Effects of Soybean Shoot Pruning on *Heterodera glycines* Infection

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ABSTRACT

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Soybean seedlings being screened against *Heterodera glycines* were clipped below or above cotyledons or above unifoliates or were not pruned. The soybeans included both resistant and susceptible cultivars. Shoot pruning below the cotyledons resulted in almost no reproduction of the nematode females. Pruning above the unifoliates gave similar results as the controls, whereas pruning above the cotyledons resulted in fewer white females. Host reactions measured in terms of index of parasitism were not affected by shoot pruning. Shoot pruning can thus be used to reduce excessive foliage in soybean in greenhouse screening against the nematodes.

Additional key words: disease screening, *Glycine max*, shoot pruning, soybean cyst nematode

Soybean cyst nematode (SCN) (*Heterodera glycines* Ichinohe) is a serious economic pest of soybean (*Glycine max* (L.) Merr.). Numerous public and private breeders are involved in developing cultivars with resistance to SCN. Soybean plants are screened in the greenhouse by growing seedlings in pots filled with SCN-infested soil or seedlings that are inoculated with eggs and larvae (1,2). White females are counted 30 days after inoculation. Plants are rated resistant if the number of white females is lower than 10% of those on susceptible Lee (4). Both routine screening and research on the inheritance of SCN resistance require that numerous plants and progeny from crosses be screened. Seedlings grow to undesirable heights and require excessive space. The foliage also prevents even application of water.

Thomas and Fehr (7) reported that removing shoots of soybean above the cotyledons had no effect on SCN/host compatibility. Other research has demonstrated that excised soybean root cultures can be used in screening for SCN resistance (3,6). Halbrendt and Dropkin (5) described a technique for SCN screening by maintaining pruned seedlings in aerated water. The objectives of this research were to evaluate the effects of pruning soybean shoots on the reproduction of *H. glycines* and to determine the proper inoculum level to use in screening for SCN resistance.

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MATERIALS AND METHODS

Experiments were conducted in the greenhouse during the spring of 1985. Essex (susceptible), Forrest (resistant to SCN races 1 and 3), and PI 88788 (resistant to SCN races 3 and 4) were studied. Seeds were germinated in vermiculite for 3 days. When the radicle was 2–3 cm long, seedlings were transplanted to plastic micropots (20 × 2.5 cm) containing methyl-bromide-sterilized soil (87% sand, 11% silt, 2% clay, 1% organic matter, pH 6.0). Micropots were housed in a 30-cm-diameter pot and placed in a temperature tank maintained at 26 ± 2 C. An *H. glycines* culture obtained from the Rhodes Farm of the University of Missouri, Clarkton, was reared on cultivar Essex in the greenhouse. Each micropot was inoculated with 750 or 1,000 eggs in experiment 1 and with 1,000 or 2,000 eggs in experiment 2. Inoculations were made 5 days after transplanting. Shoots of selected plants were pruned 2–3 days after inoculation. Pruning treatments involved clipping shoots above or below the cotyledons, clipping shoots above the unifoliates, or no shoot removal. The number of white females per plant was determined 30 days after inoculation. Micropots were soaked in water to free the soil from the roots. High water pressure was used to dislodge cysts for enumeration. The index of parasitism (IP) was calculated as (number of white females per plant/number of white females on Essex) × 100. The experiment was a split-plot design with inoculum levels in main plots and cultivar and foliage treatments in subplots with five replicates. Least significant difference (LSD) was used to compare means.

RESULTS AND DISCUSSION

Shoot removal below the cotyledon resulted in little or no SCN female reproduction in both experiments (Table 1). The number of white females per plant in treatments with shoots removed above the unifoliate was not significantly different from controls ($P = 0.05$) in either experiment. Pruning shoots above the cotyledon resulted in significantly ($P = 0.05$) fewer white females reproducing on the roots than when plants were not pruned (Table 1).

In experiment 1, Essex plants pruned above the cotyledon had fewer white females per plant than control plants, although the difference was not statistically significant ($P = 0.05$). Pruning Essex above the cotyledons in experiment 2, however, resulted in fewer white females per plant ($P = 0.05$) than the control at both inoculum levels.

Table 1. Effects of soybean shoot pruning on the number of *Heterodera glycines* white females per plant and index of parasitism (IP) on three cultivars 30 days after inoculation

Experiment number	Inoculum level (eggs/pot)	Foliage treatment	Cultivars: Essex White females	Essex IP[a]	Forrest White females	Forrest IP[a]	PI 88788 White females	PI 88788 IP[a]	Mean White females	Mean IP[b]
1	750	Pruned below cotyledons	3	1	2	1	0	0	2	1.5
		Pruned above cotyledons	129	61	73	35	5	2	69	52
		Pruned above unifoliates	129	61	171	81	14	6	105	79
		Control	211	100	175	83	11	5	132	100
	1,000	Pruned below cotyledons	3	1	1	0	0	0	1	0.4
		Pruned above cotyledons	310	88	162	46	8	2	160	70
		Pruned above unifoliates	382	108	265	75	9	2	219	96
		Control	352	100	318	90	16	4	229	100
		LSD[c] (0.05) B within A	111		55		8			
		LSD[d] (0.05) A within B	65		31		4			
2	1,000	Pruned below cotyledons	0	0	0	0	2	2	1	1
		Pruned above cotyledons	76	66	51	44	4	3	44	59
		Pruned above unifoliates	111	96	111	96	4	3	75	100
		Control	115	100	111	96	0	0	75	100
	2,000	Pruned below cotyledons	0	0	0	0	0	0	0	0
		Pruned above cotyledons	136	74	116	63	8	4	87	80
		Pruned above unifoliates	186	102	136	74	7	4	110	102
		Control	183	100	136	74	6	3	108	100
		LSD[c] (0.05) B within A	32		51		7			
		LSD[d] (0.05) A within B	21		24		3			

[a] IP = (number of white females per plant/white females on Essex control) × 100.
[b] IP = (mean number of white females for each foliate treatment/mean number of white females for the control) × 100.
[c] LSD to compare treatments within an inoculum level.
[d] LSD to compare inoculum levels within foliage treatments.

Shoot removal above the cotyledons of Forrest generally resulted in fewer white females ($P = 0.05$). The number of white females on PI 88788 was low in all cases. Pruning PI 88788 above the cotyledons suppressed ($P = 0.05$) SCN development at the 1,000-egg inoculum level in experiment 1 but not in either of the inoculum levels in experiment 2. The interactions between inoculum level and pruning treatment were generally significant ($P = 0.05$). SCN reproduction on plants pruned above the cotyledons tended to be nearer that on unpruned control plants as the inoculum level was increased.

Host-parasite compatibility or incompatibility measured in terms of IP was unaffected by shoot removal above the cotyledon. PI 88788 was always highly resistant to the SCN population used in this experiment compared with either Essex or Forrest. Our results agree with those presented by Halbrendt and Dropkin (5) and Thomas and Fehr (7) that compatibility was unaffected by shoot removal. This result was expected since other researchers have demonstrated that SCN resistance is maintained in excised roots (3,6).

Removal of shoots above the cotyledons in our experiments often resulted in fewer white females, which does not agree with results presented by Thomas and Fehr (7). This discrepancy is probably a result of the difference in inoculum levels used. Thomas and Fehr (7) used 10,000 eggs and juveniles as opposed to inoculum levels of 750–2,000 used in our research. Our experience has been that inoculum levels much above 2,000 eggs per pot tend to mask resistance and are not necessary for screening purposes. Results in our study show that pruning above the unifoliates has no effect on SCN reproduction 30 days after inoculation. Although pruning below the unifoliates reduced number of white females, it did not alter IPs.

Shoot removal to reduce vegetative growth is a useful technique in screening for SCN resistance. Pruned plants are short, thus reducing the need to stake greenhouse-grown plants. Pruning permits increased plant crowding by reducing the amount of foliage in the greenhouse, reduces watering requirements, and allows even application of water. Reduced foliage should also suppress some pest problems and decrease both the amount of pesticides needed and the time required to spray.

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