RESEARCH NOTES

Herbicide Effects in Nematode Diseases

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Herbicide use has provided agriculture with cost effective weed control and continued good crop yields, but occasional complications and adverse effects have been observed in the field. A recent review (1) discussed the effect of herbicides on plant diseases. Other studies have reported on the effects of herbicides on nematode infected crop plants (2,5,6,7,8,9,10,12). Effects ranged from aggravation of crop damage caused by nematode parasitism to reduced damage and lower nematode population levels. The differences appear to reflect the different systems, herbicide–crop–plant nematode, examined. This report extends these observations to include the effects of several herbicides applied by two methods to soybeans (*Glycine max* L.) and tomato (*Lycopersicon esculentum* L.) in root-knot nematode (*Meloidogyne incognita*) infested soil.

Stock cultures of *M. incognita* were maintained on tomato (*Lycopersicon esculentum* cv. VF 145) in the greenhouse.

In one experiment, soybean seeds, cv. Williams, were sown in 10-cm pots containing a mixture of sterilized clay soil and sand (1:1). After germination the seedlings were thinned to one plant per pot. Twenty-day-old seedlings were each inoculated with 1,000 freshly hatched *M. incognita* larvae by pouring the nematode suspension into holes around the base of the plant, pressing the holes closed, and watering. Seven days after inoculation the herbicides EPTC (S-ethyl dipropylthiocarbamate), glyphosate (N-[phosphonomethyl] glycine), or oryzalin (3,5-dinitro-N^4, N^4-dipropylsulfanilamide) were applied at six concentrations as foliar sprays to runoff. Soil contamination by the herbicides was prevented by aluminum foil covers. Plants were harvested 45 d later; the number of galls and nodules counted; and the shoot weight, shoot height, and pod and leaf number determined.

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In a second experiment, 6-wk-old tomato seedlings cv. U.C. 82 were lifted and the roots washed to remove adhering soil particles. The washed roots were soaked for 20 hr at one of six concentrations of oryzalin or 5-bromodeoxyuridine, then washed in distilled water for 30 min and damp dried with paper towels before transplanting one seedling/pot in 10-cm pots containing a steam sterilized mixture of clay soil and sand (1:1). Each plant was then immediately inoculated, as described previously, with 1,250 freshly hatched *M. incognita* larvae. The plants were harvested 45 d after inoculation; the number of galls and female nematodes were counted; and the shoot heights and weights determined.

Both experiments were a complete randomized block design with treatments replicated five times.

The effects of herbicide sprays on root-knot nematode gall formation on soybeans are shown in Table 1. Glyphosate treatments at concentrations above 10 μg/ml killed all plants. Clearly, herbicide application of EPTC, glyphosate, and oryzalin can effectively modify gall numbers before host phytotoxicity occurs.

Dip treatments of tomato roots with oryzalin or 5-bromodeoxyuridine at concentrations below 50 μg/ml showed significant reduction in nematode development, as determined by galls/plant or females/plant, with no significant effect on shoot length (Table 2). Shoot weight was not affected by 5-bromodeoxyuridine but was significantly lower for oryzalin treated plants. These observations with dip treatment are consistent with the findings and conclusions expressed by Orum et al. (9) for the activity of oryzalin. Thymidine analog, 5-bromodeoxyuridine, incorporated into DNA can arrest differentiation in biological cells (11) and interfere with embryogenesis (4). The reduced number of galls/plant and females/plant suggest inhibition may occur with the root-knot nematode; whether the mechanism is the same as for

Table 1. The effect of various concentrations of three herbicides applied as foliar sprays to soybean, *Glycine max* cv. Williams, on the number of root-knot nematode, *Meloidogyne incognita*, galls formed.

Herbicide	Concentration μg/ml	Number of galls
Control	0	116
EPTC	10	120
	50	85
	100	95
	200	95
	400	117
	800	71*
Glyphosate	10	58*
Control	0	83
Oryzalin	10	102
	50	87
	100	51*
	200	55*
	400	60*
	800	55*

*Indicates significant differences from controls ($P = .01$).

other organisms (3) remains to be determined. These results suggest that a number of potential tools for nematode control exist and should be considered for incorporation into Integrated Pest Management strategies.

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Table 2. Treatment with oryzalin and 5-Bromodeoxyuridine upon tomato responses to *Meloidogyne incognita* infections.

Treatment	Dip concentration μg/ml	Host response: Galls/plant	Egg containing females/plant	Shoot weight (g)	Shoot length (cm)
Control	0	305.7	249.3	7.1	20.0
Oryzalin	10	5.0	0	3.5	17.3
	50	1.3	0	4.6	22.3
	100	0.0	0	2.3	14.3
	200	0.0	0	1.6	15.3
	400	0.0	0	0.9	13.0
	800	0.0	0	0.7	11.0
LSD ($P = .01$)		9.4	12.5	1.6	4.3
Control	0	307.7	254.7	7.1	20.3
	10	193.3	165.3	10.0	27.3
5-Bromodeoxy-	50	182.3	138.3	6.4	19.7
uridine	100	107.3	75.3	2.6	14.7
	200	71.3	53.0	2.1	11.2
	400	43.0	13.0	0.7	10.7
	800	26.7	10.3	0.3	8.0
LSD ($P = .01$)		42.0	19.6	3.7	6.3

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