3 a-e	5.0 efg	8.0 d-g	6.0 ghi	5.3 g	6.00 qrs

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

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ONION CULTIVAR MAIN TRIAL - 2023 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Skin Thickness	Skin Attachment	Neck Finish	Overall Score	Score
KILLINGTON	Sem	G	4.7 ghi*	4.7 f	4.7 fg	5.0 kl	7.0 def	5.3 g	5.54 s
37 135	Haz	HG	5.7 efg	6.7 a-d	6.3 abc	7.7 e-h	7.3 cde	6.5 c-f	6.94 f-k
SADDLEBACK	Sto	G	5.3 fgh	5.3 def	5.3 def	6.7 hij	7.3 cde	6.0 efg	6.25 n-q
TTA 782	Tak	TD	7.7 abc	5.7 c-f	4.7 fg	8.7 b-e	4.7 k	5.3 g	6.33 m-q
THUNDERSTONE	SN	G	6.7 cde	6.0 b-f	5.3 def	7.7 e-h	6.7 efg	6.0 efg	6.42 l-q
HIGHLANDER	Tak	HG	6.3 def	5.3 def	4.3 g	4.3 l	9.0 a	5.3 g	6.08 opq
E61L 10937	EZ	TD	7.3 a-d	7.0 abc	5.0 efg	7.3 f-i	6.0 ghi	5.7 fg	6.50 k-p
E61L 10957	EZ	SpG	7.0 bcd	5.3 def	5.0 efg	7.3 f-i	6.7 efg	5.7 fg	6.33 m-q
BRADLEY	Bejo	G	6.7 cde	6.3 a-e	6.7 ab	10.0 a	3.7 l	6.0 efg	7.29 b-f
TRIAL AVERAGE			**6.5**	**6.3**	**5.8**	**7.9**	**6.9**	**6.4**	**6.82**

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 - 2023 - 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
SAFRANE	Bejo	10.0 a*	8.8 ab	C	G	6.7 c-g	114 def	SE	3.4 fg	0.9 e
CATSKILL	Sto	9.7 ab	7.2 def	C	G	6.0 e-i	112 fgh	SE	1.1 fg	0.7 e
LA SALLE	Sto	10.0 a	7.7 cde	W	G	7.3 b-e	109 h-k	SE	1.3 fg	2.9 de
SWITCHBACK	Tak	9.2 cd	6.7 fg	W	G	8.0 bc	97 p	SE	0.0 g	3.2 de
MILESTONE	Tak	9.8 ab	7.0 ef	C	G	6.7 c-g	117 cde	SE	1.4 fg	1.9 e
TRAVERSE	Tak	10.0 a	7.7 cde	W	G	7.0 c-f	101 m-p	SE	0.7 fg	1.2 e
LODESTAR	Tak	10.0 a	8.8 ab	CW	G	7.0 c-f	122 ab	SE	1.9 fg	2.6 de
RIDGE LINE	Tak	9.8 ab	8.0 bcd	W	DG	7.0 c-f	120 bc	SE	12.7 cd	15.2 bc
FRONTIER	Tak	10.0 a	8.3 abc	C	DG	8.7 ab	112 fgh	TP	15.4 bcd	1.4 e
GUNNISON	Bejo	10.0 a	8.0 bcd	W	G	7.7 bcd	102 l-o	SE	1.1 fg	0.2 e
ONEIDA	Bejo	10.0 a	8.5 abc	W	DG	7.7 bcd	110 ghi	SE	0.2 fg	2.6 e
STANLEY	CF	10.0 a	8.3 abc	C	G	7.7 bcd	120 bc	SE	2.5 fg	1.6 e
37 136	Haz	10.0 a	8.7 ab	G	LG	6.3 d-h	105 j-m	-	2.5 fg	0.2 e
OVERLOOK	Sto	9.8 ab	6.0 gh	C	G	6.3 d-h	119 bc	-	1.8 fg	4.2 de

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 - 2023 - 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
HAMILTON	Bejo	10.0 a*	8.7 ab	W	DG	7.7 bcd	120 bc	SE	2.9 fg	0.7 e
LODESTAR	SN	10.0 a	8.3 abc	C	DG	7.7 bcd	114 d-g	S	2.5 fg	2.8 de
FORTRESS	Sto	10.0 a	8.0 bcd	C	G	6.3 d-h	111 f-i	SE	2.2 fg	0.0 e
VENECIA	Bejo	9.5 bc	7.3 def	W	G	6.3 d-h	106 i-l	SE	1.8 fg	5.2 de
SUMO	CF	9.0 d	6.0 gh	C	G	6.7 c-g	119 bc	SE	1.9 fg	3.1 de
SWITCHBACK	SN	9.5 bc	6.0 gh	W	G	7.3 b-e	90 q	SE	0.2 fg	0.0 e
THUINDERSTONE	Haz	9.5 bc	7.7 cde	C	G	6.0 e-i	125+ a	-	17.6 bc	18.6 b
HAECKERO	Haz	10.0 a	9.2 a	C	DG	6.3 d-h	119 bc	-	24.4 a	2.6 de
BRADDOCK	Bejo	9.8 ab	8.3 abc	C	G	7.7 bcd	109 hij	SE	2.9 fg	2.3 e
MOUNTAINEER	Tak	10.0 a	8.0 bcd	G	LG	8.0 bc	99 op	SE	1.2 fg	0.4 e
CROCKETT	Bejo	10.0 a	8.8 ab	W	DG	7.7 bcd	120 bc	SE	5.7 ef	0.6 e
37 126	Haz	9.8 ab	9.2 a	W	DG	6.3 d-h	125+ a	-	15.2 bcd	13.2 bc
37 346 B	Haz	10.0 a	9.2 a	C	DG	6.7 c-g	100 nop	-	1.6 fg	0.0 e
37 293 C	Haz	9.8 ab	8.3 abc	W	G	4.7 i	122 ab	-	3.5 fg	0.4 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 - 2023 - 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
KILLINGTON	Sem	8.8 de*	5.7 h	W	LG	7.3 b-e	100 nop	SE	1.5 fg	5.9 de
37 135	Haz	10.0 a	8.7 ab	C	G	6.7 c-g	104 k-n	-	1.5 fg	0.0 e
SADDLEBACK	Sto	9.7 ab	6.7 fg	C	G	7.3 b-e	104 k-n	SE	2.5 fg	2.5 e
TTA 782	Tak	9.5 bc	8.0 bcd	W	G	6.0 e-i	120 bc	SF	20.0 ab	9.3 cd
THUNDERSTONE	SN	9.8 ab	7.7 cde	C	G	5.3 ghi	118 bcd	SE	3.3 fg	0.5 e
HIGHLANDER	Tak	8.5 e	6.0 gh	W	LG	8.0 bc	99 op	SE	1.0 fg	5.5 de
E61L 10937	EZ	9.5 bc	8.7 ab	W	G	5.0 hi	113 e-h	SE	5.4 ef	0.0 e
E61L 10957	EZ	9.5 bc	8.0 bcd	C	LG	5.7 f-i	104 lmn	SE	1.0 fg	0.0 e
BRADLEY	Bejo	10.0 a	9.0 a	C	DG	10.0 a	125+ a	-	10.5 de	29.4 a
TRIAL AVERAGE		**9.7**	**7.9**			**6.9**	**110**		**4.8**	**3.8**

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 - 2023 - continued

Cultivar	Source	Seeders	% Single Centers	% Double Centers	% Multiple Centers	% Hollowness in Centers	Top Height (cm)	Leaf Shape	Leaf Colour	Tip Burn Aug 14
SAFRANE	Bejo	0.0 a*	20.0 f-i	76.7 a-e	3.3 de	73.3 ab	70.5 abc	U	G	MH
CATSKILL	Sto	0.0 a	30.0 efg	70.0 a-g	0.0 e	10.0 ghi	65.0 e-i	U	PG	HS
LA SALLE	Sto	0.0 a	26.7 e-h	73.3 a-f	0.0 e	66.7 abc	65.1 e-i	B	G	H
SWITCHBACK	Tak	0.0 a	6.7 hi	90.0 a	3.3 de	50.0 b-e	59.3 kl	B	G	M
MILESTONE	Tak	0.0 a	36.7 c-f	56.7 e-j	6.7 cde	26.7 d-i	68.5 b-e	B	G	H
TRAVERSE	Tak	0.0 a	46.7 b-e	53.3 f-j	0.0 e	83.3 a	67.8 c-f	U	BG	M
LODESTAR	Tak	0.0 a	30.0 efg	60.0 d-i	10.0 cde	10.0 ghi	69.5 bcd	U	G	LM
RIDGE LINE	Tak	0.0 a	13.3 ghi	73.3 a-f	13.3 b-e	33.3 d-h	62.4 h-k	B	G	M
FRONTIER	Tak	0.0 a	13.3 ghi	76.7 a-e	10.0 cde	46.7 b-f	59.8 kl	U	BG	LM
GUNNISON	Bejo	0.0 a	46.7 b-e	50.0 g-k	3.3 de	70.0 abc	66.3 d-h	B	BG	H
ONEIDA	Bejo	0.0 a	6.7 hi	80.0 a-d	13.3 b-e	23.3 d-i	62.8 g-j	U	G	M
STANLEY	CF	0.0 a	13.3 ghi	76.7 a-e	10.0 cde	53.3 a-d	64.3 f-j	B	BG	M
37 136	Haz	0.0 a	33.3 d-g	66.7 b-g	0.0 e	16.7 f-i	62.4 h-k	B	BG	HS
OVERLOOK	Sto	0.0 a	46.7 b-e	43.3 h-k	10.0 cde	10.0 ghi	69.0 b-e	U	G	MH

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 - 2023 - continued

Cultivar	Source	Seeders	% Single Centers	% Double Centers	% Multiple Centers	% Hollowness in Centers	Top Height (cm)	Leaf Shape	Leaf Colour	Tip Burn Aug 14
HAMILTON	Bejo	0.0 a*	86.7 a	13.3 l	0.0 e	0.0 i	74.2 a	B	G	LM
LODESTAR	SN	0.0 a	16.7 f-i	73.3 a-f	10.0 cde	16.7 f-i	69.6 bcd	U	G	LM
FORTRESS	Sto	0.0 a	33.3 d-g	60.0 d-i	6.7 cde	33.3 d-h	62.6 h-k	U	BG	HS
VENECIA	Bejo	0.0 a	3.3 i	83.3 abc	13.3 b-e	6.7 hi	69.5 bcd	B	G	MH
SUMO	CF	0.0 a	26.7 e-h	60.0 d-i	16.7 b-e	20.0 e-i	65.9 d-h	B	G	H
SWITCHBACK	SN	0.0 a	33.3 d-g	60.0 d-i	6.7 cde	83.3 a	56.3 l	U	G	M
THUINDERSTONE	Haz	0.0 a	66.7 ab	30.0 kl	3.3 de	10.0 ghi	70.4 abc	B	G	M
HAECKERO	Haz	0.0 a	30.0 efg	70.0 a-g	0.0 e	16.7 f-i	61.2 ijk	U	BG	LM
BRADDOCK	Bejo	0.0 a	6.7 hi	86.7 ab	6.7 cde	76.7 ab	69.6 bcd	B	G	MH
MOUNTAINEER	Tak	0.0 a	13.3 ghi	63.3 c-h	23.3 bc	50.0 b-e	63.0 g-k	U	BG	MH
CROCKETT	Bejo	0.0 a	66.7 ab	30.0 kl	3.3 de	3.3 hi	74.0 a	B	G	M
37 126	Haz	0.0 a	46.7 b-e	43.3 h-k	10.0 cde	6.7 hi	68.1 c-f	B	G	L
37 346 B	Haz	0.0 a	3.3 i	90.0 a	6.7 cde	26.7 d-i	60.6 jk	U	BG	MH
37 293 C	Haz	0.0 a	63.3 b	36.7 jk	0.0 e	13.3 ghi	70.4 abc	B	G	HS

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 - 2023 - continued

Cultivar	Source	Seeders	% Single Centers	% Double Centers	% Multiple Centers	% Hollowness in Centers	Top Height (cm)	Leaf Shape	Leaf Colour	Tip Burn Aug 14
KILLINGTON	Sem	0.0 a*	20.0 f-i	60.0 d-i	20.0 bcd	40.0 c-g	61.7 ijk	B	PG	MH
37 135	Haz	0.0 a	26.7 e-h	73.3 a-f	0.0 e	46.7 b-f	62.6 h-k	B	G	H
SADDLEBACK	Sto	0.0 a	30.0 efg	63.3 c-h	6.7 cde	13.3 ghi	70.4 abc	B	PG	HS
TTA 782	Tak	0.0 a	53.3 bcd	43.3 h-k	3.3 de	6.7 hi	70.7 abc	B	G	LM
THUNDERSTONE	SN	0.0 a	56.7 bc	36.7 jk	6.7 cde	33.3 d-h	66.7 c-g	B	PG	HS
HIGHLANDER	Tak	0.0 a	3.3 i	40.0 ijk	56.7 a	83.3 a	51.7 m	B	G	LM
E61L 10937	EZ	0.0 a	56.7 bc	43.3 h-k	0.0 e	0.0 i	70.7 abc	B	G	M
E61L 10957	EZ	0.0 a	36.7 c-f	50.0 g-k	13.3 b-e	3.3 hi	72.4 ab	B	PG	LM
BRADLEY	Bejo	0.0 a	6.7 hi	63.3 c-h	30.0 b	6.7 hi	60.7 jk	B	G	L
TRIAL AVERAGE		**0.0**	**31.3**	**60.0**	**8.8**	**31.6**	**65.8**			

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 – 2023

Safrane: *Bejo sample*, Good appearance, Average to good tight neck finish, Odd neck finish a bit rough, Medium sized necks, Average skin thickness, Pretty good to nice skin quality, Odd one with skin cracking, Fair to good exterior colour even, Odd one with greening on skins, Interior colour cream a little uneven, Average interior blending, Dead centers 60% yellow 40% green, Good packer, Uniformity of shape a little even, Good firm solid onion, Firmness even, Smaller run size a little uneven, Mid to long term storage onion.

Catskill: *Stokes sample*, Average to good appearance, Average to good tight neck finish, Medium sized necks, Average skin thickness, Average skin quality, A few with skin cracking a little concern, Odd one with skin rot, Exterior colour uneven, Some with greening on skins, Interior colour cream even, Average interior blending, Dead centers yellow, Average packer, Uniformity of shape even, Average firmness, Firmness uneven, Small to medium run size uneven, Mid-term storage onion.

La Salle: *Stokes sample*, Good appearance, Average to good tight neck finish, Odd neck finish a bit rough, 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 fairly even, Odd one with greening on skins, Interior colour white even, Average interior blending, Dead centers yellow, Average to good packer, Uniformity of shape even, Good firmness, Firmness a little uneven, Medium run size a little uneven, Mid to long term storage onion.

Switchback: *American Takii sample*, Good to nice appearance, Good to great tight neck finish, Small to medium sized necks 70/30, Average skin thickness, Average skin quality, Some with skin cracking, Skin cracking a little concern, Good to nice exterior colour a little uneven, Odd one with greening on skins, Interior color white even, Average to good interior blending, Dead centers white and yellow, Good packer, Uniformity of shape even, Average firmness, Firmness even, Small to medium run size a little uneven, Mid-term storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2023 - continued

Milestone: *American Takii sample*, Average to good appearance, Average tight neck finish, Odd neck finish a bit rough, Mixed sized necks, Average skin thickness, Average to pretty good skin quality, Some with skin cracking, Skin cracking a little concern, Good exterior colour even, Odd one with greening or white spots on skins, Interior colour cream or white even, Poor to average interior blending, Dead centers yellow, Average to good packer, Uniformity of shape a little even, Average firmness, Firmness a little uneven, Small to medium run size a little uneven, Mid-term storage onion.

Traverse: *American Takii sample*, Fair to good appearance, Average to good tight neck finish, Medium sized necks, Average skin thickness, Average skin quality, A few with skin cracking, Skin cracking is a little concern, Odd one with skin rot, Exterior colour slightly uneven, Odd one with greening on skins, Interior colour white or cream even, Average to good interior blending, Dead centers mixture of white or yellow, Average to good packer, Uniformity of shape even, Average to good firmness, Firmness even, Small to medium run size a little even, Mid-term storage onion.

Lodestar: *American Takii sample*, Good appearance, Poor to good tight neck finish, Odd neck finish a bit rough, Medium to large sized necks, Average to thicker skins, Pretty good skin quality, A few with skin cracking, Some skin rot, Slightly dark exterior colour a little uneven, Odd one with white spots on skins, Interior color white or cream, Average to good interior blending, Dead centers 75% yellow or 25% white, Average to good packer, Uniformity of shape even, Good firm solid onion, Firmness even, Medium run size a little uneven, Mid to long term storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2023 - continued

Ridgeline: *American Takii sample*, Average appearance, Average to good tight neck finish, Odd neck finish a bit rough, Medium to average sized necks, Thicker skins, Average to nice skin quality, Odd one with skin cracking, Exterior colour slightly dark, Exterior colour a little uneven, Odd one with white spots or greening on skins, Interior colour white uneven, Good to average interior blending, Dead centers white or yellow, Okay to average packer, Uniformity of shape a little uneven, Good firm solid onion, Firmness even, Medium to large run size uneven, Mid to long term storage onion.

Frontier: *American Takii sample*, Good appearance, Average to good tight neck finish, Small to medium sized necks, Thicker skins, Pretty good to nice skin quality, Odd one with skin cracking, Odd one with skin rot, Good dark exterior colour even, Odd one with greening or white spots on skins, Interior colour cream even, Poor to average interior blending, Dead centers yellow, Good to nice packer, Uniformity of shape very even, Good firm solid onion, Firmness a little uneven, Small run size a little uneven, Mid to long term storage onion.

Gunnison: *Bejo sample*, Good to nice appearance, Good tight neck finish, Medium sized necks, Average skin thickness, Nice skin quality, Odd one with skin cracking, Nice exterior colour even, Odd one with green on skins, Interior colour white or cream even, Average to good interior blending, Dead centers white, Good to nice packer, Uniformity of shape even, Good firm onion, Firmness even, Small run size even, Mid to long term storage onion.

Oneida: *Bejo sample*, Nice appearance, Good tight neck finish, Small to medium sized necks, Average to thicker skins, Nice skin quality, Odd one with skin cracking, Nice exterior colour even, Odd one with white spots or greening on skins, Interior colour white or cream even, Average to good interior blending, Dead centers 75% yellow 25% green, 10-20% with green rings, Good to nice packer, Uniformity of shape even, Good firm solid 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 – 2023 - continued

Stanley: *Clifton sample*, Average to nice appearance, Average tight neck finish, Neck finish a bit rough, Medium sized necks, Average to thicker skins, Pretty good to nice skin quality, Odd one with skin cracking, Good exterior colour even, Odd one with greening on skins, Interior colour white or cream even, Average interior blending, Dead centers yellow, Good to nice packer, Uniformity of shape uneven, Good firm solid onion, Firmness even, Small to medium run size a little uneven, Mid to long term storage onion.

37 136: *Hazera 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, Good exterior colour a little uneven, Odd one with greening spots on skins, Interior colour cream or green uneven, Average to good interior blending, Dead centers white, 20-60% with green rings, Good to nice packer, Uniformity of shape even, Good firm onion, Firmness even, Small to medium run size a little uneven, Mid to long term storage onion.

Overlook: *Stokes sample*, Fair to average appearance, Average to good tight neck finish, Medium sized necks, Thin to average skin thickness, Fair to average skin quality, Some with skin cracking a concern, Exterior colour even, Some with greening on skins, Interior colour cream uneven, Poor to average interior blending, Dead centers yellow, Okay to average packer, Uniformity of shape very uneven, Average firmness onion, Firmness a little uneven, Medium run size uneven, Odd onion with mechanical damage, Early to mid-term storage onion.

Hamilton: *Bejo sample*, Good to nice appearance, Average to good tight neck finish, Neck finish a bit rough, Medium sized necks, Average to thicker skins, Nice skin quality, Exterior colour slightly dark even, Interior colour white even, Good interior blending even, Dead centers white or yellow, Good to nice packer, Uniformity of shape very even, Good firm onion, Firmness even, Small to medium run size even, Mid to long term storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2023 - continued

Lodestar: *Seminova sample*, Average to good appearance, Average tight neck finish, Neck finish a bit rough, Medium to large sized necks, Average to thicker skins, Pretty good skin quality, Odd one with skin cracking, Odd one with skin or basal plate rot, Slightly dark exterior colour even, Odd one with white spots or greening on skins, Interior color white or cream even, Average to good interior blending, Dead centers yellow or green, Average to good packer, Uniformity of shape even, Firm solid onion, Firmness even, Small to medium run size uneven, Long term storage onion.

Fortress: *Stokes sample*, Average to good appearance, Average to good tight neck finish, Odd neck finish a bit rough, Medium sized necks, Average to thicker skins, Average to pretty good skin quality, Odd one with skin cracking, Slightly dark exterior colour a little uneven, Odd one with greening on skins, Interior colour cream or white even, Average to good interior blending, Dead centers white or yellow, Average to good packer, Uniformity of shape even, Good firm onion, Firmness even, Small run size a little uneven, Mid to long term storage onion.

Venecia: *Bejo sample*, Good appearance, Good to great tight neck finish, Small to medium sized necks, Thin to thick skin thickness, Fair to nice skin quality, Odd one with skin cracking, Nice exterior colour slightly uneven, Some greening on skins, Interior colour cream or white even, Average interior blending a little uneven, Dead centers 8% yellow or 20% green, Good to nice packer, Uniformity of shape even, Average to good firmness, Firmness even, Small to medium run size a little uneven, Suspicion of doubles a concern, Mid-term storage onion.

Sumo: *Clifton sample*, Fair to average appearance, Average to good tight neck finish, Odd neck finish a bit rough, Small to medium sized necks, Average skin thickness, Fair to average skin quality, Some with skin cracking a concern, Good exterior colour even, Some with greening on skins, Interior colour cream or white, Poor to average interior blending, Dead centers yellow, 20-30% green rings, Okay to average packer a little uneven, Uniformity of shape very uneven, Average firmness, Firmness a little uneven, Medium run size uneven, Odd double onion, Early to mid-term storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2023 - continued

Switchback: *Seminova sample*, Average to good appearance, Good to great tight neck finish, Small to medium sized necks, Thin to average skin thickness, Fair to average skin quality, Some with skin cracking, Skin cracking a little concern, Good to nice exterior colour a little uneven, Odd one with greening on skins, Interior color white, cream and green uneven, Average interior blending, Dead centers yellow, Average to good packer, Uniformity of shape even, Average firmness, Firmness even, Small to medium run size a little even, Early to mid-term storage onion.

Thunderstone: *Hazera sample*, Appearance uneven, Poor to average tight neck finish, Neck finish is rough, Medium to large sized necks, Average to thicker skins, Fair to pretty good skin quality, Odd one with skin cracking, Odd one with skin rot, Slightly dark exterior colour a little uneven, Odd one with white spots or greening on skins, Interior colour cream, Poor to average interior blending, Dead centers yellow, Okay to average packer, Uniformity of shape a little even, Average to good firmness, Firmness a little even, Medium to large run size a little uneven, Mid to long term storage onion.

Haeckero: *Hazera sample*, Good appearance, Average to great tight neck finish, Odd neck finish a bit rough, Medium sized necks, Average to thicker skins, Pretty good skin quality, Odd one with skin cracking, Odd one with skin or basal plate rot, Exterior colour slightly even, Odd one with greening or white spots on skins, Interior colour cream even, Average interior blending, Dead centers white or yellow, Good packer, Uniformity of shape a little uneven, Nice firm solid onion, Firmness even, Small to medium run size uneven, Odd double onion, Long term storage onion.

Braddock: *Bejo sample*, Good to nice appearance, Average to good tight neck finish, Odd neck finish a bit rough, Small to medium sized necks, Average to thicker skins, Pretty good to nice skin quality, Good to nice exterior colour even, Odd one with greening on skins, Interior colour white or cream, Average to good interior blending even, Dead centers white or yellow, 20% with green rings, Good to nice packer, Uniformity of shape uneven, Good solid 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 – 2023 - continued

Mountaineer: *American Takii sample*, Good to nice appearance, Good to great tight neck finish, Small sized necks, Average skin thickness, Average to nice skin quality, Odd one with skin cracking, Odd one with skin or basal plate rot, Good exterior colour even, Odd one with greening on skins, Interior colour greenish, Average to good interior blending, Dead centers mixed, 10-30% with green rings, Good to nice packer, Uniformity of shape even, Good firm solid onion, Firmness even, Small to medium run size a little uneven, Mid-term storage onion.

Crockett: *Bejo sample*, Average to good appearance, Average tight neck finish, Neck finishes a bit rough, Medium sized necks, Average to thicker skins, Average to nice skin quality, Odd one with skin rot, Slightly dark exterior colour even, Interior colour white, Average to good interior blending even, Dead centers white or yellow, Average to good packer, Uniformity of shape a little uneven, Nice firm solid onion, Firmness even, Small run size even, Odd double onion, Long term storage onion.

37 126: *Hazera sample*, Appearance mixed, Average neck finish, Neck finishes rough, Medium to large sized necks, Average to thicker skins, Average to pretty good skin quality, Odd one with skin cracking, Odd one with basel plate rot, Exterior colour slightly dark uneven, Interior colour white uneven, Average interior blending, Dead centers yellow, Poor to okay packer, Uniformity of shape uneven, Good firm solid onion, Firmness even, Mixed run size uneven, Long term storage onion.

37 346C: *Hazera sample*, Okay to fair appearance, Poor to good neck finish, Neck finish a bit rough, Medium sized necks, Thin to average skin thickness, Fair to average skin quality, Odd one with skin cracking, Odd one with skin or basal plate rot, Exterior colour uneven, Odd one with greening on skins, Interior colour cream or white even, Average to good interior blending, Dead centers yellow or white, Okay packer, Uniformity of shape very uneven, Average to good firmness, Firmness even, Small run size uneven, Mid-term storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2023 - continued

37 346B: *Hazera sample*, Nice appearance, Good to great tight neck finish, Small sized necks, Average to thicker skins, Pretty good to nice skin quality, Odd one with skin cracking, Good exterior colour even, Some with greening on skins, Interior colour cream or white even, Average interior blending, Dead centers yellow or white, Good packer, Uniformity of shape very even, Nice firm solid onion, Firmness even, Small run size a little uneven, Long term storage onion.

KILLINGTON: *Seminis sample*, Fair to average appearance, Average to good tight neck finish, Small to medium sized necks, Thinner skins, Poor to fair skin quality, A lot with skin cracking a concern, Odd one with skin rot, Lighter exterior colour even, Odd one with greening on skins, Interior colour white or cream even, Interior blending uneven, Dead centers yellow, Poor to okay packer, Uniformity of shape very uneven, Softer firmness, Firmness uneven, Mixed run size uneven, Odd one double onion, Suspicion of doubles, Early term storage onion.

37 135: *Hazera sample*, Good to nice appearance, Average to good tight neck finish, Small to medium sized necks, Average skin thickness, Average to nice skin quality, A few with skin cracking a little concern, Good exterior colour even, A few with greening on skins, Interior colour cream or white uneven, Average to good interior blending, Dead centers yellow or white, 50-70% green rings, Okay to nice packer, Uniformity of shape uneven, Firm solid onion, Firmness even, Small run size a little uneven, Mid to long term storage onion.

Saddleback: *Stokes sample*, Average appearance, Good to great tight neck finish, Small to medium sized necks, Thin to average skin thickness, Poor to average skin quality, Skin cracking a concern, Good exterior colour even, Odd one with greening on skins, Interior colour cream or white, Average interior blending, Dead centers yellow, Average to good packer, Uniformity of shape a little uneven, Average firmness, Firmness a little uneven, Small to medium run size uneven, Mid-term storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2023 - continued

TTA 782: *American Takii sample*, Poor to fair appearance, Poor neck finish, Neck finish ripped and rough, Large sized necks, Thin to thicker skins, Fair to nice skin quality, Odd one with skin cracking, Odd one with skin or basel plate rot, Slightly dark exterior colour a little uneven, Interior colour white even, Average to great interior blending, Dead centers white, Okay to average packer, Uniformity of shape very even, Good firm onion, Firmness even, Medium run size uneven, Rougher exterior better interior, Mid to long term storage onion.

Thunderstone: *Seminova sample*, Average to good appearance, Average to good tight neck finish, Odd neck finish is a bit rough, Small to medium sized necks, Average skin thickness, Average to pretty good skin quality, Odd one with skin cracking, Exterior colour a little uneven, Odd one greening on skins, Interior colour cream or white even, Average to good interior blending, Dead centers yellow, 10-20% with green rings, Okay to average packer, Uniformity of shape a little uneven, Good firm onion, Firmness even, Small to medium run size uneven, Early to mid-term storage onion.

Highlander: *American Takii sample*, Okay to fair appearance, Good to perfect tight neck finish, Small sized necks, Thinner skins, Poor skin quality, Most with skin cracking a big concern, Lightly pale exterior colour even, Some with greening on skins, Interior colour white even, Average to good interior blending, Dead centers yellow, white or green, Okay to average packer, Uniformity of shape even, Average firmness, Firmness even, Medium run size uneven, Doubles a concern, Odd one with mechanical damage, Early storage onion.

E61L 10937: *Enza Zaden sample*, Okay to average appearance, Average tight neck finish, A few rough neck finishes, Small to medium sized necks, Average skin thickness, Average skin quality, A few with skin cracking a little concern, Some skin and basel plate rot a little concern, Exterior colour very uneven, Interior colour white or cream, Average interior blending, Dead centers white or yellow, Okay to average packer, Uniformity of shape even, Good firm onion Firmness a little uneven, Small run size a little uneven, Mid to long term storage onion.

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ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2023 - continued

E61L 10957: *Enza Zaden sample*, Okay to average appearance, Average tight neck finish, A few rough neck finishes, Small to medium sized necks, Thin to average skin thickness, Fair to average skin quality, A few with skin cracking a little concern, Odd one with skin rot, Exterior colour a little uneven, Odd one with greening on skins, Interior colour cream, Poor to good interior blending, Dead centers yellow, Okay to average packer, Uniformity of shape a little even, Good firm onion Firmness a little uneven, Small run size uneven, Odd double onion, Suspicion of doubles, Mid-term storage onion.

Bradley: *Bejo sample*, Fair to good appearance, Poor neck finish, Neck finish is ripped and rough, Large sized necks, Thick skins, Nice skin quality, Odd one with basal plate rot, Dark exterior colour even, Odd one with yellowing on skins, Interior colour white or cream, Poor to average interior blending, Dead centers yellow, Average to good packer, Uniformity of shape even, Good firm solid onion, Firmness even, Large run size a little uneven, Doubles a concern, Long term storage onion.

LONG TERM AVERAGES OF ONION CULTIVAR TRIALS

Cultivar	Source	# Years Evaluated	Yield bu/A	% Marketable	% Jumbos <3"	Days to Maturity	Firmness In*	Firmness out*	Neck Finish	Score	% Onion Maggot Damage	# of Seeders	Leaf Length (cm)
HIGHLANDER	Tak	19	997	85.0	12.9	93	8.5	6.0	9.3	6.22	3.3	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	8	1154	90.7	17.4	103	9.6	7.2	7.3	6.51	2.7	0.1	72
ONEIDA	Bejo	6	1015	83.1	4.8	105	9.5	7.9	7.6	7.41	3.2	0.1	65
LA SALLE	Sem	14	1157	92.9	14.3	105	9.5	7.7	7.3	6.79	6.4	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	30	1096	93.1	9.0	106	9.9	8.1	8.0	7.60	4.6	0.0	63
TRAILBLAZER	Tak	14	1047	91.9	15.9	106	9.8	8.3	7.9	7.43	4.3	0.0	63
MOUNTAINEER	Tak	12	1025	94.7	17.0	106	9.6	8.2	7.9	7.60	4.7	0.0	62
TRAVERSE	Tak	8	1163	94.7	12.2	106	9.6	8.1	7.4	7.45	2.2	0.0	67
HAECKERO	Haz	5	913	90	8.3	107	10	9.2	6.7	7.08	8.7	0	63
CATSKILL	Sem	9	1203	93.7	16.8	107	9.7	7.5	7.3	6.79	4.7	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)
RIDGELINE	Tak	8	1212	93.2	21.9	108	9.9	7.7	7.1	6.95	4.0	0.0	64
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	16	1237	90.2	15.4	110	9.6	7.8	6.6	6.93	2.6	0.5	67
MILESTONE	Tak	22	1308	95.7	23.0	111	9.6	7.5	6.7	7.15	4.2	0.1	65
STANLEY	CF	25	1173	91.9	16.3	111	9.9	8.5	6.5	7.13	4.2	0.8	66
FORTRESS	Sem	30	1074	95.0	8.5	111	9.8	8.0	6.8	7.34	3.5	1.2	65
HAMLET	Sem	23	1230	94.1	13.3	112	9.8	8.1	7.1	7.19	8.1	0.2	65
LIVINGSTON	Sol	14	1132	95.3	12.1	112	9.7	8.3	6.5	7.07	5.5	0.3	64
TALON	Bejo	7	1192	96.7	14.9	112	9.6	8.7	6.9	7.42	4.8	1.7	66
SAFRANE	Bejo	18	1242	93.5	18.8	112	9.8	8.6	6.8	7.25	3.2	2.4	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	12	1210	90.9	16.8	118	9.9	8.7	5.4	7.12	5.6	1.1	72

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

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

MAIN ONION STORAGE TRIAL 2022 - 2023

Cultivar	Source	% Marketable	% Weight Loss	% Sprouts	% Rot	% Soft	Firmness In **	Firmness Out **	% Sprouting at Base	% Sprouting at Top
HAECKERO	Haz	81.7 a*	6.7 b-h	10.4 lm	0.7 b	0.0 c	10.0 a	7.3 a-e	5.0 mn	5.3 gh
FORTRESS	Sto	80.1 ab	5.9 d-h	13.4 klm	0.0 b	0.0 c	10.0 a	7.2 b-f	5.7 mn	7.7 gh
LA SALLE	Sto	78.9 ab	5.0 gh	14.2 j-m	1.0 b	0.2 c	10.0 a	7.0 c-g	8.7 lmn	5.0 gh
HAECKERO	SN	78.6 ab	6.0 d-h	14.5 j-m	0.3 b	0.0 c	10.0 a	7.8 ab	7.3 lmn	7.7 gh
STANLEY	CF	75.9 abc	5.9 d-h	16.4 j-m	0.8 b	0.4 c	10.0 a	7.5 a-d	12.3 j-n	3.7 gh
POWELL	Bejo	75.2 abc	7.2 b-g	17.1 j-m	0.0 b	0.0 c	10.0 a	7.0 c-g	9.0 lmn	5.3 gh
BRADDOCK	Bejo	73.9 a-d	6.0 d-h	19.2 i-m	0.3 b	0.0 c	10.0 a	7.0 c-g	16.7 i-n	8.7 gh
MILESTONE	Tak	69.0 a-e	7.2 b-g	9.7 m	12.3 a	1.4 c	10.0 a	6.2 hi	2.3 n	4.3 gh
FRONTIER	Tak	68.5 a-e	6.4 b-h	24.3 f-k	0.3 b	0.0 c	10.0 a	7.5 a-d	10.7 k-n	15.7 e-h
MOUNTAINEER	Tak	68.0 a-e	5.5 e-h	23.8 g-l	2.0 b	0.0 c	10.0 a	7.3 a-e	16.7 i-n	15.7 e-h
37 120	Haz	67.1 a-e	8.0 bcd	20.8 h-m	3.6 b	0.0 c	9.7 abc	6.5 f-i	7.7 lmn	7.0 gh
CROCKETT	Bejo	66.9 a-e	6.2 c-h	24.9 f-k	1.4 b	0.0 c	10.0 a	8.0 a	14.0 i-n	1.0 h
OVERLOOK	Sem	66.7 a-e	5.4 fgh	27.1 e-j	0.4 b	0.0 c	9.3 c	6.8 d-h	15.0 i-n	3.7 gh
SAFRANE	Bejo	66.6 a-e	5.6 e-h	26.6 e-k	0.4 b	0.2 c	10.0 a	7.8 ab	25.0 f-l	10.7 fgh

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 2022 - 2023 continued

Cultivar	Source	% Marketable	% Weight Loss	% Sprouts	% Rot	% Soft	Firmness In **	Firmness Out **	% Sprouting at Base	% Sprouting at Top
SWITCHBACK	Tak	66.3 a-f*	4.5 h	25.5 f-k	2.0 b	0.7 c	9.8 ab	5.8 i	18.3 h-n	21.7 d-g
CATSKILL	Sto	64.9 b-f	5.1 gh	27.4 e-j	1.6 b	0.5 c	9.8 ab	7.0 c-g	15.0 i-n	6.3 gh
SCORPION	Cro	63.6 b-g	7.7 b-f	26.3 e-k	1.7 b	0.0 c	9.8 ab	6.7 e-h	24.0 g-m	23.3 d-g
SUMO	CF	59.7 c-h	5.7 e-h	33.3 c-h	0.6 b	0.3 c	10.0 a	6.7 e-h	28.3 e-k	16.0 e-h
37 118	Haz	59.3 c-h	6.3 b-h	33.5 c-h	0.3 b	0.0 c	10.0 a	6.7 e-h	14.3 i-n	30.7 c-f
SADDLEBACK	Sto	58.4 d-h	5.5 e-h	35.0 c-g	0.5 b	0.0 c	9.8 ab	6.5 f-i	30.7 e-j	23.3 d-g
SV NY 1496	Sem	55.6 e-i	5.6 e-h	31.2 d-i	2.0 b	5.0 b	8.7 d	5.8 i	18.3 h-n	16.7 e-h
RIDGE LINE	Tak	53.1 e-i	6.8 b-h	36.3 c-g	3.2 b	0.2 c	10.0 a	6.3 ghi	28.3 e-k	6.0 gh
LODESTAR	Tak	49.6 f-i	7.1 b-g	39.8 cde	2.8 b	0.0 c	10.0 a	7.3 a-e	38.3 efg	12.3 fgh
GUNNISON	Bejo	48.1 ghi	6.3 b-h	44.6 cd	0.4 b	0.0 c	10.0 a	7.7 abc	45.0 e	7.0 gh
SV NY 7331	Sem	47.9 ghi	6.2 c-h	45.4 c	0.0 b	0.0 c	9.8 ab	6.7 e-h	43.3 ef	9.3 gh
THUNDERSTONE	SN	45.8 hij	8.1 bcd	44.2 cd	1.5 b	0.0 c	10.0 a	7.0 c-g	36.7 e-h	6.7 gh
37 126	Haz	44.3 hij	8.1 bcd	43.9 cd	3.2 b	0.0 c	10.0 a	7.2 b-f	31.7 e-i	12.3 fgh
VENECIA	Bejo	44.2 hij	6.1 d-h	62.8 b	0.0 b	0.0 c	9.7 abc	7.2 b-f	65.0 cd	48.3 abc

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 2022 - 2023 continued

Cultivar	Source	% Marketable	% Weight Loss	% Sprouts	% Rot	% Soft	Firmness In **	Firmness Out **	% Sprouting at Base	% Sprouting at Top
AG 24202	SN	43.6 h-k*	8.4 bc	45.4 c	1.3 b	0.9 c	9.5 bc	6.5 f-i	43.3 ef	33.3 cde
HIGHLANDER	Tak	39.3 ijk	7.8 b-e	37.4 c-f	3.7 b	11.3 a	8.8 d	4.3 j	46.7 de	41.0 bcd
TRAVERSE	Tak	29.4 jkl	6.7 b-h	62.2 b	1.2 b	0.0 c	9.7 abc	6.7 e-h	80.0 abc	8.3 gh
ONEIDA	Bejo	27.4 kl	7.2 b-g	64.7 ab	0.2 b	0.0 c	10.0 a	7.0 c-g	70.0 bc	56.7 ab
TRIDENT	Cro	21.7 lm	8.6 b	69.3 ab	0.7 b	0.0 c	9.8 ab	6.7 e-h	86.7 ab	56.7 ab
DAWSON	Bejo	21.4 lm	8.0 bcd	69.6 ab	0.6 b	0.0 c	9.8 ab	7.5 a-d	85.7 ab	55.0 ab
MONDELLA	Bejo	17.1 lm	7.5 b-f	74.9 ab	0.2 b	0.0 c	10.0 a	7.2 b-f	89.0 ab	68.3 a
MINDI	EZ	9.9 m	11.3 a	77.3 a	1.2 b	0.0 c	9.8 ab	6.7 e-h	94.3 a	38.3 bcd
TRIAL AVERAGE		**55.2**	**6.7**	**35.9**	**1.5**	**0.6**	**9.8**	**6.9**	**33.0**	**19.4**

Listed in Order of Percent Marketable.

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

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

ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2022-2023

Haeckero: *Hazera sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority internal rot, Odd skin rot, Basal plates just starting to push out 10%, Fairly firm onion, Firmness a little uneven, Late term storage onion, Stored nice to excellent.

Fortress: *Stokes sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, No rot present, Basal plates just starting or pushing out 40-65%, Slightly firm, Firmness slightly uneven, Mid to late term storage onion, Stored good to excellent.

La Salle: *Stokes sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority internal rot, Some skin rot, Basal plates just starting to push out 10-40%, Firmness slightly uneven, Mid-term storage onion, Stored good to nice.

Haeckero: *Seminova sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, Some basal plate rot, Basal plates just starting to push out 15-35%, Firm onion, Late term storage onion, Stored good to excellent.

Stanley: *Clifton sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, Skin or basal plate rot, Basal plates just starting or pushing out 15-30%, Fairly firm onion, Firmness slightly uneven, Late term storage onion, Stored good to nice.

Powell: *Bejo sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, No rot present, Basal plates just starting or pushing out 10-35%, Firmness slightly uneven, Mid to late term storage onion, Stored good to nice.

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ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2022-2023 -- continued

Braddock: *Bejo sample,* Top & root sprouts just starting to light 0-2.5 cm, All internal rot, Basal plates just starting to push out 15-60%, Firmness slightly uneven, Mid to late term storage onion, Stored fair to nice.

Milestone: *American Takii sample,* Top sprouts just starting to moderate 0-5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Some internal rot, Basal plates just starting or pushing out 5-80%, Firmness slightly soft, Firmness uneven, Early to mid-term storage onion, Stored fair.

Frontier: *American Takii sample,* Top sprouts just starting to moderate 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority internal rot, Odd botrytis rot, Basal plates just starting to push out 5-25%, Fairly firm, Firmness a little uneven, Mid to late term storage onion, Stored good to excellent.

Mountaineer: *American Takii sample,* Top sprouts light to moderate 1-2.5 cm, Root sprouts just starting to light 0-1 cm, Internal or skin rot, Basal plates just starting or pushing out 15-70%, Some firm onions, Firmness slightly uneven, Mid to late term storage onion, Stored good to nice.

37 120: *Hazera sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Some internal rot, Basal plates just starting to push out 5-20%, Slightly soft, Firmness slightly uneven, Mid-term storage onion, Stored fair to good.

Crockett: *Bejo sample,* Tops & root sprouts just starting 0-1 cm, Majority skin rot, Some internal rot, Odd basal plate rot, Basal plates just starting or pushing out 20-80%, Firm onion, Late term storage onion, Stored nice.

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ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2022-2023 -- continued

Overlook: *Seminis sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, All internal rot, Basal plates just starting to push out 20-25%, Firmness slightly uneven, Mid to late term storage onion, Stored good.

Safrane: *Bejo sample,* Top sprouts just starting to moderate 0-2.5cm, Root sprouts just starting 0-1 cm, A few with botrytis or skin rot, Basal plates just starting to push out 15-75%, Fairly firm onion, Late term storage onion, Stored good to nice.

Switchback: *American Takii sample,* Top sprouts light to moderate 1-2.5 cm, Root sprouts just starting to light 0-1 cm, Majority skin rot, Odd internal rot, Basal plates just starting to push out 20-50%, Slightly soft onion, Firmness slightly uneven, Early to mid-term storage onion, Stored a little poor to fair.

Catskill: *Seminis sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Odd basal plate or internal rot, Basal plates just starting or pushing out 10-40%, Firmness slightly uneven, Mid to late term storage onion, Stored fair to nice.

Scorpion: *Crookham sample,* Top sprouts just starting to moderate 0-5 cm, Root sprouts just starting to light 0-2.5 cm, Majority internal rot, Odd skin rot, Basal plates just starting or pushing out 10-30%, Firmness uneven, Mid-term storage onion, Stored a little poor to good.

Sumo: *Clifton sample,* Top sprouts just starting to moderate 0-5 cm, Root sprouts just starting 0-1 cm, All skin rot, Basal plates just starting or pushing out 15-35%, Firmness uneven, Early to mid-term storage onion, Stored okay to good.

.../continued

ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2022-2023 -- continued

37 118: *Hazera sample,* Top sprouts light to moderate 1-5 cm, Top sprouts lengths slightly uneven, Root sprouts just starting 0-1 cm, Internal or skin rot, Basal plates just starting to push out 10-25%, Firmness uneven, Mid-term storage onion, Stored fair to good.

Saddleback: *Stokes sample,* Top sprouts just starting to moderate 0-5 cm, Root sprouts just starting 0-1 cm, Odd skin rot, Basal plates pushing out 40-75%, Firmness uneven, Mid-term storage onion, Stored fair to good.

SV NY 1496: *Seminis sample,* Top sprouts just starting to moderate 0-5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Odd internal rot, Basal plates just starting or pushing out 15-80%, Firmness okay, Firmness uneven, Early storage onion, Stored fair to okay.

Ridgeline: *American Takii sample,* Top sprouts just starting to moderate 0-5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Some internal rot, Odd basal plate rot, Basal plates just starting to push out 20-60%, Firmness slightly uneven, Early to mid-term storage onion, Stored fair.

Lodestar: *American Takii sample,* Top sprouts just starting to moderate 0-2.5 cm, Root sprouts just starting 0-1 cm, Skin or internal rot, Basal plates just starting or pushing out 15-75%, Firmness slightly uneven, Mid to late term storage onion, Stored a little poor to good.

Gunnison: *Bejo sample,* Top & root sprouts just starting to light 0-2.5 cm, Root sprouting is a slight concern, All internal rot, Basal plates just starting or pushing out 30-70%, Fairly firm onion, Mid to late term storage onion, Stored a little poor to good.

.../continued

ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2022-2023 -- continued

SV NY 7331: *Seminis sample,* Top sprouts just starting to moderate 0-2.5 cm, Root sprouts just starting 0-1 cm, No rot present, Basal plates just starting or pushing out 20-65%, Firmness uneven, Mid-term storage onion, Stored fair to okay.

Thunderstone: *Seminova sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority internal rot, Odd skin or basal plate rot, Basal plates just starting to push out 15-50%, Firmness even, Mid to late term storage onion, Stored fair.

37 126: *Hazera sample,* Top sprouts just starting to moderate 0-5 cm, Root sprouts just starting 0-1 cm, Sprouting is a slight concern, Majority skin rot, Odd internal or botrytis rot, Basal plates just starting or pushing out 20-70%, Firmness slightly uneven, Mid to late term storage onion, Stored fair to okay.

Venecia: *Bejo sample,* Top sprouts just starting to moderate 0-5 cm, Root sprouts just starting 0-1 cm, Sprouting is a concern, Internal or skin rot, Basal plates just starting to push out 15-25%, Mid-term storage onion, Stored a little poor.

AG 24202: *Seminova sample,* Top sprouts light to moderate 1-2.5 cm, Root sprouts just starting 0-1 cm, Sprouting is a concern, Majority internal rot, Odd basal plate rot, Basal plates just starting or pushing out 10-60%, Firmness uneven, Early to mid-term storage onion, Stored a little poor.

Highlander: *American Takii sample,* Top sprouts moderate to heavy 1-5 cm, Root sprouts light to moderate 1-2.5 cm, Sprouting is a concern, Majority internal rot, Some skin rot, Basal plates just starting or pushing out 25-55%, Soft onion, Firmness uneven, Early storage onion, Not a storage onion, Stored poor.

.../continued

ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2022-2023 -- continued

Traverse: *American Takii sample,* Top & root sprouts just starting to light 0-2.5 cm, Root sprouts are a concern, Internal or skin rot, Basal plates just starting or pushing out 40-90%, Firmness slightly uneven, Mid-term storage onion, Stored poor to fair.

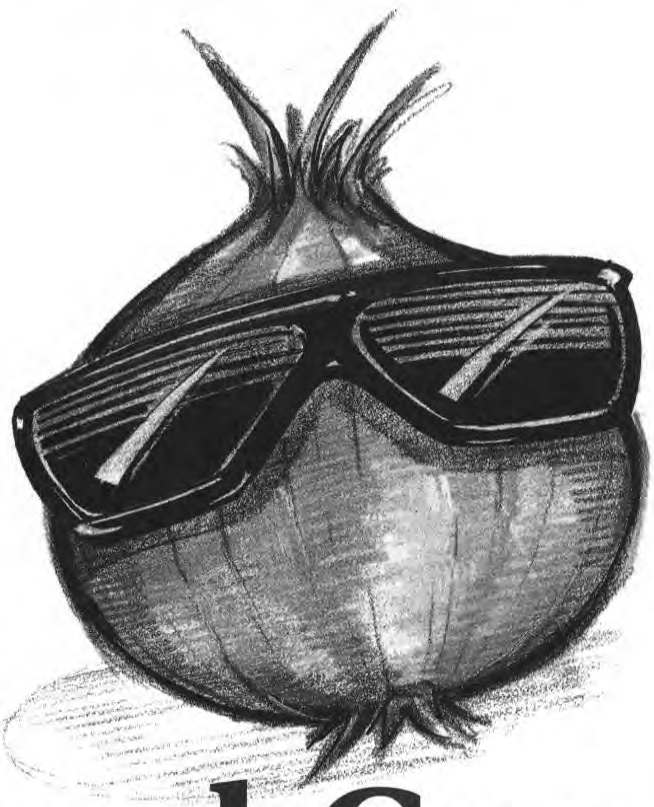
Oneida: *Bejo sample,* Top & root sprouts just starting to light 0-2.5 cm, Sprouting is a concern, Internal rot, Basal plates just starting or pushing out 10-40%, Firmness uneven, Mid-term storage onion, Stored poor to good.

Trident: *Crookham sample,* Top & root sprouts just starting to light 0-2.5 cm, Sprouting is a concern, Majority internal rot, Odd skin rot, Basal plates just starting or pushing out 40-90%, Firmness slightly uneven, Early to mid-term storage onion, Stored poor.

Dawson: *Bejo sample,* Top sprouts just starting to moderate 0-5 cm, Root sprouts just starting to light 0-2.5 cm, Sprouting is a big concern, Internal rot, Basal plates just starting or pushing out 35-65%, Firmness uneven, Mid-term storage onion, Stored poor.

Mondella: *Bejo sample,* Top & root sprouts just starting to light 0-2.5 cm, Sprouting is a concern, Internal rot, Basal plates just starting or pushing out 40-80%, Firmness uneven, Early to mid-term storage onion, Stored poor.

Mindi: *Enza Zaden sample,* Top & root sprouts just starting to moderate 0-5 cm, Root sprouts are a big concern, Majority skin rot, Some internal rot, Basal plates just starting to push out 20-45%, Firmness uneven, Early to mid-term storage onion, Stored poor.



MarshGrown *Cooks!*

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	13	82.0	6.2	11.4	9.47	6.63
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	25	78.9	6.8	13.6	9.86	7.26
HAMLET	Sem	25	78.1	7.4	15.2	9.60	6.46
POWELL	Bejo	7	77.3	7.6	14.5	9.93	6.73
NEBULA	Nun	8	77.2	5.8	16.3	9.60	7.40
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
SCORPION	Cro	7	75.9	7.1	17.6	9.76	7.14
BRADDOCK	Bejo	18	75.9	6.5	17.2	9.56	6.77
SAFRANE	Bejo	16	75.6	6.5	17.0	9.82	7.36

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	29	75.4	8.1	16.4	9.62	6.89
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	21	71.4	6.5	21.3	9.61	5.87
MOUNTAINEER	Tak	11	70.8	6.1	22.7	9.44	6.75
TARMAGON	Sto	6	70.5	10.1	19.1	8.25	5.25
CROCKETT	Bejo	11	69.0	7.5	22.8	9.91	7.72
CATSKILL	Sem	8	68.6	6.5	24.5	9.70	6.45
FRONTIER	Tak	28	68.5	7.6	24.6	9.83	7.10
HUSTLER	HM	11	64.1	9.9	27.8	8.00	5.30
RIDGE LINE	Tak	7	63.4	6.9	28.9	9.87	5.93
SADDLEBACK	Sem	7	62.1	6.5	30.8	9.60	6.04
TRAVERSE	Tak	7	60.8	7.3	31.1	9.53	6.61
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
ONEIDA	Bejo	5	55.0	7.7	36.4	9.34	6.62
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 – 2023

Compared to the previous 10-year average, air temperatures in 2023 were above average for September (18.2°C), average for June (18.1°C) and July (20.9°C) and below average May (12.7°C), and August (18.9°C). The 10-year average temperatures were: May 13.6°C, June 18.7°C, July 21.2°C, August 20.5°C and September 16.5°C. Monthly rainfall was below the 10-year average for May (52 mm), June (82 mm), August (61 mm) and September (4 mm) and above average for July (113 mm). The 10-year rainfall averages were: May 64 mm, June 96 mm, July 74 mm, August 77 mm and September 65 mm.

Above 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 on 30 April till 34 May (23.2 mm) prior to seeding slowed land preparation and created damp soil moisture levels. 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 11 May. Day time air temperatures were in the high teens to low twenties, with a mix of sun and cloud, however nightime air temperatures were in the low single digits. Seven days after seeding a heavy frost occurred just as the cotyledon leaf was just below soil surface but did not appear to damage the onions. A rainfall event on 20 May (25.8 mm) occurred as the cotyledon was just emerging. Onion emergence was good and plant vigor and stand were satisfactory. The month of May recorded below average rainfall and 3/8 of an inch of irrigation water was applied 19 days after seeding to ensure soil moisture remained adequate for seedling growth. By 5 June the second true leaf was partially grown and two small herbicide applications of Goal and Pardner were applied at the recommended rate. A heavy rainfall event on 12 June (37.8 mm) provides good moisture for the application of Prowl herbicide on 13 June. Weed pressure was low to moderate for the entire the season. Several different applications of herbicides were applied and a couple hand weeding were required to keep the trial free from weeds. The above average rainfall amounts of July allowed the onions to maintain a steady growth. When leaf lengths were recorded on the week of 24 July, the average leaf length was 65.8 cm a 2.5 drop in length compared to the 2022 trial average heights.

On-station monitoring for onion maggot fly emergence began on 12 May with 0.71 flies/trap/day. There were two peaks in onion maggot fly numbers during the monitoring period. Counts peaked at 2.94 flies/trap/day on 29 June and 0.42 flies/trap/day on 10 August. For the remainder of the monitoring period onion maggot fly numbers never reached over 0.4 flies/trap/day. Onion maggot population was extremely low for the entire season. Surprisingly at evaluation there was a trial average of 4.8% onion maggot damage. The onions with the seed treatments of Sepresto and Evergol have lower percent onion maggot damage.

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RED ONION CULTIVAR TRIAL SEASON SUMMARY - 2022 – continued

Thrips were first found on 15 June and were present throughout the growing season. Onion thrips numbers in the variety trial reached 1.13 thrips/leaf on 13 July and dropped below 1.0 thrips/leaf for the rest of the season. Thrip populations never reached the spray threshold of 3.0 thrips/leaf. An insecticide application of Movento on 13 July reduced the thrips numbers below 1.0 thrips/leaf and remained so untill monitoring stopped in September. Environmental conditions were favourable for fungal diseases to develop in July with above seasonal precipitation. Stemphylium leaf blight was found in the cultivar trial on 10 July and several fungicide applications (see Onion Management Procedures) kept severity low until early August. When tip burn began in late July the percentage of leaf damage increase each week in August. A rating of tip burn was evaluated and recorded on 14 August. Tip burn was at an evaluated level for the 2023 season. 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 occurred once or twice in August. No downy mildew developed in the trial but was found on the research station.

Bulb development started as expected in late July. Most bulb sizing occurred in early August. Cultivars Red Garcia and SVNT 4677 (4 August) were the first to lodge. It took approximately three weeks for 75% of the cultivars to reach 85% lodged. Approximately sixty percent of the cultivars reached full maturity by 28 August when at least 85% of the onions had lodged. The average days to harvest (110 days) an increase of 3 days compared to the 2022 season. The onion tops dried down in a satisfactory time frame. No seeders were present found in the trial. On 7 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 21 September. Harvest samples from each cultivar were placed in storage on 17 October and cured artificially for approximately 48 hours.

At evaluation in December, quality was good and yields were below the desired bushel per acre. For all thirteen cultivars had the highest number of bulbs in the 1 ¾-2½" diameter size range. The trial average yield of 853 bu/A was a 380 bu/A decrease from last years trial average 1234 bu/A. The average percentage of jumbos (>3" diameter) was 2.4%. This is a decrease of 25% from 2022. Cultivars Red Carpet and Red Marley had the most bulbs in the >3" category. Uniformity of shape was variable with cultivars Red Garcia and Rubillion having the best uniformity and Red Carpet the poorest. Uniformity of size was variable, with Rubillion receiving a very good rating of 8.0 while only three other cultivars had a below average rating. Five of the 13 cultivars evaluated had a very respectable 90% percent marketable or greater, and the average percent marketable for all cultivars was 85.1%. The majority of culls were peewee with doubles being the second most common cull.

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RED ONION CULTIVAR TRIAL SEASON SUMMARY – 2023 – continued

Skin quality was fair at evaluation. The trial average for skin attachment was 7.3 and all cultivars had some minor cracking. 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. Cultivars Red Garcia and Comrad had the highest percentage of single centers. 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 and third replicates then the first replicate. At evaluation all cultivars had maintained good firmness and cultivar 37 128 had the best firmness with a rating of excellent, 9.0. The third replicate had a significantly lower firmness then the first replicate. Maggot damage to onion bulbs in the evaluation samples ranged from 0.2-21.8% with a trial average of 4.6%. This is approximately a doubling in average onion maggot damage for the trial compared to the 2022 season (1.8%). Cultivar Ruby Ring only had 0.2 percent onion maggot damage and 37 128 had a high percentage of damage 21.8%.

RED ONION CULTIVAR TRIAL – 2023

MANAGEMENT PROCEDURES

Fertilizer:

90 kg/ha Nitrogen (Calcium Ammonium Nitrate 27-0-0) + 100 kg/ha Phosphorous (MESZ 10-40-0) + 200 kg/ha Potassium (ASPIRE 0-0-58) + 100 kg/ha K–Mag (0-0-22) + 35 kg/ha Manganese + 5 kg/ha Copper (99% Cu) + 3.5kg/ha Boron was worked into the soil on 4 May.

A side dressing blend of 12-0-12 6% Mg, 2.5 Ca and 13.6 S was applied on 6 July.

Seeded:

All trials were seeded on 11 May. Pelletized onion seed was seeded with a Stanhay Precision Seeder. Raw onion seed was seeded with a V-Belt seeder equipped with a 5 cm wide scatter shoe. Row spacing was 43 cm. The Main Trial was replicated three times.

Weed Control:

Pre-emergence: 1 application: **PARDNER** at 150 ml/ha and **GOAL** at 150 ml/ha and Manganese at 1.0 kg/ha on 18 May.

Post-emergence: 2 applications: **PARDNER** at 70 ml/ha and **GOAL** at 100 ml/ha and Manganese at 1.0 kg/ha on 5 and 7 June.
1 application: **PROWL H2O** 6.5 L/ha on 13 June.
1 application: **SELECT** at 375 ml/ha and **AMIGO** at 3.0 L/ha on 15 June.
1 application: **GOAL** at 175 ml/ha and Manganese at 2.0 kg/ha on 19 June.
1 application: **CHATEAU** at 140 g/ha on 29 June.

Minor Elements:

Eleven foliar sprays: Mag Max on 10 June (1.0L/ha), 16, 23 & 30 June, 28 July and 17 & 24 Aug (2.0 L/ha), 14 and 21 July and 4and 19 August (3.0 L/ha)
Eight foliar sprays: Calcimax on 16, 23 & 30 June and 7, 14 & 28 July (2.0 L/ha) and 21 July and 4 August (3.0 L/ha)

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RED ONION CULTIVAR TRIAL - 2023 - continued

Minor Elements continued:

Eight foliar sprays: Zinc Max on 14 and 28 July (1.0 L/ha), 10 &16 June, 11 & 17 July (2.0 L/ha) and 21 July and 4 Aug (3.0 L/ha)
Eight foliar sprays: Manganese Sulfate on 10 &16 June (1.0 kg/ha) and 23 June, 7, 14, 21 & 28 July and 4 August (2.0 kg/ha)
Six foliar sprays: Alexin on 28 July (2.0 L/ha), 21 July and 4, 11, and 24 August (3.0 L/ha) and 17 August (4.0 L/ha)
Five foliar sprays: Suprafeed on 14 & 28 July (2.0 kg/ha) and 21 July and 4 & 24 August (3.0 kg/ha) and 11 August (4.0 kg/ha)
Four foliar sprays: Copper Max 28 July and 24 August (1.0 L/ha) and 4 & 17 August (2.0 L/ha)
Five foliar sprays: 20-20-20 on 10 June (1.5 kg/ha), 16, 23 & 30 June and 7 July (2.0 kg/ha)
Three foliar sprays: Nutri Bor on 11 & 17 August (1.5 L/ha) and 24 August (2.0 L/ha)
One foliar spray: Epsom Salt on 7 July (2.0 kg/ha)
One foliar spray: Mancozin on 30 June (2.0 L/ha)
One foliar spray: TruPhos 10 June (2.0 L/ha)

Insect and Disease Control:

According to IPM recommendations.

DITHANE DG at 2.25 kg/ha and Minor Elements on 23 June.
APROVIA TOP at 750 ml/ha and Minor Elements on 7 July.
MIRAVIS DUO at 1.0 L/ha + **MOVENTO** at 365 ml/ha and Minor Elements on 14 July.
RIDOMIL MZ 2.25 kg/ha + **SERCADIS** at 333 ml/ha and Minor Elements on 21 July.
RIDOMIL MZ 2.25 kg/ha + **MIRAVIS DUO** at 1.0 L/ha and Minor Elements on 28 July.
ORONDIS ULTRA at 400 ml/ha + **SERCADIS** at 333 ml/ha and Minor Elements on 4 August.
MIRAVIS DUO at 1.0 L/ha + **ZAMPRO** at 1.0 L/ha and Minor Elements on 11 August.
DITHANE DG at 3.25 kg/ha + **EXIREL** at 1.2 L/ha and Minor Elements on 17 August.
APROVIA TOP at 750 ml/ha and Minor Elements on 24 August.

Harvest:

The trial was pulled and topped on 21 September. The trial was placed in a forced air and temperature controlled storage 17 October. The trial was cured for 48 hours (25^{o}C, minimum 65% RH). After curing the temperature was lowered 5^{o}C per week until 0^{o}C was attained.

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Sprout Inhibition:

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

August 18		August 22	August 24	August 31	September 5
Red Marley	Tannat	Comrad	Red Spring	37 128	Red Carpet
Barolo	SV NT 1608		Rubillion	Ruby Ring	Red Wing
SV NT 4677				Red Mountain	

EVALUATION PROCEDURES

The cultivars were evaluated on 18 – 23 December 13 after 3 weeks in storage.

 # Bulbs Harvested:

Total number of onions harvested from 4.66 m of row.

Seed Treatments:

SE = Sepresto & Evergol Prime SP = Spinosad SF = FI400 & Spinosad LD = Lorsban & Dithane
S = Sepresto F = Fungicide TP = Trigard & ProGro

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

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RED ONION CULTIVAR TRIAL - 2023 - continued

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.

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.

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% 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 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

Tip Burn:
VL = Very light L = Low M = Moderate H = Heavy S = Severe

Irrigation:
Irrigation water was applied once for the 2023 season:

30 May in the amount of 3/8 inch

RED ONION CULTIVAR TRIAL - 2023

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	Seed Treatment
RED CARPET	Bejo	87 a*	0.0 a	0 ab	9 cb	31 a	41 a	5.7 a	-
RED WING	Bejo	134 a	0.0 a	0 a	1 a	42 a	81 a	8.7 a	SE
REBILLION	Tak	136 a	0.0 a	0 a	0 a	22 a	104 a	8.9 a	SE
RUBY RING	Tak	122 a	0.0 a	0 a	0 a	23 a	89 a	8.0 a	SE
BAROLO	EZ	158 a	0.0 a	0 a	1 a	26 a	116 a	10.4 a	SE
RED MOUNTAIN	Bejo	126 a	0.0 a	0 a	0 a	27 a	85 a	8.2 a	S
SV NT 4677	Sem	143 a	0.0 a	0 a	3 ab	44 a	79 a	9.4 a	SE
COMRAD	CF	133 a	0.0 a	0 a	2 a	35 a	78 a	8.7 a	SE
RED MARLEY	Sem	135 a	0.0 a	1 b	12 c	45 a	53 a	8.9 a	SE
RED SPRING	Bejo	129 a	0.0 a	0 a	2 a	26 a	75 a	8.4 a	SE
RED GARCIA	Sem	157 a	0.0 a	0 a	4 ab	27 a	91 a	10.3 a	SE
TANNAT	EZ	150 a	0.0 a	0 a	1 a	18 a	95 a	9.8 a	SE
37 128	Haz	98 a	0.0 a	0 a	0 a	13 a	51 a	6.4 a	-
TRIAL AVERAGE		**131**	**0.0**	**0.1**	**2.7**	**29.2**	**79.9**	**8.6**	

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 - 2023 - 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
RED CARPET	Bejo	11.23 bc*	0.14 a	2.10 a	4.74 abc	3.96 f	826 bcd	93.9 a	PW
RED WING	Bejo	14.04 b	0.00 a	0.13 a	6.02 ab	7.23 b-e	1008 abc	93.0 ab	PW
REBILLION	Tak	12.11 bc	0.00 a	0.06 a	2.89 cd	8.72 abc	880 a-d	92.7 ab	PW
RUBY RING	Tak	11.68 bc	0.00 a	0.06 a	3.36 bcd	7.86 a-d	851 bcd	92.6 ab	PW
BAROLO	EZ	13.84 b	0.00 a	0.24 a	3.26 bcd	9.68 ab	994 abc	90.5 ab	PW
RED MOUNTAIN	Bejo	14.41 ab	0.00 a	0.07 a	3.62 bcd	10.00 a	1032 ab	89.4 abc	PW
SV NT 4677	Sem	13.94 b	0.00 a	0.55 a	6.01 ab	6.29 c-f	969 abc	87.9 abc	PW
COMRAD	CF	11.58 bc	0.00 a	0.31 a	4.27 a-d	6.40 c-f	828 bcd	85.9 bcd	PW
RED MARLEY	Sem	17.42 a	0.21 a	2.71 a	6.63 a	4.86 ef	1086 a	81.8 cde	D
RED SPRING	Bejo	11.31 bc	0.00 a	0.35 a	3.28 bcd	5.62 def	697 d	80.1 de	SP
RED GARCIA	Sem	12.26 bc	0.00 a	0.78 a	3.56 bcd	6.28 c-f	801 cd	77.9 e	PW
TANNAT	EZ	10.47 cd	0.00 a	0.12 a	2.24 cd	6.78 cde	689 d	75.8 e	PWRSP
37 128	Haz	7.83 d	0.00 a	0.06 a	1.68 d	3.95 f	429 e	65.3 f	R
TRIAL AVERAGE		**12.47**	**0.03**	**0.58**	**3.97**	**6.74**	**853**	**85.1**	

Listed in order of % Marketable.

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

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RED ONION CULTIVAR TRIAL - 2023 - continued

Cultivar	Source	Shape	Uniformity of Shape	Uniformity of Size	Skin Thickness	Skin Attachment	Neck Finish	Overall Score	Score
RED CARPET	Bejo	SpG	5.0 d*	6.7 bcd	6.0 c	9.0 a	5.3 gh	6.7 ab	6.98 ab
RED WING	Bejo	G	5.7 cd	7.7 ab	6.0 c	8.8 a	6.3 def	7.3 a	7.06 ab
REBILLION	Tak	G	7.3 ab	8.0 a	7.0 a	7.7 bcd	8.0 a	7.0 ab	7.30 a
RUBY RING	Tak	G	6.3 bc	6.0 cd	6.7 ab	7.3 cde	6.3 def	6.3 bc	6.63 bc
BAROLO	EZ	G	6.3 bc	7.0 abc	6.7 ab	6.0 fg	7.7 ab	6.3 bc	6.93 ab
RED MOUNTAIN	Bejo	HG	6.3 bc	6.3 cd	6.3 bc	7.7 bcd	7.3 abc	6.7 ab	6.93 ab
SV NT 4677	Sem	T	6.7 abc	5.7 d	5.0 d	6.3 efg	7.0 bcd	5.3 d	6.11 de
COMRAD	CF	FG	6.0 cd	6.3 cd	5.0 d	8.0 abc	6.7 cde	6.3 bc	6.89 ab
RED MARLEY	Sem	Mix	3.3 e	6.7 bcd	5.0 d	5.3 g	6.7 cde	5.3 d	5.78 e
RED SPRING	Bejo	T	5.7 cd	6.3 cd	6.0 c	5.3 g	5.7 fgh	5.3 d	5.89 de
RED GARCIA	Sem	T	7.7 a	5.7 d	5.0 d	6.7 def	6.0 efg	5.7 cd	6.22 cde
TANNAT	EZ	FG	6.3 bc	5.7 d	4.3 e	8.7 ab	5.0 h	5.3 d	6.37 cd
37 128	Haz	G	6.3 bc	6.7 bcd	6.0 c	8.3 abc	5.0 h	5.3 d	6.67 bc
TRIAL AVERAGE			**6.1**	**6.5**	**5.8**	**7.3**	**6.4**	**6.1**	**6.60**

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)
RED CARPET	Bejo	10.0 a*	8.8 a	DR	8.0 a	R	7.3 a	125+ a	19.9 a	144.7 a
RED WING	Bejo	10.0 a	8.7 ab	R	6.7 a	R	6.3 a	120 a	2.7 a	106.3 a
REBILLION	Tak	9.2 cd	6.7 ef	R	7.0 a	R	7.0 a	107 b	1.8 b	89.3 b
RUBY RING	Tak	9.3 bcd	7.0 de	R	6.7 a	R	7.0 a	120 a	0.2 a	97.1 a
BAROLO	EZ	9.8 ab	7.7 cd	DR	7.3 a	DR	7.3 a	105 b	2.4 b	87.5 b
RED MOUNTAIN	Bejo	9.5 a-d	7.3 cde	R	6.7 a	DR	7.7 a	120 a	1.4 a	149.4 a
SV NT 4677	Sem	9.2 cd	6.7 ef	R	6.7 a	R	5.7 a	103 b	2.6 b	97.7 b
COMRAD	CF	9.8 ab	8.0 bc	R	8.3 a	R	7.3 a	102 b	1.7 b	87.4 b
RED MARLEY	Sem	9.3 bcd	7.0 de	R	6.7 a	LR	6.0 a	103 b	1.0 b	129.5 b
RED SPRING	Bejo	9.0 d	6.0 f	DR	7.0 a	PR	5.7 a	109 b	0.8 b	88.6 b
RED GARCIA	Sem	9.7 abc	7.3 cde	R	5.7 a	DR	6.3 a	102 b	0.7 b	77.7 b
TANNAT	EZ	9.8 ab	7.0 de	DR	8.0 a	DR	7.0 a	106 b	2.2 b	69.7 b
37 128	Haz	10.0 a	9.0 a	DR	7.7 a	R	5.7 a	120 a	21.8 a	80.1 a
TRIAL AVERAGE		**9.6**	**7.5**		**7.1**		**6.6**	**110**	**4.6**	**100.4**

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	Percent Single Centres	Percent Double Centers	Percent Multiple Centers	% Jumbo > 90 mm	% Jumbo > 76 - 90 mm	% Hollowness Centres	Top Heights (cm)	Leaf Shape	Leaf Colour	Tip Burn Aug 14
RED CARPET	Bejo	20 cde*	60 a	20 cd	0.4 a	10.7 a	27 def	58.5 fgh	B	G	VL
RED WING	Bejo	17 cde	70 a	13 c-f	0.0 a	0.5 a	47 cde	67.4 ab	B	G	LM
REBILLION	Tak	43 abc	53 a	3 ef	0.0 a	0.2 a	83 ab	59.0 e-h	U	G	H
RUBY RING	Tak	37 bcd	63 a	0 f	0.0 a	0.3 a	27 def	59.3 d-g	U	G	MH
BAROLO	EZ	17 cde	57 a	27 bc	0.0 a	0.8 a	27 def	57.0 gh	U	G	LM
RED MOUNTAIN	Bejo	10 de	70 a	20 cd	0.0 a	0.3 a	37 c-f	63.9 abc	U	G	MH
SV NT 4677	Sem	27 b-e	67 a	7 def	0.0 a	1.9 a	53 bcd	62.6 c-f	U	G	MH
COMRAD	CF	67 a	33 a	0 f	0.0 a	1.3 a	63 abc	63.4 bcd	B	G	LM
RED MARLEY	Sem	0 e	60 a	40 ab	0.5 a	8.9 a	90 a	62.7 cde	B	G	VL
RED SPRING	Bejo	3 e	53 a	43 a	0.0 a	1.6 a	40 cde	56.1 gh	U	G	MH
RED GARCIA	Sem	53 ab	43 a	7 def	0.0 a	2.5 a	7 f	64.7 abc	U	G	LM
TANNAT	EZ	27 b-e	57 a	17 cde	0.0 a	0.4 a	17 ef	67.9 a	B	PG	L
37 128	Haz	3 e	53 a	43 a	0.0 a	0.3 a	30 def	55.0 h	B	G	M
TRIAL AVERAGE		**25**	**57**	**18**	**0.1**	**2.3**	**42**	**61.3**			

Listed in order of % Marketable.

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

RED ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2023

Red Carpet: *Bejo sample,* Good appearance, Average neck finish, Neck finish a bit rough, Medium to large sized necks, Thicker skins, Pretty good to nice skin quality, Odd one with skin cracking, Fairly dark exterior colour even, Dark interior colour even, Dead centers white 70% or yellow 30%, Good interior blending, Good packer, Uniformity of shape a little even, Good firm solid onion, Firmness even, Medium to large run size, Run size a little even, Mid to long term storage onion.

Red Wing: *Bejo sample,* Good to nice appearance, Average tight neck finish, Odd neck finish a bit rough, Medium sized necks, Average to thick skin thickness, Nice skin quality, Odd one with skin cracking, Good exterior colour even, Interior colour a little uneven, Dead centers white or yellow, Average to good interior blending, Good to nice packer, Uniformity of shape uneven, Nice firm solid onion, Firmness even, Small to medium run size, Run size even, Long term storage onion.

Rubillion: *American Takii sample,* Good appearance, Good tight neck finish, Small to medium sized necks, Average skin thickness, Average to pretty good skin quality, A few with skin cracking, Odd one with skin or basel plate rot, Good exterior colour even, Odd one with brown spots on skins, Interior colour even, Dead centers white or yellow, Good interior blending, Good packer, Uniformity of shape even, Average firmness, Firmness even, Small to medium run size, Run size even, Mid-term storage onion.

Ruby Ring: *American Takii sample,* Average to good appearance, Average tight neck finish, Odd neck finish a bit rough, Medium sized necks, Average skin thickness, Average to pretty good skin quality, A few with skin cracking slight concern, Exterior colour even, Odd one with brown spots on skins, Interior colour slightly uneven, Dead centers yellow 70% or white 30%, Good interior blending, Average to good packer, Uniformity of shape a little even, Average to good firmness, Firmness a little uneven, Small to medium run size, Run size a little uneven, Mid-term storage onion.

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RED ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2023 continued

Barolo: *Enza Zaden sample,* Average to good appearance, Good tight neck finish, Odd neck finish a bit rough, Small to medium sized necks, Average skin thickness, Fair to average skin quality, Some with skin cracking a concern, Odd one with skin or basal plate rot, Good dark exterior colour even, Dark interior colour even, Dead centers white, Good interior blending even, Okay to good packer, Uniformity of shape a little even, Good firm onion, Firmness a little uneven, Small to medium run size, Run size a little even, Suspicion of doubles concern, Mid-term storage onion.

Red Mountain: *Bejo sample,* Good appearance, Average to good tight neck finish, Odd neck finish a bit rough, Small to medium sized necks, Average skin thickness, Average to pretty good skin quality, A few with skin cracking, Good dark exterior colour even, Odd one with brown or white spots on skins, Average interior colour even, Dead centers white or yellow, Average interior blending, Average to good packer, Uniformity of shape uneven, Good firm onion, Firmness even, Small to medium run size, Run size a little even, Mid to long term storage onion.

SV NT 4677: *Stokes sample,* Okay to good appearance, Average to good tight neck finish, Small to medium sized necks, Average skin thickness, Fair to average skin quality, Some with skin cracking a concern, Odd one with skin rot, Exterior colour uneven, Interior colour even, Dead centers white or yellow, Average to good interior blending a little uneven, Average packer, Uniformity of shape even, Average firmness, Firmness a little uneven, Medium run size, Run size a little uneven, Early to mid-term storage onion.

Comrad: *Clifton sample,* Average 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, Good exterior colour a little uneven, Odd one with brown spots on skins, Slightly dark interior colour, Dead centers white, Average to good interior blending, Average to good packer, Uniformity of shape a little uneven, Good firm onion, Firmness even, Small to medium run size, Run size a little uneven, Mid to long term storage onion.

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RED ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2023 continued

Red Marley: *Seminis sample,* Mixed appearance, Average to good tight neck finish, Small to medium sized necks, Thin skins, Poor to fair skin quality, A lot with skin cracking a concern, Slightly pale exterior colour uneven, Odd one with brown spots on skins, Light interior colour slightly even, Dead centers white or yellow, Average to good interior blending, Okay packer, Uniformity of shape very uneven, Average firmness, Firmness uneven, Medium to large run size, Run size a little even, Suspicion of doubles concern, Early to mid-term storage onion.

Red Spring: *Bejo sample,* Average appearance, Average neck finish, Neck finish a bit rough, Small to medium sized necks, Thin to average skin thickness, Poor to fair skin quality, A lot of skin cracking a concern, Exterior colour uneven, Odd one with brown spots on skins, Dark interior colour even, Dead centers white or yellow, Average to good interior blending, Poor to good packer, Uniformity of shape even, Average firmness, Firmness uneven, Small to medium run size, Run size uneven, Suspicion of doubles, Early to mid-term storage onion.

Red Garcia: *Seminis sample,* Average to good appearance, Average tight neck finish, Neck finish a bit rough, Medium sized necks, Average skin thickness, Fair to pretty good skin quality, Some with skin cracking a little concern, Odd one with skin rot, Exterior colour a little uneven, Interior colour uneven, Dead centers white, Average interior blending, Okay to average packer, Uniformity of shape even, Average firmness, Firmness uneven, Small to medium run size, Run size uneven, Early to mid-term storage onion.

Tannat: *Enza Zaden sample,* Okay to good appearance, Average neck finish, Neck finish a bit rough, Medium sized necks, Average skin thickness, Pretty good skin quality, Odd one with skin cracking, Odd one with basel plate rot, Good dark exterior colour even, Dark interior colour even, Dead centers white, Good interior blending a little even, Okay to average packer, Uniformity of shape a little uneven, Average firmness, Firmness a little even, Small run size, Run size uneven, Early to mid-term storage onion.

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RED ONION CULTIVAR MAIN TRIAL EVALUATION NOTES – 2023 continued

37 128: *Hazera sample,* Fair to good appearance, Poor to average neck finish, Neck finish a bit rough, Medium sized necks, Average to thick skin thickness, Average to pretty good skin quality, Skin and basel plate rot a little concern, Exterior colour a little uneven, Dark interior colour, Dead centers white 70% or yellow 30%, Average interior blending, Average to good packer, Uniformity of shape a little uneven, Good firm solid onion, Firmness even, Small run size, Run size uneven, Odd double onion, 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 SKY	Bejo	6	994	90.0	34.2	81	8.6	6.7	7.8	6.53	0.9	0.0
RED SPRING	Bejo	5	704	63.7	29.4	82	8.2	6.3	7.7	5.89	1.5	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	7	898	94.1	20.0	89	9.1	6.9	8.0	7.03	2.3	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 BULL	Bejo	8	1128	93.2	42.4	97	9.6	8.0	6.6	6.90	1.1	0.2
RED MOUNTIAN	Bejo	5	1131	93.5	21.4	100	9.8	7.8	7.5	7.22	2.0	0.0
RUBY RING	Tak	10	960	94.9	21.3	100	9.7	7.5	6.9	6.79	1.3	0.0
RED CARPET	Bejo	7	1121	93.6	36.6	105	9.8	8.4	6.3	6.99	4.0	0.0
TANNAT	EZ	3	998	87.8	26.5	105	9.4	7.3	5.5	6.60	1.3	0.7
RED WING	Bejo	9	1278	96.3	48.0	110	9.7	8.3	6.6	7.19	0.7	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 2022 - 2023

Cultivar	Source	% Marketable	% Weight Loss	% Sprouts	% Rot	% Soft	Firmness In **	Firmness Out **	% Sprouting at Base	% Sprouting at Top
COMRAD	CF	91.1 a*	4.1 e	4 g	0.3 d	0.0 d	10.0 a	8.7 a	0.7 b	1.2 d
RED STONE	Haz	84.6 ab	4.4 de	9.5 efg	0.6 d	0.0 d	10.0 a	8.3 a	2.7 b	2.2 d
RED MOUNTAIN	Bejo	84.3 ab	5.5 cd	6.1 fg	3.3 bcd	0.0 d	10.0 a	7.3 b-e	2.7 b	1.5 d
RUBY RING	Tak	81.7 abc	5.1 cde	9.7 efg	2.2 d	0.6 cd	9.8 ab	6.8 efg	4.2 b	3.7 d
RED WING	Bejo	78.9 bc	5.4 cde	13.5 c-g	2.4 cd	0.0 d	10.0 a	8.2 ab	5.8 b	2.2 d
RED BULL	Bejo	78.3 bc	5.5 cde	13.5 c-g	2.1 d	0.0 d	9.8 ab	8.0 abc	5.7 b	3.7 d
RED CARPET	Bejo	75.3 bc	5.7 cd	16.6 c-f	1.7 d	0.0 d	9.8 ab	8.0 abc	7.3 b	1.7 d
8140	Haz	74.8 bcd	5.7 cd	11.4 d-g	6.3 bcd	0.4 cd	10.0 a	7.3 b-e	1.2 b	4.7 d
RUBILLION	Tak	74.1 b-e	4.4 de	18.9 cde	1.6 d	0.3 cd	9.3 c	7.0 def	2.5 b	11.7 cd
BARLO	EZ	72.5 cde	5.9 c	19.4 cde	1.6 d	0.0 d	9.8 ab	7.8 a-d	8.3 b	3.3 d
TANNAT	EZ	63.7 def	7.2 b	20.7 cd	7.7 bcd	0.0 d	9.5 bc	7.2 c-f	9.7 b	6.7 cd
SVNT 4643 NT	Sto	63.0 ef	5.3 cde	19.9 cde	9.8 abc	1.4 bc	9.7 abc	5.7 h	5.0 b	11.0 cd
RED MARLEY	Sem	62.8 ef	5.4 cde	24.2 bc	3.1 cd	3.7 a	9.8 ab	6.3 fgh	6.7 b	20.0 bc
RED NUGENT	Sto	58.0 f	5.8 c	22.1 cd	10.7 ab	2.8 b	9.7 abc	6.0 gh	8.7 b	10.0 cd
RED GARCIA	Sem	55.6 f	6.4 bc	33.2 b	3.7 bcd	0.6 cd	9.8 ab	6.5 e-h	5.7 b	25.7 b
E61D.10441	EZ	26.5 g	11.5 a	44.1 a	17.1 a	0.0 d	8.2 d	6.8 efg	35.0 a	53.3 a
TRIAL AVERAGE		**70.3**	**5.8**	**17.9**	**4.6**	**0.6**	**9.7**	**7.2**	**7.0**	**10.1**

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 - 2022-2023

Comrad: *Clifton sample*, Top & root sprouts just starting to light 0-1 cm, Root sprouts just starting 0-1 cm, A few skin rot, Odd internal rot, Basal plates just starting to push out 2-60%, Very firm onion, Late term storage onion, Stored excellent.

Red Stone: *Hazera sample*, Top & root sprouts just starting 0-1 cm, Majority internal rot, Some skin rot, Basal plates just starting to push out 2-5%, Firm onion, Firmness a little uneven, Late term storage onion, Stored excellent.

Red Mountain: *Bejo sample*, Top & root sprouts just starting 0-1 cm, Majority skin rot, Odd internal rot, Basal plates just starting or pushing out 20-80%, Fairly firm, Firmness a little uneven, Mid to late term storage onion, Stored good to nice.

Ruby Ring: *American Takii sample*, Top & root sprouts just starting to light 0-1 cm, Skin, neck and botrytis rot, Odd internal rot, Basal plates just starting to push out 5-10%, Firm onion, Firmness uneven, Mid to late term storage onion, Stored good.

Red Wing: *Bejo sample*, Top & root sprouts just starting 0-1 cm, Majority skin rot, A few neck or botrytis rot, Basal plates just starting to push out 5-60%, Firm onion, Firmness slightly uneven, Mid to late term storage onion, Stored good to excellent.

Red Bull: *Bejo sample*, Top & root sprouts just starting 0-1 cm, Majority skin rot, Some neck rot, Basal plates just starting to push out 5-75%, Firm onion, Firmness slightly uneven, Late term storage onion, Stored good to excellent.

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RED ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2022-2023 - continued

Red Carpet: *Bejo sample*, Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Odd internal or botrytis rot, Basal plates just starting to push out 15-60%, Firm onion, Mid to late term storage onion, Stored nice.

8140: *Hazera sample*, Top & root sprouts just starting 0-1 cm, Internal, skin and neck rot, Basal plates just starting to push out 5-50%, Fairly firm, Firmness a little uneven, Mid to late term storage onion, Stored good to nice.

Rubillion: *American Takii sample*, Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Odd internal rot, Basal plates just starting to push out 5%, Slightly firm, Firmness slightly uneven, Mid to late term storage onion, Stored good to nice.

Barlo: *Enza Zaden sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, All skin rot, Basal plates just starting to push out 5-35%, Fairly firm, Firmness uneven, Mid to late term storage onion, Stored good to nice.

Tannat: *Enza Zaden sample,* Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Odd internal rot, Basal plates just starting or pushing out 12-35%, Fairly firm, Mid to late term storage onion, Stored good.

SV 4643 NT: *Stokes sample*, Top sprouts just starting to moderate 1-2.5 cm, Top sprouts lengths uneven Root sprouts just starting to light 0-1 cm, Majority skin rot, Odd neck rot, Rot slight concern, Basal plates just starting to push out 15-30%, Onion slightly soft, Firmness slightly uneven, Early to mid-term storage onion, Stored a little poor to okay.

…/continued

RED ONION CULTIVAR STORAGE TRIAL EVALUATION NOTES - 2022-2023 - continued

Red Marley: *Seminis sample*, Top sprouts just starting to moderate 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Odd internal rot, Basal plates just starting or pushing out 20-50%, Firmness slightly uneven, Early to mid-term storage onion, Stored a little poor to good.

Red Nugent: *Stokes sample*, Top sprouts just starting to light 0-2.5 cm, Root sprouts just starting to light 0-2.5 cm, Skin, internal and botrytis rot, Rot slight concern, Basal plates just starting or pushing out 15-85%, Firmness slightly uneven, Early to mid-term storage onion, Stored a little poor to okay.

Red Garcia: *Seminis sample*, Top sprouts just starting to moderate 0-2.5 cm, Root sprouts just starting 0-1 cm, Majority skin rot, Odd internal rot, Basal plates just starting or pushing out 15-60%, Firmness uneven, Early to mid-term storage onion, Stored fair to good.

E61D.10441: *Enza Zaden sample,* Top sprouts just starting to moderate 0-2.5 cm, Root sprouts just starting to light 0-2.5 cm, Majority skin rot, Odd internal rot, Basal plates just starting or pushing out 15-50%, Firmness uneven, Early to mid-term storage onion, Stored poor to a little poor.

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	6	65.4	5.6	28.3	9.70	7.15
RUBY RING	Tak	8	59.5	6.6	30.8	9.59	6.45
RED WING	Bejo	6	58.7	6.0	35.6	9.62	7.00
RED BULL	Bejo	6	56.4	6.3	37.7	9.63	7.20
RED CARPET	Bejo	6	52.8	6.3	41.1	9.60	7.30
SV 4643 NT	Sto	5	52.3	6.3	39.9	9.69	5.93
RED HAWK	Bejo	5	49.7	6.5	45.0	8.58	6.10
RED NUGENT	Sto	5	48.4	7.0	43.3	9.35	5.44
RUBILLION	Tak	6	42.1	5.8	51.5	8.92	6.45
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