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VEGETABLE RESEARCH RESULTS 2002

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INDEX

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INTRODUCTION

This report summarizes the results of several vegetable studies conducted during 2002. Weather data for the 2002 growing season are included at the end of this report.

The excellent cooperation of Sean Mueller, Stan Gahn, and the crew at the Veg Crops Branch in Fremont, OH; Darren Johnson and Ken DeWeese at the Waterman Ag and Natural Resources Laboratory, Columbus, OH is greatly appreciated. Special thanks to Emily Calvert for assistance with planting and harvesting. We hope that this type of information is of benefit to the vegetable industry in Ohio and the Great Lakes region. Your comments and suggestions for future efforts are always welcome.

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Affects of Paclobutrazol, Biological Control Agents, and Other Seed Enhancements on Processing Tomato Growth, Disease Control and Yield

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Introduction:

Stretching and legginess in processing tomato transplants becomes a problem when field planting in the spring is delayed due to weather conditions. Increased internode length and thin, weak stems can also be caused by cloudy or warm weather during transplant production. Difficulties in mechanical transplanting and field survival are challenges that processing tomato growers face with increased transplant heights. Preliminary work at OSU on processing tomatoes suggests a stockier, shorter transplant can be produced with the use of the growth regulator paclobutrazol (Bonzi™) as a seed soak prior to sowing. Biological control agents (BCA's) are another transplant technology worthy of more research. BCA's are beneficial bacteria or fungi that colonize on the roots and can be effective against *pythium, phytophthora, rhizoctonia, fusarium, alternaria, and botrytis*. The objective of this research was to test the use of paclobutrazol for height control and applications of BCA's for disease suppression on processing tomatoes. This research involved (1) a greenhouse study to compare plants with and without Bonzi™ application to pelleted seed and biological agents to determine its effects on processing tomato transplant height and (2) a field study to determine any subsequent effects in the field on flowering and or/time to harvest, yield, and disease pressure with and without Bonzi™ and biological controls.

Materials and Methods:

Greenhouse Study: On April 22, 2002, 4 replications of 4 processing tomato seed lots (raw and pelleted) were sown into 288 plug trays. Treatments consisted of the following:

variety	seed trt	Bonzi (Y/N)	Biological application (Y/N)
611	Seed Systems PPI maxi coat	Y	N
611	Seed Systems PPI maxi coat	Y	Y
611	Seed Systems PPI maxi coat	N	Y
611	Seed Systems PPI maxi coat	N	N
611	Incotec 136 Mini	Y	N
611	Incotec 136 Mini	Y	Y
611	Incotec 136 Mini	N	Y
611	Incotec 136 Mini	N	N
9704	Seed Systems PPL mini coat	Y	N
9704	Seed Systems PPL mini coat	Y	Y
9704	Seed Systems PPL mini coat	N	Y
9704	Seed Systems PPL mini coat	N	N
RG611	Raw - trted by Pro Seed Technology	Y	N
RG611	Raw - trted by Pro Seed Technology	Y	Y
RG611	Raw - trted by Pro Seed Technology	N	Y
RG611	Raw - trted by Pro Seed Technology	N	N

Prior to covering the seed with soil-less mix, trays receiving paclobutrazol were misted with 20 mls of solution at 500 ppm. Trays were placed in the greenhouse and germination rates were recorded weekly for 3 weeks. Plant height was recorded at 2, 3, 4 and 5 weeks. Prior to field transplanting, plant heights and stem diameters were recorded.

Field Study: All bonzi/biological combinations using two pelleted seed lots ('611' Incotec 136 Mini and '9704' Seed Systems PPL mini coat) were planted in 4 replications for this field study along with 2 reps of the raw seedlot ('RG611'). Companion™, a liquid formulation containing the biological control agent *Bacillus subtilis,* was mixed at the rate of 0.16 fl. oz/ gallon H_2O. Each tray receiving BCA treatment received 650 mls (1.36 pts) of solution.

Plants were transplanted to the field at the Veg Crops Branch (Fremont, Ohio) into raised beds on June 7, 2002. One month after transplanting, plant heights and stem diameters were recorded and a second application of Companion™ was applied at the labelled equivalent rate of 32 oz/A. All other cultural techniques followed standard practices for the Midwest U.S. Plots were mechanically harvested on October 2, 2002, which was 117 days after transplanting. Red, green and cull fruit weights were recorded. Average marketable fruit size was recorded from 50 random fruit/plot. All cull fruit were further graded into disease and physiological disorder categories to determine any effect of Companion™ on disease development.

Results and Discussion:

Germination 3 weeks after seeding (WAS) was not significantly different for the Bonzi treatments in the three pelleted seed lots (Table 1). Germination was slightly reduced in the raw seedlot. At 4 WAS, plant height was significantly reduced with the use of paclobutrazol at 500 ppm prior to sowing. Similar results were recorded at field transplanting when paclobutrazol treated seedlings remained shorter (23-50% reduction in height depending on cultivar and seed enhancement) and had thicker stems.

One month after transplanting, there were no significant differences in plant height or stem diameter among plants treated with paclobutrazol and untreated plants (Table 2). Marketable red fruit yield of cv. '611' was not influenced by paclobutrazol or biological control agent transplant applications. Control plots for '9704', receiving no paclobutrazol or biological control, showed a reduction in marketable red T/A, and produced a significantly higher percentage of green fruit at harvest. There were no significant differences in average fruit weight for any of the treatments in either cultivar. There were no differences in the incidence of blossom end rot, anthracnose, ground rot, buckeye rot or other cull categories except early blight. There was a difference in early blight when comparing the two cultivars '611' and '9704', but differences were not significant among treatments within each cultivar (Table 2).

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We would like to thank *Mid-America Food Processors Association* for their financial support of this research.

Table 1. Affects of Paclobutrazol, Biological Control Agent and Other Seed Enhancements on Processing Tomato Growth, Disease Control and Yield - 2002
OSU Hort & Crop Science Greenhouse

				--1 WAS*--	-- 2 WAS --		-- 3 WAS --		-- 4 WAS--	--5 WAS--	- - At Transplant - - - (6.5 WAS)	
Cultivar	Seed Treatment	Bonzi (Y/N) /	Biological (Y/N)	% Germ	% Germ	Plant ht (cm)	% Germ	Plant ht (cm)	Plant ht (cm)	Plant ht (cm)	Plant ht (cm)	Stem diam. (mm)
611	Seed Systems PPI maxi coat	Y	N	67	85	3.3	85	5.0	5.3	6.5	9.8	3.3
611	Seed Systems PPI maxi coat	Y	Y	76	90	3.5	91	5.7	6.2	6.8	9.0	3.3
611	Seed Systems PPI maxi coat	N	Y	81	90	6.0	91	8.4	9.4	10.6	13.9	3.1
611	Seed Systems PPI maxi coat	N	N	82	88	5.3	88	8.0	11.1	13.1	15.6	2.9
611	Incotec 136 Mini	Y	N	61	75	3.1	78	4.8	5.6	6.0	8.3	3.2
611	Incotec 136 Mini	Y	Y	68	78	3.2	81	4.9	5.9	6.6	9.6	3.5
611	Incotec 136 Mini	N	Y	59	73	5.9	74	8.6	10.3	12.1	17.6	3.0
611	Incotec 136 Mini	N	N	68	77	5.8	78	9.1	9.7	12.8	16.3	2.8
9704	Seed Systems PPL mini coat	Y	N	57	74	1.8	77	3.1	3.9	5.2	8.9	3.2
9704	Seed Systems PPL mini coat	Y	Y	48	72	2.3	74	3.4	4.7	5.9	9.8	3.5
9704	Seed Systems PPL mini coat	N	Y	64	81	4.4	86	6.2	9.0	11.7	19.0	2.7
9704	Seed Systems PPL mini coat	N	N	79	88	3.8	89	6.0	8.4	12.0	18.4	2.7
RG611	Raw - Pro Seed Technol. trt.	Y	N	63	63	3.6	65	5.3	6.5	7.2	10.7	3.5
RG611	Raw - Pro Seed Technol. trt.	Y	Y	51	56	3.5	58	5.4	6.5	7.6	11.1	3.6
RG611	Raw - Pro Seed Technol. trt.	N	Y	54	59	4.7	60	7.6	9.3	10.5	14.9	3.1
RG611	Raw - Pro Seed Technol. trt.	N	N	60	64	5.9	67	9.1	10.7	11.0	15.4	3.1
LSD (0.05)				13.7	10.0	0.54	9.6	0.74	0.79	1.24	1.58	0.25

* WAS = weeks after seeding

Table 2. Affects of Paclobutrazol, Biological Control Agent and Other Seed Enhancements on Processing Tomato Growth, Disease Control and Yield - 2002.
Veg Crops Branch, Fremont, OH

				- 1 mth after transplant -		YIELD										
											Culls					
Cultivar	**Seed Treatment**	**Bonzi (Y/N)**	**Biological (Y/N)**	**Plant ht (cm)**	**Stem diam. (mm)**	**Red T/A**	**Green T/A**	**Culls T/A**	**% red**	**Avg. fruit wt (lbs)**	**BER (lbs/plot)**	**Anthracnose (lbs/plot)**	**Early blight (lbs/plot)**	**Ground rot (lbs/plot)**	**Buckeye rot (lbs/plot)**	**others**
611	Incotec 136 Mini	Y	N	30.7	9.6	27.4	5.2	1.8	80	0.15	0.1	8.3	1.0	1.5	0.0	1.3
611	Incotec 136 Mini	Y	Y	30.9	9.6	24.2	3.5	3.3	78	0.15	0.1	14.6	1.7	2.1	0.2	4.4
611	Incotec 136 Mini	N	Y	29.6	9.1	25.0	5.2	2.7	76	0.15	0.2	12.2	1.8	1.7	0.0	3.1
611	Incotec 136 Mini	N	N	31.4	10.0	24.5	4.0	2.5	79	0.15	0.0	11.2	1.8	1.4	0.0	2.9
9704	Seed Systems PPL mini coat	Y	N	32.8	9.4	30.0	9.3	1.2	74	0.14	0.0	5.5	0.3	1.4	0.0	0.8
9704	Seed Systems PPL mini coat	Y	Y	32.2	9.3	28.6	8.4	1.6	74	0.15	0.0	7.6	0.4	1.2	0.0	2.0
9704	Seed Systems PPL mini coat	N	Y	28.9	8.4	23.9	10.9	1.6	67	0.14	0.1	8.1	0.1	0.9	0.0	2.0
9704	Seed Systems PPL mini coat	N	N	23.8	7.6	21.3	14.2	2.0	58	0.15	0.0	10.1	0.5	1.5	0.0	1.9
LSD (0.05)				NS	NS	4.5	5.19	NS	9.75	NS	NS	NS	0.9	NS	NS	NS
p value				0.06	0.06			0.166		0.844	0.65	0.385		0.666	0.218	0.27
CV				14.2	12.7	14.9	62.6	56.5	12.5	6.5	22.8	57.9	92.2	53.3	50.0	30.8
2 Rep Observations:																
RG611	Raw-treated by Pro Seed Technology	Y	N	24.5	7.2	24.0	7.0	1.3	74	0.14	0	6.1	0.6	1.1	0	1
RG611	Raw-treated by Pro Seed Technology	Y	Y	31.8	9.8	26.6	7.6	1.5	74	0.14	0	6.4	0.5	2.2	0	1.3
RG611	Raw-treated by Pro Seed Technology	N	Y	30.2	9.7	27.1	4.0	1.6	83	0.14	0	7.1	0.9	0.9	0	1.9
RG611	Raw-treated by Pro Seed Technology	N	N	29.6	9.4	28.3	3.5	1.5	85	0.14	0	6.5	1.4	1.4	0	1.3

Transplant Quality, Disease Control and Yield in Fresh Market Tomato as Affected by Paclobutrazol and Commercial Biological Control Agents.

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Keywords: Plant growth regulator, *Bacillus subtilis*, *Streptomyces grieseoviridis*, *Lycopersicum esculentum* Mill.

Abstract

Excessive stem elongation is a common problem in vegetable transplants. Stretched and thin stems make transplant handling and establishment difficult, and thus lead to losses, especially if field planting is delayed due to poor weather. Paclobutrazol (PBZ), a plant growth regulator with anti-gibberellin activity has strong height control properties. We investigated the use of PBZ as a presoak seed treatment on fresh market tomato 'Early Cascade' while also using the transplant production phase to introduce commercial biological control agents (BCA's) with antagonistic properties against *Phytophthora spp.* causing Buckeye Rot, a common disease in unstaked fresh market tomato. When applied outside controlled environments such as greenhouses, BCA's seldom give effective disease control. An important reason for being unsuccessful is insufficient microbial colonization in the rhizosphere and subsequent failure to compete with the soil inhabiting pathogen population. The greenhouse phase during transplant production could give enough time for better BCA colonization and disease protection to the plant root system before it is subjected to the field environment. Results from two years of study indicated that at the 4 wk seedling stage PBZ reduced internode length at least by 30% and at 6 wk stage the treated plants were 18% shorter than untreated plants. At 4 wk after field transplanting the number of first cluster fruits was at least 40% more and the number of second cluster flowers was higher in treated plants. However, no significant marketable yield or disease control differences were obtained by any treatment in year 1. Also, no significant interaction between PBZ and BCA was seen in year 1. The disease pressure in year one (2001) was low and the results obtained may not reflect potential benefits. Year 2 (2002) field data will prove valuable in further yield and disease management analysis of the treatments.

INTRODUCTION

The objective of vegetable production is to optimize the yield and quality of marketable produce. This can only be achieved by first establishing a uniform stand of healthy, vigorous seedlings at optimal densities (Doolan et al., 1999). A common problem in transplants grown for field production is excessive stem elongation. The stretched stems become thin and weak. This makes transplant handling and establishment difficult and thus leads to losses, especially if field planting is delayed due to poor weather. Various plant growth regulators (PGR's) have been investigated to bring about desirable modifications in plants. Use of PGR's to control the growth and improve quality of greenhouse grown bedding plants is a standard procedure in commercial operations (Latimer, 1992). Triazole growth retardants are often considered as potential growth regulators. Among the triazole PGR's, paclobutrazol (PBZ) gives very effective growth control in many crops and offers an alternative for use in vegetable transplant production (Davis and Curry, 1991).

Research shows that PBZ has strong anti-gibberellin activity resulting in the reduction of plant height (Nishizawa, 1993). The primary mode of action of the active ingredient is inhibition of gibberellin biosynthesis (Rademacher, 1997). Earlier tomato studies also show that PBZ gives thicker stems (Souza-Machado, 1999). Studies done on vegetables, ornamentals and oilseed crops report various benefits of PBZ besides reduction in plant height (Setia et al., 1995), such as significantly improved seedling drought tolerance (Souza-Machado et al., 1999), increased chlorophyll content in pepper (Aloni and Pashkar, 1987) plus improved field establishment vigor and faster shoot dry weight gain (McKee, 1981). However, PBZ treatments have also shown delayed flowering in papaya (Rodriguez and Galan 1995) and delayed anthesis in tomato (Souza-Machado et al., 1999). It has been found that the anti-GA effect depletes 4 to 5 weeks after field transplanting in tomato seedlings (Souza-Machado et al., 1999) and leaf growth also reverts to normal (Nishizawa, 1993). Harvested tomato seeds from PBZ treated plants have not been found to carry the anti-GA affect in terms of seedling height and fresh weight forward to the next generation (Souza-Machado et al., 1999).

For consistent results and commercial success of paclobutrazol it is essential to develop a simple, efficient and environmentally safe application method (Fletcher et al., 2000). When used in vegetable crop production it is very important to use low concentrations of PBZ. Application of PBZ as a seed presoak ensures an efficient and environmentally less persistent application system. However studies conducted on vegetable crops using the seed presoak are very limited. This experiment uses PBZ as a presoak seed treatment on fresh market tomato (*Lycopersicum esculentum*) 'Early Cascade' while also using the transplant production phase to introduce commercial biological control agents (BCA's) with antagonistic properties against *Phytophthora spp.* causing Buckeye Rot, a common disease in unstaked fresh market tomato.

Most of the studies demonstrating that BCA's are effective have been conducted in controlled environments (eg. greenhouses) and sterile media. The results thus obtained often fail to remain consistent when the application is made in the field (Nemec et al., 1996). Several possible reasons may cause this lack of efficacy, including the failure of sufficient microbial colonization in the rhizosphere and subsequent inability of BCA's to compete with the soil inhabiting pathogen population. Due to great variation in cultural practices employed and natural soil properties, it is hard to predict performance of field applied BCA's. Therefore, the transplant production phase is a good opportunity to introduce BCA's in the root zone of the plant. This greenhouse phase could also give more time for better BCA colonization and disease protection to the plant root system before it is subjected to the field environment. The aim of this study is to 1) determine any difference in the quality of transplants produced from seeds presoaked in PBZ, and 2) test the efficacy of introducing two commercial BCA's (namely Companion ™ a.i *Bacillus subtilis* sp. strain GBO3 [Growth Products, White Plains, NY, U.S.A] and Mycostop ™ a.i *Streptomyces grieseoviridis* sp. strain K61 [AgBio Development Inc., Westminster, CO, U.S.A]) in the transplant production phase for Buckeye Rot control and yield improvement in fresh market tomato.

MATERIALS AND METHODS

Two years of study (2001 & 2002) were conducted on tomato 'Early Cascade'. Seeds were soaked in 500 ppm of PBZ for 6 h followed by 16 h of surface drying at ambient lab conditions (25° C, 60% RH) before planting in 200 cell plug trays. After 3 weeks in the greenhouse, the first drench application of two commercial BCA double drench treatments, Companion ™ (@ 1.2 ml/ L covering 0.2 m^2/ L) and 0.1% Mycostop ™ suspension (@ 1g/ L per 9.2 m^2) were made. At the 4 wk seedling stage, stem diameter above the cotyledons as well as first internode length were measured using an Spi gauge and thin steel ruler, respectively. Companion ™ single drench treatment was applied just before field transplanting. Field transplanting was done at the 4-week stage in 2001 and 7-week stage in 2002 on raised beds of 9.1 m long x 1.5 m on center in twin rows in a 2x5 RCB factorial design at the OSU Horticulture Farm (Columbus). In the first year of study, transplants were mechanically transplanted (July 2001) whereas in the second year, seedlings were hand transplanted (May 2002) due to wet soils. Second drenches of Companion ™ (@ 2.4 L/ ha diluted in 10 L of mix) and 0.1% Mycostop ™ suspension (@ 1g/ L per 9.2 m^2) were applied at 4 wks after transplanting (WAT). Total number of first cluster fruits, second cluster flowers, and vegetative habit of the plants was also recorded 4 WAT. Ridomil Gold ™ / Bravo ™ was sprayed in plots under chemical control while Bravo 720 ™ and Benlate ™ were applied to the whole field per commercial practice (Precheur et al., 2001) for controlling other fungal diseases. Fruits were harvested in October 2001 at 12 WAT from the center 1.8 m of each bed. Grading was done using USDA marketable/undamaged and cull categories for fresh market tomato (Decoteau, 2000). Statistical analysis of the data was conducted in SAS using proc GLM (The SAS Institute, 2001).

RESULTS

Rate of germination in PBZ-treated seeds was significantly slower at 5 days after seeding (DAS) but was comparable to the untreated seeds at 15 DAS (Table 1). At 4 wks after sowing, PBZ reduced seedling first internode length at least by 30% in both years while at the 6 wk stage (2002), internode length and total height was reduced by 18% (Figure 1). The average total height of PBZ treated, 6 wk old transplants was 20 cm vs. 24 cm for untreated plants, but no significant difference between the stem diameters was recorded (data not shown). The treated plants were darker green, exhibited better drought tolerance and were easier to handle. PBZ treated plants had at least 40% more first cluster fruits and a greater number of second cluster flowers per plant (Figure 2). The increase in flower number was significant in year 2002. No significant marketable yield or disease control differences were obtained by any treatment in 2001 (Table 2). Also, no significant interaction between PBZ and BCA was seen in year 1.

DISCUSSION

PBZ is a potent growth regulator with strong anti-gibberellin activity. It has been speculated that when seeds are soaked in the solution the seed coat tends to absorb the chemical and later release it during germination when it is taken up by the radicle of the emerging seedling and moves into the shoot system (Pasian and Bennett, 2001). Since gibberellins are required for seed germination, excessive levels of PBZ may adversely affect both the rate and germination percentage as observed by Balvoll and Maximov (1992) in cauliflower and broccoli. The affect may vary between cultivars and seed lots. It was observed that the rate of germination was slower in treated seeds, but eventually was comparable to the untreated plants. Pasian and Bennett (2001) observed similar results in a study on marigold, geranium and pepper.

Wilting, as observed, was far more severe in untreated transplants than the treated ones. This can be explained by a study on chrysanthemum showing that PBZ reduces stomatal aperture and increases epicuticular wax thereby reducing water loss under stress conditions (Smith et al., 1990). Other studies (Souza-Machado et al., 1999, Swietlik and Miller, 1983) found that PBZ improves drought resistance and increases resistance to other environmental stresses (Setia et al., 1996). The reduction in internode length was due to the blocking of gibberellic acid synthesis pathway by PBZ. Treated transplants were visually greener than untreated which may be as a result of increased chlorophyll content as found in a study done on pepper by Aloni and Pashkar (1987).

An increase in the number of first cluster fruits in PBZ treated plants indicates early reproductive maturity resulting in early floral bud set. It has been found that PBZ enhances carbohydrate assimilation and promotes flowering and fruit set (Davis et al., 1988; Setia et al., 1996). It was observed that the number of flowers at 4 WAT was higher (significant in 2002) in treated plants. This difference was not as high as the difference recorded between the number of fruits at the same stage. This indicates that PBZ is especially active during the early weeks of plant growth and the anti-GA activity of PBZ in tomato gradually depletes after 4-5 weeks in the field (Souza-Machado et al., 1999).

Our first year of field study (2001) failed to show any significant differences between the disease control treatments. The disease pressure in 2001 was low and therefore the results obtained may not reflect potential benefits. Year 2 (2002) field data will prove valuable in further yield and disease management analysis of the treatments.

CONCLUSION

PBZ is a proven plant growth regulator in production of compact and sturdier transplants. Its strong anti-gibberellin properties favor the application in very low concentrations through a seed presoak method, which ensures minimal movement of chemical in the environment (Fletcher et al., 2000). The seed presoak PBZ treatment method has potential to be commercialized, as it is simple and cost effective. Ongoing research shows that even lower concentrations and shorter soak durations can give desirable results in vegetable and flower crops (Giovinazzo and Souza-Machado, 2001). Incorporation of BCA's in the roots during transplant production can be considered as an application option but at this stage the efficacy and cost effectiveness of this application needs further research.

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Tables

Table 1. Germination percentage at 5 & 15 days after seeding (DAS) 'Early Cascade' tomato seed (2002).

Tray No.	Paclobutrazol	No Paclobutrazol	Paclobutrazol	No Paclobutrazol
	(% germination 5 DAS)		(% germination 15 DAS)	
1	45	91	98	99
2	46	100	99	100
3	24	99	99	99
4	23	100	97.5	100
5	26	92	100	100
LSD (p=0.05)	17		NS	

Table 2. Marketable, Buckeye Rot and total undamaged tomato fruit weight in t/ha (2001). LSD = NS at p= 0.05.

Treatment	Paclobutrazol			No Paclobutrazol		
	Marketable Fruit[1]	Buckeye Rot	Undamaged Fruit[2]	Marketable Fruit[1]	Buckeye Rot	Undamaged Fruit[2]
	weight (t/ha)			weight (t/ha)		
Control	5.3	0.5	19.4	5.2	0.5	22.6
Ridomil™	8.0	0.7	24.5	4.7	1.1	23.1
Companion™ (Double Drench)	5.4	0.4	23.8	5.1	0.6	24.7
Companion™ (Single Drench)	4.6	0.5	18.9	4.2	0.5	16.2
Mycostop™	5.3	1.6	23.4	6.2	0.7	21.4

[1] Marketable fruit include breaker, pink and red fruits.
[2]Undamaged includes marketable plus green fruits

Figures

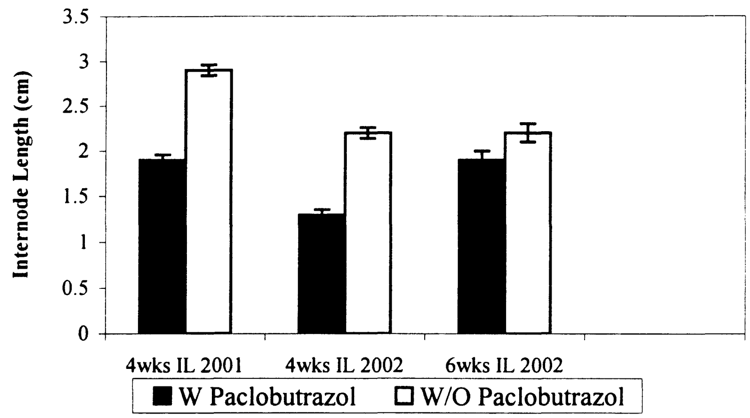

Fig. 1. First internode length (IL) at 4 & 6 wk stages of 'Early Cascade' seedlings in 2001 & 2002. Data are means ± SE of 4 replications.

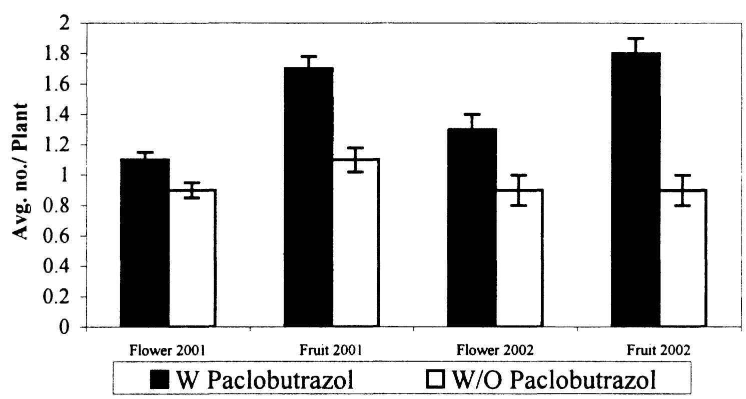

Fig. 2. Average no. of second cluster flowers and first cluster fruit per 'Early Cascade' plant at 4 wks after transplanting in 2001 & 2002. Data are means ± SE of 4 replications.

Comparison of Organic and Inorganic Mulches for Heirloom Tomato Production

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Keywords: *Lycopersicon esculentum* (Mill.), sustainable agriculture, weed suppression

Abstract

Many tomato growers face challenges in producing their crops due to stricter environmental regulations and fewer chemicals available for weed control. There is a demand for cultural practices that reduce chemical inputs and synthetic materials. Heirloom tomato varieties are becoming more popular among commercial tomato growers due to increased demand from consumers. Since most heirloom tomatoes at present are grown on small acreage, the addition of organic mulches may be a practice feasible for reducing chemical inputs for weed suppression. Heirloom tomatoes were grown using organic mulches (shredded newspaper, wheat straw and composted landscape bark) and an inorganic mulch (black plastic) plus a bare ground control to evaluate their effectiveness on heirloom tomato marketable yield and weed suppression. All treatments were grown with pre-emergence herbicide (high input) and without pre-emergence herbicide (low input). Marketable yields for the 10 treatments ranged from 3.4 to 50 MT/ha and 11.5 to 35.6 MT/ha in 2000 and 2001, respectively. Mulch x herbicide interactions were not significant for yield in either year. Mulches with and without herbicide inputs produced higher yields than unmulched plots in both years. Bare ground control with no herbicide inputs resulted in the lowest yields and highest weed densities and biomass. In an attempt to reduce chemical inputs for weed control in tomato production, organic mulching materials may be a viable option for vegetable growers.

INTRODUCTION

Methyl bromide, used as a soil fumigant to control nematodes, soil-borne pathogens and weeds in fruit and vegetable production systems, will be banned in the United States by 2005, in compliance with the U.S. Clean Air Act (Charron and Sams, 1999; Holman, 1999). There is a need for cultural practices that reduce chemical inputs and synthetic materials (Abdul-Baki and Teasdale, 1993; Abdul-Baki et al., 1996; Koike and Subbarao, 2000). Public concerns with health and environmental effects of synthetic pesticides commonly used in commercial fruit and vegetable production is prompting researchers to look at alternative, non-chemical pest control measures (Charron and Sams, 1999). As a result of consumer health and safety issues, retail sales in the U.S. organic industry reached $7.8 billion in the year 2000 (Wood et al., 2002). Production practices for vegetable and fruit production need to focus on fewer synthetic inputs, disease and weed control, reducing soil erosion, and maintaining soil structure while producing high quality fruit and profitable yields.

Fresh market tomatoes are grown for the retail, wholesale and supermarket trade (Precheur et al, 2001). Fresh market tomatoes are the most frequently produced crop on small farms in the northeastern U.S. Small acreage farms are increasing in numbers across the United States and are predominately run by part-time operators (Teasdale and Colacicco, 1985). Small farms often grow and market unique or specialty produce, avoiding competition from most large-scale vegetable production operations. An increasingly popular sector of the produce industry is heirloom and ethnic vegetable crops. Heirloom varieties, particularly tomatoes, were traditionally grown in backyard gardens and are becoming more popular with small commercial growers.

One alternative to pesticides for weed and disease suppression is the use of mulch. Mulch is defined as any material used to cover the soil surface to prevent loss of moisture, reduce weed pressure, maintain consistent soil temperatures and promote soil productivity (Jacks et al., 1955; Carter and Johnson, 1988; Abdul-Baki and Teasdale, 1994). Mulches also aid in weed suppression (Davis, 1994). Organic mulches can be as effective as herbicides in suppressing weeds (Ozores-Hampton, 1998).

Synthetic mulch such as black polyethylene film has been used in vegetable production since the early 1960's to increase soil temperatures, conserve moisture, reduce weed pressure and increase yields (Lamont, 1991; Courter et al., 1969; Carter and Johnson, 1988; Abdul-Baki et al., 1996). However, there are disadvantages to using this synthetic material. Aside cost, which can be as high as \$630/A, disposal of the material is a problem (Wiggen, 1995; Davis, 1994). Black plastic mulching materials are burned or disposed of in landfills. Since burning certain plastics give off toxic fumes such as hydrochloric acid, this mulching material is environmentally unfriendly while adding nothing to the soil structure or fertility.

Use of cover crops and living mulches for weed control and soil fertility has produced mixed results (Paine and Harrison, 1993). One problem growers face with the use of cover crops and living mulches for vegetable production is that cover crop management may interfere with spring planting and/or fall harvest (Stivers-Young and Tucker, 1999).
For cover crops to become well established and suppress weeds, the cover crop requires vigorous early growth and timely mowing to reduce its competition for water, nutrients and light (Costello and Altieri, 1994; Abdul-Baki and Teasdale, 1994; Wiles et al., 1989). The use of cover crops for weed suppression requires adequate biomass while controlling its competition with the crop to prevent yield losses (Hoffman et al., 1993). If uncontrolled, cover crop biomass may control weeds while reducing yields. In a corn-hairy vetch system hairy vetch suppressed weeds effectively without reducing corn yield, but only when corn planting coincided with precise vetch bloom time (Hoffman et al., 1993). Vegetable crop growth and yield are affected by the use of cover crop systems (Masiunas, 1998). Crop yields are generally correlated to the amount of weed suppression supplied by the cover crop mulch (Smeda and Weller, 1996). Use of living mulches has shown that competition between the crop being produced and the living mulch may cause a reduction in yield in some crops (Wiles et al., 1989). Use of living mulches such as red fescue and colonial bentgrass showed delayed silking in sweet corn and also delayed harvest 5-7 days (Nicholson and Wien, 1983).

Use of organic surface mulches, which are plowed into the soil at the end of the growing season, may be a viable option for weed suppression and improving the soil structure without interfering with the crop being produced. This cultural practice would serve several purposes in the production scheme and could be an excellent addition to any IPM program for tomato production, particularly on small acreage farms (Davis, 1994). Fresh-market tomatoes, which require multiple harvests, may be better suited to the use of mulches than processing tomatoes which are commercially harvested with a once-over mechanical harvester (Creamer et al., 1996).

The objective of this study was to test the effect of several mulches (shredded newspaper, straw mulch, composted bark, and traditional black plastic mulch along with a bare ground control) with and without pre-emergent herbicide on the marketable yield of heirloom tomato cultivar 'Nebraska Wedding' and to test their effectiveness in reducing weed density and biomass.

MATERIALS AND METHODS

Field experiments were conducted in 2000 and 2001 at The Ohio State University (OSU) Waterman Agricultural and Natural Resources Laboratory, Columbus, Ohio. Field plots were established on raised beds in a randomized complete block design with 4 replications in a 5X2 factorial using 4 mulches (composted landscape bark, wheat straw, shredded newspaper, black plastic mulch) and an unmulched bare ground control. All mulch treatments were tested with (high input) and without (low input) pre-emergence herbicide applications. Raised beds were spaced 1.5 m apart. Plots receiving pre-emergence herbicides were treated with Dual, Treflan and Sencor and incorporated by natural rainfall. A single layer of black plastic mulch was applied to raised beds with a mechanical mulch layer. Shredded newspaper, composted tan bark and wheat straw were applied to the tops of raised beds, by hand, to a depth of 10 cm after hand transplanting tomatoes. After mulches were applied overhead irrigation was used over the entire field to help keep organic mulches intact.

The heirloom tomato cultivar used in this study, 'Nebraska Wedding', is a globe-shaped medium sized fruit of orange skin and flesh color. Cultivar selection was based on prior results from heirloom tomato germplasm evaluations done at The Ohio State University.

Each mulch treatment replication consisted of 3 beds side-by-side. 'Nebraska Wedding' was planted in the middle row and the processing tomato variety 'Peto 696' was planted in the other two beds allowing buffer rows on either side of treatment rows. Data were collected from the middle row only. Each treatment row per rep measured 7.6 m in length and contained 7 plants spaced 91.4 cm apart. All tomato transplants were grown in the OSU Department of Horticulture and Crop Science greenhouse and transplanted to the field at the 6-7 week stage after hardening off plants under shade cloth. Field planting occurred on June 1, 2000 and June 8, 2001. Each plant received 296 mls of 10-52-8 starter fertilizer at transplanting. Three weeks after transplant, treatment row plants were staked and tied using the Florida weave method (Marr et al., 1991). Fruit was harvested five times in 2000, from August 22 to September 22. In 2001, fruit was harvested six times from August 17 through September 24. Marketable and cull fruit were weighed and counted. Throughout the growing season hand hoeing and backpack sprayer applications of Round-up™ (glysophate) were used for weed control between beds only. Weeds remained on top of the beds season long. This allowed for weed counts and biomass collection at the end of the season. Two 0.5 m squares were randomly placed on the top of each raised bed on October 2, 2000 and October 1, 2001. Weeds were counted, cut at ground level and dried. Final biomass dry weights were recorded.

RESULTS AND DISCUSSION

Marketable yields for the ten treatments in 2000 and 2001 ranged from 3.4 to 50 MT/ha and 11.5 to 35.6 MT/ha, respectively (Fig. 1). Mulch x pesticide interaction were not significant for yield in either year. There were similar trends in yield among the mulch treatments in both years. Mulched plots produced higher yields than bare ground, regardless of pesticide input. Yields averaged over all mulch treatments show a lower yield from low input plots in both years (Fig. 2). Low input reduced yields by 39% and 17% in 2000 and 2001, respectively. Averaged over both pesticide levels, unmulched bare ground plots produced lower yields compared to the four mulches. There were no significant differences in yield among the four mulches in either year. This suggests that organic mulches can be as effective as black plastic on fruit yield.

In 2000, mulch x pesticide interaction was significant for broadleaf biomass and density. High input plots, regardless of mulch treatment, produced lower weed biomass compared to low pesticide input (Fig. 3). Bare ground plots with no pesticide inputs had more weed biomass than any of the mulched plots. Averaged across pesticide inputs, organic mulches reduced weed biomass by 59%, 34% and 44% for newspaper, wheat straw and bark, respectively. Black plastic resulted in an 80% reduction in weed biomass.

In 2001, there was no significant mulch x pesticide interaction for weed density and biomass. However, there was a significant mulch effect (Fig. 4). The highest weed biomass was achieved in bare ground plots, regardless of pesticide input. There were no differences in biomass between plastic and the organic mulches. Averaged across pesticide inputs, black plastic, newspaper, wheat straw and bark reduced biomass by 81%, 78%, 60%, and 67%, respectively.

In an attempt to reduce chemical inputs in vegetable production systems, alternative practices need to ensure that maximum yields are achieved while reducing weed competition. The use of organic mulching materials aid in weed suppression while adding organic matter to the soil because the mulches are plowed under at the end of the growing season. Organic materials, applied to a depth of 10 cm can be as effective as black plastic mulch on tomato yield and weed suppression.

ACKNOWLEDGEMENTS

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Figures

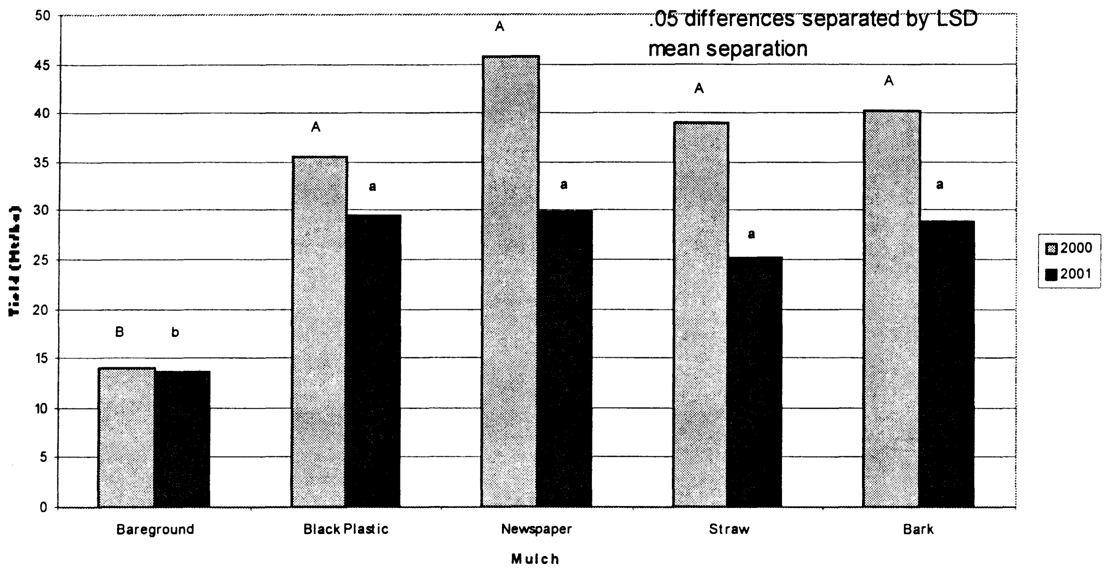

Fig. 1. Marketable 'Nebraska Wedding' tomato fruit yield for 2000 and 2001.

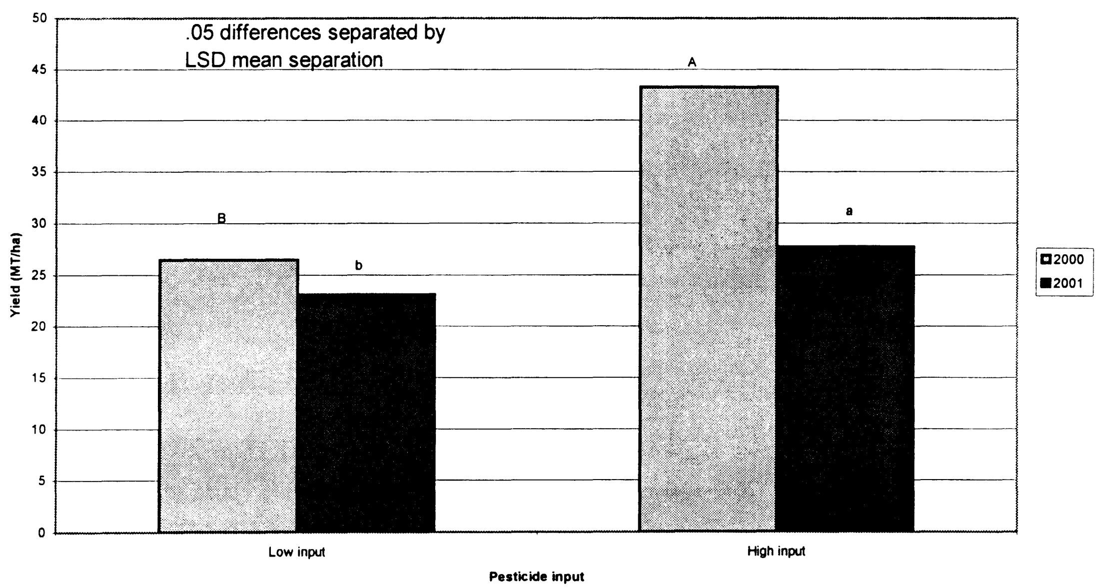

Fig.2. Marketable yield 2000 and 2001 for pesticide levels averaged across all mulches.

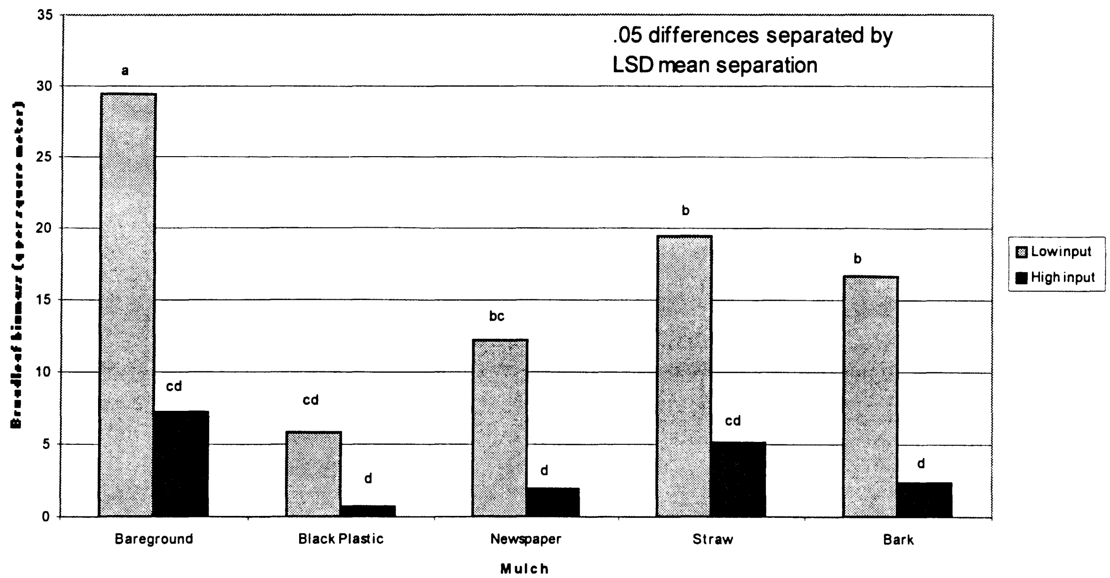

Fig. 3. 2000 broadleaf weed biomass.

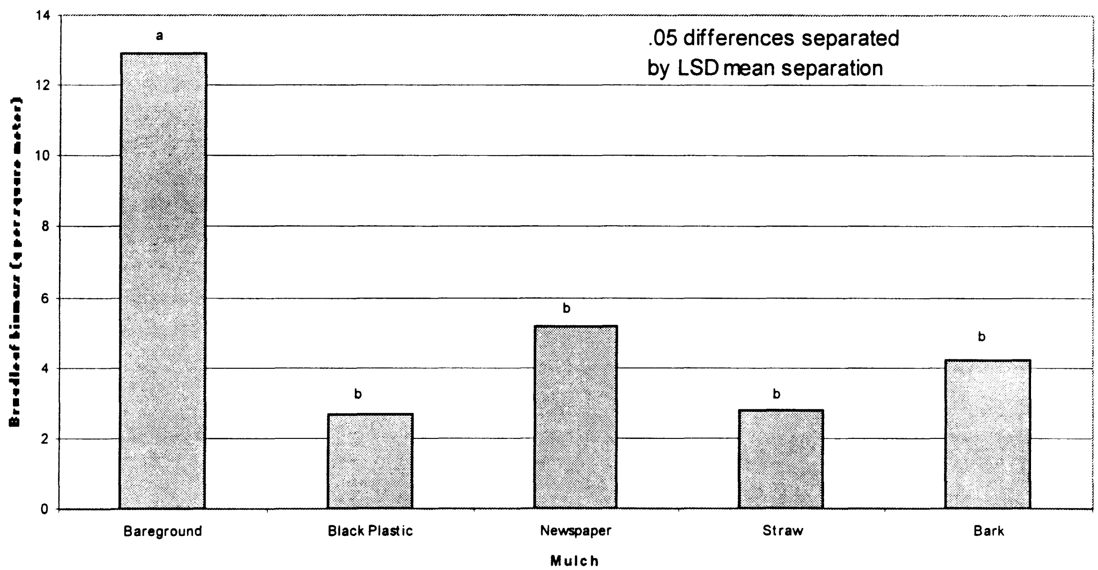

Fig. 4. 2001 broadleaf weed biomass.

Sweet Corn Seed Treatment and Seedling Establishment Trial – 2002

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Objective:

Thirteen seed treatments plus an untreated control were tested on two cultivars of sweet corn (*sh*$_2$ '277A' and *se* 'July Gold') to determine the best seed treatments for optimum stand establishment.

Materials and Methods:

Plots were established at the Waterman Ag and Natural Resources Laboratory (WANRL), Columbus, Ohio on April 24, 2002 and at the Veg Crops Branch in Fremont, Ohio on May 6, 2002. Four replications of 100 seeds were planted in rows spaced 30" apart with 4-5" between seeds. Each cultivar was planted in a randomized block design. Soil type at WANRL was Miamian silt loam and Rimer loamy fine sand was the soil type in Fremont. Soil temperatures at a 2" depth at planting were 54°F and 56°F in Columbus and Fremont, respectively. When plants reached at least the 5-6 leaf stage stand counts were taken (July 2 in Columbus, July 11 in Fremont) to determine effective seed treatments for optimum sweet corn stand establishment.

Results and Discussion:

Emergence of the *sh2* cultivar '277 A' was lowest in the UTC plots in Columbus, and all but three seed treatment combinations resulted in significantly higher emergence values. No differences were seen in Fremont, where the UTC plots had 42% emergence. The emergence range in Fremont was 24% to 53% (Table 1).

Seedling emergence of untreated (UTC) 'July Gold' (*se*) seed was lower than any of the treatment combinations at both sites. Maximum emergence values at Columbus and Fremont were 37% and 36%, respectively. Percent emergence in Columbus ranged from 1-37% and from3-36% in Fremont for the UTC and the 13 seed treatments (Table 1).

This project was part of a multi-location trial organized by the Seed Treatment Committee of the International Sweet Corn Development Association, a non-profit research organization. The information generated will be of value to sweet corn producers, industry personnel, consultants, farm advisers, extension plant pathologists and others interested in identifying the best performing seed treatments for optimum stand establishment.

Acknowledgements:

We would like to thank the *Ohio Vegetable and Small Fruit Research and Development Program* for their financial support of this research.

Table 1. Sweet Corn Seed Treatment and Stand Establishment Trial - 2002
Columbus and Fremont, OH

	sh2: '277 A'		se: 'July Gold'	
Treatment rate (in fl. oz./ cwt unless otherwise indicated)	**Columbus**	**Fremont**	**Columbus**	**Fremont**
	--- % emergence ---		--- % emergence ---	
Untreated Check	22	42	1	3
Captan 400 (3), Thiram 42S (2.5), Allegiance (0.75)	46	24	10	30
Captan 400 (3), Thiram 42S (2.5), Allegiance (0.75), Flo Pro IMZ (0.5)	26	37	13	21
Captan 400 (3), Thiram 42S (2.5), Allegiance (0.75), Flo Pro IMZ (0.5), Gaucho 480 (4)	73	42	34	34
Captan 400 (3), Thiram 42S (2.5), Allegiance (0.75), Flo Pro IMZ (0.5), L0263-A1 (3.2)	77	38	37	36
Captan 400 (3), Thiram 42S (2.5), Allegiance (0.75), Vortex (25 ppm product/cwt)	45	46	14	20
Captan 400 (3), Thiram 42S (2.5), Allegiance (0.75), L1115-A1 (100 ppm product/cwt)	46	32	10	24
Allegiance (0.75), L1115-A1 (100 ppm product/cwt), Vortex (25 ppm product/cwt)	37	38	9	18
Allegiance (0.75), L1115-A1 (50 ppm product/cwt), Vortex (25 ppm product/cwt)	40	51	12	21
Maxim 4FS (0.08), Apron XL (0.19), Divident Xtreme (2.00)	38	53	13	28
Maxim 4FS (0.08), Apron XL (0.32), CGA301940 (0.15)	40	53	12	22
Maxim 4FS (0.08), Apron XL (0.32), Cruiser 600 FS (1.28)	53	45	26	28
Maxim 4FS (0.08), Apron XL (0.32), Cruiser 600 FS (5.12)	69	49	30	32
Maxim 4FS (0.08), Apron XL (0.32), Cruiser 600 FS (1.28), CGA301940 (0.15)	63	42	15	36
LSD (0.05)	16.1	NS	10.0	14.4
p value		0.91		
CV	40.7	50.8	69.7	48.3

New Cultivar Evaluation - 2002

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Each year seed companies release new cultivars. Depending on your soil type, cultural practices, weather and location, performance of new varieties may differ from location to location. In order to evaluate these new vegetable cultivars for yield and fruit characteristics, and their performance under central Ohio growing conditions, plots were established at the Waterman Ag and Natural Resources Laboratory in the spring of 2002. Soil type was Crosby silt loam for all cultivars except ornamental corn, which was planted in a Kokomo silt loam. All plots received 100 lbs N ai/A of 34-0-0. Curbit was applied at 4 pts/A for squash and gourd plots. Plots for tomatoes, peppers and eggplant received Dual @ 1 pt/A, Treflan @ 1.5 pts/A and Sencor @ 0.5 lb/A. The new cultivars tested include:

Species	**Cultivar**	**Seed Source**
Pepper (jalapeno)	'Conchos'	Seedway
Pepper (bell)	'Super Heavyweight'	Seminis Garden Seeds
Tomato	'Window-Box Roma'	Seminis Garden Seeds
Eggplant	'Lavender Touch'	Seminis Garden Seeds
Gourd	'Autumn Wings'	Seedway
Gourd	'Apple Gourd'	Seedway
Winter Squash	'Harlequin'	Rupp Seeds
Winter Squash (spaghetti)	'Small Wonder'	Seedway
Ornamental Corn	'Autumn Explosion'	Seedway

Peppers, tomato and eggplant were all seeded into 200-cell plug trays on April 10 and transplanted to the field on June 3, 2002. Tomato, pepper, and eggplant transplants received 8 oz. starter fertilizer at transplant (10-52-10). All plots except ornamental corn were established in three replications on raised beds spaced 5' apart with black plastic mulch. All plants/seeds were hand planted except for corn. Corn was planted in 4 replications using a 4-row corn planter. There were multiple harvests for tomato, peppers and eggplant. A once-over harvest was used for gourds, winter squash and ornamental corn.

Peppers:

'Conchos' : Seeds were sown into 200-cell plug trays on April 10 and transplanted to the field on June 3. Plants were spaced 15" apart in the row. 100% survival after field establishment; this hybrid jalapeno had excellent flower and fruit set and canopy coverage. Matures in approximately 70 days. Fruits are large jalapenos that turn a green-black when ready for harvest. Very little checking (surface cracking of the skin) was observed in the fruit. Plots were harvested 7 times throughout the growing season on July 26; August 7, 14, 20, 30; September 12 & 30. Average marketable yield was 85 fruit/plant totaling 3.4 lbs. Culls totaled 13 per plant at

0.6 lbs. Average marketable fruit weight was .04 lb. This variety had excellent fruit set throughout the season.

'Super Heavyweight': Field survival was 98% after transplant. This hybrid bell pepper produced large fruit averaging just under 0.5 lbs/fruit. Fruits were blocky to oblong and thick-walled. Marketable fruit per plant averaged 8; cull fruit per plant averaged 3. The majority of the cull fruit was blossom end rot and sunscald. Since fruit was large, foliage canopy cover was not always sufficient to protect fruit, particularly during the warmer months of June, July and August. Fruit was attractive in the green stage, but once fruit began to mature to yellow, the shelf life was rather limited and showed signs of soft, "pancaking" flesh.

Tomato

'Window-Box Roma': a very unique, very compact plant that yields large fruit early. Plants have dark green rugose foliage. Fruits are large and meaty with excellent flavor. This cultivar is advertised for production in pots, containers and small spaces, but performed well in the field. Fruit matures in approximately 70 days after field transplanting. Plants were spaced 15" apart in the field but if space is limited can be planted closer due to the compact size. Fruit was harvested 5 times on August 7, 14, 20, 30 and September 12. Marketable yield averaged 50 fruit/plant with an average fruit weight of 0.13 lbs. Culled fruit per plant averaged 0.8 lbs/plant. Fruit was culled primarily due to bird and rodent damage. No disease pressure was noted with this cultivar. Small compact plants with unusual foliage and high yield potential.

Eggplant

'Lavender Touch': Fruits are cylindrical shaped with thin white skin and unusual touches of lavender. The lavender blushes seem to lessen as the fruit matures. Fruits have a mild non-bitter flavor. Uniform early fruit set was observed. No visible damage to foliage was observed from flea beetles. Plants were harvested 5 times on August 14, 20, 30 and September 12 and 30. Marketable yield averaged 6 fruits per plant with an average fruit weight of 0.42 lbs. On September 30, there were still many small fruits on the plants that did not mature in size before frost. Culled fruit were mainly due to wind scarring on the white skin.

Gourds

'Autumn Wings': plots were direct seeded through holes in black plastic mulch. Two-three seeds were planted per hole spaced 3' apart. Percent germination on July 12 was 80%. This attractive ornamental gourd mixture contains unusual 'winged' shaped gourds in various shades and patterns of green, yellow, orange and white. Excellent foliage coverage from vines. No disease or insect problems were noted. Plots were harvested on September 30. Average marketable yield was 12 gourds/vine at an average weight of 0.3 lbs. each. Very attractive variety for fall decorating and mixes well with pumpkins and other ornamental gourds.

'Apple Gourd': These unusual, apple-shaped gourds are popular at farm markets and roadside stands. Lush vine growth provided excellent foliage coverage for fruits. Plots were seeded with 3-4 seeds per hill. Germination on July 12 was 80%. No disease or insect problems were noted during the growing season. Marketable yield averaged 5 gourds/vine with an average fruit weight of 4 lbs/fruit. These gourds are medium green with darker specks of green on the flesh. Very attractive for fall decorating and popular dried and painted.

Winter Squash

'Harlequin': This acorn-type winter squash matures in approximately 90 days and has a compact bush habit yielding 4-5" diameter fruit that are green striped. The bright orange interior has good eating quality and is also very decorative. Fruits resemble small green striped pumpkins and mix well with other fall gourds and decorations. Fruits are smaller than the average acorn squash, making this variety ideal for single-servings. Fruits must be harvested when the skin is still green, before changing to a yellow/orange. Three to four seeds per hill were planted and germination on July 12 was 94%. Marketable yields averaged 5 fruits/plant with an average fruit weight of 1 lb. Only a small number of fruit was culled due to rodent damage in the field.

'Small Wonder': This hybrid spaghetti squash cultivar matures in approximately 70 days and produces oblong, pale yellow/orange fruits that are approximately 1 lb. each. Emergence on July 12 was 100%. Some vine dieback was observed due to bacterial wilt which was present in the field. This is an excellent variety for a single-serving size. Good shelf life and cooking quality with good interior stranding characteristics. Like other spaghetti squash varieties, 'Small Wonder' requires a long cooking time. Marketable yields average 9 fruits/vine with an average fruit weight of 1.1 lbs. Very few fruits were considered unmarketable due to rodent damage in the field.

Ornamental Corn

'Autumn Explosion': this colorful ornamental corn matures in approximately 102 days and produces 8-10" ears of solid and multicolored ears. Colors include purple, red, white, pink, blue and purple. Some kernels are streaked or spotted. This mix provides a nice variety of colors and many ears had solid purple husks. Plots were seeded with a John Deere 4-row seeder. Rows were 190 feet long and were spaced 30" apart with 6 inches between seeds. Emergence in the field was 90% on July 12. Marketable yield totaled 1,242 dozen ears/acre. Marketable yield was slightly reduced due to heavy worm, bird and groundhog damage that occurred late in the summer. Despite very dry growing conditions in 2002, ears had good tip fill. Each stalk produced approximately 2 ears on very tall plants, which make for easier harvesting. This variety makes a nice fall display alone or displayed with gourds and pumpkins.

Each year, testing new cultivars under Ohio growing conditions is important for determining variety performance and fruit quality. Yields for this project were calculated on a per plant basis due to the small plot size used in research plots with the exception of ornamental corn where yield was calculated on #dozens/acre. Cultural practices such as planting date, plant spacing, chemical inputs and irrigation management are important factors for quality and marketable yield in any crop.

This report and pictures of all cultivars tested can be viewed on the web at:

http://www.ag.ohio-state.edu/~vegnet/

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Update on cover crops for disease control in no-till pumpkins.

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Cover crops have been used in high-input agronomic and vegetable production systems to help reduce soil erosion, fungicide use, plant disease, and weed pressure. Cover crops have also been shown to increase soil organic matter, nitrogen availability, and moisture. Traditionally, cover crops such as hairy vetch (*Vicia villosa*) and winter rye (*Secale cereale*) that are killed and left on the soil surface have been used in pumpkin (*Cucurbita pepo*) production in the Midwest. These traditional fall-sown cover crops can be killed by herbicide applications or mowing prior to pumpkin planting. Fusarium fruit rot (FFR) can be a major disease in small roadside farm operations where pumpkin rotations are non-existent or every one or two years. Because control of FFR with fungicides does not work, there is a need for alternative production systems. Cover crops may play important roles in these alternative pumpkin production systems, as well as, help reduce FFR. The objectives of this study are as follows:

Objectives:

1. Selection of spring-sown living, fall-sown (herbicide) killed, and spring-sown (herbicide) killed cover crop mulches for use in commercial pumpkin production.
2. Determine the effects of these cover crop mulch systems on pumpkin yield and aesthetic fruit quality.
3. Determine the effects of cover crop mulches on soil-borne fungal diseases such as fruit rot of pumpkin caused by *Fusarium spp.*
4. Introduce these cover crop systems to growers for use in commercial pumpkin production.

Methods: In Oct. 2000 fall-sown cover crop treatments of winter rye 'Wheeler'(90 lb/A and 50 lb/A) were established at research branches in Columbus, Fremont, South Charleston, and Wooster, OH. In early May 2001 spring-sown cover crop treatments of spring oat 'Armor' (110 lb/A) and annual medic 'Sephi' and 'Polygraze' at 40 lb/A were established at same sites. In Sept. 2001 fall-sown cover crop treatments of winter rye 'Wheeler' (90 lb/A and 50 lb/A), hairy vetch (50 lb/A), hairy vetch + rye (50 lb/A ea) were established at research branches in Fremont, South Charleston, and Wooster, OH. In late April 2002 spring-sown cover crop treatments of spring oat 'Armor' (110 lb/A) and annual medic varieties 'Sephi' , 'Parabinga' and 'Polygraze' at 40 lb/A were established at same sites. Plot sizes were 25' by 25'. In late May of 2001 and 2002 fall-sown rye plots were killed with Round-up at 4 pt/A. In hairy vetch plots 2,4D (Lo Vol) at 2 pt/A was added. Planting strips (22" wide) on 10' centers were prepared in each treatment by spraying Round-up (5%) with a backpack sprayer. Fall-sown rye and spring-sown oat were laid down with a 2' wide walk-behind roller in June. In mid to late June Poast Plus (2 pt/A) + 24DB (2 pt/A) were sprayed on annual medic plots to control broadleaf weeds. Prior to pumpkin planting, planting strips were tilled with a roto-tiller. Pumpkin cv. 'Magic Lantern' was seeded into the cover crop treatments in early July by hand. Two seeds were planted every 2 ft. to approximate standard production practices. Seeds were established with ~8 oz. water with (10-52-10) and Admire at 2.2 oz/1000 ft. Plots were maintained with rotated applications of Bravo Ultrex @ 2.7 lb/A and Quadris @ 12.3 oz/A beginning in August. Nova 40WP @ 3.0 oz/A or Benlate @ 1 lb ai/A was also added to the spray program to help control Powdery Mildew. Sulfur-coated urea (39-0-0) was broadcasted @ 50 lb/A over entire plots at planting and banded at 50 lb/A at vine-tip. Pumpkins were watered with 1" drip irrigation tape throughout the growing season when necessary. At harvest all fruit from each treatment were graded according to color (orange, green) and weighed. Percentages of marketable (orange) and clean fruit were also calculated. Pumpkins were harvested during the first 3 weeks of October.

Results and Discussion:

Establishment, cover crop biomass and % ground cover production: In general, fall-sown rye (90 lb/A and 50 lb/A) produced enough biomass to provide season long ground cover. Early establishment (ie. prior to hard freezes) in the fall is critical to the success of winter rye and hairy vetch as cover crop mulches. Fall-sown oat and annual medic (winter-killed) do not produce enough biomass to last the following season. However, spring-sown oat at 110 lb/A planted in late April to early May provided excellent early to mid-season ground cover. Oat tends to breakdown much quicker than fall-sown rye and its ability to provide ground cover, suppress weeds, and conserve soil moisture decreased much quicker than rye during the growing season. Annual medics established well when planted in late April to early May. Spring-sown annual medic 'Sephi' provided excellent season long ground cover whereas, 'Parabinga' and 'Polygraze' provided early, but failed to provide season long ground cover due to early senescence from summer heat, spider mites, and powdery mildew.

Pumpkin yield and fruit quality: In 2001 and 2002 marketable yield (orange fruit) on fall-sown winter rye (90 and 50 lb/A), hairy vetch (50 lb/A), and winter rye (50 lb/A ea) and spring-sown oat (110 lb/a) were comparable to slightly higher than bare soil. In both years, yield of pumpkins grown in spring-sown living annual medic cover crops were reduced. In both years, fruit cleanliness was highest on fall-sown winter rye. Spring-sown oat and fall-sown hairy vetch provided intermediate fruit cleanliness. Fruit cleanliness in annual medic cover crops ranged from poor to excellent depending on variety and year.

Cover crop effect on development of Fusarium fruit rot: In 2002, research plots in Fremont, South Charleston and Wooster, OH were artificially inoculated with Fusarium fruit rot (FFR) by three different methods. Method of inoculation affected severity of FFR. In Wooster, 2002, average percent yield loss (PYL) ,based on weight, was highest in bare soil plots (43%). PYL in spring-sown annual medic ranged from 21 to 37% based on variety. In hairy vetch (50 lb/A) PYL was 27% and spring-sown oat PYL was 22%. PYL was lowest in fall-sown cover crops. PYL was 9% in rye (50 lb/A), 5% in rye (90 lb/A) and 4% in rye + hairy vetch (50 lb/A ea).

Conclusions: Overall, results show that fall-sown rye and hairy vetch can be successfully incorporated into pumpkin production in Ohio although integration and success will depend on fall-planting date, lbs/A planted, spring kill date, and method of pumpkin planting. We find that a strip tillage system may allow for easier pumpkin planting as well as offer some leeway in the window of opportunity for spring cover crop kill. Too much rye biomass and successful kill of hairy vetch has often been a problem. Spring-oat when planted at a high rate (110 lb/A) can also be successfully incorporated into a strip-tillage pumpkin production system. Planting a cover crop such as oat in the spring alleviates some of the problems of a fall-sown cover crop such as having a field free for planting and helps to avoid some of the weather contingencies necessary for a successful cover crop. Although oat will not produce as much biomass as a fall-sown rye, its growth habit makes it much easier to kill with herbicides, as well as, having a much greater window of opportunity for kill. Spring-sown annual medics when left as living mulches in a strip-tillage system with drip irrigation cause reduced yields. Competition for water and available N and allelopathy may all play a role, future work still needs to be done. Fruit cleanliness and PYL due to FFR was lowest in fall-sown rye and rye + HV plots suggesting that these cover crops provided a physical barrier between pumpkin fruit and the soil.

Weather Data – 2002

Vegetable Crops Branch, Fremont, OH

Month	Average Min. Temperature (^{o}F)	Average Max. Temperature (^{o}F)
April	39.0	60.5
May	42.1	65.3
June	58.6	83.5
July	63.9	88.2
August	60.5	84.1
September	52.3	80.2
October	38.8	61.4

Month	Rainfall (inches)	Average Normal Rainfall (inches)
April	3.47	3.35
May	4.32	3.51
June	3.65	3.98
July	3.64	3.77
August	3.31	3.28
September	3.85	3.03
October	1.49	2.38

Weather Data – 2002

Waterman Ag and Natural Resources Laboratory, Columbus, OH

Month	Average Min. Temperature (°F)	Average Max. Temperature (°F)
April	43.7	65.4
May	46.7	70.1
June	62.4	85.2
July	67.0	89.1
August	65.8	87.7
September	58.1	83.7
October	44.6	62.6

Month	Rainfall (inches)	Average Normal Rainfall (inches)
April	4.17	3.74
May	9.46	4.19
June	7.59	4.48
July	2.70	4.53
August	2.31	3.58
September	9.12	2.93
October	5.28	2.34

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