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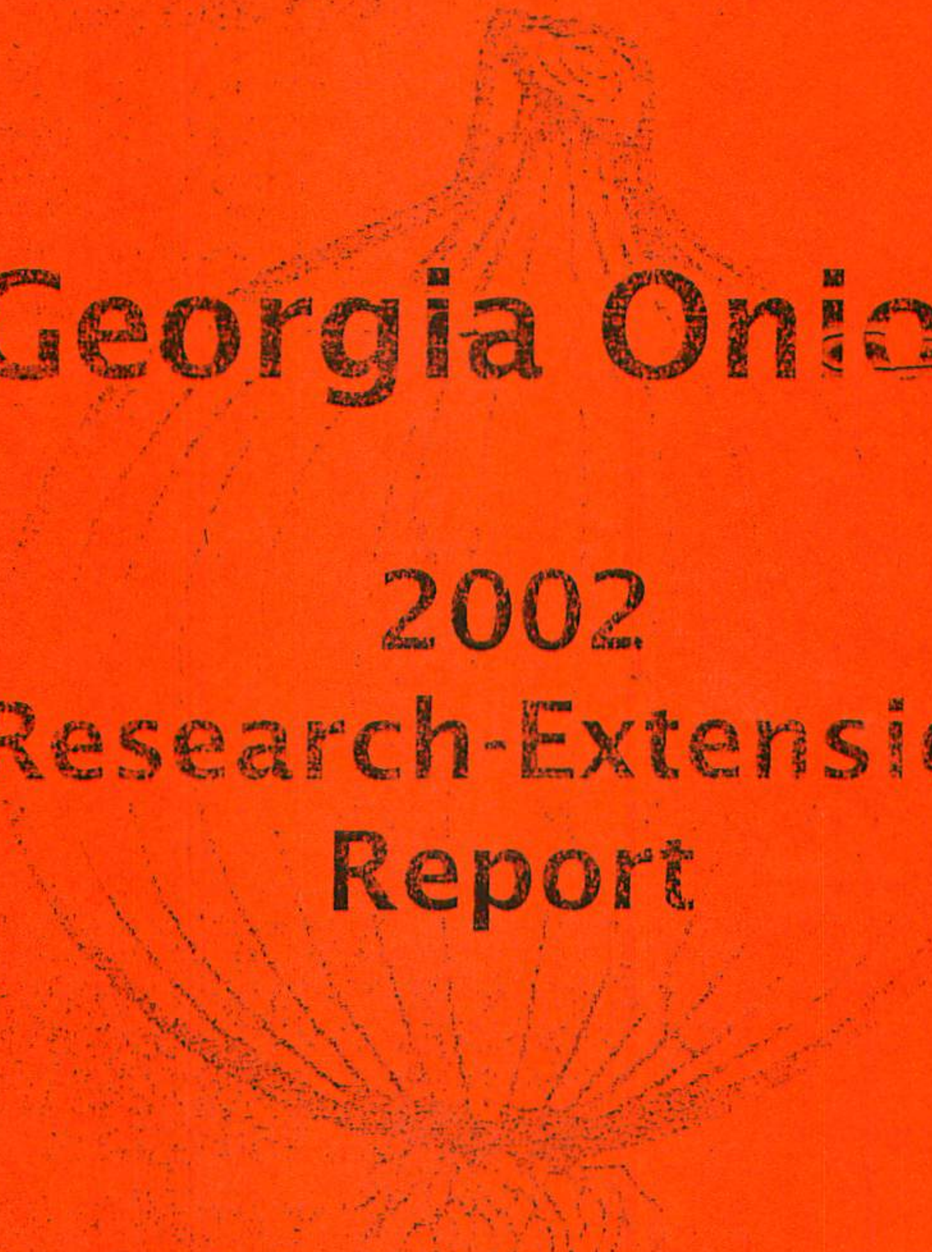
College of Agricultural & Environmental Sciences
TIFTON CAMPUS - Tifton, Georgia

Georgia Onion



2002
Research-Extension
Report

Tenth Anniversary Commemorative Edition

U.S. Department of Agriculture Cooperating
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2002 GEORGIA ONION RESEARCH - EXTENSION REPORT

(Summary Report of 2002 Data)

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THE 2002 ONION RESEARCH-EXTENSION REPORT

Georgia's onion industry is primarily based upon the production of sweet onions, so called because of a mild pungency level of the varieties grown. Georgia's sweet onion industry is said to have originated on the farm of Mose 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 2001, growers in Georgia harvested over 13,500 acres of onions with an on farm value in excess of $70 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. In commemoration of this tradition, a composite index has been included as an appendix to the 2002 edition of the Onion Research-Extension Report whereby articles may be found in any of the preceding reports according to the subject and page number within that report. Within a year the articles are arranged by author in alphabetical order.

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VIDALIA ONION VARIETY TRIALS 2001-2002

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Introduction

Conducting Vidalia onion variety trials is an ongoing endeavor to determine the suitability of onion varieties for Southeast Georgia. These trials are used by the Georgia Department of Agriculture, along with recommendations from the University of Georgia, to determine the suitability of new varieties for inclusion on the official list of varieties. Along with such parameters as yield, graded yield and disease resistance, these trials, determine quality parameters of flavor and pungency which are the primary criteria used in recommending new varieties. These trials begin in the fall with the production of transplants.

Materials and Methods

This year's trial was conducted at the Vidalia Onion and Vegetable Research Farm in Lyons, GA. Fields were prepared in August and included the application of 63 gallons of 42% metam sodium per acre. On September 12th, 2001, 800 lbs of 5-10-15 with 9% sulfur were broadcast before planting. Seed of each variety was sown on September 27th, 2001 with a Monosem planter set to deliver 50-70 seed per linear foot. On September 28th, 2001, 150 lbs of diammonium phosphate (18-46-0, DAP) was applied. This was followed by 200 lbs of $CaNO_3$ applied on October 25th and 200 lbs of $CaNO_3$ applied on November 7th, 2001.

Transplants were pulled and planted to their final spacing on November 26th, 2001. Final spacing was on beds prepared to be six ft from center to center with four rows of transplants on each bed. These rows were set 12 inches apart and plants were set 5.25 inches in the row. Each plot consisted of 50 feet of bed with 25 feet being harvested for yield data. Counts of doubles was conducted over the entire 50-ft bed. The experimental design was a randomized complete block. Beds were fertilized with 400 lbs of 5-10-15 having 9% sulfur on November 5th, 2001. Additional fertilizer applications were applied, including 150 lbs of DAP on December 6th, 2001; 200 lbs of 6-12-18 having 5% sulfur on January 9th, 2002 and January 23rd, 2002; and 200 lbs of $CaNO_3$ applied on February 5th and February 19th, 2002.

Disease control on the transplants was by applications of Dithane with copper fungicide alternating with Bravo, beginning immediately after emergence and continuing weekly until transplanting. After transplanting Dithane, Kocide, Bravo, Rovaral, Mankocide, and Quadris were applied in various combinations beginning on December 20th, 2001 and continuing weekly until April 16th, 2002.

Weed control consisted of two applications of Goal herbicide at a 3 oz per acre rate applied to the direct seeded beds on October 29th, and November 19th, 2001. After transplanting to their final spacing, a single application of Goal and Prowl was applied at the 1.5 pt per acre rate on December 19th, 2001.

Onion harvest began on April 15th, 2002, when the earliest maturing onions were pulled and allowed to dry in the field followed by clipping two days later at which time field weights were recorded. Onions were then artificially cured with forced air heated to 100 °F. Onions were removed from the dryers and graded on April 22nd, 2002. Three more harvests were conducted on April 19th, April 25th and May 2nd, 2002, as onions matured. The clipping dates were April 22nd, April 29th, and May 6th, 2002 and the grading dates were April 29th, May 6th, and May 9th, 2002, for respective harvests.

Samples consisting each of ten bulbs from each replication of each variety were tested for pungency using the pyruvate test which measures the development of pyruvate as micromoles per gram fresh weight (um/g). In addition, a ten-bulb sample of replications 1 and 2 of each variety was evaluated by a professional taste panel.

Results and Discussion

Yield data is presented in table 1, sorted in descending order based on marketable yield. The top

5 varieties for marketable yield were DPS 1039, Nirvana, DPS 1024, DPS 1032, and Sugar Belle F_1.

With the data sorted by harvest date, there was a strong correlation between this harvest date and percentage marketable yield with those varieties harvested later having a lower percentage marketable yield. There was a high incidence of late season bacterial diseases, particularly sour skin (*Burkholderia cepacia*), which lowered the marketable yield of late season varieties.

Sorting by field yield gave a good indication of the potential for a variety's yielding ability. The top 5 varieties for field yield were Savannah Sweet, DPS 1033, RCX 5195-1, DPS 1039 and DPS 1024. Variety DPS 1024 was among the top 5 performers for both field yield and marketable yield.

The top 5 varieties for jumbo yield corresponded to the top 5 varieties for marketable yield. The top 5 varieties for jumbos had more than 90% of their marketable yield as jumbos and none of the varieties had less than 80% jumbos.

Pungency, sugar content and number of doubles are listed in table 2. Seedstems were not a problem this year within the variety trial. Pungencies ranged from 1.1 to 3.5 um/g, considered to be quite good. The five mildest varieties were Sweet Melody, RCX 6043, SSC 6372 F_1, Sweet Vidalia and Savannah Sweet.

Taste panel evaluations are listed in table 3. This year, only the bitterness criteria was used to assess varieties for inclusion on the official variety list. The five varieties with the lowest bitterness were Sweet Melody, RCX 5195-1, Savannah Sweet, Liberty and Yellow Granex PRR Sunseed. Surprisingly, among all the parameters listed for taste, Granex 33 was one of the worst performers. Granex 33 is used as the standard variety for evaluating varieties for inclusion on the official list of varieties.

Summary and Conclusions

In conclusion, this was an unusual year. There was freezing weather the end of February followed by warm weather in March. The freezing weather may have damaged the onion tops, making them susceptible to severe Stemphylium leaf blight (*Stemphylium vesicarium*) infection. This was notable across most of the onion belt. Onions in the trial were not as highly infected as onions in some locations, but coupled with the warm weather in March there arose the possibility of severe bacterial disease infection. Because of this, onions were harvested earlier than usual. Even so, the later harvested varieties had a much lower percentage marketable yield. These unusual conditions may also have played a role in the taste testing where Granex 33 was low on the list. Since the weather conditions were unusual during this production year, it is difficult to assess the impact of the information from these trials. In determining the suitability of a particular variety for a particular situation it is a good idea to use several years of data.

Table 1. Vidalia Onion Variety Trial Yield Results, 2002.

Variety	Seed Company	Clipped (Date)	Field Yield (50-lb bags/Acre)	Cured Yield (50-lb bags/Acre)	Jumbos (50-lb bags/Acre)	Mediums (50-lb bags/Acre)	Marketable Yield (50-lb bags/Acre)	Percent Marketable
DPS 1039	D. Palmer Seed	4/29/02	827	804	583	47	630	78%
Nirvana (1027)	Sunseeds	4/22/02	740	706	572	39	611	86%
DPS 1024	D. Palmer Seed	4/29/02	820	789	574	29	603	76%
DPS 1032	D. Palmer Seed	4/22/02	706	669	542	57	600	90%
Sugar Belle F1 (SSC 6371)	Shamrock	4/22/02	664	638	542	42	584	92%
SSC 6372 F1	Shamrock	4/22/02	679	647	522	60	582	90%
Sweet Advantage	D. Palmer Seed	4/17/02	608	606	419	139	557	92%
Sweet Vidalia	Sunseeds	4/22/02	658	623	480	73	554	89%
WI-3115	Wannamaker	4/17/02	713	654	467	83	550	84%
99C 5092	Sakata	4/22/02	711	673	450	71	521	77%
Sweet Melissa	Sunseeds	4/29/02	750	695	450	47	497	72%
DPS 1033	D. Palmer Seed	5/6/02	853	821	475	17	492	60%
Granex 33	Seminis/Asgrow	4/29/02	660	637	457	35	492	77%
Yellow Granex PRR	Sunseeds	5/6/02	776	753	442	23	465	62%
RCX 6043	Sunseeds	4/29/02	675	650	454	11	465	72%
EX 07592001	Seminis/Asgrow	4/29/02	759	566	374	60	434	77%
WI-609	Wannamaker	4/17/02	627	475	387	47	433	91%
Cyclops (XP 6995)	Seminis/Asgrow	5/6/02	734	714	390	28	418	59%
Rio Bravo	Sunseeds	4/29/02	656	620	374	36	410	66%
RCX 5195-1	Sunseeds	5/6/02	830	813	399	7	406	50%
PS 7092	Seminis/Petoseed	4/29/02	579	551	368	32	400	73%
EX 19013	Seminis/Asgrow	5/6/02	782	765	387	8	395	52%
Southern Belle	D. Palmer Seed	4/17/02	573	455	300	94	394	87%
Numex Chaco	Lockhart	5/6/02	751	736	377	12	389	53%
EX 07592000	Seminis/Asgrow	4/29/02	714	679	363	21	384	57%
Savannah Sweet	Seminis/Petoseed	4/29/02	867	678	358	19	377	56%
Liberty	Bejo Seed Co.	5/6/02	615	576	263	29	292	51%
Sweet Melody	Sunseeds	5/6/02	502	495	269	12	281	35%
Southern Honey	D. Palmer Seed	4/29/02	558	522	212	49	261	50%
Pegasus	Seminis/Asgrow	5/6/02	633	611	237	13	250	41%
Granex Yellow, PRR	Seminis/Asgrow	5/6/02	633	599	226	6	232	39%
		R^2	0.331	0.247	0.405	0.756		
		CV	23%	29%	39%	84%		
		Adjusted LSD ($p \leq 0.05$)	262	354	263	35		

[z]Only 99C 5092 had any seedstems (2 in a single plot) as counted on 3/26/02.

Table 2. Vidalia Onion Variety Trial Quality Parameters, 2002.

Variety	Pungency (um/gfw)		Sugar (%)	Doubles (No./50-ft plot)
Southern Belle	3.5	a[z]	9.9	69
Numex Chaco	2.8	ab	7.6	6
Sweet Advantage	2.8	ab	10.0	42
Liberty	2.7	bc	7.7	2
Southern Honey	2.5	bcd	8.6	8
WI-3115	2.3	bcde	8.7	13
DPS 1039	2.3	bcdef	9.7	43
EX 07592001	2.2	bcdefg	8.1	13
Granex Yellow, PRR Asgrow	2.1	bcdefgh	8.6	6
DPS 1033	2.1	bcdefghi	8.0	8
Cyclops (XP 6995)	2.1	bcdefghij	8.3	14
PS 7092	2.0	cdefghijk	9.4	9
EX 19013	1.9	cdefghijkl	8.4	1
DPS 1032	1.9	cdefghijklm	[illegible].7	6
DPS 1024	1.9	defghijklm	[illegible].9	5
Granex 33	1.8	defghijklm	[illegible].3	7
Pegasus	1.8	defghijklm	[illegible].5	1
Rio Bravo	1.8	defghijklm	[illegible].7	8
Yellow Granex PRR Sunseed	1.8	defghijklm	[illegible].2	5
Nirvana (1027)	1.7	defghijklm	8.4	8
WI-609	1.7	defghijklm	9.0	7
Sugar Belle F1 (SSC 6371)	1.7	efghijklm	8.3	5
EX 07592000	1.7	fghijklm	8.0	3
99C 5092	1.6	ghijklm	9.0	3
RCX 5195-1	1.5	hijklm	7.7	4
Sweet Melissa	1.4	ijklm	8.3	8
Savannah Sweet	1.3	jklm	7.2	6
Sweet Vidalia	1.3	klm	8.5	7
SSC 6372 F1	1.2	lm	9.4	5
RCX 6043	1.1	m	7.6	1
Sweet Melody				6
R^2	0.613		0.745	0.657
CV	35%		9%	64%
Adjusted LSD ($p \geq 0.05$)	0.9		0.8	5

[z]Means followed by the same letter are not different by Duncan's multiple range test ($p \leq 0.05$).

Table 3. Taste Test Evaluations 2001-2002.

	Total Sulfur		Bitter		Pungency		Heat		Sweet	
Granex 33	18.3	abc	19.8	a	34.7	a	35.8	a	20.5	l
WI-3115	16.5	bcdefghijkl	19.7	ab	19.6	lm	19.9	hijklmn	21.9	jkl
DPS 1032	19.4	ab	18.7	abc	27.5	bcdef	25.5	bcdefg	26.3	efghij
DPS 1024	21.2	a	18.4	abcd	28.0	bcde	26.0	bcdef	27.9	defgh
DPS 1039	16.1	cdefghijklmno	17.7	abcde	30.0	b	27.7	bc	25.1	fghijk
Sweet Advantage	14.8	mno	17.4	abcdef	16.4	mn	21.3	fghijklm	21.7	kl
Southern Belle	16.3	bcdefghijklmno	16.9	abcdefg	21.8	ijkl	24.2	bcdefghi	23.6	ijkl
Southern Honey	17.5	bcde	16.1	bcdefgh	25.7	bcdefghijk	24.9	bcdefgh	27.7	defghi
Sweet Melissa	15.1	lmno	15.4	cdefghi	29.4	bcd	28.0	b	26.2	fghijk
Rio Bravo	14.6	no	15.3	cdefghi	29.6	bc	26.7	bcde	26.6	defghi
Numex Chaco	17.0	bcdefg	14.9	defhgij	26.0	bcdefghijk	27.3	bcd	30.2	def
SSC 6372 F1	16.5	bcdefghijk	14.7	defghijk	26.4	bcdefg	22.6	bcdefghijkl	28.9	defg
RCX 6043	17.9	bcd	14.5	efghijk	24.8	bcdefghijkl	23.3	bcdefghijkl	28.7	defgh
Sugar Belle F1 (SSC 6371)	16.6	bcdefghij	14.4	efghijk	26.0	bcdefgh	18.4	ijklmn	23.0	ijkl
Nirvana (1027)	17.5	bcdef	13.7	fghijkl	26.0	bcdefghij	21.9	cdefghijklm	28.5	defgh
Sweet Vidalia	16.1	bcdefghijklmno	13.6	fghijkl	26.0	bcdefghi	22.2	cdefghijklm	31.0	cdef
EX 19013	16.5	bcdefghijklm	13.3	ghijkl	23.8	defghijkl	24.0	bcdefghij	29.9	def
WI-609	13.3	o	12.5	hijklm	14.4	n	15.9	n	29.8	def
Granex Yellow, PRR Asgrow	16.4	bcdefghijklmn	12.3	hijklmn	23.6	efghijkl	25.2	bcdefg	31.1	cdef
99C 5092	15.2	klmno	12.1	ijklmno	24.7	bcdefghijkl	21.0	ghijklmn	30.3	def
EX 07592001	16.2	bcdefghijklmno	12.1	ijklmn	25.3	bcdefghijkl	18.2	jklmn	23.7	hijkl
EX 07592000	15.9	efghijklmno	11.8	ijklmno	25.1	bcdefghijkl	17.9	klmn	24.5	ghijkl
Pegasus	15.9	defghijklmno	11.3	jklmno	24.8	bcdefghijkl	23.3	bcdefghijk	32.1	bcd
PS 7092	16.1	bcdefghijklmno	11.0	jklmno	25.2	bcdefghijkl	18.4	ijklmn	26.2	fghijk
DPS 1033	16.9	bcdefgh	10.9	klmno	24.3	cdefghijkl	22.9	bcdefghijkl	31.5	bcde
Cyclops (XP 6995)	15.3	jklmno	10.3	lmno	21.0	jklm	21.6	defghijklm	32.4	bcd
Yellow Granex PRR Sunseed	15.9	fghijklmno	10.3	lmno	22.6	fghijkl	21.3	efghijklm	30.8	def
Liberty	15.6	hijklmno	10.0	lmno	22.5	ghijkl	22.3	bcdefghijklm	35.9	ab
Savannah Sweet	15.5	ijklmno	9.1	mno	19.6	lm	16.7	mn	35.5	abc
RCX 5195-1	15.7	ghijklmno	8.5	no	20.7	klm	17.6	lmn	39.2	a
Sweet Melody	16.7	bcdefghi	8.3	o	22.0	hijkl	21.5	defghijklm	32.0	bcd

Means followed by the same letter in a column are not significantly different by Duncan's Multiple Range Test ($p \leq 0.05$).

ONION FERTILITY EVALUATION 2002

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Introduction

Experiments have been conducted to determine the optimal fertility requirements for Vidalia Onions. The periodical reassessment of the soil test recommendations for sweet onions is one of the responsibilities of the University of Georgia in the continual reassessment of soil test recommendations for fruit and vegetables. Onions are heavy feeders and are known to require a regular supply of nutrients throughout the growing season. This experiment was designed and conducted to assess the nitrogen, phosphorus, and potassium needs of the crop along with evaluating some specific fertilizer products.

Materials and Methods

According to the soil tests at the site of the experiment the recommendation for N, P and K was 150,40 and 180 pounds respectively per acre along with 60 pounds per acre of sulfur. Treatments were designed to variy a particular element (N, P, or K) while maintaining the others at the recommended rate. Variety Sweet Melissa was transplanted on December 5th, 2001 to a final spacing of 5.25 inches in the row. Four such rows were planted 12 in. apart on beds having centers six feet apart. Each plot consisted of 20 feet of bed.

There were 24 treatments in this experiment arranged in a randomized complete block design of 4 replications (Table 1). Fertilizer applications began with all P applied with the first application unless P was the treatment under consideration in which case it was applied in 3 applications. All sulfur applications were made during the first and second fertilizer applications. The Meister fertilizer applications (Treatments 17 and 18) were applied all preplant incorporated. The Meister fertilizer application consisted of a 19-8-19 formulation applied either at 125 lbs/acre N or 150 lbs/acre N for treatments 17 and 18, respectively. The Regal Chemical treatment 1 (treatment 15) was divided into 3 equal applications while the Regal Chemical treatment 2 (treatment 16) was divided into 2 equal applications. Regal Chemical treatment 1 consisted of liquid 18-6-8 applied to supply 150 lbs/acre N. Regal Chemical treatment 2 consisted of liquid 14-0-12 with 8% sulfur applied at a rate of 211 lbs/acre N. The Regal Chemical treatments were applied over the top in 2 gallons of water using a sprinkler can. All N and K were applied in 3 applications beginning right after transplanting. Fertilizer treatments were applied on December 6th, 2001, January 29th and February 25th, 2002.

Additional fertilizer sources used diammonium phosphate (18-46-0, DAP), $CaNO_3$, and NH_4NO_3. The sulfur source was $CaSO_4$ (14% sulfur), phosphorus was from 0-20-0, and potassium was from KCl (60% K).

Leaf samples were collected on March 18th, 2002 and were analyzed for N, P, K, Ca, S, and Mg. Onions were harvested on May 8th, 2002, clipped and cured at 100 °F and then graded on May 15th, 2002.

Results and Discussion

Overall this year, there were problems with a high incidence of bacterial diseases. This was particularly evident within this experiment since onions of this experiment were the last onions harvested during the 2002 harvest season. Field weights ranged from 182 to 1038 50-lb bags per acre (table 2). At the low end was the treatment with no N and at the high end was 150 units of N applied as DAP. Treatments with relatively high rates of P in the presence of ammoniacal forms of N looked greener and grew faster throughout the growing season. This can be seen with 4 of the top 5 treatments for field yield which includes both Meister programs and 2 N rates using DAP. NH_4NO_3 as the N source also did well with a field yield of 1010 50-lb bags per acre.

Marketable yield ranged from 14.5% to 65.9% of cured yield. The highest percent marketable yield was with no N. These onions were small with very few infected with bacterial disease and yields that were unacceptable. Those treatments with less than 25% marketable onions included Regal Chemical program 2, NH_4NO_3, and DAP at both 100 and 150 lbs/acre N. It can be deduced that high growth rates and yields are associated with a high incidence of bacterial diseases in those years when such diseases are particularly troublesome.

The top 3 performers for total marketable yield (jumbos and mediums) were 150 lb/acre N with K at 100 lb/acre, 150 lb/acre N with 180 lb/acre K, and 150 lb/acre N with 0 lb/acre K. These also correspond to the treatments with the highest amount of jumbo onions.

The range of percentage foliar N for the treatments ranged from 2.0 to 4.6 (table 3). None of these values were below the adequate range of 2.0-3.0 (Maynard & Hochmuth, 1997). The top 3 treatments with the nighest foliar N values were DAP at 100 lbs/acre N, NH_4NO_3 at 150 lbs/acre N, and Regal Chemical program 1. All supply high levels of ammoniacal N.

Foliar P levels ranged from 0.37-0.68% which are within or above the adequate range of 0.30-0.50. The highest levels of P were among those treatments that had relatively high P applications and included DAP at both 100 and 150 lbs/acre N which would have resulted in 256 lbs/acre and 383 lbs/acre P, respectively. In addition, treatment 24 had a high level of foliar P with 300 lbs/acre of P applied.

Potassium levels ranged from 3.1 to 4.8%, which is considerably above the published adequacy range of 1.5-3.0. Treatments with high applications of K had, as would be expected, high levels of foliar K. Almost half the treatments had foliar K levels at or above 4.0%.

Foliar Ca levels ranged from 0.66 to 1.03%, which is within or above the adequate range of 0.6-0.8. More than half the treatments had Ca levels above 0.8%.

Sulfur levels within the foliage ranged from 0.44 to 1.15%. The adequacy range for onions is 0.2 to 0.6%. High S content has been associated with high pungency within sweet onions.

Magnesium levels ranged from 0.16 to 0.32%. Adequate levels are from 0.15-0.30%. The highest levels of Mg are among the Regal Chemical programs and Meister program 2.

Summary and Conclusions

In conclusion, there was a clear indication of suitable amounts of N and K to be used for producing an onion crop. Phosphorus appears to have a dramatic effect on growth particularly in the presence of ammoniacal forms of N even though the soil test recommends relatively little P (40 lbs/acre). This appears to translate into higher field yields but may also result in a higher incidence of diseases, particularly during those years of when bacterial diseases are common.

References

Maynard, D.N. and G.J. Hochmuth. 1997. Knott's Handbook for Vegetable Growers. 4th Edition. John Wiley & Sons, Inc. New York.

Table 1. Treatment list.

1. DAP 150 units nitrogen, 180 units potassium
2. 0 units nitrogen, 180 units potassium
3.CaNO3 75 units nitrogen, 180 units potassium
4.CaNO3 100 units nitrogen, 180 units potassium
5.CaNO3 125 units nitrogen, 180 units potassium
6.CaNO3 150 units nitrogen, 180 units potassium
7.CaNO3 175 units nitrogen, 180 units potassium
8.NH4NO3 150 units nitrogen, 180 units potassium
9.DAP 100 units nitrogen, 130 units potassium
10.0 units potassium, 150 units nitrogen
11.KCl 70 units potassium, 150 units nitrogen
12.KCl 100 units potassium, 150 units nitrogen
13.KCl 160 units potassium, 150 units nitrogen
14.KCl 190 units potassium, 150 units nitrogen
15.Regal Chemical program 1 (150 units nitrogen 18-6-8)
16.Regal Chemical program 2 (211 units nitrogen 14-0-12)
17.Meister Program 1 (125 units nitrogen 19-8-19)
18.Meister Program 2 (150 units nitrogen 19-8-19)
19.150 units nitrogen, 180 units potassium, 0 units phosphorus
20.150 units nitrogen, 180 units potassium, 40 units phosphorus
21.150 units nitrogen, 180 units potassium, 105 units phosphorus
22.150 units nitrogen, 180 units potassium, 170 units phosphorus
23.150 units nitrogen, 180 units potassium, 235 units phosphorus
24.150 units nitrogen, 180 units potassium, 300 units phosphorus

Table 2. Onion yield.				
Treatments	Field Weight 50-lb bags/Acre	Cured 50-lb bags/acre	Jumbo 50-lb bags/acre	Mediums 50-lb bags/Acre
DAP 150 units nitrogen, 180 units potassium	1038	926	173	9
Meister Program 1	1034	954	217	27
NH4NO3 150 units nitrogen, 180 units potassium	1010	924	187	7
DAP 100 units nitrogen, 130 units potassium	1004	896	122	7
Meister Program 2	962	911	231	9
KCl 160 units potassium, 150 units nitrogen	957	777	244	21
150 units nitrogen, 180 units potassium, 40 units phosphorus	937	874	317	22
0 units potassium, 150 units nitrogen	928	868	315	20
150 units nitrogen, 180 units potassium, 300 units phosphorus	911	847	304	17
150 units nitrogen, 180 units potassium, 235 units phosphorus	903	827	210	21
KCl 100 units potassium, 150 units nitrogen	897	848	338	39
CaNO3 150 units nitrogen, 180 units potassium	882	748	244	12
150 units nitrogen, 180 units potassium, 170 units phosphorus	877	811	194	33
Regal Chemical program 2 (Liquigreen)	866	801	160	13
CaNO3 175 units nitrogen, 180 units potassium	866	796	191	21
150 units nitrogen, 180 units potassium, 0 units phosphorus	844	783	287	39
Regal Chemical program 1 (Liquigreen)	838	884	258	21
KCl 70 units potassium, 150 units nitrogen	818	772	248	21
150 units nitrogen, 180 units potassium, 105 units phosphorus	800	747	241	30
KCl 190 units potassium, 150 units nitrogen	760	744	305	25
CaNO3 75 units nitrogen, 180 units potassium	692	643	244	44
CaNO3 100 units nitrogen, 180 units potassium	664	629	191	20
CaNO3 125 units nitrogen, 180 units potassium	639	593	188	23
0 units nitrogen, 180 units potassium	182	162	11	96
R2	0.619	0.611	0.481	0.760
CV	25%	38%	56%	117%
Adjusted LSD ($p \leq 0.05$)	277	249	138	22

Table 3. Foliar analyses.						
Treatments	Nitrogen (%)	Phosphorus (%)	Potassium (%)	Calcium (%)	Sulfur (%)	Magnesium (%)
DAP 100 units nitrogen, 130 units potassium	4.6	0.64	3.8	0.77	0.99	0.19
NH4NO3 150 units nitrogen, 180 units potassium	4.2	0.47	4.3	0.75	0.99	0.20
Regal Chemical program 1 (Liquigreen)	4.1	0.38	3.3	0.99	0.44	0.32
0 units potassium, 150 units nitrogen	4.0	0.52	3.1	1.03	0.83	0.22
KCl 160 units potassium, 150 units nitrogen	3.9	0.50	4.2	0.99	0.86	0.19
KCl 70 units potassium, 150 units nitrogen	3.8	0.55	4.0	0.94	0.89	0.20
150 units nitrogen, 180 units potassium, 105 units phosphorus	3.7	0.40	3.8	0.86	0.89	0.17
CaNO3 150 units nitrogen, 180 units potassium	3.7	0.47	4.1	0.84	0.97	0.18
150 units nitrogen, 180 units potassium, 235 units phosphorus	3.7	0.5[illegible]	3.5	0.95	0.92	0.17
150 units nitrogen, 180 units potassium, 300 units phosphorus	3.6	0.56	4.0	0.90	1.15	0.19
Regal Chemical program 2 (Liquigreen)	3.6	0.4[illegible]	4.2	0.68	0.92	0.24
CaNO3 175 units nitrogen, 180 units potassium	3.5	0.5[illegible]	4.7	0.97	0.84	0.18
KCl 100 units potassium, 150 units nitrogen	3.5	0.4[illegible]	3.3	0.88	0.84	0.18
150 units nitrogen, 180 units potassium, 170 units phosphorus	3.5	0.5[illegible]	3.7	0.86	0.85	0.17
150 units nitrogen, 180 units potassium, 40 units phosphorus	3.5	0.37	4.0	0.98	0.85	0.17
150 units nitrogen, 180 units potassium, 0 units phosphorus	3.4	0.33	4.1	0.90	0.79	0.17
DAP 150 units nitrogen, 180 units potassium	3.3	0.68	3.9	0.71	1.04	0.21
KCl 190 units potassium, 150 units nitrogen	3.3	0.50	4.8	0.92	0.91	0.18
CaNO3 125 units nitrogen, 180 units potassium	3.1	0.51	3.8	0.75	0.72	0.16
CaNO3 100 units nitrogen, 180 units potassium	2.9	0.51	4.2	0.85	0.80	0.18
CaNO3 75 units nitrogen, 180 units potassium	2.8	0.45	3.6	0.79	0.59	0.16
Meister Program 2	2.8	0.42	3.3	0.72	0.52	0.23
Meister Program 1	2.8	0.49	3.5	0.66	0.52	0.21
0 units nitrogen, 180 units potassium	2.0	0.50	3.6	0.95	0.50	0.20
R^2	0.347	0.298	0.288	0.507	0.733	0.585
CV	26%	28%	21%	18%	26%	22%
Adjusted LSD ($p \leq 0.05$)	1.53	NS	NS	0.23	0.21	0.06

DIRECT SEEDING VIDALIA ONIONS

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Introduction

Vidalia onion production is a labor intensive endeavor requiring large numbers of workers for hand planting and harvesting. Planting usually begins with seed being direct seeded onto beds and then grown for 8-10 weeks before, they are transplanted to their final spacing. Except for a pegger, which is used to mark the holes, the transplants are planted by hand. Even though most Vidalia onions are grown from transplants, onions from other onion producing regions of the world are grown as direct-seeded onions or as transplants using some kind of transplanting equipment.

Up to now, the Vidalia onion production region has generally had adequate sources of migrant labor to handle their planting needs. Nevertheless there have been incidents where the Federal government, through the Immigration and Naturalization Service, has disrupted the supply of labor. In addition, the H2-A program set up by the Federal government to allow guest workers has not worked very well for growers and is too expensive for small growers. Therefore alternatives are being explored and direct seeding is one of the alternatives under consideration.

Materials and Methods

An experiment was conducted to compare conventionally transplanted onions with direct seeded onions. This experiment consisted of a split-block design with the main plot effect being planting date and the split-plot effect being onion varieties with 4 replications. Onion varieties were seeded on 3 planting dates, October 5th., October 15th, and October 29th, 2001. Varieties used in this experiment were Nirvana, Pegasus, PS 7092, and Sweet Vidalia. Beds were prepared on 6-foot centers with 4 rows of onions planted on each bed. Each planting date had 4 beds (replications) of approximately 450 ft long, planted with the four varieties. Two of the beds had Sweet Vidalia and Nirvana as the outside rows with Pegasus and PS 7092 as the inside rows. This was switched with the other beds (replications). A Monosem planter with a 36-hole plate set to B2 was used to seed the varieties. This should have resulted in a seed spacing of 5.375 inches according to manufacturers directions. All the seed were coated with Filmcoat Plus from Harris Moran Seed Co. This film coating is a polymer that fills the dents in the seed to allow for better singulation in the planter.

The fertility program began with 800 lbs/acre of 5-10-15 with 9% sulfur applied as a preplant incorporated fertilizer, prior to the October 5th, 2001 planting. In addition, 150 lbs/acre of diammonium phosphate (DAP) was applied on both December 6th and December 17th, 2001. $CaNO_3$ was also applied at 200 lbs/acre on December 10th, 2001, February 5th, 2002 and February 19th, 2002. Finally, 200 lbs/acre of 6-12-18 with 5% sulfur was applied both on January 9th, and January 23rd, 2002.

Weed control consisted of a 3 oz/acre application of Goal herbicide on October 29th and November 19th, 2001. In addition, an additional 6 oz/acre of Goal was applied after the beginning of January, 2002. Finally, some hand weeding was done throughout the season as needed.

Two 3-foot sections from each variety and planting date within a replication were measured for plant stand on January 7th, 2002. The spacing between each plant was measured and the percentage of stand below 4 inches was calculated.

The first planting was harvested on April 30th, 2002, and the second planting was harvested on May 9th, 2002. The third planting was not harvested. Fifty feet of each replication for each variety and planting date were harvested. Field yields were determined immediately following harvest and the onions were placed on dryers at 100 °F until cured. Onions were re-weighed to determined cured yield and then graded and weighed to determine jumbo and medium class yields.

Seed stems were counted over a 50-foot section for each variety and planting date within a replication. The counts were made on May 14th, 2002.

Whereas growers have traditionally relied upon overhead sprinkler irrigation for producing onion transplants, irrigating direct seeded onions with overhead center-pivot irrigation systems would be difficult since insufficient water could be applied during hot dry periods in September and October when onions are seeded. As an alternative, in this study the direct seeded onions were successfully grown using drip irrigation all the way from crop emergence to harvest. The irrigation system was buried deep enough to hold it in place, but shallow enough so that it would not interfere with undercutting the onions. No overhead irrigation was used to produce these onions. Two rows of drip tape with 4-inch emitter spacing was buried 3-4 inches below the bed surface in order to insure it remained in place on the bed.

Results and Discussion

Owing to a miscommunication, the direct seeded onions received only one application of 800 lbs/acre of 5-10-15 pre-plant and no additional fertilizer was applied for the next 8 weeks. This resulted in very slow growth so that by transplanting time these onions were no larger than the transplants, which have their tops removed for transplanting. Slowing the growth of the direct seeded onions was an important factor in reducing the incidence of seed stems.

Yields overall were respectable for all the varieties and planting dates under consideration (table 1). Vidalia onions are capable of higher yields, but this was an unusual year with a high incidence of Stemphylium leaf blight (*Stemphylium vesicarium*) and late season bacterial diseases. Marketable yield (jumbos and mediums) as a percentage of cured yield ranged from 62.3 - 74.4 % across all varieties and both planting dates. This is low by most years' standards, but considering the problems during this season these numbers were acceptable. The percentage of jumbos were also low, hovering in the 50-60 % range. Typically we expect growers to see 80% of their harvest in the jumbo grade.

Seed stems can be a difficult problems to deal with in a direct seeded onion crop. These flower stalks or scapes render the onion unsalable. Table 2 lists the seed stem incidence among the varieties for the different planting dates. Later planted onions are likely to have fewer seed stems. In addition, variety plays a role in seed stem formation. Compared with other varieties, 'Sweet Vidalia' had a greater number of seed stems. Varietal differences for seed stems are apparent each year but the varieties that have the greatest numbers of seed stems change from year to year.

A lack of uniformity in plant stands is another problem encountered in direct seeded onions. Using a good quality planter is critical. Some other types of planters are not capable of properly singulating the seed. Even with the vacuum planter used in this study, seed coating is important. Without seed coating, the vacuum planter was capable of picking up more than a single seed, thus resulting in a poor stand. Table 3 lists the percentage of seedlings planted below a 4-inch spacing. The highest rate was only 10% compared with the previous year where an average of 76% of the seed were spaced below 4 inches. The seed coating used was Filmcoat Plus from Harris Moran Seed Co. This technology coats the seed with a colored polymer. Unlike a full clay pellet, this material is less bulky and resists crumbling from the seed. It is available in several bright colors, which is helpful in discerning the seed as it is planted.

Direct seeded onions grow with more of the bulb exposed than do transplanted onions. The basal plate of transplanted onions can be found at least 2 inches below the ground whereas the basal plate of direct seeded onions may be found almost at the surface of the ground. Concern has been expressed that direct seeded onions are more prone to freeze injury since more of the bulb is exposed. Over the last several years we have had freezing temperatures in the teens and have not observed any increase in injury.

There has been reported a variation in bulb shape when comparing direct seeded with transplanted onions with direct seeded onions being more cylindrical than transplanted onions. No change has been observed in bulb shape, but neither have specific measurements been taken.

Summary and Conclusions

In conclusion, direct seeding Vidalia onions may be considered a viable alternative to transplanting. We are continuing to conduct research and hope to validate some of our findings with experiment station and on-farm research in the coming years. For growers wishing to experiment with direct seeding, it is recommend that for the time being direct seeded onions be limited in quantity and with seeding being limited to mid-October. The use of coated seed, a good precision drill and limited fertilizer for the first 8-10 weeks should improve the likelihood of a reasonable stand. Irrigation is critical for the first few weeks during seed germination and establishment. Drip irrigation is a viable alternative to overhead sprinkler irrigation to insure even moisture across the bed.

Table 1. Yield parameters based on variety and planting date.

Variety	Field Yield (50-lb bags/acre)	Cured Yield (50-lb bags/acre)	Jumbos (50-lb bags/acre)	Mediums (50-lb bags/acre)
	Planted: 10/5/01	Harvested: 4/30/02		
Nirvana	381.2	366.8	209.1	39.5
Pegasus	571.2	543.0	350.8	49.9
PS7092	575.6	561.6	345.0	21.5
Sweet Vidalia	625.8	599.4	339.2	38.3
		Planted: 10/15/01	Harvested: 5/9/02	
Nirvana	428.0	418.2	223.0	45.3
Pegasus	489.0	477.7	278.2	68.5
PS7092	465.8	455.6	228.8	55.2
Sweet Vidalia	566.3	551.2	353.1	56.9

36 hole plate B2 setting
5.375" spacing

Table 2. Seedstem Formation of Direct Seeded Onions

Variety	Planting Date 10/5/01	10/15/01	10/29/01
Pegasus	9.3	0.3	0.0
Sweet Vidalia	25.0	1.3	0.4
Nirvana	7.0	0.0	0.2
PS 7092	8.8	0.3	0.0

Measured on 5/14/02

Table 3. Percent of seedlings below 4 inch in-row spacing.

Variety	Planting Date 10/5/01	10/15/01	10/29/01
Nirvana	7%	6%	9%
Pegasus	6%	8%	4%
PS 7092	10%	8%	6%
Sweet Vidalia	8%	9%	10%

Previous year with raw seed average below 4"-76%.

EFFECT OF A STRAWBERRY MULCHER ON VIDALIA ONION PRODUCTION

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Introduction

Vidalia onions are generally produced on bare-ground, however there has been work over the years looking at both plastic and natural mulches. Plastic mulch has not proven suitable for onion production because, although it does accelerate growth and development of the onions, it also increases the likelihood of thermophilic bacterial infection. Yields have even been shown to be lower with black plastic mulch compared with bare-ground (Díaz-Pérez et al., 2001). The use of natural mulch such as wheat straw has been shown to also reduced yield compared with plastic mulch or even bare-ground, but has also been shown to reduced the incidence of bacterial diseases (Díaz-Pérez et al., 2001, Juan Carlos Díaz-Pérez, personal communication). A study was undertaken to examine both wheat and pine straw mulches and compared them with the bare-ground production of onions.

Materials and Methods

The experiment had a split-block design with 4 replications. The main plot effects are the bareground, wheat, or pine straw. The split-block effects were the varieties; Pegasus, PS 7092, Sweet Vidalia, and Nirvana. Onions were direct seeded on October 5th, 2001 on beds with a 6-foot center-to-center spacing. There were 4 rows per bed with a between-row spacing of 12 inches and an in row spacing of 5.25 inches.

The fertility program began with 800 lbs/acre of 5-10-15, with 9% sulfur, applied and incorporated before planting, prior to the October 5th, 2001 planting. In addition, 150 lbs/acre of diammonium phosphate (DAP) was applied December 6th. and December 17th, 2001. $CaNO_3$ was also applied at 200 lb/acre on December 10th, 2001, February 5th, 2002, and February 19th, 2002. Finally, 200 lbs/acre of 6-12-18, with 5% sulfur, was applied on January 9th,and January 23rd, 2002.

Weed control consisted of two 3 oz/acre applications of Goal herbicide on October 29th, and November 19th, 2001. In addition, an additional 6 oz/acre of Goal was applied after January 1st, 2002. Finally, some hand weeding was done throughout the season as.

Mulch either wheat or pine straw was applied on February 14th, 2002, with a strawberry mulcher. Onions were harvested on April 30th, 2002. Varieties on bare-ground had 50 feet of row harvested for each variety within each replication. Varieties with either wheat or pine straw had 25 feet of row harvested within replication. Field, cured, and graded yields were recorded for each treatment.

Results and Discussion

Results of this experiment are listed in table 1. Overall yields were comparable between onions grown under both natural mulches or on bareground. This study also proved to be a demonstration of using mechanization in applying wheat or pine straw mulches. Figures 1 and 2 show the equipment used to apply the mulch. The equipment is attached to the tractor via the 3-point hitch and operates from the power takeoff. It is capable of chopping a single square bale without untying the bale, as long as balertwine is used around the bale rather than wire. The chopped straw is fed through an application hose (Figure 2) that the operator directs to where straw is needed. Pine straw, with its high resin content, was observed to have a risk of fire during application when towards the end of application smoke was observed to be coming from the hopper.

Summary and Conclusions

More work needs to be conducted to determine if straw mulches have a place in onion production.

References

Díaz-Pérez, J.C., R. Gitaitis, D. Bertrand, D. Giddings, W. Randle, K Harrison and R. Torrance. 2002. Influence of mulches and drip irrigation on the growth, yield and quality of Vidalia onions. HortSci. 37:748.

Table 1. Ground cover effect on yield.

Variety	Field Yields	Cured Yield	Jumbos	Mediums
	Bareground 50-lb bags/acre			
Nirvana	381	367	209	39
Pegasus	571	543	351	50
PS7092	576	562	345	21
Sweet Vidalia	626	599	339	38

Variety	Field Yields	Cured Yield	Jumbos	Mediums
	Wheat Straw 50-lb bags/acre			
Nirvana	424	407	217	52
Pegasus	458	425	286	55
PS7092	544	527	335	26
Sweet Vidalia	631	603	311	58

Variety	Field Yields	Cured Yield	Jumbos	Mediums
	Pine Straw 50-lb bags/acre			
Nirvana	447	427	218	33
Pegasus	498	479	308	85
PS7092	634	712	465	31
Sweet Vidalia	618	566	348	39

Figure 1. Strawberry mulcher operates from the 3-point hitch and is capable of handling one square bale.

Figure 2. Application of straw mulch.

EFFECT OF NITROGEN FERTILIZER ON YIELD AND BACTERIAL DISEASE INCIDENCE IN VIDALIA ONIONS

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Introduction

Vidalia onions, particularly late season varieties, are susceptible to several bacterial diseases that may dramatically reduce graded yield. The available arsenal of chemicals available to growers is limited to copper fungicides and EBDC compounds. Because of the increased vigor or growth, high N fertilization has the tendency to increase the incidence of bacterial diseases. A study was undertaken to determine if the opposite was also true, that is examining whether N fertilizer could reduce the incidence of bacterial diseases.

Materials and Methods

It was recommended from soil test results that 150-40-180 pounds per acre of N, P, and K would be needed with 60 lbs/acre of sulfur for the growth of a crop of onions. Treatments consisted of 4 levels of N fertility. These included 50, 75, 100, and 125 lbs/acre of N. The variety Cyclops was transplanted on December 5th, 2001 to a final spacing of 5.25 inches in-the-row and 12 inches between-the-row. Four such rows were planted on a bed with beds having a 6-foot center-to-center spacing. Each plot consisted of 20 feet of bed and the experiment was arranged in a randomized complete block design with 4 replications.

Fertilizer applications began by all the P being applied as part of the first fertilizer application, directly after transplanting. All sulfur applications were made during the first and second fertilizer applications. N and K were applied in 3 applications. Fertilizer treatments were applied on December 6th, 2001, January 29th, and February 25th, 2002. Fertilizer sources included $CaNO_3$ for N; superphosphate for P; KCl for K; and the sulfur source was $CaSO_4$.

Onions were evaluated for bacterial disease on May 14th, 2002, by counting the incidence of bacterial damage in each plot. Onions were harvested on May 21st, 2002, at which time the field weights and weights graded into either jumbo or medium classes were recorded.

Results and Discussion

There were no significant differences between disease incidence from either field yield or jumbos; however, there were significant differences for mediums. The lower the N rate the greater the number of mediums harvested. There were no differences for bacterial disease incidence, N, or Ca. The bacterial disease counts did increase with increasing N application, but the differences were not significant. Other fertility experiments conducted show that without N there is no bacterial disease incidence, but this, of course, is impractical since such treatments have unacceptably low yields. In conclusion, N fertilizer management does not appear to offer any practical alternative to current practices for the control of bacterial diseases.

Table 1. Yield, Bacterial Disease Incidence, and Foliar Nutrient Levels

Nitrogen lbs/acre	Field Yield	Jumbos	Mediums	Bacterial Disease (Counts/plot)	Nitrogen (%)	Calcium (%)
50	401	110	20	27	3.1	0.73
75	469	139	13	42	3.3	0.72
100	354	105	6	46	3.1	0.69
125	518	127	1	59	3.7	0.77

EVALUATION OF SULFUR FERTILITY ON EARLY MATURING JAPANESE OVERWINTERING ONIONS

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Introduction

Japanese overwintering onions were introduced to the Vidalia region several years ago. These varieties are considered controversial because many believe they are more pungent than the typical Vidalia onion. They do, however, have some attributes in which many growers have been interested. Interests include earliness, and disease resistance to some foliar diseases. This study was undertaken to evaluate sulfur fertility on these early varieties.

Materials and Methods

Recommendations from soil test results for the proposed site indicated the application of 150-40-180 pounds per acre of N, P, and K with the addition of 60 pounds per acre of sulfur. Treatments consisted of 4 levels of sulfur fertility. These included 0, 20, 40, and 60 lb/acre of sulfur. Variety Georgia Pride was transplanted on December 5th, 2001, to a final spacing of 5.25 inches in the row and 12 inches between rows. Four such rows were planted on a bed with beds having a 6-foot center-to-center spacing. Each plot consisted of 20 feet of bed and the experiment was arranged in a randomized complete block design with 4 replications.

Fertilizer applications began with an all P application directly after transplanting. All sulfur applications were made during the first and second fertilizer applications. N and K were applied in 3 applications. Fertilizer treatments were applied on December 6th, 2001, January 29th, 2002 and February 25th, 2002. Fertilizer sources included $CaNO_3$ for N, superphosphate for P and KCl for K. The sulfur source was $CaSO_4$.

Onions were harvested on April 17th, 2002, cured, and graded on April 22nd, 2002. Yield data collected included field yield, cured yield and yield of jumbos and mediums. The first and second replications were also subjected to a professional taste panel. Attributes tested by the taste panel included those of total sulfur, pungency, heat, sweetness or bitterness. Total sulphur is exemplified by the flavor found in rotten eggs, cabbage, a struck match and garlic. Pungency is associated with an irritating sharp sensation as exemplified by horseradish, mustard oil, and vinegar. Heat is associated with a chemical burning sensation as experienced in the mouth and throat. Sweetness is associated with the taste sensation of sugar. Bitterness is associated with bitter agents with a reference of caffeine.

Results and Discussion

Table 1 lists the yield results for this experiment. There were no differences between the treatments for any of the yield parameters tested. There were however significant differences for foliar sulfur levels as well as pyruvate (Table 2). The greater the amount of sulfur fertilizer the greater these values. Finally, and most surprisingly, there were no differences in taste test results for any of the parameters tested. Although high levels of sulfur are detectable in the plant tissue by foliar and pyruvate analyses, this did not translate into a detectable difference in taste. High sulfur content has always been associated with high onion pungency. These results confirm work by others that indicate that increased pungency is not perceived with increased sulfur fertilizer (Granberry et al., 1987).

Summary and Conclusions

In conclusion, reducing sulfur fertilizer cannot control the perceived increased pungency of Japanese overwintering onions.

References

Granberry, D.M., Smittle, D., Mclaurin, W. and Shewfelt, R.L. 1987. The effects of calcium sulfate on leaf and bulb tissue, sulfur content and on pungency of the "Vidalia" onion. Proc. Nat. Onion Res. Conf. December 10-11, 1987. pp 27-32.

Table 1. Yield Results

Sulfur (lbs/acre)	50-lb bags/acre			
	Field Yield	Cured Yield	Jumbos	Mediums
0	508	473	340	72
20	510	484	320	99
40	519	512	336	95
60	480	436	316	84

Table 2. Treatment effect on foliar sulfur, pyruvate, and sugar content.

Sulfur (lbs/acre)	Foliar Sulfur (%)	Pyruvate (um/gfw)	Sugar (%)
0	0.53	3.0	9.2
20	0.76	3.5	9.0
40	0.91	3.7	9.0
60	0.84	4.2	9.2

Table 3. Taste panel summary

Sulfur lbs/acre	Taste Testing Results				
	Total Sulfur	Pungency	Heat	Sweetness	Bitterness
0	14.3	23.0	18.6	27.4	10.4
20	14.5	20.2	18.3	26.5	11.2
40	16.0	23.9	21.9	24.7	11.9
60	14.3	21.2	18.6	27.4	11.3

PRODUCTION FEASIBILITY OF ORGANIC VIDALIA ONIONS

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Introduction

Vidalia onions are a high value crop that has consistently been a good source of income for the growers. Even with this profitable enterprise, growers should continue to increase profitability and diversity. As a means of diversifying and increasing profitability the organic production of vegetables is worthy of consideration. Although it still represents less than 2% of agricultural production in this country and even less than 1% in Georgia, it has the potential of being a source of high income for growers especially as there is a growing demand for organically grown produce in the large urban areas. In view of this growing demand, an experiment was designed to evaluate the feasibility of producing organic sweet onions in the Vidalia region.

Materials and Methods

Land was prepared by applying 4-6 inches of compost with the addition of fresh poultry litter, which had 60 lb/tonne of N and was applied to supply 75 lb/acre N. This was rototilled into the soil prior to transplanting. Beds were formed with a 6-foot center-to-center spacing. Four rows of onions, 12 in. apart, were planted on each bed and onion transplants were placed 5.25 in. apart in the row.

Conventionally produced transplants of variety PS 7292 were transplanted onto these beds on December 6th, 2000. No insecticides or fungicides were used to produce these onions. Weeds were removed by hand. An additional application of poultry manure was made in April, 2001 supplying an additional 75 lbs./acre N. Onions were harvested on May 10th, 2001 and cured. Graded weights were determined on May 15th, 2001.

Results and Discussion

The conventionally produced onions had higher overall yields as well as higher yields of jumbos (table 1) than the organically grown onions. However, organic grown produce generally commands a premium in the marketplace and should offset the lower yields. Cost assessment should include those higher costs for weed control and crop rotations yet pesticide costs are non-existent.

Summary and Conclusions

In this study, the onions were organically grown after transplanting. Research is needed to determine if onion transplants can be organically grown. A detailed cost analysis of market demand and prices needs to be done.

Table 1. Comparison of conventional to organic Vidalia onion production.

Variety	Field Yield (50 lb bags/acre)	Cured Yield (50 lb bags/acre)	Jumbo (50 lb bags/acre)	Medium (50 lb bags/acre)
Conventional	811	749	630	45
Organic	367	343	204	82

PRE AND POST WEED CONTROL IN ONION SEEDBEDS

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Introduction

Onion (*Allium cepa*) grows slowly and is not competitive with weeds for light, space, or nutrients, especially in seedbed production. Slow onion seed germination coupled with upright leaves provides little competition with weeds, thus growers rely on fumigant and herbicide options for weed management. Tillage is an effective weed control tool in most vegetable crops but is of little value in onions because they are traditionally planted in narrow row patterns, often with four onion rows on beds six ft from center to center.

Herbicide options in onion are primarily limited to Dacthal, applied preemergence (PRE), Goal, applied postemergence (POST), and Prowl, applied POST. In the 1990's, Dacthal was applied to most onion seedbeds for weed control. However, Dacthal rates of use often exceeded 7 lb/acre, resulting in plant stunting. Thus, Dacthal use diminished and grower dependence on metam sodium increased. Although metam sodium effectively controls many weed species, escapes commonly occur because of inadequate application methods. Therefore, two studies were conducted to determine the most effective herbicide system following metam sodium in onion seedbeds.

Materials and Methods

Two studies were conducted on farms in Tattnall County, Georgia. The experimental designs were, for each, a randomized complete block with four replications. In the first experiment, PRE herbicide options included Dacthal (4 or 8 lb/acre) and Outlook (8 oz/acre). Outlook is a potentially new onion herbicide and needs evaluation in Georgia onion seedbed production. The second experiment focused on POST herbicide applications including Goal at 3 oz/acre alone or mixed with Outlook (16 oz/acre) or Outlook (12 oz/acre) plus Prowl (24 oz/acre). POST treatments were applied when onions were in the 2-leaf stage of growth. No adjuvant was included with any herbicide application.

Weed control and onion injury were visually estimated, periodically throughout the season. Visual estimates were based on 0 = no weed control or onion injury and 100 = complete weed control or onion death. Additionally, plant stand and onion fresh weights were measured just prior to the transplant stage of growth. The data was subjected to an analysis of variance. Treatment means were separated using Fisher's Protected LSD at P = 0.05.

Results and Discussion

PRE Experiment: Dacthal applied PRE at 4 lb/acre did not visually injure onions compared to the non-treated areas adjacent to the trial. Increasing the rate of Dacthal to 8 lb/acre or applying Outlook stunted onion growth 10 to 17% compared with 4 lb/acre of Dacthal at 6 weeks after treatment (table 1). Dacthal (8 lb/acre) and Outlook did not impact the number of onion plants per row but did reduce onion transplant fresh weights by 13 to 23%.

Palmer amaranth, carpetweed and Texas panicum emerged in the non-treated areas shortly after making herbicide applications. All three herbicide treatments provided excellent control of the aforementioned weeds throughout the trial (table 2).

POST Experiment: At 5 days after treatment, Goal alone stunted onions 15% compared with the non-treated control (table 3). The addition of Outlook increased injury by an additional 6%. By 5 weeks after treatment, onions were still stunted 9% by Goal alone but injury when mixed with Outlook (16 oz/acre) or Outlook (12 oz/acre) plus Prowl ranged from 16 to 26%. Greater initial injury with the tank mixtures was likely due to pre-formulated adjuvants in the residual herbicides enhancing the onion injury by Goal. Onions did not recover at all throughout the trial when treated with Goal plus Outlook (16 oz) suggesting that soil uptake of Outlook may also be playing a role in onion stunting. Outlook at 16 oz/acre mixed with Goal reduced the number of onion plants per row foot. Additionally, mixing Outlook or Outlook plus Prowl with Goal reduced onion fresh weights by 21 to 35%.

Goal controlled Palmer amaranth only 81% at harvest of the onion transplants (table 4). Goal controlled the 1 in. Palmer amaranth that was emerged at time of application but continual emergence reduced the control by harvest. The addition of Outlook or Outlook plus Prowl improved control by at least 15% as both of these herbicides provided excellent residual pigweed control. Similar results were noted with yellow nutsedge as the addition of Outlook to Goal improved nutsedge control by 60%. Outlook often suppresses yellow nutsedge but control in this trial was greater than expected and was likely due to low nutsedge populations and the intensely irrigated environment in which onion transplants were grown. Complete carpetweed control was noted with all herbicide treatments.

Table 1. Onion visual injury, plant stand, and fresh weight response to Dacthal and Outlook PRE.

PRE treatment	Percent onion injury 1 WAT*	Percent onion injury 5 WAT*	Plants per 3 row feet	Fresh Weights**
Dacthal 4 lb	0	0	255	1290
Dacthal 8 lb	5	10	225	1120
Outlook 8 oz	12	17	220	1005
LSD (0.05)	1	3	NS*	70

*WAT = week after treatment; NS = non-significant.
**Fresh weights measured in grams at time of transplant harvest.

Table 2. Weed response to Dacthal and Outlook PRE in seeded onion.

PRE treatment	Percent weed control (5 WAT*)		
	Palmer amaranth	Carpetweed	Texas panicum
Dacthal 4 lb/A	99	99	92
Dacthal 8 lb/A	99	99	90
Outlook 8 oz/A	99	99	94
LSD (0.05)	NS*	NS	NS

*NS = non-significant, WAT = week after treatment.

Table 3. Onion visual injury, plant stand, and fresh weight response to topical applications of Goal applied alone and mixed with Outlook and Prowl when onion was in the 2-leaf stage.

POST treatment	Percent onion injury 2 WAT*	Percent onion injury 6 WAT*	Plants per 3 row feet	Fresh Weights**
Goal 3 oz/A	15	9	272	770
+ Outlook 16 oz/A	21	26	235	500
+ Outlook 12 oz/A + Prowl 24 oz/A	21	16	263	606
LSD (0.05)	4	5	27	97

*WAT = week after treatment.
**Fresh weights measured in grams at time of transplant harvest.

Table 4. Weed response to topical applications of Goal applied alone and mixed with Outlook and Prowl when onion was in the 2-leaf stage.

PRE treatment	Percent weed control (WAT*)		
	Palmer amaranth	Carpetweed	Yellow nutsedge
Goal 3 oz/A	81	100	20
+ Outlook 16 oz/A	97	100	80
+ Outlook 12 oz/A + Prowl 24 oz/A	96	100	80
LSD (0.05)	9	NS*	14

*NS = non-significant; WAT = weeks after treatment.

CAN WEEDS BE MANAGED IN DIRECT-SEEDED ONIONS?

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Introduction

The adoption by Georgia growers of direct-seeding onions (*Allium cepa*) has been limited by concerns for adequate season-long weed control. Controlling weeds in direct-seeded onions is more difficult than in transplanted onions because the patterns and rate of herbicide use for direct-seeded onions are limiting than for transplanted onions. Direct-seeded onions are more susceptible to herbicide injury than transplanted onion. For example, Goal at 1 qt/acre may be applied to transplanted onions immediately after transplanting with no concerns for crop injury. However, Goal can not be applied to seeded onions until the two-leaf stage of growth and, even then, the rates of Goal are limited to one tenth the rate applied in transplanted onions. Nevertheless, if weeds could be managed in direct-seeded onions, the absence of a need for transplanting would result in benefits of reduced labor costs, especially as an acceptable labor force becomes more difficult to find.

As with transplanted onion production, Goal and Prowl will likely be the backbone for weed control in direct-seeded onion. However, these products may not be applied on direct-seeded onions until at least two true leaves are present. Unfortunately, weeds emerging at or near the time of planting would be too large to be effectively controlled by post-emergence (POST) Goal applications, beginning at the two-leaf stage of onion growth. Even in the late 1990's, no valid pre-emergence herbicide was available for use on direct-seeded onions. However, in 2001, Dacthal was reintroduced for onions. Dacthal applied pre-emergence may provide the necessary weed control needed from seeding until onions are in the 2-leaf stage of growth when Goal and Prowl applications may begin. Therefore, a study was conducted to evaluate the potential for managing weeds in direct-seeded onions using Dacthal and Goal herbicide systems.

Materials and Methods

A study was conducted at the Vidalia Onion and Vegetable Research Farm in Toombs County, Georgia. The experimental design was a randomized complete block with four replications. Pre-emergence (PRE) herbicide options included Dacthal (8 lb/acre) or no PRE. POST options included Goal applied to 2-leaf onions followed by Goal as needed throughout the season or no POST application.

Visual weed control and onion injury estimate were periodically made throughout the season. Visual estimates were based on 0 = no weed control or onion injury, and 100 = complete weed control or onion death. Additionally, plant stand measurements were taken just prior to harvest. The data was subjected to an analysis of variance. Treatment means were separated using Fisher's Protected LSD at P = 0.05.

Results and Discussion

Dacthal (8 lb/acre) PRE stunted onion growth 21, 13, and 0 percent at 5, 12, and 24 weeks after planting (figure 1). Onion injury from POST applications of Goal was typical and ranged from 6 to 25% leaf chlorosis and plant stunting (data not shown).

Four POST applications of Goal were needed to obtain 100% henbit control, 94% Carolina geranium control, and 79% horseweed control at late-season (figure 2). Application rates were varied according to the stage of growth when the onions were at the different leaf stages. The rates were 3 oz/acre for the 2 leaf stage of growth, 4 oz/acre for the 3 leaf stage of growth, 8 oz/acre for the 6 leaf stage of growth and 8 oz/acre for the 8 leaf stage of growth. Dacthal PRE provided complete henbit and geranium control but controlled horseweed only 40%. Dacthal PRE followed by the sequential Goal applications provided excellent (>93%) control of all three weed species.

Dacthal applied PRE or Goal applied sequentially did not affect plant stands compared with the non-treated control (range 116162-130682 plants/acre). However, Dacthal followed by sequential Goal applications reduced plant stands by 26% (data not shown). Since neither Dacthal alone nor sequential Goal applications alone reduced plant stands, it is likely that the early stunting by Dacthal followed by the typical POST Goal injury from each application may have killed some of the weaker plants with repetitive herbicide injury.

Summary and Conclusions

Weed control from all herbicide systems was at a high enough level that weed competition would not impact onion yield. Onion yields followed closely with trends noted with plant stands. Yields were similar when Dacthal was applied PRE or when Goal was applied sequentially, although there was a trend for greater yields in the Dacthal system (figure 3). This trend was likely due to removal of early season weed competition by the PRE application of Dacthal. These systems provided a 514 to 605% increase in yield compared with the non-treated control. Similar to plant stands, applying Dacthal PRE and following with sequential Goal applications reduced yield at least 34% compared with either Dacthal alone or sequential Goal applications.

Unfortunately, the most troublesome weed in onions, cutleaf evening primrose, was not present in the trial. Further studies will be conducted in 2002/2003 focusing on this weed, as the presence of this weed will determine the ease with which weeds can be managed in direct-seeded onions.

NITROGEN FERTILIZATION AFFECTS BOLTING AND DECAY OF SWEET ONIONS

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Introduction

Seed-stem formation ("bolting") in onion produces poor quality bulbs with a hard center making them unmarketable. The production of 'Vidalia' type sweet onions may be severely limited by bolting, depending on the cultivar and the environmental conditions during the growing season. Although temperature and photoperiod are considered to be the main factors that initiate bolting in onions, preliminary results suggested that low rates of nitrogen fertilization increased bolting. The objective of our study was to determine the relationships of bolting, yield and bulb decay with N fertilization rate.

Materials and Methods

The study was conducted at the Horticulture Farm, University of Georgia, Coastal Plain Experiment Station, Tifton, Ga. Rye cover crop was used to minimize fertility differences among the plots prior to onion sowing. Onions were direct-seeded on 10 Oct. 1997 and 9 Oct. 1998 on 17-m long, 0.9-m wide beds formed on 1.8-m centers. Plants were spaced 0.15 m apart within rows on beds having four rows, with a 0.23 m separation between rows, and a final plant density of 58,000 plants/acre. Irrigation was applied as a complement to rainfall. The design was a split plot, with N fertility rate as the main plot and cultivar as the sub-plot. Nitrogen fertilization rates were 130, 200 and 270 lb/acre (1997-1998 season) and 91, 130, 169 and 209 lb/acre (1998-1999 season). The cultivars used were 'Granex-33', 'Pegasus' and 'Cyclops' (all from Seminis Vegetable Seeds, Staticoy, Calif.). Except for N applications, the fertilization protocols were similar to those used by commercial growers in Georgia. Bolting incidence was determined on 4 May 1998 and 12 May 1999 as the percent of plants with seed-stems. Plants were harvested when 20% of the necks of each cultivar had collapsed (tops down).

Results and Discussion

Bolting incidence declined steadily with increasing N fertilization rates up to 176 lb/acre (Fig. 1), while the percent of decayed bulbs increased at a steady rate with the rate of N applied from about 10% decay at 91 lb/acre N to about 90% decay at 209 lb/acre N. The N contents of the leaves and bulbs at harvest were directly proportional to the applied N to the soil. Total (6.6 ton/acre) and marketable (0.4 ton/acre) yields were the lowest ($P \leq 0.01$) at the lowest N rate (91 lb/acre). Rates of nitrogen higher than 129 lb/acre had no significant effect on either total (mean = 15.0 ton/acre) or marketable (mean = 9.6 ton/acre) yields. Losses in marketable yield were primarily a combination of bolting and bulb decay and were minimized at 145 lb/acre N. Yield losses at low N rates were mostly due to bolting while yield losses at high N rates were mostly due to decay. Bolting incidence varied among cultivars, with bolting being among the highest in the cultivar Pegasus (Fig. 2).

It is tempting to speculate that the excessive bolting observed by many growers in the 1997-1998 season was due to low soil N caused by the excessive rainfall during the late winter and early spring. Excessive rain could have leached applied N from the soils or in some cases prevented the application of N. Results of this study conducted over two onion growing seasons clearly demonstrate the need to manage N fertilization carefully. Insufficient N (less than 145 lb/acre) increases bolting of onions and reduces yield whereas excessive N (more than 176 lb/acre) increases bulb decay with no increase in marketable yield.

Acknowledgements

Thanks to Ben G. Mullinix for statistical support.

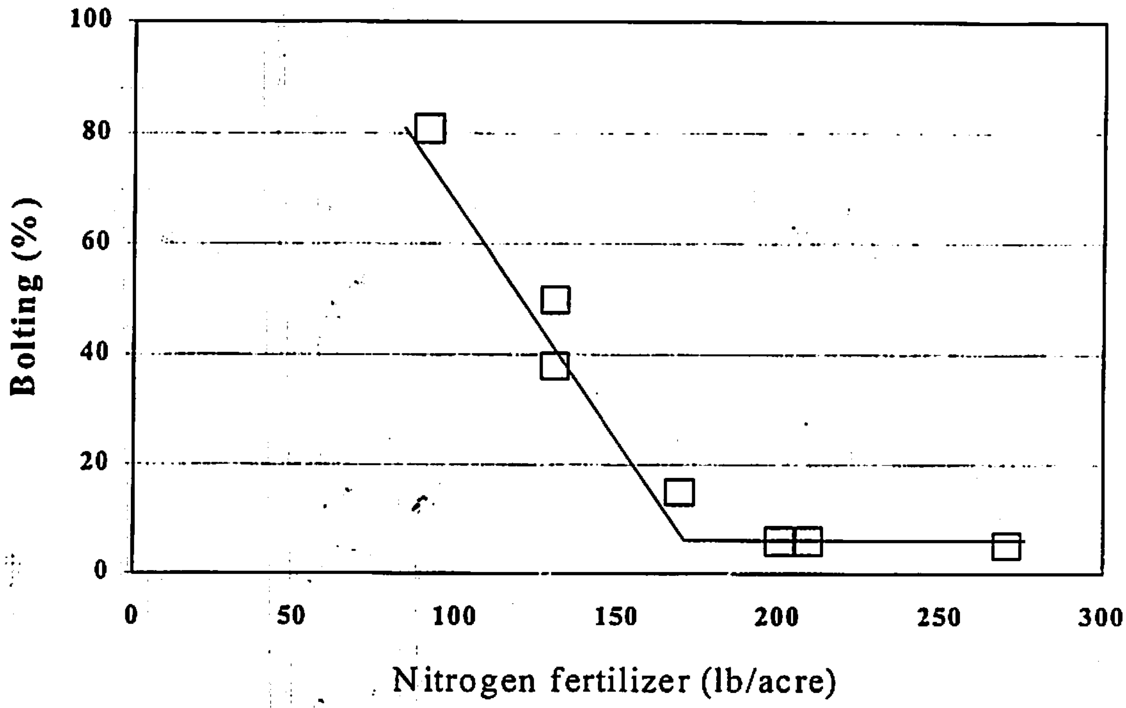

Figure 1. Effect of nitrogen fertilization on bolting (seed-stem formation) in onion

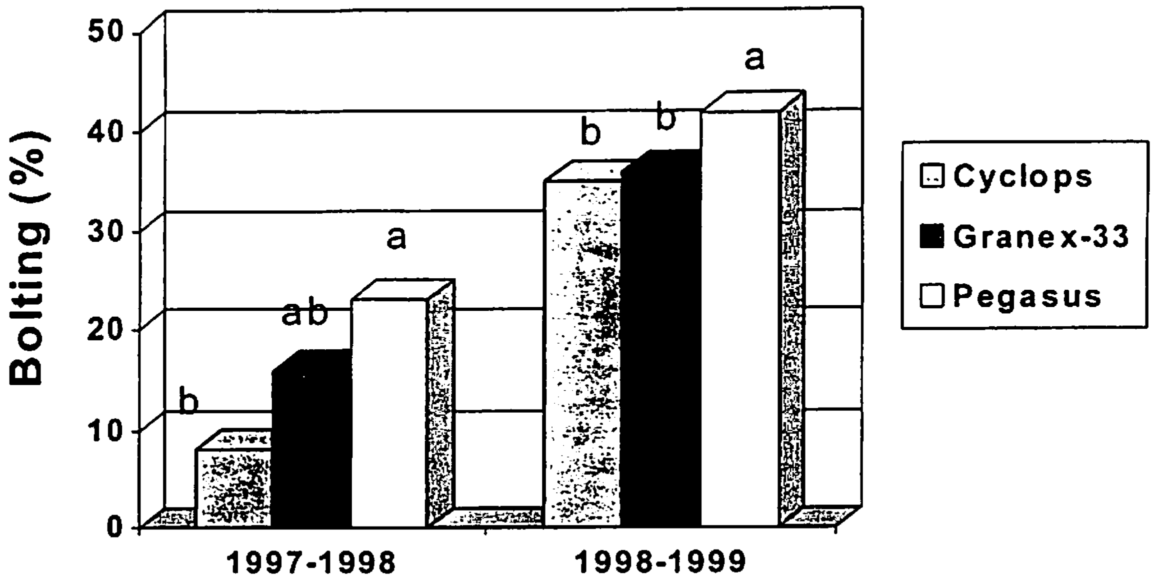

Figure 2. Effect of cultivar on onion bolting during two growing seasons. For each season, cultivars with the same letter are not significantly different (Duncan, P = 0.05).

MULCHES AFFECT BOLTING AND YIELD IN SWEET ONIONS

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Introduction

Sweet onions (*Allium cepa* 'Vidalia') are typically grown on bare soil (unmulched) and are irrigated with high-pressure systems such as sprinklers or center-pivots. Drip irrigation alone or in combination with plastic mulches is widely used for vegetable production, particularly for tomatoes and peppers. Vegetable production with drip irrigation often results in reduced water costs and reduced leaching of nutrients and other chemicals. The benefits associated with use of plastic mulches include higher yields, earlier harvests, improved weed control, and increased efficiency in the use of water and fertilizers (Lamont, 1993). Plastic mulches affect plant microclimate by modifying the soil energy balance and by restricting soil water evaporation (Liakatas et al., 1986). Modification of these microclimate factors influence soil temperature, which affects plant growth and yield (Díaz-Pérez and K.D. Batal, 2002Voorhees et al., 1981). Increased root-zone temperature is one of the main benefits associated with use of plastic mulches (Wien and Minotti, 1987). To our knowledge, there is no information on sweet onion production in Georgia under plastic film mulches or organic mulch production. The objective of this study was to determine the effects of irrigation system (drip or sprinkler) and mulch (plastic film, wheat straw or bare soil) on bolting, bulb yield and bulb quality.

Materials and Methods

The experiments were conducted during the 1999-2000, 2000-2001 and 2001-2002 seasons at the University of Georgia's Black Shank Farm, at the Coastal Plain Experiment Station, Tifton, Ga. The experimental design was a split plot, where the main plot was the irrigation system (sprinkler or drip) and the sub-plot was the type of mulch (unmulched soil, black plastic film or wheat straw). Onion seedlings ('Sweet Vidalia') were transplanted on 1 Dec. 1999, 6 Dec. 2000, and 29 Nov. 2001. Bolting incidence was determined just before harvest as the percent of plants with seed-stems (flowering stems).

Root zone temperature (RZT) over the growing season was measured by determining soil temperature midway between the plants at 10 cm below the mulch or soil surface. RZT was measured with copper-constantan thermocouples (Model 105. Campbell Scientific, Logan, Utah) connected to a data logger (CR10X, Campbell Scientific) and an AM416 Relay Multiplexer (Campbell Scientific). The data logger was programmed to record readings every 10 min and store hourly averages for each plot. In 2000 and 2001, plants were harvested when 20% of the necks had collapsed (tops down), while in 2002 when 50% of the necks had collapsed. Onions were undercut 48 h before harvest and onion tops were allowed to field-cure. Onions were hand-harvested and roots and tops were clipped. In 2000, onions were harvested on 20 Apr., 28 Apr., and 5 May for black plastic mulch, unmulched, and straw mulch treatments, respectively. In 2001, harvest was on 23 Apr. for black plastic, and on 3 May for bare soil and straw mulch treatments, respectively. In 2002, all treatments were harvested on 3 May.

Results and Discussion

Bolting: Irrigation system did not consistently affect bolting. However, the presence of mulch had a significant effect on bolting (Figure 1). Over the three seasons, plants on straw mulch had higher bolting incidences compared to plants on either unmulched soil or black plastic mulch. Bolting incidence on black plastic mulch was similar compared to that on unmulched soil. Bolting was associated with plant and environmental factors that were modified by the utilization of mulches. Consistent with a companion paper by Díaz-Pérez et al. in this Report, onion bolting increased with decreasing nitrogen content of the vegetative plant tops, with plants on wheat straw having the highest bolting incidence. Bolting also increased with decreasing root zone temperatures for the season.

Yield: At similar soil moisture conditions over the growing season, bulb yields under drip irrigation were similar to those under sprinkler irrigation (Tables 1-3). Plants grown on unmulched soil had the highest total yield during the three seasons and among the highest marketable yield. There were no consistent differences in the bulb number or yield of plants on plastic film mulch and those under wheat straw mulch. Plants on wheat straw mulch had a reduced N content. The variability in yields among mulches and seasons was partly explained by the changes in seasonal root zone temperature. Total and marketable yields and weight of individual bulbs increased with increasing root zone temperatures up to an optimum at about 16 °C (61 °F), followed by reductions in yields and individual bulb weight at higher root zone temperatures.

In conclusion, drip-irrigated onion plants yielded similarly as plants under sprinkler irrigation. Onion plants on unmulched soil yielded more than plants on black plastic mulch or wheat straw mulch. Compared to plants on either or black plastic mulch, onion bolting was highest and plant N levels were lowest in plants grown on wheat straw mulch. Bolting was associated with reduced leaf N content.

Acknowledgements

Thanks to Ben G. Mullinix for statistical support.

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Table 1. Yields of sweet onion as affected by irrigation system and mulch of plants during the 1999-2000 season.

Treatment	Marketable wt. (t/ha)	Total # (x 1000)	Total wt. (t/ha)
Irrigation			
Drip	-	178 b	53 b
Sprinkler	-	183 a	59 a
Mulches			
Unmulched	-	183 a	60 a
Plastic	-	176 b	52 c
Straw	-	181 ab	56 b
Significance			
Irrigation (I)	-	0.026	< 0.001
Mulch (M)	-	0.035	< 0.001
I x M	-	0.117	0.716

[z]Mean separation within columns by Duncan ($P \leq 0.05$).

Table 2. Yields of sweet onion as affected by irrigation system and mulch of plants during the 2000-2001 season.

Treatment	Marketable wt. (t/ha)	Total # (x 1000)	Total wt. (t/ha)
Irrigation			
Drip	30.6 a	131 a	38.0 a
Sprinkler	25.2 b	126 a	32.5 b
Mulches			
Unmulched	31.2 a	129 b	40.8 a
Plastic	25.9 b	142 a	31.0 b
Straw	26.6 b	116 c	33.8 b
Significance			
Irrigation (I)	0.006	0.188	0.015
Mulch (M)	0.045	<0.001	0.003
I x M	0.478	0.071	0.223

zMean separation within columns by Duncan ($P \leq 0.05$).

Table 3. Yields of sweet onion as affected by irrigation system and mulch of plants during the 2001-2002 season.

Treatment	Marketable wt. (t/ha)	Total # (x 1000)	Total wt. (t/ha)
Irrigation			
Drip	15.7 a	111 a	28.2 a
Sprinkler	15.3 a	107 a	25.2 a
Mulches			
Unmulched	18.6 a	126 a	32.8 a
Plastic	-	-	-
Straw	12.5 b	92 b	20.5 b
Significance			
Irrigation (I)	0.781	0.425	0.080
Mulch (M)	0.001	<0.001	<0.001
I x M	0.120	0.532	0.440

zMean separation within columns by Duncan ($P \leq 0.05$).

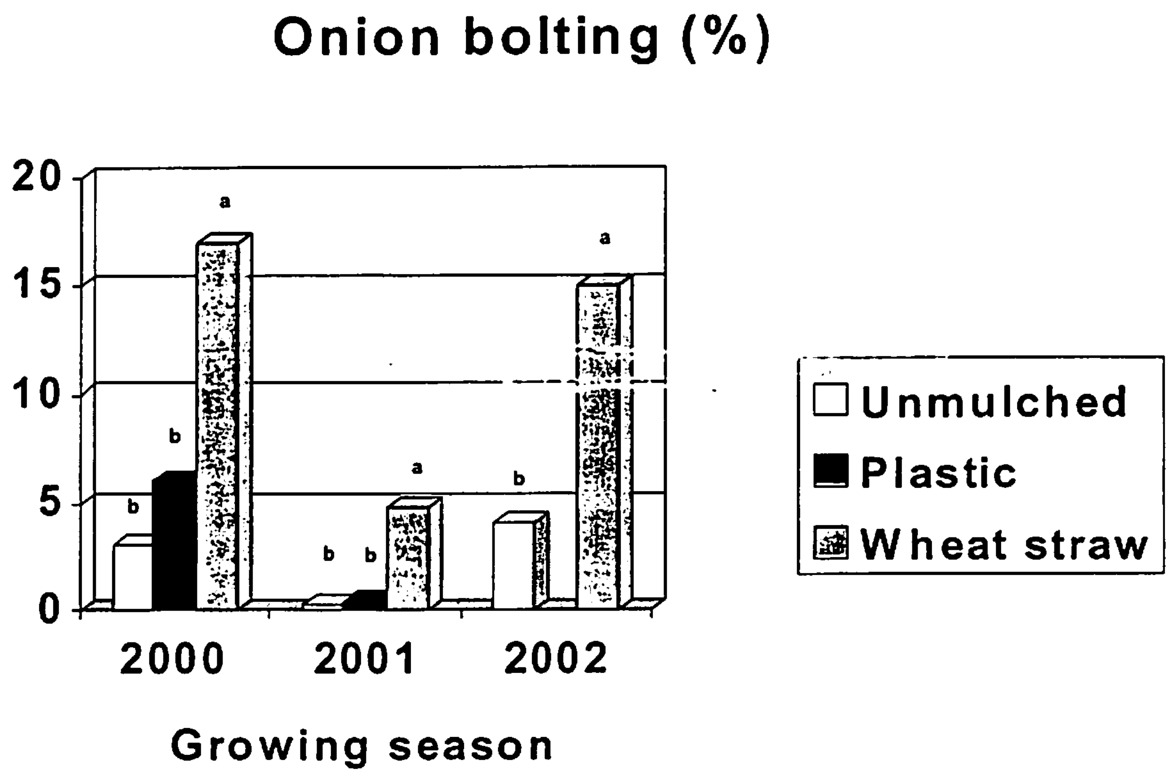

Figure 1. Onion bolting as affected by mulch during three growing seasons. For each season, mulches with the same letter are not significantly different (Duncan, P = 0.05).

REVIEW OF MANAGEMENT OF THE DISEASES BACTERIAL STREAK AND CENTER ROT ON ONIONS

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Bacterial Streak

Introduction

Bacterial streak and bulb rot (BSBR) of onion (*Allium cepa* L.) is caused by the bacterium, *Pseudomonas viridiflava* (Burkholder) Dowson, which hereafter will be referred to as PV. BSBR was first observed on short-day, sweet onions in Georgia in 1990 and has been responsible for intermittent and sporadic losses since its first occurrence. Conditions most favorable for epidemic development occur between 15 January and 30 March. Generally, new lesions are small (≤ 1.0 cm), oval, olive-green to tan, and surrounded by an area of chlorosis and water-soaking. As lesions develop, they become dark-green to black, extensively water-soaked, and develop into streaks that encompass the entire leaf. Sometimes a single leaf is affected, however under favorable conditions entire plants become blighted. Eventually interveinal areas collapse, causing the veins to appear prominent. Often, soft rot symptoms develop at the base of the leaf and in the neck of the bulb. Bulbs of severely infected plants are difficult to harvest as infected leaves become detached from necks and the bulbs remain in the ground. The primary source of inoculum for BSBR epidemics is from epiphytic populations of PV on several winter weeds, including cutleaf evening primrose (*Oenothera laciniata* Hill). Our objective was to develop an integrated management strategy based on these and additional results regarding the ecology of PV and the epidemiology of BSBR.

Effect of fertility

Materials and Methods

Effects of fertility on development of BSBR were evaluated at three different locations. Onions, cv. Granex 33, were planted at a population of about 370,650 seeds / ha in double line rows with four rows per 1.83 m bed using a standard and excessive fertility program. The standard fertilizer program consisted of 1120.82 kg/ha of 5-10-15 (NPK) and 224.17 kg/ha of 10-34-0 applied prior to planting. Side-dressings of 224.17 kg/ha of 15-0-14 were applied at 8, 12, and 16 weeks after planting, and 224.17 kg/ha of calcium nitrate were applied at 20 weeks after planting. The excessive fertilizer program was the same, except that rates of 15-0-14 at 8, 12, and 16 weeks after planting were increased to 1120.82 kg/ha to simulate some grower's practices. Plants were evaluated for BSBR incidence over time. Tissue analysis was done by lyophilizing onion leaves, grinding them into a fine powder and determining nitrogen content by the total combustion method and calcium, phosphorus and potassium content by the dry ash procedure.

Results and Discussion

Increased levels of BSBR were observed in onions receiving an excessive rate of fertilizer compared to onions grown under a standard fertility program (Table 1). The mean level of BSBR for the excessive fertility program for the three locations was 37.2% in contrast to only 14.2% BSBR for onions grown under the standard fertility program. Tissue analysis indicated that nitrogen was significantly higher in leaf tissues of plants grown using the excessive fertility program and correlated with increased levels of disease.

Effect of weed control

Materials and Methods

Effects of weed control on BSBR incidence were evaluated at four different locations (sites A,B,C, and D) by R. Torrance. Onions, cv. Granex 33, were transplanted at a population of about 370,650 plants/ha. Plants were planted in double line rows with four rows per 1.83 m bed using a standard fertility program. At sites A and B, treatment one (DCPA [dimethyl tetrachloroterephthalate 75 WP]) at 10.09 kg/ha applied as a pre-plant herbicide) was compared with treatment two (DCPA) at 10.09 kg/ha and oxyfluorfen applied as a postemergence herbicide at 2.34 l/ha). At site C, treatment one (DCPA) at

10.09 kg/ha) was compared with treatment three (oxyfluorfen at 2.34 l/ha). At site D, treatment three (oxyfluorfen at 2.34 l/ha) was compared with a control of no herbicide. Final BSBR incidence was recorded.

Results and Discussion

Applications of oxyfluorfen as a postemergence herbicide alone or in combination with DCPA significantly reduced BSBR levels (Table 2). BSBR levels ranged from as high as 24.0 % and 20.3 % in plots not receiving oxyfluorfen, whereas plots at the same sites receiving oxyfluorfen had only 11.0 and 7.6 % incidence of BSBR, respectively.

Effect of Fixed-copper sprays

Materials and Methods

Use of fixed-copper sprays were evaluated for control of BSBR. Onions, cv. Granex 33, were direct seeded using standard fertility and weed management procedures as mentioned above. Treatments were arranged in a complete block design with four replications. Each treatment consisted of a 4-row bed 15.24 m in length. Treatments were separated with a single, non-sprayed bed of onions. Alleys between blocks were 3.05 m in length. Treatments were: 1) 1.75 l/ha chlorothalonil (54%) applied weekly, 2) 1.75 l/ha chlorothalonil alternated with 1.68 Kg/ha Mankocide (300g/kg copper present as cupric hydroxide and 150g/kg mancozeb), (Griffin LLC., Valdosta, GA) on a weekly basis, 3) 1.75 l/ha chlorothalonil alternated with 2.98 kg/ha Mankocide on a weekly basis, 4) 3.36 kg/ha Mankocide applied weekly, and 5) non-sprayed control. A total of 16 sprays were applied between 13 January and 28 April. Eight disease ratings were conducted between 15 January and 30 April. In addition, percent loss of stand, leaf diameter and yield data were recorded.

Results and Discussion

Mankocide applied at 3.36 kg/ha on a weekly basis provided the best disease control of the various compounds and spray schedules tested (Table 3). Plants treated with the higher rate of Mankocide on a weekly schedule were more robust, had a significantly larger leaf diameter, and had a higher survival rate (stand count). In addition, plots receiving the higher rate of Mankocide had yields increased by 5,214 kg/ha and 8,300 kg/ha when compared to non-sprayed and chlorothalonil treatments, respectively.

Effect of onion maturity and harvest practices

Materials and Methods

Onion maturity and harvest practices were evaluated for control of BSBR. Granex 33 onions were direct seeded and managed as described above. Onions were uprooted when bulbs were immature (necks hard and tops break 8.0 cm above the bulb), mature (necks soft with ~ 20% tops down), and over-mature (all tops down and beginning to dry). A subset of onions was clipped immediately using shears dipped in a suspension of PV (1 x 108 CFU/ml) or sterile water. Another subset of onions was clipped in a similar manner after field drying for 48 h. Onions were segregated by treatment, cured with forced hot air (~ 38 C) for 72 h and stored at ~ 26 C. After 1 wk, onion bulbs were cut and evaluated for BSBR severity.

Results and Discussion

Harvesting onions at the proper stage of maturity and drying them for a minimum of 48 h, prior to removal of leaves and roots with shears contaminated with PV, provided a significant level of disease control (Table 4). Onions harvested at an immature stage, when necks were hard, had significantly higher levels of postharvest disease both in onions that were clipped immediately as well as those that were cured in the field for 48 h. In onions harvested at an immature level, BSBR levels were 79% and 68% when there were 0 and 48 h of field-curing, respectively. However, when onions were harvested at an optimum level of maturity or when over-mature, field-curing for 48 h significantly reduced BSBR levels to 15% and 18%, respectively.

Effect of onion bulb storage conditions

Materials and Methods

The effect of onion bulb storage conditions on postharvest levels of BSBR were evaluated. Granex 33 onions were uprooted at optimum maturity. After field drying for 48 h, foliage and roots were removed by clipping with shears. Bulbs were cured with forced hot air (~ 38 °C) for 72 h. Treatments applied after curing consisted of 1) stab-inoculation to a depth of 1.0 cm with a dissecting needle contaminated with PV and storage at 4 °C, 2) stab-inoculation to a depth of 1.0 cm with a sterile dissecting needle and storage at 4 °C, 3) stab-inoculation to a depth of 1.0 cm with a dissecting needle contaminated with PV and storage in a controlled atmosphere (CA) cell, and 4) stab-inoculation to a depth of 1.0 cm with a sterile dissecting needle and storage in a CA cell. Conditions in the cold room consisted of a normal atmosphere at 4 °C. The temperature and relative humidity in CA cells were established at 1 °C and

75%, respectively. The atmosphere in CA cells consisted of 3% oxygen, 5% carbon dioxide, and 92% nitrogen. Temperature, relative humidity, carbon dioxide and oxygen concentrations were determined hourly and corrected as necessary. After a 10-wk storage period, bulbs were removed, split, and evaluated for disease severity.

Results and Discussion

CA storage was effective in retarding the development of BSBR (Table 5). Mean BSBR levels in water-inoculated, control onions were 10.5% and 4.5% after 10 wk of storage in a standard cold room or CA cell, respectively. When onion bulbs were inoculated with PV prior to storage, the level of BSBR in onions stored in a standard cold room increased to 55% but remained at a relatively low level of 7% in onions stored in a CA cell. Cultural practices can have a significant impact on plant disease incidence and development.

Summary and Conclusions

Over the course of the past few years, we demonstrated that weed management, fertility management, proper decision-making regarding the stage of maturity of onion plants selected for harvest, utilizing field-curing and storing onions in CA conditions all reduced BSBR levels. When combined with chemical control in an integrated pest management strategy, they provide excellent levels of disease control for BSBR of onion.

Center Rot

Introduction

Center rot of onion is caused by the bacterium, *Pantoea ananaits* (Serrano) Mergaret et al. 1993. This is a new disease of onion, and was first observed on sweet onions in Georgia, U.S.A. in 1997. A year later it was observed in dry bulb, pungent onions in Colorado then in Michigan. Since that time it also has been reported from New Zealand and Venezuela. As the name suggests, the disease quite often affects the center leaves of the plant. Affected leaves become water-soaked, soft, and bleached white as the rot progresses. Surrounding tissues may appear tan to a darker brown. Advanced stages of the disease result in complete wilting and bleaching of all leaves. Bulb interiors may become soft, watery, and produce a foul odor. Attempts to lift the plant from the ground by grabbing the leaves may result in liquified tissues oozing from the neck and leaves breaking away from the plant. Unlike most other bacterial diseases of onion, center rot also infects seed stalks in a similar manner to the leaves, which results in plant lodging and loss of seed heads. An almost identical disease in South Africa was attributed to the closely related bacterium *Erwinia herbicola*, which is synonymous with *P. agglomerans*. *P. agglomerans* and *P. ananatis* are closely related (at one time they were considered to be the same species) and the seed of the variety that center rot was first observed on in Georgia was produced in South Africa. However, it also appears that the bacterium is endemic to the southeastern U.S. Bacteriophage specific to *P. ananatis*, presumptive evidence of the presence of the bacterium, have been recovered from several lakes in Florida and Texas.

Results and Discussion

Using PCR, we found that *P. ananatis* was in Georgia several years prior to the 1997 epidemic in Vidalia onion. The earliest evidence that the bacterium was present in the state prior to 1997 came from screening the University of Georgia's Coastal Plain Experiment Station Culture Collection. Two strains were found to be mislabeled and upon a more detailed characterization were identified as *P. ananatis*. These strains came from peach leaves and onion bulbs from 1986 and 1992, respectively. Using PCR we detected *P. ananatis* as an epiphytic resident on 23 weed species, Bermuda grass (*Cynodon dactylon*), and soybean (*Glycine max*). The latter two are significant because they are used in a rotation between onion crops. Some of the weeds *P. ananatis* has been found on in Georgia include: bristly starbur (*Acanthospermum hispidum*), broadleaf signalgrass (*Brachiaria platyphylla*), carpetweed (*Mollugo verticillata*), crabgrass (*Digitaria sanguinalis*), common cocklebur (*Xanthium pensylvanicum*), common ragweed (*Ambrosia artemisiifolia*), curly dock (*Rumex crispus*), Florida beggarweed (*Desmodium tortuosum*), Florida pusley (*Richardia scabra*), sickelepod (*Cassia obtusifolia*), spiny amaranth (*Amaranthus spinosus*), smallflower morningglory (*Jaquemontia tamnifolia*), Texas panicum (*Panicum texanum*), vaseygrass (*Paspalum urvillei*), verbena (*Verbena* spp.), and yellow nutsedge (*Cyperus esculentus*). Not only was the bacterium found on these weeds within and adjacent to onion production sites, but it also was detected on weeds as far away as 150 miles from the nearest commercial onion production.

In addition to being found on weeds, we demonstrated that the bacterium could be recovered from seed harvested from plants in a field that had a center rot epidemic (Table 6). In addition to both weeds and seed, *P. ananatis* may survive in the gut of insects. Specifically, we identified tobacco thrips, *Frankliniella fusca*, as harboring the bacterium internally. Using an assay that allows tobacco thrips to feed on peanut leaves, we were able to identify in a nondestructive manner those thrips that contained the bacteria. When placed on healthy onion plants, we were able to demonstrate disease transmission by thrips (Table 7). With an average of about eight thrips per onion plant, the transmission rate of *P.ananatis* was approximately 52 % and the mean incubation period for development of center rot symptoms was 6.8 days after the plants were first exposed to thrips. In the control plants, i.e. those receiving bacteria-free thrips, there was 0 transmission rate after a 28 day waiting period.

Overall Conclusions for Bacterial Streak and Center Rot

In conclusion, there are significant differences between bacterial streak and center rot. Table 8 summarizes some of our knowledge about these two diseases.

Acknowledgements

Funding for this research was provided by the Vidalia Onion Committee and USDA/CSREES Grant No. 99-34389-7437, entitled "Integrated Disease Management to Improve the Quality of Sweet Onions in Georgia".

Table 1. Tissue Analysis and BSBR Levels of Onions Grown Using Two Fertility Programs.

Site	Fertility Program	%N	%P	%K	%Ca	% Disease
A	Excessive	3.2 a	0.4 a	2.3 a	0.7 a	42.0 a
A	Standard	2.3 b	0.3 a	2.3 a	0.6 a	10.5 b
B	Excessive	2.7 a	0.4 a	2.1 a	0.6 a	38.5 a
B	Standard	2.1 b	0.5 b	2.1 a	0.5 a	16.0 b
C	Excessive	2.6 a	0.3 a	2.1 a	0.7 a	31.0 a
C	Standard	2.4 b	0.3 a	2.0 a	0.7 a	16.0 b

Paired values within the same column with different letters are significantly different at $P = 0.01$

Table 2. Incidence (%) BSBR of Onion at Four Sites With Different Weed Control Treatments.

Treatment	Site A	Site B	Site C	Site D
DCPA	11.6 a	2.0 a	24.0 a	ND
DCPA + Oxyfluorfen	4.6 b	0.6 b	ND	ND
Oxyfluorfen	ND	ND	11.0 b	7.6 b
No Herbicide	ND	ND	ND	20.3 a

Paired values within the same column with different letters are significantly different at $P = 0.05$

Table 3. Effect of Fixed-Copper Sprays on BSBR, Onion Leaf Diameter, Stand Loss and Yield.

Treatment	Rate /ha	% Disease	Leaf Diam. (mm)	% Stand Loss	Yield (kg/ha)
1. chlorothalonil	1.75 l	50.0	23.8	24.8	9,968
2. chlorothalonil	1.75 l	40.5	24.5	10.8	13,588
Mankocide *	1.68 kg				
3. chlorothalonil	1.75 l	44.0	25.9	10.1	16,111
Mankocide *	2.98 kg				
4. Mankocide	3.36 kg	29.5	26.6	6.1	18,268
5. No treatment	-	54.0	21.1	24.2	13,054

* Treatments applied on alternate weeks.

Table 4. Effects of Onion Maturity and Hours of Field-Curing on % Postharvest BSBR.

Onion Maturity	Field-Curing (hours)	% BSBR
Immature	0	79 c
Immature	48	68 c
Mature	0	41 b
Mature	48	15 a
Over-Mature	0	41 b
Over-Mature	48	18 a

Values with different letters are significantly different at $P = 0.05$

Table 5. Levels of Rot in Inoculated and Control Onions Stored Conventionally or in CA Cells

Type of Storage	Inoculated	% Bulb Rot
Cold Room	Water Control	10.5 a
CA	Water Control	4.5 a
Cold Room	*P. viridiflava*	55.0 b
CA	*P. viridiflava*	7.0 a

Paired values within the same column with different letters are significantly different at $P = 0.05$

Table 6. Onion seedlots harvested in 2000 from onion seedheads from research plots.

Seed Source	Number of Seedlots Tested	% Infested seedlots by IMS-PCR	% Infested seedlots by IMS Plating
Hort Hill	43	2.3	13.9
Blackshank	33	15.2	27.3
Total	76	7.9	19.7

Table 7. Results of transmission of *Pantoea ananatis* to onion, *Allium cepa*, by surface-sterilized, tobacco thrips, *Frankliniella fusca*.

Trial	Number of Infeated Thrips	% Transmission	# Days	Number of Bacteria-free Thrips	% Transmission	# Days
1	9	50	7	9	0	28
2	6	0	28	6	0	28
3	6	50	7	6	0	28
4	12	60	9	12	0	28
5	6	100	4	6	0	28
Mean	7.8	52	6.8*	7.8	0	28

* Mean of number of days of incubation based on four positive transmissions and excludes the 28 days of the one trial that no transmission ocurred.

Table 8. Comparison of Bacterial Streak with Center Rot of Onion.

Bacterial Streak	Event	Center Rot
Weeds	Source of Inoculum	Weeds, Seed, Thrips
Reduces Disease Levels	Reduced Level of Nitrogen	No Effect
Reduces Disease Levels	Weed Control	No Effect
Not Known	Drip Irrigation	No Effect
Not Known	Black Plastic Mulch	Increases Disease
Reduces Disease Levels	Copper Bactericides	No Effect
Reduces Disease Levels	Field-Curing	No Effect
Reduces Disease Levels	CA Storage	Reduces Disease Levels

EVALUATION OF SPRAY PROGRAMS FOR CONTROL OF FOLIAR PATHOGENS ON VIDALIA ONIONS

David Langston, Extension Plant Pathologist

Introduction

Foliar diseases of Vidalia onions can cause severe losses by reducing the 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 region 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.

This past year (2002) Stemphylium blight has 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 irrigation 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 Vidalia onion varieties. Growers rely upon fungicides to suppress foliar diseases. Several fungicide options are available including chlorothalonil (Bravo, Echo, Equus), mancozeb (Dithane, Manzate, Penncozeb,), iprodione (Rovral), azoxystrobin (Quadris), cyprodinil + fludioxonil (Switch), and numerous copper formulations. Vinclozolin (Ronilan) was available through 2000 but its future is uncertain as far as being labeled for use on onions. Each of these materials has strengths and weaknesses as far as their activity on specific fungi are concerned. Cost is also an issue as these materials can range from $3.00/lb to $4.00/oz. Therefore growers are more likely to use the more expensive materials sparingly and only during periods of high disease pressure.

Previous tests have indicated that many fungicide sprays administered early in the growing season have not resulted in significant foliar disease suppression, therefore a study was conducted to determine the most cost effective spray program using the more expensive fungicides later in the growing season. Special attention was given to the suppression of Botrytis leaf blight, purple blotch, and Stemphylium leaf blight.

Materials and Methods

In an effort 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 (*Allium cepa*) transplants 'Sweet Vidalia' were planted on beds (panels) spaced on 6-ft centers on December 5[th], 2001, at the Vidalia Onion and Vegetable Research Farm in Toombs County, GA. Plant spacing was 12 in. between adjacent rows and 5 in. between plants in 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 four replications. Fungicide/bactericide treatment plots were 15-ft long and were separated by non-treated border beds. Fungicides were applied using a CO_2-pressurized backpack sprayer calibrated to deliver 40 gallons per acre at 75 psi using TX-18 hollow cone nozzles. Onions were harvested on April 25[th], 2002, by digging the two center rows of each panel and allowing them to field cure. After clipping the onions were also artificially cured at approximately 100 ^{0}F for 72 hours, before weighing.

Results and Discussion

The growing season was cool and dry, and received rainfall 5.5 in. below the fifty year average. Cold weather in the fall of 2001and spring of 2002 severely reduced yields. Botrytis leaf blight and purple blotch Stemphylium were first observed at low levels on January 30[th], 2002. All fungicide treatments significantly reduced Botrytis leaf blight below the non-treated check on March 14[th], 2002, except QRD 131alternated with Bravo WeatherStik tank-mixed with ManKocide. Purple blotch/Stemphylium control was significantly improved on March 26th by all spray programs but was best when BAS 516 was used or when Quadris was alternated with either Rovral or Switch rather than Bravo WeatherStik late in the season. Total disease suppression was significantly reduced by all spray programs on April 18th with the late season combination of Quadris and Rovral or BAS 516 significantly suppressing total disease over late season applications of Quadris and the Quadris alternated with Switch combination. Significant yield improvement was observed when Quadris was used, in BAS516 treated plots, and when Rovral was rotated with Bravo WeatherStik tank-mixed with Cuprofix MZ Disperss.

Table 1. Effect of fungicide spray programs on Botrytis leaf blight, purple blotch, total disease suppression, and marketable yield.

Treatment, rate/A and spray timing[1]	Botrytis[2] Leaf Blight 3/26	Purple[3] Blotch/ Stemph. 3/14	Purple Blotch/ Stemph. 3/26	Total[4] Diseased Tissue 4/18	Marketable[5] Yield/Plot 4/24
Bravo WeatherStik, 1.5 pt/A (1,3,5,7,9) Bravo WeatherStik, 1.5/A +ManKocide @ 2.0 lb/A (2,4,6,8)...	2.8 cd[6]	24.0 cb	53.0 b	40.0 cd	18.3 b-d
Bravo WeatherStik, 1.5 pt/A (1,3) Bravo WeatherStik, 1.5/A + ManKocide @ 2.0 lb/A (2,4,6,8) Quadris @ 12.4 fl oz/A(5,7,9)...	4.3 b	2[illegible].5 cb	42.8 b-d	41.3 cd	21.0 ab
Bravo WeatherStik, 1.5 pt/A (1,3) Bravo WeatherStik, 1.5/A + ManKocide @ 2.0 lb/A (2,4,6,8) Switch @ 11.0 oz/A (5,7,9)...	3.4 bc	23.7 cb	46.0 cb	38.3 cd	17.9 b-c
Bravo WeatherStik, 1.5 pt/A (1,3) Bravo WeatherStik, 1.5/A + ManKocide @ 2.0 lb/A (2,4,6,8) Rovral @ 1.5pt/A (5,7,9)...	3.3bc	22.5 cb	45.0 cb	33.8 d	20.0 a-c
Bravo WeatherStik, 1.5 pt/A (1,3) Bravo WeatherStik, 1.5/A + ManKocide @ 2.0 lb/A (2,4) Quadris @ 12.4 fl oz/A (5,7,9) Switch @ 11.0 oz/A + ManKocide @ 2.0 lb/A (6, 8)...............	3.8 bc	26.8 cb	39.0 cd	41.3 cd	21.4 ab
Bravo WeatherStik, 1.5 pt/A (1,3) Bravo WeatherStik, 1.5/A + ManKocide @ 2.0 lb/A (2,4) Quadris @ 12.4 fl oz/A (5,7) Quadris @ 12.4 fl oz/A + ManKocide @ 2.0 lb/A (6) Switch @ 11.0 oz/A + ManKocide @ 2.0 lb/A (8) Switch @ 11.0 oz/A (9)...	4.3 b	24.3 cb	44.7 bc	40.0 cd	21.9 ab

Table 1. cont'd

Bravo WeatherStik, 1.5 pt/A (1,3) Bravo WeatherStik, 1.5/A + ManKocide @ 2.0 lb/A (2,4) Quadris @ 12.4 fl oz/A (5,7,9) Rovral @ 1.5pt/A + ManKocide @2.0 lb/A (6,8)......................	3.3 bc	23.3 cb	32.5 d	32.5 d	22.8 a
Bravo WeatherStik, 1.5 pt/A (1,3) Bravo WeatherStik, 1.5/A + ManKocide @ 2.0 lb/A (2,4,6,8) BAS 516 @ 10.6 oz/A (5,7,9)..	3.8 bc	24.5 cb	38.3 cd	33.8 d	21.6 ab
Bravo WeatherStik, 1.5 pt/A (1,3) Bravo WeatherStik, 1.5/A + ManKocide @ 2.0 lb/A (2,4,6,8) BAS 500 @ 12.0 oz/A (5,7,9)..	4.7 b	30.7 cb	47.0 cb	40.0 cd	19.9 a-c
Bravo WeatherStik, 1.5 pt/A (1,3,5,7,9,) Bravo WeatherStik, 1.5 pt/A + Cuprofix MZ Disperss @5.0 lb/A (2,4,6,8)...............................	1.8 d	21.3 c	43.5 b-d	41.3 cd	18.4 a-d
Bravo WeatherStik, 1.5 pt/A (1,3) Bravo WeatherStik, 1.5 pt/A + Cuprofix MZ Disperss @5.0 lb/A (2,4,6,8) Rovral @ 1.5pt/A (5,7,9)...	3.8 bc	25.0 cb	41.3 cd	45.0 c	20.7 ab
Bravo WeatherStik, 1.5 pt/A (1,3) Bravo WeatherStik, 1.5 pt/A + Cuprofix MZ Disperss @5.0 lb/A (2,4,6,8) Quadris @ 12.4 fl oz/A (5,7,9)...	4.3 b	23.5 cb	38.3 cd	40.0 cd	21.7 ab
QRD137 @ 4.0 lb/A (1,3,5,7,9) Bravo WeatherStik, 1.5/A + ManKocide @ 2.0 lb/A (2,4,6,8)..	4.5 b	32.0 b	66.0 a	62.5 ab	14.5 d-f

Table 1. cont'd

QRD283 @ 4.0 lb/A (1,3,5,7,9) Bravo WeatherStik, 1.5/A + ManKocide @ 2.0 lb/A (2,4,6,8)..	4.5 b	48.3 a	75.0 a	56.3 b	12.2 f
QRD131 @ 2 %/A (1,3,5,7,9) Bravo WeatherStik, 1.5/A + ManKocide @2.0 lb/A (2,4,6,8)...	7.0 a	23.3 cb	49.3 cb	68.3 a	13.6 ef
NonTreated..	7.5 a	31.8 b	77.0 a	71.3 a	15.5 c-f

[1]Spray dates are as follows: 1 = Jan 30th, 2 = Feb 11th, 3 = Feb 25th, 4 = March 6th, 5 = March 14th, 6 = March 22nd, 7 = March 29th, 8 = April 5th, 9 = April 16th.

[2]Total leaf area affected by Botrytis leaf blight in the two center rows of each plot on March 26th.

[3]Total number of lesions of purple blotch in the two center rows of each plot on March 14th and 26th.

[4]Total leaf area affected by purple blotch and Botrytis leaf blight on April 18th.

[5]Total marketable yield taken from the two center rows of each plot.

[6]Means followed by the same letter(s) are not significantly different according to Fisher's protected LSD test at P=0.05.

HIGH TEMPERATURE CONTINUOUS FLOW CURING OF SWEET ONIONS

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Introduction

The area of sweet onions grown in Georgia, has expanded from 400 acre in 1978 (Smittle and Williamson, 1978) to 13500 acre with a production value of $70.5 million in 2001 (Anonymous, 2002).

Following harvest, sweet onions in Georgia are cured and then, according to the projected market window, are stored under different environments (Maw et al., 1997b). Onions are sold by grade and then by weight within those grades. Grades used are those established by USDA through the Vidalia Onion Marketing Order (USDA, 1993).

An onion bulb is a series of concentric swollen leaf bases attached to a short stem. Curing the onion bulb: dries the scales (two-four) providing mechanical protection, a seal against water loss and an attractive cosmetic appearance; dries the roots and neck reducing the likelihood of disease traveling into the onion through those channels; and promotes the healing of wounds caused by mechanical damage or damage during growth of the bulb (Maw et al., 1998b). The term 'curing' is preferred to drying because removal of moisture must come from those parts mentioned, rather than from the entire bulb since the high water content of the bulb interior must be preserved.

Curing is a continual process taking place whenever environmental conditions are conducive to the removal of moisture from the bulb. Curing may take place in the field, during transit, during storage and even on the shelf in the grocery store. It is beneficial to the bulb to make sure it receives a minimum amount of curing and so controlled artificial curing is advised even though some natural field curing may have taken place. This may be accomplished by blowing warm air around the onion bulb while it is in an enclosed place. The standard conditions for artificial curing are to pass air heated to 100 ^{0}F over the onions at a static pressure of 0.75 in. static water pressure (Maw et al., 1998a). For a complete cure, as gauged by the scales of the bulb being dry and the neck dry enough to fold over, duration of cure has been shown to be influenced by harvest maturity of the onions (Maw et al., 1997b). For onions of the optimal harvest maturity 72 h may be sufficient, for onions of a late harvest maturity, perhaps only 48 h may be necessary, however, for onions of an early harvest maturity even 96 h may not be sufficient.

During 1997 it is estimated that $20 million worth of sweet onions in Georgia were lost to post-harvest storage diseases (personal communication, Vidalia Onion Marketing Committee). One of the most prevalent diseases was identified as neck rot caused by the fungus *Botrytis allii* (Lacy and Lorbeer, 1995). A detailed account of infestation by *Botrytis* was given by Overduin (2001), when an entire store of onions was discarded after the disease was discovered in the store. The spores of *Botrytis* overwinter or are present in soil and are prevalent in fields of the Vidalia area. The stem of an onion plant may become infested at the soil line early in the growing season. Alternatively, it is known that spores invade dead or dying leaves of the onion plant and grow downward through the neck into the bulb (Vaughan et al., 1964).

There are other species of Botrytis as for example *Botrytis byssoidea* which may be confused with *Botrytis allii*. When infected by *Botrytis allii*, onion bulbs develop a semi-watery decay, which may begin in the neck area and gradually move through the entire bulb. White to gray mycelia may appear between the scales of the onion bulb. Sclerotia may form on the outer scales on the shoulders of the bulbs and a grayish mold also form on the outer surface. Preharvest infection may occur from spores present on the external surfaces of the onion bulb. A healthy onion with a well cured neck is rarely affected by *Botrytis allii*. Only seeds that are free of *Botrytis allii* should be sown (Maude and Presly, 1977).

Whereas *Botrytis allii* may flourish in the presence of moisture and temperatures of 65-85 ^{0}F, it is also likely to be hindered by removing moisture from the path of the fungal growth and by increasing the temperature to above 100 ^{0}F (Maw et al. 1998a). Sumner et al. (1999) demonstrated this in 1997 by placing cultures of Botrytis spp. in incubators for two days at various temperatures and then allowing them to grow at 78 °F for another five weeks. All cultures abundantly grew and sporulated after heating to 86-99.5 °F, but no cultures grew after heating to 108.5 °F.

The control of neck rot was emphasized by Walker as early as 1921 (Walker, 1921) when it was emphasized that a well cured onion was less likely to encourage growth of the fungus. A current of air heated to as much as 120 °F passed over onions was found to sufficiently dry the neck and thus offer a barrier to the progress of the mycelia of the causal fungus. In 1925, Walker acknowledged that the state of maturity of the plant at harvest had a direct bearing on the amount of infection in the bulb at the time of harvest (Walker, 1925). Then again in 1926 in a thorough review of three different neck rot diseases Walker notes differences in the incidence of neck rot according to onion variety (Walker, 1926).

Vaughan et al.(1964) suggested practices that should reduce incidences of and losses from neck rot. Such practices included careful handling to avoid unnecessary damage to onions and curing in the field under suitable weather conditions with supplemental artificial curing. Maude et al.(1984) suggested a combination of treating onion seed with benomyl before drilling and then curing the immediately harvested onions at 86 °F. However neck rot in onions grown from untreated seed was not effectively controlled at this temperature. It was not recommended to leave onions in the field, after clipping and before artificial curing, since the onions were vulnerable to invasion by the pathogen.

Since the survival of spores of *Botrytis allii* is influenced by temperature, so temperature may be used as a means of either control or eradication. However, heating onions, in order to control or eradicate the spores, may also damage the flesh of the onion. Purvis (1999), indicated that cured onions can withstand rather high temperatures for short periods before they are damaged. Nevertheless, there was a large increase in ion leakage from onion scales following an exposure period of 48 hours compared with 24 hours, both at 115 °F. Curing to a high temperature of 120 °F was advocated by Walker (1921) but no period of exposure was recommended other than to fully dry the necks. Hoyle (1948) reported that no bulbs showed heat injury from artificial curing which in general took 16 h in an air blast of 105 to 118 °F. Vaughan et al.(1964) however, found that artificial drying temperatures in excess of 125 °F for 24 h or 115 °F for 48 h caused serious injury and severe losses in storage.

Palilov (1971) observed that complete varietal resistance to neck rot is not a reality, but that heating an onion infected with neck rot at 113 °F for 8-12 h disinfects newly infected bulbs. He recognized that the resistance to high temperatures of the fungus and the onion are different. Whereas an onion will survive 45 °C for 5 days and even 48 °C for a short period but is injured at 49 °C, mycelium and conidia of the neck rot fungus die at 45 °C after 5-8 h. Diatchenko (1973) states that for guaranteed disinfection of onions from neck rot they must be kept at the temperature of 113 - 118 °F for not less than 13-15 h. In the event that higher temperatures for a limited period may not allow complete curing of the onion, a two stage curing process is presented whereby curing proceeds at the recommended temperature of 100 °F until moisture has been removed and then at 115 °F for 8 h to disinfect the onions (Randle, 1997, personal communication).

Even though *Botrytis* neck rot is visible in its later stages of development as a semi-watery decay, eventually turning brown and causing the onion to lose turgidity within the infected region, identification of the disease is more difficult in its early stages of growth. Kritzman and Netzer (1978) and Kritzman (1983) used a selective medium for the isolation and identification of *Botrytis* before normal expressions of symptoms are evident in the field. Healthy tissues stained green whereas diseased tissues stained red, the color difference being caused by the difference in pH between those parts of the flesh containing actively growing fungus and those which contained little or no *Botrytis allii*.

The study by Purvis (1999) was conducted on sweet, short day onions, and even though the behavior of *Botrytis allii* could be the same for both types of onions, most other reports are related to long day, hard onions. Furthermore, since the eradication of fungal spores of *Botrytis allii* on onions through exposing the onions to a short period of high temperature has been studied both in the laboratory and on a commercial scale on long day, hard onions, the need still exists for exploring the commercial viability of such a procedure on sweet short day onions. Thus a study was conducted to explore the effect of heat treating sweet onions on a commercial scale using a continuous flow drier.

<u>Materials and methods</u>

Sweet onions (*Allium cepa*) were grown on the Vidalia Onion and Vegetable Research Farm in Toombs County, within the Vidalia onion growing region of Georgia during the season 2000-2001. They were grown according to recommendations of the Cooperative Extension Service (Boyhan, 2001). At harvest, the onions were undercut using a rotating bar (Maw and Smittle, 1986) and they were hand clipped in the field into mesh sacks. The state of maturity was observed at the time of harvest. The sacks of onions were loadened into pallet bins (Macro bin TM 34, manufactured by Macro Plastics, Fairfield, CA) and transported to the site of a continuous flow drier at the USDA-ARS National Peanut Research Laboratory in Dawson, Georgia. Approximately one pallet bin of onions was loadened directly onto the web of the dryer and four bins into a hopper from which the onions fed onto the web. One pallet bin of onions was conventionally cured at the Vidalia Onion and Vegetable Research Farm as a control for comparison with the continuous flow dryer. Three test runs were undertaken during the season with onions of three separate harvest dates.

Heat treatment of the onions was undertaken using a continuous flow dryer (Belt-O-Matic, B.N.W. Industries, Mentone, IND 46539) This dryer consisted of a moveable stainless steel web stretched between two end rollers, one of which was powered by an electrical motor whose speed could be infinitely varied by a digital speed controller. The supported web area between rollers was 72 ft^2. With the belt at the slowest speed, power cycling, by means of a Dayton solid state time relay (Dayton Electric Manufacturing Co., Chicago, ILL), reduced the speed of travel of the belt to that required for the test runs. Heated air was forced upwards through the web by a fan whose speed was controlled by a 0-60 hz digital speed controller. The air was heated by a furnace of capacity 2 million Btu, directly mounted on the exhaust side of the fan. The temperature of the flame was controlled by a variable flow proportional valve (Partlow model 70 - 3/4).

Daily ambient temperature variations caused slight fluctuations in the temperature of the resultant heated air, thus temperature settings were varied throughout the day. There was a delicate balance between air temperature, air flow and gas pressure, in order for the flame to remain lit during all hours of the day. The measured static pressure in the plenum below the web varied according to the depth of onions through which the air was passing as well as according to the speed of the fan. After passing through the layer of onions, the moisture laidened heated air was allowed to exhaust into the atmosphere rather than be recycled. A gate allowing onions to flow onto the web was set to the minimum for unobstructed flow, having a opened height of 11 in. Thus the depth of onions on the web was 11 in. or approximately two onions deep. The temperatures of air in the plenum, above the onions on the web, at the fan and ambient were monitored by five Hobo continuous temperature data loggers (Onset Computer Corp., MA). A vibrator attached to the under side of the sloping base of the bulk hopper assisted in preventing bridging at the gate.

After the onions had been heat treated by slowly proceeding through the dryer chamber, supported on the web and heated by forced air, they spilled from the end of the web into two pallet bins placed side by side outside the dryer. A sack of cotton was placed in the bottom of each pallet bin to cushion their fall. The sack of cotton was removed when a mound of onions had been established in the bottom of the pallet bin. Samples of heat treated onions were collected throughout each test run as they were discharged from the dryer. The quantities of both electricity and propane gas used during each test run were calculated from the readings taken from the electricity and propane gas meters, the latter being compensated for standard temperature and pressure. The samples were given a value of curing index on a scale of 0-5 based upon the condition of the neck, scales and roots (Maw et al., 1997a) and were taken to the Vidalia Onion Research Laboratory where they were graded according to size (Tew Manufacturing Corp, Penfield, NY) into four grades: Jumbo > 3.5 in.; large <3.5 and >3.0 in.; medium <3.0 and >2.5 in. and small <2.5 in. Onions from the samples were subsequently analyzed for *Botrytis allii*.

Test run number one. Sweet onions, cultivar Sweet Vidalia, were undercut on May 4th and clipped on May 7th. The onions were observed to be of an early harvest maturity when harvested (Maw et al. 1997b). The grade composition was 55 % - jumbo, 30 % - large, 12 % - medium and 3 % - small. Five pallet bins of onions were loadened into the dryer, a total net weight of 5639 lb of onions. The drier was started at 09.30 h on May 9th. Seven samples of onions each consisting of three replications of 100 onions were collected at eight hourly-intervals, beginning at 17.30 h on May 9th and ending at 17.30 h on May 11th. The web speed was set to provide a maximum of 17 h of curing for the onions as they traveled on the belt. The first two samples of onions had only 8 h and 16 h of heat treatment since they were taken in advance of those that been fed from the hopper. The remaining samples of onions each had 17 h of cure as they traveled on the web through the dryer.

The set-point temperature was 110 ^{0}F for the entire test run. The fan speed was 50 % of full speed, producing a linear velocity of 100-110 ft/min with a measured static pressure of 0.1-0.2 in. water gauge.

This was less than the recommended back pressure of 0.75 in (Maw et al., 1998a) but was characteristic for thin layer drying. The total electricity used was 49 kWh and the total propane gas used was 78 gal. The curing index of onions before heat treatment was 1 and afterwards was 2 for the first sample, 3 for the second sample and 4 for successive samples. The final weight of heat treated onions was 5052 lb of onions or 89.6 % of the original weight. A sample of three replications of onions was taken at harvest, representing those onions having no curing or heat treatment. The pallet bin of onions cured as a control by conventional means, was given a curing index of 5. Three replications of a representative sample were kept for analysis. There was no rainfall during this test run which would otherwise have influenced the humidity of the drying air.

Test run number two. Sweet onions, cultivar Sweet Melody, were undercut on May 11th and clipped on May 14th. The onions were observed to be of an optimal harvest maturity when harvested. The grade composition was 65 % - jumbo, 30 % - large, 4 % - medium and 1 % - small. Three pallet bins of onions having a total net weight of 3571 lb were loadened into the dryer. The dryer was started at 13.00 h on May 15th. The web speed was set to provide a maximum of 24 h of curing for the onions. Seven samples of onions, each of three replications of 100 onions, were collected at eight hourly intervals beginning at 16.00 h on May 16th and ending at 16.00 h on May 18th. All samples of onions had 24 h of curing as they traveled on the web through the dryer.

The set-point temperature was 110 °F for the entire test run. The fan speed was 50 % of full speed, producing a linear velocity of 100-110 ft / min with a measured static pressure of 0.1-0.2 in. water gauge. The total electricity used was 60 kwh and the total propane gas used was 90 gal. The curing index of onions before curing was given as 1.5 and afterwards as 4 for successive samples. The final weight of heat treated onions was 3180 lb, or 89.9 % of the original weight. A sample of three replications of onions was taken at harvest, representing those onions having no heat treatment or curing. Another pallet bin of onions were conventionally cured, from which a sample of three replications of onions was taken and given a curing index of 3.5. There was no rainfall during this test run.

Test run number three. Sweet onions, cultivar Sweet Vidalia, were undercut on May 18th and clipped on May 21st. The onions were observed to be of a late harvest maturity when harvested. The grade composition was 81 % - jumbo, 16 % - large, 2 % - medium and 1 % - small. Five pallet bins having a total net weight of 6196 lb of onions were loadened into the dryer. The dryer was started at 13.00 h on May, 22nd. As in test two, the web speed was set to provide a maximum of 24 h of heat treatment for the onions. Samples were first taken at 16.00 h on May 22nd, and at successive 8 hourly intervals, the first sample having had 3 h of heat treatment, the second 11 h of heat treatment and the third 19 h of heat treatment with the fourth and successive samples having had 24 h of heat treatment. A total of ten samples each having three replications of 100 onions were taken, with the last one being taken at 16.00 h on May 25th.

The set-point temperature was 115 °F for the entire test run. The fan speed was 40 % of full speed, producing a linear velocity of 70-80 ft / min with a measured static pressure of 0.23 in. water gauge. The total electricity used was 45 kwh and the total propane gas used was 102 gal. The curing index of onions before heat treatment was given as 1.5 and afterwards as 3.5 for 3 h of heat treatment, 4 after 11 h, 4.5 after 19 h and 5 for the successive samples of 24 h of heat treatment. The final net weight of heat treated onions was 5690 lb of onions or 91.8 % of the original weight. Another pallet bin of onions was conventional cured, from which a sample of onions was taken and given a curing index of 4. There was no rainfall during this test run.

Analyses of the samples of onions for *Botrytis allii* were made on three occasions, the immediately following curing on May 28th (assay1), the second after onions had been held in cold storage for 114 days until September 19th (assay 2) and the third after onions had been held in cold storage an additional 75 days until December 3rd (assay 3). From each replication of 100 bulbs within a sample, a sub-sample of 25 bulbs were longitudinally bisected, exposing the neck and basal areas. The halves were placed on a plastic sheet in such a position that they could be sprayed with a solution of 80 % ethanol containing 0.15 % (w / v) methyl red (Tichelaar, 1967) and 0.1 % (w / v) bromocresol green as described by Kritzman (1983). After 15 minutes the sections of onion bulbs were examined. The presence of *Botrytis allii* was indicated by a red stain on the flesh of the onion with the remaining portion staining green. A rating of absence or presence of *Botrytis allii* was given to the bulbs as a percentage of the 25 bulbs in a sub-sample.

The percentages of diseased onions were analyzed with four different models, each model emphasizing harvest maturity, cultivar, temperature or duration of cure since these effects were partially confounded with each other, using PROCMIXED (SAS 2000), to obtain the least square means and their standard errors for the unbalanced experimental design. For the various differences among assay dates, t-tests were made to determine where significant differences occurred.

Results and Discussion

Curing index: Since the drying of neck, roots and scales is time dependent and those onions used in the first cure were of an early harvest maturity, so the curing index did not reach 5 for onions of the first and second heat treatments (Table 1) which would imply they were not fully cured by the end of the allotted duration of heat treatment. This is not surprising since onions of an early maturity are known to take much longer than those onions of an optimal maturity which themselves may take up to 72 h (Maw et al.,1998). Even though intermediate samples were not taken of the second cure the gradual change through time is apparent from cures one and three. Even the conventionally cured onions were observed to be insufficiently cured during test runs two and three. In terms of appearance, a lower airflow of 70 - 80 ft / min over the onions resulted in a more uniform color distribution over the onion bulb as compared with a higher airflow which tended to cause a blotchy appearance.

Overall test runs and harvest maturities: Comparing least square means, though the percentage of diseased onions was slightly higher (Table 2) for the sample of heat treated onions compared with the conventionally cured onions immediately following curing and before storage as indicated on the first assay (1), the increase in notable disease under the calculations was significantly ($P<0.01$) less for the heat treated onions than for the conventionally cured onions, between the first and second as well as the first and third ($P<0.05$) assays. The third calculation was also significantly ($P<0.05$) less.

Between all test runs and harvest maturities: Between all cures and harvest maturities (Table 2), just as for overall cures and harvests comparing heat treated with conventionally cured onions, even though the initial disease level may have been greater, as was the case in the first cure at the first assay, the increase in disease between first and second and first and third assays was significantly ($P<0.05$; $P<0.01$) less as it was for the third calculation ($P<0.05$). However, there was no significant ($P>0.05$) difference between treatments during the second and third cures even though the calculated mean percentage differences were observed to be less.

Between cultivars: As for any variation between cultivars (Table 2), there was a significant ($P<0.01$, $P<0.05$ and $P<0.05$ respectively) difference between treatments of 'Sweet Vidalia' with the heat treated onions having the lowest increase in disease infection between assays as compared with those onions conventionally cured. Also for 'Sweet Melody' though not significantly different the percentage means of increases were less for onions heat treated as compared with onions conventionally cured except between the first and third assays. Subtracting the percentage found at the first assay from the average found at the second and third assays gave a value of disease for the heat treated less than that for the conventionally cured onions.

Between durations of heat-treatment: Comparing durations of cure (Table 2), there were two durations for heat treated onions compared with the conventionally treated onions. Pairs of percentage disease infestations were compared. Neither pair was found to have a significant difference from the conventional, yet examining the least square mean percentages the increase in disease between first and second and first and third assays was less for the heat treated onions compared with the conventionally cured onions, both for those heat treated for 17 h and those heat treated for 24 h. However, comparing the benefits of one duration of cure over the other, the average increase in disease was less for the onions heat treated for 24 h (30 %) as compared with those heat treated for only 17 h (33 %) though these were not significantly different from one another.

Between set-point temperatures: Since two set point temperatures were used for the heat treated onion cures, each of these was compared in turn with the conventional (Table 2). Although there were no significant differences, comparing least square mean percentages the increase in disease between first and second and first and third assays was less for the heat treated onions than for the conventionally cured onions, both for those heat treated at 110 and those heat treated at 115 ^{0}F. Then comparing one set-point temperature with another, the increase in disease was less for the onions heat treated at 115 ^{0}F as compared with the increase in disease as found in the onions heat treated at 110 ^{0}F though these were not significantly different from one another.

Summary and conclusions

- Heat treatment of sweet onions was undertaken using a continuous flow dryer, in order to explore the effect of heat treating on a commercial scale. Approximately 125 bushels were cured on each of three occasions during the harvest season of 2001. For the three successive test runs, set - point temperatures of 110, 110 and 115 °F and durations of heat treatment of 17, 24 and 24 h were used. Each test run took up to 72 h with onions continually passing through the dryer, during this duration.

- Samples of cured onions were taken from the dryer at regular intervals and at prescribed storage intervals were inspected for the presence of *Botrytis allii* with the aid of a dye. However, no guarantee could be given that the colored detecting liquid was entirely impartial to other diseases besides *Botrytis*.

- Over all test runs, the increase in disease between the first and second and again between the first and third assays, was significantly less for those onions that received the heat treatment compared with those onions that were conventionally cured, implying that heat treatment had some effect upon the growth of disease in or on the onion bulbs.

- Of the two cultivars used, 'Sweet Vidalia' responded more favorably to heat treatment than 'Sweet Melody'.

- Between durations of heat treatment, 24 h tended to be better than 17 h and, between set-point temperatures, 115 °F tended to be better than 110 °F.

- The benefits of heat treatment were confounded by the presence of *Botrytis allii* inside the bulb. Even though some benefit may have been received from arresting the growth of surface *Botrytis allii* it is not known whether internal disease was influenced by the heat treatment since all onions eventually decayed under long term storage.

- The dryer was serviceable throughout the study and familiarization of operating peculiarities eventually became apparent. Nevertheless, constant monitoring of the temperature was required since ambient conditions influenced the temperature of the heated air in the dryer. Likewise the humidity of the heated air was also found to vary during storms or cold fronts passing through the area as was shown by the resulting complexion of the heated onions. Over-ride switches would from time to time shut down the fan and furnace, again requiring constant vigilance. The speed of the web was checked by painting a stripe across the onions on the web and timing their movement.

- Thin layer drying was selected for the high heat study because heated air could be directly blown over each onion bulb, ensuring the maximum effect of a high temperature. However the duration of heat treatment was insufficient to ensure complete curing. Therefore, to ensure that the bulbs are properly cured with a curing index of 5, and yet limit the heat treatment to 24 h, a combination of bin curing and controlled high heat treatment may be considered, first to dry the scales, neck and roots, then to heat treat. This combination recognizes that curing attempts to reduce the likelihood of further infestation of disease into the onion bulb whereas heat treatment attempts to minimize the growth of disease already present in or on the onion bulb.

Acknowledgements

Appreciation is expressed to Steven M. Bisesi of Macro Plastics Inc., for the availability of plastic pallet bins used during this study; to George Boyhan for preparatory work associated with the study; to Juan Carlos Díaz-Pérez for a supply of onions; to Randy Hill and Kirk Deal for harvesting arrangements at the Vidalia Onion and Vegetable Research Farm; to Manuel Hall for technical assistance with curing; to Bryan Horten for technical assistance with disease analysis; to Lee Norris of B.N.W. Industries for the loan and use of the continuous flow dryer; to Thad Paulk for assistance with storing, transporting and examining the onions; and to William Randle for essential references.

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Table 1. Curing indices for onions before and after heat treatment or conventional curing.

Test Run	Before Heat Treatment	Heat Treatment						Conventionally Cured
		3 h	8 h	11h	16 h	19 h	24 h	
1	1		2		3		4	5
2	1.5						4	3.5
3	1.5	3.5		4		4.5	5	4

Table 2. Least square mean percentages and associated standard errors (SE) of onion bulbs from sub-samples found to be infested with *Botrytis allii*.

				Assays				Assay Differences				
			N[1]	1	2	3	SE	2-1[2]	3-1[2]	SE	(2+3) / 2 -1[2]	SE
overall test runs/harvests		heat treated	170	30	39	84	1.82	9 **	54 *	2.57	31*	3.15
		conventional	27	22	51	90	4.50	29	68	6.36	49	7.79
between test runs/harvests[3]	1	heat treated	45	36	51	87	3.49	17 *	52 **	7.94	33 *	6.05
		conventional	9	7	55	92	7.79	48	85	7.10	66	13.56
	2	heat treated	62	32	39	91	2.97	9	59	4.20	33	5.15
		conventional	9	35	52	92	7.79	17	57	11.10	37	13.56
	3	heat treated	63	24	28	73	2.95	4	49	4.18	26	5.12
		conventional	9	24	47	87	7.79	23	63	11.10	43	13.56
between cultivars	Sweet Vidalia	heat treated	108	29	38	79	2.47	9 **	50 *	3.50	29 *	4.29
		conventional	18	15	51	89	6.05	35	74	8.56	54	10.49
	Sweet Melody	heat treated	62	32	39	91	3.26	9	59	4.61	33	5.65
		conventional	9	35	52	92	8.56	17	57	12.11	37	14.83
between durations of heat treatment	17 h	heat treated	45	36	51	87	3.49	17	52	4.94	33	6.05
	24 h	heat treated	125	28	34	82	2.96	6	54	4.19	30	5.13
		conventional	27	25	51	91	6.75	26	66	9.55	46	11.70
between set-point temperatures	110 °F	heat treated	107	34	45	89	2.29	13	55	3.24	33	3.97
	115 °F	heat treated	63	21	22	75	3.73	1	54	5.28	27	6.47
		conventional	27	25	51	91	6.75	26	66	9.55	49	11.70

[1]Number of samples where each consisted of 25 onions.
[2]All differences are between heat treated and conventional curing treatments, using the unequal N-unequal variance t-test (Steel and Torrie, 1960) except for the two bottom groups (durations of cure and set-point temperature) where three pair-wise comparisons are made among the three means.
*, ** denote significant differences at $P<0.05$ and $P<0.01$.
[3]cure/harvest 1 = 'Sweet Vidalia', 17 h duration of cure and 110 °F set-point temperature; cure/harvest 2 = 'Sweet Melody', 24 h duration of cure and 110 °F set-point temperature; cure/harvest 3 = 'Sweet Vidalia', 24 h duration of cure and 115 °F set-point temperature.

Figure 1. Continuous flow drier used for the heat treatment study of sweet onions, with holding hopper on the right hand side and receiving pallet bins on the left hand side.

Figure 2. Pallet bins receiving onions following the heat treatment.

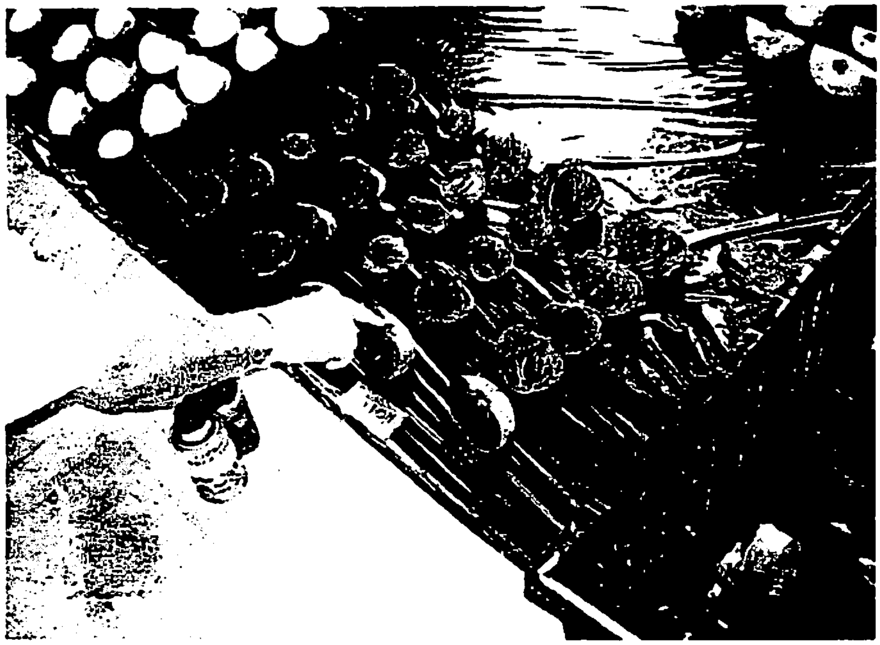

Figure 3. Onions of a sub-sample prepared for the identification of *Botrytis Allii* .

DOWN-DRAFT IN-BIN CURING OF SWEET ONIONS

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Introduction

Artificial curing of onions at the Vidalia Onion and Vegetable Research Station calls for curing odd lots of onions of different varieties and quantities on different days throughout the harvesting season. Onions are, to this date, harvested by hand according to the availability of labor. Onions are harvested into open mesh bags and may be partially cured in the field either following undercutting as the onions lay on the bed, or after clipping and bagging as the onions in the bag are waiting for collection.

During 2001 and 2002, plastic pallet bins (Model TM 34, Macro Plastics, Fairfield, California) of capacity 55,940 in.^{3}, of external dimensions 48 x 44.5 x 34.75 in. with an internal depth of 29.5 in., were introduced to the farm as an alternative to harvesting into bags, although onions in bags could still be handled by placing the bags into the bins. Therefore a means of curing the onions in the bins was sought.

Curing in bins was first attempted by placing the bins on a plenum and forcing heated air up through the small holes in the base of the bin, the air then being exhausted from the open top of the bin (Maw, 2001). This has been successfully undertaken at the Coastal Plain Experiment Station, Tifton, since 1998. However, mounting the bins on the plywood plenum requires a certain level of care and attention so as to protect the integrity of the plenum. A system was then sought whereby the bins could be handled by forklift and put on to cure with there being less chance of misalignment on the plenum or breakage of the plenum.

Materials and Methods

During 2001 two down-draft curing plenums were designed and built (Nolin Erection services at Ashburn, Georgia) and delivered to the Vidalia Onion and Vegetable Research Station, Tattnall county, Georgia. Each had the provision of taking heated air from a Peerless Crop Dryer and delivering it to eight bins placed on the floor under each of eight vent hoods. The plenum was 30 ft long, and even though a maximum of eight bins of onions could be cured at once (Figure 1), a less number could be accommodated by blocking the passage of air from any unused vents by simply twisting and tying closed the vent canopy. The pallet bins could be handled by a rough terrain forklift from the field to the curing location and the bins simply placed under the plenum (Figure 2). For fewer bins the same airflow could be maintained by venting the supply or reducing the speed of the fan. Each plenum was constructed of sheet steel in a cylindrical manner and diminished in diameter from the entrance to the furthest vent hood. The vent hoods were clamped onto the upper open area of a bin in order to provide an airtight seal.

Although the plastic bins were delivered with holes in the sides as well as the base that act as vents, in preparation for use the side wall vents were covered with plywood and duct tape to ensure that all air passed among the onions and out through the vent holes base of the pallet bin. There was no re-circulation of air from the bin back through the system thus heated air was lost once exiting the bin. However, the small area of vents (approximately 4 %), in comparison with the total area of the base of the bin, provided sufficient back pressure to enable a uniform distribution of air among all the onions throughout the inside the bin.

Duration of cure is gaged according to the stage of maturity of the onions and the condition of cure of the onions before being artificially cured (Maw et al., 1997b). Recommended conditions for curing are 100 ^{0}F heated air with 0.75 in. back pressure. Curing is considered to be complete when the onion outer scales are crisp and dry with the neck fully dry and folding over onto the shoulder of the onion bulb(Maw et al. 1997a).

Forty pallet bins were delivered to the farm on February 22nd, 2001 in time for the 2001 harvest season. They have been in use since then.

Results and Discussion

Compared with the 2000 harvest season when approximately 384 bushels of onions were cured using a conventional peanut dryer and drying wagon, with the introduction of the down-draft curing in pallet bins, drying capacity was increased. In 2001, using one overhead unit approximately 1080 bushels were dried. In 2002 with the second curing system installed, approximately 1952 bushels of onions were dried. In terms of pallet bins during the two seasons, this translates to an estimated 120 pallet bins of onions that were cured by the two down-draft drying systems over the two years.

By curing in pallet bins, batches of onions were kept separate from one another, thus reducing the possibility of bacterial diseases spreading from one batch to another. Even though one batch may have been found to be infested, that batch was cured in isolation from other onions. The down-draft system also ensured that, should the curing air be carrying disease organisms, it was exhausted from the system.

Serviceability of the curing system was commendable during the period of use. Using a forklift, there was flexibility in the position of the bin in relation to the plenum because the vent hoods, made of robust canvas covered with plastic, have ample material so as to enable an tight fit of the hood in a range of bin positions.

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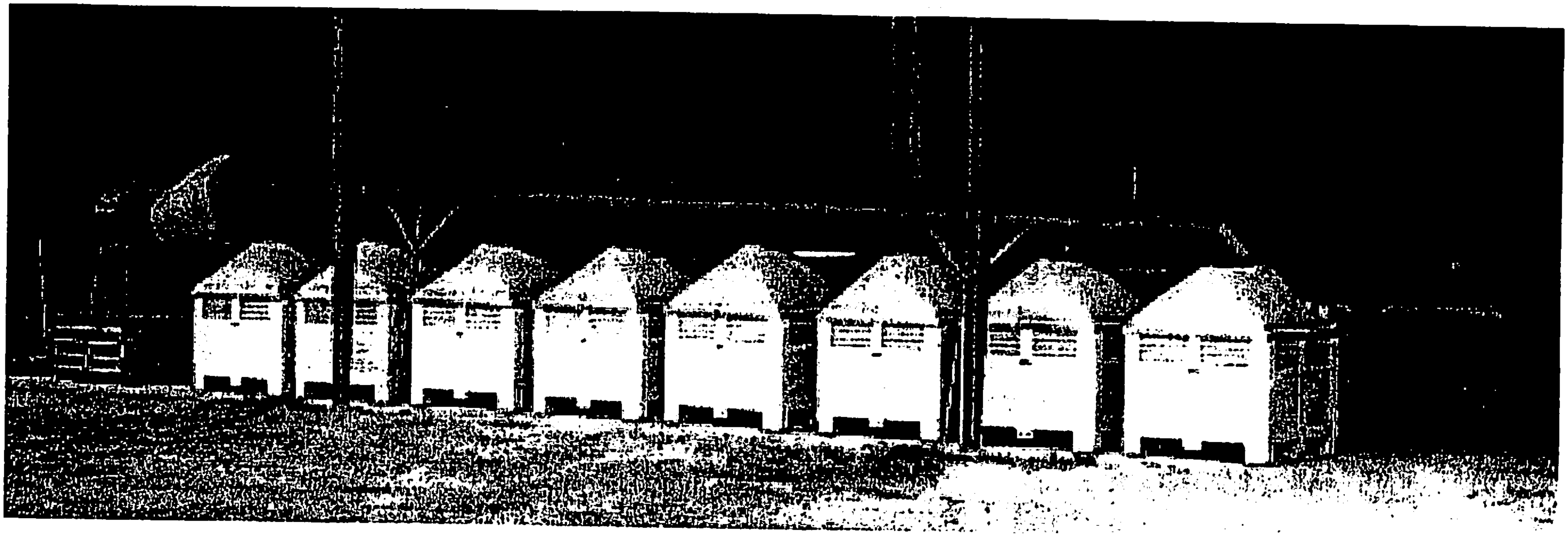

Figure 1. Down-draft plenum with hoods over each bin of onions. A second plenum is visible behind the first.

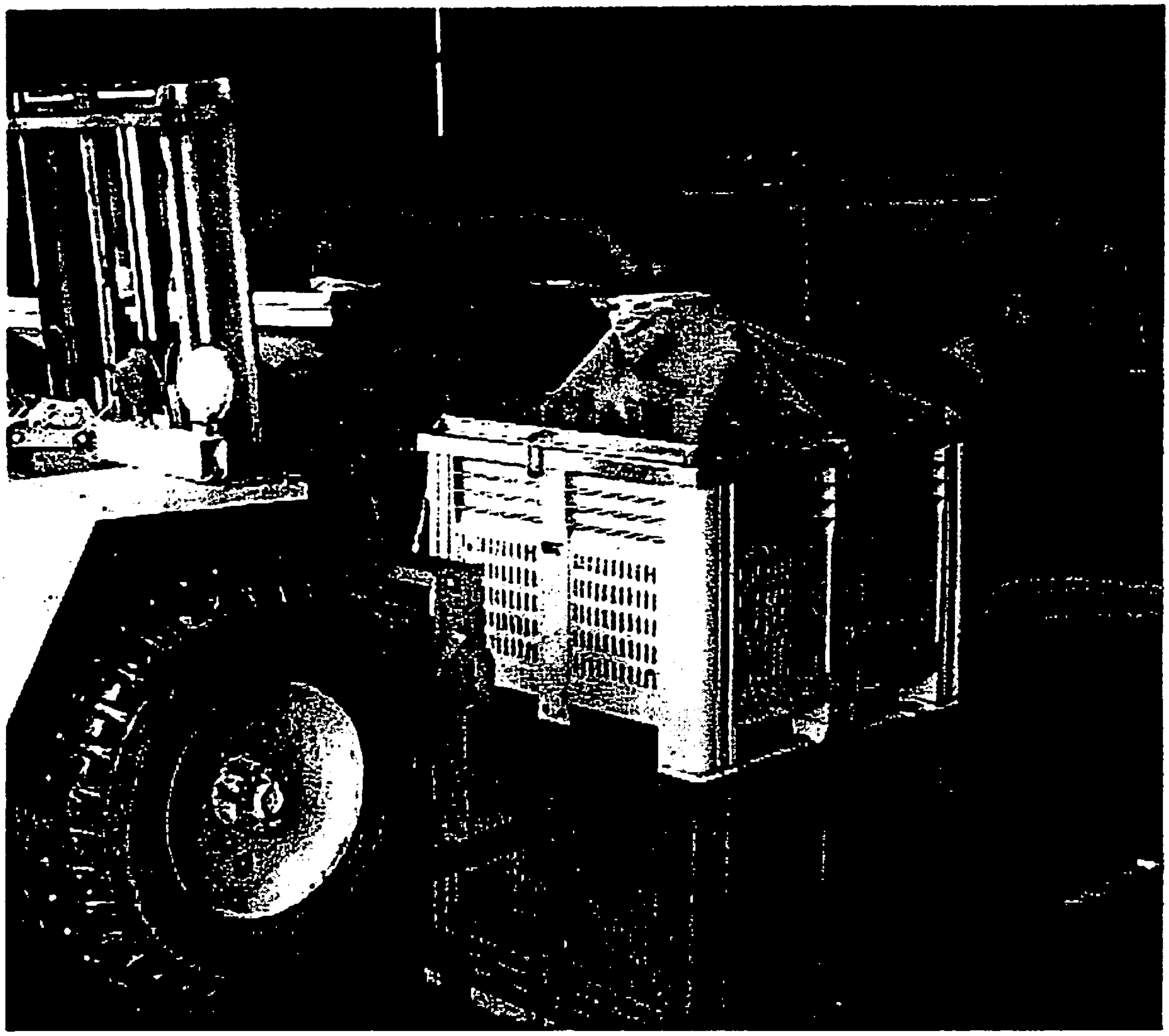

Figure 2. The pallet bins are handled by rough terrain forklift from the field to the curing location and the pallet bins simply placed under the plenum.

TRANSLUCENT SCALE IN VIDALIA ONIONS

Al Purvis, Research Horticulturalist
Thad Paulk, Research Technician

Introduction

Translucent scale of onions is a physiological disorder that may appear during cold storage. It is characterized by a clearing and water soaking of the normally opaque cells of the fleshy internal scales. Although the symptoms are similar to freezing injury, freezing injury usually affects the outer fleshy scales first whereas translucent scale is found in the second, third or even more inner scales. Furthermore, translucent scale has been observed when the storage temperature has been maintained well above the freezing point of the onion fleshy scale (approximately 30 °F or -1 °C). Predisposing factors for the development of translucent scale during storage 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 to 4 week delay between curing and cold storage (Lipton and Harris, 1965). Several workers have reported internal breakdown or watery scales in onions stored in atmospheres containing 3% O_2 + 10% CO_2 for 6 to 8 months (Chawan and Pflug, 1966; Adamicki and Kepka, 1973; Smittle, 1988; Hoftun, 1993). In all cases the onions were stored at 32 to 34 °F (0 to 1 °C), except for Smittle's (1988) which were stored at 40 °F (5 °C).

Materials and Methods

'Savannah Sweet' onions were undercut and field cured for two 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 and the large and jumbo onions were randomly sorted into eight groups of 40 onions. Each group was weighed and placed in 8-gallon (32-liter) plastic containers and the containers were placed in a 34 °F (1 °C) room to temperature equilibrate overnight. The containers were sealed and four were flushed with air and the other four with air containing CO_2 until the CO_2 concentration reached ~10%. The O_2 and CO_2 levels were monitored every three days and are shown in Fig. 1. No attempt was made to control the relative humidity, which was probably over 85%. After 13 weeks the onions were removed from the containers, weighed and rewarmed by blowing room temperature (80 °F or 27 °C) air across them. The onions were re-weighed and the external surface of each onion was examined for evidence of infection with *Botrytis allii* (neckrot), *Penicillium* spp. (blue mold), *Aspergillus niger* (black mold), and *Psuedomonas cepacia* (sour skin). Each onion was then cut in half and examined for translucent scales and internal rots.

Results

Weights before and after storage and after rewarming are shown in Table 1. All of the onions which had been stored in ~10% CO_2 exhibited internal breakdown or translucent scale (Fig. 2). No attempt was made to quantify the severity of the disorder, but all onions had two or more scales with a grayish watery texture which made them appear translucent. With many onions the disorder appeared to progress down from the neck tissues (Fig. 3). None of the onions stored in ~10% CO_2 showed any fungal growth or sporulation on the external surface (Fig. 4A and Fig. 4B). In contrast, all of the onions which had been stored in air were mostly covered with sporulating mycelia of *Botrytis allii*, *Penicillium* spp., or both (Fig. 5A and 5B). However, none of the onions which had been stored in air alone exhibited translucent scale.

Discussion

Previous studies have implicated high CO_2 as a causal factor in the development of translucent (or watery) scale in stored onions, but the results were confounded by a low (~ 3%) O_2 concentration in the storage room atmosphere. Results of our study show clearly that translucent scale is associated with high CO_2 and not low O_2 in the storage atmosphere.

High CO_2, however, was beneficial in inhibiting growth and sporulation of *Botrytis allii* and *Penicillium* spp. on the surface of onions. We have previously shown that *Botrytis allii* does not produce conidia (spores) in an atmosphere of 3% O_2 + 5% CO_2 (Purvis and Brock, 2002). High CO_2 (15% to 20%) has been used to control mold growth on strawberries during shipping. However, some cultivars of strawberries are sensitive to high CO_2 and undergo anaerobiosis, producing ethanol and other anaerobic metabolites, even in the presence of normal O_2 concentrations. It is not known if all cultivars of onions are sensitive to high CO_2, but the range of studies that have been conducted so far suggest that they may be. However, the level of CO_2 and the length of storage required for injury to occur may differ for different cultivars. Adamicki and Kepka (1973) suggested that the internal disorder was due to the combined effects of high CO_2 concentrations, low temperature, and a relatively long period of storage. With the long-day storage onions, the disorder was not observed after 162 days of storage, but was after 220 days (Adamicki and Kepka, 1973) and at 34 °F (1 °C), but not at 41 °F (5 °C) (Chawan and Pflug, 1966; Adamicki and Kepka, 1973). In contrast, Smittle (1988) reported that onions stored in 3% O_2 + 10% for 6 months at 41 °F (5 °C) exhibited 6% internal breakdown upon removal from storage and 10% internal breakdown after an additional 3 or 4 weeks at room temperature. In our study, all onions stored in 10% CO_2 at 34 °F (1 °C) exhibited translucent scale after 4 months. Thus, short-day onions with high moisture and sugar contents may be more susceptible to internal breakdown than long-day onions with lower moisture and sugar contents.

Translucent scale may be a greater problem in refrigerated storage rooms without CA than in CA rooms. Translucent scale has not been reported at the current recommended storage atmospheres (5% CO_2 + 3% O_2). CO_2 is a product of respiration and although onions respire more slowly at low temperatures, in tightly sealed rooms they will consume most of the O_2 present and produce an equivalent amount of CO_2. An example of translucent scale occurring in a tightly sealed refrigerated room (without CA) is shown in Fig. 6A and 6B. Symptoms are similar, if not identical, to those occurring in atmospheres containing 10% CO_2 (compare with figs. 2 and 3). Thus, unless fresh air exchanges are provided during storage in rooms without CA there can be a buildup of CO_2 in the storage room.

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Table 1. Initial weights, weights after storage and weights after re-warming from storage, along with associated standard deviations.

Treatment	Initial Weight (lbs)	13 Weeks After Storage Weight (lbs)	13 Weeks After Re-warming Weight (lbs)
Air	12.0 ± 1.75	11.7 ± 1.65	11.4 ± 1.63
~10% CO2	12.6 ± 0.58	12.4 ± 0.58	12.2 ± 0.38

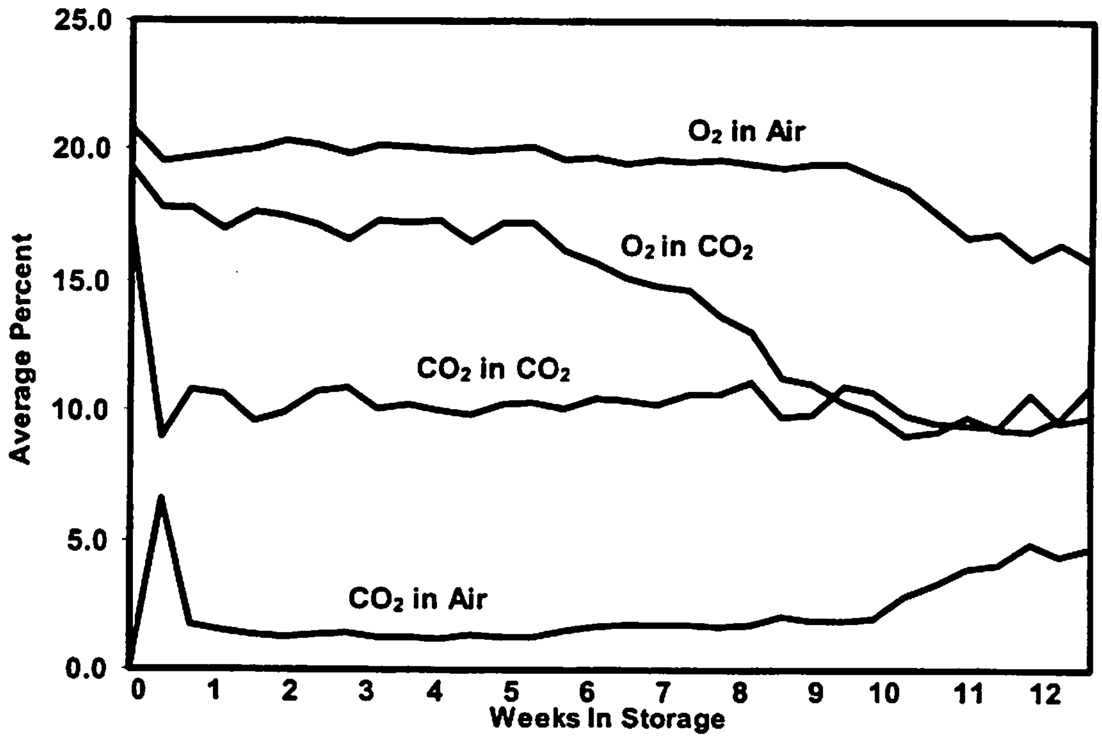

Figure 1. Mean composition of the atmosphere in each container of onions according to time in storage.

Fig. 2. Internal breakdown or translucent scale in onions stored at ~10% CO_2.

Fig. 3. Internal breakdown or translucent scale progression down from neck tissue.

Fig. 4A. Onions stored in ~10% CO_2 showed no fungal growth on the external surface.

Fig. 4B. Onions stored in ~10% CO_2 showed no fungal growth on the external surface.

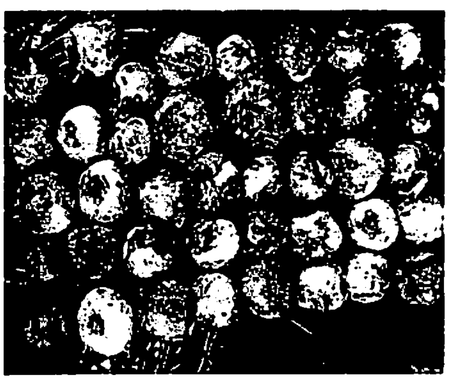

Fig. 5A. All onions stored in air were infected externally with *Botrytis allii*, *Penicillium* spp., or both.

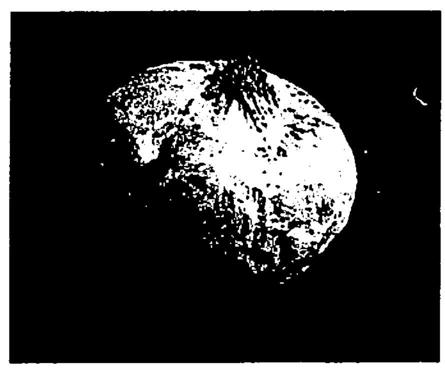

Fig. 5B. All onions stored in air were infected externally with *Botrytis allii*, *Penicillium* spp., or both.

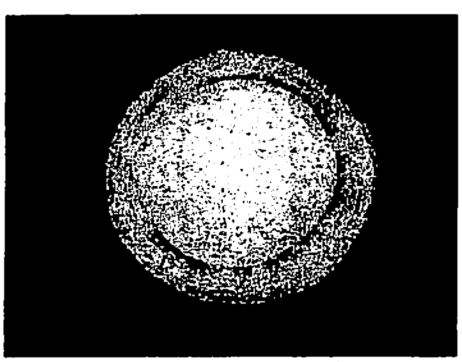

Fig. 6A. Translucent scale occurring in a tightly sealed refrigerated room (without CA).

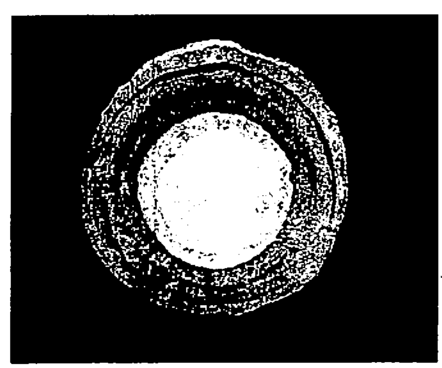

Fig 6B. Translucent scale occurring in a tightly sealed refrigerated room (without CA).

THRIPS THRESHOLD TREATMENT IN ONION

David Riley, Research Entomologist

Introduction

Thrips control in Vidalia onions is not always justified because some years the number of thrips does not reach economically damaging levels. It is beneficial to manage thrips on onions by include thrips counts as part of a regular scouting program so that insecticides are applied only when required. Applying insecticides only as required is especially important for thrips since the over use of insecticides can lead to chemical resistance and potentially higher numbers of thrips than if no treatments were made at all. Even though the over all numbers of thrips were moderately low in the Spring of 2002, the testing of thresholds showed how spray costs can be reduced.

Materials and Methods

Small plots of 'Granex 33' sweet onions, each plot 40 ft in length, were treated as follows in a randomized complete block design. There were eight treatments:- 1) untreated check, 2) sprays of Warrior 3.8 oz/acre and Atrapa 2 pt/acre by calender, 3) sprays of Warrior 3.8 oz/acre and Atrapa 2 pt/acre at one thrip per plant, 4) sprays of Warrior 3.8 oz/acre and Atrapa 2 pt/acre at one then five thrips per plant, 5) sprays of Warrior 3.8 oz/acre and Atrapa 2 pt/acre at five thrips per plant, 6) calendar sprays of Novaluron 0.19 lb ai/acre, 7) calendar sprays of Novaluron 0.14 lb ai/acre, 8) calendar sprays of Novaluron 0.09 lb ai/acre. Thrips numbers, number of sprays, weight of marketable onion yield, and estimated return per acre were evaluated. Novaluron is a reduced risk benzoylphenyl urea that inhibits chitin formation in the exoskeleton of insects.

Results and Discussion

Even though thrips were low and no significant differences was observed in the overall yields, there was a significant increase in jumbo bulbs in the Novaluron treatments. This occurred even without a significant reduction in thrips over many dates. The two thresholds of five thrips or one, then five thrips per plant, significantly reduced insecticide costs.

Table 1. Mean thrip counts, total number of sprays, total weight of onions and number of jumbos found during the thrips threshold study on onions.

Treatment	Thrips per 5 plants March 12	Thrips per 5 plants April 2	Total number of sprays	Total wt (lb) onions/10 ft	Total number of jumbos
1. Untreated	12.3 a	31.3 a	0	27.6 a	6.4 b
2. Calendar	5.8 b	14.5 c	6	21.3 a	6.7 b
3. 1 thrips	9.0 ab	23.8 ab	6	24.1 a	7.1 b
4. 1 then 5 thrips	5.5 b	20.5 bc	2	28.9 a	6.4 b
5. 5 thrips	9.8 ab	19.3 bc	2	28.4 a	6.6 b
6. Novaluron 0.19	9.0 ab	29.5 a	6	32.9 a	14.1 ab
7. Novaluron 0.14	7.3 b	24.0 ab	6	29.9 a	17.9 a
8. Novaluron 0.09	7.8 b	24.3 ab	6	28.2 a	16.0 ab

Means followed by same letters not significantly different LSD, $P<0.05$ (3 reps used for jumbo counts, treatment effect $P<0.1$).

LACHRYMATORY FACTOR ANALYSIS AS AN ALTERNATIVE TO PUNGENCY ANALYSIS TO DETERMINE ONION FLAVOR

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Matthew M. Turner, Research Assistant
Kimberly D. Peppers, Research Assistant
Jamie S. Mason, Research Assistant

Introduction

Research has shown that Gas Chromatography (GC) may be used to analyze the Lachrymatory Factor (LF) in onions as a means of measuring the pungency in onion flavor. The LF is the chemical in onions that makes eyes water when onions are cut or crushed. The GC method has the potential of replacing the pyruvic acid test method for measuring pungency in onion flavor, a method which uses spectrophotometric equipment.

Pungency analysis measuring pyruvic acid has long been used to chemically determine onion flavor. In this method an onion is crushed and the concentration of pyruvic acid from the enzymatic reaction is determined using spectrophotometry. Pyruvic acid is produced from the enzymatic reaction of alliinase with three flavor precursors. This reaction has been extensively studied by Block (Block 1992). The pungency analysis was first adapted to onions by Schwimmer and Weston (1961) and modified by Randle and Brussard (1993). It is easy to perform and is currently the only method shown to correlate with flavor perception in people (Wall and Corgan, 1992).

Nevertheless, the pyruvic acid test method is, under most circumstances slow, requiring 10 minutes for the enzyme to react with the flavor precursors and an additional time for quantification of the pyruvic acid formed, using a number of expensive chemicals. It is known that researchers take shortcuts and do not always analyze standards along with their samples. In this case, errors in the concentrations of the reagents used may alter the results of the analysis. Furthermore, the pyruvic acid test method results are dependant upon whether the onion sample is crushed or blended (Schmidt et al. 2000). Therefore, although a commonly accepted method, the pyruvic acid test method has drawbacks.

Investigations have been underway on the measurement of the LF as an alternative to that of measuring pyruvic acid for evaluation of pungency in onion flavor. The LF is formed when one of three onion flavor precursors, 1-propenyl-S-cysteine sulfoxide reacts with the enzyme alliinase. This is a fast chemical reaction which has been extensively studied by Block and coworkers (Block, 1996). It should be noted that in most onions the amount of LF should be roughly similar to that of the pyruvic acid produced It has been shown that the LF may be quickly analyzed using gas chromatography, without the use of a background analysis, (Schmidt et al. 1996). In this procedure onion juice is extracted a single time with 0.010% m-xylene in methylene chloride, briefly centrifuged and injected into a GC having a flame ionization detector. The concentration of LF is determined by comparing the peak area of the LF with that of the internal standard.

In comparison with the pyruvic acid test method the GC method is faster. With the GC method it may take only five minutes from the crushing of onions to the point at which numbers are obtained. A new sample may started every five minutes. With the pyruvic acid test method it may take 10 minutes for the enzyme reaction to occur with the flavor precursors and an additional time of 30 minutes or more for quantification of the pyruvic acid formed, using a number of expensive chemicals.

In comparison with the pyruvic acid test method the GC method is more accurate. With the GC method, only a single solution is used in the entire procedure, with no dilutions. With the pyruvic acid test method two different solutions are used. Thus using fewer solutions and dilutions the odds of error in the procedure are decreased.

However, as a disadvantage, in comparison with the pyruvic acid test method the GC method may be more demanding upon laboratory management. The time allowed for the enzyme to react until the sample is extracted is critical (Randle et al. 2002). If the sample is extracted too soon, then not all the flavor precursors will have reacted with the enzyme and the measured amount of LF will be low. If the sample is extracted too late, then some of the LF will be lost due to volatilization and the measured amount of LF will also be too low.

Also as a disadvantage, in comparison with the pyruvic acid test method the GC method may be more expensive to undertake since the cost of GC equipment is greater than that of spectrophotometric equipment. A GC may presently cost a minimum of

$10,000 while a good spectrophotometer may cost only $2,000. Therefore, the cost per sample using a GC will be higher.

A study has been undertaken to more clearly evaluate the benefits of the LF method of analyzing pungency in onion flavor in comparison with the pyruvic acid test method.

Materials and Methods

Onions were grown at the Vidalia Onion and Vegetable Research Farm. The onions were all of the cultivar Pegasus and were harvested May 2nd, 2002 and graded on May 9th, 2002. All chemicals were reagent grade or superior. Samples of onions were placed into the cylinder of an onion crusher, constructed by a local machine shop. A piston was pushed down upon the sample using a manual lever. Screens were placed in the bottom of the cylinder to separate the onion solids from the juice. The juice was directed out of the cylinder with a slot in the bottom of the cylinder, below the screens, into a waiting beaker. The crusher was thoroughly cleaned between each sample to prevent contamination.

The juice collected in the beaker was then divided into two samples. The LF sample was collected approximately 15 seconds after the onion was crushed to collect the maximum amount of LF (Kopsell, Randle and Schmidt, 2002). The pyruvic acid sample was collected approximately ten minutes after the onion was crushed and analyzed using the method of Randle and Bussard (1993).

The LF sample was a 3 mL aliquot of juice extracted a single time with 3 mL of 0.010% (v/v) *p*-cymene in methylene chloride. The extract is then centrifuged and the lower methylene chloride layer removed. A 1.0 mL sample was analyzed by GC within minutes of when the onion was crushed. A Hewlett-Packard 5890 Series II Gas Chromatograph was used for all analysis. A split injector was used at a temperature of 200°C. The GC employed a 5 m x 0.54 mm i.d. OV-1 column, and 99.999% He carrier gas at a flow rate of 10.4 mL/min. The GC oven temperature was set at 40 °C for 1 min and then increased at 10°C/min to 90°C. This program could be varied so that sample analysis was complete in 2.0 minutes. With a 5.0 minute temperature program a better resolution was obtained. The detector was a flame ionization detector (FID) maintained at a temperature of 250 °C.

Results and Discussion

A typical graph of LF concentration vs pungency is shown in figure 1. This graph has a correlation coefficient, r^2, of 0.83 and a non-zero intercept. The relatively high value of r^2 shows that there is a significant correlation between the LF concentration and the pyruvic acid concentration. Therefore, an onion can be analyzed for the LF produced rather than the pyruvic acid produced and get similar results for determining onion flavor.

The graph has a slope of 1.6 showing that there is a slightly greater increase in LF concentration for a given concentration of pyruvic acid which is not totally understood. Assuming that all pyruvic acid comes from the 1-propenyl-cysteine sulfoxide which also produces the LF, then the amount of LF and pyruvic acid should be the same. However, Lancaster et al (1998) have shown that the hydrolysis reactions producing the pyruvic acid are incomplete. Therefore, for a given amount of flavor precursor the amount of LF could be greater than the amount of pyruvic acid produced producing a slope greater than 1.

The non-zero intercept is most likely results from two factors: lower amounts of LF at low pyruvic acid concentrations or incomplete extraction from onion juice. It has been shown that at low sulfur concentrations plants have lower pungencies and the amount of LF decreases because the distribution of flavor precursors changes. At high sulfur levels onions will produce almost exclusively 1-propenyl cysteine sulfoxide, but at low sulfur levels onions produce a lower proportion of 1-propenyl cysteine sulfoxide and higher levels of flavor precursors which do not produce the LF. Therefore, at low sulfur levels, one would expect to find lower pyruvic acid concentrations and almost no LF, which is what we have found.

It should also be noted that because we have only extracted the onion juice once with methylene chloride it is possible that not all of the LF has been removed from the onion juice. Thus, even if a small amount of LF is produced it is possible that our current method does not analyze for very small amounts of LF.

Conclusions

Compared with the pyruvic acid test method of measuring pungency in onion flavor, the GC method proved to be fast, simple, and quite reliable. No background analysis was necessary. The method gave results that could be correlated with pungency and thus results that were related to onion flavor. As a disadvantage, since some volatilization of samples was inevitable, if multiple extractions were to have been taken the analysis time would have been increased. The overhead costs of the GC method of analysis may also have been higher. Nevertheless, the GC method of analyzing the LF produced in an onion is a reasonable alternative for determining the pungency in onion flavor as compared with the conventional pyruvic acid test method.

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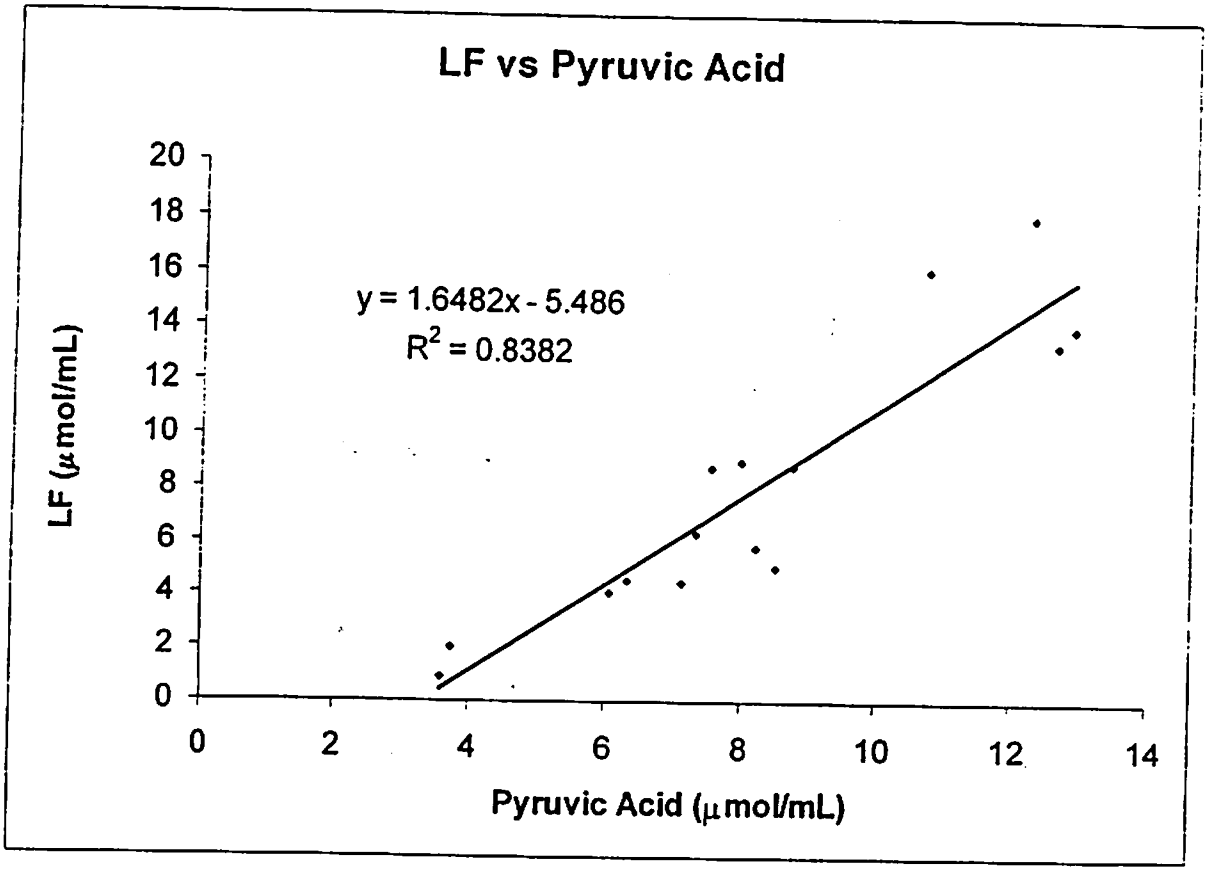

Figure 1. LF concentration vs Pyruvic Acid concentration. The diamonds are experimental data points while the line is best fit of a linear model to the data.

EXPERIMENTAL FUNGICIDES FOR THE CONTROL OF FOLIAR DISEASES OF ONION AND BOTRYTIS NECK ROT ON SWEET ONION

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Bryan Horten, Research Technician

Introduction

An experiment was conducted to evaluate two experimental fungicides for the control of Botrytis Leaf Blight (BLB), caused by *Botrytis squamosa*; Purple Blotch (PB), caused by *Alternaria porri*; and Stemphylium Leaf Blight (SLB), caused by *Stemphylium vesicarium*. The latter two diseases can occur simultaneously and have nearly identical symptomology; therefore, they were evaluated as one complex in this experiment.

Materials and methods

The trial was conducted at the Vidalia Onion and Vegetable Research Farm, Lyons, Georgia. Onions (*Allium cepa* "Sweet Vidalia) were transplanted into 4-row beds on December 4th, 2001. Beds were spaced on 6 foot centers, and row spacing on individual beds was 12 inches. Plant spacing within rows was 6 inches. Fertility, weed, and insect control was carried out according to guidelines published by the Georgia Cooperative Extension Service. Each plot consisted of a single 20-foot bed with a 5-foot buffer between plots. The experimental design was a randomized complete-block with 6 replications.

Fungicide applications were initiated on February 4th, 2002 and continued on a 7-10 day spray schedule until April 15 for a total of 8 applications. All materials were applied with a CO_2-powered backpack sprayer using a 4-nozzle spray boom with 18-inch nozzle spacing. Hollow cone nozzles (TSX-26) were used, and application volume was 40 gallons per acre (GPA). All plots, with the exception of the untreated check plot, received 2.0 lb per acre of ManKocide on a bi-weekly basis.

The center two rows of each plot were harvested on April 24th, and onions were cured for 72 hours at 100° F before weighing and grading.

Results and discussion

Cold temperatures in late February and early March contributed to significant levels of damage to onion foliage in the Vidalia region. A severe epidemic of Stemphylium leaf blight (caused by *S. vesicarium*), complexed with Purple blotch (caused by *Alternaria porri*) caused significant losses in the region and at the Vidalia Onion and Vegetable Research Farm.

In general, the fungicides used in this experiment significantly reduced the severity of Botrytis leaf blight (BLB) and the Purple blotch/Stemphylium leaf blight complex (PB/SLB) (Table 1). The tank mix of AMSF187 15WG (2.85 oz/A) and AMS 21618 480SC (3.42 oz/acre) plus Induce (0.06% vol/vol) reduced the severity of BLB and PB/SLB at the final evaluation of disease by 24% and 41%, respectively, as compared with the untreated check, and performed as well as the commercial standard (Bravo/Rovral/ManKocide). No differences were seen between fungicide treatments in terms of season-long control of BLB or PB/SLB (Table 1).

The analysis of variance performed on yield was not significant at P=0.05, but was significant at P=0.09. The tank mix of AMSF187 15WG (2.85 oz/A) and AMS 21618 480SC (3.42 oz/acre) plus Induce (0.06% vol/vol) had the highest total yields, reported as the number of 40-pound boxes harvested per acre; however, no differences were seen between any treatment with regards to the number of jumbo- or medium-grade onions harvested (Table 2). All fungicide treatments significantly reduced the severity of Botrytis neck rot, caused by *Botrytis allii* on onions that had been stored at 5° C for 5 months.

Summary and Conclusions

In conclusion, the tank mix of AMSF187 15WG (2.85 oz/A) and AMS 21618 480SC (3.42 oz/acre) plus Induce (0.06% vol/vol) appears to have potential as a management tool for foliar diseases of sweet onion. Further work should be considered to identify optimal rates and performance with currently registered fungicides, such as Rovral, against foliar, soilborne, and post-harvest diseases of onion.

Table 1. Severity of Botrytis leaf blight and Purple blotch/Stemphylium leaf blight in sweet onions treated with experimental fungicides. Experiment ONN02001, Vidalia Onion and Vegetable Research Farm, 2002.

Trt	Material	Application timing[a]	Product rate	Final disease (4/15/02)[b] BLB[d]	Final disease (4/15/02)[b] PB/SLB[d]	Percent control[c] BLB[d]	Percent control[c] PB/SLB[d]
1	Untreated Check (UTC)	--		29.3 a	54.7 a	0 a	0 a
2	AMSF187 15WG	A-I	2.85 oz /A	22.3 b	32.3 bc	36.1 b	32.5 c
	AMS21618 480SC	A-I	3.42 fl oz /A				
	ManKocide	B,D,F,H	2.0 lb/A				
	Induce		0.06% vol/vol				
3	AMSF187 15WG	A-I	3.81 oz /ha	20.3 b	37.7 b	36.1 b	27.3 bc
	AMS21618 480SC	A-I	3.42 fl oz /A				
	ManKocide	B,D,F,H	2.0 lb/A				
	Induce	A-I	0.06% vol/vol				
4	AMS21618 480SC	A-I	3.42 fl oz /A	23.3 b	33.0 bc	39.3 b	27.3 c
	ManKocide	B,D,F,H	2.0 lb/A				
	Induce	A-I	0.06% vol/vol				
5	Bravo Weatherstik 720F	A-I	1.5 pt/A	25.3 ab	37.7 b	36.1 b	19.5 b
	ManKocide	B,D,F,H	2.0 lb/A				
6	Bravo Weatherstik 720F	A,C	1.5 pt/A	21.7 b	29.2 c	39.3 b	28.6 c
	Bravo Weatherstik 720F	B,D,F,H	1.5 pt/A				
	ManKocide	B,D,F,H	2.0 lb/A				
	Rovral 4F	E,G,I	1.5 pt/A				
			P-value	0.09	0.0001	0.0001	0.0009

[a]Applications made on a 7-10 day schedule, where A=application 1 and I=application 9.
[b]Percent diseased leaf area at the final evaluation of disease (4/15/02).
[c]Percent control of disease based upon season long measurements of disease, calculated from the area under the disease progress curve. A total of 6 disease evaluations were made beginning on 3/6/02 and ending 4/15/02.
[d]BLB=Botrytis leaf blight, PB/SLB= complex of Purple blotch and Stemphylium leaf blight.

Means followed by the same letter do not differ significantly as determined by Fisher's protected least significant difference test (P value listed for each variable).

Table 2. Effect of experimental fungicides on yield and yield quality of sweet onions. Experiment ONN02001, Vidalia Onion and Vegetable Research Farm, 2002.

Trt	Material	Application timing[a]	Product rate	Yield (Boxes/A)[b]		
				Total	Jumbo	Medium
1	Untreated Check (UTC)	--		600.8 b	394.2 a	100.4 a
2	AMSF187 15WG	A-I	2.85 oz /A	739.3 a	507.6 a	104.1 a
	AMS21618 480SC	A-I	3.42 fl oz /A			
	ManKocide	B,D,F,H	2.0 lb/A			
	Induce		0.06% vol/vol			
3	AMSF187 15WG	A-I	3.81 oz /ha	680.6 ab	473.4 a	92.0 a
	AMS21618 480SC	A-I	3.42 fl oz /A			
	ManKocide	B,D,F,H	2.0 lb/A			
	Induce	A-I	0.06% vol/vol			
4	AMS21618 480SC	A-I	3.42 fl oz /A	624.4 b	438.6 a	94.7 a
	ManKocide	B,D,F,H	2.0 lb/A			
	Induce	A-I	0.06% vol/vol			
5	Bravo Weatherstik 720F	A-I	1.5 pt/A	614.7 b	410.8 a	127.1 a
	ManKocide	B,D,F,H	2.0 lb/A			
6	Bravo Weatherstik 720F	A,C	1.5 pt/A	654.6 b	463.7 a	111.6 a
	Bravo Weatherstik 720F	B,D,F,H	1.5 pt/A			
	ManKocide	B,D,F,H	2.0 lb/A			
	Rovral 4F	E,G,I	1.5 pt/A			
			P-value	0.09	0.7	0.9

[a]Applications made on a 7-10 day schedule, where A=application 1 and I=application 9.
[b]Yield of onions reported as the total number of 40-lb. boxes per acre, broken down further into jumbo and medium grades (no. of 40-lb. boxes). Onions grading out smaller than medium were not weighed.

Means followed by the same letter do not differ significantly as determined by Fisher's protected least significant difference test (P value listed for each variable).

CLASSIFICATION OF ONIONS BASED ON INTERNAL DEFECTS USING COMMERCIAL X-RAY INSPECTION EQUIPMENT

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Ron Gitiatis, Research Plant Pathologist

Introduction

Maintaining product quality is the key to success in fresh fruit and vegetable marketing. Some onion packing -houses are considering the addition of x-ray inspection to their existing optical inspection systems. The x-ray systems enable detection of voids that are likely to be associated with the presence of various bacterial or fungal rots in onions.

Materials and Methods

A series of tests, at the Vidalia Onion and Vegetable Research Farm in Toombs County, Georgia, were conducted with a commercial x-ray inspection machine (figures 1 and 2).

2001: Onions were sorted into two batches of 100 medium grade onions and one batch of 100 jumbo grade onions. Each onion from each batch was passed through the inspection machine and then halved for a visual evaluation.

2002: Two batches each of 100 onions were run through on a similar machine as in 2001. Additionally, five onions with slight to severe defects were each passed through the inspection machine 50 times to ascertain consistency in defect detection.

Results and Discussion

2001: In each series of tests, the error rate was less than 7% and the false positives were less than 6% (see tables 1 through 4).

2002: Onions with either no defects or slight defects, based upon visual evaluation of onion halves were passed by the machine 100% of the time. Onions with severe defects were rejected 100% of the time. Typical defects detected are shown in figure 3. These errors are very close to the 10% and 10% levels generally accepted for these respective errors. With appropriate addition of multiple lanes, commercially viable through-puts are possible.

Table 1. Results of the individual onion studies for 2001 and 2002 scored as accepted or rejected.

Year	Test set	Machine Accept	Machine Reject	Error %	False Positives %
2001	Medium 1	70	20	3.3	6
2001	Medium 2	84	26	7	5
2001	Jumbo	90	13	3	3
2002	Medium 1-low sensitivity	96	4	15%	2%
2002	Medium 1-High Sensitivity	66	34	13%	15%

Table 2. Results from the consistency study for five onions.

Onion	50-pass score	Onion condition on halving
1	Rejected 72% of tries	No disease with a center void
2	Rejected 95%	Obvious disease in one leaf
3	Rejected 0%	Sound throughout
5	Rejected 100%	Obvious internal disease

Table 3. Performance of the x-ray inspection machine at typical throughput rates with batches of 25 onions.

Batch	Time (sec)	No. of runs	Avg. miscount (range)	Average Defects (range)
1 (Mediums)	7	5	0.8 (0 to 2)	1 (0 to 2)
2 (Jumbos)	7	5	6 (3 to 8)	2.2 (0 to 4)
3 (Mediums)	20	10	0	2.7 (1 to 5) (5 onions had a severity score of 2 or higher)

Table 4. Accuracy as a function of rated disease severity.

Treatment	N	%Healthy visually	% with severity[1] 1 to 5	% with severity 2 to 5	%Accuracy[2] With severity 1 as criterion for acceptance	%Accuracy With severity 2 as criterion for acceptance
Control-all diseases	53	47	53	38	68	81
Center Rot	54	20	80	57	52	65

[1]0-no disease, 1- up to 20%, 2- up to 40%, 3-up to 60%, 4 up to 80%, 5 up to 100 % incidence.
[2]False Positives were zero in this evaluation.

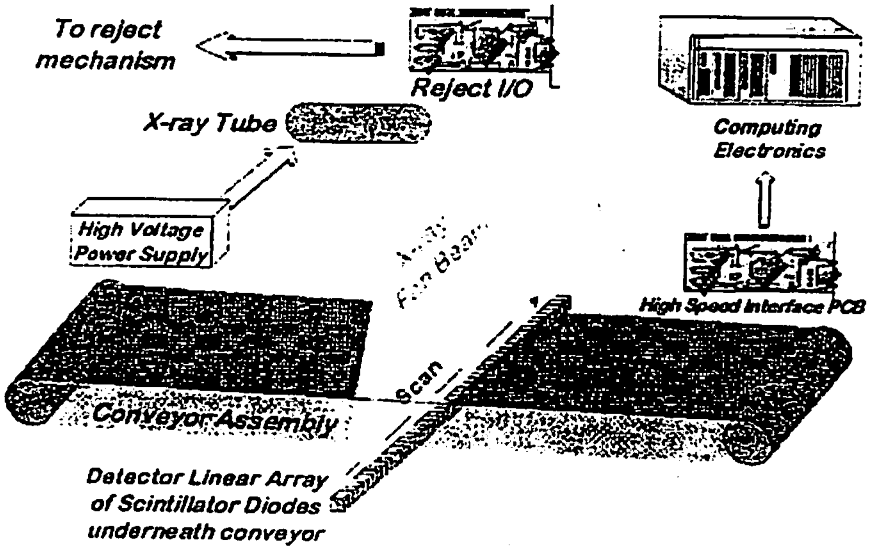

Figure 1. Schematic of x-ray inspection machines (Courtesy of Heimann Systems, Alcoa, TN).

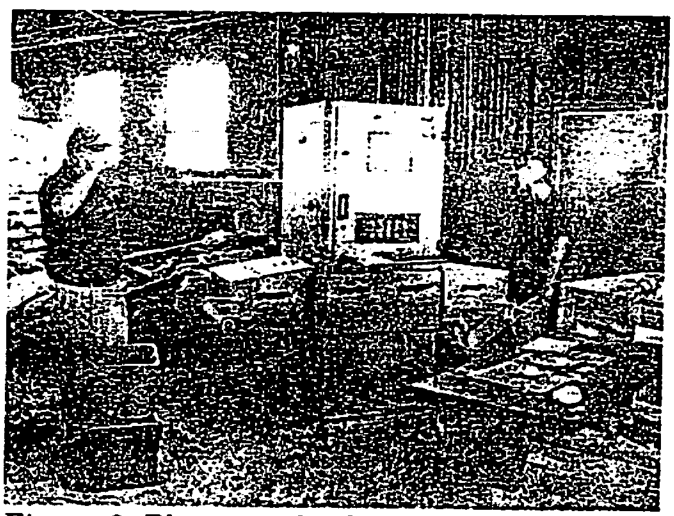

Figure 2. Photograph of the EaglePak commercial x-ray inspection machine.

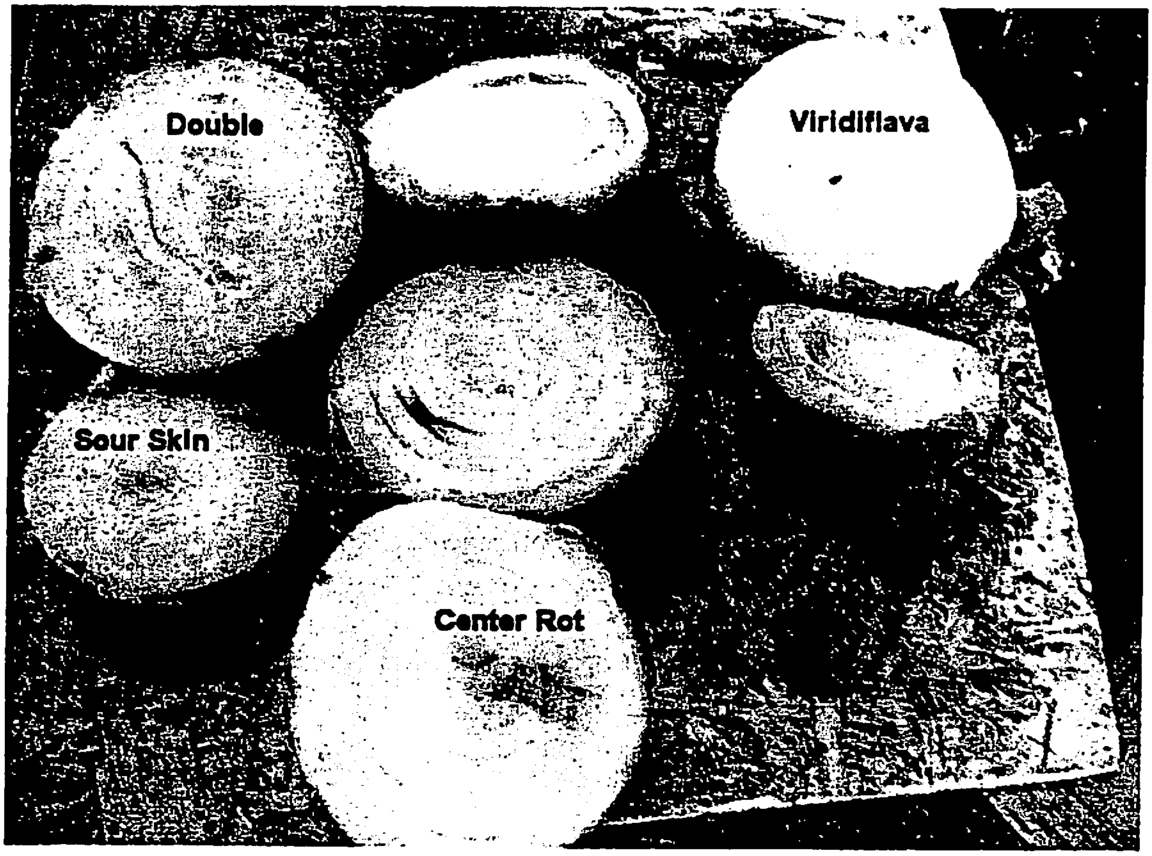

Figure 3. Typical machine-detected defects.

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