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Activated Charcoal Root Dips Enhance Herbicide Selectivity in Strawberries

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Abstract. **Field studies were conducted at 2 sites to evaluate preplant activated charcoal root dips in reducing herbicide injury to newly planted strawberries (*Fragaria* ×*ananassa*). In 1981, growth of charcoal treated 'Prelude', following application of 0.28 kg/ha terbacil (on 0.5% organic matter, Orangeburg loamy sand), was equal to control plants. Charcoal root dips did not prevent injury from 0.56 and 1.11 kg/ha of terbacil on this soil. In 1982, on Orangeburg loamy sand (0.3% organic matter), injury to 'Apollo' by diphenamid (4.5 kg/ha) or napropamide (4.5 kg/ha) applications immediately after planting was reduced by charcoal treatment. On the same soil, alachlor (3.4 kg/ha) or metolachlor (2.2 kg/ha) caused equal amounts of injury with or without charcoal root dips. Some crop protection from terbacil at 0.28 kg/ha was achieved with charcoal; however, none was observed with the 0.42 kg/ha rate.**

In recent years, registration of [2-(*a*-naphthoxy)-*N*,*N*-diethylpropionamide] (napropamide) and 5-chloro-3-(1,1-dimethylethyl)-6-methyl-2,4(1*H*,3*H*)-pyrimidinedione (terbacil) for established strawberries, has led several scientists to investigate the potential use of these herbicides on newly set strawberries (3, 4, 7, 10). Weller (10) reported that napropamide applied at 4.5 and 9.0 kg/ha immediately after planting did not reduce markedly subsequent growth of most of the 15 strawberry cultivars grown on 3.0% organic matter soil. Also a postplant treatment with terbacil at 0.28 kg/ha caused little or no injury. However, Weller (10) noted significant injury on many cultivars at 0.56 kg/ha and higher rates of terbacil. Similarly, Ahrens (3) reported that napropamide applied at 3.4 to 4.5 kg/ha was nonphytotoxic when applied 1 day to 3 weeks after planting. In the same study, terbacil at 0.14 kg/ha caused no injury when applied 3 to 4 weeks after planting, but treatment with terbacil immediately after planting increased the risk of plant injury. Conflicting results have been reported on safety of napropamide on newly planted strawberries grown on soils relatively low in organic matter. Beste et al. (4) reported that napropamide applied immediately after planting caused reduced strawberry growth; however, Putnam and Hancock (7) indicated that rates up to 4 kg/ha applied preplant-incorporated or immediately postplant caused no reduction in stolon or daughter plant production, nor in rooting of daughter plants in the 1st season of growth.

Experiments with crops such as cabbage (*Brassica oleracea* 'Capitata'), beets (*Beta vulgaris* L.), and strawberries have shown that activated charcoal can reduce the harmful effects of herbicides (1, 6, 8). At 1.2 kg/ha, 6-chloro-*N*,*N*'-diethyl-1, 3, 5-triazine-2,4-diamine (simazine), applied within a few days of planting caused no significant damage to the strawberry cultivar 'Cambridge Vigour' in field trials in which strawberry roots were dipped in an activated carbon powder prior to planting (8). Improved protection from simazine injury was obtained when strawberry roots were dipped in a slurry of activated charcoal (5) rather than in the dry activated carbon root dips reported by others (2, 8). Additionally, activated charcoal slurries gave good protection to newly set strawberries treated with dimethyl tetrachloroterephthalate (DCPA) at 4.5 kg/ha and terbacil at 0.14 kg/ha; however, less protection was shown on terbacil-treated plants at 0.28 kg/ha (5). In addition, dosages of 4.5 and 9.0 kg/ha of *N*, *N*-dimethyl-α-phenylbenzeneacetamide (diphenamid) in the presence or absence of charcoal caused significant reductions in runner development and rooting (5).

With reports indicating that terbacil (3, 5, 10), napropamide (4), and diphenamid (5) can cause phytotoxicity at time of planting, field studies were initiated to ascertain if the tolerance of newly planted strawberries to these and several other herbicides could be increased by using preplant root dips of activated charcoal.

Experiments were conducted in 1981 and 1982 at the Horticultural Crops Research Station, Clinton, N.C. The soil type was an Orangeburg loamy sand with organic matter content of 0.5% in 1981 and 0.3% in 1982. Field-grown, certified, dormant plants of 'Prelude' (1981) and 'Apollo' (1982) were used. Plants receiving charcoal root treatment were dipped briefly into a slurry of activated charcoal (120 g GRO-SAFE/L of water) (Imperial Chem. Industries, Americas, Inc., Wilmington, Del.) to the crown level just prior to transplanting. 'Prelude' plants were transplanted on 7 May 1981, and 'Apollo' plants were set on 22 Mar. 1982. Plants were spaced 60 cm apart in the row with one row per plot. The plot size was 1 m by 6 m in 1981, and 1 m by 3 m in 1982. Each experiment was conducted with 4 replicates in a randomized complete block design.

In 1981, terbacil at 0.28, 0.56, and 1.12 kg/ha was applied 4 days after transplanting. In 1982, 2-chloro-*N*-(2,6-diethylphenyl)-*N*-(methoxymethyl)acetamide (alachlor) 3.4 kg/ha; [2-chloro-*N*-(2-ethyl-6-methylphenyl)-*N*-(2-methoxy-1-methylethyl) acetamide] (metolachlor) 2.2 kg/ha; diphenamid 4.5 kg/ha; napropamide 4.5 kg/ha; and terbacil at 0.28 and 0.42 kg/ha were applied immediately following transplanting. Herbicides were applied with a CO_2 pressurized backpack sprayer calibrated to deliver about 177 liters/ha. Rainfall in the 2 weeks of 1981 after treatment was as follows: 11 May (0.2 cm); 20

Table 1. The response of newly planted 'Prelude' strawberry plants to 3 rates of terbacil with or without activated charcoal root dips, 1981.

Treatment	Rate kg/ha (a.i.)	No. of injured mother plants[z]		Reduction crop vigor[y] (%)		No. of rooted runner plants[x]
		5 June	10 Oct.	5 June	10 Oct.	
			Without charcoal			
Control		0	1	0	3	102
Terbacil	0.28	1	2	20	8	35
Terbacil	0.56	4	7	58	40	9
Terbacil	1.12	9	10	98	96	0
			With charcoal			
Control		0	0	0	0	71
Terbacil	0.28	0	1	7	3	84
Terbacil	0.56	1	2	19	9	10
Terbacil	1.12	4	9	75	76	0
LSD (5%)		2	3	9	26	60

[z]0 = no injury; 10 = all plants injured.
[y]Angle means have been retranslated to percent.
[x]Number of runner plants rooted per 1 m × 6 m plot.

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Table 2. The response of newly planted 'Apollo' strawberries to 5 preemergent herbicides with or without activated charcoal root dips, 1982.

Treatment	Rate kg/ha (a.i.)	No. of injured mother plants[z] 18 May	8 June	12 Dec.	Reduction crop vigor (%)[y] 3 May	8 June	No. of rooted runner plants[x]	Control large crabgrass (%)[x] 3 May	18 May
					Without charcoal				
Control-weedy		0	0	0	0	0	107	0	0
Control-cult.		0	0	0	0	1	104	100	100
Diphenamid	4.5	0	0	0	18	17	68	85	9
Napropamide	4.5	0	1	1	13	29	68	99	100
Alachlor	3.4	0	0	0	20	43	56	99	76
Metolachlor	2.2	0	0	0	3	36	63	98	85
Terbacil	0.28	0	0	1	11	5	93	91	74
Terbacil	0.42	1	2	1	16	43	51	94	85
					With charcoal				
Control-weedy		0	0	0	0	1	100	100	100
Diphenamid	4.5	0	0	0	4	12	100	89	9
Napropamide	4.5	0	0	0	3	13	76	100	100
Alachlor	3.4	0	0	1	16	64	31	100	71
Metolachlor	2.2	0	0	1	8	37	70	100	93
Terbacil	0.28	0	0	0	2	1	88	86	66
Terbacil	0.42	0	2	1	13	58	37	95	77
LSD (5%)		1	1	NS	4	16	50	2	6

[z]0 = no injury; 5 = all plants injured.
[y]Angle means have been retranslated to percent.
[x]Number of runner plants rooted per 1 m × 3 m plot.
[w]Weed population in weedy control consisted of large crabgrass at 10/0.1 m^2.

May (0.1 cm); and 21 May (4.1 cm). In 1982, there was no rainfall until 6 Apr. (0.2 cm), but irrigations of 1.5 cm were applied on 2 and 15 Apr., respectively. In both experiments, sprinkler irrigation was used to supplement rainfall as needed to maintain optimum growth.

Plots were evaluated for phytotoxicity to strawberry plants (1981 and 1982) and control of weeds (1982). All weed control and crop vigor ratings were based on a scale of 0 to 100, where 0 indicates either no weed control or percentage of crop vigor reduction, and 100 indicates either complete weed control or all crop plants dead. Counts of rooted runner plants per plot were made each fall at the completion of each study (8 Oct. 1981 and 12 Dec. 1982). Data were collected on mother plant shoot and root fresh weights as well as fresh weights of rooted and unrooted daughter plants. Since all growth data collected showed similar trends, only rooted runner plant production will be reported. All data were subjected to analysis of variance. Crop vigor and weed control ratings were transformed by arcsin prior to analysis of variance.

1981 experiment. 'Prelude' strawberries that received the charcoal root dip had good growth and runner production at the low rate of terbacil (0.28 kg/ha) (Table 1). In the absence of charcoal, the 0.28 kg/ha rate reduced runner establishment and crop vigor. Unacceptable crop protection with charcoal was observed with terbacil at 0.56 and 1.12 kg/ha. Terbacil at 0.56 and 1.12 kg/ha in the absence of charcoal caused severe injury and plant death.

1982 experiment. Some protection from terbacil injury (early growth) was observed in the presence of charcoal at the 0.28 kg/ha rate, but none at 0.42 kg/ha (Table 2). Strawberries without charcoal treatment outgrew initial injury caused by 0.28 kg/ha terbacil, resulting in runner production equal to the controls. Severe injury was caused by alachlor and metolachlor in the presence or absence of charcoal when applied immediately after planting. Phytotoxicity by diphenamid and napropamide applied immediately after planting was reduced by the charcoal root dip. Control of large crabgrass [*Digitaria sanguinalis* (L.) Scop.] was adequate for all treatments at 6 weeks after treatment, but was unacceptable with diphenamid by 8 weeks following treatment (Table 2). Weed control with alachlor and terbacil was declining by 8 weeks. All plots were hand weeded on 18 May and for the remainder of the study.

Current alternatives for chemical weed control in newly set strawberries include preemergence herbicides DCPA or diphenamid and *N'*-[4(4-chlorophenoxy)phenyl]-*N,N*-dimethylurea (chloroxuron) for postemergence control of weeds. Whereas DCPA is often advised for use immediately following transplanting strawberries, applications of diphenamid or chloroxuron are not recommended until new foliage has appeared and plants have had the opportunity to become established (usually 4–6 weeks) (9). Results of these experiments (Tables 1 and 2) on low organic matter soils indicated that strawberry plants with preplant root dips of activated charcoal were better able to survive treatment with diphenamid (4.5 kg/ha), napropamide (4.5 kg/ha), and the low rate of terbacil (0.28 kg/ha) when applied immediately after planting. Use of activated charcoal did not improve the selectivity of terbacil at higher rates of usage (0.42, 0.56, and 1.12 kg/ha), nor was the selectivity of the acetanilides, alachlor and metolachlor, enhanced.

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