SECTION II. HERBICIDE EFFECTS ON ESTABLISHMENT OF KENTUCKY BLUEGRASS SOD

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ABSTRACT

The effect of preemergence herbicide applications and the timing of fenoxaprop-ethyl applications on establishment of freshly laid Kentucky bluegrass (Poa pratensis L.) sod was investigated. Treatments included the postemergence herbicide fenoxaprop-ethyl at 0.20 and 0.40 kg ha^{-1} applied 28 and 14 days before sod harvest and 14 and 28 days after sod laying. Three preemergence herbicides, bensulide at 8.43 kg ha^{-1}, DCPA at 11.80 kg ha^{-1}, and pendimethalin at 1.69 kg ha^{-1} were applied over the top of the freshly laid sod. Phytotoxicity was recorded 14 days after each herbicide application. Rooting was measured 28 and 56 days after sod laying. In 1986, fenoxaprop-ethyl at 0.40 kg ha^{-1} caused phytotoxicity at all applications. No treatments inhibited rooting after 28 days, and fenoxaprop-ethyl at 0.40 kg ha^{-1} applied 14 and 28 days after sod laying were the only treatments to inhibit rooting 56 days after sod laying in 1986. This study was repeated in 1987 with the addition of fenoxaprop-ethyl at 0.28 kg ha^{-1}. Fenoxaprop-ethyl at 0.28 and 0.40 kg ha^{-1} caused phytotoxicity on three of the four application dates, and fenoxaprop-ethyl at 0.20 kg ha^{-1} burned the turf when applied 14 days preceeding to sod harvest. None of the treatments affected rooting 28 or 56 days after sod laying.

Chemical names used: O,O-bis(1-methylethyl) S-[2-{(phenylsulfonyl)amino}ethyl] phosphorodithioate (bensulide); dimethyl 2,3,5,6-tetrachloro-1,4-benzenedicarboxylate (DCPA); (±)-2-[4-{(6-chloro-2-benzoxazolyl)oxyl}phenoxy]propanoic acid (fenoxaprop-ethyl); N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine (pendimethalin)

INTRODUCTION

Both preemergence and postemergence herbicides are commonly used to control annual weeds during the production and after establishment of grass sod. These materials have the potential of delaying establishment by inhibiting rooting. Preemergence herbicide applications prevented rooting from stolon nodes of Bermuda grass (Cynodon dactylon L. Pers.) (2), and DCPA has been reported to reduce tiller and rhizome number in Kentucky bluegrass (5). Siduron (1-(2-methylcyclohexyl)-N'-phenylurea) reduced new root growth in creeping bentgrass (Agrostis palustris Huds.) (10). Bensulide and benefin (N-butyl-N-ethyl-2,6-dinitro-4-(trifluoromethyl)benzenamine) applied to freshly tilled soil before laying of Kentucky bluegrass sod caused root inhibition, whereas DCPA and siduron caused more inhibition when applied over freshly laid sod (1). The postemergence herbicide MSMA (monosodium methanearsonate) caused discoloration of turf (8).. CMA (calcium acid methyl arsenate) produced a reduction in number and length of Kentucky bluegrass rhizomes and reduction in Kentucky bluegrass tillering (5). Fenoxaprop-ethyl has recently been released for the postemergence control of warm-season annual grasses in cool-season perennial turfs. The objective of this study was to determine the effect of fenoxaprop-ethyl and preemergence herbicide applications on establishment of freshly laid Kentucky bluegrass sod. The effect of fenoxaprop-ethyl application timing in relation to sod harvesting date was also observed.

MATERIALS AND METHODS

The study was conducted on an established Kentucky bluegrass sod blend of 25% each of the cultivars 'Adelphi', 'Glade', 'Parade', and 'Rugby'. The sod was grown and transplanted on a fine-loamy mixed mesic Aquic Hapludoll Nicollet soil with a pH of 7.5, 32 g kg^{-1} organic matter, 13 mg kg^{-1} phosphorus, and 85 mg kg^{-1} potassium. The turf was mowed at 6 cm, received 200 kg nitrogen ha^{-1} $year^{-1}$, and was irrigated to prevent moisture stress. The study was arranged in a randomized complete block design with three replications. The plots measured 1.5 X 1.5 m. All herbicides were applied with a CO_2 backpack sprayer in 4155 liters water ha^{-1} at a pressure of 207 kPa.

Treatments included fenoxaprop-ethyl at 0.20 and 0.40 kg a.i. ha^{-1} applied 28 and 14 days before sod harvest and 14 and 28 days after the sod was laid. The dates of application were 2 and 16 July before sod harvest and 14 and 29 Aug. after sod laying. The sod was cut on 29 July 1986 and moved to a prepared sod bed tilled to a depth of 20 cm. No additional nutrients were applied to the sod bed. Bensulide at 8.43 kg ha^{-1}, DCPA at 11.80 kg ha^{-1}, and pendimethalin at 1.69 kg ha^{-1} were applied over the newly laid sod on 30 July. The sod was watered daily for two weeks after laying. Irrigation was withheld for 24 hours after fenoxaprop-ethyl applications.

The study was repeated in the summer of 1987. The treatments were identical to those of the 1986 study except for the addition of fenoxaprop-ethyl at 0.28 kg ha^{-1}. The first fenoxaprop-ethyl treatments were applied on 2 and 16 June 1987. The sod was cut and reestablished

on 30 June 1987. The preemergence herbicides were applied on 1 July. Final fenoxaprop-ethyl treatments were applied on 16 and 30 July.

Rooting was measured with a technique modified from King and Beard (7). Sod pieces were transplanted into wooden frames with 18-mesh fiberglass screen bottoms at the time of laying. The frames were constructed of 2.5 X 5.0 cm pine boards with inside dimensions of 30 X 30 cm. At each of the four corners, screw hooks were placed for use as the point of attachment for the hydraulic lift apparatus.

The screens were lifted vertically with a hydraulic pump apparatus (Fig. 1) at 28 and 56 days after laying. Woven steel cords (3 mm diameter) were attached to each of the four hook screws on the frame and drawn to an apex over the center of the frame. The lift apparatus was centered carefully over the frame to assure that the lifting force was vertical. The second year, the lifting apparatus was raised by mounting it on a cart 65 cm above the level of the frame. A gauge measuring hydraulic pressure was attached to the pump to facilitate measurement of force at the point of root breakage from the soil. The force needed for the vertical lift of rooting frames correlates with fresh and dry root weights (9). Rooting measurements were used as an indication of sod establishment.

Phytotoxicity was recorded two weeks after each herbicide treatment. This was the period of peak damage. Phytotoxicity was rated on a scale of one to nine, one being dead turf and nine being no damage. An analysis of variation was performed on all data at the end of the experiment.

Screens were pulled on 28 Aug. and 26 Sep. 1986, 28 and 56 days after sod laying, respectively. After the initial pulling, additional irrigation was provided to reestablish the sod. The last treatments of fenoxaprop-ethyl were not applied before the first pulling.

RESULTS AND DISCUSSION

There were no differences in rooting on the first sampling date in 1986 (Table 1). Fenoxaprop-ethyl at 0.40 kg ha^{-1} applied 14 and 28 days after sod laying reduced transplant rooting as compared with the control. For the 0.20 and 0.40 kg ha^{-1} rates of fenoxaprop-ethyl applied on the same dates, the plots treated at 0.20 kg ha^{-1} were better established than the plots treated with 0.40 kg ha^{-1}.

Fenoxaprop-ethyl causes growth suppression for about 30 days after application (S. Harrison, personal communication, Hoechst-Roussel Agri-Vet Company). This may explain why the 0.40 kg ha^{-1} rate of fenoxaprop-ethyl applied on 14 Aug. did not inhibit rooting by 29 Aug., but did on 26 Sept.

Fenoxaprop-ethyl at 0.40 kg ha^{-1} caused some shoot burn on all application dates in 1986 (Table 2). The phytotoxicity resulting from the 2 and 16 July applications probably were enhanced by bluegrass billbug (Sphenophorus parvulus) activity in the plots. The applications on 14 and 29 Aug. caused more burning than did applications on the first two dates.

The screens were pulled on 31 July and 29 August in 1987. Again the last treatments of fenoxaprop-ethyl were not applied before the first pulling. There were no rooting differences among the treatments on either sampling date in 1987. Fenoxaprop-ethyl at 0.20 kg ha^{-1} applied 14 days before harvest caused phytotoxicity. The 0.28 kg ha^{-1} rate caused phytotoxicity on only the two applications before sod harvest, but the 0.40 rate burned the turf on all application dates.

The phytotoxicity caused by the higher rates of fenoxaprop-ethyl varied by year. The treatments after sod laying caused more burn in 1986 whereas the treatments before sod cutting caused more burn in 1987. This may be because the more vigorous the condition of the turf, the more likely fenoxaprop-ethyl is to cause stunting (6). Fenoxaprop-ethyl is recommended to be applied from mid June to mid July after the cool season grass' spring period of fast growth and before the fall period of growth. The applications causing the most burn in 1986 were in the middle of the fall growth phase, whereas the 1987 applications were during the rapid growth period in the spring.

These variations in phytotoxicity may also be due to a rather narrow optimum temperature range for fenoxaprop-ethyl. During the 14 days after each of the applications causing extensive burning, the average temperature was between 25 and 30°C. When the average 14-day temperature after application was above or below this range, the intensity of phytotoxicity was much less, if present at all.

The major difference in the two studies is that the 1987 experiment was run one month earlier than the 1986 experiment, July through September in 1986 and June through August in 1987. In cool-season grasses, the fall months are when carbohydrates are being shifted to the roots producing optimum root growth as opposed to the spring months when the carbohydrates are being directed to shoot development. This is seen in the larger force needed to lift the frames on the 26 Sept. 1986 pulling than on 29 Aug. In 1987, the rooting was less extensive in the second pulling (29 Aug.) than in the first; thus, the grass plants never

reached their optimum rooting before the termination of the experiment. This could be the reason that no significant differences in rooting were seen in the 1987 trial.

Bensulide, DCPA, and pendimethalin are effective at controlling annual grasses at the rates used (4) and would be safe to use over the top of Kentucky bluegrass sod. Fenoxaprop-ethyl is effective on annual grasses applied throughout the year at 0.20 kg ha^{-1} (3) and is safe for use on Kentucky bluegrass sod. Fenoxaprop-ethyl at 0.28 and 0.40 kg ha^{-1} can slow sod establishment by causing phytotoxicity and possible root inhibition and should not be used on Kentucky bluegrass sod at these rates.

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Table 1: The effect of the herbicides on rooting of Kentucky bluegrass sod measured in pressure needed to break the roots from the soil

Treatment	Rate (kg ha^{-1})	Timing of application	Pulling pressure(kPa) 1986 4 weeks	1986 8 weeks	1987 4 weeks	1987 8 weeks
Control	-	-	814	1235	2505	1076
Fenoxaprop-ethyl	0.20	28 days prior	573	1463	2553	1277
Fenoxaprop-ethyl	0.28	28 days prior	-	-	3229	1249
Fenoxaprop-ethyl	0.40	28 days prior	1176	863	3036	1366
Fenoxaprop-ethyl	0.20	14 days prior	1007	1449	2367	1035
Fenoxaprop-ethyl	0.28	14 days prior	-	-	1932	1145
Fenoxaprop-ethyl	0.40	14 days prior	1235	1227	1973	1194
Bensulide	8.43	at sod laying	1035	897	2277	1035
DCPA	11.80	at sod laying	538	1635	2387	1076
Pendimethalin	1.69	at sod laying	731	1290	2988	1352
Fenoxaprop-ethyl	0.20	14 days after	748	1145	2663	1400
Fenoxaprop-ethyl	0.28	14 days after	-	-	2436	1138
Fenoxaprop-ethyl	0.40	14 days after	425	690	1794	800
Fenoxaprop-ethyl	0.20	28 days after	-	1339	-	900
Fenoxaprop-ethyl	0.28	28 days after	-	-	-	1387
Fenoxaprop-ethyl	0.40	28 days after	-	635	-	1063
$LSD_{.05}$			NS	449	NS	NS

Table 2: Evaluation of Kentucky bluegrass sod injury from herbicide applications taken two weeks after treatment

Treatment	Rate (kg ha^{-1})	Timing of application	Visual estimate of injury[a] 1986	1987
Control	-	-	9.0	9.0
Fenoxaprop-ethyl	0.20	28 days prior	9.0	9.0
Fenoxaprop-ethyl	0.28	28 days prior	-	7.7
Fenoxaprop-ethyl	0.40	28 days prior	7.7	6.3
Fenoxaprop-ethyl	0.20	14 days prior	9.0	8.0
Fenoxaprop-ethyl	0.28	14 days prior	-	6.3
Fenoxaprop-ethyl	0.40	14 days prior	7.3	5.3
Bensulide	8.43	at sod laying	9.0	9.0
DCPA	11.80	at sod laying	9.0	9.0
Pendimethalin	1.69	at sod laying	9.0	9.0
Fenoxaprop-ethyl	0.20	14 days after	9.0	9.0
Fenoxaprop-ethyl	0.28	14 days after	-	8.7
Fenoxaprop-ethyl	0.40	14 days after	5.6	8.7
Fenoxaprop-ethyl	0.20	28 days after	8.6	9.0
Fenoxaprop-ethyl	0.28	28 days after	-	8.3
Fenoxaprop-ethyl	0.40	28 days after	5.3	8.0
$LSD_{.05}$			0.6	0.7

[a]Ratings of injury are based on a scale of 1 through 9, 1 representing dead turf and 9 representing no damage.

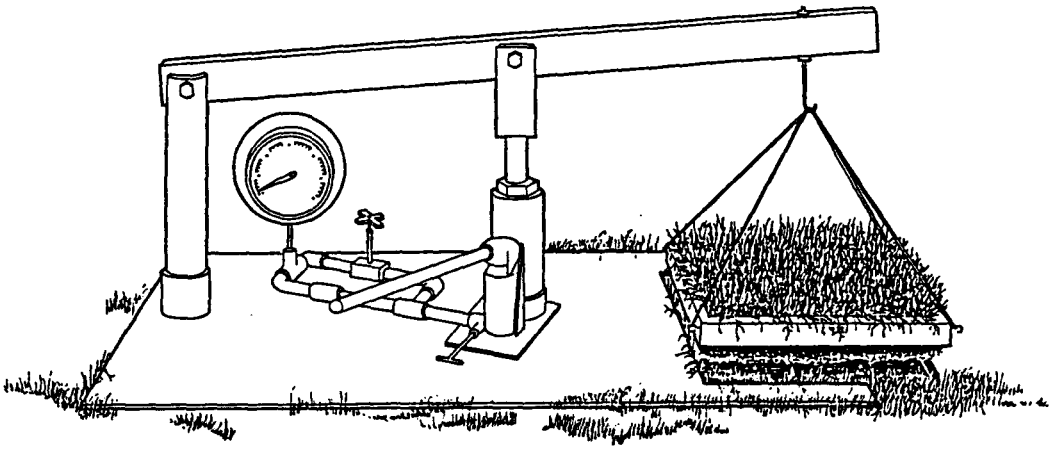

Figure 1: Hydraulic pump apparatus for lifting sod pieces.