FIELD TEST OF A NEW COTTON PETIOLE MONITORING TECHNIQUE

Derrick M. Oosterhuis, Dennis L. Coker, and Robert S. Brown[1]

RESEARCH PROBLEM

The conventional fourth-node petiole sampling approach has not consistently allowed clear detection of the onset of K deficiency. The work of Bednarz and Oosterhuis (1996) indicated that lower main-stem node petioles showed pending K deficiencies sooner than upper main-stem node petioles. Therefore, the objective of this study was to observe the effect of soil nutrient status/fertilizer regime and developing boll load size (reflected in lint yield) on petiole N and K status from two positions in the canopy (fourth and eighth main-stem node from the terminal).

BACKGROUND INFORMATION

In 1999, conventional and modified petiole sampling procedures were compared in field tests at ten Cotton Research Verification Trial (CRVTs) sites on farms in Arkansas. The results showed that the lower petiole (8^{th} main-stem node) did indeed show a drop in K status before the conventionally sampled 4^{th} node. However, it was still not possible to show that this was actually indicating a K deficiency or just a large drain on plant K supply due to the developing boll load. This was because all the fields used were highly fertilized for optimal yields.

Potassium (K) deficiencies in cotton are frequently observed in cotton fields during the middle to later parts of the growing season. These symptoms occur concurrently with reduced root growth and a developing boll load which serves as the dominant sink for available K (Oosterhuis, 1995). Previous research at the University of Arkansas (Bednarz and Oosterhuis, 1996; Oosterhuis and Steger, 1998; Coker and Oosterhuis, 2000) has evaluated the petiole sampling program with particular respect to plant physiological factors influencing plant response to deficiencies. Results showed that the boll load was a major driving force influencing petiole nutrient levels and that

[1] Distinguished professor, research specialist, and research assistant, Crop, Soil, and Environmental Sciences Department, Fayetteville.

petioles lower in the canopy, closer to the developing boll load, may be more sensitive to plant nutrient levels. Therefore, analysis of these petioles will more clearly show the development of a pending K deficiency such that timely remedial action can be taken.

RESEARCH DESCRIPTION

Replicated field plots arranged in a split-split design with high and low soil-K, well-watered and water-deficit conditions were established at Rohwer and Clarkedale. Eight treatment combinations of well-watered (W) or dryland (D) conditions, high soil-K (H) or low soil-K (L) were arranged in a split-split plot design with five or six replications. Each plot consisted of four rows 40 feet long (50 feet at Clarkedale), spaced 38 inches apart. At Rohwer, cultivar Suregrow 125 was planted into a moderately well-drained Hebert silt loam on 5 May 2001. At Clarkedale, cultivar Suregrow 747 was planted into a well-drained Calloway silt loam on 9 May 2001. Granular KCl fertilizer was hand broadcast to designated plots at Clarkedale on 26 April and at Rohwer on 25 April 2001 according to recommendations (Sabbe, 1998). Beginning at first flower, 10 to 15 petioles from main-stem nodes 4 and 8 were sampled weekly. Upon collection, the petioles were promptly dried at 60°C, ground to pass a 2-mm screen, and submitted to the Arkansas Agricultural Diagnostic Laboratory for nutrient analysis. Final lint yield and components of yield were determined by mechanically harvesting the two center rows of each plot and by hand-picking a 1-m length of each of two yield rows and counting the number of bolls.

RESULTS AND DISCUSSION

Replicated Field Experiment at Rohwer

This study was terminated on 20 June 2001 due to a severe hail storm event that occurred on 27th of May. An insufficient plant population was obtained after the plots had been replanted on the 4th of June.

Replicated Field Experiment at Clarkedale

Rainfall amounts were greater and events more frequent throughout the boll development stage, particularly compared to the previous two seasons at Clarkedale (see page 12).

Main-stem Node Petiole NO_3-N and K

Overall at Clarkedale, petiole NO_3-N measured in nodes 4 and 8 tended to decrease with the progression of boll development (Fig. 1). Node 4 petiole NO_3-N appeared to increase sharply in each of the four primary treatments between the first and second week after first flower (FF) followed by a continuous decline through four weeks after FF. We did not observe the same amount of fluctuation in node 8 petiole NO_3-N with the progression of sampling events. Beginning at FF, petiole NO_3-N was significantly lower ($P \leq 0.05$) in node 8 versus node 4 petioles under high soil-K, well-watered, or dryland conditions. We observed similar differences from petioles collected at the second and third week after FF under high or low soil-K, well-watered, or dryland conditions. The node 8 petiole NO_3-N levels at 2 and 3 weeks after FF were near deficient, while node 4 petiole NO_3-N levels appeared to be fully adequate according to current Extension recommendations.

Two different treatment interactions were observed for the level of petiole NO_3-N at various sampling dates (data not shown). At 2, 3, and 4 weeks following FF, we observed a significant interaction ($P \leq 0.05$) for water x main-stem node. At 1, 2, and 3 weeks following FF, there was a significant interaction ($P \leq 0.05$ and $0.05 < P \leq 0.1$) for soil-K level x main-stem node. These observations seemed to indicate that water deficits and low soil-K levels (together or separately) can increase the difference between node 4 and 8 NO_3-N levels during the peak boll development stage.

Potassium deficiency symptoms were apparent in mid- to upper-canopy leaves beginning at FF under the high and, more consistently, under the low soil-K levels. The concentration of K was significantly greater ($P \leq 0.05$) in node 4 compared to node 8 petioles under the well-watered, high, or low soil-K treatments at all four sampling stages (Fig. 2). These observations were very similar to what we found the previous season at the Rohwer and Clarkedale locations. Petiole K concentration was also significantly higher ($P \leq 0.05$) at node 4 versus node 8 at FF, and 2, 3, and 4 weeks following FF under the high or low soil-K levels and dryland conditions. We found significantly higher ($0.05 < P \leq 0.1$) petiole K concentration in node 4 compared to node 8 petioles at FF plus one week under the high or low soil-K levels and dryland conditions. According to current Extension recommendations, petiole-K concentrations were inadequate for optimal production in all of our primary treatments beginning at FF and this was indicated best by sampling node 8 as compared to node 4 petioles.

A significant ($P \leq 0.05$) water x main-stem node interaction for petiole-K concentration was observed at FF plus one week and at four weeks ($0.05 < P \leq 0.1$) following FF (data not shown). Water deficit appeared to minimize the difference in petiole-K concentration between nodes 4 and 8 at one week after FF. On the other hand, the difference in node 4 versus node 8 petiole-K concentration was increased at 4 weeks after FF by water-deficit conditions. We also observed a significant ($P \leq 0.05$) soil K x main-stem node interaction at three weeks after FF. Apparently, petiole-K concentration differences between nodes 4 and 8 were reduced considerably under low soil-K as compared to high soil-K conditions.

As found the previous season, node 4 and 8 petiole P and S concentrations showed similar patterns as those observed for nutrient-K among the four primary treatments at Clarkedale in 2001 (data not shown).

Yield Versus Main-stem Node-K

Figure 3 shows a regression of node 4 and 8 petiole-K concentration plotted against lint yield under *well-watered* conditions at 2, 3, and 4 weeks following FF. Data collected from the high and low soil-K treatments were individually plotted. There appeared to be a stronger relationship for node 8 compared to the node 4 position (for sampling) and petiole-K concentration response in relation to lint yield. A regression of petiole-K concentration at nodes 4 and 8 was plotted against lint yield under *dryland* conditions at 2, 3, and 4 weeks following FF (Fig. 4). The regression values showed a numerically stronger relationship between lint yield and node 8 petiole-K concentration as compared to node 4 petiole-K concentration under the *dryland* conditions.

PRACTICAL APPLICATION

Our results have shown that soil and plant water, and soil-K status can interact with the availability of petiole NO_3-N and K at different main-stem nodal positions (for sampling). At Clarkedale, collection of node 8 appeared to be better than node 4 position petioles for indication of a pending N shortage under *well-watered* or *water stress* conditions and for pending P, K, and S deficiencies under *well-watered* or *dryland*, *high* or *low* soil-K conditions. The relationship between petiole-K concentration and lint yield appeared to be noticeably stronger at main-stem node 8 compared to node 4, especially under *well-watered* conditions. Cotton producers should take into account the plant moisture status (besides soil nutrient levels and apparent boll loads) when monitoring nutrient levels in petioles during the flowering and boll development stages. Perhaps sampling node 4 and 8 petioles would be the most accurate way to monitor and ameliorate pending NO_3-N and K deficiencies during the critical flowering and boll development stages.

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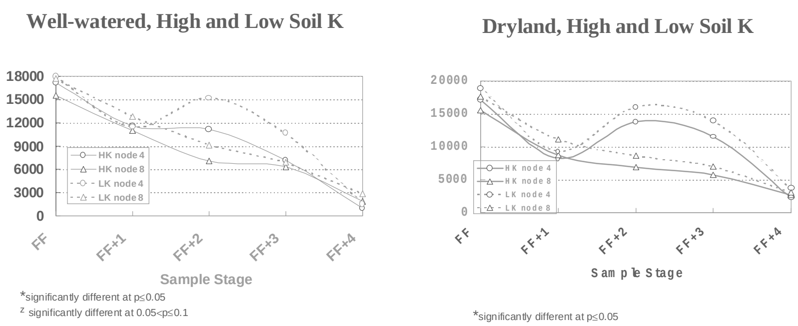


Fig. 1. Effect of water status and soil-applied K on petiole NO_3-N concentration. Clarkedale, 2001.

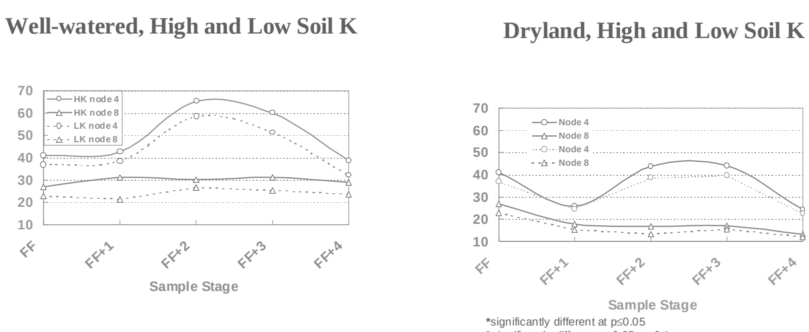
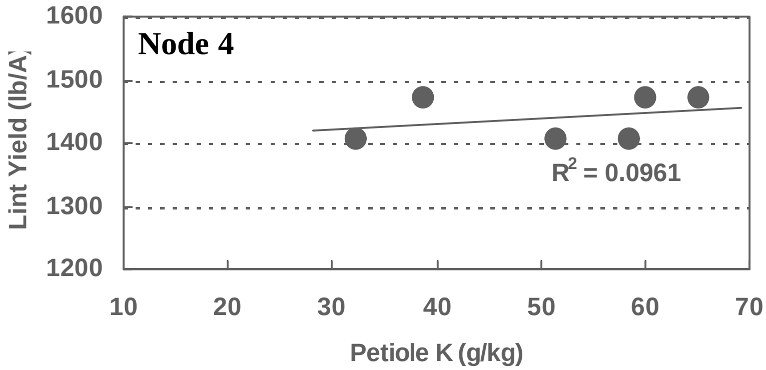


Fig. 2. Effect of water status and soil-applied K on petiole-K concentration. Clarkedale, 2001.



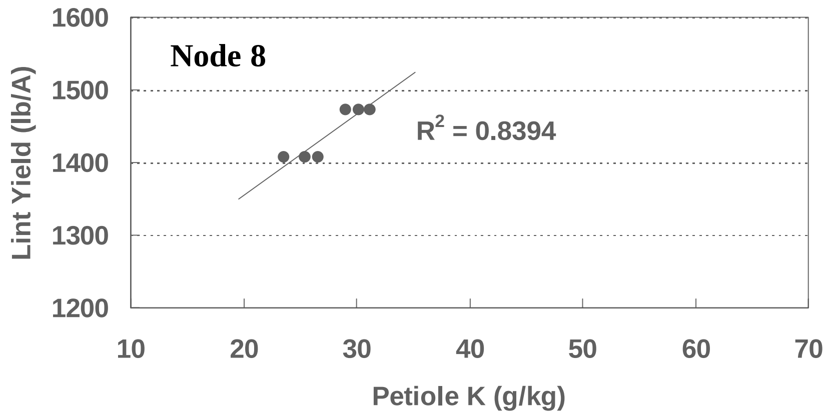
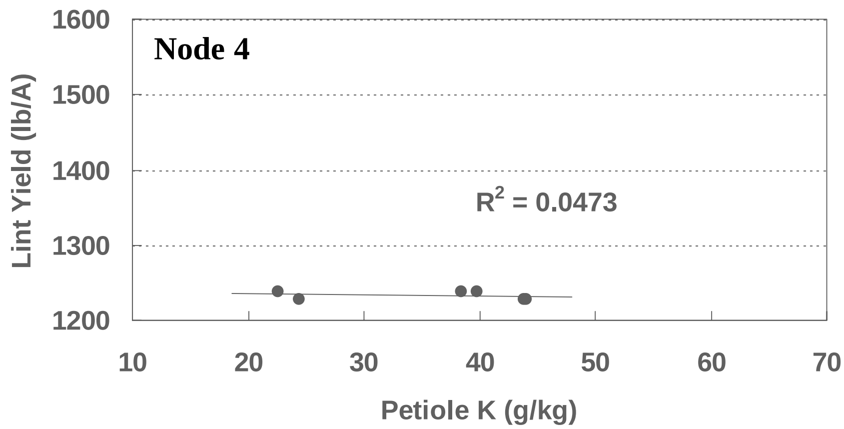


Fig. 3. Lint yield versus node 4 or 8 petiole-K concentration at 2, 3, and 4 weeks after FF with or without preplant, soil-appled K fertilizer under well-watered conditions. Clarkedale, 2001.



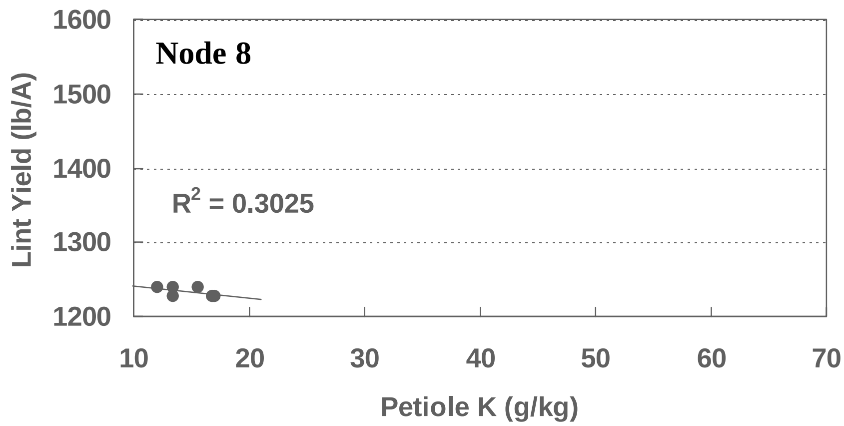


Fig. 4. Lint yield versus node 4 or 8 petiole-K concentration at 2, 3, and 4 weeks after FF with or without preplant, soil-appled K fertilizer under dryland conditions. Clarkedale, 2001.