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Coating Soybean Seed with Oxamyl for Control of *Heterodera glycines*

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Abstract: Oxamyl coated on soybean (*Glycine max* (L.) Merr. cv. Elgin) seeds in solutions of 20, 40, 80, and 160 mg/ml had no serious deleterious effects on seedling emergence and growth when planted in sterile soil. Seedling emergence on day 3 was less than that of the uncoated control, but by day 7 emergence was equal to, or greater than, the control. Shoot and root growth from seed coated with oxamyl in 40 and 80 mg/ml solutions was greater than that of the control. In soil infested with soybean cyst nematode, *Heterodera glycines,* shoot weight of soybean plants from seeds coated with oxamyl in 80 mg/ml solution was 11 and 9% greater at weeks 3 and 7, respectively, than from uncoated seeds. Numbers of juveniles (J3 and J4) and adults of *H. glycines* observed on the roots of plants from oxamyl-coated seeds were 83, 42, and 49% less at weeks 3, 5, and 7, respectively, than numbers on the roots of the untreated control. Numbers of J2 extracted from the roots of plants from oxamyl-coated seeds were 75% less at weeks 5 and 7 than those extracted from roots of uncoated seeds. The numbers of J2 extracted from the soil planted to oxamyl-coated seeds were 51 and 33% less at weeks 5 and 7, respectively, than from soil planted to uncoated seed.
Key words: *Glycine max, Heterodera glycines,* oxamyl, seed coating, soybean, soybean cyst nematode.

The soybean cyst nematode, *Heterodera glycines* Ichinohe, was first found in the United States in 1954. Since then the nematode has spread slowly northward and was found in Michigan in April 1987 (2) and Ohio (8) and Canada (1) in August 1987.

Heterodera glycines juveniles and cysts believed to be race 3 were identified from two soybean (*Glycine max* (L.) Merr.) fields in Kent County, southern Ontario (Anderson, pers. comm.). Symptoms in infested fields were circular to oval patches of stunted plants with chlorotic foliage. Yield losses were 15–20%.

In the 1950s and 1960s soil fumigation was a costly means of control of the soybean cyst nematode because of the low value of soybeans (9); however, chemical control became more practical as the value of soybeans increased. Oxamyl was one of the nonfumigant nematicides tested for the control of *Meloidogyne incognita* (Kofoid & White) Chitwood on soybean (6). When granules were applied to the soil and spray to the foliage, yields were increased but not as much as with soil fumigants. Oxamyl also has been successfully applied to cereal and forage seeds (5,7,11,12) for the control of root-lesion and root-knot nematodes. This paper reports on the effects of oxamyl coating of soybean seeds on germination and growth of the crop and on the control of *H. glycines.*

Materials and Methods

Influence of oxamyl on soybean plant growth: Oxamyl solutions of 20, 40, 80, and 160 mg/ml were prepared in a polymer sticker diluted 1:5, sticker : water. (Chemical composition and manufacturer of the sticker is in the confidential file of Canadian Seed Coaters Limited, P.O. Box 219, Brampton, Ontario, Canada L6V 2L2.) One hundred soybean cultivar Elgin 87 seeds were placed in a vial (2.7 cm d × 7 cm deep) and covered with 15 ml of a prepared oxamyl-sticker solution. The sealed vial was shaken for 20 seconds and then the oxamyl solution was decanted. The coated seeds were placed on a screened trough and dried for 2–3 minutes at 44 C with an inserted hair dryer. A total of three coats of oxamyl (12 mg of dried oxamyl-sticker/seed) were applied to the seeds. Treatments were four lots of 100 seeds coated in each of the four concentrations of oxamyl, one lot coated with sticker only, and one uncoated lot. The uncoated seeds were not placed in the drying trough.

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A Brookston silt loam soil (32.5% sand, 50.5% silt, 17% clay; 7.6 pH, 3.7% O.M.) from Kent County was steam sterilized at 124 C, 103 kPa for 40 minutes and cooled for 12 hours before use. Sixty styrofoam pots (11.5 cm d × 14 cm high) were each filled with 850 g of the prepared soil. Ten seeding sites (1.5 cm deep) were impressed into the soil surface with a multipoint dibble. One seed was placed in each site and the seeds were covered with 30 cm^3 soil. The treatments were replicated 10 times. The pots were was arranged in a randomized block design in a growth room with temperatures 18 C (night) and 22 C (day) and light intensity of 11,000 lux for 16 hours. Seedling counts were recorded from 3 to 13 days after planting. The experiment was terminated 2 weeks after planting, and fresh shoot and root weights were recorded.

Control of Heterodera glycines: A Brookston silt loam soil naturally infested with *H. glycines* was screened (5 mm openings) and thoroughly mixed in a cement mixer. The inoculum density was 2.6 second-stage juveniles (J2)/g soil as determined after 2 weeks of extraction from 10 randomly collected soil samples by the pan method (10). Sixty styrofoam pots were filled with infested soil and seeded as in the previous experiment except only five seeds were planted per pot. Thirty pots were planted to uncoated seeds and the remainder to seeds that were coated with oxamyl in a polymer sticker solution (1:5) containing 80 mg/ml, as described. Seeds in each pot were covered with 30 cm^3 infested soil. The pots were arranged in a randomized block design in a growth room with the same temperature and light intensity as in the previous experiment. On day 10, the seedlings were thinned to the first-emerged seedling in each pot. Seedlings from 10 replicates each of pots planted to untreated seeds and oxamyl-coated seeds were harvested 3, 5, and 7 weeks after plantings and shoot and root weights were recorded. At each harvest, third-stage (J3) and fourth-stage (J4) juveniles and young adults on the roots were counted under a dissecting microscope. After counting, J2 and males were extracted from the roots (10) for 2 weeks and counted. In addition, J2 and males were extracted for 2 weeks and counted from 50-g soil samples taken from each pot.

Data from both experiments were subjected to analyses of variance.

TABLE 1. Effect of four concentrations of oxamyl in a polymer sticker (1:5, sticker : water) coated on soybean seed on germination and seedling weight over 14 days grown in steam-sterilized soil.

Oxamyl (mg/ml)	Seedlings emerged 3–13 days after sowing†						Shoot wt (g/pot)	Root wt (g/pot)
	3	5	7	9	11	13		
0	2.5	3.7	4.1	5.3	6.5	6.8	8.9	5.1
0‡	0.2	2.3	3.2	4.6	5.1	6.2	8.6	5.2
20	1.7	4.7	5.9	6.3	7.3	8.0	11.4	5.7
40	0.0	5.2	6.5	6.7	7.1	7.6	11.8	7.0
80	0.1	4.0	6.5	7.2	8.4	8.5	11.8	6.6
160	0.1	4.6	5.9	6.5	6.8	7.1	11.3	7.2
$LSD_{5\%}$	0.9	1.5	1.9	1.6	1.4	1.4	2.4	1.0

† Ten seeds planted per pot.
‡ Seed coated with polymer sticker only.

RESULTS

Influence of oxamyl on seedling emergence and plant growth: The four concentrations of oxamyl coated on soybean seeds had no adverse effects on seedling emergence over 2 weeks after planting, except on day 3 (Table 1). On day 3, seedling emergence from all oxamyl-coated seed treatments and the sticker-coated seed treatment was less than that from uncoated seeds; at day 5, emergence from the sticker control treatment was less than the oxamyl treatments, but not less than the untreated control. On day 7, emergence from seed coated with oxamyl in solutions of 40 and 80 mg/ml exceeded that of the two controls; on days 9, 11, and 13 emergence from seed coated with oxamyl in 80 mg/ml solution exceeded that of the two controls. At harvest (day 14), shoot weights of seedlings from seeds coated with oxamyl in solutions of 20, 40, and 80 mg/ml exceeded that of the two controls and root weights of seedlings from seed coated with oxamyl in solutions of 40,

TABLE 2. Number of *Heterodera glycines* and growth of soybean plants grown in infested soil from uncoated seed and seed coated with oxamyl in 80 mg/ml solution 3, 5, and 7 weeks after planting.

Parameter	Oxamyl treatment on seed	Week 3	Week 5	Week 7
Shoot weight, g/pot	Uncoated	4.1	13.8	30.5
	Coated	4.6	13.4	33.5
	$LSD_{5\%}$	0.4	ns	2.8
Root weight, g/pot	Uncoated	2.8	7.3	14.5
	Coated	2.8	7.0	14.6
	$LSD_{5\%}$	ns	ns	ns
J3, J4, and females/pot roots	Uncoated	437	671	1,101
	Coated	74	388	559
	$LSD_{5\%}$	90	278	408
J2/pot roots	Uncoated	130	1,420	1,430
	Coated	105	368	347
	$LSD_{5\%}$	ns	952	1,043
Males/pot roots	Uncoated	98	978	780
	Coated	69	1,390	210
	$LSD_{5\%}$	ns	ns	380
J2/pot soil	Uncoated	1,510	10,360	97,600
	Coated	1,240	5,080	65,400
	$LSD_{5\%}$	ns	5,254	27,500

Five seed planted per pot. All but the first-emerged seedling in each pot were removed.

80, and 160 mg/ml exceeded that of the two controls.

Control of Heterodera glycines: The shoot weight of seedlings from seed coated with oxamyl, 80 mg/ml solution, was greater than that from controls by 12 and 9% at weeks 3 and 7, respectively after planting (Table 2). There were no differences in root weights between plants grown from uncoated and coated seeds at weeks 3, 5, and 7 after planting. The numbers of J3, J4, and females per pot of roots of plants from oxamyl-coated seeds at weeks 3, 5, and 7 after planting were 83, 42, and 49%, respectively, less than those from the uncoated seed (Table 2). The numbers of J2 extracted from the roots of plants from coated seed at weeks 5 and 7 after planting were 74 and 76%, respectively, less than those from uncoated seed. There were also 73% fewer males extracted from the roots of plants from coated seeds than from uncoated seeds at week 7. The numbers of J2 extracted from the soil planted to coated seed were 51 and 33% less at weeks 5 and 7, respectively, than from soil planted to untreated seed.

DISCUSSION

Soybean seeds were tolerant when coated with oxamyl up to 160 mg/ml in a polymer sticker. Seedling emergence from coated seeds was less than that of uncoated seeds only for 5 days after planting. The polymer sticker on seeds apparently slows the absorption of water and thus delays germination. Emergence from seeds coated in an oxamyl solution of 80 mg/ml exceeded that from the control from day 7 through day 13 after planting. Shoot and root weights of soybean plants from seeds coated in 80 mg/ml solutions exceeded those from the untreated controls 2 weeks after planting.

The tolerance of soybean seeds to oxamyl was greater than expected. The embryo is located in a V-shaped trough between two hard cotyledons and is protected externally only by the integument. In contrast, even though the embryo in corn seed also is protected only by a thin epidermis, corn seeds are very sensitive to oxamyl in solutions of 8 mg/ml (4). Wheat, rye, oat, carrot, and tomato seeds are sensitive to oxamyl when treated with solutions above 40 mg/ml (5,7, unpubl. data).

Improved growth of soybean from oxamyl-coated seeds (9–11%) in soybean cyst nematode-infested soil was not as great as growth of alfalfa (19–52%) from oxamyl-coated seed in soil infested with *Pratylenchus penetrans* Cobb and *Meloidogyne hapla* Chitwood 7 weeks after planting (12). Perhaps the control of *H. glycines* was not sufficient to improve growth (3). The numbers of J3, J4, and adults on roots were 84% less at week 3 and 49% less at week 7, but J2 in the soil were reduced only 51% at week 5 and 33% at week 7. However, J2 in soil 7 weeks after planting exceeded 65,000/pot planted to uncoated or oxamyl-coated seeds. Possibly Elgin 87 soybean may not be susceptible to *H. glycines* or the population density of *H. glycines* in soil may not have been large enough to cause severe stunting of plants from untreated seeds. Because the infestation with *H. glycines* in soybean fields in Ontario is recent, the many cultivars of soybean grown have not been assessed for susceptibility to *H. glycines,* nor have the races of *H. glycines* been completely determined.

Coating soybean seeds with oxamyl appears to have potential for the control of the *H. glycines.* Foliar application of oxamyl after seedling emergence may result in a larger control of *H. glycines* and consequently greater top growth and yield.

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