UPDATING PETIOLE NITRATE-BASED N FERTILIZER RECOMMENDATIONS FOR ARIZONA COTTON

Kevin F. Bronson
Jarai Mon
Doug Hunsaker
US Arid Land Agric. Res. Center, USDA-ARS
Maricopa, AZ
Randy Norton
Safford Agric. Center, University of Arizona
Safford, AZ
Hermelina Liddell
Ira H. Hays High School
Bapchule, AZ

Abstract

In-season petiole nitrate (NO_3) has historically been used in the western US in cotton to guide N fertilizer management. However, this data has not been updated in > 15 years, for new management practices and current cotton cultivars. The first objective of this study was to assess in-season cotton petiole NO_3 as affected by various N fertilizer rates to sprinkler-irrigated and furrow-irrigated cotton in Maricopa, and Safford, Arizona, respectively. The second objective was to compare petiole NO_3 with leaf N and chlorophyll meter readings. Our final objective was to update University of Arizona N fertilizer recommendations based on petiole NO_3. Samples were taken at from mid-June to early August from twelve plants per plot. Petiole-NO_3-N levels began the season very high (i.e. 25-30,000 ppm), and showed a sharp declining pattern as plant took up N. Zero-N plots went deficient by early to mid bloom. This data will be highly useful in updating University of Arizona N fertilizer recommendations.

Introduction

Nitrogen is the second most important constraint to cotton production in the western USA after water (Morrow and Krieg, 1990). Canal infrastructure of irrigation water in Arizona means basin, flood, and furrow irrigation are still the dominant choices of irrigation methods. First square to mid bloom is the optimal time to apply in-season N fertilizer to cotton (Yabaji et al., 2009). In the western USA, petiole NO_3 sampling and analysis is the recommended approach to monitor in-season cotton plant N status. However, petiole sampling can be laborious and laboratory turn-around is time-consuming. Petiole NO_3 thresholds and related N recommendations have not been updated in > 15 years (Ayala and Doerge, 2001), especially for newer high-yielding cultivars. The objectives of this study were to:

1. To assess in-season cotton petiole NO_3 as affected by various N fertilizer rates to sprinkler and surface-irrigated cotton.
2. To compare petiole NO_3 with chlorophyll meter and leaf N analysis.
3. To update University of Arizona N fertilizer recommendations based on petiole NO_3.

Methods

In March, 2014, pre-plant soil sampling to 180 cm for NO_3 was done on three samples per plot. Cotton 'DP1044B2R2F' was planted in on May 1 in Maricopa, and 'DP1044B2R2F' and 'DP1359B2RF' were planted in Safford, AZ on 28 April. Nitrogen fertilizer as urea ammonium nitrate was ground applied starting at frsit square in three splits at Maricopa and in two split applications in Safford. Nitrogen rates in Maricopa were 0, 80,104, and 208 lb N/ac and were 0, 95, and 124 lb N/ac in Safford. At both sites, the enhanced efficiency fertilizer additive 'Agrotain Plus' was added to N fertilizer and compared to urea ammonium nitrate alone

.

The experimental design at both sites was a completely randomized block, with four replicates. The irrigation at Maricopa was a linear-move sprinkler system and at Safford, surface/furrow irrigation was used.

Twelve leaves/petioles were picked from the uppermost fully expanded leaves per DGPS point or plot. Samples were dried for 72 hours at 60^0C, ground to 0.5 mm, and petioles extracted (10 mL H_2O:0.1 g) and analyzed for NO_3-N with a Seal automated spectrophotometer. Chlorophyll meter readings were taken in field with a Minolta SPAD 502 chlorophyll meter. Leaf N was analyzed on dried (60^oC), ground, leaves on a Leco TruSpec CN Analyzer.

Lint and mature seed yields was machine harvested. Mature cotton seed N was determined from grab samples at the three DGPS points per plot and the percentage of seed N to total N uptake calculated. Leaf N, petiole NO3, SPAD readings, and lint yields were analyzed with a mixed model using SAS. Replicate was considered random, and N treatment was considered fixed.

Results and Discussion

At both sites, lint yields of N-fertilized plots were similar and significantly greater than zero-N yields (data not shown). Nitrogen fertilized plots yielded 1900 and 1624 lb lint/ac, for Safford and Maricopa, respectively. Zero-N plots yielded 1736 and 1627 lb lint/ac for Safford and Maricopa. DP1359 yielded higher than DP1044 at Safford. Agrotain Plus did not affect petiole NO_3 (or leaf N or chlorophyll meter readings) or lint yields.

Petiole NO_3 levels began the season very high at both sites, ie. > 20,000 ppm (Figures 1 and 2), and declined sharply as the season progressed. Petiole NO_3 in zero-N plots dropped to significantly lower levels than the N-fertilized plots at first bloom (175th day of year (DOY) or 24 June, 2014) in Maricopa and at mid bloom on 195th DOY (14 July, 2014) in Safford. Interestingly, leaf N and chlorophyll meter readings also showed N deficiency in Safford on 195 DOY (data not shown). Leaf N showed N deficiency in Maricopa on 168 DOY and chlorophyll meter readings did the same on 196 DOY (data not shown). Correlation among the three measures were significant in most dates (Table 1 and 2). Cultivar differences at Safford were observed in leaf N and chlorophyll meter readings but not in petiole-NO_3. This may be an important benefit of petiole data if it is not sensitive to cultivar leaf color.

A spike in petiole NO_3 was observed at Maricopa on 195 DOY following fertilization. The reason for this is not clear, as the zero-N plots spiked as well.

The petiole NO_3 data (and the leaf N, chlorophyll meter and lint yields) data platueaued at the lowest N fertilizer rates at both sites. Therefore, limited information on amounts of N to apply can be inferred. However, it was noticed that the petiole NO_3 at Maricopa on 188 DOY dropped as low as 7,000 ppm at mid bloom, which according to Ayala and Doerge (2001) was borderline deficient. Leaf N however, was > 4 % at this stage, so the N-fertilized cotton was in fact not N deficient. Petiole NO_3 at Safford remained above these levels in N-fertilized plots.

Summary

- N fertilizer response was observed, but not different among N treatments.
- A petiole N response curve was not apparent, i.e. response was linear-plateau.
- Correlation between petiole NO_3 and leaf N was high.
- Petiole NO_3 detected N deficiencies earliest in in the season, followed by leaf N, while SPAD readings were insensitive at Maricopa. At Safford all three plant N indicators showed N deficiency at mid bloom.
- Cultivar differences in leaf N and SPAD were observed at Safford, but not petiole NO_3.
- Petiole NO_3 readings of Zero-N cotton were clearly below current University of Arizona thresholds.
- Petiole NO_3 readings at mid bloom at Maricopa were 7- 8,000 ppm (slightly deficient according to figure), but leaves were 4 % N and therefore not deficient.

Table1. Correlations among leaf N, petiole-NO_3-N and chlorophyll meter readings, Maricopa, 2014

Day of Year	Petiole NO_3	Leaf N	SPAD Meter
	154 Day of Year		
Leaf N	NS	1	-0.45
SPAD Meter	0.44	-0.45	1
	161 Day of Year		
Leaf N	-0.78	1	-0.68
SPAD Meter	0.82	-0.68	1
	168 Day of Year		
Leaf N	NS	1	NS
SPAD Meter	0.62	NS	1
	175 Day of Year		
Leaf N	NS	1	NS
SPAD Meter	NS	NS	1
	181 Day of Year		
Leaf N	0.81	1	0.65
SPAD Meter	0.57	0.65	1
	188 Day of Year		
Leaf N	0.75	1	0.50
SPAD Meter	NS	0.50	1
	196 Day of Year		
Leaf N	0.69	1	0.72
SPAD Meter	0.70	0.72	1
	202 Day of Year		
Leaf N	0.70	1	0.71
SPAD Meter	0.52	0.71	1

Table 2. Correlations among leaf N, petiole-NO_3-N and chlorophyll meter readings, Safford, 2014

Day of Year	Petiole NO_3	Leaf N	SPAD Meter
	164 Day of Year		
Leaf N	0.32	1	0.57
SPAD Meter	0.56	0.57	1
	181 Day of Year		
Leaf N	0.63	1	0.54
SPAD Meter	NS	0.54	1
	195 Day of Year		
Leaf N	0.61	1	0.66
SPAD Meter	0.61	0.66	1
	209 Day of Year		
Leaf N	-	1	-
SPAD Meter	NS	-	1
	223 Day of Year		
Leaf N	-	1	-
SPAD Meter	NS	-	1

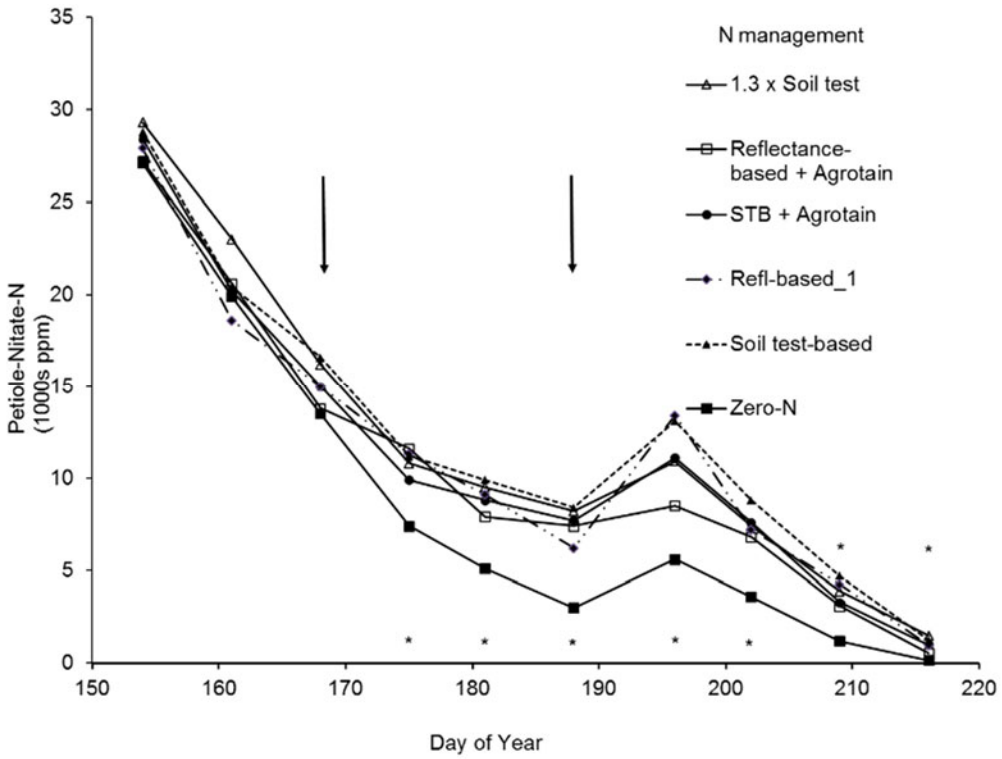

Fig. 1. Cotton petiole NO_3 as affected by N management, Maricopa, AZ, 2014 (arrows indicate N fertilizations).

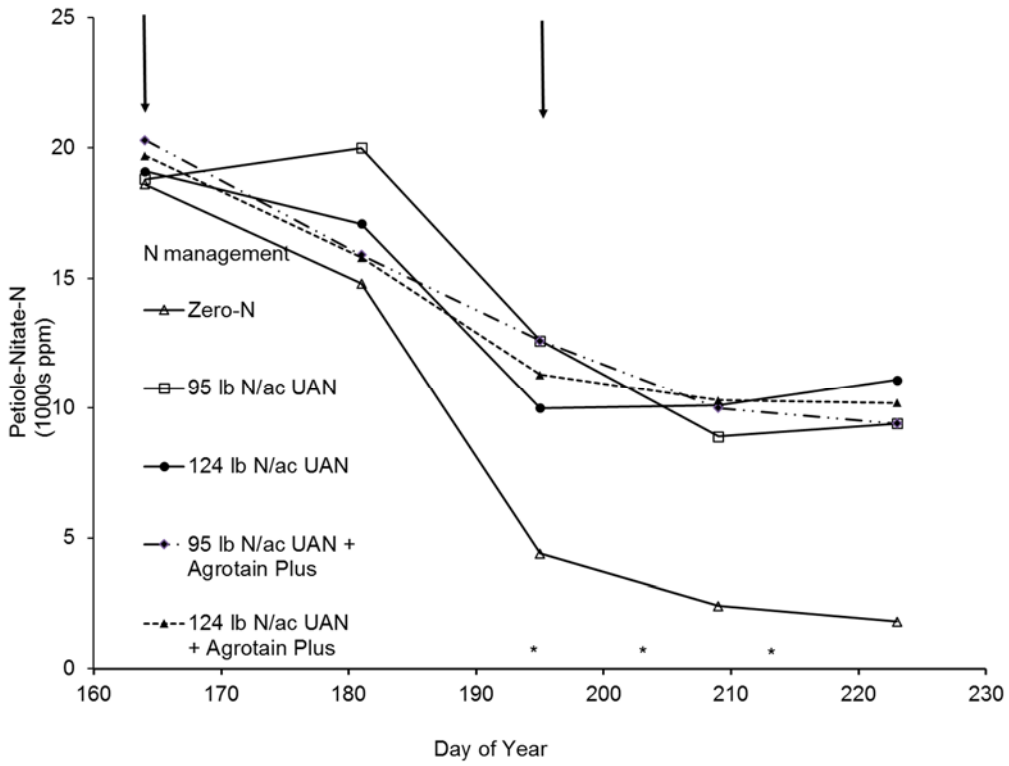

Fig. 2. Cotton petiole NO_3 as affected by N management, Safford, AZ, 2014 (arrows indicate N fertilizations)

References

Ayala, F. and Doerge, T.A. 2001. Management of fertilizer nitrogen in Arizona cotton production. Cooperative Extension, College of Agric & Life Science, University of Arizona. http://cals.arizona.edu/pubs/crops/az1243/

Morrow, M.R. and D.R. Krieg. 1990. Cotton management strategies for a short growing season environment: water-nitrogen considerations. Agron. J. 82:52-56.

Yabaji, Rajkumari, J.W. Nusz, K. F. Bronson, A. Malapati, J. D. Booker, R.L. Nichols, and T. L. Thompson. 2009. Nitrogen management for subsurface drip irrigated cotton: Ammonium thiosufalte, timing, and canopy reflectance. Soil Sci. Soc. Am. J. 73:589-597.