Potato Nitrogen Fertility and the Potential for Groundwater Contamination

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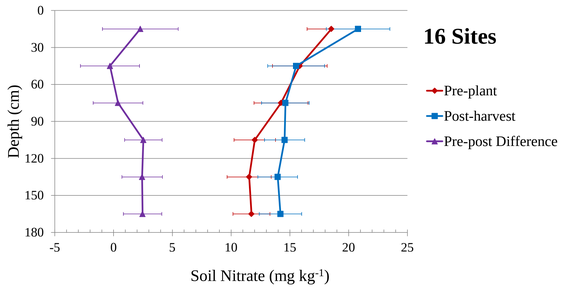
Abstract

The Tulare Lake Basin in the Southern San Joaquin Valley has high measurable nitrate levels in the groundwater. A State Water Resources Control Board commissioned report has indicated that crop land agriculture is the main source of nitrates in the groundwater. The area has also had a significant dairy presence for many years. Annual rainfall is less than 20 cm, thus irrigation is necessary for a high productivity vegetable crop endeavor. A project was undertaken to evaluate current cropping practices in potato production and its contribution, or lack thereof, to nitrate movement and potential nitrate contamination of groundwater. Sixteen potato fields were monitored for potential nitrate leaching. Pre-plant and post-harvest soil samples were collected to a depth of 2 meters. Plant, root and tuber samples were collected and analyzed for nitrogen content. Soil moisture and irrigation amounts were monitored. In general, irrigation water did not penetrate deeper than one meter through excellent irrigation scheduling. Nitrate not taken up by potato remained in the root zone for subsequent crops.

Materials and Methods

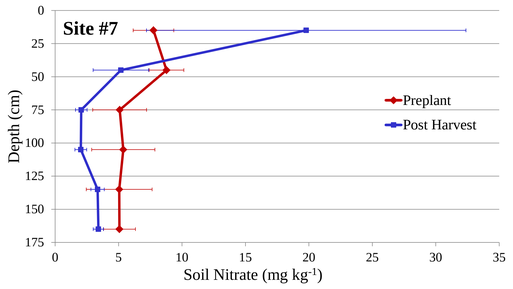
Sixteen commercial potato fields were monitored for nitrogen status. Fields were selected for different soil types and potato varieties (fresh market or chip). Soil samples were taken to 180 cm depth in 30 cm increments for nitrate status before planting and after harvest at four locations in each field. Planting occurred between January 15th and February 26th. Petiole samples were collected by the growers throughout the growing season. Leaf samples were taken during bulking for N concentration. Harvest occurred between May 14th and July 10th. Vines and tubers were collected, oven-dried, weighed and analyzed for total N content. All samples were collected from the same area of field using GPS coordinates. Irrigation water volume was measured. Soil moisture monitors were placed at 60 cm and 120 cm below the surface in each field. Soil texture and soil moisture field capacity were determined for each field by depth in the lab. Soil moisture meter readings were correlated to soil moisture content in the lab and from field samples.

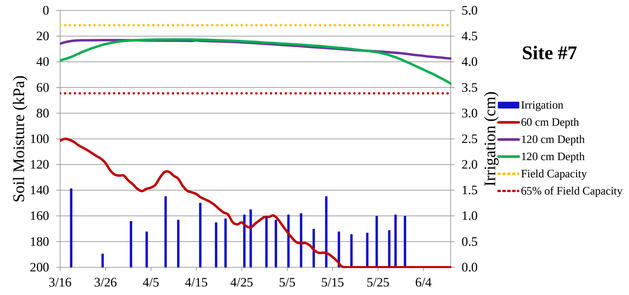


Results and Discussion

There was a large range in whole plant N (17.7 to 44.5 mg N g^{-1}) and tuber N concentration (7.8 to 16.7 mg N g^{-1}). In-season nitrogen fertilizer application was delivered with the irrigation water between 7 and 13 times and ranged from 5 to 20 kg N ha^{-1} in each irrigation. Tuber yield was very good across all fields. Petiole nitrate was within the recommended sufficiency range.

Averaged across all sites, there was no significant difference in soil nitrate concentration from pre-plant to post-harvest in the 180 cm soil profile. All growers accounted for pre-plant soil and native irrigation water N, which was substantial at some of the locations, and used petiole nitrate tests to adjust in-season N fertilizer application rate and timing.





Results and Discussion (The Good & The Bad)

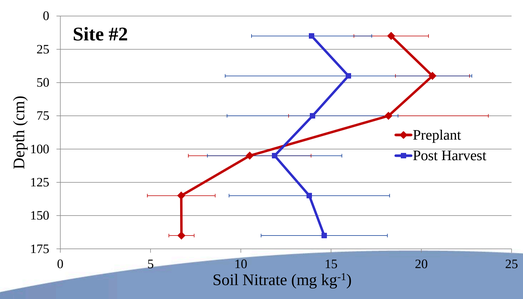
Site #7
- Sandy Loam Soil
- White-skinned chipper variety
- Higher than average vine dry matter accumulation
- Higher than average tuber yield
- Pre-plant to Post-harvest Soil Nitrate
  - – 5 kg ha^{-1} N in 180 cm profile
  - + 17 kg ha^{-1} N in 0-60 cm depth
  - – 22 kg ha^{-1} N in 60-180 cm depth
  - Less native nitrate in irrigation water (9 mg L^{-1})
- In-season Irrigation – total water applied less than ETc
  - 60 cm depth dried throughout season
  - 120 cm depth remained constant, less than field capacity

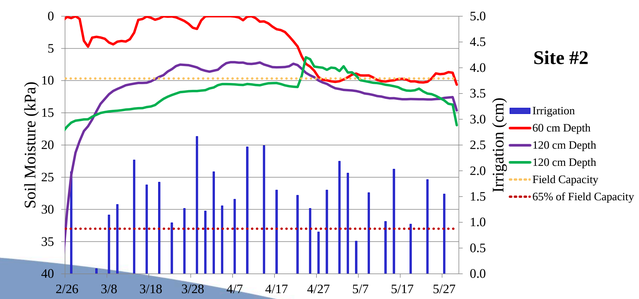
Site #2
- Loamy Sand Soil
- White-skinned fresh market variety
- Lower than average vine dry matter accumulation
- Lower than average tuber yield
- Pre-plant to Post-harvest
  - + 7 kg ha^{-1} N in 180 cm profile
  - – 20 kg ha^{-1} N in 0-60 cm depth
  - + 27 kg ha^{-1} N in 60-180 cm depth
  - Higher amount of native nitrate in irrigation water (32 mg L^{-1})
- In-season Irrigation – total water applied exceeded ETc
  - 60 cm depth exceeded field capacity throughout season
  - 120 cm depth exceeded field capacity for most of the season

Conclusion

Nitrogen fertilizer application following fertility guidelines for potatoes in Kern County was sufficient to achieve adequate plant growth and acceptable tuber yield. There was substantial nitrate in the soil profile prior to planting and an equivalent amount remained following harvest. Irrigation management is critical for optimum yield and to prevent potential ground water contamination. Crop rotation to a deeper rooted crop than potatoes is necessary to utilize nitrogen remaining in the soil profile.

	Harvest Date	N Applied (all sources)	Tuber Yield	Vine Dry Matter	Tuber N	Plant N	Tuber N	Plant N	Nitrogen Use Efficiency	Water Applied	Soil Nitrate 0-60 cm Pre-plant	Soil Nitrate 0-60 cm Post-harvest	Soil Nitrate 60-180 cm Pre-plant	Soil Nitrate 60-180 cm Post-harvest	Prior Crop	Rotation Crop
		-kg ha^{-1}-	-Mg ha^{-1}-	-kg ha^{-1}-	-- mg g^{-1} --		-- kg ha^{-1} --		-- % --	-- cm --	---------- kg ha^{-1} ----------					
Site #2	May 30	298	51.5	1617	11.0	17.7	149	30	61	47.5	87	67	94	122	Potato	Carrot
Site #7	June 16	375	62.1	3841	10.9	27.7	166	106	72	22.6	39	56	46	24	Corn	Carrot
8-Site Average		302	60.5	2525	11.4	29.8	161	76	78	39.5	70	80	98	112		





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