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Response of Pepper and Tomato to Six Nitrogen Rates

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Objective

To determine optimum nitrogen rate for fresh market tomato and bell pepper. Nitrogen levels tested were 100, 150, 200, 250, 300, and 350 pounds/acre.

Summary

A surprising lack of statistical difference was found for most metrics measured. Similar total yield was found across all fertilizer levels tested for tomato, and for the 100 to 300 pounds nitrogen/acre for peppers, only the 350 pound/acre level had lower total yield. Pepper plant height was stunted by higher nitrogen levels. This lack of differences may indicate that the important factor in nitrogen (and perhaps other nutrients) application is not in how much is applied, but more on how it is applied, especially in conjunction with how the plants are irrigated.

Methods

Planting

Plants of Outsider pepper and Mountain Gem tomato were started in the greenhouse April 15, 2020. Tomatoes were planted to the field May 28 and peppers planted June 3. Plants were set on raised, black plastic mulched beds, 6” high, 22” wide at the top and 5.5-feet on center. Tomatoes were set in single rows 18” in the row (5280 plants/acre). Pepper plants were set in double rows 14” between double rows and 18” in the row (10,560 plants/acre). Peppers and tomatoes were placed in separate trials as a completely randomized design with 16 plants per plot for peppers and 8 plants/plot for tomatoes. Each trial had four replications with guard plants separating each plot.

Plant care: Aside from fertilizer applications, plots were irrigated as needed and insects and diseases controlled using standard commercial practices. Weeds in the row were controlled with the black plastic and between row weeds controlled by cultivation.

Fertilizer applications:

The soil type was a Spinks loamy fine sand with no slope, a CEC of 3.2, and a pH of 6.5. A pre-plant soil analysis revealed 472 ppm calcium, 95 ppm phosphorus, 64 ppm potassium, and 84 ppm magnesium. Prior to bed shaping, potassium (0-0-61), sulfur (95%), and boron (10%) were broadcast and incorporated at a rate of 175, 25 and 4 pounds per acre, respectively. After planting, liquid nitrogen (28-0-0) was applied through the drip system to provide a season total of 100, 150, 200, 250, 300, and 350 pounds/acre of actual nitrogen beginning June 16 and ending August 31. The pepper and tomato trials had separate drip systems to allow for the difference in how the 28-0-0 was applied through the season. For peppers, 75% of the total nitrogen for each treatment was applied between June 16 and July 8, and the remainder applied between July 15 and August 31. For tomatoes, equal amounts of 28-0-0 was applied weekly from

June 16 through August 31. Treatments were applied weekly through the drip system using a 0.45 gallon/minute/100 feet tape.

Harvest and Data Collection

Peppers were harvested August 12, 19, 26 and September 16. Tomatoes were harvested August 12, 19, 26, and September 2 and 16. Fruit from peppers was graded into jumbo (>240 grams), extra-large (200–239 grams), large (180–199 grams), medium (160–179 grams), number 2 (poorly shaped but suitable for processing), and culls. Tomato fruit was graded into number 1 large (>2.5-inches), number 1 small (<2.5-inches), number 2 (poorly shaped and fruit with minimal scarring), and culls. Most culls in both trials were due to blossom end rot. Average number 1 fruit weight was calculated for peppers and average number 1 large fruit weight was calculated for tomatoes. On September 22, remaining fruit was stripped from the plants in both trials, weighed, and included in total yield but not individual grades. Differences between treatments in plant height were visible for the peppers. To document the difference, pepper plant height was measured July 2 and 17. Visible differences were not observed between treatments with the tomatoes.

Results and Discussion

Pepper:

Outsider pepper had statistical differences in total yield, average number 1 weight, and yield medium fruit, and plant height (Table 1). Total yield for the six treatments ranged from 903 1.25-bushel cartons/acre for 350 pounds of nitrogen to 1363 cartons/acre for 100 pounds of nitrogen. Nitrogen levels of 150, 200, 250 and 300 pounds/acre were similar to 100 pounds/acre for total yield. The 100 pound/acre nitrogen level was among the leaders in all traits exhibiting statistical differences, including average number 1 fruit weight, yield of jumbo and medium fruit, and plant height on July 17, and was alone in having the highest July 2 plant height. Among treatments having similar total yield there is a distinct trend for decreasing yield with increasing nitrogen level. This is also seen in jumbo yield and plant height.

The heavy nitrogen application of the higher nitrogen treatments during the vegetative growth phase obviously hindered plant growth as seen by reduced plant height (Table 1 and Figures 1 and 2). Except for the highest nitrogen level, plants in the higher fertilizer treatments eventually recovered from the initial poor growth as shown in the similar total yield. It is surprising that the lowest nitrogen level (100 pounds/acre) had similar yield as higher values indicating the important factor is not how much nitrogen is applied, but rather how it is applied. The best way to fertilize peppers appears to be to provide most of the nitrogen early, during the plant growth stage, and then provide smaller, maintenance levels during the fruit maturation phase.

Tomato:

Treatment differences were found for Mountain Gem tomato in mean number 1 large fruit weight, number 1 small, number 2, and yield at final harvest (Table 2). The trend was similar to pepper in that the lower rates tend to be at the higher end of yield. The only strong difference observed was that the 350-pound treatment had significantly smaller fruit as shown in this treatment standing alone for the smallest average large

number 1 fruit weight at 236 grams and the largest yield of number 1 small fruit at 472 cartons/acre.

The most surprising result in both species is the general lack of significant differences between treatments (Table 1 and 2). Of the nine metrics evaluated in Outsider pepper, four were statistically different and of the seven tomato metrics, four were statistically different. It was also expected that higher nitrogen level treatments would increase incidence of blossom end rot and this was not the case.

Care was taken through irrigation application to keep nutrients as much as possible within the root zone. Higher-level treatments obviously took longer to apply fertilizer and therefore, the higher the nutrient level, the more water that treatment received during the day of nutrient application. This occurred once a week. On non-treatment days, plots were irrigated the same and as needed with soil moisture monitored using a Diviner 2000 soil moisture monitoring system to avoid overwatering and leaching nitrogen out of the root zone.

The results of this trial indicate higher nitrogen levels do have detrimental effects on the two species tested. They also indicate that if irrigated in such a way as to keep nutrients within the root zone, lower nitrogen applications have just as good, if not better, results than higher applications. This is especially important on sandy-soil sites, with high water infiltration rates. If irrigated too long, nutrients are easily leached through the soil and beyond the root zone. This causes a loss in maximum irrigation efficiency, maximum nutrient efficiency, and a waste of a valuable natural resource.

Table 1. Yield in 1.25 bushel cartons/acre, size grades, and plant height of Outsider bell pepper in response to six nitrogen levels. Peppers grown at the Southwest Michigan Research and Extension Center, Benton Harbor, Michigan in 2020. Average number 1 fruit weight is in grams. Plant population was approximately 10,560 plants per acre. Numbers in bold in the same column are not statistically different from the highest number in that column.

Pounds nitrogen per acre	Total Yield	Avg. No. 1 Wt.	Yield Jumbo	Yield Extra Large	Yield Large	Yield Med.	Yield No. 2	Yield Cull	Yield final	Ht. 1 7/2 (in.)	Ht. 2 7/17 (in.)
100	**1363**	**191**	**359**	296	274	**204**	35	51	143	**11.9**	**14.9**
150	**1169**	**159**	**248**	143	171	**256**	30	195	126	10.3	**13.1**
200	**1048**	157	100	137	197	**239**	31	151	193	10.4	**12.8**
250	**1041**	**171**	**155**	153	255	**196**	24	91	166	9.6	**12.8**
300	**1024**	155	84	161	198	**217**	28	148	189	9.5	12.0
350	903	**162**	79	192	178	169	28	95	162	9.4	11.5
$lsd_{0.05}$	**384**	**32**	**254**	**NS**	**NS**	**84**	**NS**	**NS**	**NS**	**1.4**	**2.3**

Table 2. Yield in half bushel cartons/acre and size grades of Mountain Gem tomato in response to six nitrogen levels. Tomatoes grown at the Southwest Michigan Research and Extension Center, Benton Harbor, Michigan in 2020. Average number 1 fruit weight is in grams. Plant population was approximately 5280 plants per acre. Numbers in bold in the same column are not statistically different from the highest number in that column.

Pounds nitrogen per acre	Total Yield	Yield No. 1 Large	Avg. No. 1 Large Fruit Weight	Yield No. 1 Small	Yield No. 2	Yield Cull Fruit	Final Harvest
100	4108	2102	**269**	257	**375**	652	**721**
150	3698	1748	**260**	305	**289**	706	**651**
200	3250	1653	**261**	202	217	604	**573**
250	3470	1804	**249**	283	**353**	660	370
300	3401	1751	**266**	235	**354**	536	**525**
350	3373	1663	236	**472**	**276**	643	320
$lsd_{0.05}$	**NS**	**NS**	**32**	**127**	**158**	**NS**	**288**

Figure 1. Overview of the 2020 pepper trial at the Southwest Michigan Research and Extension Center showing plant growth differences between treatments. Picture taken on July 17, 2020.

Figure 2. Plant growth from treatment 6 (350 pounds nitrogen/acre). Picture taken August 4, 2020.