Nitrate Leaching Potential for Drip Irrigated Cauliflower (Brassica oleracea var. Botrytis) Grown on a Sandy Loam Soil

F. Cassel S., Josue Samano Monroy, and D. Goorahoo

Department of Plant Science and Center for Irrigation Technology, California State University, Fresno.

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Introduction

- Nitrate (NO_3) contamination of groundwater is a significant unresolved environmental issue worldwide. Any Nitrogen (N) fertilizers not taken up by shallow rooted vegetable crops with high demand for N, such as Cauliflower (*Brassica oleracea*), can leach to the groundwater. Hence, in adopting a preventative strategy to mitigate nitrate contamination of groundwater it is critical to determine and control the amount of nitrate below the root zone by implementing strategies that optimize crop yield while minimizing the soil nitrate leaching index (LI).
- When combined with the appropriate fertilizers, surface drip irrigation can be a useful tool to help mitigate the nitrate leaching potential of a cauliflower crop.

Objectives

- To evaluate the agronomic benefits and environmental implications of potential nitrogen leaching in a cauliflower cropping system using organic soybean based (ORG) and conventional urea ammonium nitrate-32 (UAN) fertilizers at three different nitrogen rates (75, 150 and 225 lbs N/acre).
- To compare the nitrogen leaching potential for cauliflower grown with organic soybean based (ORG) and conventional urea ammonium nitrate-32 (UAN) fertilizers.

Fig. 1. Cauliflower growth along the season.

Materials & Methods

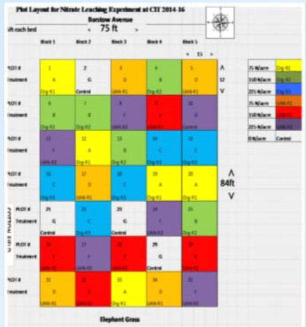

Fig. 2. Field layout with color plots to differentiate treatments.

Study description

- Location: California State University, Fresno, University Agricultural Laboratory.
- Crop: Cauliflower cropping system.
- Study conducted during two growing seasons.

Experimental Design:

- RCBD - Randomized Complete Block Design, consisting on two fertilizer types: UAN32 and organic soybean based (main factor), three nitrogen rates: 75, 150 and 225 lbs N/acre (secondary factor) plus one control.
- Each treatment was replicated five times resulting in 35 blocks.

Field setup:

- Five foot beds, two cauliflower lines per bed, double line surface drip irrigation 5/8".
- Soil solution access tubes (SSAT's) were installed at 12 and 24 inches depth.
- Five access tubes were installed to measure moisture levels with a Diviner 2000.

Data measurements and analysis:

- Pre-planting and post harvest soil sampling (total N).
- Soil solution sampling (NO_3) & moisture monitoring.
- Cauliflower head and leaf (yield and biomass, total N).

Fig. 3. Soil Solution Access Tubes. 12" and 24"

Fig. 4. Vacuum pump and syringe to collect soil solution.

Results

Marketable Cauliflower yield from the fertilized plots were significantly different ($p<0.01$) from the control plots (no fertilizer), with yield increases of 23% and 59% in years 1 and 2, respectively (Fig. 5).

Plant yield also showed a significant response when compared to fertilizer rate. Generally, there was an increment of 24% in response to R2 and R3, as compared to Control and R1 in both years (Fig. 6).

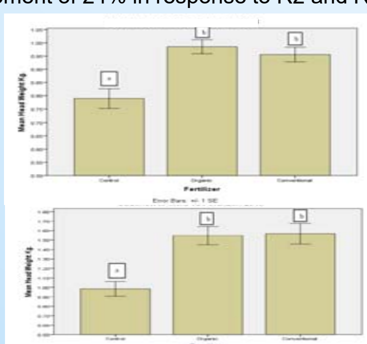

Fig. 5. Cauliflower yields for the different fertilizer treatments in years 1 (top) and 2 (bottom).

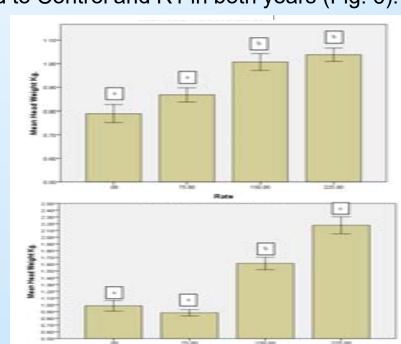

Fig. 6. Cauliflower yields for the different nitrogen fertilizer rates in years 1 (top) and 2 (bottom).

Results cont'd

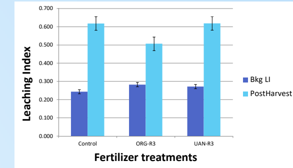

Fig. 7. LI for pre and post-harvest soils

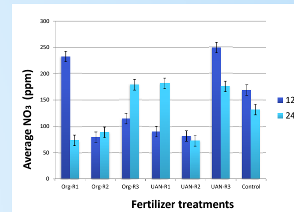

Fig. 8. Nitrate concentration in soils

Leaching Index (LI) was different among the treatments, but NO_3 levels in soil solution did not show any statistical significance for the different treatments (Figs. 7 & 8)

Table 1. Average soil Nitrates in years 1 and 2

Fertilizer Rate	Year 1 NO_3-N mg/l	Year 2 NO_3-N mg/l
0 lbs/N acre	1.76 ± 1.16	0.27 ± 0.75
75 lbs/N acre	8.95 ± 0.82	2.51 ± 0.43
150 lbs/N acre	9.97 ± 0.82	5.42 ± 0.43
225 lbs/N acre	16.54 ± 0.82	8.15 ± 0.43

Soil nitrate increased with N fertilizer rates (Table 1). The highest rate of 225 lbs N /acre resulted in significantly higher NO_3-N levels compared to the other treatments.

Concluding Remarks

SSAT soil solution for Nitrates samples had a high degree of variability. It is advisable that assessment of nitrate leaching potential should be based on data from both SSAT and soil core samples. Overall, for the sandy loam soil used in this study, LI values would imply that cauliflower growers should not exceed the 150 lbs N/acre rate. There is a greater potential to leach nitrate, with no significant economic yield increase, in increasing applications from 150 to 225 lbs N/acre.

References

- *Addressing Nitrate in California's Drinking Water: With a Focus on Tulare Lake Basin and Salinas Valley Groundwater: Report for the State Water Resources Control Board Report to the Legislature.* Center for Watershed Sciences, University of California, Davis, 2012.
- Zotarelli, L., Scholberg, J. M., Dukes, M. D., & Muñoz-Carpena, R. (2007). Monitoring of nitrate leaching in sandy soils. *Journal of environmental quality*, *36*(4), 953-962.