GEORGIA ONION RESEARCH-EXTENSION REPORT 2010

THE UNIVERSITY OF GEORGIA

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J. Scott Angle, Dean and Director

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Vidalia Onion Committee

VIDALIA ONION VARIETY TRIAL, 2009-2010

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Introduction

In an effort to improve onion production and quality, onion varieties were once again evaluated and compared during the 2009-2010 season.

Materials and Methods

There were 49 varieties in the trial. Varieties 1-15 (Table 1) were sown on September 3, 2009, and transplanted on November 2, 2009 and were considered early varieties representing yellow onions. Varieties 16-49 (Table 1) were sown on September 25, 2008 and transplanted on November 30, 2009. Varieties 16-42 were considered standard varieties representing yellow onions and varieties 43-49 were red onions. Plant beds were sown in high density plantings of 60 seed/linear foot. Row spacing was 12 inches with 4 inch in-row spacing.

The trials had the following fertility and pest management programs:

Fertility Program Early Planting

Date	Amount	Fertilizer	Formulation
9/1	600 lbs.	5-10-15	30-60-90
9/3	150 lbs.	18-46-0	27-69-0
9/29	200 lbs.	10-10-10	20-20-20
10/1	200lbs.	CaNO3	31-0-0
10/19	200 lbs.	CaNO3	31-0-0
			139-149-110

Fertility Program Standard Planting

Date	Amount	Fertilizer	Formulation
9/16	600 lbs.	5-10-15	30-60-90
9/28	150 lbs.	18-46-0	27-69-0
10/19	200 lbs.	10-10-10	20-20-20
10/23	200 lbs.	CaNO3	31-0-0
11/2	150 lbs	18-46-0	27-69-0
			135-218-110

Pesticide Program Early Planting

Date	Amount/A	Material
9/3/09	3.0 pts.	Dacthal
11/5/09	1.0 qt.	Goal
11/5/09	1.5 pts.	Prowl
2/11/10	14 oz.	Pristine
3/5/10	11/2 pts.	Rovral
3/16/10	14 oz.	Pristine

Pesticide Program Standard Planting

Date	Amount /A	Material
9/25/09	3.0 pts.	Dacthal
1/14/10	1.5 pts.	Goal
1/14/10	1.5 pts.	Prowl
2/11/10	14 oz.	Pristine
3/5/10	1.5 pts	Rovral
3/16/10	14 oz.	Pristine

The experiment was a randomized complete block design with four replications. Each plot was 25 feet long with a 5 ft in-row alley. Onions were pulled, laid on the ground for two to three days prior to clipping to cure by exposure to sunlight, then weighed to determine total green weight. After 24-48 hours of additional forced-air curing, onions were graded for size and marketability.

Size and Quality parameters were:

Colossal:	over 4 inches in diameter
Jumbo:	3-4 inches
Medium:	2-3 inches
Cull:	Off shaped, off color, damaged, diseased or onions below 2 inches

Approximately 50 lbs of onions were transported the Vidalia Onion Research Laboratory in Tifton, Georgia for storage testing. A 10-bulb sample was used to

determine pungency, LF, and sugar profiles.

Results and Discussion

Cull rates are expressed as % marketable onions and should be noted. In the early trial most culls were either off-shaped (deeper than they were round) or were spongy in texture. In the standard trial, culls were predominantly related to bacterial infections associated with center rot (*Pantoea ananatis*) or sour skin (*Burkholderia cepacia*). Because of the excessively cold conditions experienced during the winter and early spring months, entries in the standard variety trial gained size and matured slowly. As environmental conditions improved, onions were more prone to bacterial infections. By the May 24th harvest, cull rates were greatly escalated for many varieties due to center rot, sour skin and other diseases. One should pay particularly close attention to the late cultivars with higher % marketability as these data imply higher tolerance to center Rot and/or sour skin.

Dry Weight Yield. Yield is reported as number of 60 lb bags/A for total dry weight yield subdivided by planting date and by yellow vs. red onions (Tables 2, 3, 4). Early planted onions had a range of 855 -161 60 lb bags/A (25.7- 4.8 tons/A). Varieties Candy Kim, WI-129, DP Sweet 1407, SSC 2893, WI-131 and Candy Ann had the highest yields among the early planted varieties and were not significantly different from one another (Table 2). Later planted yellow onions had a range of 1,349 - 619 60 lb bags/A (40.5 – 18.6 tons/A). Varieties Sweet Caroline, NUN 1006, Miss Megan, Century, HSX-70300H-Y and Mr. Buck had the highest yields among the later planted varieties and were not significantly different from one another (Table 3). Later planted red onions had a range of 1,246 – 945 60 lb bags/A (37.4 – 28.4 tons/A). Varieties Mata Hari, J 3005, Lambada, J 3004 and Pinot Rouge had the highest yields among the later planted red varieties and were not significantly different from one another (Table 4).

Marketable Yield. Marketable yield is reported as number of 40 lb bags/A and is subdivided by planting date and by yellow vs. red onions (Tables 5,6,7). Early planted onions had a range 834 – 225 of 40 lb bags/A. Varieties Candy Ann, DP Sweet 1407, SSC 1535 F1, WI-129, Candy Kim, Sweet Deal and Honeybee had the highest marketable yields among the early planted varieties and were not significantly different from one another (Table 5). Later planted yellow onions had a range of 1,476 – 536 40 lb bags/A. Varieties J 3003 and Century had the highest marketable yields among the later planted varieties and were not significantly different from one another (Table 6). Later planted red onions had a range of 1,428-804 40 lb bags/A. Varieties J 3005, Mati Hari and Red Coach had the highest marketable yields among the later planted red varieties and were not significantly different from one another (Table 7).

Percent Marketable Yield. Percent Marketable yield is subdivided by planting date and by yellow vs. red onions (Tables 8, 9, 10). Early planted onions had a range of 92.7 - 42.6 % marketable yield. Varieties NUN 1003, NUN 1004, NUN

1002, SSC 1535 F1, and SVR 07956013 had the highest % marketable yields among the early planted varieties and were not significantly different from one another (Table 8). Later planted yellow onions had a range of 91.3 – 26.6 % marketable yield. Varieties J 3006, J 3003, Sapelo Sweet and Nirvana had the highest % marketable yields among the later planted varieties and were not significantly different from one another (Table 9). Later planted red onions had a range of 82.9 – 44.5 % marketable yield. Varieties Red Coach, J 3005, and J 3004 had the highest % marketable yields among the later planted red varieties and were not significantly different from one another (Table 10).

Colossal Yield. Yield according to size grade Colossal is also subdivided by planting date and by yellow vs. red onions (Tables 11, 12, 13). Early planted onions had a range of 120 – 10 40 lb bags of Colossals/A. Varieties Wi-129, SSC 1535 F1, Sugar Belle, NUN 1004, Wi-131, DP Sweet 1407, SVR 07956013, and Candy Kim had the highest yields of Colossals/A among the early planted varieties and were not significantly different from one another (Table 11). Later planted yellow onions had a range of 511 - 6 40 lb bags of Colossals/A. Varieties Miss Megan and Mr. Buck had the highest yields for Colossals among the later planted varieties and were not significantly different from one another (Table 12). Later planted red onions had a range of 415 – 173 40 lb bags of Colossals/A. Varieties J 3005, Mata Hari, J 3004, and Red Coach had the highest yields of Colossals among the later planted red varieties and were not significantly different from one another (Table 13).

Jumbo Yield. Yield according to size grade Jumbo is subdivided by planting date and by yellow vs. red onions (Tables 14, 15, 16). Early planted onions had a range of 702 - 168 40 lb bags of Jumbos/A. Varieties Candy Ann, DP Sweet 1407, Wi-129, Candy Kim, Sweet Deal, SSC 1535 F1, Honeybee and SSC 2893 had the highest yields of Jumbos/A among the early planted varieties and were not significantly different from one another (Table 14). Later planted yellow onions had a range of 1,125 - 291 40 lb bags of Jumbos/A. Varieties J 3003, Century and Nirvana had the highest yields for Jumbos among the later planted varieties and were not significantly different from one another (Table 15). Later planted red onions had a range of 995 - 561 40 lb bags of Jumbos/A. Varieties Mata Hari, J 3005, Pinot Rouge and Red Coach had the highest yields of Jumbos among the later planted red varieties and were not significantly different from one another (Table 16).

Medium Yield. Yield according to size grade Medium is subdivided by planting date and by yellow vs. red onions (Tables 17, 18, 19). Early planted onions had a range of 113 - 19 40 lb bags of Mediums/A. Varieties Candy Ann and SSC 1535 F1had the highest yields of Mediums/A among the early planted varieties and were not significantly different from one another (Table 17). Later planted yellow onions had a range of 176 - 17 40 lb bags of Mediums/A. Varieties J 3006 and Sapelo Sweet had the highest yields for Mediums among the later planted varieties and were not significantly different from one another (Table 18). Later planted red onions had a range of 57 - 15 40 lb bags of Mediums/A. Varieties J 3004, HSX-

8099H-R and Pinot Rougehad the highest yields of Mediums among the later planted red varieties and were not significantly different from one another (Table 19).

 # Seed Stems. Number of seed stems/A is subdivided by planting date and by yellow vs. red onions (Tables 20, 21, 22). Early planted onions had a range of 53,724 – 4,719 seed stems/A. The variety NUN 1003 had the highest # seed stems/A among the early planted varieties (Table 20). Later planted yellow onions had a range of 5,373 – 0 seed stems/A. Varieties Sweet Uno and Miss Meagan had the highest # seed stems/A among the later planted varieties and were not significantly different from one another (Table 21). Later planted red onions had a range of 1,742 – 0 seed stems/A. The variety Red Coach had the highest # seed stems/A among the later planted red varieties (Table 22). It was quite clear that there was a significant seed stem problem in the early planted varieties as the average for all early planted varieties was 18,644 seed stems/A. The averages for later planted standard varieties and later planted standard red varieties were 931 and 456 seed stems/A, respectively.

Postharvest Storage. Pre-storage weights for the early planting, standard planting and standard planting red onions are listed in tables 23, 24 and 25, respectively. Onions went into storage between April 22, 2010 and May 29, 2010. Total weights for early planting, standard planting and standard planting red onions after removal from storage (September 20-22, 1010) are listed in tables 26, 27 and 28, respectively. Onions were graded after storage and marketable weight and percent marketable onions by variety are listed for the early planting, standard planting and standard planting red onions in Tables 29, 30, and 31, respectively.

Pungency and flavor characteristics. Pungency and flavor characteristics are presented in Table 32. Briefly, pungency values (μmol pyruvate/ml) ranged from 2.3 (J 3005) to 4.8 (EMY Granex 110) and the mean pungency of all 49 varieties was 3.9 μmol pyruvate/ml. Percent BRIX values, essentially a specific gravity measurement of soluble solids, ranged from 8.4 (DP Sweet 1407) to 11.2 (Pinot Rouge). The mean %BRIX for all varieties was 9.3. Lachrymatory factor (LF) values (μmol/ml) ranged from 1.4 (J 3005) to 7.6 (Granex Yellow PRR) and the mean for all varieties was 4.0 μmol/ml. Finally, total sugars (Glucose + Fructose + Sucrose) as g/100 g fresh weight ranged from 4.5 (EMY 55350) to 6.5 (J 3004) and had a mean value of 5.4 g/100 g fresh weight for 44 of the varieties as total sugars data was not collected for the varieties Granex Yellow PRR, HSX-8099H-R, J 3002, Miss Megan, and Sweet Uno .

Table 1. List of onion varieties, entry number, company, onion type, seeding dates, and harvest dates for the 2009-2010 variety trial.

Entry #	Variety	Company	Onion Type	Sown	Harvest
1	WI-129	Wannamaker Seed	Early	3-Sep-09	27-Apr-10
2	WI-131	Wannamaker Seed	Early	3-Sep-09	27-Apr-10
3	Candy Ann	Solar Seeds	Early	3-Sep-09	19-Apr-10
4	Candy Kim	Solar Seeds	Early	3-Sep-09	22-Apr-10
5	Honeybee	Shamrock Seed	Early	3-Sep-09	19-Apr-10
6	Sugar Belle	Shamrock Seed	Early	3-Sep-09	29-Apr-10
7	Sweet Deal	Shamrock Seed	Early	3-Sep-09	19-Apr-10
8	SSC 1535 F1	Shamrock Seed	Early	3-Sep-09	27-Apr-10
9	SSC 2893	Shamrock Seed	Early	3-Sep-09	19-Apr-10
10	NUN 1002	Nunhems	Early	3-Sep-09	27-Apr-10
11	NUN 1003	Nunhems	Early	3-Sep-09	27-Apr-10
12	NUN 1004	Nunhems	Early	3-Sep-09	27-Apr-10
13	DP Sweet 1407	DP Seeds	Early	3-Sep-09	22-Apr-10
14	SVR 07956013	Seminis	Early	3-Sep-09	29-Apr-10
15	10229	Hazera	Early	3-Sep-09	29-Apr-10
16	Sweet Uno	Enza Zaden	Standard	25-Sep-09	24-May-10
17	Sweet Jalene	Enza Zaden	Standard	25-Sep-09	19-May-10
18	Georgia Boy	DP Seeds	Standard	25-Sep-09	19-May-10
19	Miss Megan	DP Seeds	Standard	25-Sep-09	24-May-10
20	Mr Buck	DP Seeds	Standard	25-Sep-09	24-May-10
21	Sapelo Sweet	DP Seeds	Standard	25-Sep-09	10-May-10
22	NUN 1006	Nunhems	Standard	25-Sep-09	19-May-10
23	Sweet Caroline	Nunhems	Standard	25-Sep-09	24-May-10
24	Caramelo	Nunhems	Standard	25-Sep-09	24-May-10
25	Sweet Vidalia	Nunhems	Standard	25-Sep-09	19-May-10
26	Nirvana	Nunhems	Standard	25-Sep-09	10-May-10
27	Goldeneye	Seminis	Standard	25-Sep-09	19-May-10
28	Century	Seminis	Standard	25-Sep-09	24-May-10
29	Granex Yellow PRR	Seminis	Standard	25-Sep-09	24-May-10
30	Savannah Sweet	Seminis	Standard	25-Sep-09	24-May-10
31	J 3001	Bejo	Standard	25-Sep-09	19-May-10
32	J 3002	Bejo	Standard	25-Sep-09	19-May-10
33	J 3003	Bejo	Standard	25-Sep-09	24-May-10
34	J 3006	Bejo	Standard	25-Sep-09	10-May-10
35	J 3007	Bejo	Standard	25-Sep-09	19-May-10
36	EMY 55350	Emerald Seeds	Standard	25-Sep-09	24-May-10
37	EMY 55375	Emerald Seeds	Standard	25-Sep-09	24-May-10
38	EMY Granex 110	Emerald Seeds	Standard	25-Sep-09	24-May-10
39	Sweet Jasper	Sakata Seed	Standard	25-Sep-09	24-May-10
40	Sweet Harvest	Sakata Seed	Standard	25-Sep-09	29-Apr-10
41	XON 403Y	Sakata Seed	Standard	25-Sep-09	24-May-10
42	HSX-70300H-Y	Hortag	Standard	25-Sep-09	24-May-10
43	Red Coach	Enza Zaden	Red	25-Sep-09	26-May-10
44	Pinot Rouge	DP Seeds	Red	25-Sep-09	26-May-10
45	J 3004	Bejo	Red	25-Sep-09	26-May-10
46	J 3005	Bejo	Red	25-Sep-09	26-May-10
47	Mata Hari	Nunhems	Red	25-Sep-09	26-May-10
48	Lambada	Nunhems	Red	25-Sep-09	26-May-10
49	HSX-8099H-R	Hortag	Red	25-Sep-09	26-May-10

Table 2. Dry Weight of early harvested varieties.

Harvest Date	Entry #	Variety	60 lb units/A	*P* =0.05 LSD= 139.7
4/22/2010	4	Candy Kim	855	a
4/27/2010	1	WI-129	809	ab
4/22/2010	13	DP Sweet 1407	804	ab
4/19/2010	9	SSC 2893	784	ab
4/27/2010	2	WI-131	751	ab
4/19/2010	3	Candy Ann	707	bc
4/19/2010	7	Sweet Deal	679	bcd
4/19/2010	5	Honeybee	678	bcd
4/29/2010	15	10229	607	cde
4/27/2010	8	SSC 1535 F1	605	cde
4/29/2010	6	Sugar Belle	556	def
4/29/2010	14	SVR 07956013	486	ef
4/27/2010	12	NUN 1004	418	f
4/27/2010	10	NUN 1002	242	g
4/27/2010	11	NUN 1003	161	g

Table 3. Dry Weight of standard harvested varieties.

Harvest Date	Entry #	Variety	60 lb units/A	*P* =0.05 LSD= 183.3
5/24/2010	23	Sweet Caroline	1349	a
5/19/2010	22	NUN 1006	1347	a
5/24/2010	19	Miss Megan	1294	ab
5/24/2010	28	Century	1212	abc
5/24/2010	42	HSX-70300H-Y	1208	abc
5/24/2010	20	Mr Buck	1170	abcd
5/19/2010	18	Georgia Boy	1163	bcd
5/24/2010	24	Caramelo	1152	bcde
5/19/2010	31	J3001	1144	bcdef
5/24/2010	41	XON 4031	1143	bcdef
5/19/2010	35	J3007	1140	bcdef
5/24/2010	39	Sweet Jasper	1130	bcdefg
5/24/2010	33	J3003	1125	bcdefgh
5/24/2010	36	EMY 55350	1106	cdefgh
5/19/2010	27	Goldeneye	1098	cdefgh
5/24/2010	30	Savannah Swee	1095	cdefgh
5/24/2010	29	anex Yellow PF	1042	cdefghi
5/19/2010	32	J3002	1014	defghi
5/24/2010	37	EMY 55375	978	efghi
5/19/2010	17	Sweet Jalene	966	fghi
5/19/2010	25	Sweet Vidalia	948	ghij
5/24/2010	16	Sweet Uno	944	hij
5/10/2010	26	Nirvana	910	ijk
5/10/2010	34	J3006	779	jkl
5/24/2010	38	EMY Granex 11	745	kl
5/10/2010	21	Sapelo Sweet	736	kl
4/29/2010	40	Sweet Harvest	619	l

Table 4. Dry Weight of standard harvested red varieties.

Harvest Date	Entry #	Variety	60 lb units/A	*P* =0.05 LSD= 222.2
5/26/2010	47	Mata Hari	1246	a
5/26/2010	46	J 3005	1242	a
5/26/2010	48	Lambada	1233	a
5/26/2010	45	J 3004	1074	ab
5/26/2010	44	Pinot Rouge	1056	ab
5/26/2010	43	Red Coach	1007	b
5/26/2010	49	HSX-8099H-R	945	b

Table 5. Marketable Yield early harvested varieties.

Harvest Date	Entry #	Variety	40 lb units/A	*P* =0.05 LSD= 21.5
4/19/2010	3	Candy Ann	834	a
4/22/2010	13	DP Sweet 1407	805	ab
4/27/2010	8	SSC 1535 F1	802	ab
4/27/2010	1	WI-129	794	abc
4/22/2010	4	Candy Kim	743	abcd
4/19/2010	7	Sweet Deal	706	abcd
4/19/2010	5	Honeybee	694	abcd
4/29/2010	14	SVR 07956013	630	bcd
4/19/2010	9	SSC 2893	629	bcd
4/29/2010	6	Sugar Belle	613	cd
4/27/2010	2	WI-131	612	cd
4/27/2010	12	NUN 1004	577	d
4/29/2010	15	10229	382	e
4/27/2010	10	NUN 1002	330	e
4/27/2010	11	NUN 1003	225	e

Table 6. Marketable Yield standard harvested varieties.

Harvest Date	Entry #	Variety	40 lb units/A	*P* =0.05 LSD= 33.9
5/24/2010	33	J 3003	1476	a
5/24/2010	28	Century	1309	ab
5/24/2010	20	Mr Buck	1196	bcd
5/24/2010	19	Miss Megan	1133	bcd
5/24/2010	37	EMY 55375	1130	bcd
5/19/2010	22	NUN 1006	1098	bcde
5/19/2010	18	Georgia Boy	1093	bcde
5/10/2010	26	Nirvana	1090	bcde
5/24/2010	30	Savannah Sweet	1072	bcdef
5/10/2010	34	J 3006	1071	bcdef
5/24/2010	41	XON 403Y	1052	cdef
5/19/2010	27	Goldeneye	1049	cdef
5/24/2010	29	Granex Yellow PRR	997	cdefg
5/19/2010	17	Sweet Jalene	942	defgh
5/19/2010	31	J 3001	928	defgh
5/24/2010	24	Caramelo	916	defgh
5/10/2010	21	Sapelo Sweet	905	defgh
5/24/2010	39	Sweet Jasper	869	efgh
5/19/2010	32	J 3002	862	efgh
5/24/2010	36	EMY 55350	840	fghi
5/19/2010	35	J 3007	798	ghij
5/19/2010	25	Sweet Vidalia	790	ghij
5/24/2010	16	Sweet Uno	743	hijk
5/24/2010	38	EMY Granex 110	716	hijk
4/29/2010	40	Sweet Harvest	617	ijk
5/24/2010	42	HSX-70300H-Y	600	jk
5/24/2010	23	Sweet Caroline	536	k

Table 7. Marketable Yield standard harvested red varieties.

Harvest Date	Entry #	Variety	40 lb units/A	*P* =0.05 LSD= 20.1
5/26/2010	46	J 3005	1428	a
5/26/2010	47	Mata Hari	1357	ab
5/26/2010	43	Red Coach	1241	abc
5/26/2010	45	J 3004	1179	bc
5/26/2010	44	Pinot Rouge	1135	c
5/26/2010	49	HSX-8099H-R	813	d
5/26/2010	48	Lambada	804	d

Table 8. Percent Marketable Yield early harvested varieties.

Harvest Date	Entry #	Variety	% Mkt/A	*P* =0.05 LSD= 9.5
4/27/2010	11	NUN 1003	92.7	a
4/27/2010	12	NUN 1004	92.1	a
4/27/2010	10	NUN 1002	90.6	a
4/27/2010	8	SSC 1535 F1	88.1	a
4/29/2010	14	SVR 07956013	86.2	ab
4/19/2010	3	Candy Ann	78.5	bc
4/29/2010	6	Sugar Belle	73.6	cd
4/19/2010	7	Sweet Deal	69.5	cde
4/19/2010	5	Honeybee	67.9	de
4/22/2010	13	DP Sweet 1407	66.6	de
4/27/2010	1	WI-129	66.2	de
4/22/2010	4	Candy Kim	60.1	ef
4/27/2010	2	WI-131	54.8	f
4/19/2010	9	SSC 2893	53.1	f
4/29/2010	15	10229	42.6	g

Table 9. Percent Marketable Yield standard harvested varieties

Harvest Date	Entry #	Variety	% Mkt/A	*P* =0.05 LSD= 12.6
5/10/2010	34	J 3006	91.3	a
5/24/2010	33	J 3003	89	ab
5/10/2010	21	Sapelo Sweet	81.4	abc
5/10/2010	26	Nirvana	79.8	abcd
5/24/2010	37	EMY 55375	77.4	bcde
5/24/2010	28	Century	72.3	cdef
5/24/2010	20	Mr Buck	68.5	defg
4/29/2010	40	Sweet Harvest	66.2	efgh
5/24/2010	30	Savannah Sweet	65	efghi
5/19/2010	17	Sweet Jalene	64.9	efghi
5/24/2010	29	Granex Yellow PRR	64.3	fghij
5/24/2010	38	EMY Granex 110	64.1	fghij
5/19/2010	27	Goldeneye	63.6	fghijk
5/19/2010	18	Georgia Boy	62.7	fghijkl
5/24/2010	41	XON 403Y	61.3	fghijkl
5/24/2010	19	Miss Megan	58.3	ghijklm
5/19/2010	32	J 3002	57.7	ghijklm
5/19/2010	25	Sweet Vidalia	55.3	hijklm
5/19/2010	22	NUN 1006	54.5	hijklm
5/19/2010	31	J 3001	54.3	hijklm
5/24/2010	24	Caramelo	53.3	ijklm
5/24/2010	16	Sweet Uno	52.2	jklm
5/24/2010	39	Sweet Jasper	51.1	klm
5/24/2010	36	EMY 55350	50.6	lm
5/19/2010	35	J 3007	46.5	m
5/24/2010	42	HSX-70300H-Y	33.6	n
5/24/2010	23	Sweet Caroline	26.6	n

Table 10. Percent Marketable Yield standard harvested red varieties.

Harvest Date	Entry #	Variety	% Mkt/A	*P* =0.05 LSD= 9.78
5/26/2010	43	Red Coach	82.9	a
5/26/2010	46	J 3005	76.5	ab
5/26/2010	45	J 3004	73.7	ab
5/26/2010	47	Mata Hari	72.6	b
5/26/2010	44	Pinot Rouge	71.1	b
5/26/2010	49	HSX-8099H-R	57.5	c
5/26/2010	48	Lambada	44.5	d

Table 11. Yield of early harvested varieties by size Colossal.

Harvest Date	Entry #	Variety	40 lb units/A	*P* =0.05 LSD= 57.8
4/27/2010	1	WI-129	120	a
4/27/2010	8	SSC 1535 F1	110	a
4/29/2010	6	Sugar Belle	109	a
4/27/2010	12	NUN 1004	100	ab
4/27/2010	2	WI-131	99	ab
4/22/2010	13	DP Sweet 1407	90	abc
4/29/2010	14	SVR 07956013	76	abcd
4/22/2010	4	Candy Kim	63	abcde
4/19/2010	5	Honeybee	48	bcde
4/27/2010	10	NUN 1002	33	cde
4/19/2010	9	SSC 2893	20	de
4/29/2010	15	10229	19	de
4/19/2010	3	Candy Ann	19	de
4/27/2010	11	NUN 1003	16	e
4/19/2010	7	Sweet Deal	10	e

Table 12. Yield of standard harvested varieties by size Colossal.

Harvest Date	Entry #	Variety	40 lb units/A	*P* =0.05 LSD= 116.7
5/24/2010	19	Miss Megan	511	a
5/24/2010	20	Mr Buck	446	ab
5/24/2010	41	XON 403Y	340	bc
5/24/2010	37	EMY 55375	337	bc
5/24/2010	28	Century	322	cd
5/24/2010	33	J 3003	280	cde
5/19/2010	18	Georgia Boy	266	cdef
5/24/2010	36	EMY 55350	255	cdefg
5/24/2010	24	Caramelo	249	cdefgh
5/24/2010	30	Savannah Sweet	238	cdefgh
5/19/2010	22	NUN 1006	231	cdefgh
5/24/2010	23	Sweet Caroline	229	cdefgh
5/19/2010	27	Goldeneye	226	cdefgh
5/24/2010	16	Sweet Uno	211	defghi
5/19/2010	31	J 3001	187	efghij
5/19/2010	35	J 3007	187	efghij
5/24/2010	29	Granex Yellow PRR	177	efghij
5/24/2010	39	Sweet Jasper	176	efghij
5/24/2010	42	HSX-70300H-Y	153	fghijk
5/19/2010	17	Sweet Jalene	145	ghijk
5/19/2010	25	Sweet Vidalia	144	ghijk
5/10/2010	34	J 3006	135	hijkl
5/10/2010	26	Nirvana	98	ijkl
5/24/2010	38	EMY Granex 110	93	jkl
5/19/2010	32	J 3002	81	jkl
5/10/2010	21	Sapelo Sweet	40	kl
4/29/2010	40	Sweet Harvest	6	l

Table 13. Yield of standard harvested red varieties by size Colossal.

Harvest Date	Entry #	Variety	40 lb units/A	P=0.05 LSD= 138.6
5/26/2010	46	J 3005	415	a
5/26/2010	47	Mata Hari	335	ab
5/26/2010	45	J 3004	335	ab
5/26/2010	43	Red Coach	327	ab
5/26/2010	48	Lambada	215	bc
5/26/2010	49	HSX-8099H-R	204	bc
5/26/2010	44	Pinot Rouge	173	c

Table 14. Yield of early harvested varieties by size Jumbo.

Harvest Date	Entry #	Variety	40 lb units/A	*P* =0.05 LSD= 154.4
4/19/2010	3	Candy Ann	702	abcd
4/22/2010	13	DP Sweet 1407	683	abcd
4/27/2010	1	WI-129	648	abcd
4/22/2010	4	Candy Kim	642	abcd
4/19/2010	7	Sweet Deal	623	abcd
4/27/2010	8	SSC 1535 F1	594	abcd
4/19/2010	5	Honeybee	585	abcd
4/19/2010	9	SSC 2893	570	abcd
4/29/2010	14	SVR 07956013	503	bcd
4/27/2010	2	WI-131	470	cde
4/29/2010	6	Sugar Belle	457	de
4/27/2010	12	NUN 1004	444	de
4/29/2010	15	10229	344	ef
4/27/2010	10	NUN 1002	254	fg
4/27/2010	11	NUN 1003	168	g

Table 15. Yield of standard harvested varieties by size Jumbo.

Harvest Date	Entry #	Variety	40 lb uni	*P* =0.05 LSD= 190.3
5/24/2010	33	J 3003	1125	a
5/24/2010	28	Century	941	ab
5/10/2010	26	Nirvana	936	ab
5/19/2010	22	NUN 1006	828	bc
5/24/2010	30	Savannah Sweet	795	bcd
5/19/2010	18	Georgia Boy	778	bcde
5/19/2010	27	Goldeneye	773	bcde
5/24/2010	29	Granex Yellow PRR	773	bcde
5/10/2010	34	J 3006	761	bcdef
5/19/2010	17	Sweet Jalene	736	cdefg
5/19/2010	32	J 3002	733	cdefg
5/24/2010	37	EMY 55375	727	cdefg
5/10/2010	21	Sapelo Sweet	713	cdefgh
5/19/2010	31	J 3001	697	cdefgh
5/24/2010	20	Mr Buck	692	cdefghi
5/24/2010	41	XON 403Y	660	cdefghij
5/24/2010	39	Sweet Jasper	649	cdefghij
5/24/2010	24	Caramelo	609	defghijk
5/19/2010	25	Sweet Vidalia	599	efghijk
5/24/2010	19	Miss Megan	597	efghijk
5/19/2010	35	J 3007	575	fghijk
5/24/2010	36	EMY 55350	560	ghijk
5/24/2010	38	EMY Granex 110	523	hijk
4/29/2010	40	Sweet Harvest	503	ijk
5/24/2010	16	Sweet Uno	499	jk
5/24/2010	42	HSX-70300H-Y	420	kl
5/24/2010	23	Sweet Caroline	291	l

Table 16. Yield of standard harvested red varieties by size Jumbo

Harvest Date	Entry #	Variety	40 lb units/A	*P* =0.05 LSD= 145.8
9/25/2009	47	Mata Hari	995	a
9/25/2009	46	J 3005	982	a
9/25/2009	44	Pinot Rouge	915	ab
9/25/2009	43	Red Coach	878	ab
9/25/2009	45	J 3004	788	b
9/25/2009	48	Lambada	574	c
9/25/2009	49	HSX-8099H-R	561	c

Table 17. Yield of early harvested varieties by size Medium

Harvest Date	Entry #	Variety	40 lb units/A	P=0.05 LSD= 21.5
4/19/2010	3	Candy Ann	113	a
4/27/2010	8	SSC 1535 F1	99	a
4/19/2010	7	Sweet Deal	73	b
4/19/2010	5	Honeybee	61	bc
4/29/2010	14	SVR 07956013	50	cd
4/29/2010	6	Sugar Belle	48	cd
4/27/2010	10	NUN 1002	43	cde
4/27/2010	2	WI-131	43	cde
4/27/2010	11	NUN 1003	41	cde
4/19/2010	9	SSC 2893	39	ef
4/22/2010	4	Candy Kim	39	def
4/27/2010	12	NUN 1004	33	def
4/22/2010	13	DP Sweet 1407	33	def
4/27/2010	1	WI-129	26	ef
4/29/2010	15	10229	19	f

Table 18 Yield of standard harvested varieties by size Medium

Harvest Date	Entry #	Variety	40 lb units/A	*P* =0.05 LSD= 33.9
5/10/2010	34	J 3006	176	a
5/10/2010	21	Sapelo Sweet	152	a
4/29/2010	40	Sweet Harvest	108	b
5/24/2010	38	EMY Granex 110	100	bc
5/24/2010	33	J 3003	72	cd
5/24/2010	37	EMY 55375	66	de
5/19/2010	17	Sweet Jalene	61	def
5/24/2010	24	Caramelo	58	defg
5/24/2010	20	Mr Buck	58	defg
5/10/2010	26	Nirvana	56	defg
5/24/2010	41	XON 403Y	52	defg
5/19/2010	27	Goldeneye	50	defgh
5/19/2010	18	Georgia Boy	49	defgh
5/19/2010	32	J 3002	48	defgh
5/24/2010	29	Granex Yellow PRR	47	defgh
5/19/2010	25	Sweet Vidalia	47	defgh
5/24/2010	28	Century	46	defgh
5/24/2010	39	Sweet Jasper	44	defgh
5/19/2010	31	J 3001	43	defgh
5/19/2010	22	NUN 1006	40	defgh
5/24/2010	30	Savannah Sweet	39	defgh
5/19/2010	35	J 3007	37	efgh
5/24/2010	16	Sweet Uno	33	efgh
5/24/2010	42	HSX-70300H-Y	28	fgh
5/24/2010	36	EMY 55350	26	gh
5/24/2010	19	Miss Megan	24	gh
5/24/2010	23	Sweet Caroline	17	h

Table 19. Yield of standard harvested red varieties by size Medium

Harvest Date	Entry #	Variety	40 lb units/A	*P* =0.05 LSD= 20.1
5/26/2010	45	J 3004	57	a
5/26/2010	49	HSX-8099H-R	49	ab
5/26/2010	44	Pinot Rouge	47	abc
5/26/2010	43	Red Coach	37	bc
5/26/2010	46	J 3005	31	bcd
5/26/2010	47	Mata Hari	27	cd
5/26/2010	48	Lambada	15	d

Table 20. # Seed Stems of early harvested varieties

Harvest Date	Entry #	Variety	#SS/A	Recorded
4/27/2010	11	NUN 1003	53724	4/9/2010
4/27/2010	12	NUN 1004	43342	4/9/2010
4/27/2010	10	NUN 1002	42471	4/9/2010
4/29/2010	14	SVR 07956013	32888	4/9/2010
4/22/2010	4	Candy Kim	17206	4/9/2010
4/29/2010	6	Sugar Belle	16117	4/9/2010
4/27/2010	8	SSC 1535 F1	15537	4/9/2010
4/19/2010	5	Honeybee	9946	4/9/2010
4/19/2010	3	Candy Ann	9002	4/9/2010
4/27/2010	2	WI-131	7405	4/9/2010
4/27/2010	1	WI-129	7260	4/9/2010
4/22/2010	13	DP Sweet 1407	7115	4/9/2010
4/19/2010	7	Sweet Deal	6970	4/9/2010
4/19/2010	9	SSC 2893	5953	4/9/2010
4/29/2010	15	10229	4719	4/9/2010

Table 21 # Seed Stems of standard harvested varieties

Harvest Date	Entry #	Variety	#SS/A	*P* =0.05 LSD= 1340.8	Recorded
5/24/2010	16	Sweet Uno	5373	a	4/9/2010
5/24/2010	19	Miss Megan	4356	a	4/9/2010
4/29/2010	40	Sweet Harvest	2251	b	4/9/2010
5/19/2010	17	Sweet Jalene	1670	bc	4/9/2010
5/19/2010	31	J 3001	1597	bcd	4/9/2010
5/24/2010	20	Mr Buck	1307	bcde	4/9/2010
5/24/2010	38	EMY Granex 110	1162	bcde	4/9/2010
5/19/2010	35	J 3007	1089	bcde	4/9/2010
5/24/2010	42	HSX-70300H-Y	1017	bcde	4/9/2010
5/24/2010	24	Caramelo	799	cde	4/9/2010
5/10/2010	34	J 3006	653	cde	4/9/2010
5/19/2010	18	Georgia Boy	581	cde	4/9/2010
5/10/2010	21	Sapelo Sweet	436	cde	4/9/2010
5/24/2010	37	EMY 55375	436	cde	4/9/2010
5/10/2010	26	Nirvana	435	cde	4/9/2010
5/19/2010	22	NUN 1006	363	cde	4/9/2010
5/24/2010	39	Sweet Jasper	291	de	4/9/2010
5/19/2010	27	Goldeneye	290	de	4/9/2010
5/19/2010	25	Sweet Vidalia	218	e	4/9/2010
5/24/2010	36	EMY 55350	218	e	4/9/2010
5/19/2010	32	J 3002	218	e	4/9/2010
5/24/2010	23	Sweet Caroline	218	e	4/9/2010
5/24/2010	29	Granex Yellow PRR	73	e	4/9/2010
5/24/2010	30	Savannah Sweet	73	e	4/9/2010
5/24/2010	33	J 3003	0	e	4/9/2010
5/24/2010	41	XON 403Y	0	e	4/9/2010
5/24/2010	28	Century	0	e	4/9/2010

Table 22. # Seed stems of standard harvested red varieties

Harvest Date	Entry #	Variety	#SS/A	Recorded
5/26/2010	43	Red Coach	1742	4/9/2010
5/26/2010	47	Mata Hari	726	4/9/2010
5/26/2010	46	J 3005	290	4/9/2010
5/26/2010	45	J 3004	218	4/9/2010
5/26/2010	48	Lambada	145	4/9/2010
5/26/2010	44	Pinot Rouge	73	4/9/2010
5/26/2010	49	HSX-8099H-R	0	4/9/2010

Table 23. Postharvest analysis pre-storage weight (lbs) early planting

Variety	lbs	*P* = 0.05
DP Sweet 1407	63.2	a
WI-129	60.8	ab
Sweet Deal	59.2	ab
SSC 1535 F1	58.2	ab
Candy Ann	58.1	ab
Candy Kim	53.6	abc
SSC 2893	50.5	abcd
Honeybee	48.5	abcd
SVR 07956013	42.8	bcd
Sugar Belle	36.4	cde
WI-131	35.6	cde
NUN1004	33.6	de
10229	22.7	ef
NUN 1002	10.7	f
NUN1003	7	f

Table 24. Postharvest analysis pre-storage weight (lbs) standard planting

Variety	lbs	*P* = 0.05
Granex Yellow PRR	71.5	a
J 3001	70.0	ab
J3002	69.0	abc
Sweet Jalene	66.4	abcd
Goldeneye	65.7	abcd
NUN 1006	64.4	abcde
Georgia Boy	64.3	abcde
J3003	61.3	abcdef
Nirvana	60.1	abcdef
EMY 55375	60.0	abcdef
Mr Buck	59.1	abcdef
Savannah Sweet	58.2	abcdef
Sweet Vidalia	57.9	abcdef
Sweet Harvest	54.0	abcdefg
Sapelo Sweet	53.0	bcdefgh
J3007	51.3	cdefgh
Century	50.5	defgh
J3006	50.1	defgh
Sweet Jasper	49.3	defgh
Miss Megan	46.7	defgh
Carmelo	46.7	efgh
EMY Granex 110	44.7	fgh
XON 403Y	38.8	fgh
EMY 55350	38.5	gh
Sweet Uno	35.5	hi
HSX-70300H-Y	29.4	i
Sweet Caroline	19.1	i

Table 25. Postharvest analysis pre-storage weight (lbs) standard planting red onions

Variety	lbs	*P* = 0.05
Red Coach	68.35	a
J3005	53.8	ab
Mata Hari	59.65	ab
J3004	62.75	ab
Pinot Rouge	60.55	bc
Lambada	43.65	cd
HSX-8099H-R	39.95	d

Table 26. Postharvest analysis post-storage weight (lbs) early planting

Variety	Lbs	P= 0.05
DP Sweet 1407	61.1	a
WI-129	58.2	ab
Sweet Deal	57.1	ab
Candy Ann	56.3	ab
SSC 1535 F1	55.25	ab
Candy Kim	51.95	abc
SSC 2893	48.85	abcd
Honeybee	45.8	abcd
SVR 07956013	41.25	bcd
Sugar Belle	34.8	cde
WI-131	34.2	cde
NUN1004	31.55	de
10229	21.8	ef
NUN 1002	10.2	f
NUN1003	6.6	f

Table 27. Postharvest analysis post-storage weight (lbs) standard planting.

Variety	Lbs	P= 0.05
Granex Yellow PRR	67.7	a
J3002	66.95	a
J 3001	64.1	ab
Goldeneye	63.2	ab
Sweet Jalene	61.95	abc
NUN 1006	60.8	abcd
Georgia Boy	60.7	abcd
EMY 55375	57.55	abcd
J3003	57.35	abcd
Nirvana	57.35	abcd
Mr Buck	56.35	abcdef
Savannah Sweet	56.35	abcdef
Sweet Vidalia	54.9	abcdef
Sweet Jasper	51.6	abcdefg
Sapelo Sweet	50.8	abcdefg
Century	48.3	bcdefg
J3006	46.9	bcdefg
J3007	46.55	bcdefg
Miss Megan	44.75	cdefg
Carmelo	44.65	cdefg
Sweet Harvest	44.15	cdefg
XON 403Y	43.35	defg
EMY 55350	41.4	efg
EMY Granex 110	38.25	fg
HSX-70300H-Y	36.6	g
Sweet Uno	33.55	gh
Sweet Caroline	17.95	h

Table 28. Postharvest analysis post-storage weight (lbs) standard planting red onions.

Variety	lbs	*P* = 0.05
Red Coach	65.3	a
J3005	60.2	ab
Mata Hari	58.5	ab
J3004	57.3	ab
Pinot Rouge	52.4	b
Lambada	39.2	c
HSX-8099H-R	38.2	c

Table 29. Postharvest analysis post-storage marketable weight (lbs) and % marketable (MKT) onions early planting.

Variety	lbs	*P* = 0.05	% Mkt	*P* = 0.05
DP Sweet 1407	53.1	a	82.4	abc
10229	50.0	ab	70.5	c
SSC 2893	49.4	ab	78.5	bc
Honeybee	46.0	abc	77.0	bc
Candy Ann	45.5	abc	79.6	bc
Sweet Deal	45.1	abc	86.2	abc
NUN 1002	39.3	abcd	96.0	a
SVR 07956013	38.9	abcd	96.3	a
SSC 1535 F1	34.8	bcd	82.5	abc
Candy Kim	31.7	cde	87.7	ab
WI-129	30.3	cde	91.5	ab
NUN1004	28.1	de	91.3	ab
NUN1003	16.9	ef	89.4	ab
Sugar Belle	9.9	f	91.4	ab
WI-131	5.9	f	88.1	ab

Table 30. Postharvest analysis post-storage marketable weight (lbs) and % marketable (MKT) onions standard planting.

Variety	lbs	*P* = 0.05	% Mkt	*P* = 0.05
J3002	57.5	a	89.0	abc
Granex Yellow PRR	55.8	ab	87.6	abcd
NUN 1006	54.3	ab	89.4	abc
EMY 55375	53.6	abc	91.2	abc
Nirvana	53.0	abc	92.2	abc
Goldeneye	50.5	abcd	80.8	abcd
Georgia Boy	50.0	abcde	82.0	abcd
Savannah Sweet	49.8	abcdef	89.2	abc
J3003	48.7	abcdef	82.1	abcd
J 3001	48.6	abcdef	73.4	cd
Sweet Vidalia	45.9	abcdef	82.8	abcd
Sweet Jasper	44.7	abcdefg	96.4	ab
Mr Buck	44.1	abcdefg	77.8	abcd
Sapelo Sweet	41.9	abcdefgh	84.4	abcd
Sweet Jalene	41.2	abcdefgh	71.0	cd
Century	39.7	bcdefgh	76.6	bcd
J3007	39.2	bcdefgh	80.3	abcd
EMY 55350	36.9	cdefgh	97.2	ab
XON 403Y	36.8	cdefgh	99.7	a
J3006	36.7	cdefgh	77.7	abcd
Miss Megan	34.5	defgh	77.9	abcd
Sweet Harvest	33.4	defgh	64.9	d
EMY Granex 110	32.8	efgh	75.8	bcd
Carmelo	32.6	fgh	75.2	bcd
HSX-70300H-Y	28.1	ghi	83.3	abcd
Sweet Uno	25.6	hi	78.8	abcd
Sweet Caroline	11.8	i	69.5	cd

Table 31. Postharvest analysis post-storage marketable weight (lbs) and % marketable (MKT) onions standard planting red onions

Variety	lbs	*P* = 0.05	% Mkt	*P* = 0.05
Mata Hari	51.9	a	89.1	a
Red Coach	46.6	ab	71.8	bc
Pinot Rouge	45.6	abc	88.8	a
J3005	44.7	abc	75.0	abc
J3004	37.4	bcd	65.5	c
Lambada	34.5	cd	89.0	a
HSX-8099H-R	31.7	d	82.8	ab

Table 32. LF, Pungency, % Brix and Total sugars 2009-2010 Vidalia Onion Variety Trial.

Variety Code	Seed Variety	Seed Company	Skin Color	(µmoles/mL)	% Brix	Sugars
1	WI-129	Wannamaker Seed	yellow	4.7	9.2	4.7
2	WI-131	Wannamaker Seed	yellow	3.5	8.5	5.4
3	Candy Ann	Solar Seeds	yellow	3.9	9	5.2
4	Candy Kim	Solar Seeds	yellow	4.4	8.8	4.7
5	Honey Bee	Shamrock Seed	yellow	4	9.5	6
6	Sugar Belle	Shamrock Seed	yellow	4.6	9.8	5.4
7	Sweet Deal	Shamrock Seed	yellow	4.1	9.2	6.4
8	SSC 1535 F1	Shamrock Seed	yellow	4.1	10.2	5
9	SSC 2893	Shamrock Seed	yellow	4.1	8.8	5.5
10	NUN 1002	Nunhems	yellow	4.1	9.4	5.8
11	NUN 1003	Nunhems	yellow	3.8	10.2	6
12	NUN 1004	Nunhems	yellow	3.9	9.9	5.9
13	DP Sweet 1407	DP Seeds	yellow	3.6	8.4	5.5
14	SVR 07956013	Seminis	yellow	3.4	9.8	5.3
15	10229	Hazera	yellow	4.8	10.2	5.6
16	Sweet Uno	Enza Zaden	yellow	3.4	8.9	
17	Sweet Jalene	Enza Zaden	yellow	4	8.9	6.2
18	Georgia Boy	DP Seeds	yellow	3.7	9.6	6.4
19	Miss Megan	DP Seeds	yellow	3.7	9.1	
20	Mr. Buck	DP Seeds	yellow	3.7	9	4.8
21	Sapelo Sweet	DP Seeds	yellow	4	9.4	4.8
22	NUN 1006	Nunhems	yellow	2.4	9.7	5.9
23	Sweet Caroline	Nunhems	yellow	3.6	8.8	5.5
24	Caramelo	Nunhems	yellow	3.8	9.7	4.8
25	Sweet Vidalia	Nunhems	yellow	3.4	8.8	4.8
26	Nirvana	Nunhems	yellow	3.3	9.5	5.9
27	Golden Eye	Seminis	yellow	3.6	9	6.2
28	Century	Seminis	yellow	3.5	9.3	5.8
29	PRR	Seminis	yellow	4.5	9.7	
30	Savannah Sweet	Seminis	yellow	4.5	8.9	5.6
31	J 3001	Bejo	yellow	3.7	8.6	5.7
32	J 3002	Bejo	yellow	3.9	8.4	
33	J 3003	Bejo	yellow	4.2	9.8	6.5
34	J 3006	Bejo	yellow	3.3	8.9	6.1
35	J 3007	Bejo	yellow	4	8.7	5.6
36	EMY 55350	Emerald Seeds	yellow	3.6	9.9	4.5
37	EMY 55375	Emerald Seeds	yellow	4.4	9.6	5.6
38	EMY Granex 110	Emerald Seeds	yellow	4.8	9.7	5.2
39	Sweet Jasper	Sakata Seed	yellow	3.6	9.2	6
40	Sweet Harvest	Sakata Seed	yellow	3.8	9.4	6.2
41	XON 403Y	Sakata Seed	yellow	4.2	9.2	6.5
42	HSX-70300H-Y	Hortag	yellow	4.1	9	5.6
43	Red Coach	Enza Zaden	red	4	8.9	5.1
44	Pinot Rouge	DP Seeds	red	4.2	11.2	5.3
45	J 3004	Bejo	red	3.8	8.9	6.5
46	J 3005	Bejo	red	2.3	8.4	6.1
47	Mata Hari	Nunhems	red	4.7	9.4	6.1
48	Lambada	Nunhems	red	3.7	10.6	4.5
49	HSX-8099H-R	Hortag	red	4	9.5	
	Mean			3.9	9.3	5.4

POSTHARVEST FUNGICIDE DRENCH TEST FOR CONTROL OF BOTRYTIS DURING STORAGE

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Introduction

The storage disorder Botrytis neck rot (BNR, *Botrytis allii*) is a major postharvest problem limiting the storage potential of Vidalia Sweet Onions. The majority of specialty crop industries apply postharvest fungicides to their crop (usually in conjunction with automated grading and sorting lines) prior to being placed into storage. However, due to the particular requirement for a curing of the outer leaves of onion, applying water to the bulbs was thought to be counter-intuitive, and lead to excessive sporolation and disease during storage. Though BNR is largely an internal disorder, a large percentage of postharvest losses are related to rots associated with the presence of external pathogens that spread on the surface of the bulb in storage. These high rates are observed even if bulbs are adequately cured. This is likely related to the high levels of inoculum present on the surface of the bulbs from the field. Thus, the objective of the study was to evaluate postharvest drench applications of numerous commercial fungicide formulations on their ability to control the incidence of botrytis during and after storage.

Materials and Methods

The cultivar 'Sapelo Sweet' was used for this study. Bulbs were undercut on May 10th at the Vidalia Onion and Vegetable Research Facility in the spring of 2010. After harvest, bulbs were transported to the Vidalia Onion Research Facility (VORL) in Tifton, where bulbs were graded for size and quality, and sorted into 20 bulb bags. The six fungicides treatments used in this study were 1) Luna (6.84 fl oz/acre), 2) Pristine (18.5 oz/acre), 3) Scholar (16 fl oz/acre), 4) Scholar (32 fl oz/acre), 5) water only control, and 6) no water control. To apply the drench, the 20 bulb bag was placed into a 117 L Rubbermaid container, and 1 gallon of the drench solution was poured twice over the onion bulbs (bag was turned over between applications)(figure 1). After application, a botrytis inoculated bulb was placed into the bag prior to subsequent curing or storage activities.

Figure 1. Fungicide drench application technique. Drench solution was collected, and then reapplied to bulbs one additional time.

After drenching, half of the bulbs were placed immediately into regular air storage (34°F, 70% R.H.) while the other half of the bulbs were forced air heat cured (97°F) for two days in a peanut drier. Bulb samples were removed after 2 and 4 months, and warmed to room temperature (70°F) under controlled conditions. The following day, 4 bags of bulbs were removed, weighed, cut in half, and evaluated for botrytis neck rot, sour skin, slippery skin, damage, sprouts, and other storage defects, while a similar set of 4 bulbs were maintained at room temperature and evaluated in an identical manner after 14 days.

Results and Discussion

Across all postharvest treatment effects and storage durations, the incidence rate for botrytis was 19.3%. The fungicide treatments all resulted in a reduced percent botrytis (figure 2). Scholar (32 oz) performed the best, resulting in an 80% reduction in botrytis, followed by Luna (72%), Scholar (16 oz)(60%), and Pristine (55%), when compared to the no water control (typical onion postharvest handling. It is interesting to note that the bulbs treated with just water also resulted in lower levels of botrytis. This is possible related to the simple washing of inoculum off the bulbs prior to storage.

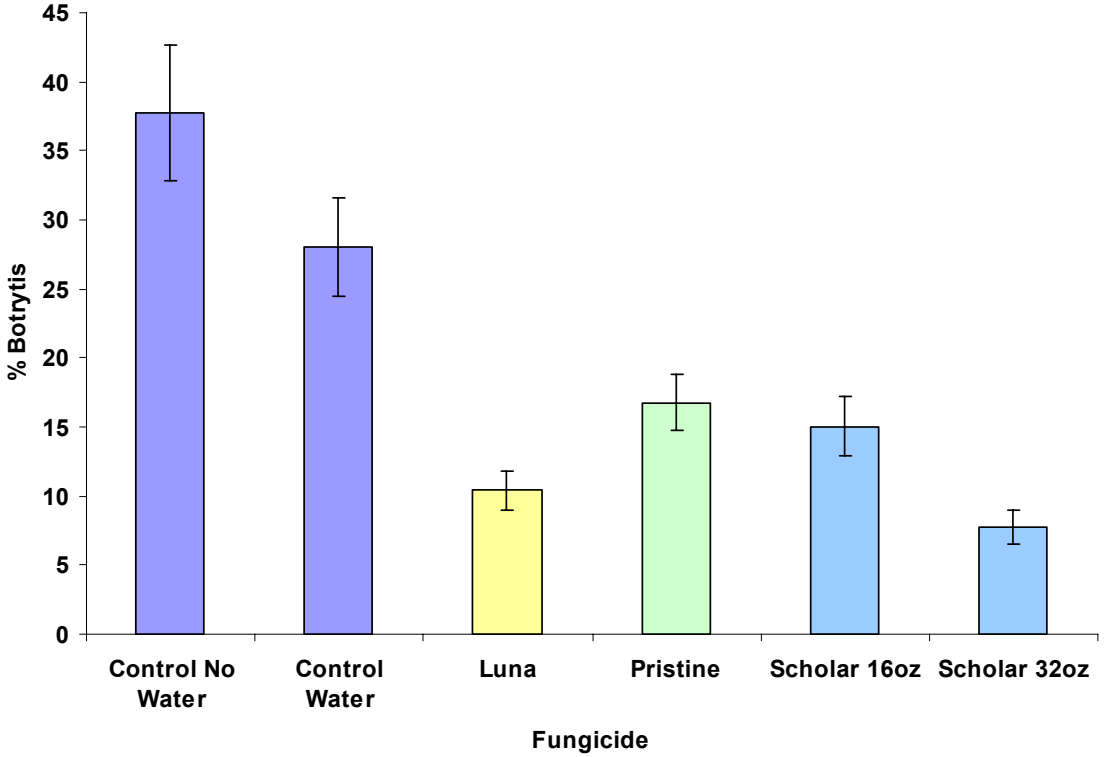

Figure 2. Effect of 4 fungicides on the percent botrytis during storage of Sapelo Sweet Vidalia onion.

As expected, whether bulbs were placed immediately into storage wet, or were cured (dried) prior to storage, there was a significant impact on the amount of botrytis observed on the control bulbs. As seen in figure 3, heating (H) the control bulbs reduced the amount of botrytis by half when compared to the no heat (NH) treatment. However, the fungicide treated bulbs responded differently. In most cases (exception of Scholar 16 oz), the heat treatment resulted in significantly higher rates of botrytis. This implies that the fungicides may have residual activity that is lost when placed under high heat (evaporation). Or, the activity is lost through the spatial separation of the fungicide (dry outer leaves) from the moist inner leaves, where the botrytis is more likely to be growing.

With respect to the storage and 14-day post-storage simulated marketing period, the pattern of botrytis in the control bulbs proceeded as expected. The incidence rate nearly doubled from 2 to 4 months (figure 4) and more than doubled over the 2-week shelf period at room temperature (figure 5). However, there were no significant increases in the amount of botrytis observed in the fungicide treatments

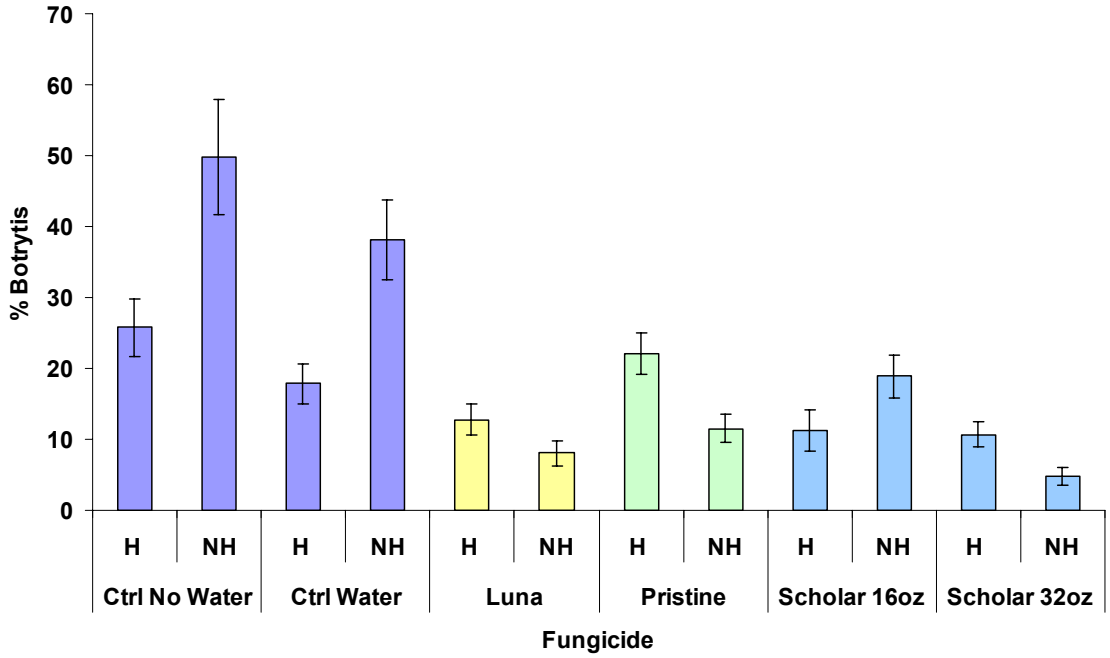

Figure 3. Effect of post-drench heat (H) curing (97°F) or no heat (NH) on the efficacy of fungicide treatments.

from the 2 month to the 4 month removal (figure 4). This suggests that the fungicides are still actively controlling the botrytis (though there is some trending towards loss of activity in some of the fungicide treatments). No similar residual benefit was observed during the shelf-life period, as significant increases in botrytis were observed after 2-weeks at room temperature in most treatments (except Scholar). Irrespective, all fungicides offered considerable benefit over the non-treated control bulbs.

Conclusion

This was the first year of a relatively large pilot study. It was found that a treatment with a postharvest fungicide offers great promise as a tool for reducing storage losses due to *botrytis allii*. However, much research is needed in this area before any recommendations can be made. A repeat of this study is planned for 2011. Further studies are required to determine the effect of a post-drench heat cure on the fungicides, optimal rates of application, and whether significant cultivar differences are present.

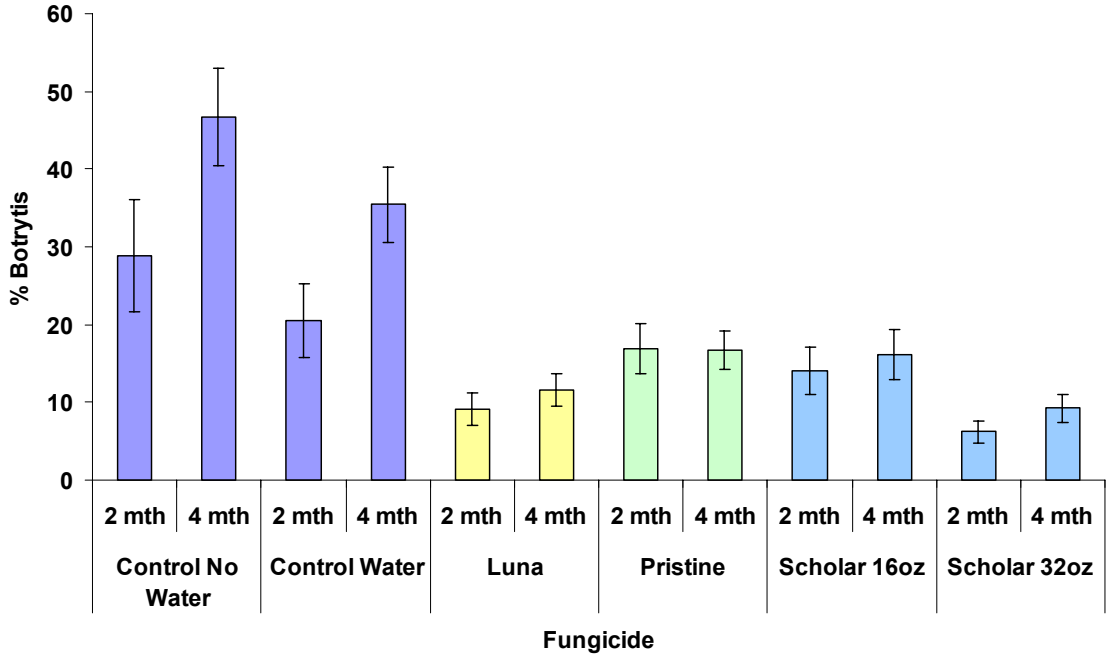

Figure 4. Effect of regular air storage (34°F, 70% R.H.) duration (2 or 4 months) on the percent botrytis infection of Sapelo Sweet onion bulbs.

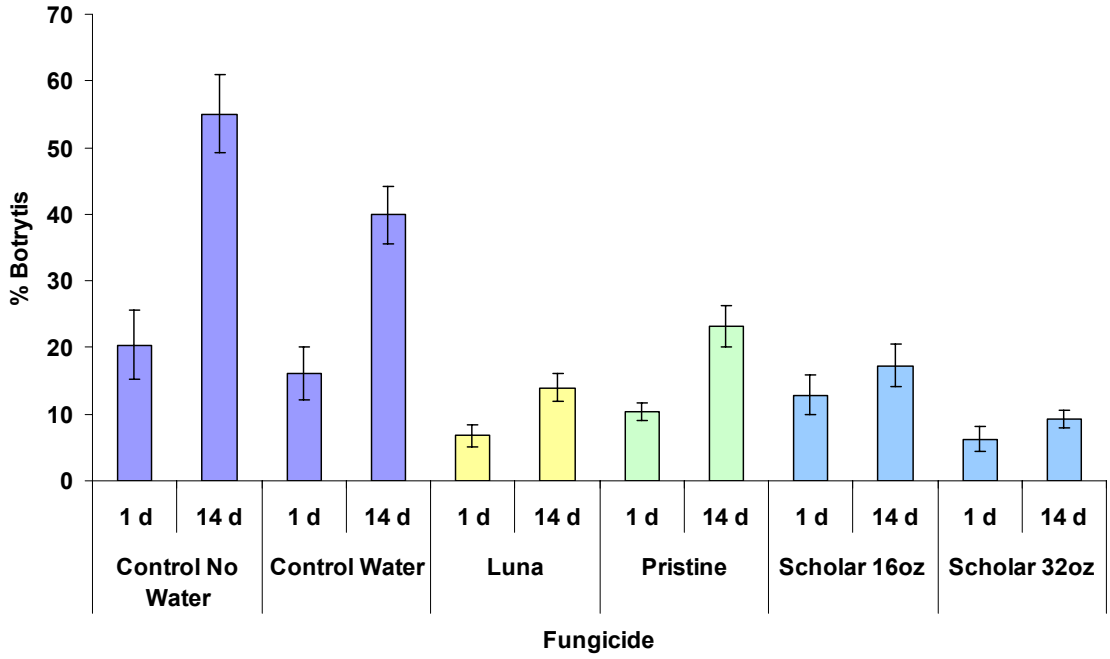

Figure 5. Effect of post-storage simulated marketing at room temperature (70°F) duration (1 or 14 days) on the percent botrytis infection of Sapelo Sweet onion bulbs.

LOW DISEASE PRESSURE OBSERVED IN 2009-2010 ONION SEASON

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The disease pressure for the 2009-2010 season was low and few onion samples were delivered to the Tifton Plant Disease Clinic for diagnosis. Correspondingly, few calls were made on onion disease problems. Even our new friend, onion yellow bud, did not show up to any significant degree. Fungicide plots at the Vidalia Onion and Vegetable Research Center were virtually devoid of disease and plots that did not receive fungicide treatment were indistinguishable from those that received season long fungicide applications.

DOUBLE-CROPPING ONIONS BEHIND CROPS THAT POTENTIALLY SUPPRESS OR INCREASE SOUR SKIN

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Introduction

Sour skin of onion, caused by the soilborne bacterium *Burkholderia cepacia*, continues to be a postharvest disease problem in Georgia. Losses to sour skin can be particularly severe if higher than normal temperatures occur at harvest. Earlier studies indicated that certain crops, e.g. pearl millet (*Pennisetum glaucum*), may suppress *B. cepacia* populations, whereas other crops, e.g. corn (*Zea mays*) may increase populations of the sour skin pathogen (1,2). During the past several years, UGA and USDA personnel have been evaluating corn and pearl millet in a double-cropping scheme with Vidalia sweet onions to determine if a crop rotation and/or double-cropping strategy can effectively reduce sour skin levels in Vidalia onions. In 2010, the work was expanded to include peanut and soybean along with corn and pearl millet in double-cropping scenarios with sweet onions.

Materials and Methods

The experiments were conducted in field plots and microplots at the University of Georgia's Blackshank Farm (BSF), at the Coastal Plain Experiment Station, Tifton, GA and in a commercial onion field in Evans County, GA. Experiments were conducted during the 2009-2010 season.

BSF Field Plots. Treatments were arranged in a randomized complete block design. Each treatment consisted of four, four-row beds ~20 m in length, with a 1.8-m separation between the centers of adjacent beds. Treatments consisted of planting onions following a summer crop of either 1. corn (*Zea mays*), 2. pearl millet (*Pennisetum glaucum*), 3. peanut (*Arachis hypogaea*), or 4. soybean (*Glycine max*). In the spring/summer of 2009, pearl millet and corn crops were planted in the same location as in previous years but plot sizes were reduced to half the area used in previous years. Peanut and soybean were added to the study in the areas vacated by the pearl millet and corn plots. Vidalia sweet onions, cv. Sweet Vidalia, were transplanted Dec 10, 2009 and grown until May 9, 2010. Approximately 10 m of bed length of the two interior beds were harvested from each plot when ~ 80% of the onion tops were down. Onions were air dried in the field 48 hrs after undercutting and prior to clipping of roots and foliage. Onions were removed from the field and

temporarily stored at the Vidalia Onion Research Lab on the Tifton Campus where they were weighed, graded and classified as either marketable or cull.

Microplots. Microplots 1 m in diameter and surrounded by an aluminum ring (~30 cm high with ~30 cm buried in the soil, were established at BSF. Microplots were seeded with five *B. cepacia* infected onion bulbs and planted with either corn, pearl millet, peanut or soybean in the spring/summer of 2009. Nine onion plants (cv. Sweet Vidalia), were transplanted Dec 10, 2009 into each microplot. The trial consisted of nine replications. Onions were dug, allowed to field-cure for 48 hr and then harvested in May, 2010. Harvested bulbs were held temporarily at ambient temperature at the Vidalia Onion Research Lab, Tifton, GA. Onions were graded as either marketable or cull and culls were specifically graded for sour skin incidence.

Evans County. A field in Evans County, that had been planted with carrot (*Daucus carota* subsp. *sativus*) in the winter/spring of 2008-2009, was planted either with corn or pearl millet in the summer of 2009, followed by a planting of Vidalia sweet onions in the fall of 2009. Approximately 50 onion bulbs were harvested from four randomly selected areas (n=200) previously planted with corn. In addition, 50 onions were harvested from four randomly selected areas (n=200) previously planted with pearl millet. Onions were graded for sour skin incidence.

Results and Discussion

Blackshank Farm in Tifton. Double-cropping onions after a summer crop of pearl millet had neither a positive or negative effect on total yield (Table 1), but significantly reduced sour skin incidence, thereby increasing marketable yield (Table 2). This is the third year of similar data where onions double-cropped behind pearl millet had significantly (P = 0.05) less sour skin (3, 4).

Microplots and Evans County. Unfortunately results from the microplots (Table 3) and the commercial field in Evans County (Table 4) provided no evidence

Table 1. Yields and size of onions (cv. Sweet Vidalia) harvested from field plots double-cropped behind either corn, pearl millet, peanut or soybean.

	Yield	# Bulbs / Plot				
Treatment	lbs/Plot	Pee Wee	Small	Medium	Large	Jumbo
Corn	32.34 a	9.8 a	12.8 a	3.0 a	24.8 a	8.5 ab
Millet	30.75 a	11.3 a	10.3 a	22.5 ab	27.5 a	9.0 b
Peanut	20.75 a	15.8 a	13.5 a	29.0 a	11.3 a	4.3 b
Soybean	35.20 a	15.8 a	9.3 a	13.0 b	22.3 a	24.5 a

Values within a column followed by the same letter are not significantly different (P=0.05)

Table 2. Grades of onions (cv. Sweet Vidalia) harvested from field plots double-cropped behind either corn, pearl millet, peanut or soybean.

Treatment	% Total Culls	% Sour Skin	% Marketable
Corn	26.7 ab	18.5 b	73.3 ab
Millet	18.8 a	5.4 a	81.2 a
Peanut	35.9 b	21.4 b	64.1 b
Soybean	33.9 b	13.7 ab	66.1 b

Values within a column followed by the same letter are not significantly different (P=0.05)

Table 3. Sour skin incidence in onions (cv. Sweet Vidalia) harvested from micro-plots double-cropped behind either corn, pearl millet, peanut or soybean.

	% Sour Skin									
Treatment	Rep1	Rep2	Rep3	Rep4	Rep5	Rep6	Rep7	Rep8	Rep9	Mean
Corn	75.0	42.9	55.6	75.0	22.2	75.0	55.6	100.0	37.5	59.9 a
Millet	40.0	37.5	62.5	60.0	57.1	44.4	100.0	33.3	88.9	58.2 a
Peanut	40.0	14.3	37.5	14.3	50.0	40.0	28.6	0.0	100.0	43.3 a
Soybean	0.0	33.3	37.5	57.1	57.1	83.3	42.9	50.0	28.6	36.1 a

Values within a column followed by the same letter are not significantly different (P=0.05)

Table 4. Sour skin incidence in onions harvested from a commercial field in Evans County that were double-cropped behind either corn or pearl millet.

	% Sour Skin				
Treatment	Rep1	Rep2	Rep3	Rep4	Mean
Corn	23.5	17.9	9.1	14.0	16.1 a
Millet	18.5	28.3	21.6	20.8	22.3 a

Values within a column followed by the same letter are not significantly different (P=0.05)

that double-cropping onions behind pearl millet affected sour skin levels when compared to planting onions behind corn. When comparing the three experiments, namely The Blackshank Farm, Microplots and Evans County, there is one striking difference between the sites. The Blackshank Farm plots have been in continuous onion production for at least 15 years, whereas the Microplots had never had onions planted there and Evans County had not been in onions within recent memory. This would indicate that the mode of action of pearl millet may not be a direct effect upon the bacterium *B. cepacia*. More likely, there is an indirect affect of the

preceding crop which influences the composition of the soil microflora. Soil microbial community composition is very complex and is affected by different variables including cropping history, farm management practices and soil types. It is possible because of the long-term onion production at the Blackshank Farm site that the microbial community was more readily affected by the presence of pearl millet and a suppressive soil was created. In areas such as Evans County, which had no history of onion production, the soil microbial community was probably different and less influenced by the preceding pearl millet crop. On the other hand, crops such as corn may stimulate *B. cepacia* populations directly, thereby increasing their numbers and increase sour skin incidence as hypothesized by Haudenshield and Lorbeer (2). However, data from the Microplot area and the Evans County site would not appear to support that hypothesis. In any case, the long-term cropping history or even the site itself appears to interact with double-cropping choices and sour skin incidence.

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EVALUATION OF LATE SEASON PRE-HARVEST PRACTICES TOWARDS MINIMIZING POSTHARVEST LOSSES IN VIDALIA ONIONS

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Introduction

Post harvest losses in onions are a major concern to Vidalia onion growers. Numerous microbial agents are known to contribute towards post harvest losses. Fungal pathogen *Botyritis allii*, and bacterial pathogens *Pantoea ananatis,* and *Burkholderia cepacia,* responsible for center rot and sour skin respectively, are considered the most important (Langston 2001). Currently a number of post harvest management strategies are available and practiced diligently; however, it should be brought to notice that late season pre harvest infections, injury by pests, and environmental factors are the primary causal agents that predispose onions to post harvest infections. Thrips are known to transmit *P. ananatis* (Wells et al. 2002, Gitaitis et al. 2003); thrips injury can also predispose the infested plants to other pathogens, such as *B. cepacia*. The goal of this project is to assess whether there is any correlation between late season pre harvest (insecticide and fungicide) applications and post harvest pathogen induced losses.

Methods

A trial was conducted at the University of Georgia, Vidalia Onion Research Farm near Reidsville, Georgia from 14 January through 13 May, 2010. The field trial included six treatments and an untreated check. Treatments were replicated four times in a randomized complete block design. The details of treatments are included in Table 1. Each plot was considered a replicate and plots were on raised beds and measured 6' wide and 25' long. Two onion varieties, Savannah Sweet and Century were planted; hence there were 56 plots in total.

First treatment application was on 7th April. Subsequent applications were made at approximately 10 day intervals: 19th April, 29th April, and 5th May. Sprays were applied using a tractor-driven high volume sprayer at 60 gal/A and 60 PSI driven at 3 mph. Observations were taken on the same day prior to application. The number of adult and immature thrips on 10 plants in each plot was counted. On 5th May, a visual disease rating was also undertaken for each of the 56 plots. Ratings were made by assigning a value from 1-11 (low to high) based on the amount of disease

Table. 1

Treatment #	Treatment	Rate of application
1	Actigard	1.0 oz/A
2	Radiant + Provado	10.0 oz/A +3.5 oz/A
3	Boscalid	18.5 oz/A
4	ManKocide	2.25 lbs/A
5	LEM17	24 oz/A
6	Q8Y78	18 oz/A
7	Untreated check	

symptoms observed in each plot. Onions were dug on 10th May and were harvested after 3 days. This procedure is considered standard for Vidalia onions (Boyhan et al. 2003). Fifty onions per plot were collected in 6 bags and were stored at the Vidalia onion storage facility at Tifton. One bag per plot was sampled for Sour Skin, *Botrytis*, and Center Rot at 0 months, 2 months, and 4 months post harvest. At each time interval there were two removals (0 days and 14 days). Analysis of variance was conducted to evaluate differences among treatments and LSD was used to separate treatment means.

Results

Pre harvest thrips counts:

Adults:

The incidence of adult tobacco thrips, *Frankliniella fusca*, on onions were affected by treatment applications (especially application 1 and 2) (Table 2). There were no significant differences among treatments at 3rd post treatment sampling. First post treatment counts indicated that fewer thrips were found on Radiant + Provado and ManKocide treated plots than on untreated control plots. Thrips densities in the remaining four treatments did not vary significantly from the untreated control. Second post treatment counts revealed that Radiant + Provado treated plots had fewer thrips than all other treatments except LEM17. No differences were observed between Q8Y78 and LEM17 treated plots (Table 2).

Larvae:

Differences in thrips larval densities were noticed among treatments during all three post treatment counts (Table 3). At the first post treatment count, plots treated with Radiant + Provado had fewer thrips than all the other treatment plots and untreated check plots. The trend remained the same for the other two post treatment counts. ManKocide, LEM17, and Q8Y78 had fewer thrips than Actigard at the 2nd post treatment count. Third post treatment count also indicated that fewer larvae were found on plots treated with ManKocide, LEM17, Q8Y78 and Boscalid than on Actigard treated plots. However, except Actigard none of the treatments were different from untreated control.

Table 2. Number of adult *Frankliniella fusca* on Vidalia onion plants on 3 post treatment dates.

	Number of Adult *F. fusca*		
Treatment	19-Apr-10	29-Apr-10	5-May-10
Untreated Control	18.25a	21.75ab	7.12
Actigard	18.25a	24.37a	7.62
Radiant +Provado	12.75b	10.62d	4.00
Boscalid	15.00ab	19.25ab	7.75
ManKocide	12.75b	20.62ab	7.00
LEM17 + MSO	14.75ab	11.75cd	5.00
Q8Y78 + MSO	16.25ab	17.37bc	7.87

*Counts represent mean number of adult thrips found on treatment plots. Counts from both the cultivars (Savannah Sweet and Century) were pooled. Treatments differences were estimated at $\alpha = 0.05$. Means with the same letters indicate that they are not different from each other.

Table 3. Number of *Frankliniella fusca* larvae on Vidalia onion plants on 3 post treatment dates.

	Number of Immature Thrips		
Treatment	19-Apr-10	29-Apr-10	5-May-10
Untreated Control	3.25a	7.25ab	20.25ab
Actigard	2.75a	10.25a	30.00a
Radiant +Provado	0.25b	2.62c	7.00c
Boscalid	3.87a	7.87ab	16.62bc
ManKocide	1.87ab	5.50bc	14.12bc
LEM17 + MSO	3.37a	4.00bc	18.75b
Q8Y78 + MSO	2.75a	4.50bc	14.12bc

*Counts represent mean number of thrips larvae found on treatment plots. Counts from both the cultivars (Savannah Sweet and Century) were pooled. Treatments differences were estimated at $\alpha = 0.05$. Means with the same letters indicate that they are not different from each other.

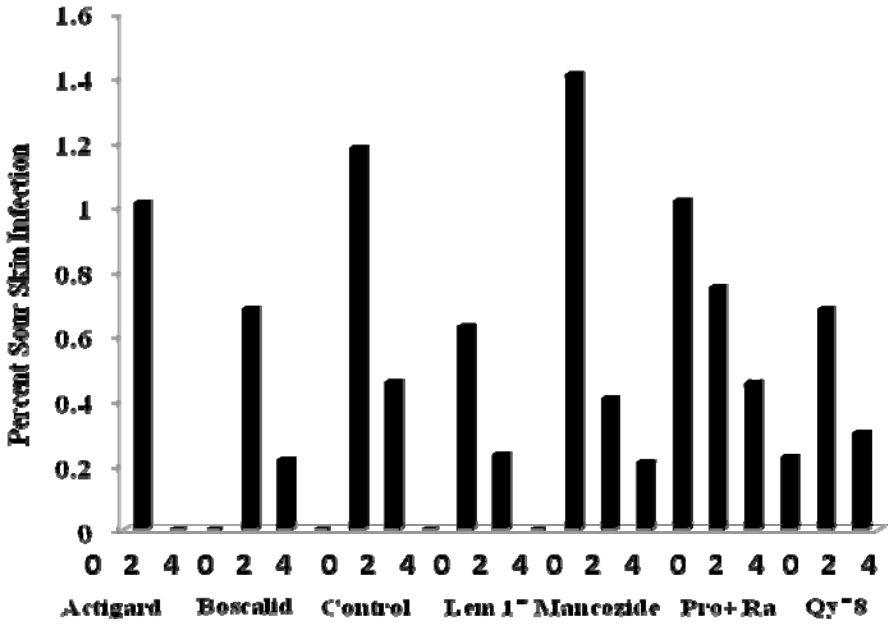
Pre harvest disease rating:
A single disease rating undertaken prior to harvest did not show any differences among treatments. All treatments including untreated control had very low disease incidence.

Post harvest ratings:

Center Rot:
Very few onions had Center Rot symptoms during the entire sampling period, hence no statistical analysis were performed to evaluate the effect of pre harvest applications on Center Rot incidence.

Sour skin:
In comparison to Center Rot, Sour Skin infections were common, especially in the first two sampling intervals. However, the infection levels remained consistently low and no significant differences were noticed among treatments. Sour Skin incidence throughout the sampling period is explained in the form of a bar graph (Fig. 1). No differences were noticed between Savannah Sweet and Century.

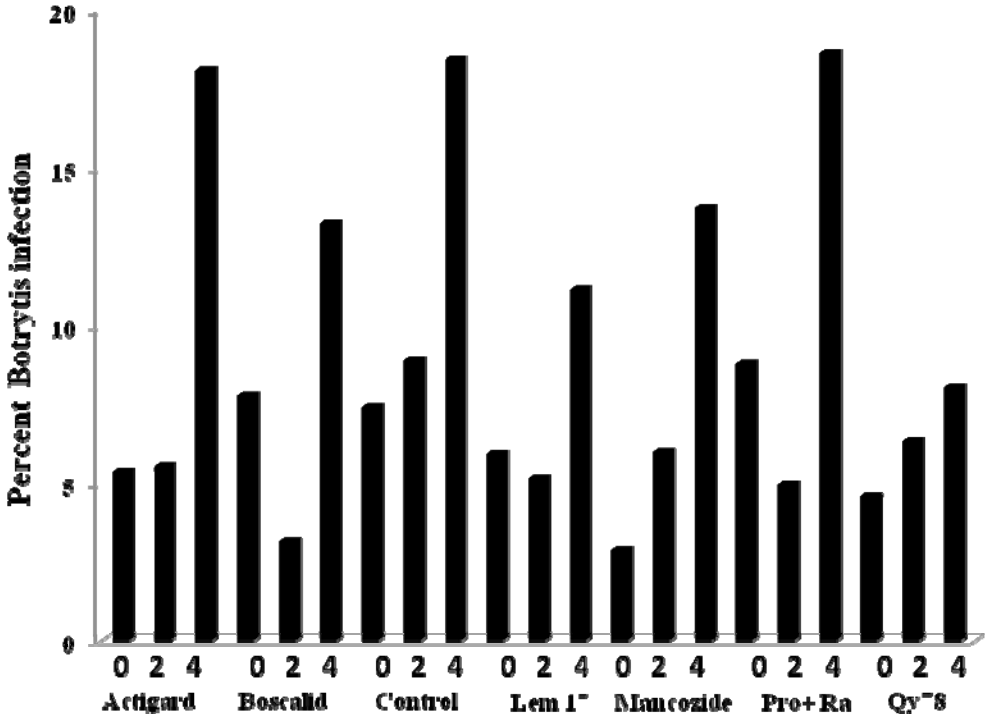
Figure 1. Effect of late season pre harvest applications on Sour Skin incidence in stored onions.



* Bar graph represents percent Sour Skin infection throughout the sampling period. The numbers 0, 2, and 4 represent months in storage. Treatment names are directly indicated below storage intervals.

***Botrytis*:**
In contrast to Sour Skin, *Botrytis* incidence was severely influenced by late season pre harvest applications. In general, *Botrytis* incidence increased with time. Actigard and Radiant+Provado had no effect on *Botrytis* incidence and incidence in these samples was as high as onions retrieved from untreated plots. All the other treatments reduced *Botrytis* incidence when compared to onion bulbs retrieved from untreated plots. Actigard, which induces systemic resistance against a multitude of pathogens (Sticher et al. 1997, Cole 1999, Pappu et al. 2000), did not have any effect on *Botrytis* incidence. On the contrary, two proprietary chemicals recommended for late season pre harvest application significantly reduced *Botrytis* incidence. Longer duration storage followed by removal at 14 days resulted in the highest level of botrytis incidence (> 26%). Incidence of *Botrytis* also varied with the cultivars planted. Savannah Sweet onions were typically less susceptible than Century onions. The incidence of *Botrytis* across all treatments and throughout the sampling period is explained with a bar graph (Fig. 2).

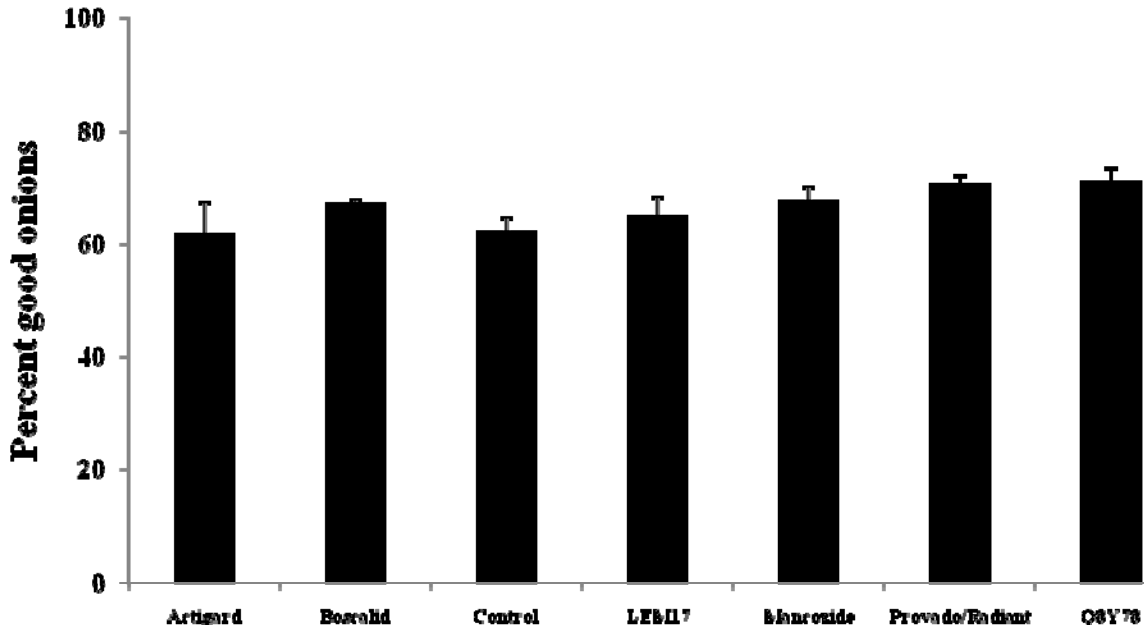
Fig. 2. Effect of late season pre harvest applications on *Botrytis* incidence in stored onions.



* Bar graph represents percent *Botrytis* infection throughout the sampling period. The numbers 0, 2, and 4 represent months in storage. Treatment names are directly indicated below storage intervals.

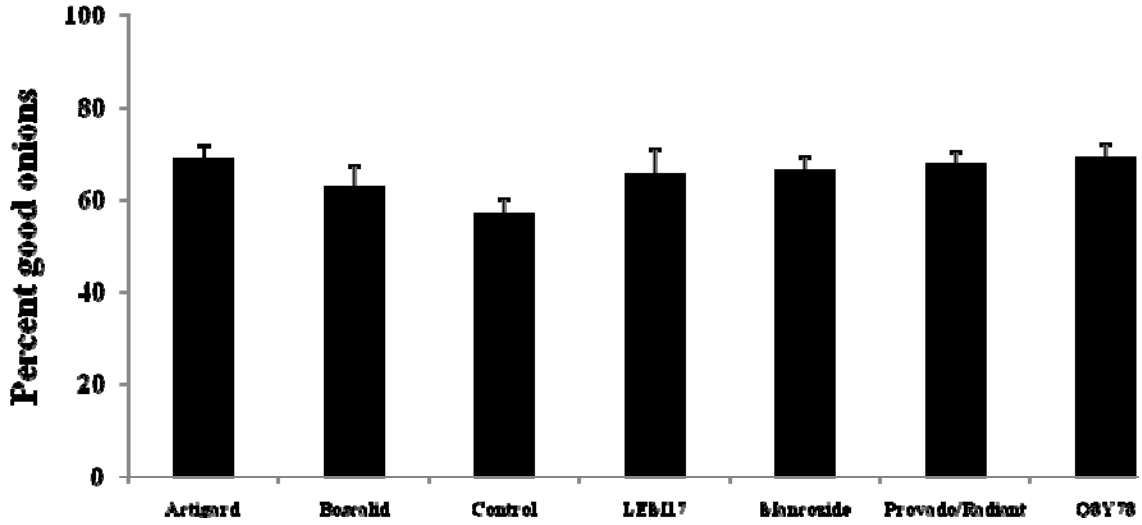
Yield data and interpretations:
Percentage of good onions was estimated for both Savannah Sweet and Century. The data are presented only for samples that were stored for 4 months and removed after 14 days. None of the treatments significantly affected the percentage of good onions either in Savannah Sweet (Fig. 3) and or in Century (Fig. 4). In both cultivars approximately more than one-third of the stored onions were classified as bad onions. Pre harvest treatments, particularly Lem 17, Boscalid, and Qy78 reduced Botrytis infection rates. None of the pre harvest applications had any effect on the quality of onions after a longer storage period. However, a suite of other reasons besides insects and pathogens could have also contributed to the loss of quality. Even though, pre harvest applications did not show any remarkable effects, they showed some promise and may be useful in reducing post harvest losses. Repeating the same trial for another season under high pathogen pressure will assist in assessing the effectiveness of these pre harvest applications on reducing pathogen induced storage losses.

Figure 3. Percentage of good onions in Savannah Sweet.



*Bars represent mean percentage of good onions after four months of storage and sampled after 14 days of removal.

Figure 4. Percentage of good onions in Century.



*Bars represent mean percentage of good onions after four months of storage and sampled after 14 days of removal.

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DETECTION OF ONION POSTHARVEST DISEASES BY ANALYSES OF HEADSPACE VOLATILES USING AN ELECTRONIC NOSE AND GC-MS

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Introduction

Fungal and bacterial diseases affect stored onions and cause substantial losses in storage. Outbreaks of these fungal and bacterial diseases are usually caused by a few damaged and infected onions which eventually spread the pathogen and spoil to nearby wholesome onions in storage. Botrytis neck rot (caused by fungus *Botrytis allii*) and sour skin (caused by bacteria *Burkholderia cepacia*) are two major onion diseases (Schwartz and Mohan 2008). Botrytis neck rot infects onion bulbs from the neck to inner layers; the sour skin usually displays the symptom with brown and water soaked main scales under the first one or two layers. Due to the nature of these two pathogens, they are virtually undetectable by human visual inspection which is a common practice in most onion packing houses. Because no effective detection methods are available, onion handlers are unaware of the presence of these diseases in the early stage until onions exhibit visual symptoms that make them unsalable at the end of the storage period. For instance, Botrytis neck rot could cause as high as 50 to 70% storage losses in some years (Ceponis et al. 1986; Boyhan and Torrance 2002).

In order to reduce postharvest losses, an effective detection technology that can identify pathogen infected onions in storage would be of great value to the onion industry. One study has shown that the volatile profile from *Botrytis allii*-inoculated onions is different from sterile water-inoculated onion bulbs (Prithiviraj et al. 2004). Unlike gas chromatography-mass spectrometry (GC-MS) or a human sensory panel, a gas sensor array offers an alternative method for rapid and inexpensive detection of volatile patterns. The gas sensor array, also known as the "electronic nose" (E-nose), is a chemical sensing and identification device that provides a rapid method of differentiating volatile profiles instead of identifying individual volatile compounds as GC-MS does (Mandelis and Christofides 1993; Schaller et al. 1998). The overall goal of this study was to explore whether the E-nose can detect and differentiate Botrytis neck rot, sour skin, and healthy onion bulbs by measuring their headspace volatiles, as well as to characterize volatile profiles of three onion treatments by using the GC-MS.

Materials and methods

Plant materials and inoculation

Vidalia sweet onion bulbs cv. Nirvana harvested in April 2008 were used for this study. The onion samples were picked at optimum maturity when ~80% of the necks were soft enough for leaves to collapse. Onion samples were stored in a cold room at 4 ^{o}C (R.H. 80%) for about 4 weeks before they were tested. Before use, dry skins were removed, basal roots were trimmed and the bulbs were surface sterilized using 70% ethanol. Onions were then washed with sterilized distilled water to remove chemical residues. Cultures of *Burkholderia cepacia*, strain Bc 98-4, were produced on tryptic soy agar after incubating at 30 ^{o}C for ~ 48 h. Cultures of *Botrytis allii*, strain Ba 09-1 , were produced on potato dextrose agar (PDA) after incubating at ~ 22 ^{o}C for ~ 148 h. Bc 98-4 was stored and maintained in 15% glycerol at > ~-80 ^{o}C. Ba 09-1 was stored and maintained on both diseased onion bulbs and PDA plates at ~ 4 ^{o}C. A square (1 cm x 1 cm) of onion flesh was cut out with a depth of 6.5 mm using a razor blade and a similar size agar containing *Botrytis allii* culture was removed from the inoculum plate and filled the hole in the onion. Every effort was made to use agar plugs of the same size which would provide a similar concentration of Botrytis for each bulb. In total, four holes were cut along the equatorial line of the bulb with equal distance. Similar physical wounds were made in control onions using a razor blade but without filling the *Botrytis allii* inoculum. The detailed method for sour skin inoculation was presented by Li et al. (2009).

The control and Botrytis inoculated onions were stored in the air conditioned room at 24±2 ^{o}C, while sour skin inoculated onions were placed in an incubator at 30^{o}C (the optimal growth temperature for the sour skin). *Botrytis allii* inoculated onions were placed in a plastic container sealed by the aluminum foil, where a high humidity environment was created to facilitate the growth of the fungus by wet paper towels in the container. Onion bulbs with different treatments were placed in glass jars with 2 L volume and 89 mm wide mouth covered by a square of aluminum foil (100 x 100 mm). The contained onion samples were placed under room temperature (24±2 ^{o}C) for 12 h before each measurement to allow the headspace gas to reach the equilibrium. Therefore, the temperature should not be a factor when the volatile compounds were analyzed for the three treatments.

Experiment design

Experiments were designed to explore whether the E-nose could delineate volatile profiles from three treatments: Botrytis neck rot, sour skin, and healthy onions. Ten onions were used for each of three treatments (control, Botrytis neck rot, and sour skin) which were measured on 5, 6, 7 dai and total 270 data sets were combined for statistical analysis. Each onion headspace was measured twice and the average of these two measurements was used as the third measurement.

Gas sensor array and data acquisition

Headspace samples from three onion treatments (control, sour skin, and Botrytis neck rot) were analyzed with a hand held E-nose which contains 32 conducting polymer sensors (Smith Detection Inc., Pasadena, CA). The characteristics of the gas sensor array were described in a separate paper (Li et al. 2009). During the sampling process, the E-nose sampling needle was inserted into the concentration chamber to draw headspace volatiles. Each sampling process took about 2 min. The conducting polymer sensors within the E-nose were purged by the ambient air between each measurement. The raw sensor resistance values were normalized to improve the signal to noise ratio by embedded data preprocessing algorithms in the E-nose. The preprocessed data were saved in a Microsoft Access file (Microsoft Inc., Redmond, WA) for further statistical analyses and pattern recognition algorithm development.

Volatile identification and quantification

Three replicates with one bulb for each replicate were used for each of control, sour skin and Botrytis neck rot treatments. Both the control and Botrytis were maintained at room temperature (~ 24±1 ^{o}C) while containers of sour skin samples were maintained at 30 ^{o}C in a water bath to facilitate the growth of the *Burkholderia cepacia*. Carboxen/polydimethylsiloxane (CAR/PDMS) solid phase microextraction (SPME) fibers from Supelco Inc., (Sigma-Aldrich, St Louis, MO, USA) were conditioned according to manufacturer's instructions. Onions were kept in separate 2-Liter glass containers when the headspace samples were measured by the SPME fibers. SPME fibers were exposed to onion vapors for 60 minutes on both 3 and 6 days after inoculation (dai). SPME fibers were then analyzed using a Shimadzu GC-17 gas chromatograph (Shimadzu Corporation, Kyoto, Japan) and P5050A mass spectrometer (Shimadzu Corporation, Kyoto, Japan) using an injector temperature of 270 ^{o}C, and a transfer line temperature of 280 ^{o}C. Peak identification was made by comparing MS fragment patterns with spectra from the National Institute of Standards and Technology (NIST) NIST 21 and NIST 107 created by Shimadzu Corp and Wiley library database Wiley7. Data with peak areas less than 10^6 were rejected. Peaks observed on only one of three replicates were also rejected.

Results and Discussion

Three classes discrimination using the E-nose

Fig. 1 shows a 3-D principal component analysis (PCA) score plot with first three principal components of the E-nose data in the experiment (data from 5, 6, and 7 dai were combined). In general, the three treatments formed three differentiable clusters although with certain degree of overlap with each other. The compactness of three treatments vary from each other, with "control" group being the most compacted cluster, while the sour skin and Botrytis neck rot clusters being looser. The relative locations of onion samples on the PCA score plot generally reflect the differences in their volatile profiles. The data suggest that the volatile profiles from the control group are more uniform than these from pathogen inoculated treatments. The first principal component explains 88.5% of total variance, reduced

from 98% when only two classes (Botrytis neck rot and control) were compared. The second and third principal components explain 10.5% and 0.5% of total variance, respectively, both increased compared to the two classes situation. This suggests that the discriminant power from the first principal component was reduced and information from more principal components is needed to maximize the differentiation power when three treatments were compared.

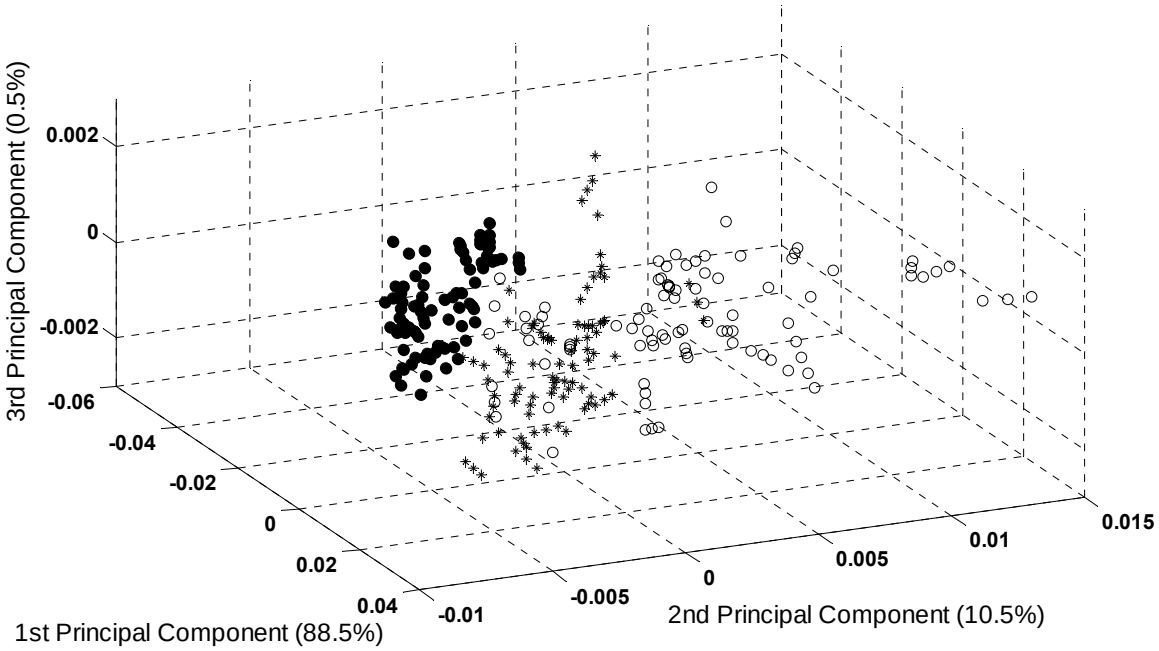

Figure 1. Three dimensional score plot of principal component analysis of the E-nose response to three onion treatments. Symbols "○" represent Botrytis neck rot infected onions; symbols "●" represent healthy control onions; symbols "*" represent sour skin infected onions.

GC-MS data analysis

Twenty four major volatile compounds were identified by the GC-MS in the headspace of the three treatments with three replicates measured on 3 dai and 6 dai. Based on their chemical and biological properties, the chemicals in Table 1 were categorized into four broad groups: Aliphatic (12), acid (1), sulfur (11), and alcohols (1). In all chromatograms a large number of small unresolved peaks were observed from ~ 7 to 13 minutes. These peaks were found to be primarily hydrocarbons along with a smaller number of alcohols and ketones. The identity of the peaks was difficult to obtain due to the peaks being unresolved and the lack of similarity found when comparing mass spectra to the computer data bases.

Both the total number of volatile compounds detected and total abundance of the volatile compounds varied greatly among the three different treatments, in particular between control healthy onions and pathogen inoculated onions. Only 3 and 8 major volatile compounds were detected in control healthy onions on 3 dai and 6 dai, respectively, whereas 17 and 20 compounds were found in *B. cepacia* inoculated bulbs, and 21 and 15 were identified in *B. allii* inoculated bulbs, at 3 dai

and 6 dai, respectively. For those compounds detected in the control group, most of them were aliphatic compounds with the exception of two sulfur compounds (dipropyl disulfide and propylpropenyl disulfide), while in pathogen inoculated treatments all 11 sulfur compounds were present. With regard to the abundance of volatiles, total amount of volatile compounds detected in pathogen inoculated bulbs was one or two orders of magnitude higher than that of control bulbs. On 3 dai, the abundance of volatile compounds in *B. cepacia* and *B. allii* inoculated onions were 30 times and 101 times higher than those in control, respectively; on 6 dai, they were 23 and 7 times higher than those in control, respectively. The compounds detected in pathogen inoculated bulbs with relatively high concentration include Dipropyldisulfide (DPDS), 1-Propanethiol, Methylpropyldisulfide, 2-undecanone, 2,4-octanedione, 4-(dimethyl-cyclopentenyl) butanone, and 2-hexyl-5-methyl-3(2H)-furanone. In particular, the abundance of dipropyldisulfide (DPDS) in *B. allii* inoculated bulbs was 46 times higher than that detected in healthy bulbs and it accounted for 61% of total volatile compounds detected in Botrytis treatment. This chemical is primarily due to the breakdown of propylcysteinesulfoxide or propenylcysteinesulfoxide. These compounds are presumably due to the breakdown of the onion cell wall and contents of the bacteria and fungi and can be used as indicators of the attack by either fungi or bacteria on onion bulbs.

Among total 24 compounds detected, 16 compounds were unique to pathogen inoculated bulbs, in which three compounds were unique to *B. allii* inoculated bulbs, two compounds were unique to *B. cepacia* inoculated bulbs, and 11 compounds were found common to both pathogen inoculated bulbs. Only seven compounds were found to be present in all three treatments. Compounds *Z*-propanethiol-*S*-oxide and 1-(methylthiol)-1-propene were only detected from onion bulbs inoculated with *B. allii* on both 3 and 6 dai. Although compound (Z)-1-(methylthio)-1-Propene was found only in *B. allii* inoculated onions, it was detected only on 3 dai with relatively small amount. Two compounds, 2-Nonanone and 2-octyl-5-methyl-3(2H)-furanone, were found unique in *B. cepacia* inoculated bulbs on both 3 and 6 dai. Eleven compounds were found in common for both the *B. cepacia* and *B. allii* inoculated bulbs, which explains why these two pathogen inoculated bulbs showed greater similarity than they were to control group as observed in the HCA dendrogram of the E-nose data. Some differences exist between two treatments. For instance, although dimethyl disulfide was present in both *B. allii* and *B. cepacia* inoculated bulbs, it was detected in *B. allii* inoculated bulbs only on 3 dai with relatively small quantity compared to that detected on both 3 and 6 dai with relatively higher abundance in bulbs inoculated with *B. cepacia*.

Table 1. Average abundance of mass-ions (x 10^6) of volatile compounds detected in control healthy, *B. allii* and *B. cepacia* inoculated onion bulbs

RT (h.m)	Compound	Group	C3	C6	B3	B6	S3	S6	Treat
2.64	*Z*-propanethiol-*S*-oxide	Sulfur	0	0	2.6	2.7	0	0	B
2.74	(*E*)-1-(Methylthio)-1- Propene	Sulfur	0	0	1.3	0	0	0	B
2.89	(*Z*)-1-(Methylthio)- 1- Propene	Sulfur	0	0	2.2	5.4	0	0	B
10.84	2-Nonanone	Aliphatic	0	0	0	0	8	9.6	S
26.51	3(2H)-Furanone, 2-octyl-5-methyl-	Aliphatic	0	0	0	0	0.5	1.5	S
1.93	1-Propanethiol	Sulfur	0	0	4.6	1.3	2	4.4	BS
3.03	Dimethyldisulfide (DMDS)	Sulfur	0	0	1.6	0	8	4	BS
5.87	2,5-dimethylthiophene	Sulfur	0	0	3.8	0	0	0.5	BS
6.47	methylpropyldisulfide	Sulfur	0	0	25.4	7.3	4.3	19.9	BS
6.49	methylpropenyldisulfide	Sulfur	0	0	0.1	0	2.5	1.1	BS
13.43	4-(1,2-Dimethyl-cyclopent-2-enyl)-butan-2-one	Aliphatic	0	0	2.4	7.9	3.3	52.8	BS
13.85	n-dodecane	Aliphatic	0	0	1.7	0.8	0.6	2.4	BS
17.1	1-Nonanol	alcohol	0	0	0.1	0.4	0.3	1.6	BS
17.74	Pentalene/aromadenrene	Aliphatic	0	0	1.8	0	0	1.3	BS
17.94	Dipropyltrisulfide (DPTS)	Sulfur	0	0	0.9	0	0	1.1	BS
22.58	2-Tridecanone	Aliphatic	0	0	1.1	0.7	1	2.6	BS
11.21	Heptanoic Acid	acid	0	1.3	0	2.2	0	0	CB
1.59	Acetone	Aliphatic	2.8	3.2	5.3	8	6	4.1	CBS
11	Undecane	Aliphatic	0	0.8	40.6	0	28.8	19.2	CBS
11.72	Dipropyldisulfide (DPDS)	Sulfur	0	8.3	383.4	64.9	23.1	96.5	CBS
11.92	Propylpropenyldisulfide	Sulfur	0	3.8	47	13.2	4.9	25.8	CBS
16.94	2-Undecanone	Aliphatic	3.2	5.2	89.7	31.8	58.9	111.9	CBS
19.39	2,4-Octanedione	Aliphatic	0.2	0.5	7.3	4.8	11.6	43.1	CBS
21.25	3(2H)-Furanone, 2-hexyl-5-methyl-	Aliphatic	0	0.2	4.4	16.7	19.8	123.1	CBS
	Total Acids		0	1.3	0	2.2	0	0	
	Total Alcohols		0	0	0.1	0.4	0.3	1.6	
	Total Aliphatics		6.2	9.9	154.3	70.7	138.5	371.6	
	Total Sulfurs		0	12.1	472.9	94.8	44.8	153.3	
	Total of all metabolites (relative abundance)		6.2	23.3	627.3	168.1	183.6	526.5	
	Total of all metabolites (numbers)		3	8	21	15	17	20	

C=control bulbs; B=*B. allii* inoculated bulbs; S=*B. cepacia* inoculated bulbs. The numbers after each letter indicate 3 or 6 days after inoculation. Volatile compounds observed on only one of three replicates and abundance less than 10^6 were rejected.

Conclusion

The E-nose successfully discriminated two pathogen inoculated bulbs (*B. allii* and *B. cepacia*) and healthy bulbs during five to seven days after inoculation. The GC-MS experiments confirmed and validated the results observed in the E-nose data. Total 24 major volatiles were identified from the headspace of three treatments. Sixteen compounds were specific to *B. allii* and (or) *B. cepacia* inoculated onion bulbs. The abundance of volatile compounds detected in pathogen inoculated bulbs was one to two orders of magnitude higher than that of control healthy bulbs. This study characterized that *B. allii* and *B. cepacia* inoculated onion bulbs emit different volatile metabolites from healthy onions and demonstrated that the E-nose could potentially be used as an effective tool for onion postharvest disease detection in storage.

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In vitro ASSAY EVALUATING FUNGICIDE ACTIVITY AGAINST *Colletotrichum gloeosporioides*, CAUSAL AGENT OF TWISTER DISEASE OF ONION

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Introduction

In the fall of 2007, onion seedlings with twisted and distorted leaves were observed in seedbeds in multiple fields in the Vidalia-onion region of Georgia. Signs of fungal fruiting bodies were observed on the outside sheath of a few of the seedlings. Laboratory tests confirmed the causal agent was the fungus *Colletotrichum gloeosporioides*. A disease with similar symptoms called 'twister' has been reported on onion in tropical regions (1). The fall of 2007, was unusually warm with maximum temperatures reaching 26C during the day. The pathogen is present on many crops in the United States but to our knowledge this was the first report of *C. gloeosporioides* causing twister disease of onion in the United States. In Nigeria and Brazil, yield losses of up to 100% were observed in fields with infected onions (1). The impact of infection on the growth of the transplants and subsequent yield in Vidalia onions is currently unknown, and there is limited knowledge regarding management of this disease with fungicides.

Materials and Methods

Fungicides commonly used for disease management programs in onion were mixed at field rates (1x) and diluted to represent 0.75x, 0.5x and 0.25 x concentrations of the field rate. A negative control using no fungicide was employed for each treatment. Fungicides evaluated and 1x concentrations are listed in Table 1.

One cm diameter wells were cut from the centre of potato dextrose agar (PDA) plates (15 cm diam). Aliquants of the different fungicide suspensions ranging from 0.25x -1.0x were pipetted into each well. A mycelium/spore suspension of *C. gloeosporioides* was spread on to the surface of each plate. Plates were incubated and zones of inhibition (cm) surrounding each fungicide-containing well were measured. Data were recorded and analysed using General Linear Models (GLM) and mean differences were determined by calculating least significant difference (LSD) value at P=0.05 level using SAS.

Table 1. Fungicides evaluated for in vitro efficacy test against the onion twister fungus, *Colletotrichum gloeosporioides.*

Product	1x Rate
Acrobat	6.4 oz
Aliette	3.0 lbs
Bravo	2 pt
Manzate	2.4 qt
Omega 500	1.0 pt
Rovral 4	1.5 pt
Scala	18 fl oz
Switch	14 oz
Topsin M	10 fl oz

Results and Discussion

Among the different fungicides tested Acrobat, Rovral 4, Scala, Switch and Topsin M displayed no activity against the twister fungus even at full strength (1.0x rate) (Table 2). Of the remaining fungicides, Manzate produced significantly larger zones of inhibition at all rates (0.25x – 1.0x) compared to all other products. The next most effective fungicide was Aliette at 3 lbs at 0.5x -1.0x rates which was significantly different from all other products except Omega 500 at the 0.75x rate (Table 2). Bravo at all rates and three of the four rates tested for Omega 500 were the least effective of those fungicides that displayed any efficacy at all. Based on these results, Manzate had the greatest efficacy in laboratory *in vitro* assays against the twister fungus and may be the best candidate for future trials in the field.

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Table 2. Mean zone of inhibition (cm) produced by test fungicides at 1.0x, 0.75x, 0.5x and 0.25 x rates in potato dextrose agar (PDA) plates when inoculated with the onion twister fungus *Colletotrichum gloeosporioides.*

Product	Rate	Concentration	x Diam. Inhib.(cm)	LSD = 0.69
Manzate	2.4 qt	0.25x	3.55	a
Manzate	2.4 qt	0.5x	3.54	a
Manzate	2.4 qt	1x	3.37	a
Manzate	2.4 qt	0.75x	3.26	a
Aliette	3 lbs	1x	2.3	b
Aliette	3 lbs	0.75x	2.1	bc
Omega 500	1 pt	0.75x	1.73	bcd
Aliette	3 lbs	0.5x	1.73	bcd
Omega 500	1 pt	1x	1.6	cd
Omega 500	1 pt	0.5x	1.57	cd
Omega 500	1 pt	0.25x	1.33	de
Bravo	2 pt	0.75x	1.2	de
Bravo	2 pt	0.5x	1.17	de
Bravo	2 pt	1x	1.13	de
Bravo	2 pt	0.25x	1.1	de
Aliette	3 lbs	0.25x	0.87	e
Omega 500	1 pt	0x	0	f
Bravo	2 pt	0x	0	f
Aliette	3 lbs	0x	0	f
Topsin M	10 fl oz	0x	0	f
Topsin M	10 fl oz	0.25x	0	f
Topsin M	10 fl oz	0.5x	0	f
Topsin M	10 fl oz	0.75x	0	f
Topsin M	10 fl oz	1x	0	f
Scala	18 fl oz	0x	0	f
Scala	18 fl oz	0.25x	0	f
Scala	18 fl oz	0.5x	0	f
Scala	18 fl oz	0.75x	0	f
Scala	18 fl oz	1x	0	f
Acrobat	6.4 oz	0x	0	f
Acrobat	6.4 oz	0.25x	0	f
Acrobat	6.4 oz	0.5x	0	f
Acrobat	6.4 oz	0.75x	0	f
Acrobat	6.4 oz	1x	0	f
Switch	14 oz	0x	0	f
Switch	14 oz	0.25x	0	f
Switch	14 oz	0.5x	0	f
Switch	14 oz	0.75x	0	f
Switch	14 oz	1x	0	f
Manzate	2.4 qt	0x	0	f
Rovral 4	1.5 pt	0x	0	f
Rovral 4	1.5 pt	0.25x	0	f
Rovral 4	1.5 pt	0.5x	0	f
Rovral 4	1.5 pt	0.75x	0	f
Rovral 4	1.5 pt	1x	0	f

USING PCR TO IDENTIFY THRIPS' FEEDING PATTERNS PRIOR TO THEIR ENTRY INTO ONION FIELDS

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Introduction

In Georgia, center rot of onion infections, caused by *Pantoea ananatis*, generally occur in the late spring 4-6 wks prior to harvest. Although the bacterium can be seedborne, it has been hypothesized that thrips account for the majority of disease outbreaks and spread of the pathogen (2,3). Several weeds have been identified as non-symptomatic, resident hosts of epiphytic populations of the pathogen, but no definitive association has been made between specific weeds and onion epidemics (1). It has been hypothesized that as thrips feed on the contaminated weeds they ingest the bacterium which is deposited as feces on the leaf surface. The bacteria in the feces could establish populations on the leaf as an epiphyte and infect the plant through natural openings, such as stomata, as populations increase. Alternatively, the bacteria could immediately infect the plant by colonizing feeding wounds. Either way, bacteria on weeds are the most likely source of initial inoculum and weeds are the most likely source for thrips to acquire the bacterium. The objective of this study was to capture thrips in flight along the edge of onion fields, identify the thrips species, extract plant DNA from thrips' digestive tracts, sequence the DNA and identify the plant material that the thrips last fed upon prior to its entry in the onion field.

Materials and Methods

Thrips collection: A method to collect and process thrips has been described previously (5). Briefly, a pick-up truck was parked next to onion fields in Evans County, Tift County and two sites in Toombs County. Using magnetic clips, yellow poster boards were hung on the side of the truck as a lure and a platform to collect thrips. Thrips were vacuumed off of the yellow poster boards using a disposable filtration unit modified in to a suction device that trapped thrips. A vacuum pump was attached to the filtration unit with approximately 2 m of heavy vacuum tubing. A portable gasoline-powered generator was used to supply electricity to the vacuum pump which created a vacuum of approximately 450 mm Hg. The filter cups containing captured thrips were temporarily stored on ice for transport to the lab and then transferred to a -80C freezer. After freezing the thrips were sorted by species and transferred to microcentrifuge tubes. Samples were stored at -80C until DNA was extracted.

DNA extraction of thrips: Total DNA was extracted from individual thrips using the DNeasy Plant Mini kit (Qiagen, Valencia, CA) with a slight modification of the manufacturer's mini protocol. Buffer adjustments were as follows: 50µl AP1 bffer, 0.5µl RNase, 16.25 µl AP2 buffer, 100 µl AP3 buffer and 30 µl AE (elution) buffer. The 30 µl of AE buffer were divided into 20 µl for the first elution and 10 µl for the second elution. The AW buffer was used according to the protocol. One thrips was placed in each microcentrifuge tube for extraction. AP1 buffer and RNase were added and the thrips were crushed using sterile mini-pestles. The DNA extracts were stored at -20C.

PCR amplification and sequencing: A Taq PCR Core kit (Qiagen, Valencia, CA) was used for PCR. The following mixture was used for PCR (total reaction volume: 100µl): 10µl 10x PCR buffer, 10µl Q solution, 2µl dNTPs, 2µl ITS4 primer (10µmol), 2µl N-nc18S10 primer (10µmol) (7), 0.5µl Taq, 68.5 µl nuclease-free water and 5 µl DNA. The thermocycler was programmed as follows: 94C for 3 min., followed by 40cycles: 94C for 1 min, 52.5C for 1 min., 72C for 1 min. A final extension was done at 72C for 5 min. The PCR products were run on a 1.2% agarose gel, stained with ethidium bromide and viewed under UV light. For sequencing the PCR bands were cut from the gel and purified using the Gel Purification kit (Qiagen, Valencia, CA). The purified bands were sequenced at the University of Georgia sequencing facility in Athens, GA. The obtained sequences were submitted for a search in GenBank using the BLASTX algorithm and results were analyzed for a match with existing accessions.

Weed collection and processing: Weeds were collected in plastic bags and placed on ice until transported to the laboratory in Tifton. Weeds were identified to species in most cases. An aliquant of weed foliage and stems were washed 15 min. in a phosphate, physiological saline (PBS) buffer (0.01M K_2HPO_4-KH_2PO_4 [ph 7.0] and 0.75% NaCl) to dislodge epiphytic bacteria. Aliquants were either plated onto a bacteriological growth medium (nutrient agar or PA20 (4) and incubated 48-72 hr at 28C, or used for PCR using ITS (intertransgenic spacer region) primers that are specific for *P. ananatis*(6).

Results and Discussion

Prior to April 6, 2010, all attempts to collect viable thrips were negative as no thrips landed on the yellow poster lures. Data for thrips collections from April 6 - April 29 are presented in Table 1. A total of 323 thrips were captured, but the majority (74%) were *Frankliniella tritici*. Since this species is not noted to colonize or feed upon onions to any appreciable level, resources were directed to the other 26% thrips species in terms of extracting DNA, running PCR, purifying gene sequences and conducting BLAST searches on the 18S rRNA plant genes. From the 14 tobacco thrips (*F. fusca*) collected, a DNA sequence for plant material was obtained from 29% of the samples. Weed DNA identified inside of tobacco thrips included: small Venus lookingglass, Carolina geranium, and narrowleaf purple cudweed (Table 1).

Only one western flower thrips was collected in this survey and the weed DNA identified inside of it matched the GenBank DNA sequence of the twoflower passion flower. The remaining thrips species known to transmit onion pathogens collected in this survey was *Thrips tabaci* (onion thrips). From the 10 onion thrips collected, 30% contained DNA from wandering cudweed (Table 1). Currently, PCR results for DNA of *P. ananatis* or RT-PCR results for RNA of *Iris yellow spot virus* (IYSV) in any of the thrips samples is pending. Results from weed surveys (current and past results combined) to identify resident carrier hosts of *P. ananatis* are presented in Table 2. It is interesting to note that out of the 32 weeds identified as carriers of *P. ananatis*, cudweed was the only one also identified in thrips digestive tracts. Cudweed also was detected inside of both onion and tobacco thrips and accounted for 44% of the weeds identified in thrips' digestive tract. However, these results should be viewed as preliminary, since the sample size of known vectors represented a small portion of the total population of thrips captured. Furthermore, out of the total number (31) of known vectors collected, only 29% yielded useable DNA to sequence and identify the plant species on which thrips had been feeding. This represented only 9% of the 323 thrips collected, as the majority of thrips collected were *F. tritici*. With such a small sample size representing the known vectors it is difficult to draw any firm conclusions, but with further research the weeds which are important in the epidemiology of thrips-transmitted pathogens may yet be determined.

Table 1. Thrips species, sampling sites along borders of onion fields, sampling dates, numbers of thrips captured, and plant material identified in thrips' gut by amplifying the plant's 18S gene and conducting a BLAST search in GenBank.

Thrips Species	Location	Date	#	Weed Common Name	Weed Latin Binomial
Frankliniella fusca	Tift	6-Apr	3	Small Venus Lookingglass	*Triodanis biflora*
F. tritici	Tift	6-Apr	38	ND	
F. fusca	Tift	7-Apr	2	Carolina Geranium	*Geranium carolinianum*
F. tritici	Tift	7-Apr	8	Toadflax	*Linaria vulgaris*
F. fusca	Tift	14-Apr	2	Narrowleaf Purple Cudweed	*Gnaphalium purpureum*
F. occidentalis	Tift	21-Apr	1	Twoflower Passion Flower	*Passiflora biflora*
F. tritici	Tift	21-Apr	3	ND	
F. tritici	Toombs 1	1-Apr	35	ND	
F. tritici	Toombs 1	15-Apr	27	ND	
unidentified	Toombs 1	22-Apr	5	ND	
F. tritici	Toombs 2	1-Apr	2	ND	
F. fusca	Toombs 2	1-Apr	3	ND	
F. tritici	Toombs 2	15-Apr	80	ND	
F. tritici	Toombs 2	22-Apr	17	ND	
F. tritici	Toombs 2	29-Apr	21	ND	
Thrips tabaci	Toombs 2	29-Apr	1	ND	
unidentified	Toombs 2	29-Apr	16	Wandering Cudweed	*G. pensylvanicum*
F. tritici	Evans	22-Apr	2	ND	
F. tritici	Evans	29-Apr	30	ND	
F. fusca	Evans	29-Apr	27	ND	
Total			323		

Table 2. Weed and crop species from which the onion center rot pathogen, *Pantoea ananatis*, was detected.

Common Name	Latin Binomial
Arrowleaf Sida	*Sida rhombifolia*
Bermuda Grass	*Cynodon dactylon*
Bristly Starbur	*Acanthospermum hispidum*
Broadleaf Signalgrass	*Brachiaria platyphylla*
Carpetweed	*Mollugo verticillata*
Common Chickweed	*Stellaria media*
Common Cocklebur	*Xanthium pennsylvanicum*
Common Ragweed	*Ambrosia artemisiifolia*
Cowpea	*Vigna unguiculata*
Crabgrass	*Digitaria sanguinalis*
Cudweed	*Gnaphalium spp.*
Curly Dock	*Rumex crispus*
Entireleaf Morningglory	*Ipomoea hederacea*
Florida Beggarweed	*Desmodium tortuosum*
Florida Pusley	*Richardia scabra*
Hyssop Spurge	*Chamaesyce hyssopifolia*
Ladysthumb	*Persicaria maculosa*
Palmer Amaranth	*Amaranthus palmeri*
Pink Purslane	*Portulaca pilosa*
Rescue Grass	*Bromus catharticus*
Sicklepod	*Cassia obtusifolia*
Slender Amaranth	*Amaranthus viridis*
Smallflower Morningglory	*Jaquemontia tamnifolia*
Soybean	*Glycine max*
Spiderflower	*Cleome hassleriana*
Spiny Amaranth	*Amaranthus spinosus*
Stinkweed	*Thlaspi arvense*
Tall Verbena	*Verbena bonariensis*
Texas Panicum	*Panicum texanum*
Vaseygrass	*Paspalum urvillei*
Wild Radish	*Brassica spp.*
Yellow Nutsedge	*Cyperus esculentus*

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SULFUR DIOXIDE AND OZONE TREATMENTS FOR THE POSTHARVEST CONTROL OF ONION BOTRYTIS

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Introduction

The storage disorder Botrytis neck rot (BNR, *Botrytis allii*) is a major postharvest problem limiting the storage potential of Vidalia Sweet Onions. In other crops (e.g. grape, peaches, and litchi), a postharvest fumigation with sulfur dioxide (SO_2) is routinely used to control pathogens, including Botrytis, while ozone is routinely used as a surface and water sterilant. Results from the 2008 and 2009 SO_2 experimentation with onion had shown great promise for reducing the incidence of botrytis, using continuous low-dose sulfur emitting sheets (2008), or high dose monthly room fumigations (2009). In a similar manner, ozone applications in other industries have provided support for its potential use in controlling storage pathogens in onion. Thus, the objective of the study was to evaluate the ability of SO_2 and ozone at controlling the incidence of botrytis during and after storage.

Materials and Methods

Three varieties, the early 'WI-129', as well as 'Sapelo Sweet' and 'Caramelo' were undercut on April 26th, May 10th and May 24th, respectively at the Vidalia Onion and Vegetable Research Facility in the spring of 2010. After undercutting, 2/3^{rds} of the bulbs were harvested, then transported to the Vidalia Onion Research Facility (VORL) in Tifton, where half were then heat-cured (36-38ºC) for 48 hours, while the other half of the bulbs were maintained inside the VORL facility (zero cure). The remaining 1/3rd of the undercut bulbs were permitted to field cure for 48 hours before being transported to Tifton. After completion of all curing treatments (0 days, 48 hours field, or 48 hours heat), bulbs were graded and sorted into 20 bulb bags. The bulbs were then placed into one of four cold storage rooms all held at 34ºF, with 70% R.H. at the VORL. The four treatments were 1) regular air storage (RAS), 2) controlled atmosphere storage (CAS, 3% O_2 + 5% CO_2), 3) one-time sulfur dioxide fumigation followed by RAS (SO_2), or 4) continuous ozone under RAS (O_3). For the SO_2 fumigation treatment, 1000 ppm of SO_2 was injected into a sealed cold storage room for one-hour, with fans on continuously to help circulate the gas. At

the completion of the fumigation, the room was vented with air for 3-4 hours until SO_2 levels were reduced below detectable levels (less than 1 ppm). For the ozone treatment, an Air-Zone XT-4000 ozone generator was programmed to inject ozone into the room in order to maintain a continuous exposure between 0.1 and 10 ppm. Ozone concentration was continuously monitored using an Eco-Sensor A-21Z ozone detector. Bulb samples were removed after 2 and 4 months, and warmed to room temperature under controlled conditions. The following day, 4 bags of bulbs were removed, weighed, and evaluated for botrytis neck rot, sour skin, slippery skin, damage, sprouts, and other storage defects, while a similar set of 4 bulbs were maintained at room temperature and evaluated in an identical manner after 14 days.

Results and Discussion

For all three cultivars, there was a significant effect of both the field curing and the postharvest storage treatments on the incidence of botrytis. Over all treatment effects, the incident rate of botrytis was 36%, 22%, and 37% for 'WI-129', 'Sapelo', and 'Caramelo', respectively.

Curing had a significant effect on the rate of botrytis. This is especially evident in earlier harvest dates. As seen in figure 1, WI-129 benefitted from curing, though it did not matter whether it was field or a heat cure. Sapelo Sweet, which was harvested 2 weeks later, only benefitted slightly from a curing treatment, while the last cultivar, Caramelo, curing did not significantly reduce the incidence rate of botrytis.

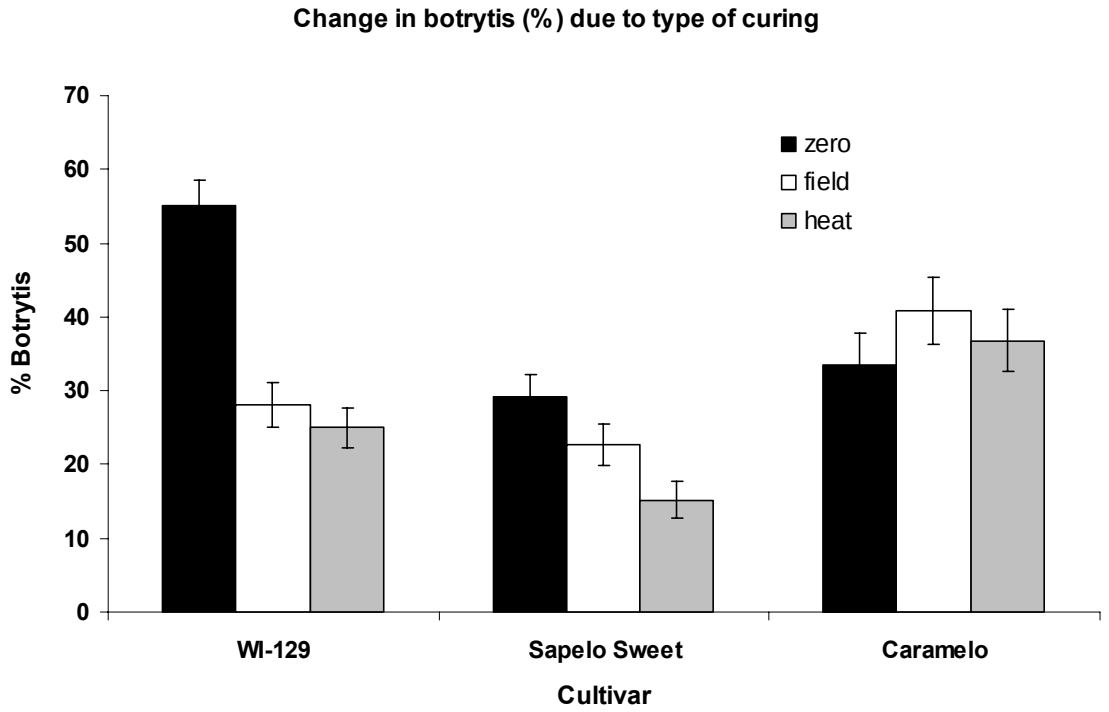

Figure 1. Changes in % botrytis in WI-129, Sapelo Sweet, and Caramelo cultivars after zero, 2-days of field, or 2-days of heat (97°F) after 4 months of storage and a14 days of a simulated marketing period at 70°F.

There were significant differences due to storage condition. Though there were slight reductions observed in WI-129 and Caramelo, there was no significant benefit from storing the bulbs in an atmosphere of ozone compared to regular air storage for any cultivar (figure 2). CA storage did result in lower levels of botrytis for WI-129 and Caramelo, when compared to air. However, sulfur dioxide fumigation resulted in the greatest benefit of any storage treatments. The fumigation resulted in a 46%, 65% and 38% reduction in botrytis for WI-129, Sapelo Sweet, and Caramelo, respectively. This is the 3rd consecutive year where a benefit from sulfur dioxide fumigation has been observed.

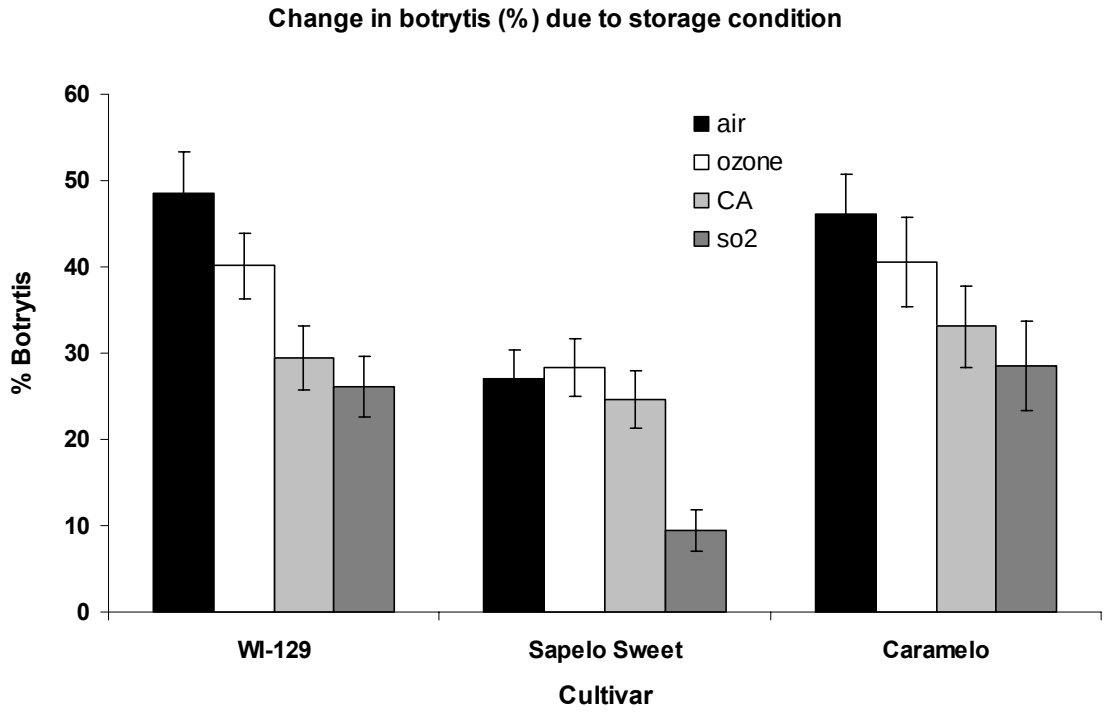

Figure 2. Changes in % botrytis in WI-129, Sapelo Sweet, and Caramelo after storage under regular air storage (RAS, 34°F, 70% R.H.), ozone (+RAS), controlled atmosphere storage (3% O_2 + 5% CO_2, 34°F, 70% R.H.), or sulfur dioxide fumigation (+RAS).

Storage duration and time on the shelf both have a significant impact on the amount of botrytis observed on the bulbs. As seen in figure 3, the amount of botrytis increased substantially from 2 to 4 months of storage, and also from 1 to 14 days at room temperature during a simulated marketing period. Though only WI-129 is shown, nearly identical trends were observed in Sapelo Sweet and Caramelo.

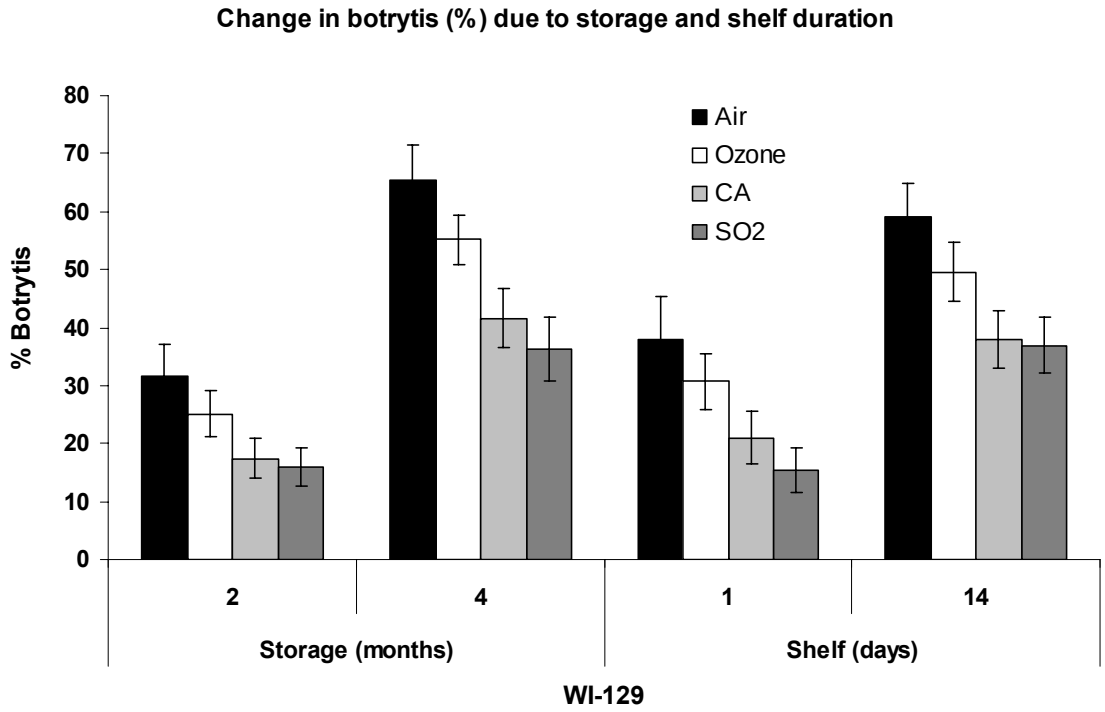

Figure 3. Changes in % botrytis in WI-129 cultivar after 2 or 4 months of storage under regular air storage (RAS, 34°F, 70% R.H.), ozone (+RAS), controlled atmosphere storage (3% O_2 + 5% CO_2, 34°F, 70% R.H.), or sulfur dioxide fumigation (+RAS), and after 1 or 14 days of a simulated marketing period at 70°F.

Conclusion

Sulfur dioxide fumigation holds great promise as a method of controlling postharvest *Botrytis allii* spread and infection during storage and subsequent marketing period. Based on three years of data, the treatment has consistently reduce the amount of botrytis, whether by using low-emitting sheets in boxes, monthly fumigations, or one initial fumigation prior to storage. The technology works as well or better than CA in many cases. The technology can be adapted to current facilities, but there are workplace hazards with the use of the fumigant.

ANNUAL REPORT OF THE VIDALIA ONION RESEARCH LABORATORY

UNIVERSITY OF GEORGIA - TIFTON CAMPUS

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Introduction

The Vidalia Onion Research Laboratory continues to support and accommodate many post harvest activities. This report lists the users and their usage of this facility for the 2009-2010 season.

Table 1. Experiments requiring CA.

Researcher(s)	Crop	Experiment	Number of rooms	Storage specifications	Duration (months)
Gitaitis MacLean Torrance	Onion	Variety Trial	4	34°F+70% RH 3% O_2+5% CO_2+92% N_2	4
Padda MacLean	Blueberry	Storage	4	34°F+90% RH 3% O_2+13% CO_2+84% N_2 6% O_2+13% CO_2+81% N_2 10% O_2+13% CO_2+77% N_2 21% O_2+79% N_2	1.75
Bansal MacLean	Onion	Storage	1	34°F+70% RH 3% O_2+5% CO_2+92% N_2	4
MacLean	Pomegranate	Storage	1	34°F+70% RH 3% O_2+5% CO_2+92% N_2	1.5
MacLean Ellis	Persimmon	Storage	3	34, 45, & 55°F+90% RH 3% O_2+5% CO_2+92% N_2	1.75

Table 2. Cold storage users and usage.

Researcher(s)	Crop(s)	Temperature (°F)	% RH	Duration (months)
MacLean	Onion	34	70	4
	Pomegranate	41	90	1.5 & 2
	Blueberry	34	90	1 & 2
	Tomato	55	85	1
	Muscadine	34	90	0.5, 1, & 2
	Persimmon	34, 45, 55	90	1.75
MacLean, Bansal, Gitaitis, Sanders	Onion	36	≥80	4
Srinivasan, MacLean, Bansal	Onion	36	≥80	4
Torrance	Onion	34	70	4
Langston, Sanders	Onion	34	70	3
		36	≥80	3 & 5
Bansal	Onion	70	90	1
Johnson	Onion	34	70	3
Li	Onion	34	70	6
Riley	Onion	36	≥80	1
	Eggplant, squash, bell pepper, & zucchini	36	≥80	<1
Diaz	Watermelon	45	50	<1
	Various seed	45	50	12
	Tomato, cucumber, eggplant, & bell pepper	36	≥80	<1
Sparks	Tomato	70	85	1
	Corn	36	≥80	<1
Gitaitis	Onion	39	70	4

Table 2. Cold storage users and usage (continued).

Researcher(s)	Crop(s)	Temperature (°F)	% RH	Duration (months)
Ruter	Camellia seed	45	50	12
	Hibiscus	45	50	1
Conner	Muscadine	34	90	<1
	Cuttings & seed	36	70	12
	Pecan	36	70	<1
		69	45	2
Culpepper	Soil samples	45	50	3

Table 3. Facilities and equipment users.

Facility or equipment	Researcher(s)	Crop(s)
Warehouse	MacLean	Onion, pomegranate
	Diaz	Tomato, bell pepper, cucumber, eggplant, watermelon, papaya
	Boyhan	Bell peppers, snap beans
	Langston	Bell pepper, cantaloupe, strawberry, onion
	Gitaitis	Onion
	Srinivasan	Onion
	Conner	Pecan
	Riley	Onion, tomato, eggplant, squash, bell pepper
	Sparks	Tomato
	Sanders	Onion
	Ruter	Camellia, hibiscus
	Bansal	Onion
Lab	MacLean	Onion, tomato, blueberry, persimmon, muscadine, pomegranate
	Diaz	Watermelon, bell pepper
	Conner	Muscadine
	Bansal	Onion
	Abbey	Blueberry
	Mehra	Blueberry
	Li	Onion
	Shonte	Pomegranate, tomato
	Killadi	Muscadine, tomato
	Špika	Pomegranate
Grader and sizer	MacLean	Onion
	Riley	Onion, tomato
	Gitaitis	Onion
Dryers	Diaz	Bell pepper, tomato, poblano
	Conner	Clover, pecan
	Ruter	Holly, rose, hibiscus, azalea
	Ozias-Akins	Millet
Growth chamber	MacLean	Tomato, petunia
Mill grinder	Diaz	Tomato, bell pepper