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Title. Strawberry response to preplant nitrogen dose rates in annual hill plasticulture production

Jayesh Samtani, Assistant Professor and Small Fruits Extension Specialist, Hampton Roads Agricultural Research and Extension Center (AREC), School of Plant and Environmental Sciences, Virginia Tech., 1444 Diamond Springs Rd. Virginia Beach, VA 23455. jsamtani@vt.edu
Mark Hoffmann, Assistant Professor and Small Fruits Extension Specialist, Department of Horticultural Science, North Carolina State University, Raleigh, NC, mhoffma3@ncsu.edu

Public Abstract.

Proper nitrogen dosage is a key component towards ensuring quality crop plant and fruit harvest. Currently, there is little known about nitrogen needs of the different strawberry varieties. As such, commercial growers in the south and mid-Atlantic region of the U.S. rely on findings from a single study that recommends 60 lb/acre of preplant nitrogen for the Chandler variety though they grow many other newer varieties. The purpose of this study was to gather preliminary data on optimal preplant concentration of nitrogen fertilizer for various strawberry varieties and advanced germplasm. In this non-replicated trial, strawberry plants were treated with five different nitrogen concentrations (urea), 0, 30, 45, 60, and 75 lb/acre applied at the time of making beds. Five varieties, Chandler, Camarosa, Festival, Merced, Ruby June, and three advanced germplasms, 146T54, 1240, and 143T35 were transplanted on 9 Oct. In the following spring season, an additional 7 lb/acre/week of nitrogen was applied through drip irrigation to a total of 55 lb nitrogen/acre. Fruits were harvested twice per week from 16 April through 17 June, categorized into marketable and non-marketable fruits and weighed. We recorded fruit size, fruit firmness, and total soluble solids (TSS) once a week during the month of May. For the season-long total (marketable + non-marketable) yield, 143T35 yields were lower than Chandler. Marketable yield for other varieties was not different than Chandler. Chandler had a significantly higher non-marketable yield when compared to other varieties except for Camarosa. When averaged over varieties, only the 0 lb/acre nitrogen had lower season-long total yield (marketable + non-marketable) and marketable yield than 60 lb/acre rate. Merced (38.3 mm fruit width), Ruby June (37.3 mm fruit width) and 146T54 (37.3 mm) had significantly higher fruit size over Chandler (34 mm fruit width). The different preplant nitrogen rates did not influence fruit size. Fruit firmness was not influenced by variety or nitrogen rate. The soil ammonium content of the different preplant fertilizer rate plots were not different than the standard plot (60 lb/acre) in November and in March. The nitrate-nitrogen content in no pre-plant nitrogen plot was lower than the 60 lb/acre standard rate in March. The soil nitrate and ammonium content for each of the variety when compared to Chandler was the same in November and in March.

Objective. To understand preplant nitrogen needs of strawberry varieties and advanced germplasm.

Justification and description.

There are limited studies on understanding nitrogen needs of strawberry plants in the mid and south-Atlantic regions. Current strawberry recommendations of preplant nitrogen are based on a single variety 'Chandler' done at North Carolina State University (Miner et al., 1997). Although 'Chandler' continues to remain a popular variety for our region, in the current decade, growers have adopted other varieties as a result of replicated variety trials done in our region (Flanagan et al., 2020, Gu et al., 2017, North Carolina Cooperative Extension, 2020). Most strawberry growers grow more than one variety. Excessive nitrogen can result in excessive leaf production, greater susceptibility to diseases, and reduced fruit firmness (Miner et al., 1997). Over application of nitrogen can consequently have economic and environmental concerns (Carranca et al., 2018). We proposed a dose-response study of nitrogen on multiple strawberries varieties to characterize effects on production and nutritional quality.

Materials and Methods.

We conducted a field study in fall 2020 to include 8 different strawberry varieties (including advanced germplasm) at the Hampton Roads AREC in Virginia Beach, VA. List of varieties included Chandler, Camarosa, Festival, Merced, Ruby June (source, Cottle Farms, NC) and three advanced germplasms from the Lassen Canyon Nursery, CA-146T54, 1240, and 143T35. Treatments were non-replicated with 10 plug plants of each variety and included fall nitrogen (urea) rates 0,30,45,60 and 75 $kg.ha^{-1}$ N/acre. In the spring season, we applied another 61 $kg.ha^{-1}$ N/acre to all five nitrogen treatments based on current recommendations by Miner et al.

Timeline and data collection. Strawberry plants were transplanted on 9 October 2020. Nitrogen treatments were added preplant at the time of making raised beds on 1t Sept 2020. These plants overwintered, produced blooms in the spring season, and the strawberry harvest season was from 16 April to 17 June. We collected marketable and non-marketable fruit yield by hand-harvesting berries twice a week. The non-marketable category that comprised of small berries <10 g wt., misshapen berries, insect, animal, and bird damaged fruits and diseased fruits were weighed separately. We recorded fruit size, fruit firmness, and total soluble solids (TSS) once a week during the month of May. Fruit width was recorded on five marketable fruits using a digital Vernier caliper (Neiko, Taiwan). We checked the firmness of the fruit using a tabletop fruit texture analyzer (GS-15 Fruit Texture Analyzer, QA Supplies, Norfolk, VA, USA) on five fruits per treatment. From the same five fruits, calyces were removed, berries were placed in labeled, plastic freezer bags for each treatment and placed in freezer at -14.5°C (5.8°F). Berries were thawed, crushed, and sieved to separate the juice from the pulp. °Brix was measured, using a digital refractometer (MA 871, Milwaukee, WI) at 21°C sample temperature.

For each nitrogen rate and variety, we collected soil samples twice during the growing season- in fall on 6 Nov. 2020 and on 10 March before spring fertigation began. To analyze nitrogen content in the soil, samples were taken at each treatment at the depths of 0-5 inches. Soil samples were sent on ice to NC State University (co-PI Hoffmann) and stored at -20C. Soil samples were ground, weighed, and prepared for Nitrogen extraction. NH_4^+ and NO_3^- content were measured by the Environmental & Agricultural Testing Services (EATS) at NC State University. Adjusted NH4+ and NO3- (mg/L) rates were reported after measuring soil dry weights. Nitrogen estimation in the plant by treatment were done using plant tissue analysis lab once during

flowering/fruiting on 13 April 2021 at the North Carolina Department of Agriculture, Plant Tissue lab. for all varieties.

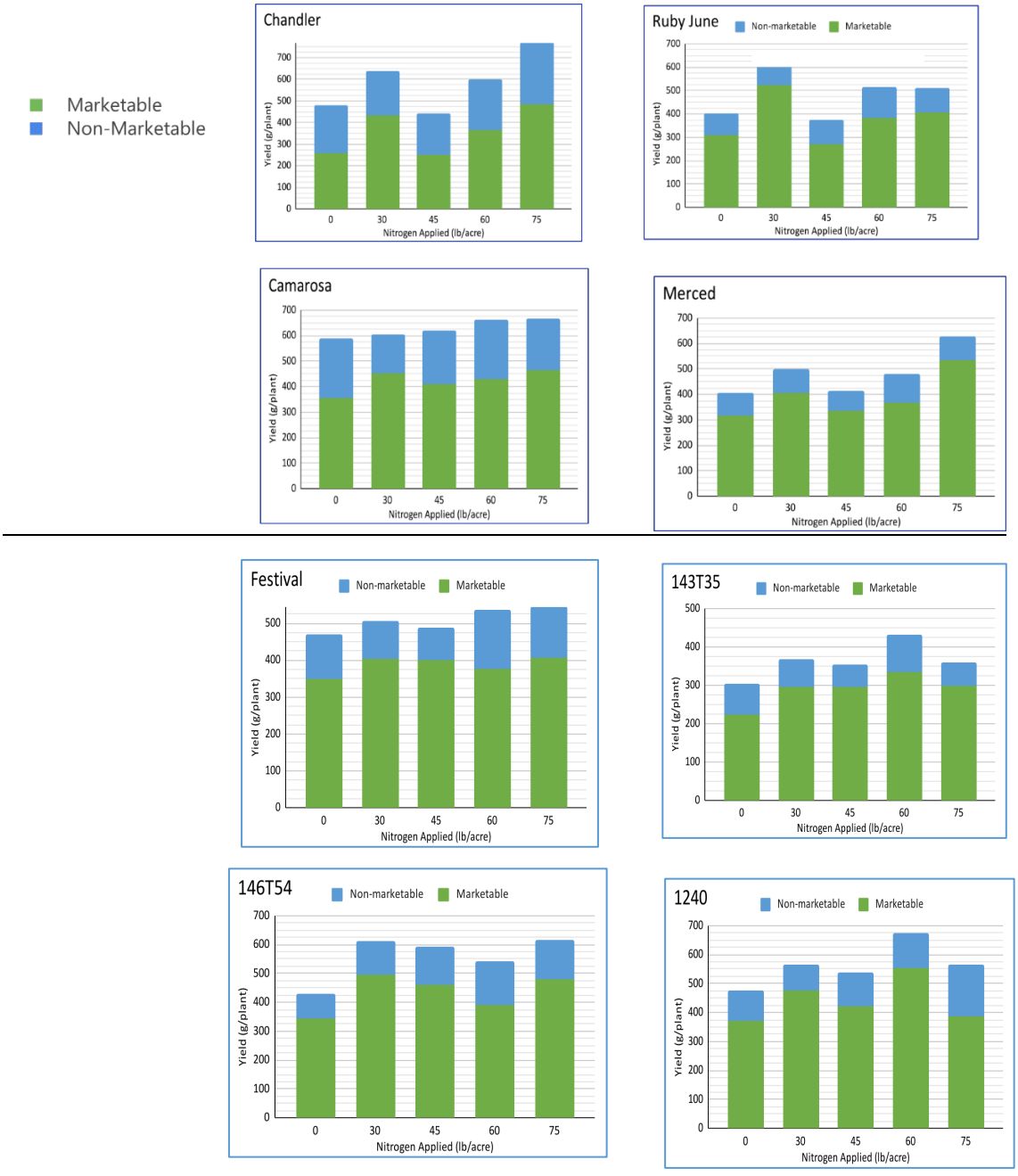
Data analysis.

We conducted a student t-test on yield, fruit size, fruit firmness, and TSS by variety (averaged over nitrogen rates) and by nitrogen rates (averaged over variety) at $P \geq 0.05$. The t-test was run on the grand averages for fruit size, firmness and TSS for the month of May. Each variety comparison was made to 'Chandler' which was used as a reference variety and each nitrogen rate was compared to, 60 $kg.ha^{-1}$ which was used a standard reference.

Results.

For the season-long total (marketable + non-marketable) yield by variety, '143T35' yields were lower than Chandler (Figure 1). Marketable yield for other varieties was not different than Chandler. Chandler had a significantly higher non-marketable yield when compared to other varieties except for Camarosa. When averaged over varieties, only the 0 $kg.ha^{-1}$ nitrogen had lower season-long total yield (marketable + non-marketable) and marketable yield than 60 $kg.ha^{-1}$ rate. Merced (38.3 mm fruit width), Ruby June (37.3 mm fruit width) and 146T54 (37.3 mm) had significantly higher fruit size over Chandler (34 mm fruit width). The different preplant nitrogen rates did not influence fruit size. Fruit firmness was not influenced by variety or nitrogen rate. The soil ammonium content of the different preplant fertilizer rate plots were not different than the standard plot (60 $kg.ha^{-1}$) in November and in March. The nitrate-nitrogen content in no pre-plant nitrogen plot was lower than the 60 $kg.ha^{-1}$ standard rate in March. The soil nitrate and ammonium content for each of the variety when compared to Chandler was the same in November and in March.

Figure 1. Marketable and non-marketable yield of the different strawberry varieties.



Outreach. Findings from this study were presented at Virginia Tech's 2021 Virtual Summer Research Symposium on 29 July (attendance of 65 including students and faculty) and at the 2021 Virginia Preplant meeting held in-person on 28 July 2021 in Stanardsville, VA, and on 4 August 2021 in Virginia Beach, VA. Both meetings together had 28 growers in attendance and

the content has 16 online views https://www.youtube.com/watch?v=9ujs6W7sneY&list=PLZRthM0lfbcP7il9UEU0OOerfGfSbD5f. A facebook video https://www.facebook.com/1947895/videos/133418075483531 showing the different varieties during fruiting was released on 27 June 2021. The video has 265 views to date.