Fluid JOURNAL
Official Journal of the Fluid Fertilizer Foundation
Winter 2009
Vol. 17 No. 1, Issue #63

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What About Mn On Glyphosate-resistant Soybeans And Conventional Soybeans?

Studies run to develop liquid fertilization strategies to prevent or correct possible yield deficiencies.

Summary: *This study was conducted in order to determine if glyphosate-resistant soybeans respond differently from conventional soybeans to applied manganese (Mn) and, if so, to develop liquid fertilization strategies that will prevent or correct deficiencies. Averaged over the two years in Experiment I, yield of the conventional soybean variety was 7 bu/A greater than its glyphosate-tolerant isoline when no Mn was applied. Addition of Mn improved yield of the glyphosate-resistant variety but the yield of the conventional isoline decreased at the highest Mn rate. Leaf tissue Mn at full bloom in the glyphosate-resistant variety was less than half of the conventional variety when no additional Mn was applied. Foliar-applied liquid Mn also proved to be effective in improving yield of glyphosate-resistant soybeans. Yield of soybeans was maximized with a combination of 0.3 lb Mn/A applied as a starter and another 0.3/A applied at the four-leaf stage or foliar application of 0.3 lb Mn/A at the 4-leaf, 8-leaf, and full bloom stages. These two treatments both improved yield by 12 bu/A over the untreated check. Full yield benefit was not achieved with starter-only application even at the higher rate of Mn.*

Many farmers have noticed that soybean yields on high pH soil, even under optimal conditions, are not as high as expected. In Kansas, average yield seldom exceeds 60 to 65 bu/A even when soybeans are grown with adequate rainfall and/or supplemental irrigation water. Application of glyphosate may retard manganese (Mn) metabolism in the plant. Glyphosate may also have an adverse effect on populations of soil microorganisms that are responsible for the reduction of Mn to a form that is plant available. Manganese availability is strongly influenced by soil pH. As soil pH increases, plant-available Mn decreases. It is unlikely that Mn deficiencies will occur on acid soils. Addition of supplemental Mn at the proper time may correct deficiency symptoms and result in greater soybean yields on soils with pH at 7 or above.

In higher plants photosynthesis in general and photosynthetic O_2 evolutions in Photosystem II (Hill Reaction), in particular, are the processes that respond most sensitively to Mn deficiency. Manganese deficiency-induced changes in O_2 evolution are correlated with changes in the ultrastructure of thylakoid membranes (internal chlorophyll containing membranes of the chloroplast where light absorption and the chemical reactions of photosynthesis take place).

When Mn deficiency becomes severe, the chlorophyll content decreases and the ultrastructure of the thylakoids is drastically changed. Manganese acts as a cofactor, activating about 35 different enzymes. Manganese activates several enzymes leading to the biosynthesis of aromatic amino acids such as tyrosine and secondary products such as lignin and flavonoids. Flavonoids in root extracts of legumes stimulate *nod* (nodulation) gene expression. Lower concentrations of lignin and flavonoids and Mn-deficient tissue are also responsible for a decrease in disease resistance of Mn-deficient plants.

In nodulated legumes such as soybeans that transport nitrogen (N) in the form of allantoin and allantoate to the shoot, the degradation of these ureides in the leaves and in the seed coat is catalyzed by an enzyme that has an absolute requirement of Mn. Ureides account for the majority of N transported in the xylem sap to the aerial portions of the soybean. Tissue Mn deficiency and drought stress can increase shoot ureide concentration. Foliar Mn applications have been shown to be effective in prolonging N_2 fixation.

Information is needed to determine if field-grown glyphosate-resistant soybeans respond to applied Mn in a manner different from conventional soybeans, and if so, what fertilization practices are best to correct the problem. Currently, there is little information on Mn fertilization of soybeans in Kansas.

The objective of this research was to determine if the response of glyphosate-resistant soybeans to applied Mn is different from that of conventional soybeans, and if so, to develop fertilization strategies that will prevent or correct deficiencies leading to improved yield for soybean producers.

Mn effects

Experiment I. Yield of glyphosate-resistant variety KS 4202 RR was 7 bu/A lower than the conventional variety when no Mn was applied (Figure 1). The application of 2.5 lbs Mn/A improved yield and equaled that of the conventional isoline. Yield of the conventional variety was depressed at the high rate of Mn.

Tissue Mn concentration (uppermost expanded trifoliate at full bloom) in the herbicide-resistant variety was less than half of the conventional variety when no Mn was applied (Figure 2).

Experiment II. Yield of the glyphosate-resistant soybean variety KS 4202 was maximized by a combination of Mn applied as a starter two inches to the side and two inches below the seed at a planting rate of 0.33 lb Mn/A and a foliar application at the same rate applied at the 4-leaf stage (Table 1). A starter alone application at either 0.3 or 0.6 lb Mn/A did not give results equaling the combination of the starter and foliar treatment. Application of foliar Mn applied at 0.33 lb Mn/A at the V4, V8, and R2 stages of growth gave yields equal to the starter plus one foliar application at the V4 stage. One or two foliar applications were not as effective as the starter plus foliar or the three foliar applications.

Higher rates of starter-applied Mn and single foliar applications will be investigated in 2009 in order to determine if timing is critical or if higher rates applied earlier in the growing season may be as effective as lower rates applied more frequently.

This research provides evidence that the glyphosate-resistant soybean variety used in this experiment did not accumulate in the same manner as the conventional variety and did not respond to application of Mn in this high-yield environment.

Table 1. Foliar applied manganese effects on soybean yield, 2005-2007	
Stage of Growth	Yield, bu/A
Starter (0.33 lb)	65
Starter (0.66 lb)	70
Starter (0.33 lb) + V4 (0.33 lb)	76
V4 (0.33 lb)	67
V4 +V8 (0.33 + 0.3 lb)	73
V4 + V8 + R2 (0.33 + 0.33 + 0.33 lb)	76
Untreated Check	64
LSD (0.05)	3

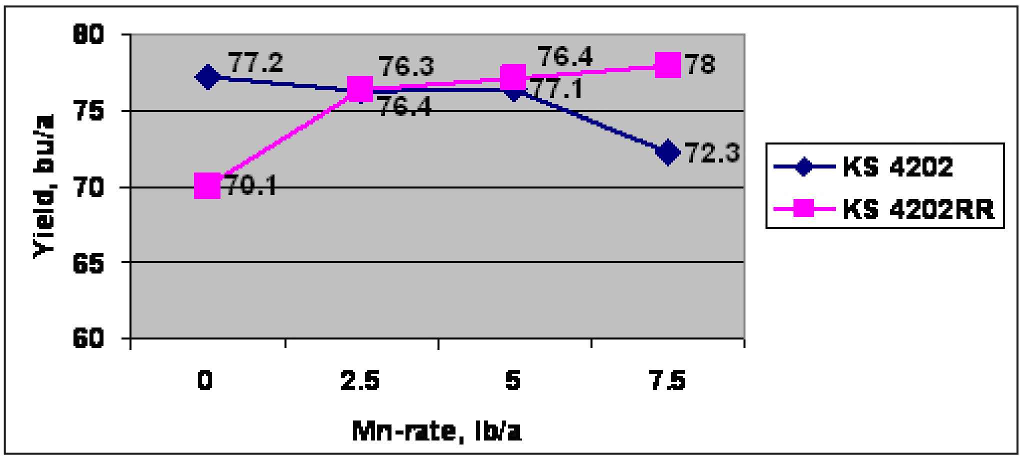

Figure 1. Soybean yield response to applied Mn, Scandia, KS, 2005-2006.

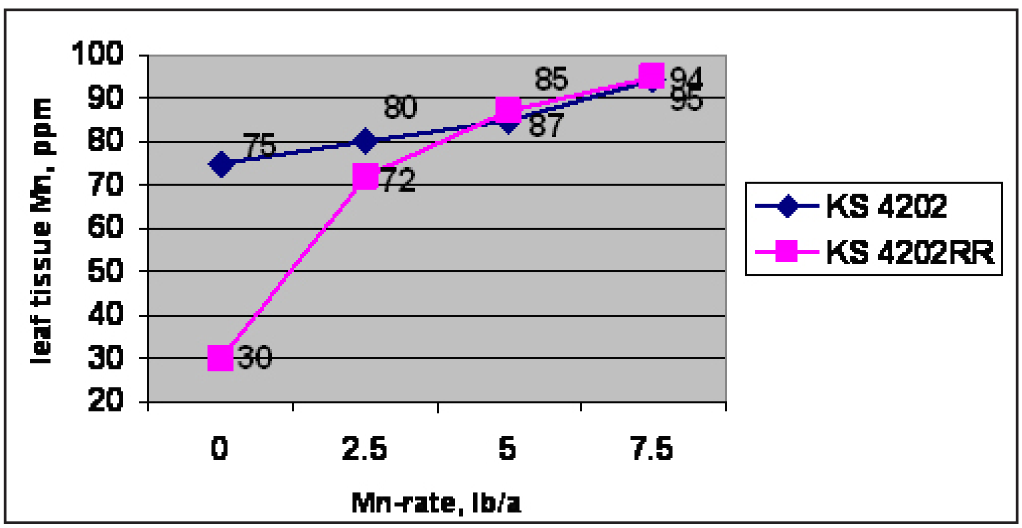

Figure 2. Soybean leaf tissue Mn concentration (uppermost expanded trifoliate at full bloom), Scandia KS, 2005-2006.

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