Final Report for NYSBGA
Developing an Annual Strawberry Production System Using Northeastern Varieties
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The goal of this project was to evaluate NY bred and/or NY adapted strawberry varieties in an annual strawberry production system and compare them to currently available mid-Atlantic adapted and produced varieties. Yield potential from the annual system was compared to the matted row system. The project also evaluated the feasibility of producing strawberry plug plants for on-farm use.

I have experimented with using the annual Chandler plug system at The Berry Patch of Stone Wall Hill Farm and have had disappointing results. Using the generally accepted system of using row cover for winter protection on Chandler, in our cold microclimate, many flower buds are killed in February and March as the plants begin to grow but are then subjected to significant numbers of freezing nights. Yields have not been competitive with my matted row system.

This grant began with the construction of a propagation area and set up of an automatic mist system to enable me to propagate the plants outdoors. A working system was in place by mid-July when we collected our first daughter plants. This time was chosen as it immediately followed harvest and would also allow five to six weeks of rooting time, enabling us to target a late August planting date. Daughter plants of Northeastern varieties were collected in buckets of water and "stuck" in the plugs within one hour of collection.

All varieties rooted well and did not appear to have any problems in the propagation process. We separated larger daughter plants from smaller daughter plants to see if that has an impact on yield. Leaf spot was a concern due to the frequent misting of the plants during the propagation process. This can be lessened by using daughter plants with no evidence of the disease.

Due to the exceedingly wet summer (20 inches of rain in August) at our farm, the planting of the plugs was delayed later than I would have liked. I was aiming for a planting date between August 20th and September 1st. We could not get onto the ground to plant until September 11th. Three days after planting we covered them with row cover to enhance the growing climate. The plants took well and we had very few losses. The row cover stayed on the plants until mid-November, when we uncovered the plants to give them an opportunity to harden off some more before covering them with mulch. We covered them with straw mulch on December 3rd. Prior to mulching them, I did crown counts. All varieties appeared to have 1-2 crowns per plant – less than I had hoped. I also noticed that some of the Northeastern varieties had put out flowers in the fall. Those flower clusters are lost for yield the following spring.

Straw mulch was removed April 3, 2004. Most plants appeared to be in good condition. The leaves were noticeably greener than plants in the matted row system. As the spring progressed, the plants grew well and started flowering in early May. The Chandler flower clusters emerged later than the Northeastern varieties, a surprise to me.

Data collection in 2004 took a slightly different tact than I had planned due to some unexpected and rare pest problems. The plots started to flower in early May (see photos in Appendix 2) and initial observations showed there to be distinct differences in the number of flower clusters between varieties. On May 18th, I noticed sudden collapse of some flower clusters. The culprit was finally diagnosed as the larvae of strawberry crown moth.

Since I knew that yield data would be compromised, I quickly changed gears and started data collection in the third week of May with counts of flower clusters. By knowing the number of flower clusters produced per plant, I would at least be able to extrapolate some reliable yield data. Every plant in every plot had the number of flower clusters counted. This data is summarized in Table 1. Yield data collection started on June 1st, with the first ripening berries. 2004 was a record year for earliness – a full 7 days earlier than ever before. Another pest problem became apparent as the season progressed, that of tarnished plant bug (TPB) damage to the berries. This pest is usually only a problem in our latest ripening berries (those that flower and start to develop at the end of May / early June), but they seem to have attacked the plasticulture planting early. I'm perplexed by the severity of the damage in the planting as my monitoring indicated that we were not over threshold for the nymphs until very late in the flowering period. Late varieties in my matted row plantings were not affected anywhere near the same degree. Because of the degree of TPB damage to the plots, I suspended yield collection on June 14th. However, since I was able to collect flower cluster data, and early data on fruit size, I have put together a table with extrapolated yields (Tables 2 and 3).

With an early end to strawberry season in 2004, we were able to propagate new plants during the week of July 5th. The plants once again took nicely, and we again had a problem with leaf spot. The plants were planted August 25th and 26th – later than I had planned due to another very wet summer. We kept waiting for the ground to dry out so we could use our water-wheel transplanter, but finally gave up and hand planted the plots instead. We did not have as good a take on the plants in 2004, I believe because they were hand-planted instead. Even though we fertilized with nutrient solution 2 days after transplanting, I believe the lack of the watering-in effect from hand transplanting instead contributed to a much poorer stand than we had the previous year. We covered the rows with row cover in late September and removed the row cover on Thanksgiving weekend. Straw mulch was applied December 3rd. The planting had good snow cover from mid-January through the end of March. There was some open, sub-zero weather in January that had potential to cause some winter injury. Straw mulch was removed on April 9th, 2005. The plants were growing well and some of the flower trusses started to bloom in early to mid-May. Frost protection was needed seven times during the growing season. This was provided with double layer row cover.

Harvest of the plots occurred during June 2005, data is presented in Table 4. Double layer row cover was successful at preventing freeze damage, despite very low temperatures in May.

Project results:

Table 2. Yield Potential of Varieties grown in Plasticulture based on number of flower trusses – 2004 – Planted at 12 inch in-row spacing.

Plasticulture	# Flower	Lower End	Lower End	Higher End	Higher End

	trusses per square ft.	Yields/Plant (2 oz/truss)	Yields Lbs/acre	Yields/Plant (4 oz/truss)	Yields Lbs/acre
Annapolis	2.37a	4.74 oz	4302	9.48 oz	8604
Chandler	2.99a	5.98 oz	5427	11.96 oz.	10854
Jewel	3.49ab	6.98 oz	6334	13.96 oz.	12668
Mesabi	4.28b	8.56 oz	7768	17.12 oz.	15536
Matted row	10-12		10800^		

Means with the same letters are not significantly different at 1% level of significance.
Based on 14520 plants per acre (6 foot centers with 2 rows per bed at 12" in-row spacing)
^ Actual yield from 2004 crop including Pick your own. Large losses were experienced in the pick your own crop due to an early season and subsequent lack of pickers. 2003 yields were 13315 lbs per acre.

Table 3. Yield potential of the same varieties if grown at 9" in-row spacing (19360 plants per acre)

Plasticulture	# Flower trusses per plant	Lower end yields Lbs/A (2 oz./truss)	Higher End yields Lbs/A (4 oz./truss)
Annapolis	2.37	5735	11470
Chandler	2.99	7236	14472
Jewel	3.49	8446	16892
Mesabi	4.28	10358	20716

Table 4. Mean number of flower clusters, yield per plant, and yield per acre in 2005.

	Mean # Flower trusses per plant***	Mean Yield/plant**	Mean Yield/Acre (Plasticulture Plant population = 14520 plants per acre)
Annapolis	2.31a	3.39 oz a	3076 a
Chandler	1.87a	2.61 oz a	2367 a
Jewel	2.36a	4.86 oz ab	4414 ab
Mesabi	3.67b	6.86 oz b	6229 b
Matted row (multiple varieties)			8333^

*** Highly significant P = 0.0664%
** Highly significant P = 0.3381%
^Actual yield from 2005 crop – including pick your own with losses from PYO. This is approximately 23 – 38% lower than our typical yields.

As the data above indicates there is a significant difference in yield potential between the four varieties tested. In 2004, Annapolis plugs on a plasticulture system produced the fewest number of flower trusses and Mesabi produced the most. Chandler, the variety most widely used for an annual plasticulture system, produced the second lowest number of flower trusses. In 2005, Chandler produced the least number of flower trusses. Yields in 2005 in my matted row system were atypically low. This seems to have occurred in the plasticulture system as well.

Another aspect of the project was to determine if there is a difference in yield potential based on the size of the daughter plant initially used for rooting. Data from 48 plants that were rooted from large daughter plants and 48 plants rooted from smaller daughter plants of Mesabi was collected and analyzed. Plants resulting from larger daughter plants had a larger number of flower clusters. Statistically, it was significant at the 2% level of significance.

One of the other goals of the project was to determine the feasibility of setting up an on-farm propagation system to produce one's own plug plants. The propagation system worked well, and it should be very easy for any grower to set up an on-farm propagation system to produce strawberry plugs. We had a success rate of 99% in getting the daughter plants to root.

Project assessment:

Propagation:
Because of the nature of the propagation process, I think it will be helpful for growers who consider this process to do the propagating under cover in a high tunnel or greenhouse. I was hoping to find a way to accomplish this process in the cheapest way possible (i.e. on ground cover outside, negating the need for a structure). Unfortunately, to produce plants with as little disease as possible, without applying a constant stream of fungicides, I am now convinced that exposing the plants to as little additional moisture as possible is extremely important.

A more problematic concern is the limited number of varieties that currently do not have plant patents associated with them. Growers who use this system to produce plants for themselves will need to make appropriate arrangements with plant patent holders to pay royalty fees. There will be some varieties for which this option is unavailable as some nurseries hold exclusive propagation rights. Another option is to buy high quality tips from a good nursery.

Planting:
More research is needed to determine appropriate planting dates. This may be variety dependent. I believe planting technique is also more important than I had realized. Even with wet soils, I think it is important to use a planting technique that will ensure good soil-soil contact.

Yield potential:
More research is needed on all aspects of growing strawberries in a plasticulture system to maximize yield potential. Of particular importance is the need to determine adequate fertilization rates and application timing. I suspect that yield potential in the plasticulture system would increase with some well-timed fertilizer applications, particularly in the fall. The question is what those rates need to be, when they need to be applied, and what interaction exists with planting date and variety. I also believe that adjusting plant spacing can result in much higher yields. Decreasing the plant spacing from 12 inches to 8 or 9 inches within the row will result in a higher plant population, increasing number of flower trusses per acre, and the resulting yields.

When looking at production per square foot, my current matted row system outperforms the plasticulture system. This may not be the case for other growers. In most years, I get good to very good yields from my matted row system, but it is also at the expense of very high labor

input, and opportunity costs. With the increasing difficulty of finding labor to perform jobs such as hoeing and competing needs on the farm at the same time, a grower with a sharp pencil may find that their yields from a plasticulture system result in similar or greater profitability than from their matted row system, especially when opportunity costs are considered.

Economics:

The key to making the plasticulture system a viable option for strawberry growers is the ability to adequately determine the labor cost trade-offs of the two systems. The upfront costs of purchasing plug plants to establish a planting are very high –about $5000 per acre including shipping. If yields are low, profitability will be hard to achieve. However, labor requirements should be far less with the plasticulture system. We spend between $1000 and $2000 per acre on weed control in a new planting (we don't use herbicides). The opportunity costs of constantly weeding a new strawberry planting are extremely high in a diverse operation such as ours, and the stress added to the new planting is impossible to measure. Add to that the ability to use one's land more efficiently, and the ability to effectively manage a more diverse operation, and profitability may be much easier to achieve than with a matted row system. If a grower can find a source of high quality tips, profitability will be much easier to achieve as plant costs will be reduced and shipping charges will be virtually eliminated.

Adoption:

I am going to continue to experiment with the plasticulture system on our farm to try to determine a more labor efficient system of producing strawberries. Seeing the results from this project convinces me that it is possible to use Northeastern varieties in a plasticulture system. Adjustments need to be made to the cultural practices but the basic premise of using Northeastern varieties in this system is a plausible one.

I plan to try to find a source of high quality tips to propagate. I would like to try an earlier planting date (perhaps early August) if we can get fully rooted plugs earlier in the summer. Additionally, I would like to try rooting only larger size daughter plants.

Many questions still need to be answered and many more questions will arise as the work progresses, but I do feel that there is potential for this system to work for growers who would like to reduce labor and input costs to produce high quality strawberries. Over time, I believe it can pay dividends for the NYS strawberry industry.