

# Evaluation of Manganese Fertility of Upland Cotton in the Lower Colorado Valley

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## Abstract

*A field experiment was conducted during the 2001 growing season to evaluate the effect of Manganese (Mn) fertility on growth, development, and yield of a commonly grown upland cotton variety in the Yuma Valley of Arizona. This project also provided an evaluation of the University of Arizona (UA) critical level for Mn fertility for cotton (1.0 ppm Mn). The study consisted of two treatments, which included an untreated control and a treatment receiving two foliar applications each of a pint of the product 3-0-0-27.4 using 18 gal./acre carrier. Plant growth and development measurements, including estimates of fruit retention (FR) levels and height to node ratios (HNR's) were similar for both treatments during the season. There was not a significant difference in lint yield between the control (untreated) and the treated plots. These results support the current UA Mn fertility guideline for cotton on not applying Mn when soil test levels exceed 1.0 ppm.*

## Introduction

Fertility management in a cotton (*Gossypium* spp.) production system is critical for healthy plant growth and the maintenance of profitability. In Arizona soils, Nitrogen (N), phosphorus (P), and potassium (K) are the most commonly applied nutrients in cotton production systems. Nutrient management is essential for optimizing plant response and yield, and should be based upon guidelines obtained from soil and plant tissue analyses. These guidelines and nutrient management recommendations should be established through soil test and plant tissue correlation and calibration procedures. The purpose of soil test calibration is to describe the soil test results in easily understood terminology and to simplify the process of making fertilizer recommendations by placing soils in response categories (Dahnke and Olson, 1990). A method which involves plotting relative yield against soil test values can effectively provide visual indication of the reliability of a specified soil test and its correlation to plant response or to the uptake of a specific nutrient (Dahnke and Olson, 1990). Based on the outcome of such correlation studies, effective fertilizer recommendations have been made. For example, a DPTA extractable level of Manganese (Mn) greater than 1.0 ppm is usually considered sufficient for cotton production, and a level below 1.0 ppm are indicative of possible deficient levels of Mn (Silvertooth and Norton, 1998; Servi Tech Crop File fertilizer recommendations on cotton).

In the absence of adequate levels of Mn, it is typical for the upper and the young leaves of cotton to become yellowish gray or reddish gray in color with green veins. In contrast, excessive amounts of the nutrient (usually found in acidic soil environments) can cause crinkle leaf (Neal, 1937; Lovett, 1938). Other toxicity symptoms include appearance of abnormal leaves, which are puckered, mottled, partially chlorotic and distorted in early stages, with necrotic lesions appearing between the veins. However, in Arizona where soil pH is typically alkaline in nature (pH  $\geq$  8.0), toxic levels should not occur.

There are no extensive reports regarding Mn fertilization to cotton. This fact necessitates additional study to evaluate Mn and micronutrient requirements by cotton in relation to growth, development and yield. Hence, the

objective of this study was to determine the effect of Mn application on growth, development, and yield of a commonly grown upland cotton variety in Arizona.

## **Materials and Methods**

A Mn fertility field experiment was conducted in the lower Colorado River Valley of the southwestern Arizona during the 2001 growing season. The Mn experiment was located in the Yuma Valley on a Gadsden clay loam soil. The two treatments included a control plot (0 Mn fertilizer) and a treated plot receiving two in-season applications of 3-0-0-27.4 fertilizer as a Mn source. Plots were arranged in a randomized complete block design with four replications. Plots consisted of 80, 42 inch rows and extended the full length of the irrigation run (620 ft.). Agronomic information for this study is presented in Table 1 and pre-season soil chemical analysis results are presented in Table 2. Dates and rates of applied fertilizer for the treated plots are summarized in Table 3. The Mn treatments were applied foliarly at the rate of 1 pt. of the fertilizer to the acre using 18 gal./acre carrier.

Basic plant measurements were collected from all plots at significant phenotypic stages of the study. These measurements included plant height, number of mainstem nodes, node of the first fruiting branch, number of aborted or missing fruit, and the number of nodes above the top white flower (NAWF). This information was collected to track crop growth and development over the season. Final lint yield for both treatments in the experiment was determined by harvesting each plot into a separate module that was subsequently weighed and ginned to determine lint yield. Lint yield data was subjected to analysis of variance according to procedures outlined by Gomez and Gomez (1984) and the SAS Institute (1996) to determine if there was a significant difference in lint yield due to the fertilizer Mn treatment.

## **Results and Conclusions**

Basic plant measurements revealed no differences between the fertilized and the control plots. Fruit retention and HNR estimates for the fertility study indicated strong vigor (HNR) and high FR levels over the entire season for both treatments (Figure 1). Though both treatments exhibited HNR within the optimum growth thresholds, a slight difference in HNR was detected between the two treatments towards the end of the season (Fig 1). The increase in HNR for the untreated plots however did not result in a significant increase in yield over the treated plots. No differences with respect to lint yield were detected between the untreated control and the fertilized treatment (Table 4). The results of the plant measurements and lint yield are in agreement with UA fertility guidelines for cotton, that positive cotton response to Mn fertilization is unlikely when soil Mn levels exceed 1.0 ppm. Soil test Mn levels for this site greatly exceeded the 1.0 ppm UA critical level (Table 2).

## **Summary**

The soil test results, crop growth, and lint yield results from this study reinforce the current UA Mn fertilization guidelines for irrigated cotton in relation to soil nutrient levels.

## **Acknowledgments**

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Table 1. Agronomic information for Mn fertility study, Yuma Valley, AZ, 2001.

Planting Date	3 March
Variety	DP 5415 RR
Termination Date	8 August
Harvest Date	

Table 2. Pre-application soil test result for Mn fertility study (1 foot depth), Yuma Valley, AZ, 2001.

	Unit	Sampling Location		
		North End	Middle	South End
		Content		
*pH		8	8.2	8.1
ECe	dS/m	1.4	1.8	1.5
**Ca	ppm	7000	6800	7100
Mg	ppm	1000	120	120
Na	Ppm	240	260	210
K	ppm	240	260	210
NO <sub>3</sub> -N	ppm	18	24	30
PO <sub>4</sub> -P	ppm	13	11	12
Zn	ppm	1.0	1.0	0.9
Cu	ppm	0.29	0.29	0.25
Fe	ppm	9.3	9.5	9.3
Mn	ppm	5.4	5.4	5.0
B	ppm	0.30	0.32	0.36
SO <sub>4</sub> -S	ppm	14	13	13

\*pH and EC<sub>e</sub> obtained from 1:1 water extract

\*\*Exchangeable cations using neutral molar ammonium acetate

NO<sub>3</sub>-N and PO<sub>4</sub>-P from Olsen bicarbonate extract

Zn, Cu, Fe, and Mn from DPTA extract

B and SO<sub>4</sub>-S from hot water extract

Table 3. Treatments for the Mn fertility study, Yuma Valley, AZ, 2001.

Treatment	Product*	Rate (lbs. Mn/acre)
1	-	0
2	3-0-0-27.4	0.5

\*1pt of material applied foliarly on 4 June and 15 June using 18 gal./acre carrier (4 lb 2.81 oz Mn/gal.).

Table 4. Lint yield results for Mn fertility study, Yuma Valley, AZ, 2001.

Treatment	Lint Yield (lbs. lint/acre)
1	1577
2	1551
LSD	94
OSL	0.4428
C.V. (%)	2.7

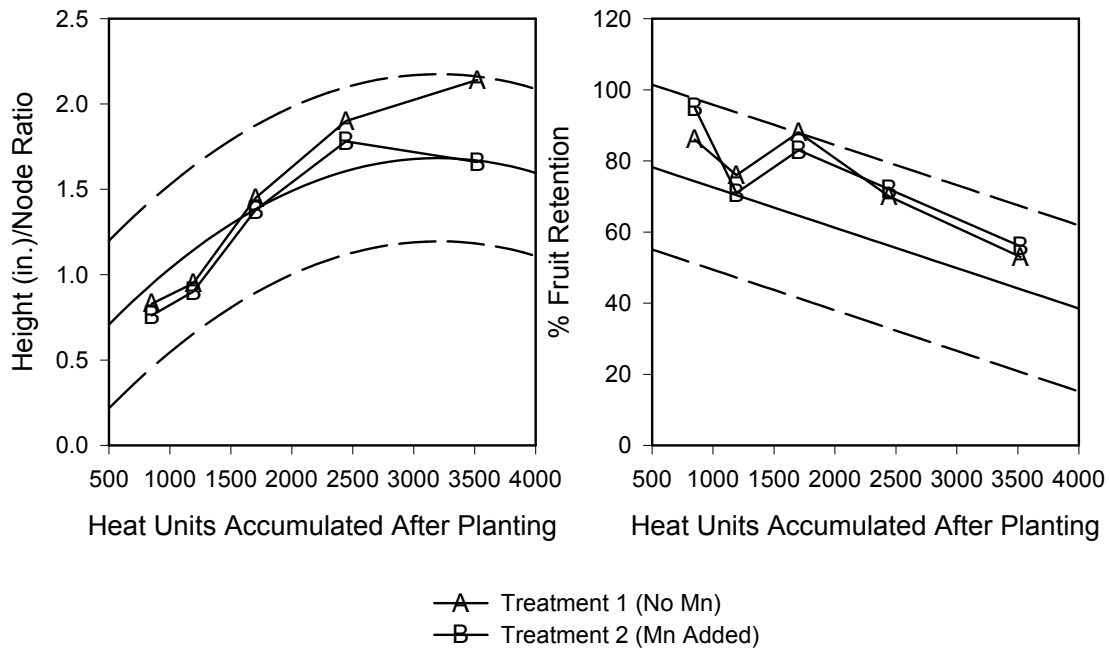


Fig. 1. 2001 Manganese Fertility Study, Yuma Valley, AZ.