Final Project Report to the NYS IPM Program, Agricultural IPM, 2003-2004.

I. Title: Utilizing IPM Strategies in Pumpkins and Winter Squashes Grown Using Intensive Plasticulture Techniques

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IV. Type of Grant: Systems comparison trial

V. Project Locations: Albany and Columbia Counties

VI. Abstract.

Winter squash and pumpkin growers in the Northeast are seeking production systems that are more cost-effective than those they are currently using. An intensive plasticulture system that utilizes transplants and high plant populations, plastic mulch and drip irrigation, scouting, and as-needed fertilizer and pesticide applications is consistent with this objective because it results in greatly increased yields of marketable fruit. This system increases certain inputs – plant numbers and agricultural plastics, most notably – in order to increase marketable yields per acre. At the same time, other inputs – including herbicides, insecticides, fungicides and fertilizers – may be reduced. Three field trials were undertaken in 2003 to evaluate various aspects of the plasticulture system: pumpkin fertigation treatments were evaluated at Al Lansing's farm in Albany County, and winter squash fertigation and pumpkin and winter squash disease management treatments were evaluated at Cornell's Valatie farm in Columbia County. At the Lansing farm we evaluated the impact of four nitrogen fertigation rates – 50, 65, 80, and 95 lb N/acre - on pumpkin yields. The number of pumpkins increased with increasing fertilizer rates. At the Valatie farm we evaluated how four rates of nitrogen fertilizer – 30, 45, 60 and 75 lb N/acre - affected the yields of acorn and butternut squashes. The squashes exhibited yield responses only at the highest N rate. Average fruit size was not impacted by these treatments. New, powdery mildew tolerant varieties of squash out-yielded standard varieties even when the newer varieties were given the lowest rates of N and the standards were given the highest N rates. These studies suggest that high yields of acorn and butternut squashes grown using plasticulture techniques may be obtained by selecting good varieties, using high plant populations, and by choosing modest fertilizer rates. In another trial at the Valatie farm we intended to find out how three disease management strategies affected disease incidence, fruit yield, and fruit quality in pumpkins and acorn and butternut squashes. Heavy rains just prior to harvest followed by a rapid Phytophthora infestation destroyed the entire trial making data collection impossible. We expect to repeat this work in 2004.

VII. Background and Justification.

Recent research has stimulated interest in developing an intensive winter squash and pumpkin production system that integrates use of transplants at relatively high populations, agricultural plastics, scouting for proper pest diagnosis, and as-needed use of pesticides and fertilizers. Several trials conducted in the Northeast in recent years have shown that use of pumpkin and butternut squash transplants produces far better yields than direct-seeding. This research also shows that relatively small, fairly economical plug sizes may be used without jeopardizing yield gains. These findings have been consistent over a range of planting dates and soil management practices. Trials conducted in 2001 at Cornell's research farm in Valatie showed that marketable yields of acorn and butternut squashes can be improved by increasing plant populations. The Valatie trial also began to identify fertigation programs for butternut and acorn squash that utilize less fertilizer more efficiently. When plastic mulch is used, all fertilizer is placed under the mulch, allowing for a significant reduction in the total amount of fertilizer required, and reducing the risk of leaching during a rainy spring. Incremental fertilization is accomplished relatively easily when drip irrigation is used. Fertigation has the potential to increase yields while minimizing the potential for groundwater contamination.

Recent successes in breeding disease-resistant varieties have tremendous potential for improving marketable crop yields and reducing fungicide inputs. Powdery mildew-resistant and tolerant varieties have improved with respect to fruit characteristics valued in the marketplace. Use of these varieties may offer growers an opportunity to reduce their fungicide applications or switch to alternative materials. Effective fungicides, disease-resistant varieties, crop rotation, plastic mulches, and raised beds represent a powerful set of tools with which to design a disease management plan. Integration of these strategies has the potential to improve the profitability of pumpkin and winter squash production while minimizing the adverse environmental impacts of farming.

VIII. Objectives.

1) To demonstrate the components and economic impact of a system for producing winter squashes and pumpkins that utilizes transplants, plasticulture and IPM.

2) To demonstrate alternative disease management strategies for use in the plasticulture system. Elements in this system that contribute to disease management include use of disease-resistant varieties, crop rotation, raised beds, plastic mulch, and drip irrigation.

3) To demonstrate alternative fertilization strategies that minimize ground- and surface water pollution potential and achieve high yields.

IX. Procedures. Three field trials were undertaken in 2003: pumpkin fertigation treatments were evaluated at Al Lansing's farm in Albany County, and winter squash fertigation and pumpkin and winter squash disease management treatments were evaluated at Cornell's Valatie farm in Columbia County. All three trials utilized completely randomized block designs, with treatments replicated three times in each location. Each trial utilized a planting strategy incorporating transplants, raised beds, plastic mulch and drip irrigation.

X. Results and Discussion.

PUMPKIN FERTIGATION. At the Lansing farm we evaluated the impact of four nitrogen fertigation rates – 50, 65, 80, and 95 lb N/acre - on pumpkin yields. The grower's in-row spacing of 36" and between-row spacing of 8' were utilized in the trial. Two seeds per cell of 'Pankow Field' pumpkins were sown into 38-cell trays and transplanted in late June at about four weeks of age. Every week beginning a week after transplanting a complete and balanced fertilizer was injected into the drip system until a total of 50 lb N/acre was provided. Each week thereafter, liquid nitrogen (32% N) was injected into the system in accordance with the trial's treatment plan.

Hot temperatures and dry conditions prevailed at the time of planting and for much of the season. Irrigation resources could not adequately meet crop water demands on the farm's sandy soils. As a result, yields were much lower than expected (see Table 1). The number of pumpkins increased with increasing fertilizer rates. Average fruit size was not impacted by these treatments. Although earlier research indicated that yields would be optimized at N rates of 60 to 80 lb/acre, this study suggests that yields might have increased further if N was applied at rates above the 95 lb/acre applied in this trial. We were not able to identify an optimal N fertilizer rate for this system. The sandy soils at the Lansing farm likely required more water and more N than soils investigated elsewhere. In an effort to supply enough water to meet crop demands, N may have been inadvertently leached from the system. Additional research is needed to clarify optimal N rates.

Table 1. Pumpkin yield response to four different nitrogen rates
Lansing Farm, Albany County, 2003

	Pumpkin Yield (per 300' of row)			
Nitrogen	Number	Weight (lb)	Ave. Wt. (lb)	Yield/Acre (lb)
50	52	467	9.0	8,480
65	45	600	13.3	10,890
80	61	559	9.2	10,150
95	78	778	10.0	14,120

SQUASH FERTIGATION. At the Valatie farm we evaluated how four rates of nitrogen fertilizer – 30, 45, 60 and 75 lb N/acre - affected the yields of acorn and butternut squashes. One seed per cell was sown into 98-cell trays. Transplants were set out in late June using a 24” in-row spacing and 60” between rows. A complete fertilizer was applied at the time of bed shaping. Liquid nitrogen was delivered in 15 lb/acre increments according to the treatment schedule. ‘Autumn Delight’ and ‘Table Ace’ acorn squashes exhibited a yield response only at the very highest rate of N (see Table 2). The highest N rate (75 lb/acre) increased the number of fruits per plant, which, in turn, increased yields. Fruit size was not affected by these treatments. These findings are slightly at odds with our earlier work. We undertook a study in 2001 in which we found yields of acorn squash grown using a plasticulture system much like this one to have been optimized using 55 lb N/acre. To gain a clearer picture of optimal N fertilization, future research treatments will include a broader range of N rates. ‘Table Ace,’ an “old standard” variety, was more responsive to N rate than ‘Autumn Delight,’ a relatively new, powdery mildew tolerant variety. The selection of acorn squash variety is clearly an important part of developing a good squash system. Interestingly, yields of ‘Autumn Delight’ using 30 lb N/acre were greater than those of ‘Table Ace’ using 75 lb N/acre.

Table 2. Acorn squash yield responses to four different nitrogen rates
Valatie Farm, Cornell University, Columbia County, 2003

	‘Autumn Delight’			‘Table Ace’		
Nitrogen	Number	Weight (lb)	Ave. Wt. (lb)	Number	Weight (lb)	Ave. Wt. (lb)
30	21.3	37.8	1.8	18.0	29.7	1.7
45	19.1	33.7	1.8	16.2	25.9	1.6
60	20.2	33.3	1.6	15.8	26.1	1.7
75	24.2	42.1	1.7	24.2	34.6	1.4

Note: yields reported here are per 16 row feet

‘Avalon’ and ‘Waltham’ butternut squashes also exhibited a yield response to N rate (see Table 3), and, as was the case with the acorn squashes, it was the “older” butternut variety that was lower yielding and showed the greatest fertilizer response. ‘Avalon,’ a new variety that has performed quite well in variety evaluations, out-yielded ‘Waltham,’ an industry standard, even when ‘Avalon’ was given the lowest rate of

N and 'Waltham' was given the highest rate. 'Avalon' showed an insignificant yield response as the N rate was increased from 30 to 75 lb/acre.

Table 3. Butternut squash yield responses to four different nitrogen rates
Valatie Farm, Cornell University, Columbia County, 2003

	'Avalon'			'Waltham'		
Nitrogen	Number	Weight (lb)	Ave. Wt. (lb)	Number	Weight (lb)	Ave. Wt. (lb)
30	14.0	40.8	2.9	10.2	25.1	2.5
45	13.6	35.0	2.6	12.8	28.8	2.3
60	11.8	31.7	2.7	11.7	27.9	2.4
75	15.2	43.9	2.9	14.2	37.4	2.6

Note: yields reported here are per 16 row feet

These studies suggest that high yields of acorn and butternut squashes grown using plasticulture techniques may be obtained by selecting good varieties, using high plant populations, and by choosing modest fertilizer rates. It appears that there is some potential to increase yields above those experienced here by increasing fertilizer rates, but further research is required to identify these rates with greater accuracy.

DISEASE MANAGEMENT. In another trial at the Valatie farm we intended to find out how three disease management strategies affected disease incidence, production economics, fruit yield, and fruit quality in pumpkins and acorn and butternut squashes. The objective was to compare a relatively intensive spray program with two "low input" programs (including one that organic growers would be permitted to use) and an unsprayed control. The three treatments are summarized in Table 3. Two week old acorn squash, butternut squash, and pumpkin transplants (all grown in 98-cell flats) were set out in late June using a 24" in-row spacing and 60" between rows. The fungicides were applied on three occasions on ten day intervals beginning after the first powdery mildew lesion was detected. Disease pressure was quite low until very late in the season. A casual evaluation made prior to our scheduled harvest date identified treatment differences in the incidence of powdery mildew, but this was not quantified. Heavy rains followed by a rapid Phytophthora infestation destroyed the entire trial (and an adjacent variety trial) making data collection impossible. We will make an effort to repeat the trial in 2004.

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