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Brief Articles

PREVENTION OF TRIFLURALIN EFFECT ON COTTON WITH SOIL APPLIED LIPIDS[1]

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ABSTRACT

Trifluralin (a,a,a-trifluoro-2,6-dinitro-*N,N*-dipropyl-*p*-toluidine) applied at 1 and 5 ppm as a soil-incorporated surface-horizon (7.6 cm) band reduced growth and fruiting of cotton (*Gossypium hirsutum* L.) in greenhouse culture. Soil-incorporated D-*a*-tocopherol or oleic acid reduced the herbicide effect. Surface injections of aqueous acetone solutions of cottonseed oil as hill applications also reduced the trifluralin effect.

Additional index words: **Trifluralin, Cotton, Herbicide injury, Lipid-herbicide interaction.**

TRIFLURALIN (*a,a,a*-trifluoro-2,6-dinitro-*N,N*-dipropyl-*p*-toluidine) is widely used as a preplanting soil-incorporated herbicide in cotton (*Gossypium hirsutum* L.) culture. Earlier reports acknowledge that trifluralin can have adverse effects upon the cotton plant (1). Any adverse effects are offset by the low cost, effective control of weeds afforded by soil-incorporated trifluralin.

Trifluralin effects on cotton are usually visible in the seedling stage as a stunting of the seedling and an inhibition of lateral root initiation in the treated soil band. Herbicide effect on roots is restricted to the contact area, and lateral roots are initiated from the main root below the treated zone. In earlier laboratory work, we found that trifluralin inhibition of lateral-root formation could be prevented by addition of lipid to trifluralin-treated soil (3). We postulated from these findings that lipid "spot treatments" to the immediate seed zone of herbicide-treated soil could offset the adverse trifluralin effect. This report presents results of a study of lipid-trifluralin interactions on greenhouse-cultured cotton.

MATERIALS AND METHODS

All seed were from the same lot of M-8 cotton, a colchicine-doubled haploid derived from 'Deltapine 14' variety. The greenhouse soil mixture consisted of Ochlockonee silt loam, fine sand, and ground peat moss, (3:1:1, v/v). The following series of experiments were conducted, aimed at determining the proper method for application of lipid to the soil and the lipid material most effective in ameliorating herbicide effect.

Experiment I. Previously reported laboratory experiments (2) indicated that D-*a*-tocopherol (vitamin E) and oleic acid circumvented the trifluralin effect. An experiment was conducted using two levels of trifluralin (1 and 5 ppm, w/w of soil) and two lipid additions (D-*a*-tocopherol and oleic acid) at 1,000 ppm of soil. The herbicide and/or lipids were mixed with soil in a small mortar mixing unit, and a 7.6 cm surface band was placed on top of untreated soil in 30 cm diameter pots. Ten acid-delinted cotton seeds were planted 3.2 cm deep in an equally spaced 20 cm diameter circular pattern. The pots were set in clay saucers and watered from the bottom. The soil surface was shaded by covering the pots with kraft paper until seedlings began to emerge.

After 3 weeks the plant stands were thinned, leaving the best two seedlings per pot. The plants removed were used to determine the number of lateral roots per seedling in the 7.6 cm trifluralin-treated soil. Other data included plant height at 7 and 11 weeks and at maturity, number of blooms and bolls, and date of first bloom.

Experiment II. A short-term experiment was conducted to assess the efficacy of hill injection treatment with lipid. The 7.6 cm trifluralin-treated soil zone in 30 cm diameter pots was set up as in Experiment I. Four hills of five seeds per hill were planted per pot in an equally spaced 20 cm diameter circle. Each seed hill was subsequently treated with lipid in the following manner. Cottonseed oil as the lipid source was emulsified in 50% aqueous acetone and injected from a 16-gauge needle and syringe at the soil surface at levels of 0, 5, 10, 15, or 20 ml of a 10 mg lipid/ml solution. Comparable 50% acetone controls were included in the test. Lateral root production in the herbicide-treated 7.6 cm zone was determined 3 weeks after seeding, as a measure of lipid reversal of trifluralin effect. All seedlings were used for root counts.

Experiments III and IV. Based on results of Experiments I and II, two tests were conducted to compare trifluralin effect at 1 ppm in soil (equivalent to 1.1 kg/ha) with trifluralin + lipid injection at 200 mg oil per hill. Planting and cultural procedures were as in Experiment II. The lipid was emulsified, as in prior experiments, in 50% aqueous acetone. Appropriate controls were included in the tests. Three weeks after seeding plants were thinned to the two best in each pot. Data derived from the tests included emergence of seedlings, data of first bloom, total blooms and bolls, plant height at maturity, and weight of seed cotton. The data from duplicate experiments were combined for statistical analysis.

RESULTS AND DISCUSSION

The initial experiment showed that trifluralin at rates of 1 ppm of soil has a significant effect on cotton growth and fruiting in pot culture (Table 1). Plant height was reduced throughout the plant growth period, and at maturity was reduuced 13 cm by 1 ppm and 29 cm by 5 ppm of the herbicide. Hamilton and Arle (2) previously reported that stunting of field grown cotton was visible 3 months after emergence when trifluralin was applied at .84 kg/ha before furrowing. Lateral roots in the surface 7.6-cm zone were reduced approximately 1/3 by 5 ppm tri-

Table 1. Interacting effects of trifluralin and lipids incorporated into a 7.6-cm deep surface soil band on development and fruiting of cotton.

Treatment	Plant height, cm 7 weeks	Plant height, cm 11 weeks	Plant height, cm at maturity	Lateral roots†/ seedling	Blooms/ plant	Bolls/ plant	Time of first bloom‡
Control	41 A*	68 A	105 AB	9.0 A	8.8 AB	4.2 A	0
D-a-tocopherol	32 B	57 B	105 A	7.7 B	9.3 AB	4.2 A	+2
Oleic acid	40 A	69 A	113 A	9.0 A	10.7 A	4.3 A	+7
D-a-tocopherol + 1ppm trifluralin	35 AB	60 B	98 B	9.0 AB	8.7 B	3.3 B	+6
Oleic acid + 1ppm trifluralin	34 AB	65 A	99 B	9.4 A	8.2 B	3.7 AB	+2
D-a-tocopherol + 5ppm trifluralin	30 B	43 D	78 CD	7.0 BC	4.8 D	2.2 C	+12
Oleic acid + 5ppm trifluralin	33 B	48 C	85 CD	9.0 A	6.0 CD	2.3 C	+11
Trifluralin 1ppm	33 B	55 BC	92 BC	7.8 BC	7.3 BC	2.5 C	+9
Trifluralin 5ppm	24 C	39 D	76 CD	6.7 C	5.2 CD	2.3 C	+14

* Means within a data measurement group followed by the same letter are not significantly different at the .05 level of probability. † Lateral roots in upper 7.6 cm of tap root. ‡ Control considered as 0, delay in bloom noted as +.

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Table 2. Lateral-root production by 7.6-cm of the upper radicle of cotton seedling in soil treated with trifluralin, lipid, or trifluralin-lipid combinations. Lipid (crude cottonseed oil was applied as a hill injection in 50% aqueous solution (10 g/liter) as seedling time.

Lipid-acetone treatment	Trifluralin	No herbicide
Control (no lipid, no acetone)	3.4 D*	15.3 A
5 ml (50 mg)/hill	4.5 D	12.5 AB
10 ml (100 mg)/hill	6.4 CD	13.1 AB
15 ml (150 mg)/hill	9.4 BC	15.9 A
20 ml (200 mg)/hill	12.1 AB	15.7 A

* Means followed by the same letter are not significantly different at .05 level of probability.

Table 3. Lipid alteration of trifluralin effect on growth and fruiting of cotton.

Treatment	Percent seedling emergence	Date of first bloom†	Blooms/plant	Bolls/plant	Wt of seed cotton, g/plant	Plant height, cm
Control	90 A*	0 A	8.9 A	4.8 A	21.6 A	74.5 AB
Control + lipid	80 A	0 A	9.7 A	5.2 A	22.5 A	75.8 A
Trifluralin	95 A	+1 A	8.0 A	4.8 A	18.4 B	69.1 C
Trifluralin + lipid	86 A	+2 A	8.9 A	4.6 A	20.3 AB	72.6 B

* Means followed by the same letter are not significantly different at the .05 level of probability. † Date first floom considered 0 for control, + indicates days of delay in first bloom.

fluralin 3 weeks after planting (Table 1). The number of blooms or bolls produced was reduced, although the ratio of bolls set per bloom produced was not altered. The time to first flower was delayed 9 days by 1 ppm and 14 days by 5 ppm of trifluralin.

Reversal of trifluralin effect by D-*a*-tocopherol and oleic acid was not completely successful in pot culture, and in some instances D-*a*-tocopherol had a marginal adverse effect on lateral roots and height. The adverse effect of D-*a*-tocopherol was not noted in previously reported (3) laboratory, short-term growth studies and is difficult to explain. The effect was apparently transient and plants were not affected in final height, total flowers, or bolls. Oleic acid was more effective in reversing trifluralin impact than D-*a*-tocopherol, especially for lateral root production.

The primary aims of Experiment II were to determine the effectiveness of a crude lipid in prevention of trifluralin injury and to test the efficacy of hill application techniques. A 200-mg application of crude cottonseed oil per hill effectively reversed the root-inhibiting effect of trifluralin (Table 2). Translated to field terms, this equates to approximately 2.6 kg/ha of lipid under normal cotton-plant spacing systems.

The effectiveness of cottonseed oil in ameliorating trifluralin impact on roots prompted additional experiments in which plants were grown to maturity (Table 3). In these tests, trifluralin at 1 ppm did not significantly alter seedling emergence, date of first bloom, or blooms per plant, although a trend towards reduction in total blooms was evident. The herbicide treatment did significantly reduce plant height and yield of seed cotton. Lipid incorporation by hill injection reduced the seed-cotton and plant height reductions induced by trifluralin (Table 3).

These experiments provide evidence that soil amendment with crude lipid can alter the action of soil-incorporated trifluralin. The present results, coupled with our previous report (3), provide a basis for future field experimentation to ascertain the utility of lipids for nullifying the toxicity of soil-incorporated lipid-soluble herbicides in localized soil zones, such as the immediate seeding or planting site. Such techniques may permit use of herbicides of higher phytotoxicity on crops of lower tolerance. A salient area of consequence might entail use of biologically degradable lipid-solvent systems for slow release of lipid-soluble pesticides for long-term persistence.

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SEMIDWARFNESS, STEM SOLIDNESS, AND TILLERING OF F_2 PLANTS FROM 17 SPRING WHEAT CROSSES[1]

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ABSTRACT

Combining resistance to the wheat stem sawfly (*Cephus cinctus* Norton) with semidwarfness and higher grain yields in wheat (*Triticum aestivum* L.) is a plant breeding objective in Montana. Parental and F_2 populations from 17 crosses of 6 standard-height, solid-stemmed wheat selections with three semidwarf, hollow-stemmed selections were evaluated in the field for semidwarfness (plant height), stem solidness, and tillering.

Plant height data from crosses with 'Bonanza' suggest additive gene action, whereas skewness for tallness from crosses with 'Shortana' and MT 6830 suggest either dominance or some type of epistasis. The lack of dominance in solid-stemmed by hollow-stemmed crosses is considered an indication of genetic additivity for stem solidness. All parents except Shortana tillered equally; Shortana had more tillers than standard height parents ND 681, ND 683, and ND 6850. A negative relationship between plant height and stem solidness indicates that selection of solid-stemmed, semidwarf types should be possible.

The variation exhibited by these three plant characteristics offers plant breeders an opportunity to combine desirable features of each.

Additional index words: Sawfly resistance, Plant height, *Cephus cinctus* Norton.

IN wheat (*Triticum aestivum* L.) stem solidness provides resistance to the wheat stem sawfly (*Cephus cinctus* Norton) (4), semidwarfness has provided the plant structure for potential yield increases (6), and tillering is an important component of yield (1). Combining semidwarfness with stem solidness has not yet resulted in high-yielding, sawfly-resistant selections, although we know that high yield and sawfly

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