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Effects of Foliar Application of Boron and Dimilin on Soybean Yield

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Abstract

Foliar application of mineral nutrients and insecticides to increase soybean yields is recommended in some soybean production areas. Studies were conducted at Stoneville, Mississippi, in both sandy and clay soils to determine if this practice is effective for soybeans grown in this state. Boron, Dimilin, and a combination of boron and Dimilin were applied at the recommended foliar rates for foliar application when soybeans were in the R3 stage of development. In 1998, four varieties, two each from maturity groups (MG) IV and V, were used. Experiments were conducted in both irrigated and nonirrigated fields. In 1999, only MG IV varieties were tested in an irrigated field. Yields and various yield components were measured. Results from both years indicated that none of the treatments significantly improved soybean yields. Due to the insignificant results in yield increase with boron and Dimilin foliar applications, recommendations to soybean growers could not be made based on this research.

Introduction

Soybean yields in Mississippi have increased steadily in recent years because of improved soybean varieties and cultural practices, such as the early soybean planting system (ESPS). This development has encouraged people to explore even more ways to maximize soybean yields and profits. Various foliar applications of mineral nutrients, some combined with insecticide, have interested soybean researchers and producers in the South.

Boron is needed in small quantities by the soybean at the reproductive stage. It has special importance in retaining flowering and fruit setting. It is leachable in light sandy soils. Research has been done on boron foliar application near pod-setting and seed-filling stages to determine if yields are affected. Results have been inconsistent with variations attributed to different soil types. Application of 0.25 to 0.4 pound per acre of boron has been recommended in Georgia (Soybean Digest 1997), where it consistently improved yields on sandy soil – by as much as 10% – but there was no significant response on better soils. Research at the University of Missouri showed an average of 13.5 bushels per acre yield increase with a foliar spray of boron (Soybean Digest 1996). Touchton and Boswell (1975) found that soybean yields responded to foliar application of boron at different levels in two types of soil. At one site, yields were increased when the application levels were at 0.25, 0.5, and 1 pound per acre. However, at the other site, the yield was only increased with boron applications of 1 pound per acre.

Foliar applications of boron combined with an insecticide such as Dimilin have been recommended as a strategy for increasing soybean yields. Dimilin is an insecticide applied early in the reproductive stage to prevent later infestations of velvet-bean caterpillar. Research in Georgia (Soybean Digest 1997) showed that a combination of boron and Dimilin applied at the early pod-set stage (R3) provided a yield increase greater than that for boron alone (Fehr et. al 1971). Georgia Coastal Plain soybean growers

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were advised to apply a late foliar spray of boron combined with Dimilin as a yield enhancement treatment. Research results in Mississippi showed positive effects by applying Dimilin in 1997 (Blaine, personal communication). Considering the relatively low costs of boron and Dimilin applications, soybean growers might find the combined application to be valuable strategy if it consistently increases yield by 4 to 5 bushels per acre.

This study was undertaken to provide valuable information for Mississippi soybean growers in making production decisions involving the use of boron and Dimilin. Objectives of this study were to determine two factors: (1) whether foliar application of boron after flowering (R3 stage) increase soybean yield on soil types in Mississippi; and (2) if results show a positive conclusion, would boron use prove profitable for growers in this state.

Materials and Methods

Variety — Two varieties of each maturity group (IV and V) were used in the experiments. They were AP 4880 (IV), DP 3478 (IV), DP 3588 (V), and Hutcheson (V). All were high-yielding varieties in the Mississippi variety trials in 1997 and were widely used by the state's soybean growers.

Location, field, planting dates, and plot configuration — Locations, soil types, planting dates, and plot configurations of the experiment in 1998 are summarized in Table 1. Four fields were involved in two different soil types. Since two fields at the Stoneville site were very similar except the length of the plots, results from these fields were pooled together. Experiments in 1999 were similar to those in 1998, except for a few different planting dates and the fact that MG IV varieties were planted only in late April.

Treatments and rate of applications — Table 2 shows a summary of the treatments, commercial chemical products used, and rates at which the products were used in 1998 and 1999 experiments. The chemicals – Solubor (source of boron) and Dimilin – were supplied by the U.S. Borax Company. Rates used in the experiments were the average rates for commercial uses suggested by the chemical company and other previous studies. Detailed information about those chemicals can also be obtained through the company. Treatments were applied at or near the R3 stage of growth, when the pod-setting process starts.

Experimental design — The 1998 experiment was a split-split plot design. The main unit was two planting dates, the subunit was irrigation system, and the sub-subunit was five chemical treatments. Four replications were used. The experiment also included nonirrigated plots that had an identical plot arrangement within the same field. In 1999, the experiment was a randomized block design with four replications.

Cultural practices — After the seed germinated and seedlings were established, plots were trimmed into 20-foot lengths. Seeding rate was eight seeds per foot with an average germination rate of 85% to 90%. Conventional weed control methods were applied throughout the growing season, and all the guidelines were followed for producing optimum soybean yields in Mississippi. Applications were all applied around the R3 stage. Soil samples were taken twice from the fields (before and after the growing season) to record information about pH, nitrogen, phosphorus, potassium, and other micronutrients. Boron was specifically examined in the second sampling. The results from nutrition analysis showed no deficiency of any nutrient in the soils tested.

Data collection and analysis — Yield components, such as height, pod number, seed number, and 100-seed weights per plant were recorded in both years. Final yields were also collected for all the treatments. Data were analyzed separately due to the unbalanced number of plantings and varieties between the two years.

Table 1. Summary of experiment locations, soil types, previous crops planted, date of planting (DOP), and plot configurations in 1998.

Location	Soil type	Previous crop	DOP-1	DOP-2	Row space	Row length
					in	*ft*
Stoneville, Miss.	Sandy	Cotton	4/22	5/19	30	20
Stoneville, Miss.	Sandy	Cotton	—	5/14	30	35
Stoneville, Miss.	Sharkey Clay	Soybean	4/23	5/20	20	20
Moorhead, Miss.	Sharkey Clay	Rice	4/24	5/18	20	20

Table 2. Summary of treatment, product, and rates used in foliar application studies in 1998.

Treatment	Product	Application rate
Control	No treatment	—
Boron (B)	Solubor	1.25 lb/A
Dimilin (D)	Dimilin liquid	2 oz/A
Combination	B + D	B at 1.25 lb/A + D at 2 oz/A

Results and Discussion

Yields varied largely from plot to plot within the same experiment and treatment in both 1998 and 1999. Tables 3-5 show summary yields for foliar applications under different irrigation conditions and planting dates in four fields in 1998. A statistical analysis was performed and indicated the variations were relatively large (the values of least significant difference [LSD] were greater than 10% of value of the yields in most of the fields tested). When this factor is taken into consideration, foliar application treatments did not result in a significant increase in soybean yields over those of the controls regardless of all environmental considerations such as irrigation, planting date, variety, and soil type. Although certain varieties in specific conditions had significantly higher yields than those of the controls (Table 4d and Table 5a), there was no general trend to follow.

Several previous studies with positive results used multiple foliar applications. Reinbott and Blevins (1995) reported that foliar boron or magnesium applied separately four times during reproductive growth did not affect soybean yield. However, in his experiments, four foliar applications of a combination of boron and magnesium increased soybean yield 12% and 4% at two separate locations over a 3-year period. Schon and Blevins (1990) claimed that with multiple foliar boron applications, the final number of pods on branches was increased and further increased yields. Soybean producers in Mississippi may not be willing to apply any foliar supplement on soybean more than once. Therefore, this approach was not considered in this experiment.

Previous research indicated that the foliar applications were most likely to be effective when the soybean yield was high. The average yields of both treatments and controls in 1999 were higher compared with the previous year (Table 6); however, the differences between treatments and controls were still not significant enough to be detected. Data of other yield components had shown no significant difference between the treatments and the controls (data not shown).

Several factors may contribute to how soybean plants respond to a foliar application at the reproductive stage. The first is the level of the nutrients in the soils. Nitrogen is usually not required for soybean production because it can be obtained from the atmosphere through the nodulation process. In concentration, the level of the nutrients in the fields used for these experiments was not all above deficiency level. Therefore, foliar applications of both nitrogen and boron may not have a significant effect on soybean final yield. Secondly, plant health itself may be a factor that influences the foliar application method. If plants were drought stressed during early (1998) or late (1999) vegetative growth, they may not have been in optimum health to respond to nitrogen and boron applications to maximize yield. Thirdly, in recent years, soybean growers have used earlier varieties, resulting in earlier maturity. When foliar applications were applied at the pod-setting stage (R3), time may have been too short for soybean plants to effectively utilize added nutrients.

Table 3. Summary of mean yields for the foliar application study at Moorhead, Mississippi (clay soil), in 1998.

Treatment	AP 4880	DP 3478	DP 3588	Hutcheson
	bu/A	*bu/A*	*bu/A*	*bu/A*
(a) Planting-1 (4/24)				
Control	31.4	39.7	33.3	21.5
Boron	42.8*	33.9	27.4	18.0
Dimilin	37.2	31.6	33.6	26.2
D+B	36.1	32.6	30.4	20.4
LSD (α= 0.05)	10.0	NS	NS	NS
(b) Planting-2 (5/18)				
Control	41.3	44.6	33.1	36.6
Boron	41.8	42.0	36.7	37.2
Dimilin	40.3	39.0	34.6	40.7
D+B	45.1	38.0	33.9	37.1
LSD (α= 0.05)	NS	NS	NS	NS

*Value of the treatment is significantly higher than that of control.

Table 4. Summary of mean yields for foliar application studies at Stoneville, Mississippi (clay soil), in 1998.

Treatment	AP 4880	DP 3478	DP 3588	Hutcheson
	bu/A	*bu/A*	*bu/A*	*bu/A*
(a) Planting-1 (4/23, Nonirrigated)				
Control	22.7	21.1	20.3	16.4
Boron	20.0	18.4	22.8	19.6
Dimilin	20.7	22.7	18.7	17.2
D+B	17.5	17.5	21.0	20.2*
LSD (α= 0.05)	NS	NS	NS	3.6
(b) Planting-1 (4/23, Irrigated)				
Control	55.7	52.9	59.4	53.7
Boron	56.2	55.6	52.6	50.9
Dimilin	51.6	54.6	56.3	52.6
D+B	55.8	54.9	54.2	48.2
LSD (α= 0.05)	NS	NS	NS	NS
(c) Planting-2 (5/20, Nonirrigated)				
Control	16.3	16.7	17.1	—
Boron	14.6	15.1	16.1	—
Dimilin	18.1	17.5	19.0	—
D+B	14.8	15.1	17.7	—
LSD (α= 0.05)	NS	NS	NS	—
(d) Planting-2 (5/20, Irrigated)				
Control	47.6	48.0	51.9	—
Boron	52.1*	51.0	53.0	—
Dimilin	49.9	49.0	57.2*	—
D+B	50.2	48.6	52.1	—
LSD (α= 0.05)	4.4	NS	5.1	—

*Value of the treatment is significantly higher than that of control.

Table 5. Summary of mean yields for foliar application studies at Stoneville, Mississippi (sandy soil), in1998.

Treatment	AP 4880	DP 3478	DP 3588	Hutcheson
	bu/A	*bu/A*	*bu/A*	*bu/A*
(a) Planting-1 (4/22, Nonirrigated)				
Control	46.4	51.2	43.0	49.1
Boron	55.5	51.6	46.0	50.2
Dimilin	48.6	48.8	50.2*	47.6
D+B	54.1	55.4	49.1	47.8
LSD (α= 0.05)	NS	NS	6.2	NS
(b) Planting-1 (4/22, Irrigated)				
Control	53.6	56.6	51.7	55.3
Boron	61.7	57.6	54.0	52.2
Dimilin	62.9	64.1	50.7	52.4
D+B	56.8	51.4	50.4	50.4
LSD (α= 0.05)	NS	NS	NS	NS
(c) Planting-2 (5/19, Nonirrigated)				
Control	56.9	54.1	39.0	45.8
Boron	51.6	44.6	35.5	44.6
Dimilin	52.3	45.3	37.7	46.6
D+B	53.6	45.4	33.6	50.3
LSD (α= 0.05)	NS	NS	NS	NS
(d) Planting-2 (5/19, Irrigated)				
Control	64.7	66.1	44.6	51.1
Boron	68.2	60.3	40.5	44.3
Dimilin	65.2	57.6	47.0	49.5
D+B	63.9	57.1	42.3	47.6
LSD (α= 0.05)	NS	NS	NS	NS

*Value of the treatment is significantly higher than that of control.

Table 6. Summary of yield effects of foliar applications of nutrients (B, N) and fungicide (Dimilin) on soybean yield in 1999.

Treatment	Clay soil		Sandy soil	
	AP 4880	DP 3478	AP 4880	DP 3478
Control	68.7	70.4	74.9	63.6
Boron	64.2	69.2	72.9	65.7
Dimilin	70.8	68.7	70.9	64.0
D+B	68.9	69.4	79.1	62.8
LSD	NS	NS	NS	NS

Summary

In these trials, the application of boron and Dimilin through soybean leaves did not significantly improve soybean yields in either sandy or clay soils, regardless of whether the fields were irrigated or nonirrigated. Therefore, growers should continue to base decisions related to foliar nutritional applications on experience and soil testing information. The effectiveness of foliar applications of boron at increasing soybean yield may largely depend on soil conditions and water stresses experienced by the crops. Under most deep-tillage conditions, the crop can access enough micronutrients from the soil for maximum yield production. However, it is incorrect to conclude that yields would never respond to foliar nutritional applications. To examine the effects of foliar applications on yield improvement in soybean production, more studies are needed under normal climate conditions.

References

Fehr, W.R., E.E. Caviness, D. T. Burmood, and J.S. Pennington. 1971. Stages of development descriptions for soybeans *Glycine max* (L.) Merrill. *Crop Sci.* 11: 929-931.

Poole, W.D., G.W. Randall, and G.E. Ham. 1983. Foliar fertilization of soybean: I. Effect of fertilization sources, rates, and frequency of application. *Agron. J.* 75:195-200.

Reinbott, T.M, and D.G. Blevins. 1995. Response of soybean to foliar-applied boron and magnesium and soil-applied boron. *J. Plant Nutr.* 18(1): 179-200

Schon, M., and D. Blevins. 1990. Foliar boron applications increase the final number of branches and pods on branches of field-grown soybeans. *Plant Physiol.* 92:602-605

Soybean Digest. 1996. April, p. 31.

Soybean Digest. 1997. August/September, p. 6

Touchton, J.T., and F.C. Boswell. 1975. Effect of B application on soybean yield, chemical composition, and related characteristic. *Agron. L.* 167: 417-420.

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