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Georgia Onion

2005 Research-Extension Report

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2005 GEORGIA ONION RESEARCH - EXTENSION REPORT

(Summary Report of 2005 Data)

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THE 2005 ONION RESEARCH-EXTENSION REPORT

Georgia's onion industry is primarily based upon the production of sweet onions, so called because of the mild pungency level and moderately high sugar level of varieties grown. Georgia's sweet onion industry is said to have originated on the farm of Moses Coleman, two miles East of Vidalia, more than 60 years ago. Mr. Coleman is given the credit of having observed the mild taste of some onions he had grown. It is reported that he sold a 50 pound bag for as much as $3.50. During 2005, growers in Georgia harvested over 10,500 acres of onions with an on farm value in excess of $65 million.

The University of Georgia and USDA/ARS, through Research and Extension programs, provide information on the production and handling of onions. The Onion Research-Extension Report is an official University of Georgia publication for conveying current information, either in the form of progress reports of research and demonstrations underway or reports of conditions in the field. Since the Onion Research-Extension Report is intended to convey current information, it should not be considered as a final authority containing peer reviewed manuscripts. The Onion Research-Extension Report may serve as a means of accountability to those who have supported the described programs. The Onion Research-Extension Report has been continuously edited and published since the first report, covering data gathered during 1992.

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VIDALIA ONION VARIETY TRIAL 2004-2005

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Introduction

Each year for the past several years we have conducted onion variety trials to assess the performance of onions in the Vidalia onion growing area of southeast Georgia. These trials assess entries for total yield, graded yield, number of doubled onions, seed-stems, disease incidence, harvest date, pyruvate, and percent sugar. These trials are used in part to determine the suitability of varieties for inclusion on the Georgia Department of Agriculture's official list of Vidalia onions. These trials include a broad spectrum of short-day Granex type onions available for production in the Vidalia growing district covering a full range of maturity classes.

Materials and Methods

Onions were grown following University of Georgia Cooperative Extension Service recommendations for fertility, as well as for disease, insect, and weed control. These onions were grown as a transplanted crop with onion seed sown in high density (60 seed/ ft) on 21st September 2004. Four rows are sown on beds prepared 6 ft on centers. These plants were pulled, 50% of their tops removed and reset to their final spacing on 29-30 November 2004. The final spacing was 12 in. between-rows and 5.5 in. Within the row on beds prepared with 6 ft centers. Four rows were planted per bed. The experiment was arranged as a randomized complete block design with four replications. Each plot or experimental unit was 35 ft of planted bed. There was 5 ft of bed length between plots, acting as a buffer. The number of seed-stems (flowering plants) and the number of plants that had more than one bulb (doubles) were counted for the entire 35 ft plot on 11th April 2005. In addition, the number of plants infected with center rot (*Pantoea ananatis*) were counted for each plot on 20th April 2005.

Twenty five ft of each plot was harvested when the onions were considered mature. After removal of the tops and roots the onions from each plot were immediately weighed. Onions were harvested on 25th April, 2nd, 9th, 16th and 23rd of May 2005. Onions harvested on the first two harvests were heat cured for 24 h while the later harvests were not subject to heat curing to minimize the effects of warm weather bacterial diseases. Onions were then graded into size classes of jumbos (≥3 in.) or mediums (≥2 in. and < 3 in.) and these weights recorded. A ten bulb sample from each plot was sent to National Labs, Collins, GA for analyses of pyruvate and percent sugar. Pyruvate analysis is an indicator of onion pungency and is measured as micromoles/gram fresh weight of onion tissue.

Results and Discussion

Nine companies submitted onion seed for evaluation in the trial. Florida Seed had the fewest number of entries with two, while Dessert Seed and Seminis Seed had the most with eight entries. This year was the largest trial held to date with 49 entries.

It is desirable to have a single bulb produced per plant for dry bulb onion production. For a number of environmental and physiological reasons, onion bulbs sometimes split, forming two or more bulbs. Variety in conjunction with environmental conditions plays a role in double formation. This year the number of doubles ranged from 0 for variety 1200 to 118 for 'Southern Belle' (Table 1). Both 'Sweet Advantage' and 'Southern Belle' had about one-third of their onions as doubles. 'Sweet Melody', 'WI-129', 'WI-3115', and 'Nirvana' also had high incidences of doubles with about 20% doubling.

Seed-stems or flowering in onions is also undesirable. Under normal conditions, onions are biennial, forming a bulb the first year, in which energy is stored to produce a flower or scape the second year. This can be short-circuited, however, if the plant has reached sufficient biomass (about the 10 leaf stage) followed by cool temperatures. These conditions can occur in southeastern Georgia during early spring, resulting in large numbers of seed-stems. It is known that variety plays an important role in seed-stem formation. Some years there can be many seed-stems across many varieties while in other years only a few varieties will exhibit this trait.

The 2004-05 season had few seed-stems across varieties. 'Sweet Vidalia' had the most with an average of 20 seed-stems/plot. Along with 'Sweet Vidalia', variety SSC 6372 F_1 also had a high number of seed-stems with 17. Compared with the previous year, this year there were few seed-stems. In the 2003-04 season, there were 7 out of 34 entries with 90 or more seed-stems per plot.

Center rot is a bacterial disease of onions in which the center most recently mature leaf is infected. Center rot can develop to destroy the entire bulb. Warm temperatures during bulb formation favor development of this disease. Center rot is a newly described disease for the Vidalia onion area. The incidence of center-rot will vary from year to year depending upon environmental conditions that favor development. The 2004-05 season was a mild year for center-rot incidence. Incidence ranged from 0 to under 4 infected plants per plot. Although there were statistical differences in incidence at this low a rate it is unclear if these differences actually represent varietal differences.

Total or field yields ranged from 570 fifty pound bags per acre for variety 34140 to 1233 fifty pound bags for 'SR1001'. Total yield is a good indicator of the potential for a particular variety, but does not always translate into an overall good variety because of unacceptable losses in the grading process. For a variety to be considered as having a good yield it should consistently have high yields of jumbo onions which generally command the highest prices in the market. The jumbo yields in this trial ranged from 445 to 1214 forty pound boxes per acre. The highest jumbo yielding variety was 33076, which did not differ from the 9 other varieties with greater than 1000 forty pound boxes per acre. Medium yields often are inversely correlated with jumbo yields. In other words, poorly performing varieties may often have the highest medium yields.

Harvest date continues to be an important characteristic of tested varieties. All of those varieties harvested on 25th April, 2005 would be classed as Japanese overwintering onions. These extra early varieties remain controversial because of perceived poor taste although the apparent poor taste of these varieties is not universally accepted. Neither pyruvate nor taste panel evaluations have consistently indicated these varieties to have poor taste parameters, yet the perceived poor quality continues to remain with these varieties. Late maturing varieties continue to be plagued by late season warm weather bacterial diseases such as sour skin and slippery skin.

Pyruvate analyses ranged from 2.9 to 5.1 um/g fresh weight (gfw). Ironically, the lowest pyruvate value waas found with variety WI-609, which is one of the early Japanese overwintering types. This is indicative of the problem where pyruvate has proven ineffective in discerning differences between these Japanese overwintering onions and other types. The highest valued varieties did not statistically differ from half of the listed varieties. Three-quarters of the entries did not differ as to sugar content, which ranged from 7.8-12.3%. Even among those entries with statistically lower sugar content, their content was exceptionally high. Generally, sugar content in short-day onions range from 6-8%.

In conclusion, these trials continue to provide important information to growers about the performance of Vidalia onion varieties. When examined over several years these trials provide important yield and quality information that growers can use in making varietal selections.

Table 1. Variety incidence of doubles, seed-stems and center rot.

Entry	Company	Doubles (#/plot)	Seed-stems (#/plot)	Center Rot Incidence (Average #/plot)
1200	Nunhems	0	0	1.1
Var. No. 105101	Dessert Seed LLC	1	3	2.1
Pegasus	Seminis	2	1	0.6
Serengeti 1202	Nunhems	2	0	1.2
Gobi 1201	Nunhems	3	0	3.7
Var. No. 15085	Dessert Seed LLC	3	3	0.4
Var. No. 114101	Dessert Seed LLC	4	4	1.1
Var. No. 34140	Dessert Seed LLC	4	1	0.2
Savannah Sweet	Seminis	4	3	0.9
Granex Yellow PRR	Seminis	4	2	0.9
Sweet Jasper (XON-202Y)	Sakata Seed	6	3	0.4
Var. No. 128101	Dessert Seed LLC	6	7	1.2
XON-403Y	Sakata Seed	6	0	0.4
EX 07542007	Seminis	7	0	0.6
Var. No. 15094	Dessert Seed LLC	8	11	0.6
Century	Seminis	9	1	2.7
Var. No. 108101	Dessert Seed LLC	10	1	0.8
XON-204Y	Sakata Seed	10	0	0.7
SR1001	Nunhems	10	1	1.2
Mr. Buck	D. Palmer Seed	11	4	1.9
HSX-61304 F-1	Hortag Seed	11	9	3.3
WI-131	Wannamaker Seeds	14	2	0.8
Candy	Seminis	15	0	1.7
HSX-19406 F-1	Hortag Seed	16	10	2.1
FS 2011	Florida Seed	17	1	2.3
XON 303Y	Sakata Seed	19	0	0.2
Granex 33	Seminis	20	3	1.9
Var. No. 15082	Dessert Seed LLC	21	1	1.7
Georgia Boy	D. Palmer Seed	23	3	1.1
33076	Shamrock Seed Co.	26	2	1.9
SSC-1535	Shamrock Seed Co.		1	1.1
Sugar Belle (SSC 6371 F1)	Shamrock Seed Co.	30	2	0.4
SSC 6372 F1	Shamrock Seed Co.	31	17	2.6
Sweet Vidalia	Nunhems	34	20	1.2
EX 07542008	Seminis	34	0	2.8
HSX-18201 F-1	Hortag Seed	35	7	2.6
FS 2005	Florida Seed	36	2	0.9
WI-102	Wannamaker Seeds	36	1	1.5
WI-609	Wannamaker Seeds	36	4	0.4

Table 1 cont. Variety incidence of doubles, seed-stems and center rot.

Entry	Company	Doubles (#/plot)	Seedstems (#/plot)	Center Rot Incidence (Average #/plot)
DPS 1290	D. Palmer Seed	43	7	0.2
Sweet Melody	Nunhems	59	6	0.6
WI-129	Wannamaker Seeds	62		0.7
WI-3115	Wannamaker Seeds	65	4	1.1
Nirvana	Nunhems	68	1	1.3
Sweet Advantage	D. Palmer Seed	102	1	0.0
Southern Belle	D. Palmer Seed	118	4	1.5
	CV	18%	33%	38%
	LSD (p=0.05)	2	1	0.3

Table 2. Variety yield, graded yield, and harvest date.

Entry	Field Yield (50lb bags/acre)	Jumbos (40 lb boxes/acre)	Mediums (40 lb boxes/acre)	Harvest Date
33076	1096	1214	37	4/25/05
WI-3115	1190	1179	39	4/25/05
WI-131	1093	1178	30	4/25/05
WI-129	1175	1162	46	4/25/05
1200	1032	1141	12	5/9/05
FS 2011	1054	1123	31	4/25/05
WI-609	1060	1093	33	4/25/05
XON-204Y	1114	1057	25	5/9/05
WI-102	1208	1052	46	4/25/05
SSC-1535	917	1000	50	4/25/05
Serengeti 1202	802	942	40	5/9/05
XON 303Y	887	933	50	5/16/05
FS 2005	995	929	44	4/25/05
DPS 1290	1035	911	64	5/16/05
XON-403Y	1128	882	36	5/16/05
Sugar Belle (SSC 6371 F1)	903	868	75	4/25/05
Var. No. 108101	927	833	30	5/16/05
Georgia Boy	848	815	58	5/9/05
Savannah Sweet	858	812	38	5/16/05
EX 07542007	836	810	34	5/9/05
SR1001	1233	795	24	5/16/05
Century	969	790	30	5/16/05
Var. No. 15082	942	769	34	5/16/05
SSC 6372 F1	795	756	125	5/2/05
Sweet Vidalia	858	743	36	5/9/05
Var. No. 15094	751	731	37	5/16/05
Sapelo Sweet	862	728	61	5/16/05
Mr. Buck	807	720	162	5/9/05
EX 07542008	834	718	69	5/9/05
Granex 33	893	696	58	5/16/05
Sweet Melody	814	694	76	5/9/05
Nirvana	798	691	185	5/2/05
Pegasus	886	689	139	5/23/05
Var. No. 128101	900	689	28	5/16/05
Gobi 1201	894	686	59	5/9/05
Var. No. 15085	765	684	37	5/16/05
SSC-1600	736	681	75	4/25/05
Ohoopee Sweet	755	675	79	5/9/05
Var. No. 105101	637	664	35	5/9/05

Table 2 cont. Variety yield, graded yield, and harvest date.

Entry	Field Yield (50lb bags/acre)	Jumbos (40 lb boxes/acre)	Mediums (40 lb boxes/acre)	Harvest Date
Var. No. 114101	812	608	24	5/23/05
Sweet Jasper (XON-202Y)	749	566	50	5/16/05
Sweet Advantage	727	511	271	5/2/05
Granex Yellow PRR	686	485	42	5/16/05
HSX-19406 F-1	743	484	56	5/16/05
Var. No. 34140	570	481	43	5/16/05
HSX-61304 F-1	882	445	35	5/23/05
	14%	17%	70%	
	230	254	66	

Table 3. Variety pyruvate and sugar content.

Entry	Pyruvate (um/gfw)	Sugar (%)
WI-609	2.9	8.1
Candy	3.0	9.2
Serengeti 1202	3.0	9.6
Var. No. 128101	3.1	9.7
Savannah Sweet	3.1	8.5
FS 2011	3.2	7.8
WI-3115	3.3	8.4
EX 07542007	3.3	9.5
WI-131	3.4	8.3
Var. No. 15094	3.4	9.7
HSX-19406 F-1	3.4	9.1
Century	3.5	9.6
WI-102	3.5	8.8
Sweet Jasper (XON-202Y)	3.5	9.8
33076	3.5	8.7
Sugar Belle (SSC 6371 F1)	3.5	9.6
SSC 6372 F1	3.5	11.2
Pegasus	3.6	9.6
SSC-1535	3.6	9.0
FS 2005	3.6	8.8
SR1001	3.6	9.6
Var. No. 114101	3.6	9.0
Var. No. 34140	3.7	9.5
Var. No. 105101	3.7	10.0
DPS 1290	3.7	9.5
Sweet Melody	3.8	10.1
Southern Belle	3.8	10.6
Sweet Vidalia	3.8	10.1
Gobi 1201	3.8	8.7
HSX-18201 F-1	3.8	9.7
SSC-1600	3.8	10.1
Georgia Boy	3.9	9.9
Mr. Buck	3.9	10.0
XON-403Y	3.9	10.4
Var. No. 15085	4.0	11.3
WI-129	4.0	11.1
HSX-61304 F-1	4.0	9.3
Granex 33	4.1	8.8

Table 3 cont. Variety pyruvate and sugar content.

Entry	Pyruvate (um/gfw)	Sugar (%)
EX 07542008	4.4	12.3
XON-204Y	4.4	9.9
Sweet Advantage	4.5	11.6
1200	4.6	11.8
Nirvana	4.6	11.5
Ohoopee Sweet	4.8	11.0
Var. No. 108101	5.1	12.2
XON 303Y	5.1	11.5
	19%	18%
	1.3	3.3

CONTROLLED ATMOSPHERE STORAGE OF VARIETY TRIAL ONIONS, 2003-2004

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Introduction

Controlled atmosphere (CA) storage of onions has allowed the dramatic expansion of onion production in the Vidalia region. CA storage involves placing onions in sealed rooms where the atmosphere is adjusted to 5% CO_2 and 3% O_2 content. In addition, the temperature is maintained at 34 °F. Under these conditions, onions that would otherwise store for only a month or so, can now be stored for up to 6 months.

CA storage has dramatically increased onion production, however, it has not been the panacea growers had hoped. In some years 50-70% of the onions are thrown away resulting from disease accumulation including Botrytis neck rot. This experiment was designed to evaluate varieties from the 2004 variety trial for their marketability after 5.5 months of CA storage.

Materials and Methods

Approximately 50 lbs. of onions from each experimental unit of the 2004 variety trial were placed in CA storage at the Vidalia Onion Laboratory in Tifton, GA. Storage conditions consisted of 5% CO_2, 3% O_2, 70% relative humidity, and 34 °F. All onion varieties were placed in CA storage on 19th May 2004 and removed on 6-7th October 2004.

Onions were then evaluated into marketable and non-marketable onions and the percentage of marketable onions calculated. The marketable onions were re-evaluated 12 days after removal from CA storage and the percentage of marketable onions were again calculated. All data was transformed with arcsine (square root(x)) prior to its analysis and back transformed to its original units.

Results and Discussion

Overall the onions stored very well during the year, unlike the previous year when none of the onions had greater than 25% marketable onions after removal from CA storage. The percentage of marketable onions ranged from 64% to 93% marketable for 606DY and 'Mr. Buck', respectively (Table 1). 'Mr. Buck' did not significantly differ from 'Savannah Sweet' with 86% of marketable onions after removal from CA storage. Maturity class was not a factor in percentage marketable onions with early, mid-season, and late onions present in the entire range of percentage of marketable onions.

After 12 days at an ambient temperature the percentage of marketable onions ranged from 16% for Exp. Yellow Granex 15085 to 67% for SSC 33076 and SSC 1600. Overall, there was a 34% drop in marketable onions during the 12 days after removal from CA storage.

Summary and Conclusion

In conclusion, there are differences between varieties for CA storability, but these differences are difficult to characterize for consistency from one year to the next. In light of the results from 2003 where all of the entries did poorly in CA, there must be some other factors that play a primary role in storability. Overall, the major reason for onions being unmarketable after CA storage is Botrytis neck rot, which is acquired in the field, but it is known why this disease is more severe in some years and not in others. In addition, there is no easy way to detect this pathogen once it has gained entry to the onion. Onions may appear sound when placed in CA, but then may subsequently develop disease symptoms rendering them unmarketable.

Table 1. Variety trial controlled atmosphere storage results, 2004.

Entry	Company	After 4.5 months of CA Storage Marketable (%)	Marketable 12 days out of storage (%)
Mr Buck	D. Palmer Seed	93%	59%
SSC 33076	Shamrock	93%	67%
72766DY	Shaddy	93%	63%
Georgia Boy	D. Palmer Seed	92%	64%
SSC-1600	Shamrock	91%	67%
Granex Yellow PRR	Seminis	91%	55%
XON-204Y	Sakata	89%	61%
Ohoopee Sweet	D. Palmer Seed	88%	49%
WI-129	Wannamaker	87%	46%
SSC 6372 F1	Shamrock	87%	61%
SSC 1535	Shamrock	87%	54%
Exp. Yellow Granex 34140	Dessert Seed	86%	45%
WI-3115	Wannamaker	86%	49%
Savannah Sweet	Seminis	86%	57%
Rosali (Red)	Bejo	84%	45%
DPS 1318	D. Palmer Seed	84%	49%
Granex 33	Seminis	84%	56%
XON-203Y (01ZG 5034)	Sakata	84%	60%
SSC 6371 F1 (Sugar Belle)	Shamrock	84%	61%
Sapelo Sweet	D. Palmer Seed	83%	62%
Southern Honey	D. Palmer Seed	82%	35%
Exp. Yellow Granex 15094	Dessert Seed	80%	42%
Sweet Vidalia	Sunseeds	79%	37%
XON-303Y	Sakata	78%	44%
WI-609	Wannamaker	78%	49%
XON-202Y (99C 5092)	Sakata	77%	40%
Granex EM90	Clifton Seed	77%	33%
Exp. Yellow Granex 15082	Dessert Seed	76%	37%
Pegasus	Seminis	74%	39%
Century	Seminis	74%	41%
DPSX 1290	D. Palmer Seed	74%	33%
Cyclops	Seminis	73%	46%
SRO 1001	Sunseeds	71%	44%
Exp. Yellow Granex 15085	Dessert Seed	69%	16%
606DY	Shaddy	64%	21%
	CV	14%	16%
	LSD (0.05)	8%	5%
Observational			
Tsubame	Yae Nogei Co., Ltd.	94%	59%
Nozomi	Yae Nogei Co., Ltd.	81%	52%

FERTILIZATION OF DIRECT-SEEDED ONIONS

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Introduction

The direct-seeding of onions offers several advantages over transplanting, not the least of which is lower plant establishment cost. There are some perceived disadvantages to direct seeding including increased cold injury, increased seed-stems, and poor stand. Perceived concerns over cold injury on directly drilled stands were highlighted in the early 1980s when there were 3 years which had temperatures as low as in the single digits. During this time greater injury was experienced for direct seeded onions compared with transplanted onions. However, it should be pointed out that over the last 75 years these were the only years when temperatures were so low.

Stand establishment has largely been addressed with improved vacuum planters and encrusted seed. Combining these two technologies results in excellent seed singulation and good stand establishment. However for direct seeding to be successful growers should be cognizant of local field conditions especially that of soil moisture. High soil moisture can result in clogging the planter causing poor singulation, while dry conditions can result in the planter riding up on the bed with seed not planted at the proper depth. Furthermore uniform soil moisture must be maintained during the critical period of seed germination.

Seed-stem formation has been largely eliminated by seeding on October 15th plus or minus a week. Earlier seeding results in too much growth with larger sized plants in the spring, more prone to seed-stem formation. On the other hand, seeding later than the third week of October results in plants too small to withstand the cold, harsher conditions of the impending winter.

Onions from transplants require about 130 lb/acre N and an additional 150 lb/acre N to produce the dry bulbs post-transplanting. This means that 280 lb/acre of N is required by the crop. With direct-seeded onions it is unclear what the optimum fertilization should be for southeastern Georgia. An experiment was undertaken to address this issue.

Materials and Methods

Encrusted seed of 'Century' were direct seeded on 13 October, 2004 with a vacuum planter (Monosem Corp., Lenexa, KS) set to seed at a 4 in. in-row spacing. Four such rows were planted on beds prepared 6-ft on centers. These beds had 800 lb/acre of 5-10-15 with 9% S applied preplant and incorporated. This supplied 40, 80, and 120 lb/acre of N, P, and K, respectively.

The Texan treatments were modifications of recommendations provided by the Extension Service of Texas. It is recommended that 20 lb/acre N be applied preplant with all the P. This is followed by 25-40 lb/acre N applied every 3 weeks up to 40 days prior to harvest. Potassium application is generally not needed under the soil conditions found in Texas.

There were 8 fertilizer treatments arranged in a randomized complete block design. Each experimental unit or plot was 30 ft long with 20 ft of each plot harvested. Treatment 1 consisted of a total of 195 lb/acre N applied as follows: 25 lb/acre N applied as $Ca(NO_3)_2$ on 24 November, 2004. In addition, 50 lb/acre N was applied on 12th January, 2005; 27 lb/acre N was applied on 20th January, 2005; and finally 53 lb/acre of N was applied on 16th February, 2005.

Treatment two consisted of 150 lb/acre N with 25 lb/acre N applied on 24th November, 2004 and 85 lb/acre N applied on 16th February, 2005. Treatment three was similarly provided with 40 lb/acre N applied 24th November, 2004 and 115 lb/acre N applied on 16th February, 2005.

Treatment four was the standard treatment, which consisted of 150 lb/acre N. Twenty-five lb/acre N was applied on 24th November, 2004 as diammonium phosphate (DAP). In addition, 43 lb/acre N was applied as 6-12-18 with 4% S and finally 42 lb/acre N was applied as $Ca(NO_3)_2$ on 16th February, 2005. Treatment five consisted solely of DAP with 25 lb N applied on 24th November, 2004, 45 lb/acre applied on 12th January, 2005 and 40 lb/acre N applied on 16th February, 2005.

Treatments 6-8 used 10-10-10 fertilizer with 12% S. Treatment six consisted of 195 lb/acre N applied as 40 lb/acre N on 24th November, 2004 and 115 lb/acre N applied on 16th February, 2005.

Treatment seven consisted of 25 lb/acre N applied on 24th November, 2004 and 85 lb/acre N applied on 16th February, 2005. Finally, treatment eight consisted of 25 lb/acre N applied on 24th November, 2004, 50 lb/acre N applied on 12th January, 2005, 12 lb/acre N applied on 20th January, 2005 and 68 lb/acre N applied on 16th February, 2005.

Results and Discussion

The highest total yield was with treatment six at 184 lb/plot. This was significantly better than treatments one, two, and seven, contrasting with the results of 2003-04 when there were no differences between the treatments. This may indicate that the higher nitrogen rate may be better, but treatment one did have the higher N rate with a lower total yield. The highest jumbo yield was with treatment three which significantly differed from treatments five, seven , and eight. Finally, the highest yields of medium sized onions was with treatment two, which was significantly higher than for treatments six, seven, and eight. These results are inconclusive as to the optimum fertilizer rate for to direct-seeded onions, yet it may be deduced that the amount currently recommended for dry bulb onion production is sufficient to produce a reasonable yield and that all of the fertilizer required during a transplant phase of production can be eliminated.

The question remains as to whether fertilizer should be applied in December or January. With the intermittent treatments there was no fertilizer applied in these months whereas with the continuous treatments there was. Initially it was thought that in order to help the control of seed-stem formation in the spring, that holding back fertilizer during mid-winter (December & January) might reduce the amount of seed-stems in the spring. I turns out that there was not benefit of withholding fertilizer. Seed-stems have been largely eliminated in direct seeded onion production by waiting until mid-October before drilling the seed.

Summary and Conclusions

In conclusion this experiment suggests that fertilizer rates for dry bulb onion production are sufficient to produce onions established by direct-seeding. The additional cost of fertilizer associated with transplant production is eliminated. For the control of seed-stems fertilizer timing is not as effective as the time of sowing the seed.

Table 1. Fertilization effect on total and graded yield of direct seeded onions.

	Treatment	Total Yield (lb/20-ft plot)	Jumbos (lb/20-ft plot)	Mediums (lb/20-ft plot)
1	Texas (continuous, 195 lb N)	120.8	66.7	5.5
2	Texas (intermittent, 150 lb N)	136.7	68.7	8.9
3	Texas (intermittent, 195 lb N)	152.8	84.8	8.3
4	Standard	151.0	70.1	6.5
5	DAP (150 lb N)	146.2	49.0	5.6
6	10-10-10 (intermittent 195 lb N)	184.0	67.5	4.6
7	10-10-10 (intermittent 150 lb N)	124.3	56.1	5.1
8	10-10-10 (continuous, 195 lb N)	154.5	51.4	4.6
	CV	14%	20%	28%
	LSD (p=0.05)	41.4	25.4	3.5

EVALUATION OF ONION FERTILIZATION

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Introduction

Onions are heavy feeders particularly when grown as a transplanted crop since they require as much fertilizer for the transplants as for the onions during bulb production. In addition, onions are a long season crop, therefore fertility management must be considered over several months. A fertility study was undertaken to grow onions under a range of nitrogen fertilizer rates to evaluate nitrate meters. In addition, several different commercial fertilizers were evaluated in the same study.

Materials and Methods

The experiment was conducted at the Vidalia Onion and Vegetable Research Center in Lyons, Ga. Transplants for the experiment were produced on site and followed University of Georgia Cooperative Extension Service recommendations. Disease, insect, and weed control also followed University of Georgia Cooperative Extension Service recommendations. A soil test recommended 40 lb/acre P_2O_5, 90 lb/acre K_2O, and 60 lb/acre S. These were applied to all treatments unless otherwise noted.

The experimental design was a randomized complete block with four replications. Each plot or experimental unit consisted of a 20 ft of bed with 4 rows of onions planted 12 in. apart across the bed, with 5.5 in. between onion in the row. Beds were prepared on 6 ft centers. The variety Sweet Vidalia was used for this study. Plants were transplanted on 18th November, 2004. There were nine treatments having nitrogen rates of 0, 25, 50, 75, 100, 125, 150, 200, and 300 lb/acre split-applied in 3 equal applications, on 24th November, 2004, 12th January, 2005 and 16th February, 2005. All the phosphorus was applied in the first application. Sulfur was applied in a split application on the first and second application dates.

In addition to the nine nitrogen rates, a standard treatment was included in all tratments. This consisted of 400 lb/acre of 5-10-15 with 9% sulfur and 150 lb/acre of 18-46-0 (diammonium phosphate, DAP) applied on the first application date. This was followed by 400 lb/acre of 6-12-18 with 4% sulfur applied on the second application date. Finally on the third application date, 400 lb/acre of calcium nitrate was applied.

Humate (JTS Natural Products, Marietta, GA), a granular mined organic mineral was applied in two treatments with and without fertilizer. This product was applied at a rate of 150 lb/1000 ft^2. The treatment with fertilizer also received the P, K, and S as described above along with 150 lb/acre N split-applied as calcium nitrate in three applications as described above.

TurfPro (Organic Products, Claxton, GA) was a humic acid material applied at a rate of 20 gal/acre in a single application on the first application date. The treatment with fertilizer was applied as described for the Humate product.

The Agrotain fertilizer treatments in the first case consisted of regular 10-10-10 fertilizer with 12% sulfur applied at a rate of 500 lb/acre on the first application date. This was followed by their slow release granular 10-10-10 (J-MAXX 10-10-10, Agrotain International, Sugar Hill, GA) applied at a rate of 400 lb/acre on the second application date. Finally, on the third application date their slow release 47-0-0 fertilizer was applied at 100 lb/acre. The second Agrotain treatment consisted of their 10-10-10 product applied on the first and second application dates at 400 lb/acre rate, followed by 47-0-0 at 100 lb/acre.

Nitamin is the trade name for a slow release 30-0-0 liquid fertilizer from Georgia Pacific (Decatur, Ga.). The P, K, and S were applied to these treatments as described above. Nitamin was applied at 100% of the recommended rate of nitrogen of 150 lb/acre as a single application on the first application date. In addition, a treatment of 100% of the nitrogen rate of Nitamin was split-applied on the first and third application dates. Similarly, two Nitamin applications were applied at 70% of the recommended nitrogen rate (105 lb/acre N), one treatment as a single application on the first application date and the other treatment with a split-application on the first and third application dates.

The next treatment consisted of a processed poultry litter product (Perdue AgriRecycle, Horsham, PA) with a 4-2-3 formulation. It was split-applied at a rate of 150 lb/acre N on the dates indicated above. No other fertilizer (P, K, or S) was applied to this treatment.

The next treatment consisted on 150 lb/acre N split-applied as calcium nitrate. Sulfur was also applied to this treatment as indicated above, but there was no P or K fertilizer applied. The next two treatments consisted of 10-10-10 with 12% sulfur split-applied either in three applications on the dates indicated above or on the first and third application dates.

Results and Discussion

Total yield ranged from 170 to 1289 fifty pound bags/acre. The highest yielding treatment was 22, 10-10-10 with 12% S. This treatment did not differ from the other top seven yielding entries. All of these entries received at least 150 lb/acre N.

The three lowest yielding entries received no N fertilizer. Products such as the TurfPro and the humate performed poorly in this test without the addition of N fertilizer. These humic acid derivative products have never performed well in onion production. The manufacturers of these products have touted their benefits, but in most cases their performance has been on turf or pasture. The clean cultivation techniques used in onions may contribute to their low performance.

The 4-2-3 pelleted poultry litter did not perform as well as might be expected. It was applied at the 150 lb/acre N rate, but the actual formulation may be less than the listed 4% N by the time it is used. This product had a strong ammoniacal odor indicating that N was being lost. Since this is an organic product there may be a more complex N composition containing molecules that must be mineralized to a form that plants can use.

The Nitamin and Agrotain products are relatively new products that offer an alternative for onion fertilization. Both of these products are slow release fertilizer products that give growers the opportunity to reduce the number of fertilizer applications to their crops. In addition, both products are water soluble so they can be tank mixed with other chemicals or injected into irrigation systems.

As mentioned earlier, the series of N rates included in this experiment were to be used as a basis for developing protocols to use with Cardy nitrate meters (Spectrum Technologies, Inc., Springfield, IL.), however, we were never able to get reproducible results from these meters. Initially, leaf tissue was used, without success and then root tissue was tried. This too proved fruitless and was later abandoned.

Summary and Conclusions

In conclusion, growers have many options for their fertility program. Nitrogen is key to any such program. All treatments that did not contain or had low rates of N faired poorly in this experiment.

Table 1. Fertilizer treatments effect on field and graded yields.

	Fertility Experiment Treatments	Field Yield	Jumbos	Mediums
		(50-lb bags/acre)		
1	0 N	170	14	78
2	25 N	438	152	101
3	50 N	688	336	58
4	75 N	827	425	56
5	100 N	850	420	53
6	125 N	899	406	43
7	150 N	934	529	52
8	200 N	986	490	24
9	300 N	1110	583	27
10	Standard	1092	349	99
11	Humate (150 lb/1000 ft^2) without fertilizer	187	18	93
12	Humate (150 lb/1000 ft^2) with fertilizer	1058	424	23
13	TurfPro w/o fertilizer	191	33	85
14	TurfPro with fertilizer	1061	401	20
15	Agrotain Fertilizer (10-10-10, J-MAXX 47-0-0)	1090	479	22
16	Nitamin 100 % of standard (150 lb N)	688	346	74
17	Nitamin 100% of standard split-application (1st & 3rd)	971	387	28
18	Nitamin 70% of standard (105lb N)	441	185	106
19	Nitamin 70% of standard split-application (1st & 3rd)	860	380	37
20	4-2-3 Pelleted Poultry Litter (150 lb nitrogen)	808	419	51
21	150 N no P or K	988	619	35
22	10-10-10 12% Sulfur, 3 applications	1289	354	19
23	10-10-10 12% Sulfur, 2 applications (1st & 3rd appl.)	1061	313	18
24	Agrotain Fertilizer (J-MAXX 10-10-10, J-MAXX 47-0-0)	1230	526	31
	CV	15%	28%	71%
	LSD (p=0.05)	239	187	68

EVALUATION OF ONION BULB HEIGHT/WIDTH RATIOS AND NUMBER OF CENTERS, 2003-2004

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Introduction

Onion bulb characteristics are important for those producers whose onions are used for processing. One such postharvest product is onion rings. For maximum onion ring production per onion; a round onion with a single center is desirable. Vidalia onions are yellow Granex type onions, characterized by a broad shoulder at the leaf end tapering towards the root. The height to width ratio is usually between 0.6 and 0.8. Onions destined for Vidalia onion production can have a height to width ratio of 1.0 to accommodate the processing industry, but should not have a height to width ratio that exceeds 1.0.

This experiment was designed to evaluate onion height/width ratios and the number of centers.

Materials and Methods

Having been in controlled atmosphere storage (CA), the onion used in this study were removed 6-7th October, 2004. A five bulb sample was taken from each experimental unit or plot and the onions of the sample measured for height and width. These measurements were made at the broadest point through the axis of the onion and at the broadest point perpendicular to this axis. The average height and width were calculated for each experimental unit. Then the height width ratio was calculated. The onions were then cut perpendicular to their polar axis and the number of centers were counted. The number of centers were averaged for the five onions of the sample. Analyses were conducted on the gathered data.

Results and Discussion

The number of centers in the onions averaged below 2.0 for the varieties tested. There were a few exceptions including; XON-202Y, 'Ohoopee Sweet', 'Southern Honey', DPSX 1290, 'Mr. Buck', and 'Sweet Vidalia', all of which averaged 2 or more centers per onion.

The height/width ratio ranged from 0.6-0.9 for the tested onions. None of the onions were above 1.0, nor were there any with a height/width ratio of 1.0. Several had height/width ratios of 0.9 including XON-303Y, Exp. Yellow Granex 34140, and 'Ohoopee Sweet'. Based on this study, these varieties would be good candidates for use in processing onion rings.

Table 1. Number of centers and height/width ratios for onion varieties, 2004.

Variety	Seed Company	No. centers/bulb	Height/width ratio
WI-129	Wannamaker	1.1	0.8
WI-3115	Wannamaker	1.3	0.7
WI-609	Wannamaker	1.3	0.7
Savannah Sweet	Seminis	1.9	0.7
Granex 33	Seminis	1.6	0.7
Pegasus	Seminis	1.3	0.7
Century	Seminis	1.6	0.7
Cyclops	Seminis	1.6	0.7
Granex Yellow PRR	Seminis	1.7	0.6
SRO 1001	Sunseeds	1.1	0.7
XON-202Y (99C 5092)	Sakata	2.2	0.6
XON-203Y (01ZG 5034)	Sakata	1.4	0.7
XON-204Y	Sakata	1.7	0.7
XON-303Y	Sakata	1.7	0.9
Exp. Yellow Granex 34140	Dessert Seed	1.7	0.9
Exp. Yellow Granex 15085	Dessert Seed	1.4	0.7
Exp. Yellow Granex 15094	Dessert Seed	1.5	0.7
Exp. Yellow Granex 15082	Dessert Seed	1.8	0.7
72766DY	Shaddy	1.0	0.7
606DY	Shaddy	1.1	0.7
Ohoopee Sweet	D. Palmer Seed	2.4	0.9
Southern Honey	D. Palmer Seed	2.1	0.7
DPSX 1290	D. Palmer Seed	2.6	0.7
Georgia Boy	D. Palmer Seed	1.5	0.7
Sapelo Sweet	D. Palmer Seed	1.8	0.7
Mr. Buck	D. Palmer Seed	2.4	0.6
Granex EM90	Clifton Seed	1.9	0.6
SSC 6372 F1	Shamrock	1.5	0.7
SSC-1600	Shamrock	1.4	0.5
SSC 6371 F1 (Sugar Belle)	Shamrock	1.6	0.6
SSC 1535	Shamrock	1.4	0.5
Rosali (Red)	Bejo	1.3	0.8
Sweet Vidalia	Sunseeds	2.0	0.7
SSC 33076	Shamrock	1.2	0.7
DPS 1318	D. Palmer Seed	1.7	0.8
	CV	11%	7%
	LSD (0.05)	0.1	0.1
Observational			
Tsubame	Yae Nogei Co., Ltd.	1.0	0.7
Nozomi	Yae Nogei Co., Ltd.	1.8	0.7

EVALUATION OF DOUBLE CROPPING, BIOFUMIGATION AND SOLARIZATION FOR MANAGEMENT OF SOILBORNE PATHOGENS

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Introduction

Vidalia sweet onions are prone to several soilborne diseases that reduce yield and lower bulb quality. Three that commonly occur and are of particular importance are sour skin, caused by the bacterium *Burkholderia cepacia*, pink root, caused by the fungus *Phoma terrestris* and basal rot, caused by *Fusarium oxysporum* f. sp. *cepae*. Although several fumigants have demonstrated efficacy against *P. terrestris* and other fungi, one of the most effective, methyl bromide, is being removed from the marketplace because of environmental concerns. As for sour skin, there are few alternatives to control *B. cepacia*, as even methyl bromide is ineffective against *B. cepacia*.

In this report are the preliminary results from experiments evaluating treatments designed to affect soilborne pathogens. These included 6 wks of solarization with clear plastic, biofumigation with turnips, and double-cropping with pearl millet. Rotations with corn and cowpea were included for comparison. Biofumigation is a technique that uses the natural release of isothiocyanate from cruciferous crops, such as turnip during its organic decomposition. Methyl isothiocyanate is a primary breakdown product of metam-sodium and is responsible for the biocidal and volatile nature of several commercially available fumigants.

Materials and Methods

Soils with ten years of onion production were harrowed, shaped into beds and covered with clear plastic (3.0 mil thickness) for a minimum of 10 wks in mid-summer in Southern Georgia in 2002 - 2004.

Results and Discussion

In 2003, total yield, mean bulb weight and number of jumbo grade onions were significantly higher and pink root (*Phoma terrestris*) levels were significantly lower in plots receiving a combination of solarization and biofumigation with turnips. In 2004, trends were similar for total yield, mean bulb weight, number of jumbo grade bulbs, but were not significantly different. Pink root levels were significantly lower in both solarization and solarization plus biofumigation in 2004. Significantly fewer bulbs with Fusarium basal rot occurred in solarization plots in 2003, but because of lack of disease pressure there were no significant differences among treatments in 2004. Solarization had a long-term impact on reducing total number of fungi / g soil in both years. In addition, solarization significantly reduced the numbers of weeds, particularly yellow nutsedge, in onion plots in 2004. Solarization periods in two consecutive years in the same location reduced the number of colony-forming-units (CFU) of *Burkholderia cepacia* (sour skin bacterium) / g soil a thousand fold.

Except for days with extreme cloud cover, e.g. when tropical storm Bonnie passed through southern Georgia, the daily high mean soil temperature at a 15 cm depth during solarization exceeded 40 C (Fig. 1). In contrast, the daily high soil temperature in plots planted in corn, cowpea, or millet rarely were above 35 C (Fig. 1). Although numerical trends of increased yield occurred with solarization and with solarization plus biofumigation, mean yields were significantly different for the combined solarization and biofumigation treatment in only one year, 2003 (Table 1). It is interesting to note that biofumigation with turnip alone, i.e. without the solarization treatment, had the lowest yield in both years.

Solarization treatments alone or in combination with biofumigation decreased pink root levels (Table 2), Fusarium basal rot levels (Table 3), weeds (Table 4) and reduced soil populations of *Burkholderia cepacia*, the causal agent of sour skin (Fig.2). In contrast, biofumigation with turnip alone, a supposed producer of glucosinolates and isothiocyanates, had little effect on any of the plant pathogenic fungi, bacteria or weeds evaluated. Either not high enough concentrations of these biocidal compounds were produced, or the microorganisms could tolerate the chemicals. Either way, there seemed to be little benefit of the biofumigation treatment alone. These preliminary results also suggest that double cropping onions with corn or leaving the soil fallow did little to reduce populations of the sour skin bacterium. In contrast, double cropping with pearl millet significantly reduced *B. cepacia* populations (Fig. 2) and solarization reduced bacterial populations to below detectable levels.

Future Research

Unfortunately, data exists (not shown) which suggests that *B. cepacia* begins to recolonize solarized soils in the 3 month interim between termination of solarization and the transplanting of onion seedlings. An attractive hypothesis, which we plan to pursue in future tests, would be to select soilborne bacteria from soil previously planted in pearl millet and introduce them to solarized soil to determine if they prevent *B. cepacia* from recolonizing.

Table 1. Yield (tons/A) of onions grown in soil i) biofumigated (turnips), ii) biofumigated + solarized, iii) solarized only, or iv) standard (cowpea).

Treatment	2003	2004
Turnip + Solarization	58.0 a*	34.4 a
Solarization	54.3 ab	32.2 a
Control	51.5 ab	31.3 a
Turnip	51.1 b	30.5 a

* Different letters indicate significantly different at the $P = 0.05$ level.

Table 2. Pink root (*Phoma terrestris*) ratings (0 - 5; where 0 = no disease, 1 = trace, ..., and 5 = 100% disease) of onion bulbs (n=400) at harvest from plots biofumigated with turnip, solarized, or rotated with cowpea (control) in 2003 and 2004.

Treatment	2003	2004
Turnip + Solarization	1.3 c*	2.5 b
Solarization	1.8 b	2.1 c
Control	2.0 b	3.3 a
Turnip	2.5 a	2.6 b

* Different letters indicate significantly different at the $P = 0.05$ level.

Table 3. Fusarium basal rot ratings (0 - 5; where 0 = no disease, 1 = trace, ..., and 5 = 100% disease) of onion bulbs (n=400) at harvest from plots biofumigated with turnip, solarized, or rotated with cowpea (control) in 2003 and 2004.

Treatment	2003	2004
Turnip + Solarization	0.8 ab*	1.0 a
Solarization	0.3 b	1.0 a
Control	1.5 a	1.0 a
Turnip	1.0 ab	0.5 a

* Different letters indicate significantly different at the $P = 0.05$ level.

Table 4. Weed counts in treated onion plots in 2004.

Treatment	Mean # Weeds[1] / 120 ft^2
Turnip + Solarization	35 a
Solarization	5 a
Control	360 ab
Turnip	465 b

[1] Weed population primarily composed of crabgrass and yellow nutsedge

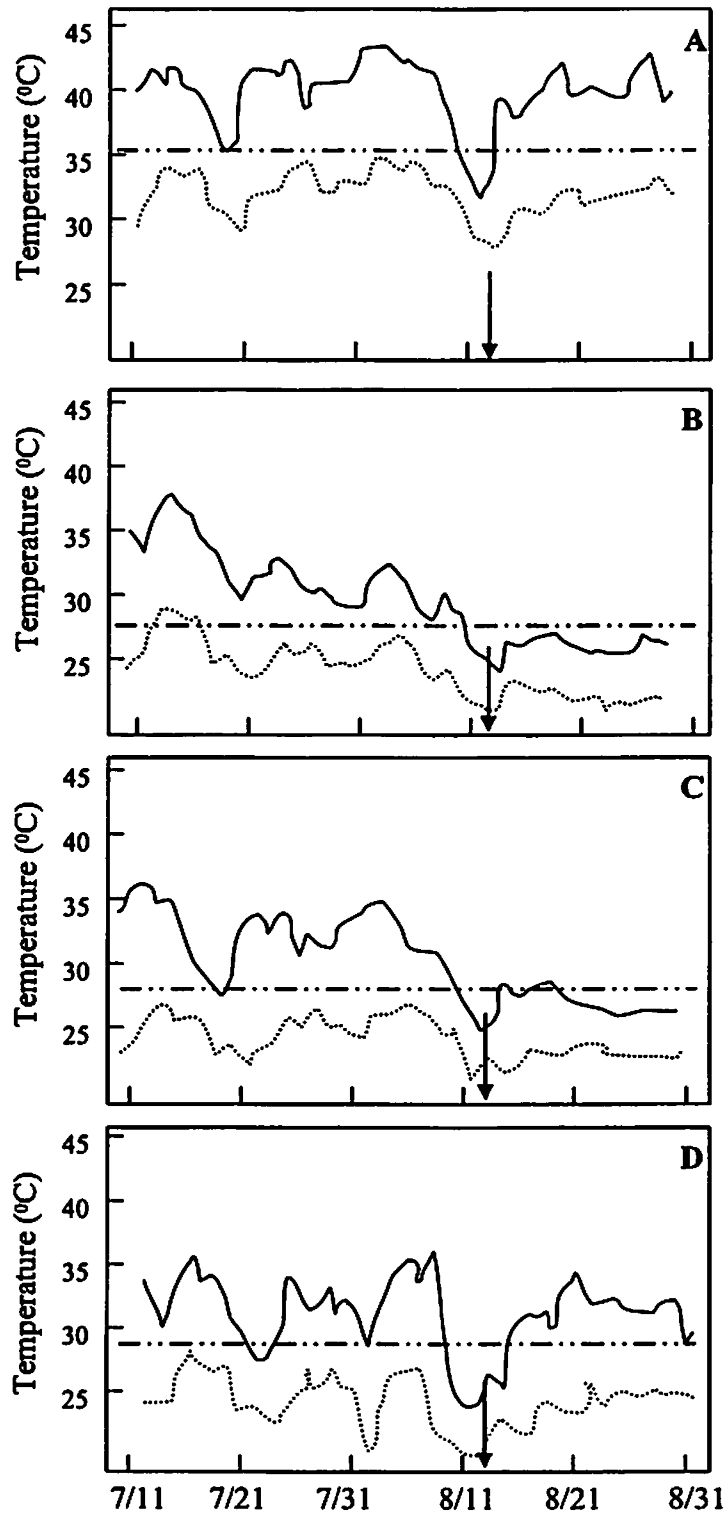
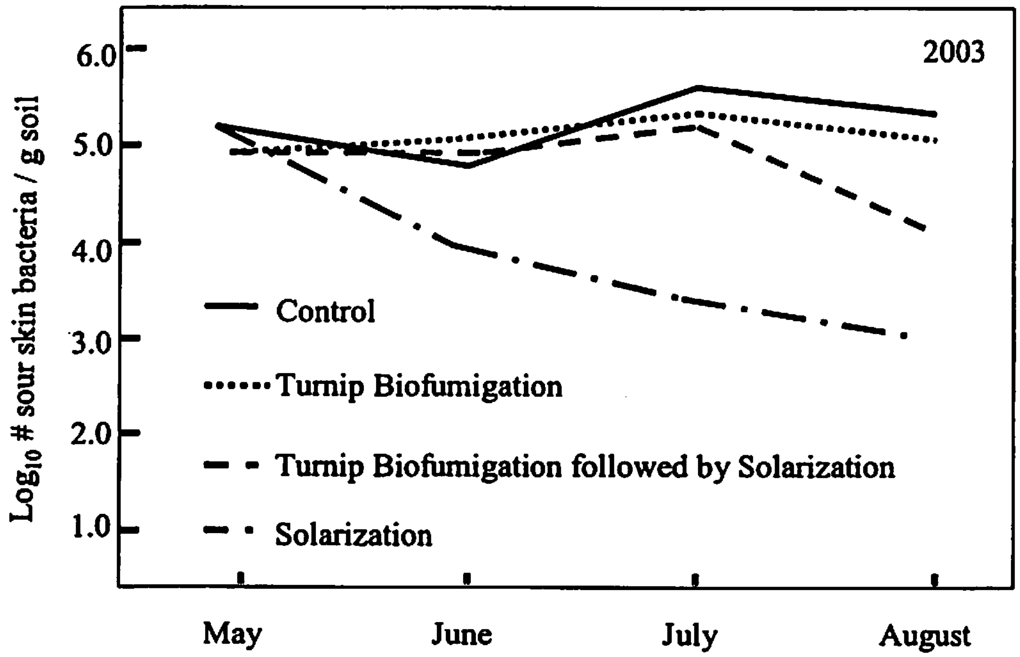


Fig. 1. Daily mean high (solid line) and mean low (dotted line) soil temperatures (ºC) at 15 cm depth during solarization period for plots treated as (A) solarization with clear plastic, (B) onion double-cropped with corn and no solarization, (C) onion rotated with carrot [fallow during sampling period] and no solarization, and (D) onion double-cropped with pearl millet and no solarization. Arrow indicates date of tropical storm Bonnie. Dash-dotted line represents mean soil temperature from 7/11 to 8/31.



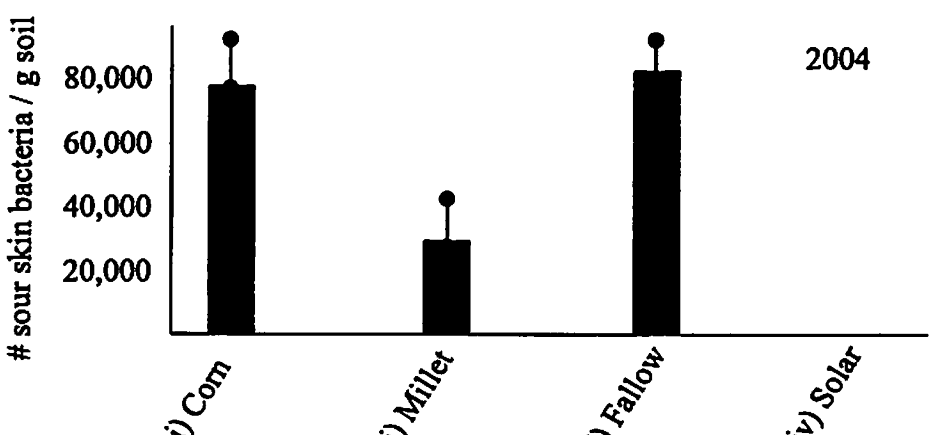


Fig. 2. Effects of double-cropping with selected crops or solarization treatment on populations (colony-forming units (CFU) per gram of soil) of sour skin bacteria, *Burkholderia cepacia*, on PCAT semi-selective medium in 2003 (upper) and 2004 (lower).

EVALUATION OF SPRAY PROGRAMS FOR CONTROL OF FOLIAR PATHOGENS OF ONIONS

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Introduction

Foliar diseases of Vidalia onions can cause severe losses by reducing yield and quality of marketable onions. Some of these diseases do not become evident until after onions have been placed in storage. The most common foliar diseases in the Vidalia onion growing area are Botrytis leaf blight (*Botrytis squamosa*), purple blotch (*Alternaria porri*), and Stemphylium leaf blight (*Stemphylium vesicarium*). Stemphylium blight has become the most widespread and destructive foliar fungal disease of onions in Georgia. The disease was first identified in Georgia in 1998 and since has increased to levels that have caused severe losses. In 2002, Stemphylium blight cost growers millions of dollars in yield loss and quality. Management options for suppressing losses to these diseases are rotation, deep turning diseased tissue, avoiding irrigating that prolongs leaf wetness, avoiding dense plant spacings, avoiding excessive fertilization, and preventive fungicide applications. No information is available on cultivar resistance to the foliar fungal pathogens among the Vidalia onion varieties. Fungicides are used to suppress losses from foliar diseases of onions by most growers in the Vidalia onion area.

Several fungicide options are available that include chlorothalonil (Bravo, Echo, Equus), mancozeb (Dithane, Manzate, Penncozeb, etc), iprodione (Rovral), azoxystrobin (Quadris), pyraclostrobin (Cabrio), cyprodinil + fludioxonil (Switch), pyrimethanil (Scala), pyraclostrobin + boscalid (Pristine), and numerous copper formulations. Vinclozolin (Ronilan) has been available through 2000 but may soon be no longer labeled for use on onions. Each of these materials has strengths and weaknesses as far as activity on specific fungi are concerned. Cost is also an issue as these materials range from $3.00/lb to $4.00/oz. Therefore growers are likely to sparingly use the more expensive materials during periods of high disease pressure. Previous tests have indicated that many of the early fungicide sprays have not resulted in significant foliar disease suppression compared with spray programs initiated at mid-season. It was the objective of these trials to determine the most effective spray timing for foliar disease control on onions. It was the focus of these trials to measure the suppression of fungal diseases such as Botrytis leaf blight, purple blotch, and Stemphylium leaf blight.

Materials and Methods

Spray trials were conducted to determine the most effective fungicides and their use patterns for control of Botrytis leaf blight; *Botrytis squamosa*, Purple Blotch; *Alternaria porri* and Stemphylium leaf blight *Stemphylium vesicarium*. Four rows of onion transplants (*Allium cepa* 'Savannah Sweet') were planted on 6 ft wide beds on 17th November, 2004 at Vidalia Onion and Vegetable Research Center in Toombs Co. GA. Plant spacing was 12 in. between adjacent rows and 5 in. between plants within the same row. The fertility program for these onions was consistent with University of Georgia Extension Service recommendations. The experimental design was a randomized complete block with six replications. Fungicide/bactericide treatment plots were 20 ft long and were separated by non-treated border panels. Fungicides were applied using a Lee SprayTrac® sprayer calibrated to deliver 40 gal/acre at 75 psi using TX-18 hollow cone nozzles. Onions were harvested on 2nd May, 2005 by digging the two center rows of each bed and allowing the onions to field dry. Onions were then cured at approximately 100 °F for 72 hours before weighing.

Results and Discussion

The growing season was cool and somewhat dry, but plots received over 10 in. of rainfall during the experiment. Generally, a 7 day spray schedule significantly reduced disease and increased plot health greater than a 14 day or Skybit advisory schedule. Fungicides used in spray programs had a greater effect in increasing yields than did spray timing. A Bravo-Pristine-Rovral program showed the greatest increases in yield, although these differences were not statistically significant. Generally in dryer years with lower disease pressure, spray programs that call for fewer sprays will suffice for disease suppression. Although more disease may be observed in the field in plots receiving fewer sprays, yield will seldom be negatively affected by a small difference in disease.

During wet years with a high inoculum potential, a more expensive and intensive spray program will often result in a greater monetary return. This type of relationship is often observed in high value crops like onions where a small increase in yield can more than pay for the fungicide used to achieve that yield. More research into weather-based spray programs may help growers determine when and how often to use fungicides and may fine tune the cost benefit of those fungicides.

OZONATION OF SWEET ONIONS DURING CURING

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Introduction

Curing is an essential part of preparing sweet onions for an extended shelf life, be it for the fresh market or for later markets after storage. Onions are cured in order to dry the outer scales, roots and neck which in turn seals the onion bulb against internal water loss, provides the bulb with some physical protection, reduces the likelihood of disease entering the bulb and aids in the healing of scarred tissue.

The shelf life of onions after harvesting and curing is dependent upon many factors including the presence of disease on or in the onions at the time the onions are harvested. Surface diseases tend to proliferate later in the harvesting season as climatical conditions become more conducive for their development. Internal diseases however are likely to have entered the onion during the growing stage of onion production.

The removal of disease from an onion bulb is dependent upon the type and nature of the disease. Internal diseases, once established, are difficult, if not impossible, to remove. Surface diseases may be controlled according to type and persistence, with mild cases possibly being dried and eliminated during curing. Yet there comes a level of disease infestation at which curing encourages disease growth and at best helps those onions with disease to be more easily recognized and sorted from those without disease.

Ozone is a blue, gaseous, powerfully oxidizing form of oxygen, O_3, derived from O_2 by an electrical discharge or exposure to ultraviolet radiation. It has a notable smell and its name is derived from the Greek word "ozein" meaning to smell or reek (Davis, P. 1976.). It is naturally occurring and may be smelt around electrical motors.

Ozone has pesticidal properties and is known as a bactericide. Ozone irreparably damages cell walls (Flurry, 2005) and may be used in poultry houses to combat salmonella. As for onions, ozone may be administered while they are in storage (Smith, C, 2005), the onions remaining in an atmosphere containing ozone throughout their time of storage.

Nevertheless, little is known as to the benefits of short duration exposure of onions to ozone. Therefore a study has been conducted to examine the behavior of ozone and its usefulness in cleansing or neutralizing disease, notably surface disease, while onions are being cured.

Material and Methods.

Onions were grown on the Vidalia Onion and Vegetable research farm, Reidsville, GA., according to recommendations (Sumner et al. 2001). They were harvested on six occasions throughout the season from May 2nd through May 19 th, 2005, and varied in variety according to when a test was required since onion varieties range from maturing early, at mid season or late in the season. During each of the six test runs, two pallet bins holding 56000 in^3 or 1300 pounds of onions of the same variety in both bins were used.

Once harvested for each test run, both pallet bins of onions were cured by passing heated air (100 ^{0}F) provided by a Peerless Crop Dryer (Peerless Manufacturing, Shellman, GA) through a plenum (Nolin Erection Services, Ashburn, GA) then around onions supported in the pallet bins (MacroBins model TM34, Macro Plastics Inc. Fairfield, CA) the air entering the pallet bin in a downdraft manner (Maw and Paulk, 2002). The pallet bins were delivered with vents in the sides as well as the bottom. The side vents were covered with plywood, each section bolted in place and sealed with tape. The remaining open vented area in the bottom was 7.4 % of the total base area. The onions were in open-mesh bags inside the pallet bin. The bags were closely packed in the bin over each other so as to reduce the likelihood of tunnels forming between the bags through which air could pass thus avoiding circulating around each onion.

While being cured, one bin of onions was supplied with ozone and one was not, with the same variety used in each case. Ozone was produced by a combination air compressor and generator (Ozone Technologies Inc.). Ozone was administered to the onions via a manifold into the curing air before the air circulated around the onions. The manifold was constructed of 0.5 in. p.v.c. pipe in the form of a grid with the pipe having 0.24 in. holes spaced at various locations on the grid. The manifold was placed on the top of the pallet bin under one of the hoods of the dryer plenum and over the onions being held in the bin. Ozone was supplied to the manifold by a flexible pipe leading from the ozone generator, having first passed through a flow control valve. Among the six test runs, treatments included two ozone rates (5 L/min and 10 L/min) and three application durations (24, 48 and 72 h).

Following curing and ozonation, samples of onions from both bins of a test run were placed in 25 pound boxes (five boxes from each bin) a total of ten boxes per test run and a total of 60 boxes for the entire study in 2005. On being placed in a box the onions were counted and the entire box of onions weighed before being placed on shelves in a shelf life storage room. The climate in the storage room was controlled by a window type air-conditioner maintaining the temperature of the room at approximately 22 ^{0}C (71.6 ^{0}F) and the humidity at a level as prescribed by the air conditioner. Circulation fans constantly ran inside the storage room.

Test run number one. Onions of mixed varieties were harvested Monday, May 2nd, were placed on to cure Monday, May 2nd and were given 48 h of curing and ozonation at 10 L/min, the curing being switched off Wednesday, May 4th. The onions were placed in storage on Thursday, May 5th, 2005.

Test run number two. Onions of mixed varieties were harvested Wednesday, May 4th, were placed on to cure Thursday, May 5th and were given 24 h of curing and ozonation at 10 L/min, the curing being switched off Friday, May 6th. The onions were placed in storage on Tuesday May 10th, 2005.

Test run number three. Onions of mixed varieties were harvested Monday, May 9th, were placed on to cure Monday, May 9th and were given 72 h of curing and ozonation at 10 L/min, the curing being switched off Thursday, May 12th. The onions were placed in storage on Friday, May 13th, 2005.

Test run number four. Onions of mixed varieties were harvested Thursday, May 12th, were placed on to cure Thursday, May 12th and were given 24 h of curing and ozonation at 5 L/min, the curing being switched off Friday, May 13th. The onions were placed in storage on Tuesday, May 17th, 2005.

Test run number five. Onions of mixed varieties were harvested Thursday, May 12th, were placed on to cure Monday, May 16th and were given 72 h of curing and ozonation at 5 L/min, the curing being switched off Thursday, May 19th. The onions were placed in storage on Wednesday, May 25th, 2005. Test run number six. Onions of mixed varieties were harvested Thursday, May 19th, were placed on to cure Tuesday, May 24th and were given 48 h of curing and ozonation at 5 L/min, the curing being switched off Thursday, May 26th. The onions were placed in storage on Friday, May 27th, 2005.

During storage the onions were periodically examined for shelf life until the onions had decayed and had been removed. On each occasion the onions were sorted, the good onions being counted, weighed and replaced into the box, the bad onions being counted, weighed and discarded. Results (not shown) are based upon the percentage of good onions remaining in storage after each examination compared with the beginning weights of onions placed in storage.

Results and Discussion

During the first examination, approximately two months after the onions had been placed in storage, it was observed that some boxes had a high incidence of onions decaying from sour skin, with fruit flies swarming the box. Other boxes of onions, however, survived with few or no onions decaying. On the second examination, approximately one month from the first, a few onions were removed from the boxes for having the presence of soft centers, sprouting, slippery skin and only two were noted to have highly decomposed. During the second examination the diseases were observed to be void of the sweet smell of sour skin. Aspergillus niger was found on the surface of some onions. These onions had been isolated from circulating air. During the third examination most of the onions removed had sprouted and those notably of onions from the second and third harvests. Only one onion was found decomposed during the third examination. Over the first three examinations the diseases were reported to be bacterial in nature, notably soft rot, sour skin and slippery skin. Even by the third examination many of those onions of the first, fifth and sixth harvests remained bright and attractive in complexion.

Since only one year of this study has been conducted, no statistical determination has been made of the results so far, however, there are indications that there may be a benefit in applying ozone during curing.

References

Flurry, A. 2005. UV-ozone process advances wastewater recycling. The Georgia Engineer, August/September, p:39.

Davis, P. 1976. The American Heritage Dictionary of the English Language. Dell publishing Company Incorporated, 1 Dag Hammarskjold Plaza, New York, NY 10017.

Smith, C. 2005. Personal correspondence, Ozone Technologies, Florida.

Sumner, P.E., B.W. Maw, A.C. Purvis, W.C. Hurst. 2001. Onion Production - Harvesting, curing and storage. pg 29-34. Onion Production Guide, UGA Extension Bulletin 1198, edited by G.E. Boyhan, D.M. Granberry and W.T. Kelly.

Maw, B.W. and J.T. Paulk. 2002. Down-draft in-bin curing of sweet onions. 2002 Onion Research - Extension Report. Cooperative Research-Extension Publication No. 3-02, University of Georgia, Tifton, Georgia.

EFFECTS OF CO_2, RELATIVE HUMIDITY AND HIGH TEMPERATURE ON TRANSLUCENT SCALE IN ONIONS

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Introduction

Translucent Scale in Short-day onions (*Allium cepa* L.) is a physiological disorder that may appear during periods of high temperature and high humidity at the end of the growing season. It is characterized by a clearing and water soaking of the normally opaque cells of the fleshy internal scales. Although, the symptoms of Translucent Scale in stored onions are found in the second, third or even more inner scales, high temperature symptoms are most common on outer scales.

Predisposing factors for the development of Translucent Scale during the end of the growing season are thought to be high humidity and temperatures (90 °F or 32 °C) during the last two months of the growing season and a 2 - 4 week delay between curing and cold storage (Lipton and Harris, 1965). Symptoms continue to progress during storage. Extended periods of field curing can increase the induction of Translucent Scale. While it is hard to simulate field growing conditions, it is possible to simulate how onions are handled after harvest. It was the objective of this experiment to determine what effect CO_2, relative humidity and high temperature has on induction of Translucent Scale in sweet onions.

Materials and Methods

Onions were undercut and field cured for four days before the tops and roots were removed. The de-topped onions were put in 60 pound mesh bags and cured in pallet bins for 48 hours with 100 °F (37 °C) forced air. The onions were graded, placed in 60 pound mesh bags and placed in a 34 °F (1 °C), 70 % relative humidity room for one month.

After one month of storage, the onions were re-graded and large onions were selected. The onions were randomly sorted into four groups of 40 onions. Each group was weighed and placed in 8 gallon (32 liter) plastic containers. A "HOBO Pro Series" data logger was affixed to the upper inside wall of each container to record temperature and humidity at hourly intervals for the duration of the experiment.

Containers were placed in a room with temperature averaging 92 °F (33 °C) for three weeks. Each container was allowed to equilibrate in temperature overnight. After temperature equilibration, the buckets were sealed. Each of the two atmosphere treatments, air and air + high CO_2 (> 7%), were divided into low humidity (77% rh) and high humidity (94% rh) sub-treatments. An air pump was connected to the air-low humidity treatment. This pump pumped air (open system) through a 1 quart (1 liter) glass jar filled with 20 ounces (600 ml) Drie-rite to remove moisture. An air pump was connected to the air-high humidity treatment and pumped air (open system) through a 1 quart (1 liter) glass jar filled with 20 ounces (600 ml) of de-ionized water to maintain a high relative humidity. The CO_2-low humidity treatment had an air pump connected in-line that circulated the atmosphere through a 1 quart (1 liter) glass jar filled with 20 ounces (600 ml) Drie-rite to remove moisture. The CO_2-high humidity treatment had an air pump attached in-line that circulated the atmosphere through a 1 quart (1 liter) glass jar filled with 20 ounces (600 ml) de-ionized water to maintain a high relative humidity. Gas levels were checked daily with a portable O_2/CO_2 analyzer.

After three weeks, the treatments/replications were removed from the buckets and divided into 2 groups of five onions each, weighed and visually evaluated. One group of five onions (evaluation 1) were evaluated and the second group of onions (evaluation 2) were placed in a room at 45 °F (7 °C), 60% relative humidity for 7 days, then evaluated. Onions were evaluated by the following criteria: external/internal *Botrytis allii* (neck rot). *Penicillium* spp. (blue mold), external/internal *Pseudomonas cepacia* (sour skin), *Aspergillus niger* (black mold), white mold and Translucent Scale. Onions were cut equatorially to determine the presence of internal fungal and bacterial diseases as well as Translucent Scale.

Results and Discussion

Table 1 shows the incidence of the fungal and bacterial disease evaluated. There was no presence of blue mold or external neck rot in any of the treatments for evaluations 1 and 2. All treatments had some degree of black mold, but the air-low rh had a significant amount less than the other treatments. There was some of external sour skin in evaluation 1, but it was not significantly different between the treatments. There was no incidence of external sour skin in evaluation 2. Internal sour skin in evaluation 1 showed no significant difference between the treatments. The air-high rh treatment in evaluation 2 had a high incidence of internal sour skin than the other treatments. There was not a significant difference of the incidence of internal neck rot among any of the treatments. In evaluation 1, the CO_2-high rh treatment showed a significant difference in the incidence of white mold (55%), compared with the air-low rh (5%), air-high rh (0%) and CO_2-low rh (5%) treatments. In evaluation 2, the CO_2-high rh treatment, although less than in evaluation 1, showed a significant difference in the incidence of white mold (40%), compared with the air-low rh (0%), air-high rh (5%) and CO_2-low rh (5%) treatments.

Table 2 shows the incidence of Translucent Scale. Induction of Translucent Scale for evaluation 1 is significantly different between the air-low rh (10%), air-high rh 100%), CO_2-low rh (95%) and CO_2 high rh (100%). There is a slight reduction in incidence for the CO_2-low rh (95%) treatment, but not significantly different. However, evaluation 2 shows no difference between the incidence (100% for all treatments) of Translucent Scale for any of the treatments, indicating that the problem will intensify once initiated.

Table 2 also shows a breakdown of the incidence of Translucent Scale by ring number. Evaluation 1, ring 1 through ring 4, shows a significant difference between the air-low rh treatment (10%), and the remainder of the treatments. Both CO_2 and the air-high rh treatments displayed a high (> 50%) incidence of Translucent Scale. There appeared to be a lower incidence in the CO_2-Low rh than the other high rh treatments, but not significantly different. There is not a significant difference in the incidence in evaluation 2, however it is clear that Translucent Scale continues development.

Summary and Conclusion

The incidence of Translucent Scale can be induced by high levels of relative humidity and/or high concentrations of CO_2 at high temperatures. Once the problem is initiated, there is no reversal of the damage, instead the damage to the onion will intensify. It appears that with high relative humidity levels, the pathway for venting the CO_2 from the onion bulb becomes restricted, keeping the gas inside the onion. Also, high humidity increases fungal spread and development. Little can be done to change the growing environment, therefore, onions should be cured properly, graded and placed in storage and cooled to just above freezing as quickly as possible after harvesting to minimize losses. The quicker the onion bulb temperature is reduced, the lower the respiration and transpiration rate, thus the lower the rate of CO_2 production and moisture accumulation.

Reference

Lipton, W.J. and C.M. Harris. 1965. Factors influencing the incidence of translucent scale of stored onion bulbs. Proc. Am. Soc. Hortic. Sci..87:341-354.

Table 1. Percent Fungal and Bacterial Diseases

Evaluation	1	1	1	1	2	2	2	2
	Air Low RH	Air High RH	CO_2 Low RH	CO_2 High RH	Air Low RH	Air High RH	CO_2 Low RH	CO_2 High RH
Black Mold	75 b	100 a	100 a	100 a	65 b	100 a	100 a	100 a
Internal Neck Rot	10 ab	30 a	15 ab	5 b	0 a	0 a	0 a	0 a
External Sour Skin	15 a	5 a	5 a	5 b	0 a	0 a	0 a	0 a
Internal Sour Skin	10 a	15 a	0 a	15 a	10 b	30 a	0 b	10 b
White Mold	5 b	0 b	5 b	55 a	0 b	5 b	5 b	40 a

Table 2. Percent Translucent Scale

Evaluation	Treatment	Translucent Scale	Ring 1	Ring 2	Ring 3	Ring 4	Ring 5	Ring 6	Ring 7	Ring 8
1	Air-Low RH	10 b	5 b	5 b	5 c	0 d	0 b	0 b	0 b	0 b
1	Air-High RH	100 a	95 a	95 b	80 b	75 b	60 a	35 a	20 a	20 a
1	CO_2-Low RH	95 a	90 a	95 b	85 ab	50 c	25 b	10 b	0 b	0 b
1	CO_2-High RH	100 a	100 a	100 a	100 a	100 a	75 a	45 a	25 a	15 ab
2	Air-Low RH	100 a	100 a	100 a	85 b	75 a	55 a	45 a	10 a	0 b
2	Air-High RH	100 a	100 a	100 a	100 a	90 a	70 a	50 a	25 a	10 a
2	CO_2-Low RH	100 a	100 a	100 a	100 a	90 a	65 a	30 a	10 a	0 b
2	CO_2-High RH	100 a	100 a	100 a	100 a	90 a	75 a	50 a	15 a	0 b

DECREASE IN BULB FIRMNESS DURING STORAGE OF ONIONS

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Introduction

Although much of the Vidalia onion crop is sold fresh, significant portion of harvested bulbs go into storage so that growers can extend their marketing season. By putting bulbs into refrigerated or controlled atmosphere storage growers can avoid selling their entire harvested product at a time when the market is flooded and prices are low. Operating a storage facility however, is expensive, with high initial capital investment and a large overhead, particularly with ever increasing energy costs. The growers must be sure that the price they can command for bulbs out of storage more than makes up for the additional costs of storing them. For this to happen, growers must be able to ensure that long-term storage measures will be adequate to prevent bulb quality deterioration.

Controlled atmosphere (CA) storage has improved the ability to prevent weight loss and, so doing, maintain high quality in storage. By lowering ambient oxygen concentrations and increasing carbon dioxide levels, growers are able to decrease bulb respiration in CA storage and subsequent weight loss that occurs as sugars are degraded during respiration. Although refrigerated storage slows the rate of these reactions and reduces weight loss, it does not have as dramatic an effect as CA storage. Much research has been conducted on onion weight loss over time, but far less is known about the effects of storage on other quality attributes, including texture, flavor and color.

Firmness is an important constituent of texture. When a person consumes food, texture can have almost as important effect as taste upon flavor perception. With so much emphasis being placed on flavor perception in Vidalia onions it is worthwhile to examine firmness.

It was the primary objective of this study examine the effect of field treatments of calcium chloride and ammonium sulfate upon bulb firmness at harvest. In addition, the influence of long-term refrigerated storage on firmness was to be examined.

Materials and Methods

The field study was conducted as a strip-plot randomized factorial design with the main plot being variety and the sub plots being fertility. Two varieties, Georgia Boy and Sweet Vidalia were used. Seed was sown on 21st September, 2004 and the plants transplanted into the field on 23rd November, 2004. With the exception of fertility treatments, onions were grown using standard procedures outlined by the University of Georgia Agricultural Extension Service. Plots received 400 lb/acre of 5-10-15 pre-plant. At six and eight weeks after transplanting, 200 lb/acre of 6-12-18 (equivalent with no S) were applied. At 14 weeks 200 lb/acre of calcium nitrate was applied. All fertilizer was applied by hand to the base of the plant. Fertility treatments consisted of ammonium sulfate and calcium chloride. Applications of ammonium sulfate were made at six and twelve weeks post-transplant giving a total application of 36, 72, and 108 lb/acre of S for the growing season. Four applications of calcium chloride were made at 7, 11, 15 and 19 weeks post transplant. Total amounts of calcium chloride applied were 0,100 and 200 lb/acre equivalent.

Onions were cut and harvested on 9th and 11th May, 2005 and cured at 100 ^{o}F for approximately 100 hours. After curing, onions were weighed and graded. Only one variety, Georgia Boy was placed in refrigerated storage at 2 ^{o}C and 70% rh in Tifton, GA. After ten weeks in storage bulbs were analyzed in the lab for firmness, using a small fruit penetrometer with a 1mm diameter probe. Bulbs were sliced longitudinally and the first intact and fully turgid scale was removed and tested at the equator (usually the third scale from the outside). Three penetrometer readings were taken for individual bulb scales and approximately 15 bulbs were tested per replication (a total of 45 readings were averaged for each treatment/replication).

Results and Discussion

After one year results show that large decreases in firmness (~10%) can occur after ten weeks in refrigerated storage. This change was empirically noticed by our lab team during the analysis of the stored onions. This is likely due to sustained activity of cell wall degrading enzymes. We do not know if maintaining a CA environment would affect these results. Also noteworthy was the effect of calcium chloride on firmness. Though not initially found to be significant, after ten weeks of storage those onions that received calcium chloride in the field were *significantly* firmer than those which received no supplemental calcium. It is speculated that as more calcium was supplied to the bulb there would be created more pectin cross linkages with calcium ions. Firmness was being increased by there being a thickening and increase in strength of the cell wall.

Listed in Table 1, are the firmness readings for bulbs at harvest and after ten weeks of storage. At harvest treatments were not significant and neither ammonium sulfate nor calcium chloride fertility affected firmness. After ten weeks in storage however, our results show that firmness increased as calcium levels increased with 200 lb/acre calcium being firmer than 0 lb/acre calcium chloride ($F=5$, $P<0.01$). Additionally, storage time had a large, significant effect on firmness ($F=129$, $P<0.0001$), causing it to decrease over time.

Summary and Conclusions

Because the effects of calcium chloride were observed only after ten weeks in storage, additional calcium chloride fertility may act to further slow down the loss of firmness in storage, if not increasing it at harvest. Future work will be done to evaluate if storage conditions can influence the activity of cell wall altering enzymes such as pectin methyl esterase and polygalacturonase.

Table 1. Average penetrometer (± std. error) readings are presented as Newtons/mm^2 a unit of force for the onion variety *Georgia Boy*, for three levels of calcium chloride, 0,100 and 200 lb/acre and three levels of ammonium sulfate, 36,72, and 108 lb S/acre at harvest and after ten weeks in storage.

	S level					
	36		72		108	
CaCl	Harvest	Storage	Harvest	Storage	Harvest	Storage
0	1.07±0.009	1.00±0.008	1.09±0.028	0.98±0.009	1.08±0.018	0.97±0.009
100	1.10±0.022	0.98±0.012	1.14± 0.031	0.99±0.013	1.07±0.029	0.96±0.008
200	1.09±0.023	0.99±0.015	1.16±0.016	1.02±0.008	1.09±0.038	1.05±0.006

THE EFFECTS OF LIQUID CALCIUM CHLORIDE ON YIELD IN VIDALIA ONION

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Introduction

In recent years a number of growers in the Vidalia growing region have incorporated liquefied calcium chloride into their fertility regime. Under the trade name of HI-CAL®Liquid (TETRA Technologies, The Woodlands, TX) this liquid solution is 12% calcium and 26% chloride by weight. With a pH of 7, the liquefied calcium chloride is a convenient way to apply more calcium and chloride without changing the soil pH, as would occur with applications of calcium carbonate. Though recently available in granular form, the liquid solution remains a popular alternative. Growers have applied the calcium chloride through fertilizer injection units linked to irrigation or via tank sprays in the field.

There are various reasons for using calcium chloride. Reasons may be the correction of potential calcium or chloride deficiencies and the improvement of the quality characteristics of bulb size or storability. As for quality, current investigations are underway to determine which quality parameters of onions calcium chloride may affect.

In 2004-05 a two year field study was initiated to determine the effects of calcium chloride on onion growth, metabolism, and yield as well as the effects of calcium chloride as a countermeasure for losses associated with growing onions under a low sulfur (S) regime as is typical in the Vidalia region.

Materials and Methods

The study was conducted as a strip-plot randomized factorial design with the main plot being variety and fertility treatment being the sub plots. Two varieties, Georgia Boy and Sweet Vidalia were used. Seed were sown on 21st September, 2004 and transplanted into the field on 23rd November, 2004. With the exception of fertility treatments, onions were grown using standard procedures outlined by the University of Georgia Agricultural Extension Service. Plots received 400 lb/acre of 5-10-15 with 9% S pre-plant. At six and eight weeks after transplant 200 lb/acre of 6-12-18 (equivalent with no S) were put out. At 14 weeks 200 lb/acre of calcium nitrate was applied. All fertilizer was applied by hand to the base of the plant. Fertility treatments consisted of ammonium sulfate and calcium chloride applications. Applications of ammonium sulfate were made at six and twelve weeks post-transplant, giving a total application of 36, 72, and 108 lb/acre of S for the entire growing seasons (including pre-plant). Four applications of calcium chloride were made at 7, 11, 15 and 19 weeks post transplant. Total amounts of calcium chloride applied were 0,100, 200 lb/acre corresponding to 0, 22.9, and 45.8 gallons/acre of the HI-CAL liquid solution.

Onions were cut and harvested on 9th and 11th May 2005 and cured at 100 °F for approximately 100 hours. After curing, onions were weighed and graded.

Results and Discussion

Cured yields in 50 lb bags/acre for GA.Boy and Sweet Vidalia for each treatment are listed in table 1. Because there are possible levels of interaction, i.e. calcium level by S level by variety, the marginal means of each treatment have been placed in separate tables (2a,2b,2c) to make for easier interpretation.

Overall yields for most treatments were high. When averaged over all treatments, Sweet Vidalia had a significantly higher yield than Georgia Boy, with 736 compared with 696 fifty pound bags/acre after curing. When considering treatment effects however, only Georgia Boy was affected by fertility treatments, with the 36 lb S/acre treatment being significantly less than both the 72 and 108 lb S./Acre treatments. Calcium chloride had no influence on yield in either variety or at any level of S.

The largest difference in yield was due to variety, which is not at all surprising considering the large variation seen in the variety trial each year. Although sweet Vidalia tended to have a higher yield than Georgia boy for most treatment combinations, variations in Sweet Vidalia were also high. Climatic temperature fluctuations were the most likely reason for this to happen.

During the 2004-2005 season, a large number (up to 20 % of a given plot) of Sweet Vidalia bulbs bolted, sending up flower stems. Typically, after a seed stem is sent up, a bulb will not further enlarge, thereby introducing a source of variation. This may be why Sweet Vidalia did not respond to fertility treatments.

Although Georgia Boy responded to increases in ammonium sulfphate, calcium chloride had no effect. The difference in yield linked to ammonium sulphate came between the lowest level (36 lb/acre) and the two higher levels of S (72/108 lb/acre). Even though current recommendations call for between 50-60 lb S/acre, less S was used for the low S treatments because a broad range of S fertility was needed. This was to determine if calcium chloride could alleviate yield reductions caused by low levels of S, applied as ammonium sulphate. During the season being reported, calcium chloride did not influence yield reductions associated with low S fertility.

Results this year did not indicate a yield benefit from calcium chloride applications between 0 and 200 lb/acre. However, calcium concentrations in mature bulb tissue ranged from 0.15 % in the 0 calcium chloride treatment to around 0.21 % in the 200 lb/acre treatment (data not shown). Both of these levels are low for onions. Previously, calcium concentrations in the bulb near 0.5% to 0.8% were found. Low bulb calcium content coupled with field observations in high soil calcium production areas indicated that application rates may have been too low for the low calcium soils.

In the coming seasons, higher application rates will be investigated. Because the use of liquefied calcium chloride is widespread and has drawn favorable reviews from a number of growers based upon overall bulb quality, current investigations are underway into numerous parameters of quality in onions and how the application of calcium chloride may affect those parameters.

Table 1. Mean yields (± standard error) given in 50 lb bags/acre are given for two varieties of onion, Georgia Boy and Sweet Vidalia for three levels of calcium chloride, 0,100 and 200 lb/acre and three levels of ammonium sulfate, 36,72, and 108 lbs S/acre. Onions were cured prior to weighing. The number of 50 lb bags/acre is calculated based on 80,000 plants/acre.

	S level					
	36		**72**		**108**	
CaCl	**GA Boy**	**Swt. Vid.**	**GA Boy**	**Swt. Vid.**	**GA Boy**	**Swt. Vid.**
0	**673 ± 18**	**702 ± 17**	**735 ± 7**	**737 ± 48**	**718 ± 9**	**761 ± 47**
100	**645 ± 19**	**771 ± 32**	**698 ± 28**	**734 ± 63**	**717± 19**	**764 ± 37**
200	**649 ± 12**	**734 ± 24**	**716 ± 41**	**683 ± 29**	**726 ± 19**	**719 ± 24**

Table 2 a. Mean yields (± standard error) given 50 lb bags/acre for two varieties, Georgia Boy and Sweet Vidalia averaged across S and calcium fertility levels. "A,B" indicates significance at $P<0.01$.

Variety	***Yield***
GA Boy	**696±8 A**
Swt. Vid.	**736±12 B**

Table 2 b. Mean yields (± standard error) given 50 lb bags/acre for two varieties, Georgia Boy and Sweet Vidalia averaged across levels of ammonium sulfate in lbs S/acre. "A,B" indicates significance at $P<0.01$ within a single variety.

	GA Boy	***Swt. Vid.***
S level		
36	**657 ± 10 (A)**	**731 ± 15 (A)**
72	**716 ± 16 (B)**	**727 ± 27 (A)**
108	**720 ± 9 (B)**	**748 ± 21 (A)**

Table 2 c. Mean yields (± standard error) given in 50 lb bags/acre for two varieties, Georgia Boy and Sweet Vidalia averaged across levels of calcium chloride in lbs/acre. "A,B" indicates significance at $P<0.01$ within a single variety.

	GA Boy	***Swt. Vid.***
CaCl level		
0	**704 ± 10 (A)**	**729 ± 20 (A)**
100	**686 ± 14 (A)**	**766 ± 25 (A)**
200	**697 ± 17 (A)**	**712 ± 15 (A)**

EVALUATION OF SEED-CORN MAGGOT ADULT LURE ON TRAPS

David Riley, Research Entomologist

Introduction

Seed-corn maggot (Order: Diptera, Family: Anthomyiidae, Genus: *Delia*, species: *platura* (Meigen)) is an important pest of onions in the Vidalia Onion growing area of Georgia. Seed-corn maggot damages onions through reduction of seedling stands and contamination of the harvested onion bulbs at the end of the season. Mid to late season stand loss caused by seed-corn maggot has not been observed, only secondary invasion of the crop after some other factor has damaged the crop.

Pupae of the seed-corn maggot can be attached to harvested portions of root crops, from which adult flies can emerge in fresh markets. The adult flies are small (4-5 mm long), grayish brown and males have gray stripes on the thorax. The abdomen tends to be smaller than what you observe on houseflies, relative to the overall body size. The eggs are white, oblong and about 0.9 in length. The larvae are less than 1 mm in the first instar to 7 mm in the third instar and tend to occur in clusters at the base of the plant or feeding inside of the root stem. The puparium is 4-5 mm long and is light reddish brown. The complete life cycle (from egg to adult) ranges from 15 to 77 days (depending on temperature) with an average of three weeks under warm conditions. Diapausing pupae in the winter have been reported in northern States, extending this time period. There are likely 3-4 generations per year in Georgia. Oviposition by adults occurs within a temperature range of 10-27oC and usually decaying plant material and/or newly emerging plant seedlings are targeted.

In the Vidalia onion area, onions are infested in the fall and if winter frost damage to the crop occurs, flies can be observed in damaged fields once the temperature increases. Crops planted in cool seasons are particularly susceptible to infestation of seedlings, a problem generally not seen in warm seasons. The standard treatment for control of this pest is to treat preventatively during the susceptible cool season planting with pre-plant, in-furrow insecticides. Management of mid to late season infestations that occur due to some crop damage if of most concern when dealing with a root crop such as onions or turnips. If frost damage occurs in the winter crop 1-2 months before harvest, and adult seed-corn maggots are detected on yellow sticky traps in the field, then we recommend a treatment for adults to reduce the level of contamination of the crop with pupae that could wind up in the harvest.

Materials and Methods

In the spring of 2005, sticky traps baited with a new lure for seed-corn maggot adults were evaluated at Tifton, GA. The objective of the study was to test the relative attractiveness of the ChemTica Internacional P316 Seed-corn & Onion Maggot Lure supplied by AgBio Inc. Lures, supplied by Dr. Jan Meneley AgBio Inc., were placed on 3 x 5" yellow sticky cards (Olson Products, P.O. Box 1043, Medina, OH 44258, Phone: 330-723-3210) and these cards placed next to unbaited traps in a seed-corn maggot susceptible field crop. In the spring just prior to planting sweet-corn, five baited and five unbaited sticky cards were placed around the perimeter of the corn field at approximately 100 ft intervals with 30 ft between paired baited and unbaited traps. Sticky cards were attached with staples to wooden stakes at a trap height of 10" to 12" above the ground on March 28, 2005 at the Coastal Plain Experiment Station. Cards were checked three times a week for the first week and then weekly for the following three weeks for numbers of *Delia* spp. adults. Sticky traps were replaced at each observation interval. Flies were identified to genus on the cards and also wrapped in plastic and placed in a freezer for later identification. The data was analyzed using Proc GLM and LSD tests for separation of paired means. The data was reported as the number of *Delia* spp. adults per card for each sample date. The percent maggot-damaged seeds and/or infested plants was not taken because casual observation of the sweet corn revealed no noticeable damage.

Results

The results indicated that seed-corn maggot baits significantly enhance trap captures of *Delia* adults near susceptible crops. Four-times as many adults were captured on the baited traps as unbaited traps. Unfortunately, we were not able to correlate trap capture rates with damage to sweet corn, but the enhanced traps have definitely shown promise for field use. The next step will be to evaluate these traps in the Vidalia onion growing area, especially at locations where seed-corn maggots have been a problem in the past.

Table 1. Seed-corn maggot adult flies captured on baited and unbaited sticky traps, Spring 2005.

Treatment	3/30	3/31	4/8	4/15	4/21	Average
baited yellow trap	5.4 a	15.0 a	3.4 a	9.6 a	4.6 a	7.4 a
unbaited trap	0.6 b	5.0 b	1.4 a	1.2 b	1.4 b	1.8 b

* means within columns followed by the same letter not significantly different (LSD, $P>0.05$).

CONSUMER ACCEPTABILITY OF VIDALIA ONION VARIETIES

Robert L. Shewfelt, Research Food Science and Technologist

Abstract

Forty-nine varieties of Vidalia onions were evaluated by 490 consumers on The University of Georgia campus. Four varieties (23, 29, 34 & 39) were superior while an additional fifteen varieties (1, 7, 13, 14, 18, 20, 22, 24, 26, 27, 31, 36, 37, 38, & 49) were also rated highly acceptable. This information should be considered with yield and growth characteristics in selecting varieties for the next growing season. Sample differentiation was not as clean as expected. A higher number of participants may be required for better differentiation in future studies.

The test population was 53.3% female and 46.7% male. The age groupings of participants were 54.5% under 30, 16.9% in their 30s, 14.3% in their 40s and 14.3% over 49. An associated questionnaire revealed that 86.6% of responses indicated that they purchased onions at the supermarket, 45.4% purchased then by the Vidalia name, 39.2% use appearance and 27.2% as primary characteristics for purchase of Vidalia onions, 65% consider taste to be the most important quality characteristic, 59.45 store their whole onions or leftovers in the refrigerator, 41% expect a storage life of less than 2 weeks while over 94% do not expect a storage life of more than 4 weeks and 84.6% satisfied with the onions available for purchase. Vidalia onions command a strong reputation for quality among the participants at the University of Georgia campus. It is important to maintain that reputation by meeting the needs of the consumer.

Introduction

Onions grown in Toombs, Montgomery and additional counties in southern Georgia, known as Vidalia onions, are considered to be sweet due to the absence of pungency. Pungency is related to the degree of precursor sulfur compounds in the onion that are converted to pungent compounds during tissue disruption (Randle, 1997). The presence of these compounds is in turn due to the presence of sulfur and nitrogen compounds in the soil (Cooling and Randle, 2003). The soils in the Vidalia area that produce these premium onions are low in sulfur. Although onions grown in this area are mild, not all onion varieties are created equal. Some varieties are sweeter (less pungent) than others (Randle, 1997).

Food scientists prefer using instrumental measures of quality, but not all of these measures provide adequate estimates of consumer acceptability. Thus, they evaluate quality using analytical and affective sensory tests. Analytical tests use a small number of trained human panelists to quantify specific quality attributes such as sweetness, bitterness and pungency while affective tests use large numbers of naïve consumers to determine acceptability (Resurreccion, 1998). Most affective tests use a 9-point Hedonic scale (9=like extremely; 1=dislike extremely). This scale, however, has many limitations including (1) it is not of equal intervals making it statistically questionable, (2) it generally collapses to a 3 or 4 point scale due to end effects, and (3) it has an indirect link to acceptability (Henderson, 2002). A 3-point acceptability scale (2=tastes great, 1=acceptable, 0=unacceptable) has proven to be a more meaningful scale in evaluating consumer acceptability (Dubost et al., 2003; Henderson, 2002) despite concerns that it is not balanced (Meilgaard et al., 1993). Understanding the behavior of consumers with respect to a *commodity* like onions is important. Some investigators take a product orientation to describe internal and external factors of quality, but a consumer orientation describes quality in terms of purchase and consumption attributes (Shewfelt, 1999).

The objective of this study was to evaluate the consumer acceptability of 49 varieties of Vidalia onions for purchase decisions by Vidalia onion growers.

Materials and Methods

Onions were as part of the variety trial on the Vidalia Onion and Vegetable Research Farm, Reidsville, GA. They were grown under standard conditions on commercially sized beds with four rows per bed in a randomized complete block design in plots 35-feet long and 6-feet wide. Plant densities approximated 12 plants per linear foot. Each replication was a minimum of twenty-five feet in length. Onions were harvested at maturity and shipped to the Food Science Department of The University of Georgia in Athens. They were stored at 34 ^{0}F until testing. Any samples showing evidence of damage during shipment or decay during storage were discarded. Food Science Department had no information on the varieties other than the serial number (1-49) of each variety.

Onions were evaluated on seven days in June at seven different locations on The University of Georgia campus in Athens with 70 participants tasting three varieties that were clearly described as Vidalia onions using the sampling schedule shown in Table 1.

Thus, fourteen varieties were assigned a three-digit code and evaluated each day by fifteen participants. Each variety was evaluated on two separate occasions. Sample presentation was randomized and samples were presented one at a time. Participants were asked if the sample "Tastes Great," was "Acceptable" or was "Unacceptable". They were asked not to compare one sample with another Each variety was thus tasted by 30 participants.

Samples were presented in diced form. In cutting the samples approximately 10-20% of the top and bottom of each onion was removed before the diced samples were prepared. A total of 490 consumers participated. Each participant received $5.00 for participating in the test. While some consumers who were approached declined the opportunity to taste raw onions, most willingly participated. After tasting the samples and before receiving compensation, each participant answered a short survey shown in Figure 1.

Data were analyzed by Analysis of Variance with mean separations by Least Significant Difference (LSD) using SAS.

Results and Discussion

A complete means separation using LSD based on an average of the three points in the acceptability scale is shown in Table 2. A comparison of all the means, as shown by the letters following, show that there is no significant difference between the top 38 varieties (all followed by the letter a) or between the bottom 27 varieties (followed by the letter f). Of these varieties, sixteen were neither significantly different from the best nor the worst ones (followed by the letters abcdef). In this test, it would appear that the use of 30 participants is not sufficient to obtain differentiation. For better differentiation the number of participants evaluating each variety should be increased to 50. Experience this summer indicates that it would not be a problem to find willing participants.

A more manageable separation into five somewhat arbitrary categories is shown in the right-hand column of Table 2 based on the mean of the three categories. Another way of evaluating the differences between varieties is shown in the next to last column of Table 2 which represents the percentage of participants who rated the samples either "Tastes Great" or "Acceptable." While the lowest rating in this column was 70% sounds reasonably good, it means that 30% of participants rated that variety as "Unacceptable". Ideally, at least 90 % of the participants should rate the sample "Tastes Great" or "Acceptable". Using this criterion, varieties 23, 29, 34, 37, 39 & 42 were acceptable to more than 95% of participants while varieties 1, 7, 12, 13, 14, 15, 17, 18, 20, 22, 24, 26, 27, 31, 36, 38, 41, 43, 45, 46, 48 & 49 were acceptable to more than 90% of participants. Using both criteria the superior varieties were 23, 29, 34 and 39 which were in the top group each time. Varieties 1, 7, 13, 14, 18, 20, 22, 24, 26, 27, 31, 36, 37, 38, and 49 were in the top two groups using both criteria. It would also be useful to conduct an experienced panel of 8-10 judges who would evaluate sweetness and pungency for all varieties.

The demographic profile of the participants is shown in Table 2. The population was closely split between males and females, but it was dominated by participants under the age of 30. Of the seven locations, the population at four locations was greater than 50% from the under 30 group. Avoidance of heavily populated student areas would provide a more balanced age range.

Consumer behavior data are shown in Tables 3-5. The most popular place to buy Vidalia onions for the participants is the supermarket (86.6% of responses) with less than 10% citing a farmer's market or roadside stand (Table 3). Some participants indicated that they will only purchase Vidalia onions by traveling to Vidalia or the surrounding counties. Almost half (45.4%) of the sample specified Vidalia as the type of onion they bought indicating a high loyalty for the Vidalia name. Appearance (39.2%) and size (27.9%) were the two most important characteristics used by consumers in purchasing Vidalia onions, while taste (65%) was critical in satisfaction during consumption of the onion (Table 4). The refrigerator (59.4%) is the most common place of storage for onions in the home with on (20.1%) or under (8.8%) the counter accounting for most other methods. Some dedicated participants reported tying their onions up in old stockings (4.5%). Many consumers store whole onions outside the refrigerator and place leftovers in the refrigerator. A large number of participants (41%) expect less than a two-week shelf life, while a majority (53.4%) expect less than 4 weeks shelf life. These numbers combined with the high satisfaction rate (84.6%) suggests that shelf-life extension is not a critical area for onions. The level of satisfaction for onions is much higher than what we have observed for fresh fruits and vegetables.

Summary and Conclusions

A complete means separation using LSD based on an average of the three points did not provide the clear separation of varieties expected. In looking at those varieties that rated the highest on the 3-point scale and were rated as acceptable by the most participants, four varieties (23, 29, 34 & 39) emerged as superior and fourteen (1, 7, 13, 14, 18, 20, 22, 24, 26, 27, 31, 36, 37, 38 & 49) as highly rated. Ten varieties (2, 4, 5, 8, 9, 10, 19, 28, 30 &32) rated as unacceptable by at least 20% of participants should be considered as the least desirable selections. Increasing the number of participants from 30 to 50 tasting each variety should provide a cleaner separation of the desirable varieties from the undesirable ones.

The selection of sites provided a good balance of males and females in the sample population, but future site selection should avoid areas with heavy student traffic to get a more balanced sample by age. Onions, particularly Vidalia onions, have a good reputation on the University of Georgia campus and the satisfaction level is high. Vidalia growers appear to be delivering high quality onions that are meeting the shelf-life expectations of their consumers.

References

Cooling, T.W. and W. M. Randle. 2003. Sulfur and nitrogen availability interact to affect the flavor biosynthetic pathway in onion. J. Amer. Soc. Hort. Sci. 128: 776-783.

Dubost, N.J., R.L. Shewfelt and R.E. Eitenmiller. 2003. Consumer acceptability, sensory and instrumental analysis of peanut soy spreads. J. Food Quality 26: 27-42.

Henderson, J.A. 2002. Innovative Methods to Measure Consumer Acceptability of Fresh and Formulated Foods. M.S. Thesis, University of Georgia, 70pp.

Meilgaard, M., C.V. Civille and B.T. Carr. 1991. Sensory Evaluation Techniques. CRC Press, Boca Raton FL.

Randle, W.M. 1997. Onion flavor chemistry and factors influencing flavor intensity. In Flavor Chemistry and Antioxidant Properties. (S.J. Risch and C-T. Ho, eds.). American Chemical Society, Washington.

Resurreccion, A.V.A. 1998. Consumer Sensory Testing for Product Development. Aspen Publishers. Gaithersburg MD.

SAS. 2002. SAS 9.1. SAS Institute, Inc. Cary NC.

Shewfelt, R.L. 1999. What is quality? Postharvest Biol. Technol. 15:197-200.

Table 1. Separation of varieties by mean score [2 = tastes great (TG), 1 = acceptable (Acc), 0 = unacceptable].

Var	Mean	% Taste	% Acceptable	% TG + Acc	Grouping
14	1.50a	56.7	36.7	93.4	Best
23	1.50a	53.3	43.3	96.6	
39	1.50a	50.0	50.0	100.0	
29	1.47ab	50.0	46.7	96.7	
34	1.47ab	50.0	46.7	96.7	
38	1.47ab	56.7	33.3	90.0	
13	1.43abc	53.3	36.7	90.0	
1	1.40abcd	46.7	46.7	93.4	Close
7	1.40abcd	50.0	40.0	90.0	
18	1.40abcd	46.7	46.7	93.4	
20	1.40abcd	43.0	50.0	93.0	
37	1.40abcd	40.0	60.0	100.0	
49	1.40abcd	50.0	40.0	90.0	
22	1.37abcde	46.7	43.3	90.0	
24	1.37abcde	43.3	50.0	93.3	
25	1.37abcde	53.3	30.0	83.3	
26	1.37abcde	43.3	50.0	93.3	
27	1.37abcde	46.7	43.3	90.0	
31	1.37abcde	46.7	43.3	90.0	
33	1.37abcde	53.3	30.0	83.3	
35	1.37abcde	53.3	30.0	83.3	
36	1.37abcde	46.7	43.3	90.0	
16	1.33abcdef	46.7	40.0	86.7	Mid-range
42	1.33abcdef	36.7	60.0	96.7	
45	1.33abcdef	40.0	53.3	93.3	
17	1.30abcdef	40.0	50.0	90.0	
43	1.30abcdef	40.0	50.0	90.0	
46	1.30abcdef	40.0	50.0	90.0	
15	1.27abcdef	36.7	53.3	90.0	
6	1.23abcdef	36.7	50.0	86.7	
12	1.23abcdef	33.3	56.7	90.0	
41	1.23abcdef	33.3	56.7	90.0	
44	1.23abcdef	36.7	50.0	86.7	
48	1.23abcdef	33.3	56.7	90.0	
10	1.17abcdef	36.7	43.3	80.0	Poor
11	1.17abcdef	30.0	56.7	86.7	
19	1.17abcdef	36.7	43.3	80.0	
21	1.17abcdef	40.0	36.7	76.7	

Table 1 Cont Separation of varieties by mean score [2 = tastes great (TG), 1 = acceptable (Acc), 0 = unacceptable].

Var	Mean	%Taste	% Acceptable	%TG+Acc	Grouping
28	1.13bcdef	33.3	46.7	80.0	
47	1.13bcdef	26.7	60.0	86.7	
5	1.10cdef	30.0	50.0	80.0	
40	1.10cdef	23.3	63.3	86.6	
3	1.07def	23.3	60.0	83.3	Worst
4	1.07def	26.7	53.3	80.0	
8	1.07def	26.7	53.3	80.0	
32	1.07def	26.7	53.3	80.0	
2	1.03ef	30.0	46.7	76.7	
9	1.03ef	23.3	56.7	80.0	
30	1.00f	30.0	40.0	70.0	

[abcdef] All values followed by the same letter are not significantly different ($p<0.05$).

Table 2. Demographic profile of consumers evaluating Vidalia onions in this study.

		N	%
Gender:	Male	229	46.7
	Female	261	53.3
Total:		490	100.0
Age range:	18-29	267	54.5
	31-40	83	16.9
	41-49	70	14.3
	>49	70	14.3
Total:		490	100.0

Table 3. Point of purchase information for test participants.

		Responses	%
Purchase location:	Supermarket	432	86.6
	Farmer's Market	26	5.2
	Roadside Stand	17	3.4
	Other	24	4.8
Type of onion purchased:	Vidalia	331	45.4
	Other sweets	93	12.8
	Green onions	81	11.1
	Spanish	71	9.7
	Other	153	21.0

Table 4. Quality characteristics important to consumers of Vidalia onions at purchase and consumption.

		Responses	%
Purchase quality:	Appearance	280	39.2
	Size	199	27.9
	Aroma	70	9.8
	Label	56	7.8
	Other	280	15.3
Consumption quality:	Taste	429	65.0
	Firmness	99	15.0
	Aroma	88	13.3
	Other	44	6.7

Table 5. Consumer behavior, expectations and satisfaction.

		Responses	%
Method of home storage:	Refrigerator	331	59.4
	On counter	112	20.1
	Under counter	49	8.8
	In stocking	25	4.5
	Other	40	7.2
Expectation of storage life:	Less than 2 weeks	194	41.0
	2-4 weeks	253	53.4
	5-8 weeks	16	3.3
	9-12 weeks	8	1.7
	More than 12 weeks	3	0.6
Satisfaction:	Satisfied with available onions	404	84.6
	Not satisfied	26	5.5
	Not always satisfied	47	9.9

Code No. _______

Survey Accompanying Consumer Test
(one-on-one interview)

1. Gender M__ F __

2. Age range 18-29 __30-39 __ 40-49 __ > 49 __

3. Where do you purchase your Vidalia onions? How often?
   Supermarket ____ Farmer's market ____ Roadside stand ____
   Other ___ (Specify) ________________________________

4. What type of onions do you buy? (accept all answers)
   Vidalia ____ Spanish ____ Other sweets ____ Green onions ____
   Other ____ (Specify) ________________________________

5. What quality characteristics do you look for when buying Vidalia onions? (accept all answers)
   Label ____ Aroma ____ Appearance ____ Size ____
   Other ____ (Specify) ________________________________

6. What quality characteristics are important to you when you consume a fresh onion? (accept all answers)
   Taste ____ Aroma ____ Firmness ____ Other ____ (Specify)__________

7. How do you store whole onions or any leftovers? (accept all answers)
   Refrigerator ____On counter ____ Under counter _____
   In stocking ____ Other ____ (Specify)________________________________

8. How long do you expect onions you buy to keep in the home?
   Less than 2 weeks ____ 2-4 weeks ____ 5-8 weeks _____
   9-12 weeks ____ More than 12 weeks ____

9. In general, are you satisfied with the onions available in the supermarket?
   Yes ____ No ____If no, why ________________________________
   Depends ____ On what? ________________________________

Thank you for your time.

Figure 1. Questionnaire used to determine demographics and handling practices of participants.

THRIPS SPECIES COMPOSITION AMONG ONIONS IN THE VIDALIA PRODUCTION AREA

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Reid Torrence, Reid Torrance, Extension Coordinator, Tattnall County
Stan Diffie, Research Professional

Introduction

The detection of Iris Yellow Spot Virus (IYSV) and Tomato Spotted Wilt Virus (TSWV) in onions in the Vidalia production region in the last two years has heightened interest in thrips-virus interactions within this cropping system. While several species of thrips are known to vector TSWV, the thrips species responsible for vectoring of IYSV in the Vidalia region is unknown. In areas of the world where IYSV is prevalent, the onion thrips, *Thrips tabaci*, is reported to be the primary vector. Although present in the Vidalia region, this species typically represents a very small proportion of the population (less than 1 percent). The primary species reported to occur on onions in Georgia are the tobacco thrips, *Frankliniella fusca*, and the western flower thrips *F. occidentalis*. The literature reports that the western flower thrips does not transmit IYSV. The ability of the tobacco thrips to transmit IYSV is unknown.

Materials and Methods

A search for thrips was conducted throughout the Vidalia Onion Region and, when found, those thrips were identified.

Results and Discussion

Concurrent with the detection of IYSV in the Vidalia region, onion thrips were detected in cull piles of onions imported from Peru. If this thrips were to become better established in the Vidalia region, it may result in increased vectoring of IYSV. To monitor this situation, commercial onion fields in the Vidalia area were sampled periodically to determine the species composition of thrips in the area. Ten fields were selected in Toombs and Tattnall Counties for sampling (five fields in each county). On each sample date, plants were visually searched and adult thrips collected for identification. Each field was searched for 30 minutes (2 individuals sampled for 15 minutes each) and as many thrips were collected as time allowed. In addition to the ten commercial fields, the site of the original cull piles where onion thrips were detected was also sampled on each sample date. On the last sample date, four additional commercial fields were sampled. On each date, thrips were placed into alcohol and examined in the laboratory for identification.

Thrips species composition for each location on each sample date are presented in Table 1. The primary thrips species collected was the tobacco thrips. Although onion thrips was detected in several commercial fields, this species represented a low proportion of the population in any commercial field. The cull pile location did contain an elevated proportion of onion thrips.

Overall, the thrips populations in the ten regularly sampled commercial fields consisted of 97 percent tobacco thrips and only 1.6 percent onion thrips (Table 2). These numbers were similar for all commercial fields. The thrips population in the cull pile location was 32.9 percent onion thrips (total for all dates). While this continues to be of concern, it should be noted that the sampled commercial field located closest to the cull pile field consisted of about 0.5 percent onion thrips. While thrips species composition in the Vidalia region does not appear to have shifted, this situation likely justifies continued monitoring.

Table 1. Number of thrips collected in 30 minutes of plant searching.

Location	Number of thrips collected in 30 minutes of plant searching								
	Feb. 11			Feb. 22			March 14		
	F. fusca	*Thrips sp.*	Other	*F. fusca*	*Thrips sp.*	Other	*F. fusca*	*Thrips sp.*	Other
Toombs 1	0	0	0	3	0	0	-	-	-
Toombs 2	5	0	0	8	0	0	27	0	1
Toombs 3	6	0	0	20	3	1	14	0	0
Toombs 4	10	0	0	23	0	0	65	0	0
Toombs 5	-	-	-	6	0	0	35	0	1
Tattnall 1	2	0	0	5	0	0	41	1	1
Tattnall 2	2	0	0	1	0	0	12	0	0
Tattnall 3	2	0	0	19	0	1	27	0	0
Tattnall 4	1	0	0	7	0	0	21	0	0
Tattnall 5	0	0	0	11	0	0	71	1	1
Cull Pile	1.	7	0	8	6	0	12	2	0

Table 1. Cont'd.

Location	Number of thrips collected in 30 minutes of plant searching					
	April 4			April 27		
	F. fusca	*Thrips sp.*	Other	*F. fusca*	*Thrips sp.*	Other
Toombs 1	28	1	0	51	0	0
Toombs 2	49	0	1	56	0	1
Toombs 3	17	0	1	62	3	1
Toombs 4	83	0	3	51	0	0
Toombs 5	60	0	1	91	0	0
Tattnall 1	45	5	0	48	1	0
Tattnall 2	58	0	1	31	0	0
Tattnall 3	23	8	0	77	2	0
Tattnall 4	88	0	0	97	0	3
Tattnall 5	65	1	5	44	0	0
Cull Pile	6	1	3	19	8	0
Toombs				94	9	3
Toombs				85	0	0
Tattnall				43	0	0
Tattnall				80	1	0

Table 2. Species distribution of thrips collected across all fields and all sample dates.

Fields	Number of thrips collected			Percent of population	
	F. fusca	*Thrips sp.*	Other	*F. fusca*	*Thrips sp.*
Regularly sampled fields	1568	26	23	97.0	1.6
All commercial fields	1870	36	23	96.9	1.9
Cull piles	46	24	3	63.0	32.9

EFFICACY OF SELECTED INSECTICIDES AGAINST TOBACCO THRIPS ON ONIONS

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Introduction

A small plot trial was conducted in a commercial onion field in Toombs County, Georgia, to evaluate the efficacy of selected insecticides and insecticide combinations against thrips on onions. In a preliminary study, identification of adult thrips collected form the test area showed the thrips population consisted of over 95 % tobacco thrips, *Frankliniella fusca*.

Materials and Methods

Test plots one bed wide (6 foot bed with 4 rows of onions) and 25 feet long were prepared. Plots were arranged in a randomized block design with 4 replications of 13 treatments. Plots were separated across rows by a non-treated bed of onions. Plots were not separated down the row, but the first and last 3 to 4 feet of each plot was avoided when sampling; thus providing a 3 to 6 foot treated buffer between plots.

Treatments were applied with a CO_2 pressurized (60 psi) backpack sprayer with a spray volume of 30 gal/acre and 4 hollow-cone nozzles per bed (broadcast application). Treatments were applied on 18 and 25 April, 2005.

Treatments were:

- Warrior 1CS at 2.56 fl oz/acre (0.02 lb AI/acre)
- Warrior 1 CS at 3.84 fl oz/acre (0.03 lb AI/acre)
- Agrimek 0.15EC at 10 fl oz/acre (0.01 lb AI/acre) + Agri-oil at 0.5%
- Actara 25WG at 3.0 oz/acre (0.0468 lb AI/acre)
- Actara 25WG at 4.0 oz/acre (0.0625 lb AI/acre)
- Lannate 2.4LV at 24 fl oz/acre (0.45 lb AI/acre)
- Lannate 2.4LV at 48 fl oz/acre (0.9 lb AI/acre)
- Assail 30SG at 5.5 oz/acre (0.1 lb AI/acre)
- Agrimek at 10 fl oz/acre + Warrior at 3.2 fl oz/acre + Agri-oil at 0.5%
- Agrimek at 10 fl oz/ac + Actara at 3 oz/acre + Agri-oil at 0.5%
- Engeo at 2.74 fl oz/acre
- Engeo at 3.42 fl oz/acre
- Non-treated check

Thrips were sampled periodically after each treatment by searching 5 randomly selected plants in each plot and counting the number of adult and immature thrips on each plant. The individual plant counts were combined for a plot and the number of thrips per 5 plants is reported. Thrips counts were analyzed with the PROC ANOVA procedure of PC-SAS. Where significant differences were detected ($P<0.05$), means were separated with LSD ($P=0.05$).

Results and Discussion

All insecticide treatments significantly reduced adult thrips populations at one day after the first treatment (4/19) as compared with the check, with no significant differences among treatments (Table 1). At seven days after the first application (4/25), the Lannate and Actara treatments were not significantly different than the check, and all the other treatments provided control similar to one another. At three days after the second application (4/28), all treatments again showed significant reductions in adult thrips populations as compared to the check. Adult thrips densities were statistically similar across all treatments on the last two sample dates.

Immature thrips densities were very low until the final sample date (14 days after the second application)(Table 2). On the final sample date, all treatments except Warrior at the lower rate showed significant reductions in the number of immature thrips as compared to the check, with no statistical differences among these treatments. Total thrips counts showed similar trends to the adult counts on all but the last sample date, where trends were similar to the immature counts (Table 3).

Comparisons of two rates of the same products or treatment combinations showed no consistent significant differences. The high rate of Lannate generally showed a numerical, but not statistically different, reduction in thrips as compared to the low rate. Warrior and Actara did not show consistent numerical differences and no statistical differences when comparing the two rates of each product. The insecticide combinations (Agrimek+Warrior, Agrimek+Actara, Engeo) did not provided significantly different control as compared to the best individual product of each combination.

While all of the insecticide treatments evaluated showed some degree of efficacy against tobacco thrips, none of the treatments consistently performed better than the standard insecticide (Warrior).

Table 1. Adult thrips densities in insecticide efficacy trial on onions - Toombs County, Spring 2005.

Treatment	Adult thrips per 5 plants					
	4/19	4/21	4/25	4/28	5/2	5/9
Check	6.7 a	15.5 a	17.7 a	19.7 a	11.5 a	40.7 a
Lannate 0.45	2.5 b	10.2 b	17.0 a	8.0 bc	11.2 a	23.7 a
Lannate 0.9	1.5 b	6.7 bcde	12.5 ab	7.7 bc	9.2 a	24.5 a
Warrior 2.56 oz	3.7 b	4.2 de	7.0 b	5.5 c	11.7 a	32.2 a
Warrior 3.84 oz	1.5 b	6.0 bcde	8.2 b	8.2 bc	6.0 a	20.5 a
Actara 3 oz	3.5 b	8.5 bcd	12.7 ab	9.5 bc	8.7 a	32.0 a
Actara 4 oz	2.5 b	9.2 bc	10.7 ab	12.7 b	10.0 a	37.0 a
Assail	1.0 b	3.0 e	5.0 b	6.0 c	5.5 a	19.0 a
Agrimek	2.7 b	8.5 bcd	7.0 b	6.2 c	6.7 a	29.0 a
Agrimek+Warrior	2.2 b	2.5 e	7.0 b	4.2 c	6.5 a	20.2 a
Agrimek+Actara	1.2 b	4.5 cde	5.7 b	5.2 c	4.5 a	14.5 a
Engeo 2.74 oz	2.2 b	3.0 e	6.2 b	4.2 c	9.7 a	21.7 a
Engeo 3.42 oz	2.0 b	4.7 cde	6.0 b	6.5 c	8.5 a	25.0 a

Numbers within columns followed by the same letter are not significantly different (P=0.05).

Table 2. Immature thrips densities in insecticide efficacy trial on onions - Toombs County, Spring 2005.

Treatment	Immature thrips per 5 plants					
	4/19	4/21	4/25	4/28	5/2	5/9
Check	1.5 a	0.0 a	2.5 a	0.7 a	1.0 a	17.7 a
Lannate 0.45	1.0 a	2.0 a	2.0 a	0.7 a	0.7 a	9.0 bc
Lannate 0.9	0.0 a	1.2 a	1.7 a	0.5 a	0.7 a	5.0 c
Warrior 2.56 oz	0.2 a	0.0 a	0.7 a	0.5 a	0.2 a	13.7 ab
Warrior 3.84 oz	0.2 a	1.0 a	2.0 a	0.7 a	0.5 a	5.2 bc
Actara 3 oz	0.2 a	1.0 a	0.2 a	1.7 a	0.7 a	5.2 bc
Actara 4 oz	1.0 a	0.7 a	0.7 a	0.7 a	0.7 a	7.5 bc
Assail	0.0 a	0.2 a	0.5 a	0.7 a	0.5 a	3.5 c
Agrimek	0.7 a	0.7 a	1.2 a	0.7 a	1.2 a	8.5 bc
Agrimek+Warrior	0.2 a	0.2 a	0.2 a	1.5 a	1.5 a	3.2 c
Agrimek+Actara	0.2 a	1.0 a	0.5 a	0.2 a	0.5 a	1.2 c
Engeo 2.74 oz	0.0 a	0.5 a	1.5 a	0.0 a	0.0 a	9.0 bc
Engeo 3.42 oz	0.5 a	0.5 a	0.5 a	0.0 a	0.2 a	3.2 c

Numbers within columns followed by the same letter are not significantly different (P=0.05).

Table 3. Adult and immature thrips densities in insecticide efficacy trial on onions - Toombs County, Spring 2005.

Treatment	Total thrips per 5 plants					
	4/19	4/21	4/25	4/28	5/2	5/9
Check	8.2 a	15.5 a	20.2 a	20.5 a	12.5 a	58.5 a
Lannate 0.45	3.5 b	12.2 ab	19.0 ab	8.7 bcd	12.0 a	32.7 bc
Lannate 0.9	1.5 b	8.0 bcde	14.2 abc	8.2 bcd	10.0 a	29.5 bc
Warrior 2.56 oz	4.0 b	4.2 de	7.7 c	6.0 cd	12.0 a	46.0 ab
Warrior 3.84 oz	1.7 b	7.0 bcde	10.2 bc	9.0 bcd	6.5 a	25.7 bc
Actara 3 oz	3.7 b	9.5 bcd	13.0 abc	11.2 bc	9.5 a	37.2 abc
Actara 4 oz	3.5 b	10.0 bc	11.5 abc	13.5 b	10.7 a	44.5 ab
Assail	1.0 b	3.2 e	5.5 c	6.7 cd	6.0 a	22.5 bc
Agrimek	3.5 b	9.2 bcd	8.2 c	7.0 cd	8.0 a	37.5 abc
Agrimek+Warrior	2.5 b	2.7 e	7.2 c	5.7 cd	8.0 a	23.5 bc
Agrimek+Actara	1.5 b	5.5 cde	6.2 c	5.5 cd	5.0 a	15.7 c
Engeo 2.74 oz	2.2 b	3.5 e	7.7 c	4.2 d	9.7 a	30.7 bc
Engeo 3.42 oz	2.5 b	5.2 cde	6.5 c	6.5 cd	8.7 a	28.2 bc

Numbers within columns followed by the same letter are not significantly different (P=0.05).

SIMULATION MODEL FOR X-RAY INSPECTION ECONOMICS IN ONION PACKINGHOUSES

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Introduction

Inadequate segregation of diseased onions prior to controlled atmosphere (CA) storage spells huge economic losses to the Vidalia onion grower-handlers. Suppliers, for example, lost from as much as 10-20% (Purvis et al., 2002) to 50-70% of their CA-stored onions due to Botrytis neck rot (Boyhan & Torrance, 2002). There are about 125 million pounds of onions that can be put into CA storage each year (University of Georgia College of Agricultural and Environmental Sciences, 2001). While there are no economic estimates found in literature for disease-related losses at the retail level, Sumner et al. (2001) has indicated that bacterial soft rot and various mold rots, indicative of poor handling practices, could also manifest at the terminal or retail markets.

The virtually undetectable progression of these pathogenic diseases and the premium placed by customers on quality highlight the importance of adopting a more stringent inspection method in packinghouses. The use of X-ray imaging inspection technology, while well-studied in its potential to offer better product quality control, has remained nonexistent in the Vidalia onion industry.

A project, then, has been proposed to develop a model that would simulate the incidence, detection and removal of internally damaged onions as the commodity moves from the field to the packinghouse. The results of the simulation model would enable suppliers to assess the costs and benefits of this technology under varying agronomic, operational and market environment realities. While this proposed project may be limited only to assessing packinghouse level impacts, it is recognized that the adoption of the technology will have economic implications beyond the packinghouse. The development of an integrated model incorporating the distribution and sales systems would be necessary to provide a more accurate assessment of the technology's full impact on the Vidalia onion industry.

Objectives

The overall objective of this project is to assess the likely impact of adding X-ray imaging technology on the profitability of an onion packinghouse. To achieve this end, 2 submodels will be developed. The first submodel will simulate the movement of onions from the field to the packinghouse, focusing primarily on internal damage incidence, detection and removal. The second submodel will use the results of the previous one to give an economic assessment of the inspection technology.

Materials and Methods

Freshly harvested onions from 4 cultivars covering early, mid- and late season maturity categories were obtained from the Vidalia Onion and Vegetable Research Center in Lyons, Georgia. Polar and equatorial diameters and the weight of each onion were measured and resulting data were fitted to theoretical probability distributions. Statistical tests, such as the Chi-Square and Kolmogorov-Smirnov tests, were conducted to determine goodness of fit.

These onions were passed through an X-ray linescan inspection unit. All onions were placed on the belt conveyor with a consistent orientation (x-ray beam to be collinear with the root-shoot axes of the produce). Visual evaluation of X-ray images for the presence of distinct features indicative of defects, as described in the literature, will be done to assess the internal quality of the onions. Defective onions were removed from the system and were quartered to verify if a defect is indeed present. Quartering involved cutting the onion across its equatorial diameter and then halving along its neck-root axis. This method, according to Tollner (2004), provides a more stringent evaluation of disease or damage incidence. The performance of the X-ray inspection unit was measured in terms of hit, miss, false alarm and correction rejection rates.

Results and Discussion

Statistical distributions of bulb size and mass for the 4 onion cultivars (Sugar Belle, Sweet Vidalia, Savannah Sweet and Pegasus), as well as the X-ray inspection unit performance measures, are presented in Figure 1.

Future Research

Actual packinghouse studies will be conducted. Other parameters necessary in the development of the model will be measured or estimated using published or field sources. Among those that will be measured include (a) number of onions entering a packinghouse per unit time, (b) size and weight distribution of these onions, (c) probability of external damage rejection, (d) probability of internal damage incidence, and (e) false alarm and error rates of the X-ray machine. Those that will be estimated include: (a) probability of bruise damage in packinghouses, (b) field production cost, (c) packinghouse cost, and (d) market price. The results of the simulation model will be used to assess the costs and benefits of adding an X-ray machine under varying field, packinghouse and market conditions. Results will be reported for each cultivar tested.

The simulation model will be developed using the ARENA, a discrete-event simulation modeling and analysis software.

References

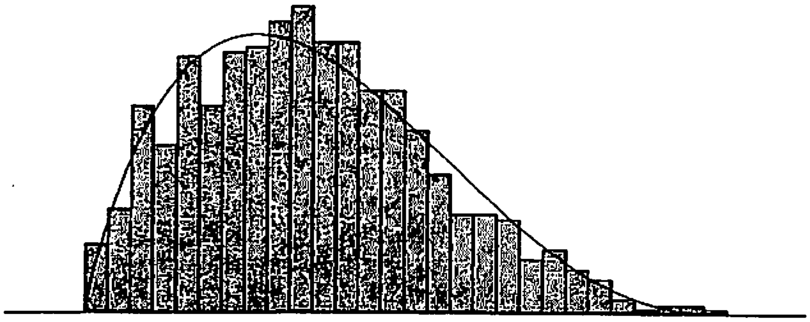
Boyhan, G.E. and R.L. Torrance. 2002. Vidalia Onions – Sweet Onion Production in Southeastern Georgia. HortTechnology 12(2), 196-202.

Purvis, A.C., J. Brock, J.T. Paulk. 2002. Does Botrytis Spread to Sound Onion in Storage? [online]. University of Georgia Vidalia Onion Research Laboratory. Available: http://www.cpes.peachnet.edu/vorl/Sotrage%20Diseases.htm.

Sumner, P.E., B. Maw, A.C. Purvis and W.C. Hurst. 2001. Harvesting, Curing and Storage [online]. In Onion Production Guide (G. Boyhan, D. Granberry and T. Kelley, eds.) pp. 29-34.

A. Statistical Distributions

a. Mass (All 4 Cultivars)



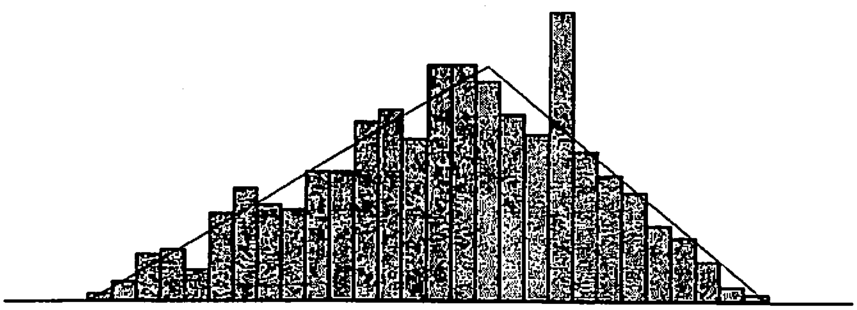
Distribution Summary

Distribution: Beta
Expression: 57 + 684 * BETA(1.89, 3.43)
Square Error: 0.000904

Chi Square Test
Number of intervals = 22
Degrees of freedom = 19
Test Statistic = 16.2
Corresponding p-value = 0.642

Kolmogorov-Smirnov Test
Test Statistic = 0.0312
Corresponding p-value > 0.15

b. Minimum (Equatorial) Diameter (All Cultivars)



Distribution Summary

Distribution: Triangular
Expression: TRIA(45, 95.6, 131)
Square Error: 0.001948

Chi Square Test
Number of intervals = 24
Degrees of freedom = 22
Test Statistic = 35.6
Corresponding p-value = 0.0352

Kolmogorov-Smirnov Test
Test Statistic = 0.022
Corresponding p-value > 0.15

B. Internal Damage Detection

Cultivar	Performance Measures			
	Hit Rate, %	False Alarm, %	Miss (Error), %	Correct Rejection,%
Sugar Belle	87.50	14.41	12.50	85.59
Savannah Sweet	100	14.96	0	85.01
Sweet Vidalia	96.43	32.03	3.57	67.97
Pegasus	97.39	10.0	2.61	90.0