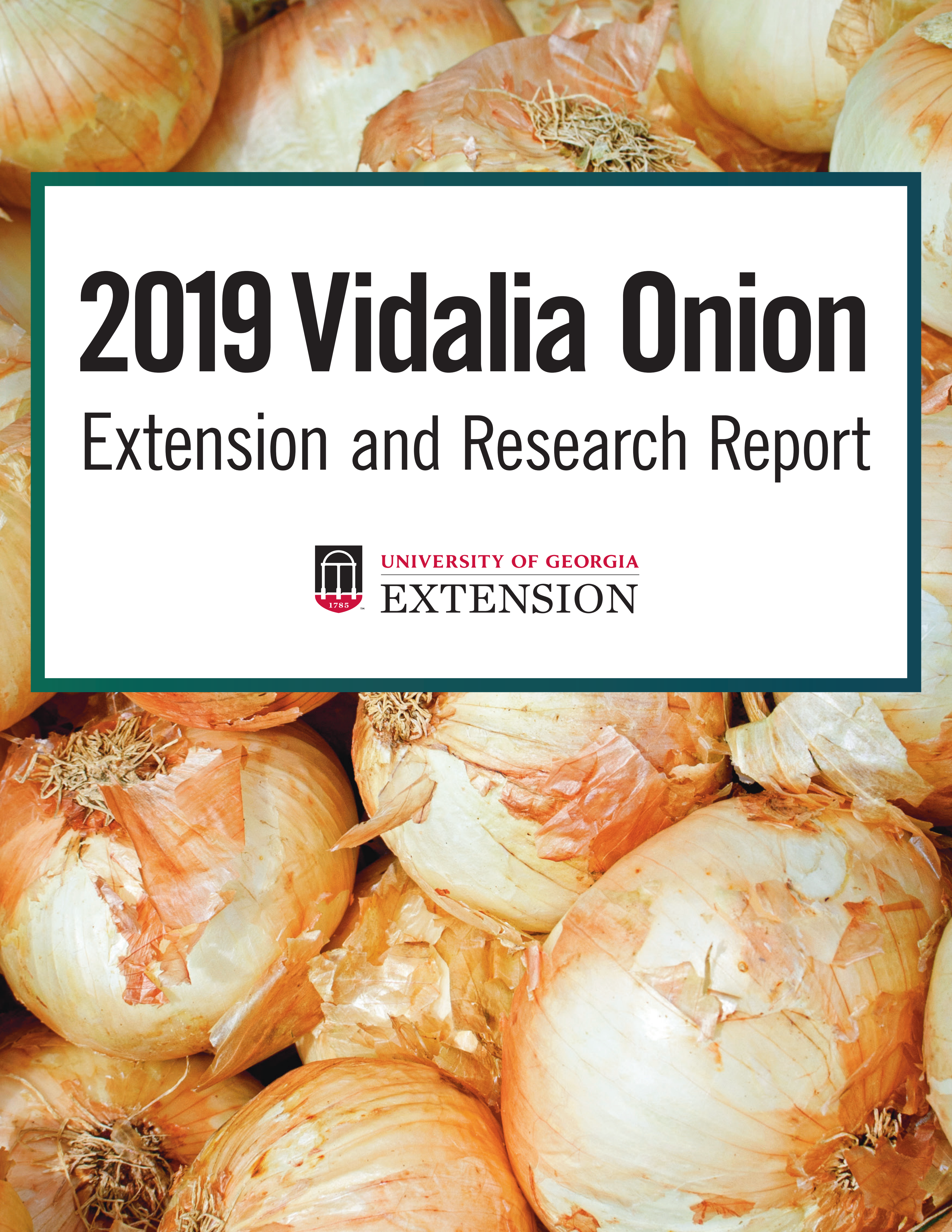

2019 Vidalia Onion

Extension and Research Report

UNIVERSITY OF GEORGIA EXTENSION

2019 University of Georgia Vidalia Onion Extension and Research Report

Andre Luiz Biscaia Ribeiro da Silva, editor

Contributing Authors

Department of Horticulture

Faculty

A. da Silva
T. Coolong
J. Diaz-Perez

Staff

J. Candian
G. Gunawan
A. Bateman
J. Bautista

Department of Plant Pathology

Faculty

B. Dutta
A. Hajihassani
B. Kvitko

Staff

M.J. Foster
M. Donahoo
J. Marquez

Department of Crop and Soil Sciences

Faculty

S. Culpepper

Staff

J. Vance

Department of Entomology

Faculty

D. Riley

Department of Food Science and Technology

Faculty

L. Dunn

Agricultural and Environmental Service Lab

J. Lessl
T. Ona
D. Jackson
C. Chan

County and Regional Faculty

C. Tyson, Area Onion Agent
A. Shirley, Tattnall County
J. Edenfield, Toombs County
B. Reeves, Candler County
S. Powell, Treutlen County
S. Tanner, Emanuel County
Z. Williams, Bacon County

Vidalia Onion and Vegetable Research Center Staff

R. Hill
D. Thigpen
Georgia Department of Corrections

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2019 University of Georgia Vegetable Extension and Research Report

UGA Vidalia Onion Variety Trial 2018-19 Crop Season

C. Tyson, A. da Silva, J. Edenfield, B. Reeves, A. Shirley, A. Bateman, R. Hill, D. Thigpen, S. Powell, S. Tanner, and Z. Williams

Introduction

The University of Georgia evaluates short day onions to determine their performance characteristics in standardized growing practices. The varieties are placed in the trial by participating seed companies. These trials are conducted at the Vidalia Onion and Vegetable Research Center (VOVRC).

Materials and methods

There were 45 varieties entered into the 2018 – 2019 trial. The seedbeds were grown at the VOVRC in Lyons, Georgia. Seedbed treatment included a 75 gallon per acre fumigation treatment of metam sodium. The seedbeds were planted on September 17, 2018, and the trial was transplanted on November 28, 2018. Upon harvest and grading, one bag of jumbo onions per plot is sent to the Vidalia Onion Research Lab in Tifton, Georgia, to undergo controlled atmospheric storage conditions. The storage duration is carried out until September 15, 2019. Seedbed and trial fertility, as well as fungicide programs are listed below.

The trial evaluated all 45 varieties in 25 foot long by 6 foot wide plots. Each variety was replicated four times and harvested based on a committee decision of maturity. The plant population for the trial was equivalent to 87,120 plants per acre.

Seedbed Fertility:

- 250 lb/A of 10-10-10 applied September 11, 2018 (preplant)
- 150 lb/A of 18-46-0 applied September 17, 2018
- 200 lb/A of 10-10-10 applied October 1, 2018
- 200 lb/A of 10-10-10 applied October 15, 2018
- 200 lb/A of 10-10-10 applied October 29, 2018

Note: All fertilizer applications were applied with a First Products brand drop spreader.

- 400 lb/A of 5-10-15 applied November 30, 2018
- 400 lb/A of 5-10-15 applied January 10, 2019
- 400 lb/A of 5-10-15 applied January 29, 2019
- 150 lb/A of calcium nitrate applied February 7, 2019
- 150 lb/A of calcium nitrate applied February 20, 2019
- Total lb/A: 106.5 (N) – 120 (P) – 180 (K) – 36 (S)

Note: Soil sample test results called for 125 -150 lb/A nitrogen,60 lb/A of phosphorus, 90 lb/A of potash, and 40 – 60 lb/A of sulfur.

Trial Fungicide Schedule:

Date	Fungicide applied
Jan. 10	Pristine (14.5 oz/A) + Magna-Bon (12 oz/A)
Jan. 22	Bravo (1pt/A) + ProPhyt (4 pt/A)
Jan. 31	Fontelis (16 oz/A)
Feb. 11	Bravo (1pt/A) + Magna-Bon (12 oz/A)
Feb. 21	Inspire Super (16 oz/A)
Mar. 7	Orondis Ultra (6 oz/A) + Bravo (1 pt/A)
Mar. 18	Orondis Ultra (6 oz/A) + Luna Tranquility (16 oz/A)
Mar. 29	Orondis Ultra (6 oz/A) + Luna Tranquility (16 oz/A)

Harvest Timing

Each variety was evaluated and selected for harvest based upon signs of weak tops and adequately sized bulbs. A committee of Extension Agents determined the harvest/pulling of varieties. Participating seed companies reserve the right to specify when or what characteristics determine the harvest of their variety. Varieties were dug 7 days prior to harvest date.

April 10: Candy Joy, Fast Track, Quick Start

April 16: Candy Ann, New Frontier, Vidora, DP 1407

April 22: J3013, J3014, J3015, Sweet Agent, Candy Kim, WI – 129, Sweet Emotion, Sweet Harvest, Plethora, 2002-Nunhems, Emy 55033, Emy 55126, DP Sapelo Sweet, J3010, Red Duke, Red Sensation, Dulciana, Sofire, Althea, Vulcana

April 30: Pirate, Macon, Allison, J3009, J3016, J3017, Sweet Azalea, Sweet Magnolia, Century, Granex Yellow PRR, Sweet Jasper, XON – 109Y, Sweet Caroline, Emy 55045, Emy 55455, 3662 Hazera, Red Hunter, Mata Hari

Results and discussion

The following tables show field and marketable yields, as well as yields for colossal, jumbo, and medium sized bulbs. For additional information regarding the performance of a given variety, please contact your Extension Agent or the Vidalia Onion and Vegetable Research Center. We would like to thank the participating seed companies as well as the Vidalia Onion Committee for their support of this trial.

Table 1. Effect of fungicide treatments on disease severity and the area under disease progression curve.

Variety	Company	Total yield 40 lb. bags/acre	
Sweet Magnolia	Seminis	1354	a*
Sweet Emotion	Shamrock	1314	ab
Candy Kim	Solar	1286	abc
New Frontier	Wannamaker	1255	abcd
DP1407	DPSeeds	1230	abcde
Sweet Agent	Seminis	1221	abcde
Sweet Caroline	Nunhems	1220	abcde
Pirate	Bejo	1200	abcdef
J3016	Bejo	1197	abcdefg
Candy Ann	Solar	1192	abcdefgh
WI-129	Wannamaker	1163	abcdefghi
Vidora	Nunhems	1121	abcdefghij
J3009	Bejo	1115	abcdefghijk
Century	Seminis	1097	abcdefghijkl
Emy5545	Emerald	1091	bcdefghijkl
J3017	Bejo	1075	bcdefghijkl
Allison	Bejo	1069	bcdefghijkl
J3013	Bejo	1063	bcdefghijkl
Sweet Azalea	Seminis	1063	bcdefghijkl
Granex Yellow PRR	Seminis	1042	cdefghijkl
Fast Track	Shamrock	1038	cdefghijkl
Vulcana	Nunhems	1019	defghijkl
Dulciana	Nunhems	994	defghijklm
Quick Start	Shamrock	992	efghijklm
J3014	Bejo	971	efghijklm
Plethora	Nunhems	968	efghijklm
2002	Nunhems	957	fghijklm
Mata Hari (Red)	Nunhems	942	fghijklm
DPSapelo Sweet	DPSeeds	941	fghijklm
Candy Joy	Solar	938	ghijklm
Sofire (Red)	Nunhems	932	hijklm
Red Sensation (Red)	Bejo	917	ijklm
Sweet Jasper	Sakata	913	ijklm
Emy55126	Emerald	911	ijklm
3662	Hazera	911	ijklm
Sweet Harvest	Sakata	898	jklm
Althea	Nunhems	895	jklm
J3015	Bejo	892	jklm
XON-109Y	Sakata	880	jklm
Red Hunter (Red)	Bejo	864	jklm
Emy55033	Emerald	862	jklm
J3010 (Red)	Bejo	861	jklm
Emy55045	Emerald	856	klm
Macon	Bejo	839	lm
Red Duke (Red)	Bejo	743	m

* Letters that are the same between varieties indicate that those varieties are not significantly different according to Tukey test ($P \leq 0.05$)

Table 2. Vidalia onion marketable yield (40 lb. bags/acre) measured after grading.

Variety	Total yield 40 lb. bags/acre	
Pirate	1013	a*
Sweet Caroline	1006	ab
Sweet Magnolia	991	ab
Century	977	abc
J3016	966	abc
Candy Ann	951	abcd
J3009	933	abcde
Vidora	917	abcde
Vulcana	914	abcde
New Frontier	911	abcdef
Allison	898	abcdefg
Quick Start	895	abcdefg
Fast Track	894	abcdefg
DP1407	888	abcdefgh
Dulciana	868	abcdefghi
J3013	867	abcdefghi
Sweet Azalea	858	abcdefghi
Sofire (Red)	853	abcdefghi
Candy Joy	852	abcdefghi
J3017	829	abcdefghi
Granex Yellow PRR	820	abcdefghij
2002	820	abcdefghij
Emy5545	815	abcdefghij
Althea	797	abcdefghij
Sweet Agent	787	abcdefghij
Red Sensation (Red)	783	abcdefghij
J3010 (Red)	780	abcdefghij
3662	761	abcdefghij
Mata Hari (Red)	740	abcdefghij
J3014	731	abcdefghij
Plethora	700	bcdefghij
Emy55045	682	cdefghijk
Sweet Jasper	679	cdefghijk
Red Hunter (Red)	652	defghijkl
Macon	640	efghijkl
XON-109Y	631	efghijkl
Red Duke (Red)	605	fghijkl
DPSapelo Sweet	596	ghijkl
J3015	582	hijkl
Emy55126	564	ijkl
Candy Kim	516	jklm
Sweet Harvest	384	klmn
Emy55033	349	lmn
Sweet Emotion	219	mn
WI-129	186	n

* Letters that are the same between varieties indicate that those varieties are not significantly different according to Tukey test ($P \leq 0.05$)

Table 3. Vidalia onion colossal yield (40 lb. bags/acre) measured after grading.

Variety	Total yield 40 lb. bags/acre	
Sweet Agent	168	a*
DP1407	153	ab
Pirate	148	abc
New Frontier	147	abc
J3016	136	abcd
Sweet Magnolia	123	abcd
Candy Ann	121	abcde
Vidora	112	abcdef
Fast Track	100	abcdefg
Candy Kim	92	abcdefgh
Sweet Azalea	83	abcdefgh
Emy5545	79	abcdefgh
J3013	74	bcdefgh
Sweet Caroline	67	bcdefgh
Century	64	bcdefgh
J3017	61	cdefgh
Allison	47	defgh
Dulciana	45	defgh
Sweet Emotion	45	defgh
Quick Start	30	efgh
Sweet Jasper	30	efgh
3662	27	fgh
Granex Yellow PRR	26	fgh
J3009	26	fgh
WI-129	26	fgh
Sweet Harvest	24	fgh
XON-109Y	24	fgh
Emy55045	21	fgh
Plethora	18	gh
Candy Joy	18	gh
J3015	17	gh
Red Sensation (Red)	17	gh
J3014	15	gh
Macon	15	gh
Red Hunter (Red)	15	gh
Emy55126	12	gh
Vulcana	12	gh
DPSapelo Sweet	11	gh
Mata Hari (Red)	6	h
Red Duke (Red)	6	h
2002	5	h
Sofire (Red)	5	h
Althea	3	h
Emy55033	3	h
J3010 (Red)	2	h

* Letters that are the same between varieties indicate that those varieties are not significantly different according to Tukey test ($P \leq 0.05$)

Table 4. Vidalia onion jumbo yield (40 lb. bags/acre) measured after grading.

Variety	Total yield 40 lb. bags/acre	
Sweet Caroline	879	a*
J3009	850	ab
Century	842	ab
Sweet Magnolia	824	ab
Pirate	809	abc
Vulcana	809	abc
Allison	799	abc
J3016	790	abc
Candy Ann	771	abcd
Quick Start	758	abcd
J3013	755	abcd
Vidora	738	abcde
New Frontier	734	abcde
J3017	731	abcde
Fast Track	723	abcde
Sofire (Red)	721	abcde
Dulciana	720	abcde
2002	714	abcde
DP1407	711	abcde
Granex Yellow PRR	703	abcde
Sweet Azalea	703	abcde
Candy Joy	676	abcdef
J3014	661	abcdef
Emy5545	650	abcdef
Red Sensation (Red)	649	abcdef
Mata Hari (Red)	637	abcdef
3662	620	abcdef
Althea	614	abcdef
Plethora	614	abcdef
J3010 (Red)	602	bcdef
Sweet Agent	581	bcdefg
Emy55045	543	cdefgh
Red Hunter (Red)	543	cdefgh
Sweet Jasper	514	defgh
J3015	507	defgh
Macon	507	defgh
XON-109Y	501	defgh
Emy55126	478	efgh
DPSapelo Sweet	470	efgh
Red Duke (Red)	416	fghi
Candy Kim	413	fghi
Sweet Harvest	321	ghi
Emy55033	284	hi
Sweet Emotion	168	i
WI-129	154	i

* Letters that are the same between varieties indicate that those varieties are not significantly different according to Tukey test ($P \leq 0.05$)

Table 5. Vidalia onion medium yield (40 lb. bags/acre) measured after grading.

Variety	Medium yield 40 lb. bags/acre	
Red Duke (Red)	183	a*
Althea	180	a
J3010 (Red)	177	a
Candy Joy	157	ab
Sweet Jasper	135	abc
Sofire (Red)	127	abcd
Emy55045	118	bcde
Macon	118	bcde
Red Sensation (Red)	118	bcde
DPSapelo Sweet	115	bcdef
3662	113	bcdefg
Quick Start	107	bcdefgh
XON-109Y	106	bcdefgh
Dulciana	103	bcdefgh
2002	101	bcdefghi
Mata Hari (Red)	97	cdefghij
Red Hunter (Red)	94	cdefghijk
Vulcana	92	cdefghijk
Granex Yellow PRR	91	cdefghijk
Emy5545	86	cdefghijkl
Emy55126	74	defghijklm
Century	71	defghijklm
Fast Track	71	defghijklm
Sweet Azalea	71	defghijklm
Plethora	68	efghijklmn
Vidora	67	efghijklmn
Emy55033	62	efghijklmno
Sweet Caroline	61	efghijklmno
Candy Ann	59	fghijklmno
J3015	59	fghijklmno
J3009	57	fghijklmno
Pirate	56	ghijklmno
J3014	54	hijklmno
Allison	53	hijklmno
Sweet Magnolia	44	ijklmno
J3016	41	jklmno
Sweet Harvest	39	jklmno
J3013	38	klmno
J3017	38	klmno
Sweet Agent	38	klmno
New Frontier	30	lmno
DP1407	24	mno
Candy Kim	11	no
Sweet Emotion	6	o
WI-129	6	o

* Letters that are the same between varieties indicate that those varieties are not significantly different according to Tukey test ($P \leq 0.05$)

Table 6. Vidalia onion culls yield (40 lb. bags/acre) measured after grading.

Variety	Culls yield 40 lb. bags/acre	
Sweet Emotion	1095	a*
WI-129	977	a
Candy Kim	770	b
Sweet Harvest	514	c
Emy55033	513	c
Sweet Agent	434	cd
Sweet Magnolia	363	cde
Emy55126	347	cdef
DPSapelo Sweet	345	cdef
New Frontier	345	cdef
DP1407	342	cdefg
J3015	310	defgh
Sweet Azalea	277	defghi
Emy5545	275	defghi
Plethora	268	defghi
XON-109Y	250	defghi
J3017	246	defghi
Candy Ann	240	defghi
J3014	240	defghi
Sweet Jasper	234	efghi
J3016	231	efghi
Granex Yellow PRR	222	efghi
Sweet Caroline	214	efghi
Red Hunter (Red)	212	efghi
Vidora	204	efghi
Mata Hari (Red)	203	efghi
Macon	199	efghi
J3013	197	efghi
Pirate	187	efghi
J3009	182	efghi
Emy55045	174	efghi
Allison	170	efghi
3662	150	fghi
Fast Track	144	ghi
2002	138	hi
Red Duke (Red)	138	hi
Red Sensation (Red)	134	hi
Dulciana	126	hi
Century	120	hi
Vulcana	106	i
Althea	98	i
Quick Start	97	i
Candy Joy	86	i
J3010 (Red)	81	i
Sofire (Red)	79	i

* Letters that are the same between varieties indicate that those varieties are not significantly different according to Tukey test ($P \leq 0.05$)

UGA Variety Trial Quality Report 2018-19 Crop Season

C. Tyson, J. Lessl, D. Jackson, T. Ona, C. Chan, A. da Silva, J. Edenfiel, B. Reeves, A. Shirley, A. Bateman, R. Hill, D. Thigpen, S. Powell, S. Tanner, and Z. Williams

Introduction

Each season the University of Georgia, Agricultural and Environmental Services Laboratories evaluates the flavor-associated compounds in the short-day onions grown in the Variety Trial. These onion varieties are submitted by the participating seed companies, grown at the Vidalia Onion and Vegetable Research Center (VOVRC), and once harvested and dried, submitted to the Agricultural and Environmental Services Laboratories for analysis of the pungency-related compounds; pyruvic acid, lachrymatory factor, and methyl thiosulfinate content. Due to association of Vidalia onions with low pungency and sweet flavor, this annual evaluation provides useful information about the relative flavor quality of these onion varieties.

When the cells within the onion bulb are ruptured my mechanical means or during chewing, a complex chain of chemical reactions begins, resulting in the formations of highly volatile compounds responsible for onion pungency and flavor. One of the first chemicals to be formed is known as the onion lachrymatory factor (propanethial S-oxide), due to its tear-causing capability. The lachrymatory factor is responsible for the majority of the mouth burn and pungency of onions; however, due to its unstable nature, it quickly breaks down into further flavor-associated compounds, including the methyl thiosulfinates. Methyl thiosulfinates (specifically the C-4, methyl thiosulfinates) are a class of compounds, which each provide a specific flavor, and collectively producing the characteristic flavors of fresh onions. Pyruvic acid is a byproduct of this chemical pathway, and although pyruvic acid does not produce a flavor response itself, due to its formation at a similar ratio to the more unstable flavor compounds, it is commonly analyzed as a proxy for onion pungency.

This publication summarizes the flavor analysis results from the 2018-2019 growing season, as well as compares the performance of each variety over the past four growing seasons.

Materials and methods

Forty-five onion varieties were analyzed as part of the 2018 – 2019 variety trial. Each variety was grown at the VOVRC in quadruplicate plots, with each replicated harvested, dried, and submitted to the lab individually. Cores were taken from 10 onions within each replicated, composited, onion juice expressed, and analyzed following the procedures described in Kim *et al*. 2017[1].

Results and discussion

The following tables compare the concentrations of flavor-associated compounds in onions grown as a part of the 2018-2019 variety trial. Additionally, the cumulative variety flavor quality rankings are provided for the past four growing seasons. For additional information regarding the performance of a given variety, please contact your Extension Agent or the Vidalia Onion and Vegetable Research Center.

Table 1. Pyruvic acid content in onions submitted to the UGA Agricultural & Environmental Services Labs as a part of the 2018-2019 variety trial.

Variety	Pyruvic Acid µmole/g	
Mata Hari (Red)	6.3	a*
3662	6.1	ab
DPSapelo Sweet	6.0	abc
Sofire (Red)	5.7	abcd
J3017	5.7	abcde
Emy5545	5.6	abcde
Quick Start	5.6	abcde
Granex Yellow PRR	5.5	abcde
Vulcana	5.5	abcde
Dulciana	5.5	abcde
J3015	5.4	abcdef
Fast Track	5.4	abcdef
Emy55045	5.4	abcdef
WI-129	5.4	abcdef
XON-109Y	5.2	abcdef
J3016	5.2	abcdef
Candy Ann	5.2	abcdef
Pirate	5.2	abcdef
DP1407	5.1	abcdef
J3009	5.1	abcdef
Sweet Emotion	5.1	abcdef
Althea	5.1	abcdef
New Frontier	5.1	abcdef
Sweet Caroline	4.9	abcdef
Plethora	4.9	abcdef
J3014	4.9	abcdef
Century	4.8	abcdef
Emy55033	4.7	abcdef
Vidora	4.7	abcdef
Sweet Jasper	4.7	abcdef
Candy Kim	4.7	abcdef
Candy Joy	4.7	abcdef
Emy55126	4.6	abcdef
Macon	4.6	abcdef
Allison	4.6	abcdef
2002	4.5	abcdef
J3013	4.5	abcdef
Sweet Azalea	4.3	bcdef
Sweet Harvest	4.3	bcdef
Sweet Agent	4.2	bcdef
Sweet Magnolia	4.1	bcdef
Red Duke (Red)	4.1	cdef
J3010 (Red)	4.0	def
Red Hunter (Red)	3.8	ef
Red Sensation (Red)	3.5	f

* Letters that are the same between varieties indicate that those varieties are not significantly different ($P \leq 0.05$)

Table 2. Lachrymatory factor (Propanethial S-Oxide) content in onions submitted to the UGA Agricultural & Environmental Services Labs as a part of the 2018-2019 variety trial.

Variety	Lachrymatory Factor µmole/g	
3662	5.7	a
Ganex Yellow PRR	5.1	ab
Mata Hari	5.0	abc
Sofire	5.0	abc
J3009	5.0	abc
Sapelo	5.0	abc
J3016	5.0	abc
Pirate	4.9	abc
Vulcana	4.9	abc
Emy 55455	4.9	abc
J3017	4.9	abc
Dulciana	4.8	abcd
Sweet Caroline	4.5	abcde
J3015	4.5	abcde
Emy 55045	4.4	abcde
XON-109Y	4.3	abcde
Sweet Azalea	4.2	abcdef
Athena	4.2	abcdef
Century	4.1	abcdef
Plethora	4.0	abcdef
J3014	3.9	abcdef
Sweet Magnolia	3.9	abcdef
Quick Start	3.9	abcdef
Fast Track	3.8	abcdef
1407	3.8	abcdef
Sweet Jasper	3.7	abcdef
Emy 55033	3.7	abcdef
Allison	3.7	abcdef
Sweet Emotion	3.6	abcdef
Candy Ann	3.5	abcdef
New Frontier	3.4	bcdef
Macon	3.4	bcdef
Vidora	3.3	bcdef
Emy 55126	3.3	bcdef
2002	3.1	bcdef
J3013	3.1	bcdef
Red Duke	3.0	bcdef
Wannamaker	2.9	bcdef
Sweet Harvest	2.8	bcdef
Candy Joy	2.8	bcdef
J3010	2.8	cdef
Candy Kim	2.7	cdef
Sweet Agent	2.5	def
Red Sensation	2.4	ef
Red Hunter	2.0	f

* Letters that are the same between varieties indicate that those varieties are not significantly different according to Tukey test ($P \leq 0.05$)

Table 3. Methyl thiosulfinate content in onions submitted to the UGA Agricultural & Environmental Services Labs as a part of the 2018-2019 variety trial.

Variety	Methyl Thiosulfinates nmole/g	
Candy Kim	109.3	a
Candy Joy	107.3	ab
Wannamaker	103.5	abc
Candy Ann	97.3	abcd
Quick Start	82.8	abcde
1407	82.7	abcde
Sapelo	79.7	abcdef
J3013	69.6	abcdefg
Sweet Emotion	67.5	abcdefg
Sofire	65.4	abcdefg
Fast Track	64.4	abcdefg
J3015	57.9	abcdefg
Mata Hari	57.0	abcdefg
Sweet Harvest	56.0	abcdefg
New Frontier	54.2	abcdefg
J3014	51.8	abcdefg
Athena	47.7	abcdefg
Vidora	44.0	abcdefg
Sweet Agent	42.9	bcdefg
Emy 55033	39.3	cdefg
Red Hunter	33.1	defg
Macon	32.6	defg
J3017	30.6	efg
Red Duke	29.3	efg
2002	28.4	efg
Pirate	27.4	efg
J3010	26.5	efg
Emy 55126	26.0	efg
Allison	25.4	efg
Emy 55455	24.7	efg
3662	24.2	efg
Ganex Yellow PRR	23.7	efg
Sweet Jasper	20.7	efg
Red Sensation	19.9	efg
Vulcana	19.4	efg
J3009	19.2	efg
XON-109Y	19.2	efg
Emy 55045	18.6	efg
J3016	16.4	fg
Century	16.3	fg
Plethora	15.2	fg
Dulciana	15.1	fg
Sweet Azalea	14.1	fg
Sweet Caroline	13.9	g
Sweet Magnolia	9.7	g

* Letters that are the same between varieties indicate that those varieties are not significantly different according to Tukey test ($P \leq 0.05$)

Table 4. Overall quality ranking of the 2019 variety trial onions based on Pyruvic acid, Lachrymatory factor, and Methyl Thiosulfinates.

Variety	Rank
Red Sensation (Red)	1
Red Hunter (Red)	2
J3010 (Red)	3
Red Duke (Red)	4
Sweet Agent	5
2002 (White)	6
Sweet Magnolia	7
Emy 55126	8
Allison	9
Sweet Azalea	10(t)
Macon	10(t)
Sweet Jasper	10(t)
Sweet Harvest	13
Plethora	14(t)
Vidora	14(t)
Emy 55033	16
Century	17
J3013	18
Sweet Caroline	19
New Frontier	20
Candy Kim	21(t)
XON-109Y	21(t)
Candy Joy	23(t)
Emy 55045	23(t)
J3014	25
J3016	26
Dulciana	27(t)
J3009	27(t)
Sweet Emotion	27(t)
Pirate	30(t)
Athena (White)	30(t)
Vulcana	32
WI-129-Wannamaker	33
Emy 55455	34
Fast Track	35(t)
Granex Yellow PRR	35(t)
1407	37(t)
Candy Ann	37(t)
J3017	37(t)
3662	40
J3015	41
Quick Start	42
Mata Hari (Red)	43(t)
Sofire (Red)	43(t)
Sapelo	45

* Letters that are the same between varieties indicate that those varieties are not significantly different according to Tukey test ($P \leq 0.05$)

Table 5. Overall quality ranking of variety trial onions grown for four consecutive years (2016-2019) based on Pyruvic acid, Lachrymatory factor, and Methyl Thiosulfinates.

Variety	Rank
Sweet Agent	1
Sweet Magnolia	2
Vidora	3(t)
Sweet Azalea	3(t)
Sweet Harvest	5
Plethora	6
Century	7
1407	8
New Frontier	9
Allison	10
XON-109Y	11
Pirate	12(t)
Sweet Jasper	12(t)
Sweet Caroline	14
Candy Joy	15
Candy Kim	16
Candy Ann	17
Fast Track	18
Granex Yellow PRR	19(t)
Macon	19(t)
Sapelo	21
Emy 55455	22

* Letters that are the same between varieties indicate that those varieties are not significantly different according to Tukey test ($P \leq 0.05$)

Fertilizer Nitrogen Rate and Variety Evaluation for Vidalia Onion Production

A. da Silva, C. Tyson, T. Coolong, and L. Dunn

Introduction

Long growing seasons and relatively shallow root system makes Vidalia onion a crop with high requirements of soil nitrogen (N) availability during crop development. Current recommendations for N fertilizer application for Vidalia onion varies from 125 to 150 lb. of N/acre. However, growers have routinely produced high quality Vidalia onion crops using less than N fertilizer recommendations. In addition, much of the work conducted on total N applications was done in the 1980s and 1990s. During the last 20 years, many new varieties with relatively higher nitrogen fertilizer use efficiencies have been released. This should allow for using reduced N rates during crop production, consequently reduction on costs with fertilizer input for growers.

Several studies were performed in recent years related to fertility and production practices in Vidalia onions. These studies were mostly focused in a single variety with limited number of factors. New information on the Vidalia onion requirements for N fertilizer applications would benefit growers. Therefore, research is required to determine N fertilizer recommendations for the current available varieties of Vidalia onion. This research must help growers to reduce costs associated with fertilizer inputs while maintaining yield. Thus, the objective of the study was to identify N fertilizer application rates in different varieties of Vidalia onion that maximize plant growth and yield.

Materials and methods

A field experiment was conducted in the 2018/2019 Vidalia onion season at the University of Georgia – Vidalia Onion and Vegetable Research Center located in Lyons, GA. Soil in the experimental area is classified as Irvington loamy sandy soil type with 2% of slope and a low water holding capacity. Climate of the region is classified as a humid subtropical climate, characterized by high temperatures with accumulated rainfall events in the spring/summer and dry periods in the fall/winter (Koppen, 1931).

Table 1. List of treatments.

Treatment	Variety	N rate (lb./acre)
1	Sweet Agent	75
2	Sweet Agent	90
3	Sweet Agent	105
4	Sweet Agent	120
5	Sweet Agent	135
6	Vidora	75
7	Vidora	90
8	Vidora	105
9	Vidora	120
10	Vidora	135
11	Quickstart	75
12	Quickstart	90
13	Quickstart	105
14	Quickstart	120
15	Quickstart	135

Vidalia onion was planted on 17 September, 2018 in nursery beds, and transplanted to field-beds on 19 December, 2018. The experimental area was comprised of 4 adjacent field-beds 5-in tall, 370-ft long, and 6-ft center to center spacing. Each field-bed was comprised of 4 onion rows with an in-row spacing of 4 inches, and experimental plots were 20-ft long with 5 ft skip between plots within each bed. During the entire season, crop management practices associated with soil preparation, transplanting, irrigation and management of pest, weeds and diseases followed the University of Georgia recommendation.

Five N fertilizer rates and three Vidalia onion cultivars were evaluated in a randomize complete block design with 4 replications (table 1). The N Fertilizer were applied at transplanting, and at 30, 58, and 92 days after transplanting (DAT) to a total N fertilizer rate of 75, 90, 105, 120 and 135 lb/ac., each application timing received 20% of the season total N applied, except by the last application when 40% of the season total N was applied. In addition to N fertilizer application, Vidalia onion plants received a total of 134 lbs/ac of P and K, applied at transplanting and at 25 days after transplanting.

Vidalia onions were harvested on 25 April 2019 (127 DAT), cured for a week and graded according to the Georgia Department of Agriculture in: Colossal (> 3¾ inches), Jumbo (3¾ to 3¼ inches), Medium (2 to 3¼ inches), Culls (< 2 inches). Marketable yield was calculated as Colossal, Jumbo, and Medium, while total yield was calculated as Marketable yield and culls. Statistical analyses were performed to compare total yield and bulb size distribution among treatments.

Results and discussion

Rainfall accumulation was 13 inches during the entire onion season, which matched with the 12.8 inches of onion water demand for the same period of time (data retrieved from http://irrigating.uga.edu). Still, rainfall events were not uniformly distributed throughout the season and irrigation events were required to supply dry periods. In the early season, scattered heavy showers events (January to February) might induced nutrient leaching, particularly N applied early in the season, while, later in the season, there was a well distribution of rainfall events, from mid-season (March) to harvesting (April) (Fig. 1).

Vidalia onion yield parameters were mostly affected by the N rate applied instead variety (Table 2). Total yield was the highest for the 105, 120, and 135 lb. of N/acre, indicating that the N rate of 105 lb./acre was sufficient to sustain total yield. Lowest total yields were measured for 75 and 90 lb. of N/acre. Colossal onions represented in average 2% of total yield only, and the N rate of 135 lb./acre had the highest yield of Colossal. Jumbo onions represented in average 62% of total yield. The highest yield for Jumbo onions were measured for the N rate of 135 lb./acre as well, but no significant difference was measured between 135 and 120 lb./acre. The N rate of 105 lb./acre had no significant difference from 120 and 90 lb./acre, while 75 lb./acre had the lowest yield of Jumbo onions. Contrarily to yield of onions size Jumbo, Medium onion had a higher yield for the N rate of 75 lb./acre, following by N rates of 90, 105, and 120 lb./acre. Lowest medium onion yields were measure for 135 lb./acre. Yield of medium onions represented 25% of total yield. N rate treatments had no significant difference for yield of cull onions that represented 11% of total yield.

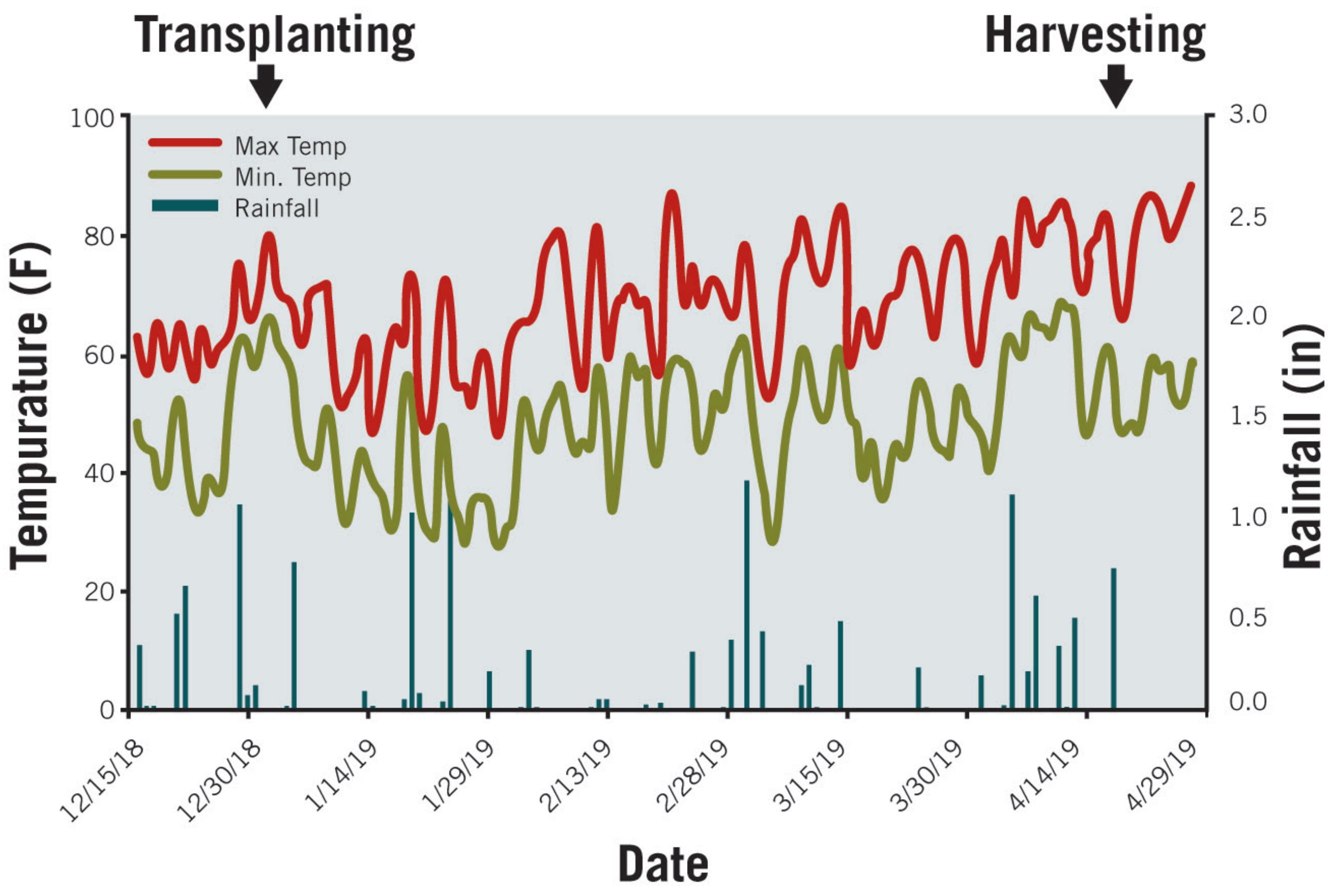

Figure 1. Weather condition of minimum and maximum temperature and rainfall during the 2018/2019 Vidalia onion season in Lyons, GA.

Table 2. Total yield and bulb size distribution for Vidalia onion grown in the 2018/2019 season.

Treatment	Total yield		Colossal		Jumbo		Medium		Culls
	40 lb. bags / acre								
Nitrogen Rate									
135	998	a*	42	a	692	a	155	c	109
120	900	a	20	b	618	ab	174	bc	88
105	898	a	12	bc	538	bc	209	b	139
90	761	b	5	c	486	c	214	b	57
75	688	b	2	c	343	d	283	a	61
p-value	***<0.001***		***<0.001***		***<0.001***		***<0.001***		***0.409***
Variety									
QuickStart	848		5	b	496		248	a	99
Sweet Agent	848		32	a	557		147	b	112
Vidora	851		9	b	554		227	a	61
p-value	***0.995***		***<0.001***		***0.079***		***<0.001***		***0.380***
Nitrogen Rate * Variety									
p-value	***0.546***		***0.277***		***0.264***		***0.347***		***0.535***

*Values followed by similar letters indicate no significant difference ($p < 0.05$) among planting date or planting method.

The Vidalia onion varieties evaluated had minimal impact on yield, and significant differences were only measured for the yield of medium onions, in which QuickStart and Vidora had higher yield of medium onions than Sweet Agent. Total yield, Jumbo, and culls average 849, 536, and 91-40 lb. bags/acre, respectively.

Conclusion

Vidalia onion yield parameters were more affected by N rate than the varieties studied. The N rate of 135 lb./acre had the highest onion yield, but no significant difference was measure from the 105 lb./acre for the 2018/19 Vidalia onion season. This indicated that the application of N rates higher than 105 lb./acre might not be necessary to increase yield. However, a second year of study is required to evaluate the effect of Vidalia onion varieties and fertilizer N rates on yield in a different weather condition, since higher N rates might be required in rainy years and lower N rates in drier years.

Effects of Control Release Fertilizer on Vidalia Onion Production

A. da Silva, C. Tyson, A. Shirley, J. Candian

Introduction

Appropriated timing of fertilizer application during the crop development will ensure soil nutrient availability thorough onion growing season. In the state of Georgia, fertilizer is typically applied five times for Vidalia onion production, but most recently control release fertilizer applications have been reducing the number of fertilizer applications while maintaining yield. Thus, the objective of this study was to evaluate different fertilizer strategies including control release fertilizer for Vidalia onion production under the Georgia environmental conditions.

Materials and methods

A field experiment was conducted in the 2018/2019 Vidalia onion season at the University of Georgia – Vidalia Onion and Vegetable Research Center located in Lyons, GA. The objective was to evaluate different fertilizer strategies including control release fertilizer for Vidalia onion production.

Soil in the experimental area is classified as Irvington loamy sandy soil type with 2% of slope and a low water holding capacity (USDA soil survey, 2018). Climate of the region is classified as a humid subtropical climate, characterized by high temperatures with accumulated rainfall events in the spring/summer and dry periods in the fall/winter (Koppen, 1931). Vidalia onion (c.v. Pirate) was planted end of September in nursery beds, and transplanted to field-beds on 19 December 2018.

The experimental area was comprised of 4 adjacent field-beds 5-in tall, 145-ft long, and 6-ft center to center spacing. Each field-bed was comprised of 4 onion rows with an in-row spacing of 4 inches, and experimental plots were 20-ft long with 5 ft skip between plots within each bed. A factorial experimental design with six fertilizer strategies comparing the grower standard practices (GSP) against five (5) control release fertilizer strategies were replicated 4 times in a randomized complete block design. Table 2 has a list of fertilizer strategies with application times, date of fertilizer application, and nutrient rates applied in each application.

Weather conditions (i.e., maximum and minimum temperature, solar radiation, and rainfall) were hourly monitored using a weather station from the Georgia Automated Environmental Monitoring Network (http://www.georgiaweather.net/). Crop management practices associated with soil preparation, irrigation and management of pest, weeds and diseases followed the University of Georgia recommendation.

Vidalia onions were harvested on 25 April 2019 (127 DAT), cured for a week and graded according to the Georgia Department of Agriculture in: Colossal (> 3¾ inches), Jumbo (3¾ to 3¼ inches), Medium (2 to 3¼ inches), Culls (< 2 inches).

Statistical analyses were performed to compare total yield and bulb size distribution among treatments.

Results and discussion

During the Vidalia onion season, there was a rainfall accumulation of 13 inches, which matched with the 12.8 inches of onion water demand for the same period of time (data retrieved from http://irrigating.uga.edu). Still, rainfall events were not uniformly distributed throughout the season and irrigation events were required to supply dry periods. In the early season, scattered heavy showers events (January to February) might induced nutrient leaching, particularly nitrogen (N), while, later in the season, there was a well distribution of rainfall events, from mid-season (March) to harvesting (April) (Fig. 1). Therefore, the use of control release fertilizer was key to ensure nutrient availability during the entire season and provide high crop yields.

All control release fertilizer strategies increased Vidalia onion total yield compared to the grower standard practice (Table 1). In average, control released fertilizer treatments had 25% higher total yields than the grower standard practice. However, the CRF - 1 and CRF – 2 were the fertilizer strategies that required the lowest number of fertilizer application and nutrient requirements to increase total yield. Regarding bulb size distribution, the CRF - 4 had the highest colossal yield, but this yield was only significantly higher than the grower standard practice, indicating that all control release fertilizer strategies studied similarly yield for colossal bulbs. Jumbo and medium bulbs are sizes of most interest for growers. Control release fertilizer strategies had higher jumbo yields than the grower standard practice.

Table 1. Total yield and bulb size distribution for Vidalia onion grown in the 2018/2019 season.

Fertilizer strategy	Total yield		Colossal		Jumbo		Medium		Culls
40 lb. bags / acre									
GSP	852	b*	5	b	604	b	206	a	37
CRF - 1	1116	a	54	ab	977	a	77	b	21
CRF - 2	1128	a	22	ab	930	a	124	b	56
CRF - 3	1149	a	38	ab	968	a	95	b	46
CRF - 4	1150	a	72	a	914	a	113	b	61
CRF - 5	1160	a	38	ab	914	a	115	b	81
p value	*<0.001*		*0.03*		*0.001*		*<0.001*		*ns*

*Values followed by similar letters indicate no significant difference ($p < 0.05$) among planting date or planting method.

Particularly, the CRF - 1 and CRF – 2, with lower nutrient requirement, had 38% and 35% higher jumbo yield than the grower standard practice, respectively. Contrarily, grower standard practice had the highest yield of medium bulbs, which indicates that control release fertilizer programs increase bulb size. There was no significant difference among fertilizer strategies for cull bulbs.

Conclusion

Overall, control release fertilizer strategies increased Vidalia onion yields compared to the grower standard practice for the weather conditions of the studied season (2018/2019), when heavy rainfall events occurred early in the season. Previous studies have indicated that control release fertilizer strategies perform better than the application of dry fertilizer in rainy years. Particularly, the CRF - 1 and CRF - 2 required a lower number of fertilizer application and nutrients applied to increase yield. Nevertheless, a second year of study is required to evaluate the effect of control release fertilizer strategies in Vidalia onion yield for dry years.

Table 2. Description of treatment, number of applications, date, days after transplanting (DAT) and nutrient rates in 2018/2019 season.

Fertilizer strategy	Number of fertilizer application	Application		Nutrients									
				N	*P*	*K*	*Mg*	*Mn*	*B*	*Zn*	*Ca*	*Fe*	*S*
		Date	DAT	lbs./acre									
GSP	4	12/19/2018	0	20.0	40.0	60.0	4.0	1.0	0.4	0.4	36.0	0.0	12.0
		1/22/2019	34	20.0	40.0	60.0	4.0	1.0	0.4	0.4	36.0	0.0	12.0
		2/15/2019	58	20.0	40.0	60.0	4.0	1.0	0.4	0.4	36.0	0.0	12.0
		3/21/2019	92	54.0	0.0	0.0	0.0	0.0	0.0	0.0	66.5	0.0	0.0
		Total of nutrient		**114.0**	**120.0**	**180.0**	**12.0**	**3.0**	**1.2**	**1.2**	**174.5**	**0.0**	**36.0**
CRF - 1	1	12/19/2018	0	96.0	96.0	144.0	12.0	3.0	0.1	1.2	108.0	20.4	50.4
		Total of nutrient		**96.0**	**96.0**	**144.0**	**12.0**	**3.0**	**0.1**	**1.2**	**108.0**	**20.4**	**50.4**
CRF - 2	2	12/19/2018	0	48.0	48.0	72.0	6.0	1.5	0.1	0.6	54.0	10.2	25.2
		1/22/2019	34	48.0	48.0	72.0	6.0	1.5	0.1	0.6	54.0	10.2	25.2
		Total of nutrient		**96.0**	**96.0**	**144.0**	**12.0**	**3.0**	**0.1**	**1.2**	**108.0**	**20.4**	**50.4**
CRF - 3	3	12/19/2018	0	72.0	120.0	180.0	12.0	3.0	0.1	1.2	84.0	20.4	50.4
		2/15/2019	58	27.1	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0
		3/21/2019	92	27.1	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0
		Total of nutrient		**126.3**	**120.0**	**180.0**	**12.0**	**3.0**	**0.1**	**1.2**	**150.5**	**20.4**	**50.4**
CRF - 4	4	12/19/2018	0	36.0	60.0	90.0	6.0	1.5	0.1	0.6	42.0	10.2	25.2
		1/22/2019	34	36.0	60.0	90.0	6.0	1.5	0.1	0.6	42.0	10.2	25.2
		2/15/2019	58	27.1	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0
		3/21/2019	92	27.1	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0
		Total of nutrient		**126.3**	**120.0**	**180.0**	**12.0**	**3.0**	**0.1**	**1.2**	**150.5**	**20.4**	**50.4**
CRF - 5	5	12/19/2018	0	24.0	40.0	60.0	4.0	1.0	0.0	0.4	28.0	6.8	16.8
		1/22/2019	34	24.0	40.0	60.0	4.0	1.0	0.0	0.4	28.0	6.8	16.8
		2/15/2019	58	24.0	40.0	60.0	4.0	1.0	0.0	0.4	28.0	6.8	16.8
		3/21/2019	92	54.2	0.0	0.0	0.0	0.0	0.0	0.0	66.6	0.0	0.0
		Total of nutrients		**126.3**	**120.0**	**180.0**	**12.0**	**3.0**	**0.1**	**1.2**	**150.5**	**20.4**	**50.4**

Planting Method and Date of Transplanting Impact on Vidalia Onion Production

A. da Silva, J. Candian, C. Tyson, A. Shirley

Introduction

Annually, almost 14,000 acres of Vidalia onion are produced in Georgia. Seeds are planted in nursery beds in September, hand-transplanted to fields in November/December, and harvested in April/May. Transplanting and harvestings, due to the high labor demanding, are very costly in the onion production industry in Georgia. Alternative methods of transplanting are available for growers, however, such methods have never been used or introduced to Georgia growers. Particularly, the performance of a mechanical planting method, such as the onion bulb planter, require investigation under the onion production conditions of Georgia (e.g., weather conditions, soil type, and others). Thus, the objectives of this study are 1) to evaluate the performance of mechanical bulb set planting as an alternative planting method to the hand-transplanting of Vidalia onions, and 2) to determine planting dates that can maximize bulb yield and quality for each planting method.

Materials and methods

A field experiment was conducted in the 2018/2019 Vidalia onion season at the University of Georgia – Vidalia Onion and Vegetable Research Center located in Lyons, GA. A two factorial experimental design with two planting methods and two planting dates (table 1) was used with 4 replications in randomized complete block design. Each panel (plot) was comprised by 20 ft. long and contain four rows of onion with a 10 ft. border between adjacent plots in a bed. Onion beds were 6 ft. center spaced, onion rows within each bed were 12 inches spaced with a 4 inches space between onion plants. Planting dates were 11 November, 2018, and 19 December, 2018. Planting method treatments were the conventional hand-transplanting and a mechanical bulb set planting. The conventional hand-transplanting had seeds (cv. Pirate) planted on September 17th and were manual transplanted to experimental plots. The mechanical planting of bulb sets (cv. Pirrot) was performed using a 4 rows suction onion bulb planter (J.J. Broach, Madrid, Spain). Bulb sets were 1 inch diameter and planted 1/3-inch deep in the soil.

Table 1. List of treatments.

Planting Method	Planting date
Bulb set	11/21/18 (Early)
Bulb set	12/12/18 (Late)
Transplanting	11/21/18 (Early)
Transplanting	12/12/18 (Late)

Crop and pest management practices followed the University of Georgia recommendations, excepted by herbicide application, where transplant treatments received herbicide at planting date, and bulb sets received two applications at 2 and 6 weeks after planting. This management was used to avoid bulb set mortality. All treatments received 4 fertilize application: 1) 400 lbs./ac of 5-10-15 at planting, 2) 300 lbs./ac of 5-10-15 at 34 days after planting (DAP), 3) 200 lbs./ac of 5-10-15 at 58 DAP, and 4) 320 lbs./ac of 15.5-0-0 at 92 DAP.

Vidalia onions were harvested 127 DAP for both planting dates. Harvested bulbs were field cured, weighed and graded according to the Georgia Department of Agriculture in colossal (>3¾ inches), jumbo (3¾ to 3¼ inches), medium (2 to 3¼ inches), culls (< 2 inches). Statistical analyses were performed to compare total yield and bulb size distribution among treatments.

Results and discussion

There were no significant differences for the interaction or main effects of planting method and planting date for Vidalia onion total yield (table 2), indicating that mechanical planting for onion production had similar total yield to hand-transplanting. Hand transplanted areas had higher yield of Jumbo onions, but lower yield of Medium onions than the mechanical planted areas. Planting method had no significant difference for cull onions, but the later planting date increased the cull onions compared to the early planting date.

Vidalia onions size Colossal presented an interaction between planting method and planting date, in which the mechanical planted areas had higher yield of Colossal onions for the early planting date, while the later planting date increased the yield of Colossal onions for the hand transplanting areas.

Table 2. Effect of planting date and planting method on Vidalia onion total yield and bulb size distribution.

Treatment	Total yield	Jumbo		Medium		Culls	
	40 lb. bags / acre						
Planting date							
Early	1170	901		115		87	b
Late	1327	917		86		216	a
p-value	***ns***	***ns***		***ns***		*	
Planting method							
Bulb set	1168	821	b**	124	a	174	
Transplanting	1351	1011	a	71	b	135	
p-value	***ns***	*		*		***ns***	

ns = not significantly different
* p < 0.05

**Values followed by similar letters indicate no significant difference (p < 0.05) among planting date or planting method.

Table 3. Effect of the interaction planting date and planting method on the yield of Vidalia onion size Colossal.

Planting method	Planting date			
	40 lb. bags / acre			
	Early		Late	
Bulb set	70	a* A**	25	a B
Transplanting	61	b A	188	a A

*Values followed by similar high case letters within a planting date indicate no significant difference (p < 0.05) among planting method.

*Values followed by similar lower case letters within a planting method indicate no significant difference (p < 0.05) among planting date

Conclusion

The alternative mechanical planting using bulb sets showed potential to maintain onion yield compared to the conventional hand-transplanting method. However, the mechanical planting method should be used by growers seeking for a Medium onion size market, since this method of planting had higher Medium onion yield but lower Jumbo onion yield compared to conventional hand transplanting method. Overall, planting method had no impact on yield of cull onions, but a delay in planting date will increase the yield cull onions.

Use of Different Bulb Set Size for Mechanical Planting of Vidalia Onion

A. da Silva, C. Tyson, A. Shirley, R. Hill, D. Thigpen

Introduction

The use of a mechanical planter for Vidalia onion production is an alternative for the intense labor required for onion planting time. However, the performance of an onion bulb planter requires investigation under the onion production conditions of Georgia. The objective of this study was to determine the impact of bulb set size used in a mechanical planter on Vidalia onions for total and marketable yield, and bulb size distribution.

Materials and methods

A field experiment was conducted in the 2018/2019 Vidalia onion season at the University of Georgia – Vidalia Onion and Vegetable Research Center located in Lyons, GA. Three sizes of bulb set size for mechanical planting was compared. Bulb sets size were A (<¾ in), B (¾ to 1-½ in), and C (>1-½ in) (Fig. 1), and planted in 9 January, 2019, which was considered 0 days after planting (DAP). A total of 9 adjacent onion beds with 230 ft. long and 6 ft. center spaced were used. Each panel (plot) was comprised by an onion bed that contained four rows of onion. Onion rows within each bed were 12 inches spaced with a 4 inches space between onion plants, and bulb sets were planted ⅓-inch deep in the soil using a 4 rows suction onion bulb planter (J.J. Broach, Madrid, Spain).

Crop and pest management practices followed the University of Georgia recommendations, excepted by herbicide application, which the experimental field received two applications of Gold 2XL and Prowl at a rate of 16 oz/acre each at 2 and 6 weeks after planting. This management was used to avoid bulb set mortality. All treatments received 4 fertilizer application: 1) 400 lbs/ac of 5-10-15 at planting, 2) 300 lbs/ac of 5-10-15 at 34 days after planting (DAP), 3) 200 lbs/ac of 5-10-15 at 58 DAP, and 4) 320 lbs/ac of 15.5-0-0 at 92 DAP.

Vidalia onions were harvested on 25 April 2019 (127 DAT), cured for a week and graded according to the Georgia Department of Agriculture in Colossal (> 33/4 inches), Jumbo (33/4 to 31/4 inches), Medium (2 to 31/4 inches), and Culls (< 2 inches). Marketable yield was determined a sum of Colossal, Jumbo, and Medium onions.

Statistical analyses were performed to compare total and marketable yield and bulb size distribution among treatments.

Results and discussion

There was a higher total yield for Vidalia onion for the biggest size of bulb sets, size C, compared to sizes B and A. However, the highest total yield of bulb set sizes C were not reflected in higher marketable yield and there was no significant difference between treatments for marketable yield (Fig. 2). The lack of significant difference among treatments for marketable yield was mostly due to the higher amount of cull onions for bulb sets size C compared to B and A (Table 1), indicating that growers using mechanical planting method for Vidalia onion production do not necessarily need the biggest bulb set size (C) to increase marketable yield.

Figure 1. Bulb set size distribution: A (< $^3/_4$ in), B ($^3/_4$ to 1-$^1/_2$ in), and C (>1-$^1/_2$ in).

Vidalia onions classified as Jumbo had a higher yield for bulb set sizes C and B, compared to the bulb set size A. Therefore, bulb sets size B were enough to maintain yield for Jumbo onion. Contrarily, bulb sets sizes A had a higher yield for Medium onions, compared to B and C.

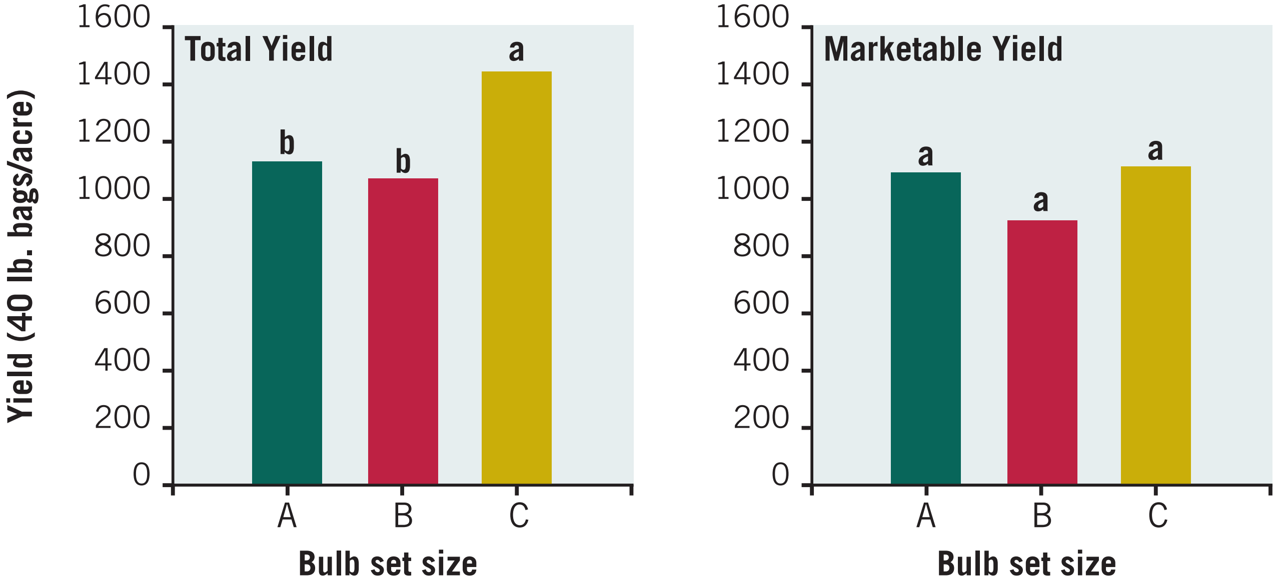

Figure 2. Difference on total and marketable yield for Vidalia onion among bulb set sizes A (<3/4 in), B (3/4 to 1-1/2 in), and C (>1-1/2 in).

Table 1. List of treatments.

Bulb set size	Jumbo		Medium		Culls	
	40 lb. bags /acre					
A (<$^3/_4$ in)	484	b*	597	a	48	b
B ($^3/_4$ to 1-$^1/_2$ in)	697	a	218	b	150	b
C (>1-$^1/_2$ in)	857	a	239	b	337	a

*Values followed by similar letters indicate no significant difference ($p < 0.05$) among planting date or planting.

Conclusion

Bulb set size C had the highest Vidalia onion total yield, but it did not reflected in higher marketable yield compared to bulb sets size B and A. Bulb set size B was enough to maintain Vidalia onion marketable yield and increase the number of Jumbo onions, while bulb set size A was also enough to maintain Vidalia onion marketable yield and increase Medium onion.

Evaluation of Fungicide Programs for Post-Infection Curative Activity on Onion Downy Mildew in Toombs County, Georgia

B. Dutta, J. Edenfield, Z. Williams

Materials and methods

Four rows of 'Plethora' onions were transplanted into 6-ft beds (panels) on 19 Nov (2018) at a commercial onion grower's field in Lyons, GA. The fertility and insecticide programs were consistent with the University of Georgia Extension recommendations. Four replications of treated plots were 20-ft long and were separated by non-sprayed 10 ft buffer within the row. Non-treated plots were not used in this trial as it was conducted in the grower's field. Treatments were applied post-infection and curative activity of the spray programs were compared. Treatments were applied with a backpack sprayer calibrated to deliver 36 gal/A at 48 psi through TX-18 hollow cone nozzles. Treatment applications were made on 4 Apr, 8 Apr, 12 Apr, 15 Apr, 18 Apr and 22 Apr. Plots were irrigated once a week using overhead irrigation. Disease severity was assessed on 8 Apr (rating was taken prior to 2nd spray on 8 Apr as indicated above), 16 Apr and 23 Apr as percent leaf area with symptoms per plot. Area under disease progress curve (AUDPC) was calculated using disease severity ratings from the three assessment periods. Data were analyzed in the software ARM (Gylling Data Management, Brookings, SD) using the Fisher's protected LSD test at P≤0.05.

Results and discussion

The mean rainfall received during Dec (2018) and Apr (2019) was 10.0 in. and 3.5 in., respectively. The average high and low temperatures for the month of Dec (2018) were 61° and 45° F, respectively and for the month of Apr (2019) were 79° and 56° F, respectively. Fungicide program treatments were started after downy mildew was observed on Mar 31. After first fungicide application on 4 Apr, disease severity was recorded. Initial disease severity between two fungicide programs and grower's standard program were not significantly different from each other. Disease progressed rapidly in two-weeks and significant differences were observed among treatments. On 23 Apr, grower's standard treatment had significantly higher disease severity and AUDPC compared to two fungicide programs. Fungicide program comprised of Bravo, Orondis Ultra and Omega 500 had significantly lower disease severity and AUDPC compared to fungicide program comprised of Bravo, Orondis Ultra and Zampro. Phytotoxicity was not observed in this trial.

Table 1. Severity of diseases in the initial and final stages of downy mildew, and area under disease progress curve (AUDPC) according to fungicides program.

Treatment and rate of product per acre	Application No.[z]	Initial disease severity (%) on 8 Apr[y]	Final disease severity (%) on 23 Apr[x]	AUDPC[v]
Bravo Weather Stik 1.5 pt	1-6	38.5 a	65.5 c	428.2 c
Orondis Ultra 8 fl oz	1,2,4			
Zampro 14 fl oz	1,2,4			
Bravo Weather Stik 1.5 pt	1-6	30.0 a	55.2 b	390.5 b
Orondis Ultra 8 fl oz	1,2,4			
Omega 500 1 pt	1,2,4			
Grower's standard		50.0 a	85.5 a	850.5 a
P-value		**0.472**	**0.015**	**0.042**

[z]Application dates were on 1=4 Apr, 2=8 Apr, 3=12 Apr, 4=15 Apr, 5=18 Apr and 6=22 Apr.

[y]Disease severity was rated on a 0 to 100 scale (0 = no infection and 100 = 100% of leaf area infection) on 8 Apr, 16 Apr and 23 Apr.

[x]Means followed by the same letter in each column are not significantly different according to Fisher's protected LSD test at P≤0.05.

[w]AUDPC was calculated from ratings taken on 8 Apr, 16 Apr and 23 Apr.

Evaluation of Fungicides to Manage Botrytis Leaf Blight in Georgia

B. Dutta, M. Foster, M. Donahoo

Materials and methods

Four rows of 'Allison' onions were transplanted into 6-ft beds (panels) on 14 Dec (2018) at the Vidalia Onion and Vegetable Research Center located in Lyons, GA. The fertility and insecticide programs were consistent with the University of Georgia Extension recommendations. Experimental design consisted of a randomized complete block with five replications. Treated plots were 20-ft long and were separated on each side by non-treated border panels. Plots were separated by a 3 ft bare-ground buffer within the row. Treatments were applied with a backpack sprayer calibrated to deliver 40 gal/A at 75 to 80 psi through TX-18 hollow cone nozzles. Treatment applications were made on 22 Fe, 8 Mar, 1 Mar, 8 Mar, 15 Mar and 22 Mar. Plots were irrigated once a week using overhead irrigation. Natural inoculum was relied upon. Disease severity was assessed on 11 and 21 Mar, and 4 Apr as percent leaf area with symptoms per plot. Area under disease progress curve (AUDPC) was calculated using disease severity ratings from the four assessment periods. Data were analyzed in the software ARM using the Fisher's protected LSD test at P≤0.05.

Results and discussion

The mean rainfall received during Dec (2018) and Apr (2019) was 10.0 in. and 3.5 in., respectively. The average high and low temperatures for the month of Dec (2018) were 61° and 45° F, respectively and for the month of Apr (2019) were 79° and 56° F, respectively.

Botrytis leaf blight symptoms first appeared on 11 Mar, significant differences in disease severity were observed among untreated check (66.2%), and fungicide treated plots. Disease progressed over a four-week period and reached 86.3% (disease severity) in untreated plots by the end of the trial. Final disease severity and AUDPC values were not significant among treatments; however, they were significantly lower than untreated check plots. Phytotoxicity was not observed with any of the treatments used.

Table 1. Severity of diseases in the initial and final stages of Botrytis leaf blight, and area under disease progress curve (AUDPC) according to fungicides program.

<table>
<tr><th>Treatment and rate of product per acre</th><th>Application No.[z]</th><th>Initial disease severity (%) on 11 Mar[y]</th><th>Final disease severity (%) on 4 Apr[x]</th><th>AUDPC[v]</th></tr>
<tr><td>Luna Tranquility 16 fl oz.</td><td>1-6</td><td rowspan="3">33.2 b[x]</td><td rowspan="3">43.8 b</td><td rowspan="3">922.8 b</td></tr>
<tr><td>Inspire Super 20 fl oz.</td><td>1,2,4</td></tr>
<tr><td>Scala 18 fl oz</td><td>1,2,4</td></tr>
<tr><td>Omega 500 1 pt</td><td>1-6</td><td rowspan="3">24.5 b</td><td rowspan="3">47.5 b</td><td rowspan="3">951.8 b</td></tr>
<tr><td>Inspire Super 20 fl oz.</td><td>1,2,4</td></tr>
<tr><td>Scala 18 fl oz</td><td>1,2,4</td></tr>
<tr><td>Miravis Prime 11.4 fl oz</td><td>1,4</td><td rowspan="3">34.1 b</td><td rowspan="3">41.3 b</td><td rowspan="3">875.7 b</td></tr>
<tr><td>Inspire Super 20 fl oz.</td><td>2,5</td></tr>
<tr><td>Scala 18 fl oz</td><td>3,6</td></tr>
<tr><td>Untreated check</td><td></td><td>66.2 a</td><td>86.3 a</td><td>1880.7 a</td></tr>
</table>

[z]Application dates were 1=22 Feb; 2=8 Mar; 3=1 Mar; 4=8 Mar; 5=15 Mar; 6=22 Mar.
[y]Disease severity was rated on a 0 to 100 scale (0 = no infection and 100 = 100% of leaf area infection) on 11 and 21 Mar, and 4 Apr.
[x]Means followed by the same letter in each column are not significantly different according to Fisher's test at P<0.05.
[w]AUDPC was calculated from ratings taken on 11 and 21 Mar, and 4 Apr.

Evaluation of Onion Growth Stage Directed Chemical Applications and Thrips Management Program on Center Rot Incidence in Onion Bulbs in Georgia

B.Dutta, C. Tyson, J. Edenfield, Z.Williams, S. Tanner, A. Shirley, B. Reeves, S. Powell

Material and methods

Four rows of 'Alison' onions were transplanted into 6-ft beds (panels) on 11 Dec at the Vidalia Onion and Vegetable Research Center located in Lyons, GA. The fertility program was consistent with University of Georgia Extension Service recommendations. Experimental design consisted of a randomized complete block with four replications. Treated plots were 20-ft long and were separated on each side by non-treated border panels. Plots were separated by a 3 ft bare-ground buffer within the row. Treatments were applied with a backpack sprayer calibrated to deliver 33 gal/A at 40 psi through TX-18 hollow cone nozzles. Applications were made at two growth stages (bulb initiation and bulb swelling) with a total of three applications per growth stage at 7-day intervals. Bactericide treatments were applied with or without an insecticide program for thrips management. Thrips management program was followed according to the UGA Cooperative Extension recommendation. Natural infection was relied upon. Plots not treated with bactericides were considered as negative control. Center rot bulb symptoms were assessed 10 days after harvest following incubation at 28° C and 50% RH on 17 May. Marketable yield was also calculated for each treatment. Data for mean center rot incidence and marketable yield were analyzed within

each growth stage using the Fisher's protected LSD test at $P \leq 0.05$. Weather during the experiment was moderately wet with 15.5 in. of accumulation occurring between 15 Mar and 30 Apr.

Results and discussion

For treatments where thrips management program was not utilized, non-bactericide treated check had significantly higher center rot incidence in bulb and lower marketable yield compared to other treatments. Treatments with either Agrititan or Kocide 3000+Agrititan had significantly lower center rot bulb incidence and higher marketable yield compared to other treatments. Bulb incidence and marketable yield for Nordox or Kocide 3000 were not significantly different from each other. For treatments where thrips management program was followed, non-bactericide treated check had significantly higher center rot incidence in bulb and lower marketable yield compared to other treatments. Treatment with Kocide 3000+Agrititan had significantly lower center rot bulb incidence and higher marketable yield compared to other treatments. Bulb incidence for Nordox or Kocide 300 was not significantly different from each other but lower than Agrititan. Phytoxicity was not observed with any of the treatments.

Table 1. Severity of diseases in the initial and final stages of Botrytis leaf blight, and area under disease progress curve (AUDPC) according to fungicides program.

Growth stage, treatment and rate per acre	App timing[z]	Center rot bulb incidence (%)[y]	Marketable yield (lb./plot)[v]
Bulb initiation and bulb swelling **without** thrips management program			
Kocide 3000 1.5 lb	1-6	48.4 b	52.2 x
Agrititan 1% (v/v)	1-6	31.2 c	55.5 y
Kocide 3000 1.5 lb	1-6		
+Agrititan 1% (v/v)	1-6	27.6 c	69.2 x
Nordox 1lb	1-6	44.6 b	
Untreated check	-	69.7 a	27.5 z
Bulb initiation and bulb swelling **with** thrips management program			
Kocide 3000 1.5 lb	1-6	34.2 c	58.5 x
Agrititan 1% (v/v)	1-6	41.6 b	35.5 y
Kocide 3000 1.5 lb	1-6	18.4 d	62.7 w
+Agrititan 1% (v/v)	1-6		
Nordox 1lb	1-6	33.5 c	
Untreated check	-	53.5 a	18.2 z
Untreated check	***-***	***53.5 a***	***18.2 z***

[z]Bactericide-treatment applications were made: 1 = 18 Feb, 2 = 25 Feb, 3 = 4 Mar, 4 = 11 Mar, 5 = 18 Mar, 6 = 25 Mar.
[y]Mean center rot bulb incidence was calculated as number of bulbs with center rot/total number of bulbs evaluated × 100.
[x]Means followed by the same letter(s) within each growth stage are not significantly different according to Fisher's protected LSD test at P≤0.05.
[v]Mean marketable yield (lb) per treatment calculated as difference between mean field weight (lb) and weight of cull (lb).

Transplant Onion Tolerance to Pyroxasulfone

S. Culpepper, J. Vance

Introduction

In transplant onion, the standard weed management program consists of applying Prowl plus Goal within two days of transplanting into a weed free field. However in recent years, wild radish has been emerging later in the growing season and becoming a problem at harvest for a few growers. Thus, research was conducted to determine transplant onion response to pyroxasulfone and to determine if the herbicide in a system with Prowl plus Goal could improve late-season wild radish control.

Materials and methods

An experiment was conducted during 2018-2019 at the Vidalia Onion Research Farm located near Reidsville, Georgia. Plethora onions were transplanted on November 28, 2018 followed one day later with an at-plant application of Prowl plus Goal applied over the entire study except for the non-treated control. Pyroxasulfone treatments were then applied as follows:

1. Pyroxasulfone 1X rate Jan 10, 2019.
2. Pyroxasulfone 2X rate Jan 10, 2019.
3. Pyroxasulfone 1X rate Feb 25, 2019.
4. Pyroxasulfone 2X rate Feb 25, 2019.

Weed control (wild radish and cutleaf eveningprimrose) and crop response were measured throughout the season followed by harvest.

Results and discussion

Crop Response: Goal plus Prowl did not visually damage onions. Similarly, pyroxasulfone regardless of application rate or timing did not visually harm onions. Stand counts and heights taken throughout the season also noted no negative impact on onions by any herbicide treatment.

Weed Response:

- *Wild radish:* Prowl plus Goal provided excellent early season control; however, in mid-January a significant emergence flush occurred leading to only 83% control at harvest. The addition of pyroxasulfone (either rate) in January to that system noted a 13 to 15% increase in control at harvest; in contrast, applying pyroxasulfone in February did not improve control.
- *Cutleaf eveningprimrose:* Prowl plus Goal provided excellent early season control; however, in mid-January a significant emergence flush occurred leading to only 88% control at harvest. The addition of pyroxasulfone (either rate) in January to that system noted a 6 to 10% increase in control at harvest; in contrast, applying pyroxasulfone in February did not improve control.

Onion Yields: Since stand was not influenced by herbicide treatment, 30 onions per plot were harvested and weighed to determine herbicide treatment impact on yield. The addition of pyroxasulfone (either rate) in January following Goal plus Prowl at-plant noted 11 to 13% higher onion weights when compared to Prowl plus Goal by itself; this response was a result of improved weed control

Thrips Control in Onion Spray Trial

D. Riley

Material and methods

In 2019, an insecticide efficacy trial was conducted to evaluate various chemicals for the control of thrips in onions at the Vidalia Onion and Vegetable Research Center, Tattnall County, Georgia. Onions, hyb. CandyAnn, were transplanted on November 10, 2018 into four rows per bed at approximately 2-3 inches between plants and maintained with standard cultural practices. A total of 600 lb./acre of 10-10-10 was applied to clay loam field plots. Irrigation was applied at about one half inch weekly with an overhead sprinkler system if there was no rainfall. Total numbers of thrips per plant were counted on 10 plants per plot on Feb 6, Mar 8, Mar 29, Apr 4, and Apr 17 and collected from onion tops during the test to determine species of thrips. Most of the thrips were collected from the plant after bulb formation in March. Five applications of insecticide were made on Mar 5, 20, 29 and Apr 11. Foliar insecticide treatments were applied with a tractor mounted, sprayer delivering 54 GPA with six TX18 hollow cone tips per bed. Products used included:

Radiant, spinetoram, is a nicotinic acetylcholine receptor (nachr) allosteric modulator - IRAC Group 5 with broad spectrum activity; **Torac,** tolfenpyrad, is a mitochondrial complex 1 electron transport inhibitor – IRAC Group 21A with both insecticide and Group 39 fungicide activity; **experimental** insecticide product; **unsprayed** check. All spray treatments included the adjuvant Kinetic at 0.25% v/v. Harvested onions were from the plot-center 15 ft of bed.

Overall proportion of adult thrips

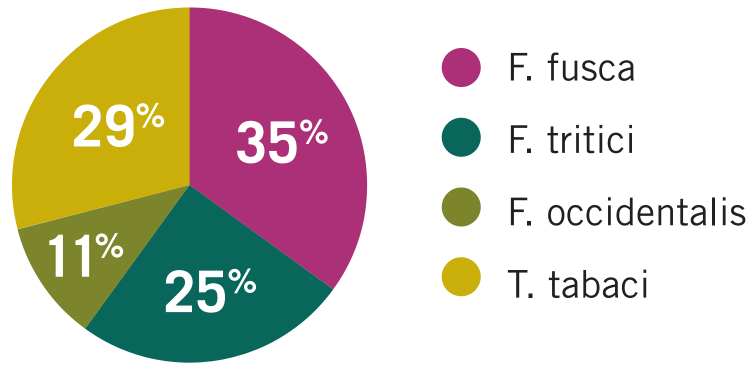

Figure 1. Overall proportion of adult thrips

Results and discussion

Tobacco thrips and onion thrips were the most prevalent species in this test (see graph). The results indicated that early in the test (Table 1), all insecticide treatments provided significant control of thrips which was 75% non-*T. tabaci* according to the adult sample. The season average was 71% non-*T. tabaci* indicating that *T. tabaci* was slightly more prevalent at the end of the test. The Radiant and Torac treatments provided consistent thrips control in onions (Tables 1), the experimental treatment appeared to be weak on *T. tabaci* overall. However, thrips numbers were too low to adequately evaluate effects on yield (Table 2). The only effect that was marginally significant was an increase in small bulb size in the check plots where thrips were not controlled. Torac treatment resulted in the high bulb weight, but, again, the effect was not statistically significant.

Table 1. Treatment effects on thrips collected at the VOVRC, near Reidsville GA per 10 plants by date in 2019.

Treatment and product rate/acre	Total thrips on Mar 8	Total thrips on APR 4	*F. occidentalis* on APR 4	thrips nymphs on APR 4	*F. fusca* on APR 17	Not *T. tabaci* on APR 17
Untreated check	1.0a*	5.75a^{m}	1.00a*	4.25a*	0.75a*	1.25a*
Radiant 1SC 10 fl oz/a	0.0b	1.00b	0.25b	0.00b	0.25b	0.25b
Torac 21 fl oz/a	0.0b	1.00b	0.00b	0.50b	0.00b	0.25 b
EXP 3.2 fl oz/a	0.0b	0.75b	0.00b	0.00b	0.25b	1.00a
EXP 6.4 fl oz/a	0.0b	1.25b	0.00b	0.75b	0.25b	1.25a
EXP 9.6 fl oz/a	0.0b	2.25ab	0.00b	0.00b	0.00b	0.00b

* Means within columns followed by the same letter not significantly (LSD, P<0.05) or
^{m} (LSD, P<0.05) with a marginal spray effect.

Table 2. Treatment effects on over all thrips and onion yield at the VOVRC, near Reidsville, Georgia, per 15 ft of bed spring 2019.

Treatment and product rate/acre	Total thrips over all dates	No. of small size bulbs	*Wt. of large size bulbs*	Wt. of jumbo size bulbs	*Total wt. of bulbs per plot*	Not *T. tabaci* on APR 17
Untreated check	2.20a*	69.5a[m]	15.3a*	10.1a*	78.5a*	1.25a*
Radiant 1SC 10 fl oz/a	0.70a	48.0b	18.2a	10.9a	71.6a	0.25b
Torac 21 fl oz/a	0.75a	62.3ab	17.9a	16.0a	83.9a	0.25 b
EXP 3.2 fl oz/a	1.20a	44.0b	16.2a	9.4a	66.1a	1.00a
EXP 6.4 fl oz/a	0.65a	49.0b	18.6a	12.9a	78.4a	1.25a
EXP 9.6 fl oz/a	1.65a	56.5ab	14.5a	13.6a	74.9a	0.00b

* Means within columns followed by the same letter not significantly (LSD, P<0.05)
[m] (LSD, P<0.05) with a marginal spray effect.

‘Vidalia’ Onion (*Allium cepa* L.) Bulb Yield as Affected by Rate of Organic Fertilization

J. Díaz-Pérez, J. Bautista, G. Gunawan, A. Bateman

Introduction

There is a growing interest in organic fertilizers because of increased demand for organic sweet onions and other vegetables. There are, however, limited studies on sweet onion bulb yield and quality in response to organic fertilization. The objective of this study was to evaluate the effects of organic fertilizer rate on ‘Vidalia’ onion bulb yield.

Materials and methods

Experiments were conducted at the Horticulture Farm, Tifton Campus, University of Georgia. There were five organic fertilization treatments [microSTART60 3-2-3 organic fertilizer, Perdue AgriRecycle, LLC; 3-2-3 equivalent to 0, 54, 108, 160 and 214 lb./acre of N]. Experimental design was a randomized complete block with six replications and five treatments (N rate). The experimental unit consisted of a 20 ft long bed.

The soil of the farm is a Tifton Sandy Loam (a fine loamy-siliceous, thermic Plinthic Kandiudults) with organic matter content of 0.5% and a pH of 6.5. Plants were grown on raised beds (6 ft from center to center of each bed). Each bed had four rows 9 inches apart, with an in-row plant spacing of 6 in. Beds were covered with black plastic film mulch and there were two lines of drip tape per bed, each drip tape being located midway between alternate rows. Before laying the plastic mulch and before transplanting, N treatments were applied to the soil (only to the bed area) as organic fertilizer (microSTART60 3-2-3, Perdue AgriRecycle, LLC). No additional fertilizer was applied after transplanting. Onion seedlings ‘Yellow Granex PRR’ grown at the Vidalia Onion and Vegetable Research Center, University of Georgia, Lyons, GA, were transplanted on 12 Dec. 2012 and 2013.

Results and discussion

Total and marketable yields and individual bulb weight increased quadratically with increasing organic fertilization rate and responses failed to reach a plateau. The fraction of extra-large bulb increased with increasing organic fertilization rate. Incidence of onion bolting was maximal at 54 lb/acre of N and decreased with increasing organic fertilization rate. The percentage of bulb dry weight was highest in the unfertilized control and decreased with increasing organic fertilization rate. Organic fertilization rate had no consistent impact on bulb soluble solids content and pungency (measured as pyruvate concentration) in the two seasons.

Incidence of onion bolting (mean incidence = 7.0 %) was maximal at 54 lb/acre of N and decreased with increasing fertilization rates (Table 1). The incidences of double bulbs (mean = 1.2%), botrytis rot (mean = 0.8%) and sour skin (mean = 15.0%) increased with increasing fertilization rate.

Conclusion

Onion bulb yields increased with increasing organic fertilization rate, while incidences of bulb diseases responded differently to N rate. Botrytis rot was the main cause of postharvest bulb decay in all organic fertilization rates.

Table 1. Disorders, diseases, and quality attributes of sweet onion bulb immediately after harvest as influenced by organic fertilizer rate. Nitrogen was provided by chicken manure organic fertilizer (3-2-3 N-P-K), Tifton, Georgia.

Treatment	Bolting (%)	Doubles (%)	Botrytis rot (%)	Sour skin (%)
Fertilizer (lb./acre N)[z]				
0	4.2	0.4	0.0	5.2
54	18.3	0.7	0.6	13.9
108	9.1	1.3	1.5	18.5
160	5.6	1.3	0.9	18.7
214	4.1	1.5	2.4	18.6
Significance	**0.010**	**0.103**	**0.499**	**0.090**
L[y]	0.264	0.024	0.035	0.005
Q	0.049	0.065	0.110	0.005

[z] Organic fertilizer (Perdue) applied before planting.
[y] L = linear; Q = quadratic response.

A Survey of Plant-Parasitic Nematodes Associated with Onion in Georgia

A. Hajihassani, J. Marquez, C. Tyson,
A. Shirley, J. Edenfield

Introduction

Plant-parasitic nematodes are known to cause varying degrees of economic damage in onion production. Nematodes cause critical yield constraints often without causing distinct symptoms. Damage symptoms caused by the nematodes include yellowing, reduced onion stand, stunted roots and poor growth that can be confused with fertility imbalance, drought, or poor cultural practices. In the field, nematodes contribute to increased damage and impose additional stress to onions which increases water and fertilizer consumption, and pesticide applications due to impaired root systems. In Georgia, onion crops are subjected to damage by different types of nematodes. Survey for plant-parasitic nematodes are valuable to determine the presence and distribution of various nematode species on a regional basis, and yield loss estimates can be enhanced by a better understanding of nematode dispersal (Kotcon, 1990). Therefore, a survey was conducted to document the incidence and abundance of plant-parasitic nematodes associated with onion.

Materials and methods

29 soil samples were randomly collected from onion fields in Tattnall and Toombs counties during the end of a growing onion season in April and May 2018. Each composite sample consisted of 30-40 soil cores (1-inch-diam. x 12-inch deep) taken at about every 9-12 feet across rows in a diagonal transect of each field. Each composite soil sample was thoroughly mixed and a 100 cm3 sub-sample was used for nematode extraction by sieving and centrifugal flotation method (Jenkins, 1964). Plant-parasitic nematodes were identified to the genus level based on morphological features of juveniles and adults and counted using an inverted microscope.

Results and discussion

In soil samples from onion fields a total of 7 genera were detected (Table 1). The most frequently found genera were *Meloidogyne* and *Paratrichodorus* both of which occurred in over 62% of the samples (Table 1). Prior to conducting this survey in the region, the species of stubby-root nematode was identified as P. minor using both morphological and DNA-based methods (Hajihassani *et al.*, 2018). The average number of *Meloidogyne* spp. and *Paratrichodorus* per 100 cm3 sample was around 23 and 8. Incidences of other nematode genera were 48% for *Mesocriconema*, 41% for *Helicotylenchus*, and 27% for *Hoplolaimus*, 14% for *Heterodera* and 10% for P*ratylenchus*.

Table 1. Disorders, diseases, and quality attributes of sweet onion bulb immediately after harvest as influenced by organic fertilizer rate. Nitrogen was provided by chicken manure organic fertilizer (3-2-3 N-P-K), Tifton, Georgia.

Nematode Genera	Incidence	Abundance (Numbers of second-stage juveniles/100 cm^3 of soil)		
		Minimum	Maximum	Mean
Root-knot (*Meloidogyne* spp.)	62%	1	150	23.1
Stubby-root (*Paratrichodorus* spp.)	62%	1	32	8.3
Ring (*Mesocriconema* spp.)	48%	2	126	20.1
Spiral (*Helicotylenchus* spp.)	41%	2	170	39.5
Lance (*Hoplolaimus* spp.)	27%	2	8	3.5
Cyst (*Heterodera* spp.)	14%	12 (juveniles)	32 (juveniles)	2.7
Root lesion (*Pratylenchus* spp.)	10%	2	4	2.6

Conclusion

Overall, root-knot (*Meloidogyne* spp.) and stubby-root (*Paratrichodorus* spp.) nematodes were the most prevalent nematode genera under onion production systems with an incidence of 62% of the samples. A damage threshold for the root-knot and stubby-root nematodes has not been established in onion. Therefore, the economic losses to onions by these nematode species are currently unknown. Several onion fields had high population densities of *Meloidogyne* spp.; however, no information is available from Tattnall and Toombs counties on the effects of root-knot nematodes on onion growth and yield. Although ring (*Mesocriconema* spp.) and spiral (*Helicotylenchus* spp.) nematodes are not known as causing damage to onion, their presence in relatively large numbers in the samples is interesting and warrants further investigations. The cyst nematodes occurred in some of the onion fields in Tattnall County and need to be identified at the species level. This survey indicates that proper control tactics such as pre-plant soil treatment with nematicides need to be considered by growers to manage nematode pests in onion.

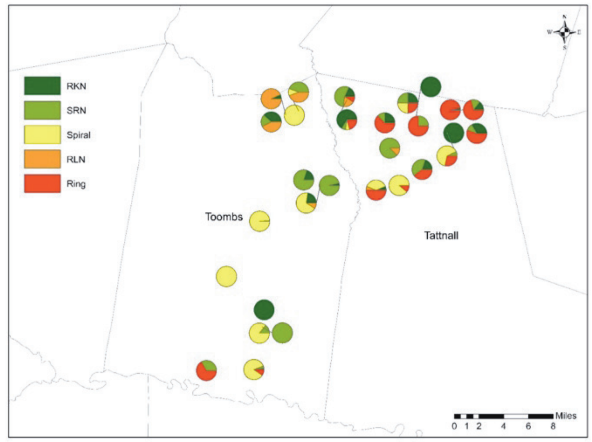

Figure 1. Distribution of major plant-parasitic nematodes (RKN: root-knot, SRN: stubby-root, Spiral, RLN: root-lesion, and Ring nematodes) in each onion field surveyed in 2018.

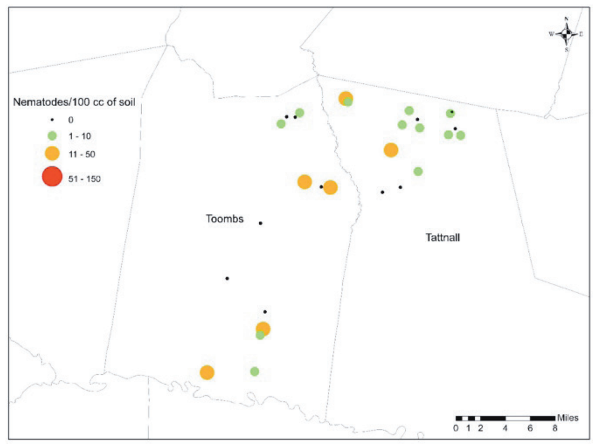

Figure 2. Distribution and abundance of stubby-root nematodes (*Paratrichodorus* spp.) in 29 onion fields surveyed in Georgia in 2018.

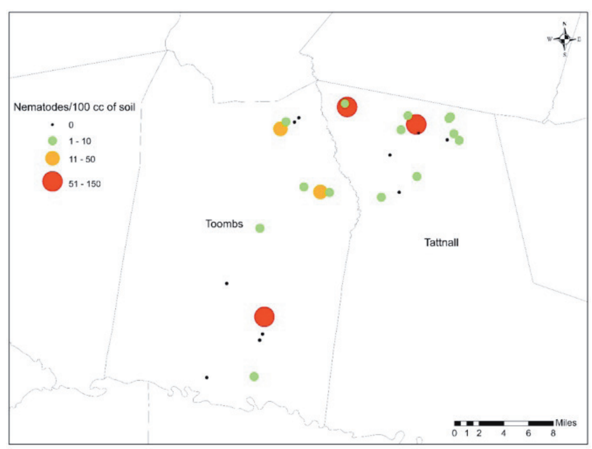

Figure 3. Distribution and abundance of root-knot nematodes (*Meloidogyne* spp.) in 29 onion fields surveyed in Georgia in 2018.

A Simple Virulence Assay for Center Rot Disease on Onion Production

B. Duta, B. Kvitko

Introduction

Over the last year we have made significant progress towards characterizing the genetic basis of virulence in *Pantoea* bacteria causing center rot disease of onion. This work was conducted with an eye towards developing improved diagnostic tools to quickly and accurately identify problematic strains and to inform the development of new center rot management strategies. Onion center rot is a recurring disease of concern in the Vidalia region and many other onion producing regions nationwide. Center rot is caused by several different species of *Pantoea* bacteria although *Pantoea ananatis* is most commonly associated with the disease. A major obstacle for accurate diagnosis of center rot is that not all *P. ananatis* strains are able to cause disease on onion and the genetic basis for onion virulence is unknown. *Pantoea ananatis* is unusual among bacterial pathogens in that strains that are highly virulent on onion lack the virulence-associated protein secretion systems that are essential for other bacterial plant pathogens. Based on the observation that onion virulent *Pantoea* strains are able to clear the color from inoculated red onion scales, we developed a simple virulence assay based on produce onions that is easy to perform and is not dependent on a supply of vegetative onion plants.

Materials and methods

Based on red scale clearing and foliar assays, we assembled a panel of P. *ananatis* strains with variable onion virulence. Whole genome sequencing of this strain panel followed by comparative genomics analysis allowed us to identify four clusters of plasmid-borne genes, we termed OVRs (Onion Virulence Regions) that strongly correlated with onion virulence. Similar work conducted in the lab of Steve Beer at Cornell University identified a chromosomal cluster of genes they termed HIVIR (High Virulence) predicted to code for the synthesis of an, as of yet, unidentified phosphonate phytotoxin that functions as a primary virulence factor to kill host plant cells. When the plant cell vacuole is disrupted, onion and other alliaceous plants generate the characteristically pungent phytoanticipin allicin. Allicin is an antimicrobial reactive sulfur compound and natural oxidant that reacts spontaneously with thiol groups and depletes the reduced glutathione pool. Among the four clusters of plasmid-borne genes associated with onion virulence, we identified a sub-cluster of 11 genes that was enriched in annotated functions associated with sulfur metabolism and thiol-redox homeostasis.

Results and discussion

We found that engineered deletion strains lacking the 11 genes reached 100-fold lower populations in onion bulb scales. Both natural variant *Pantoea* isolates and engineered mutant strains lacking these genes had major growth defects in red onion extracts as well as increased sensitivity to garlic extract and to pure allicin. Therefore we have named these 11 genes the Alt (allicin tolerance) gene cluster. A nearly identical cluster of plasmid-borne genes was identified in a sequenced onion pathogenic *Enterobacter cloacae* strain. This strain also demonstrated higher tolerance to allicin than a strain lacking these genes. In an onion neck stab assay we found that both a functional HIVIR chromosomal cluster and the Alt gene plasmid cluster were required for *Pantoea* to colonize onion bulbs. Based on these observations we propose that *Pantoea ananatis* uses a novel virulence strategy to infect onions. Onion virulent *Pantoea* are likely acting necrotrophs. We hypothesize that they deploy a non-host-specific phosphonate phytotoxin to kill onion cells and disrupt host immunity. The presence of plasmid-borne allicin tolerance genes allows the pathogen to tolerate the effects of reactive sulfur species released by damaged host tissue and colonize onion bulbs to high loads.

Interestingly, the HIVIR and Alt gene loci are unevenly distributed among *Pantoea ananatis* strains. Thus it is possible that specific *Pantoea* strains causing a foliar disease outbreak in onion would be unlikely to progress to causing disease in bulbs if that strain lacked happened to lack the alt genes. With this in mind, we have developed a set of multiplex PCR primers to screen *Pantoea* strains for the presence of the HIVIR and alt gene clusters. Strains with both virulence clusters would present the highest risk for bulb disease.

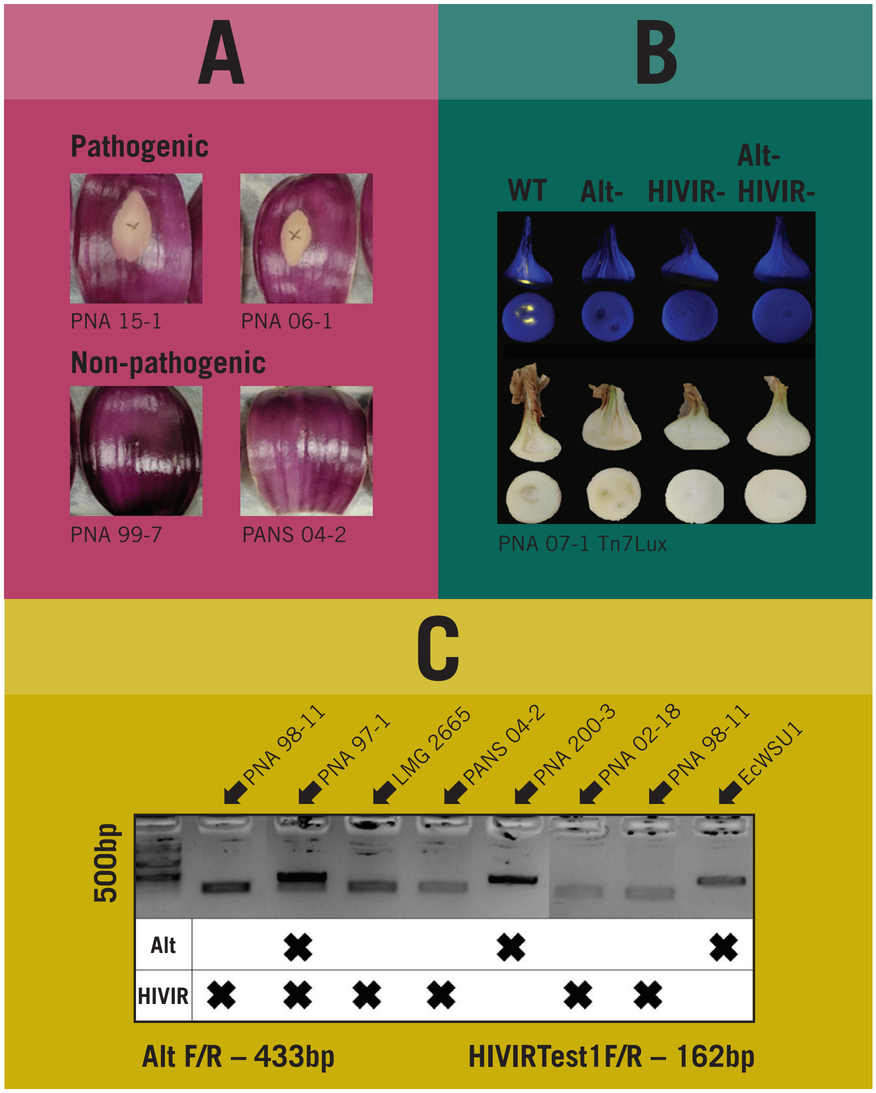

Figure 1.

A. Red scale clearing onion virulence assay. Representative results after inoculation with pathogenic and non-pathogenic *Pantoea* strains.

B. Both Alt and HIVIR are required for bulb infection after neck inoculation. The yellow in false color image are bioluminescently labeled *Pantoea*.

C. Multiplex PCR for the Alt and HIVIR onion virulence loci.