

Title of Project: Determining Optimum Nitrogen Nutrition Management for Off-season High Tunnel Plasticsulture Strawberry Production for Arkansas and the Southeast

Final Report

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Research Proposal

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Objectives

The objective of this project is to investigate nitrogen fertilization regimes and continue to develop nitrogen fertilizer recommendations for off-season high tunnel plasticsulture strawberry production in Arkansas and the southeast. To this end we propose to:

- Study the effect of four nitrogen fertilization rates in Fayetteville, AR on strawberry petiole nitrate levels from November through May, with the goal of developing optimum nitrogen management protocols for off-season high tunnel plasticsulture strawberry production in Arkansas and the southeast

Justification

The plasticulture system of strawberry production is management intensive and requires significant monetary investment but provides 2 to 3-fold higher yield, earlier harvest, higher fruit quality, and higher customer appeal. Combining the plasticulture system with high tunnel strawberry production increases environmental control and provides opportunities for off-season strawberry production with premium quality fruit and profits.

Nutrient management for strawberry plasticulture has been investigated intensively in California and Florida, but similar information for the mid-south where the environment, harvest duration, and yield potential differ markedly, is lacking. Currently, nitrogen fertilization rate recommendations for strawberry growers in Arkansas and the mid-south are derived from research conducted in North Carolina on 'Chandler' strawberries. More information on the optimum rate of nitrogen application to force early production but also maintain plant growth for sustained production through fall, winter and early spring is required. Ongoing studies at the University of Arkansas indicate that fruit quality is affected by accumulation and/or over application of nitrogen and that standard nitrogen application rates derived from the annual plasticulture system appear to adversely affect fruit color, flavor/sugar content and texture. It is likely that current standard nitrogen fertilization rates are excessive for high tunnel plasticulture strawberry production in Arkansas and the southeast. Recommendations regarding sustainable nitrogen fertilization management are needed.

Methodologies

This project focused on high tunnel plasticulture strawberry production at the University of Arkansas Research Farms in Fayetteville, Arkansas. The experimental design consisted of 4 post-plant nitrogen applications with 5 replications for each treatment for a total of 20 experimental units (Table 1). Nitrogen application rates were based on the optimum rate recommended for plasticulture strawberries. Treatment 1 is the optimum rate from (0.67 lb N/A per day) and treatments 2, 3, and 4 are based on a percentage of this rate (0.67%, 0.33%, and 0% respectively) as indicated in Table 1.

The cultivar 'Festival' was chosen for the study based on nearly three years of observations in our high tunnel strawberry production research. 'Festival' is a plasticulture-adapted short-day strawberry variety and the best overall performer in our studies. It exhibits superior qualities including high production rates (up to 2.25 lb/plants, ~35,000 lb/A), high fruit quality, low disease incidence and few insect problems.

Leaves and petioles of all replications were sampled on six dates throughout the pre-production season and six dates throughout the production seasons between November 2012 and February 2013. All foliar samples were sent to the University of Arkansas Altheimer Lab for nutrient analysis.

Integrated pest management practiced were followed for pest control including the use of predatory mites for mite control. In addition, to aid pollination during the off-season, bumble bees were placed in the high tunnel.

Table 1. Treatments and locations of the proposed study

Location	Cultivar	Treatment
Fayetteville	St. Festival	1 - 0.670 lb N/A per day
		2 - 0.446 lb N/A per day (67% of treatment 1)
		3 - 0.223 lb N/A per day (33% of treatment 1)
		4 - 0 lb N/A per day (0% of treatment 1)

Results**Foliar and Petiole Nitrogen**

On 18 January 2013 there were significant differences between the 100% N treatment and the other treatments. This treatment had the lowest N foliar content. Although not significantly different for the other sampling times, this treatment generally had the lowest N foliar content. Foliar N was within the sufficiency ranges for all sampling dates. There were no differences in petiole nitrogen levels between the four nitrogen fertigation treatments on any dates. Nitrate N was below the normal ranges for for all sampling dates. Means and SEM are found in Table 2 (foliar) and Table 3 (petiole).

Table 2. Effects of four nitrogen (N) percentage fertigation rates on mean % foliar nitrogen (\pm SEM) of ‘Strawberry Festival’ leaves in a high tunnel at the UAREC Fayetteville, AR (6 November 2012 to 2 February 2013; $P < 0.05$; Students t- test).

Date	N Fertigation rate (%)			
	0% N	33	66	100
6 Nov. 2012	2.90 \pm 0.036	2.96 \pm 0.063	2.92 \pm 0.063	2.98 \pm 0.066
20 Nov. 2012	2.76 \pm 0.070	2.83 \pm 0.043	2.90 \pm 0.061	2.77 \pm 0.091
5 Dec. 2012	3.01 \pm 0.026	3.01 \pm 0.007	2.93 \pm 0.092	2.89 \pm 0.060
18 Dec. 2012	2.93 \pm 0.051	2.85 \pm 0.018	2.90 \pm 0.026	2.87 \pm 0.016
1 8 Jan. 2013	2.76 \pm 0.019a	2.73 \pm 0.029a	2.76 \pm 0.019a	2.62 \pm 0.027b
5 Feb. 2013	2.88 \pm 0.076	2.85 \pm 0.024	2.82 \pm 0.020	2.79 \pm 0.089
Average	2.87	2.87	2.87	2.82

Table 3. Effects of four nitrogen (N) percentage fertigation rates on mean petiole nitrogen (ppm) (\pm SEM) of ‘Strawberry Festival’ leaves in a high tunnel at the UAREC, Fayetteville, AR (6 November 2012 to 2 February 2013; $P < 0.05$; Students t- test).

Date	N Fertigation rate (%)			
	0	33	66	100
6 Nov. 2012	1406.67 \pm 104.08	1786.67 \pm 165.23	1973.33 \pm 84.13	1500 \pm 31.80
20 Nov. 2012	1600.00 \pm 79.74	1526.67 \pm 119.73	1566.67 \pm 88.52	1406.67 \pm 105.37
5 Dec. 2012	2106.67 \pm 108.68	2513.33 \pm 79.65	2333.33 \pm 40.96	2446.67 \pm 133.46
18 Dec. 2012	1366.67 \pm 110.97	1206.67 \pm 53.67	1266.67 \pm 139.22	1342.67 \pm 186.18
8 Jan. 2013	1226.67 \pm 68.70	1240.00 \pm 58.38	1286.67 \pm 113.81	1266.67 \pm 22.05
5 Feb. 2013	1500.00 \pm 77.32	1466.67 \pm 40.15	1491.00 \pm 74.01	1474.67 \pm 128.98

Strawberry fruit yield

Data from early harvest dates (27 Nov. 2012, 4 December 2012 and 7 December 2012) were excluded in the analysis because of missing data points, as many plants were not producing fruit yet. There were no significant differences in mean weights of strawberry fruit yield (g) among nitrogen fertilizer treatments (Table 4). Yield was lower than previous season's yield.

Table 4. Effects of four nitrogen (N) percentage fertigation rates on mean strawberry fruit yield (g) (\pm SEM) of 'Strawberry Festival' fruit in a high tunnel at the UAREC, Fayetteville, AR (27 November 2012 to 28 May 2013).

N Fertigation rate (%)	g
0	298.5 \pm 22.44
33	315.4 \pm 20.19
66	339.9 \pm 24.89
100 (recommended)	275.2 \pm 21.65

Conclusions

The objective of this study was to begin the development goal of optimum nitrogen management protocols for off-season high tunnel plasticulture strawberry production in Arkansas and the southeast. Results indicate that our nitrogen fertilization treatments did not significantly affect N foliar content, nitrate-N petiole content, or yield although it appears that higher N fertilizer application might have a negative effect on yield. In this study, we only tested the optimum recommended N application, not higher.

Impact

Based on this project, we were able to receive a grant from the NASGA to test higher N fertilization levels and how these levels affect plant quality, yield, and mite incidence. This project was part of a M.S. student thesis (D. T. Johnson, major advisor). This student will be defending his thesis in the spring of 2014.

Citation(s) for any publications arising from the project

No citations at this date.