

Agronomic Overview of Citrus Nitrogen Management Planning Results from the Irrigated Lands Regulatory Program

Background and Objectives

Irrigated Lands Regulatory Program (ILRP) Orders require Central Valley irrigators to complete Nitrogen Management Plans (NMPs) for each crop. For acreage designated highly vulnerable, NMP data are reported to growers' water quality coalitions, who in turn summarize them for the Water Board. The South San Joaquin Valley Management Practices Evaluation Program (SSJV MPEP) analyzed 2016 NMP data from an agronomic perspective to examine the yield growers realize across a range of N application rates. The data also illustrate commonly, occasionally, and rarely reported ranges of N application rates. For most crops, the N balance (N applied minus N removed in the crop, and thus the N subject to storage and loss) grows steadily as N application increases. Citrus is no exception. This poster is a helpful snapshot of what growers reported in 2016, which may inform discussion about how to improve NMP data collection, and perhaps about how best to balance profitability and environmental risk associated with N fertilization of citrus. Note that crop classes reported by different coalitions varied and are grouped here to the extent feasible.

Methods

2016 Citrus NMP Dataset

- Source: anonymized NMP data from 12 water quality coalitions.
- Total acreage of citrus NMP data: over 116,700 acres.
- NMP data reported: crop type, acreage, total N applied, crop yield, and total N removed.
- Crops included in this analysis: oranges, mandarins, lemons, grapefruit, and other.

Analysis Methods

- Removed N applied and yield outliers with the interquartile technique.
- Binned data into 20 groups by equally dividing N application from min to max.
- Calculated N removed based on N concentrations from Geisseler (2016) x reported crop yield.
- Calculated area-weighted averages (AWA) of yield, N applied, and N balance for each bin.
- Identified the upper limit of N application for the majority of acreage as an N application threshold.

Results

Table 1. NMP Data Summary and Threshold Analysis Results for Oranges, Mandarins, Lemons, Grapefruit and All Citrus.

Parameter	Value					Unit
	Oranges	Mandarins	Lemons	Grapefruit	All Citrus	NA
Total Area	80,810	17,348	4,162	541	116,738	ac
Number of NMP Units	2,414	209	146	34	3,209	NA
N Removal Coefficient	2.96	2.96	2.58	2.96		lb/ton
AWA¹ N Applied	132	146	154	137	139	lb/ac
AWA N Removed	45	46	40	58	44	lb/ac
AWA Yield	753	620	774	979	731	cartons/ac
AWA N Balance	87	100	114	79	95	lb/ac
N Threshold²	133	181	224	157	150	lb/ac
Total Area Above N Threshold	34,831	3,079	58	68	44,653	ac
Percent Acreage Above N Threshold	43	18	1	13	38	%
AWA N Rate Above Threshold	174	197	265	180	187	lb/ac
AWA N Balance Above N Threshold	127	147	209	146	141	lb/ac
Equivalent Amount of N Reduction³	1,454,115	49,059	2,366	1,554	1,657,200	lb
% N Applied Above N Threshold	13.6	1.9	0.4	2.1	10.2	%
AWA N Balance Reduction⁴	41	16	41	23	37	lb/ac
AWA Yield Above N Threshold	793	675	1,081	577	749	cartons/ac

¹ Area-Weighted Average (3 bins)

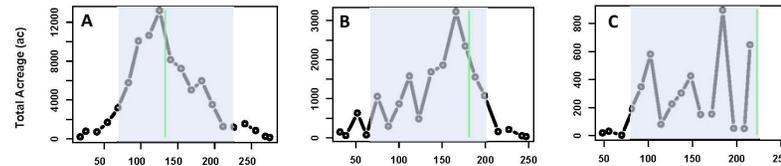
² The upper limit of N application for the majority of the fields (green lines in the Figures)

³ The amount of N reduced if all N applications above the threshold were reduced to the threshold

⁴ From AWA N Balance

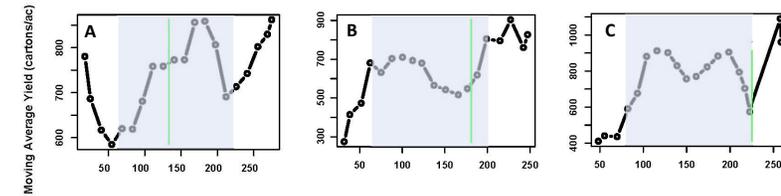
Results (cont.)

Figure 1. Distribution of N Application by Acreage for A) Oranges, B) Mandarins, and C) Lemons



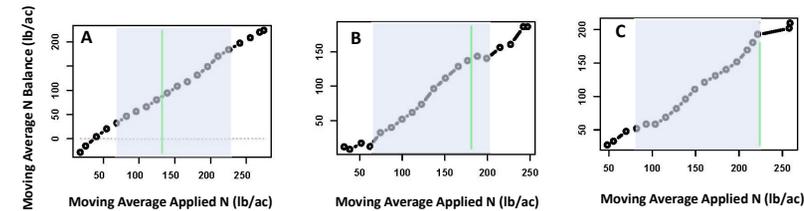
A wide variation of N application was observed for all crops. Shaded areas represent 90% of the reported data. An N application threshold was identified as the upper limit of N application for the majority of the acreage (green lines). The N application threshold is apx. 130 lbs/ac for oranges, 180 lbs/ac for mandarins, and 225 lbs/ac for lemons.

Figure 2. Yield Response to N Application for A) Oranges, B) Mandarins, and C) Lemons



For oranges, crop yield generally increases with N application until apx. 175 lbs/ac. For mandarins and lemons, the yield response is more variable and there is no clear trend. Note that yield responses in the un-shaded areas represent less than 10% of the reported data.

Figure 3. N Balance Compared to N Applied for A) Oranges, B) Mandarins, and C) Lemons



The N balance increases as N applied increases for each crop. This demonstrates a relatively constant rate of N use efficiency.

Notes: 1) Green lines indicate the N threshold for each crop, defined as the upper limit of N application for the majority of fields. 2) Moving averages are based on three data bins. 3) Shaded areas represent 90% of reported NMP data.

Discussion

Patterns in N application and resulting yield furnish clues about possible opportunities to recover a larger fraction of N applied. The results of the NMP data analysis show the variable and uneven yield response of citrus crops to applied N in the Central Valley. In general, crop yield increases with increased applications of N, but this response is not steady or reliable. N balance, on the other hand, grows steadily with increasing N rate. This balance may be stored and recycled in future crops, incorporated into perennial tissues or soil organic matter, or leached to groundwater. With some crops, growers who apply N in the upper-end of the reported range might reduce relative risk of N leaching to the groundwater by reducing rates of applied N; however, for citrus, the highest average yields are consistently beyond the selected N threshold. Note that crop quality is not considered in this analysis, but can sometimes decline at higher N application rates.

It is a challenge to unravel how production and environmental risk are affected by N management based on the 2016 data, but subsequent years of NMP data will be analyzed and reported for the purpose of observing how field N rates, balances, and yield provide clues about efficient use of N while maintaining production and profitability. While informative, NMP data are affected by many factors, including seasonal variations in crop yields, root system morphology, annual precipitation and irrigation (e.g., drought), N transformations in soil, depth of groundwater, crop management, etc.

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Buena Vista Coalition
 Cawelo Water District Coalition
 Kaweah Basin Water Quality Association
 Kern River Watershed Coalition Authority
 Kings River Watershed Coalition Authority
 Tule Basin Water Quality Coalition
 Westside Water Quality Coalition

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