

Nitrogen management in strawberry production

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The impending renewal of the 'Ag waiver' has focused regulatory scrutiny on the irrigation and fertilization management practices of vegetable and strawberry growers in the Central Coast region. In 2010 we conducted a monitoring survey of 30 commercial strawberry fields in the Watsonville-Salinas area to evaluate current nitrogen fertilization practices, and to identify ways to improve fertilization efficiency. The fields were planted with either 'Albion' or a common proprietary day-neutral variety. Cooperating growers were asked to provide detailed information on their fertilization practices. In all fields root zone soil nitrate-N ($\text{NO}_3\text{-N}$) concentration was sampled monthly from March through August. In four of these fields (two of each variety), 12 randomly selected whole plants per field were collected at monthly intervals. Fruit were removed, and the dry weight of leaves and crowns and their total N content were determined. Fruit samples were also dried for measurement of their N content; total N uptake in fruit was estimated from grower-reported marketable yields.

To evaluate the amount of $\text{NO}_3\text{-N}$ lost through leaching, suction lysimeters (6 per field, 24" depth) were installed in three of the fields. Once per week from early June through August, a vacuum was applied to these lysimeters throughout an irrigation event, and the soil solution drawn into the lysimeters was analyzed for $\text{NO}_3\text{-N}$ concentration. Water meters monitored irrigation input; infrared photography was used to determine the degree of canopy development, from which crop evapotranspiration (ET_c) was calculated. In each field leachate $\text{NO}_3\text{-N}$ concentration was multiplied by the calculated weekly leaching volume to estimate the load of $\text{NO}_3\text{-N}$ lost through leaching.

Results:

Across fields there was a trend toward declining root zone soil $\text{NO}_3\text{-N}$ as the season progressed (Fig. 1). From April through August average root zone $\text{NO}_3\text{-N}$ was maintained around 5 PPM. Among fields there were substantial differences in N management, with some fields remaining below 2 PPM $\text{NO}_3\text{-N}$ for extended periods, while in other fields N fertigations caused spikes in soil $\text{NO}_3\text{-N}$ above 10 PPM. There was no clear difference in crop vigor between fields with low or high soil $\text{NO}_3\text{-N}$.

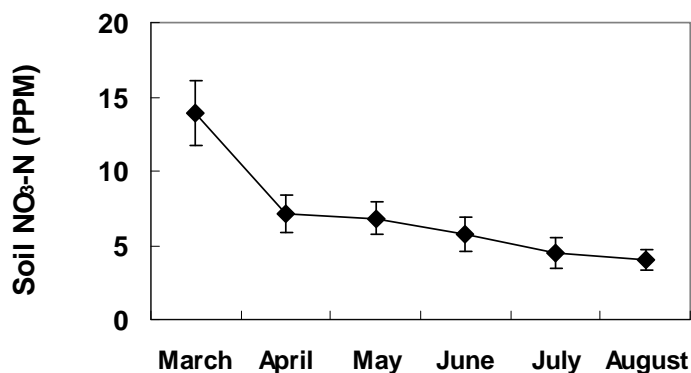


Fig. 1. Mean root zone soil $\text{NO}_3\text{-N}$ concentration of the monitored fields; bars indicate standard error of measurement.

Crop N content in vegetative tissue increased linearly throughout the season (Fig. 2). Averaged across fields, the N content of vegetative tissue (crowns and leaves) increased by just over 0.5 lb per acre per day, and totaled 83 - 102 lb/acre by the end of August (Table 1). The N uptake of the two varieties was similar. Across fields, fruit N concentration averaged between 1.2 - 1.5 % on a dry weight basis, with fruit averaging approximately 9% dry matter. Based on the grower-reported seasonal yield, the total N content of marketable fruit varied among fields from 64 - 99 lb/acre. Therefore, estimated seasonal N content in above-ground biomass ranged from 147 - 199 lb/acre.

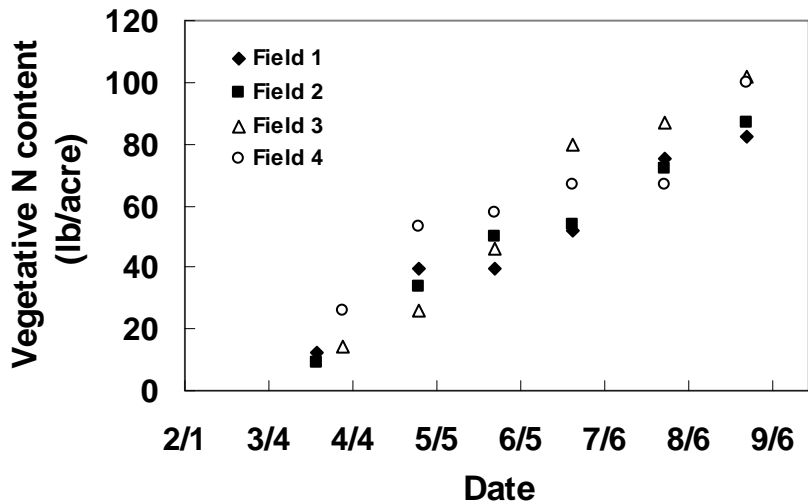


Fig. 2. N uptake in vegetative tissue (leaves and crowns); fields 1 and 2 were ‘Albion’, fields 3 and 4 were a day-neutral proprietary variety.

Table 1. Above-ground plant nitrogen uptake; estimates include vegetative N uptake through August, fruit yield through September.

	Above-ground plant biomass N (lb/acre)			
	Field 1	Field 2	Field 3	Field 4
Vegetative tissue	83	87	102	100
Fruit	64	82	81	99
Total	147	169	183	199

It should be noted that these estimates are lower than total crop N uptake, for several reasons. Cull fruit was not included, and some early leaves undoubtedly dried down and were lost before late season plant sampling. Assuming that cull fruit represent approximately 15% of the total produced, and loss of leaf tissue before the final plant sampling date represented 10% of the total produced during the season, total plant N uptake into above-ground biomass may have approached 220 lb N/acre. Another important consideration is plant population. All four of these fields were planted in a two-row configuration at a plant population of approximately 21,000/acre. Some fields in the Watsonville-Salinas region, and most fields in the Santa Maria

area, are planted on a 4-row configuration at plant populations as high as 30,000/acre on beds. Preliminary data from 4-row fields in Santa Maria indicated that vegetative N uptake was at least 20% higher than in the 2-row fields reported here. We found that plant population did not affect fruit N concentration, so fruit N content should be proportional to fruit yield, regardless of plant population.

The bottom line is that total strawberry crop annual N uptake probably averages at least 200 lb/acre, and fields with high plant population, above average yield, or an extended production season may take up substantially more N. N uptake is approximately linear from early spring through at least August, with an average uptake of 1-1.5 lb N per acre per day.

The three fields in which leachate samples were collected by lysimeter showed varying trends in soil solution NO₃-N concentration (Fig. 3). Field 2 began with relatively high soil solution NO₃-N, and values trended lower through the season as root zone NO₃-N declined. In field 1, relatively low soil solution NO₃-N early in the season increased as the grower increased N fertigation later in the season. Field 16 was maintained at low root zone NO₃-N throughout the season, and soil solution NO₃-N remained low as well.

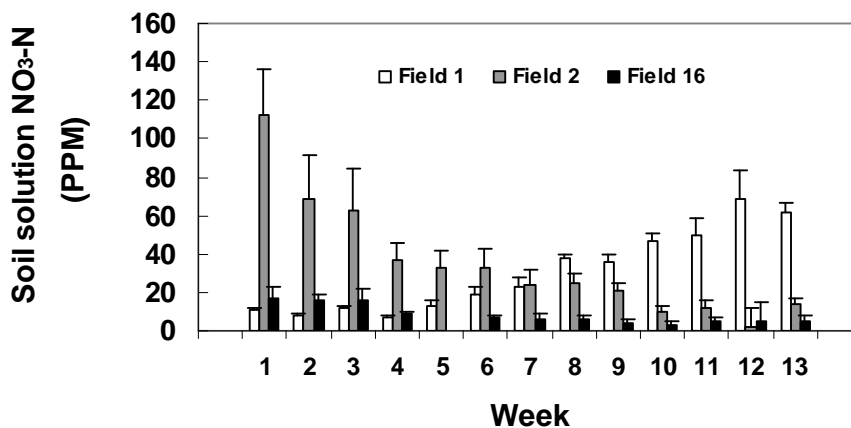


Fig. 3. Mean soil solution NO₃-N concentration at 24" depth by week over the period June 1 - August 30, 2010; bars indicate standard error of measurement.

Estimates of weekly leaching volume were calculated as the difference between ET_c and irrigation applied. In field 16, irrigation was marginally less than ET_c for most of the sampling period, with a significant leaching volume occurring only in week 3. In fields 1 and 2, irrigation exceeded ET_c over the sampling period by 5.1 and 2.5 inches, respectively. Multiplying weekly soil solution NO₃-N at 24" depth by the calculated weekly leaching volume gave a rough estimate of the NO₃-N leaching load. Over this 13 week period (early June through August), the estimated NO₃-N leaching load was 25, 24 and 2 lb N/acre in fields 1, 2 and 16, respectively.

Complete fertilization records were obtained for 17 of the 30 fields monitored (Fig. 4); other growers were reluctant to share that information, or kept incomplete records. While fertilization practices varied widely among growers, the mean seasonal N application was 187 lb N/acre, nearly evenly split between preplant and fertigated N (an average of 96 and 92 lb N/acre, respectively). These estimates do not include NO₃-N contained in irrigation water. Irrigation water NO₃-N concentration was greater than 10 PPM in 4 of these fields, and greater than 20

PPM in 2 fields. There was no correlation between seasonal N fertilizer rate and marketable yield.

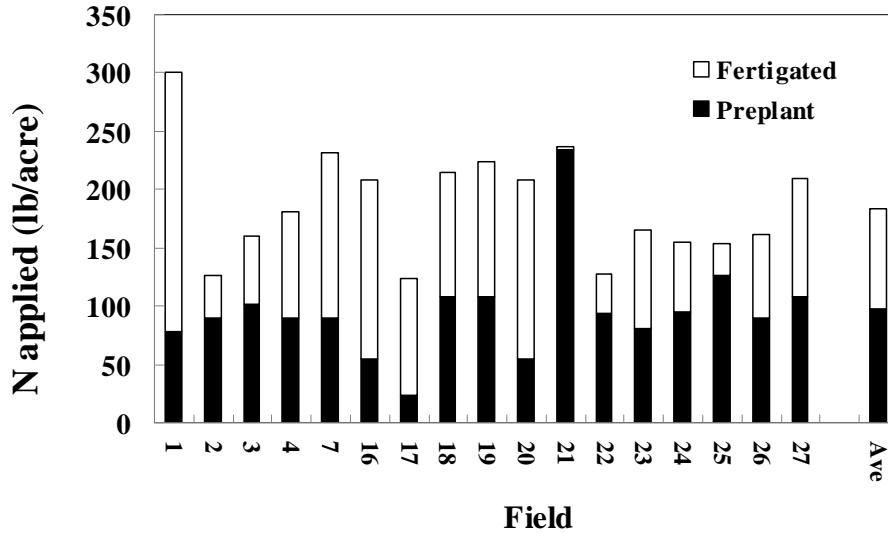


Fig. 4. Seasonal N fertilization rate applied.

From this initial year of study we draw the following conclusions regarding nitrogen management in strawberry production:

- 1) strawberry N uptake rate is relatively slow, much lower than vegetable crops. As a comparison, lettuce N uptake rate can reach 4 lb N per acre per day in the weeks before harvest, more than twice that of strawberries.
- 2) Given this low N uptake rate, strawberries can thrive with relatively low soil nitrate reserves; a number of highly productive fields in this survey were maintained around 5 PPM root zone soil NO₃-N during the summer months.
- 3) With careful irrigation, nitrate leaching losses from strawberry fields can be relatively low. However, a combination of high N fertilization rates and inefficient irrigation could still represent a nitrate leaching hazard.

This monitoring study focused solely on the spring though summer portion of the production cycle. Beginning in fall, 2010, we began monitoring the N dynamics of strawberry production beginning with preplant bed preparation. Those results will be the subject of a future newsletter article.