REDUCING THE SEVERITY OF PHYTOPHTHORA ROOT ROT DAMAGE IN SOYBEANS WITH SELECTED MANAGEMENT OPTIONS[1/]

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Phytophthora root rot of soybeans (PRR) is a major concern for soybean growers in south-central and southeastern Minnesota, where it can be responsible for major yield reductions. In these regions, PRR is generally a serious problem when soybeans are grown on poorly drained soils and/or there is a moderate amount of rainfall within 2 to 3 days of planting.

Previous research has shown that PRR causes a reduction in the number of harvestable plants per acre and this is the major contributing factor to a reduction in soybean yield. Some control options have been identified. These include the selection of least susceptible varieties, systemic fungicide use, and use of cultural practices such as the tiling of poorly drained fields.

The positive interactions of potassium usage with severity of diseases in crops have been researched for some time. The impact of either soil test level for potassium or use of potash fertilizers on the incidence and severity of PRR, however, is not well documented. The interactions among potash use, variety selection, and fungicide (Ridomil) use have also not been researched. Therefore, this study was designed to measure the effect of potash fertilization, variety, and Ridomil use on PRR in fields where this disease organism has limited soybean production in the past.

EXPERIMENTAL PROCEDURE

This study was conducted in grower fields at six locations in Dodge and Mower counties in south-central Minnesota in 1988 and 1989. Sites selected were poorly to moderately well drained. All sites selected had a previous history of damage caused by PRR. Special emphasis was given to selecting sites that had relatively low levels of soil test potassium.

Soil samples were collected from 0-6, 6-12, 12-24, 24-36, 36-48, and 48-60 inch increments prior to initiation of the study. Routine soil test procedures were used to analyze samples for pH, P, K, and organic matter. Results of these analyses are summarized in Table 1.

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Table 1. Selected soil properties for the experimental sites.

Property	Depth	MR (88)	MM (88)	DH (88)	MM (89)	MG (89)	MA (89)
	inches						
pH	0-6	5.9	7.3	6.5	5.5	7.0	6.2
P, ppm (Bray & Kurtz #1)	0-6	17.0	57.3	44.9	34.5	29.5	24.0
Organic Matter,%	0-6	2.7	8.7	5.8	3.6	4.8	3.1
K, ppm ($1N\ NH_4C_2H_3O_2$)	0-6	115	165	172	141	127	82
	6-12	66	109	94	82	54	37
	12-24	39	90	97	75	55	50
	24-36	40	40	45	77	43	49
	36-48	70	-	46	64	37	59
	48-60	84	-	45	60	40	94

Site and Year (column heading spanning MR (88) through MA (89))

Three factors (rate of applied potash, soybean variety, Ridomil use) were combined in a complete factorial design. A split-split plot arrangement was used with each treatment replicated 4 times at each site. Potash rates were used as the main plots. Soybean varieties were the split plots and Ridomil use was the split-split plot.

Potash, supplied as 0-0-60, was broadcast at rates of 0, 48, 96, and 192 lb. K_2O per acre. This fertilizer was incorporated with a disk before planting.

Three soybean varieties selected for varying degrees of resistance to PRR were planted in mid to late May each year. The 54-254 variety is susceptible to PRR with no major gene for resistance. The BSR-101 variety contains the gene, $R_{ps}1$ which confers resistance to Race 1 and 2 of PRR. Corsoy 79 has the $R_{ps}1c$ gene which gives resistance to Races 1, 2, 3, and 6. Races 1, 2, 3, 4, and 6 are present in south-central MN. Therefore, the Corsoy 79 is the most resistant variety for this region while BSR-101 can be damaged by Races 3, 4, or 6 if they are present. The 54-254 variety is susceptible to all races tested and is clearly the most susceptible variety used in this trial.

When used, the Ridomil was applied at a rate of 6 lb./acre. This granular material was applied in-furrow at the time of planting.

Stand counts were taken during the growing season and plant heights were measured in mid-July. The most recently matured leaflet was also collected at early to mid-bloom, dried, ground, and analyzed for K. Grain yields were measured in early October and corrected to 13.5% moisture

RESULTS AND DISCUSSION

Damage caused by PRR was observed at all sites selected in 1988. The severity of damage, however, was not consistent from site to site. In 1989, damage was observed only at the MA site.

The rate of potash applied had no significant effect on yield throughout the study (Table 2). There was also no significant interaction between either rate of applied K_2O and variety or rate of applied K_2O and Ridomil use. Therefore, the effects of applied K_2O are summarized in Table 2. These results indicate that the soils at all sites selected had adequate amounts of K to support the yields that were achieved.

Table 2. Influence of rate of applied K_2O on grain yield of soybeans.

Site	Year	K_2O Applied (lb./acre) 0	48	96	192
		- - - - - - - - bu./acre	- - - - -		
MR	1988	32.2	29.7	29.9	28.4
MM	1988	42.8	44.6	44.0	44.6
DH	1988	46.2	46.9	44.3	41.6
MM	1989	38.9	38.9	38.1	36.5
MG	1989	41.1	41.4	40.0	41.5
MA	1989	39.2	39.7	40.5	37.6

In this study, the MA site in 1989 had the lowest soil test level for K (82 ppm). Yet, there was no response to applied potash. Apparently, the subsoil K combined with the K found to a depth of 6 inches was adequate for relatively high yields of actively growing soybeans.

Soybean yields were reduced by PRR at 4 of the 6 sites selected for this study. Both variety and Ridomil use had a significant effect on yield at these locations. The interaction between variety and Ridomil use was also highly significant (Table 3).

The most severe infestation of PRR occurred at the MR site in 1988 where the use of Ridomil increased the yield of each variety. Infestation was less severe at the MM and DH sites in 1988 and the MA site in 1989. At these sites, the use of Ridomil increased the yield of only the 54-254 variety.

These results show that variety selection is a major concern for fields where PRR is known to be a major problem. Considering variety only, lowest yields for all treatments were produced by the 54-254 variety. Overall yields from the BSR-101 and Corsoy 79 varieties were nearly equal. For situations where the

Table 3. The influence of variety and Ridomil use on soybean yields in south-central Minnesota.

Site	Year	Ridomil Use	54-254	BSR-101	Corsoy 79	Ave.
			- - - - - - - -	bu./acre	- - - - - - -	
MR	1888	no	8.9	34.9	33.0	25.6
		yes	24.4	41.1	36.3	33.9
		Ave:	16.7	38.0	34.7	
MM	1988	no	15.7	51.4	50.1	39.1
		yes	42.0	52.4	52.1	48.8
		Ave:	28.9	51.9	51.1	
DH	1988	no	33.7	51.4	44.3	43.1
		yes	40.8	51.9	45.6	46.1
		Ave:	37.3	51.7	45.0	
MM	1989	no	33.3	37.6	42.7	37.9
		yes	35.8	38.0	41.0	38.3
		Ave:	34.6	37.8	41.9	
MG	1989	no	37.8	40.8	44.6	41.1
		yes	36.6	40.3	45.9	40.9
		Ave:	37.2	40.6	45.3	
MA	1989	no	29.3	42.0	43.3	38.2
		yes	37.0	40.5	43.5	40.3
		Ave:	33.2	41.3	43.4	

severity of the PRR is high, Ridomil use produced yield increases which ranged from 15 bu./acre (54-254 variety) to approximately 3 bu./acre (BSR-101 variety). For all other sites where damage was a problem, Ridomil use had no positive impact on yield if resistant soybean varieties were planted.

The PRR organism causes yield reductions in soybeans by stunting the plants as well as reducing the number of emerged plants. In this study, the rate of applied potash had no significant effect on either plant height (Table 4) or emerged stand (Table 5) when averaged over variety and Ridomil use. There was also no significant interaction between either potash rate and variety or potash rate and Ridomil use. This was true for both plant height and stand measurements.

Table 4. The influence of rate of applied K_2O on plant height of soybeans.

Site	Year	K₂O Applied (lb./acre) 0	48	96	192
		- - - - plant height (in.) - - -			
MR	1988	26	27	26	26
MM	1988	27	26	26	27
MM	1989	24	24	24	23
MG	1989	21	21	21	22
MA	1989	18	19	20	19

Table 5. The influence of rate of applied K_2O on emerged stand of soybeans.

Site	Year	K₂O Applied (lb./acre) 0	48	96	192
		- - - - - - plants/ft. - - - - -			
MR	1988	6.8	6.9	7.2	7.1
MM	1988	6.1	6.6	6.5	6.6
DH	1988	6.6	6.7	6.4	6.5
MM	1989	7.1	7.0	6.9	7.2
MG	1989	6.7	6.7	6.6	6.6
MA	1989	6.0	6.0	5.8	5.7

The use of Ridomil produced substantial increases in the height of all soybean varieties where there was the highest severity of PRR damage (MR, 1988). Where damage from PRR was less severe, the Ridomil use produced increases in plant height for the susceptible 54-254 variety only (Table 6). These observations coincide with the effect of Ridomil on soybean yield.

Plant height was also affected by variety. For sites where PRR was not a problem, the Corsoy 79 variety was the tallest, the 54-254 variety was the shortest and the height of the BSR-101 variety was intermediate. Since yields from the BSR-101 and Corsoy 79 varieties were nearly equal, there does not appear to be a strong relationship between plant height and yield.

Stand emergence was also significantly affected by Ridomil use. Again, major effects were observed at the MR site in 1988. The use of this product improved the stand of all varieties at this site (Table 7). Emerged stand was not improved by Ridomil use at sites where yields were not affected by PRR.

Table 6. The influence of soybean variety and Ridomil use on height of soybeans in south-central Minnesota.

Site	Year	Ridomil Use	54-254	BSR-101	Corsoy 79	Ave.
			- - - - plant height (in.) - - - -			
MR	1888	no	22	24	29	25
		yes	25	26	32	24
		Ave:	24	25	31	
MM	1988	no	21	26	29	25
		yes	26	27	30	28
		Ave:	24	26	30	
MM	1989	no	22	23	27	24
		yes	23	23	26	24
		Ave:	22	23	27	
MG	1989	no	20	22	23	22
		yes	19	21	24	21
		Ave:	20	22	24	
MA	1989	no	16	18	21	19
		yes	18	18	21	19
		Ave:	17	18	21	

SUMMARY AND CONCLUSIONS

The results of trials conducted at six experimental sites in both 1988 and 1989 showed that there are management practices that growers can use to overcome damage caused by Phytophthora Root Rot (PRR) in soybeans.

Variety selection is important. The use of resistant varieties in fields where the severity of the infestation is not high is certainly one management practice that should be encouraged whenever potential damage from PRR is suspected.

The use of the fungicide, Ridomil, can also be an important management practice where the severity of PRR is high or where susceptible varieties are used. It should be noted, however, that the yield of a susceptible variety treated with Ridomil was not as high as the yield of newer varieties which are resistant to select races of PRR.

The use of potash fertilizer had no significant effect on yield, plant growth, and emerged stand at all sites used for the study. These results indicate that soils which have a soil test K level of 100 ppm (0-6 inches) are capable of supplying adequate K for a soybean crop of 40-50 bu./acre. There was also no significant interaction between rate of applied potash and either variety or Ridomil use. This would indicate that the presence of PRR in a field to be planted to soybeans does not automatically call for the application of potash fertilizer. Potash fertilization decisions should continue to be based on the results of appropriate soil tests.

Table 7. The influence of soybean variety and Ridomil use on the emerged stand of soybeans in south-central Minnesota.

Site	Year	Ridomil Use	54-254	BSR-101	Corsoy 79	Ave.
			- - - - - - - plants/ft. - - - - - - -			
MR	1888	no	5.6	5.8	6.6	6.0
		yes	9.3	6.9	7.7	8.0
		Ave:	7.5	6.4	7.2	
MM	1988	no	4.8	6.1	6.9	5.9
		yes	7.2	6.7	6.9	6.9
		Ave:	6.0	6.4	6.9	
DH	1988	no	6.6	6.2	6.4	6.4
		yes	6.7	6.1	7.3	6.7
		Ave:	6.7	6.2	6.9	
MM	1989	no	6.3	7.1	7.4	6.9
		yes	7.1	7.2	7.2	7.2
		Ave:	6.7	7.2	7.3	
MG	1989	no	6.6	6.5	6.5	6.5
		yes	7.0	6.8	6.5	6.8
		Ave:	6.8	6.7	6.5	
MA	1989	no	4.8	6.1	6.2	5.7
		yes	6.0	6.1	6.0	6.0
		Ave:	5.4	6.1	6.1	

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