Effect of Fertilizers and Rates of Application on Incidence of Soybean Diseases in Northern Alabama

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ABSTRACT

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Field incidence of soybean stem canker (SSC), *Phytophthora* root rot (PRR), bacterial blight of soybean (BBS), soybean mosaic virus (SMV), and soybean cyst nematode (SCN) females on soybean cultivar Bragg were compared under complete (20-20-20), ammonium nitrate (34-0-0), superphosphate (0-46-0), and muriate of potash (0-0-60) fertilizers, and rate regimes with unfertilized controls on Decatur silty clay loam (Rhodic paleudult) in northern Alabama. Plants fertilized with muriate of potash had higher incidence of PRR and SMV. Plants fertilized with complete fertilizer had the lowest incidence of PRR and SMV, and the highest yield. Both complete and superphosphate fertilizers lowered the incidence of SMV at application rates from 0 to 100 kg/ha, then increased up to 200 kg/ha. Ammonium nitrate fertilizer had no effect on incidence of SMV. The incidence of BBS and the number of SCN females were not affected by either type of fertilizers or rate of application. Application rates of any of the four fertilizers reduced incidence of SSC. It is recommended to use only complete fertilizer to increase yield and reduce field incidence of PRR, SMV, and SSC.

Soybean (*Glycine max* (L.) Merr.) is one of the important cash crops in Alabama. Soybean production is affected by several diseases (15). Soybean cyst nematode (SCN), *Heterodera glycines* Ichinohe, is a major pest of soybean in Alabama and caused estimated yield losses of 1.5% in 1992 and 1993 (18). Soybean stem canker (SSC), caused by *Diaporthe phaseolorum* (Cooke & Ellis) Sacc. var. *caulivora* K.L. Athow & R.M. Caldwell, is also economically important in Alabama (2). SSC was reported to be widespread in 1982 and 1983, causing moderate to severe yield losses in 17 and 19 Alabama counties, respectively (17). An outbreak of bacterial blight of soybean (BBS) caused by *Pseudomonas syringae* pv. *glycinea* was reported in northern Alabama in 1986 (9). Most commercial soybean varieties grown in this area were susceptible to bacterial blight, with incidence from 50 to 100% (9). Yield losses of soybean cultivar Essex ranged from 4 to 40% in 1986 (1).

Phytophthora root rot (PRR), caused by *Phytophthora megasperma* Dreschs. f. sp. *glycinea* T. Kuan & D.C. Erwin, is another major disease of soybean in Alabama (4); PRR caused estimated yield losses of 0.2 and 0.1% in 1992 and 1993, respectively (18). Soybean mosaic virus (SMV) is a potential threat to the soybean industry in Alabama (3,11). Yield losses (12-14), reduced seed quality (8,12,13), and decreased oil content (5) and nodulation (16) have been reported in soybean affected by this pathogen. Host nutrition is reported to affect disease incidence and severity (7).

The purpose of this study was to determine whether fertilizer application and rates affect development of five major soybean diseases in northern Alabama.

MATERIALS AND METHODS

Experiments with four fertilizer formulations each at five rates were conducted simultaneously at Alabama A&M University Research Station from 1989 to 1992 on Decatur silty clay loam (Rhodic paleudult). To avoid confounding the effects of fertilizer applications, the experimental field used each year was not located in the same area but within the same site. Each year, the field was prepared by tractor disking and harrowing, and treated with trifluralin (Treflan) with a formulation of 1.8 kg a.i. per 3.8 liters (4 lbs/gal) applied at the rate of 1.7 liters/ha (1.5 pints/acre) 1 week before application of fertilizers. Soil samples taken once in 1989 before fertilizers were added showed levels of N-P-K to be

45, 25, and 122 ppm, respectively. Alabama soybean fertilizer recommendations for this particular site were 101 kg/ha N, 67 kg/ha P, and 0 kg/ha K according to the Auburn University Soil Testing Laboratory (Auburn University, AL 36849).

The total experimental field area was 28.4 × 76.8 m divided lengthwise into four blocks with 91-cm margins between them. The treatments for the blocks were as follows: block I, complete fertilizer (20-20-20); block II, ammonium nitrate fertilizer (34-0-0); block III, superphosphate fertilizer (0-46-0); and block IV, muriate of potash fertilizer (0-0-60). The five rates of fertilizer application for each block were as follows: 0 kg/ha (control), 50 kg/ha, 100 kg/ha, 150 kg/ha, and 200 kg/ha, each randomly assigned within the block in a split-plot design and replicated three times. Each plot corresponded to one fertilizer rate broadcast and incorporated into soil with a hand hoe 1 week prior to seeding. Each plot was seeded with seven rows of soybean (1 seed per 2 cm). Soybean cultivar Bragg, grown extensively in the southeastern United States and in Alabama (11), was used in this study. It is susceptible to BBS, PRR, SSC, SMV, and SCN (9,10,11).

Field disease incidence of SSC, PRR, BBS, and SMV, and the number of SCN females were determined between the R1 and R2 stages of soybean growth, as described by Fehr et al. (6). Four plants from each plot were arbitrarily chosen and removed from the plot. Attached roots were washed with tap water to remove soil. The number of nodules, size of nodules, and number of *H. glycines* females were recorded. On the same four plants, the number of pods per plant per plot was also determined. At the R8 growth stage (6), four plants from each plot were arbitrarily selected and measured for height from the soil level to the uppermost youngest leaves. Three center rows of each plot were harvested with a combine, and the yield was computed as kg/ha. The data were analyzed statistically as for a split-plot design. The linear and quadratic effects of rates of fertilizer were tested using contrasts. The significant contrasts were then subjected to regression analysis.

RESULTS AND DISCUSSION

According to Tukey's studentized range (HSD) test, the 3-year fertilization study

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on soybean cultivar Bragg showed a significant effect of the different fertilizer treatments on PRR, SMV, height, and yield ($P < 0.05$) (Table 1). Plants fertilized with potash had the highest incidence of PRR and SMV, and the lowest yields, followed by those fertilized with superphosphate. Plants fertilized with complete fertilizer had the lowest incidence of PRR and SMV, the shortest height, and the highest yields.

The rate of application of all fertilizers according to HSD significantly affected the incidence of SSC ($P < 0.05$). Regression equations showed a highly significant quadratic effect, with 58% of the variation in SSC accounted for by rates of fertilizer. However, further analysis of the data revealed that 98% of this variation was accounted for by a single contrast of the zero rate versus all others. The application of any rate of any of the four fertilizers tested reduced the percent incidence of SSC from 7.7 to 0.7.

There was a highly significant interaction between the type of fertilizer and the rate of application on the incidence of SMV ($P < 0.01$) (Fig. 1). The addition of either complete fertilizer or superphos-

phate up to 100 kg/ha lowered the incidence of SMV; then the incidence increased through the 200 kg/ha rate. The different rates tested of the ammonium nitrate fertilizer had no effect on the incidence of SMV. The application of muriate of potash fertilizer had an effect opposite that of the first two fertilizers; the incidence of SMV increased up to the 100 kg/ha rate and then decreased with the higher rates.

The incidence of BBS and the number of SCN females were not affected by either the type or the rate of fertilizer. Likewise, the effects of the different fertilizers and rates were not significant for the number of nodules, size of nodules, number of SCN females, and number of pods.

Although potash and superphosphate decrease significantly the incidence of SSC, these fertilizers increased field incidence of PRR and SMV. It is recommended to use only complete fertilizer to reduce field incidence of PRR, SMV, and SSC, and to increase soybean yield.

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Table 1. The effect of fertilizers on incidence of *Phytophthora* root rot (PRR) and soybean mosaic virus (SMV), and on height and yield of soybean cultivar Bragg^y

Fertilizer	Incidence (%)		Height (cm)	Yield (kg/ha)
	PRR	SMV		
Complete (20-20-20)	7.40 b ^z	17.48 c	49.60 b	1,942.10 a
Ammonium nitrate (34-0-0)	7.06 b	19.14 c	51.80 ab	1,740.40 ab
Superphosphate (0-46-0)	9.44 ab	28.14 b	58.24 a	1,665.33 b
Muriate of potash (0-0-60)	12.72 a	36.80 a	52.92 ab	1,527.73 b

^y Data are means over five rates of application (0, 50, 100, 150, and 200 kg/ha) for 3 years.

^z Means with the same letter in a column are not significantly ($P < 0.05$) different according to Tukey's studentized range (HSD) test.

Fig. 1. Effect of fertilizers and rates of application on incidence of soybean mosaic virus symptoms in 3-year field trials in northern Alabama. Where Y = incidence and x = fertilizer rate: complete fertilizer (♦), 20-20-20 N-P-K, $Y = 30.70 - 0.43x + 0.002x^2$, $R^2 = 0.73$; ammonium nitrate (■), 34-0-0 N-P-K, $R^2 = 0.22$ (NS); superphosphate (▲), 0-46-0 N-P-K, $Y = 35.07 - 0.29x + 0.001x^2$, $R^2 = 0.57$; and muriate of potash (×), 0-0-60 N-P-K, $Y = 33.26 + 0.23x - 0.001x^2$, $R^2 = 0.48$.