

Herbicide Effects on Bermudagrass Turf

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Commercial sod producers and their customers desire high quality sod. An important sod quality is the absence of weeds, as weedy sod is generally considered poor in quality. Preemergence herbicides applied in the early spring are the primary means of controlling summer annuals, such as the crabgrasses. Preemergence herbicides, however, have caused adverse effects to some turfgrass species and cultivars (3,4,10).

Potential adverse effects

Dinitroaniline herbicides, such as oryzalin and pendimethalin, have been used extensively in turfgrass weed control. As far as their effects on root growth are concerned, varying results have been reported. One study showed that neither numbers nor tensile strength of roots was adversely affected (9). A second study associated pendimethalin with lower tensile strength and reduced root growth (2). Other dinitroaniline herbicides, including benefin and prodiamine, produced similar results in a third study; and in a fourth study, so did pendimethalin in some cases, but not in others (5,6).

Another concern with these preemergence herbicides is their potential to cause injury in zones of the soil profile where root initiation occurs. Under some conditions, such as high moisture and low soil organic matter content, dinitroaniline herbicides have been detected in areas of the soil profile where rhizomatous turfgrasses would be initiating roots (1). This is of concern since those herbicides can affect root and rhizome development (7). Certain warm season turfgrasses, such as the bermudagrasses, rely on root initiation from stolons as well as rhizomes. Under conditions which would not be favorable for downward movement of herbicides, their presence further up in the soil profile may still inhibit root initiation from stolons.

Rapid rooting is necessary for establishment of healthy sod or sprigs. Detrimental effects from pre-emergence herbicides may also add stress to established turfgrasses and cause delays in resumption of early spring growth. Ideally, adverse effects from herbicides should be minimal during these important periods of growth.

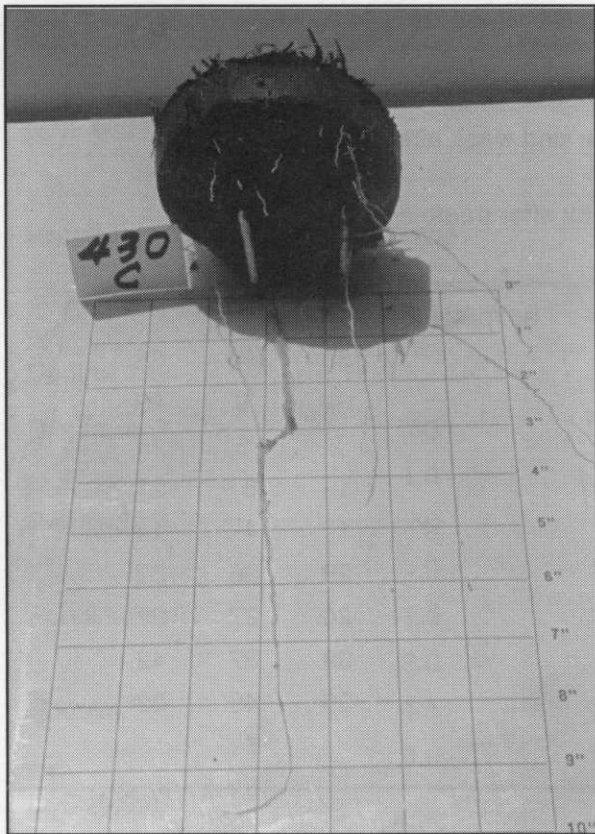
Measurement of root injury

Let's take a look at some research on a common bermudagrass sod that was conducted over a two year period about five years ago in Mississippi. Turf managers in that region typically try to have their pre-emergence herbicides applied by the middle of March. This is also the time that warm season turf is resuming active growth. Anything that might adversely affect this growth is obviously to be avoided.

The objective of this research was to determine if commonly-used preemergence herbicides would cause root injury to commonly-grown bermudagrass in this environment. In this particular set of experiments, herbicides were applied to the sod in early March. At three different times following herbicide application (two, four, and eight weeks), plugs of sod were removed from the field plots and replanted in a greenhouse in cups containing sand. After allowing growth in the greenhouse for a further six week period, the sod plugs were removed from the cups, the sand was washed from the roots, and observations were taken.

The first of these observations was the total number of roots which had grown down into the sand. The second was the number of roots which appeared to be malformed, and for purposes of comparison the number of roots which appeared to be normal. Roots malformed by dinitroaniline herbicides typically appear shortened or stubby, with swollen tips. Many call such symptoms "clubbed roots" or "baseball bats." After all the counting was done, the roots were clipped from under the soil line of the plugs and weighed.

Looking first at total number of roots (Table 1), we can draw several conclusions. The most significant

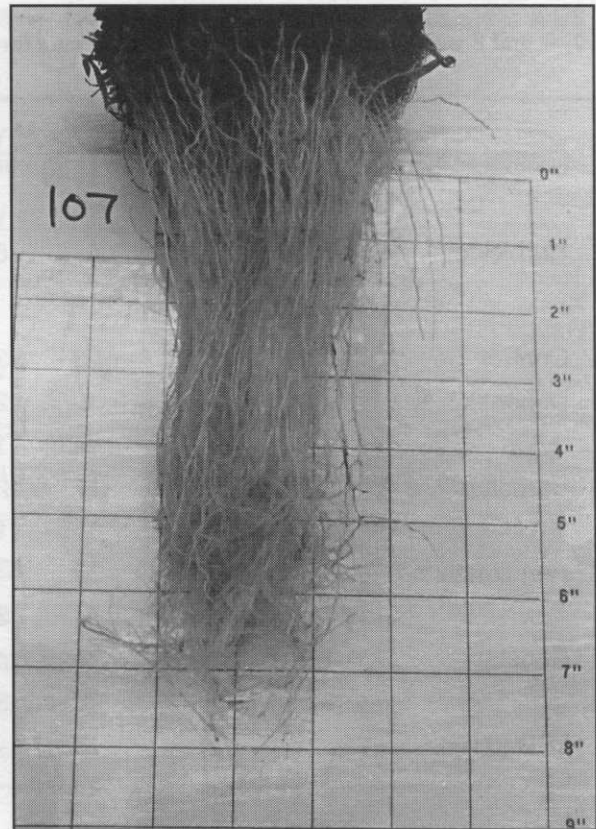


Untreated bermudagrass

reduction in the number of total roots occurred in plots which had received applications of prodiamine (Barricade®) or dithiopyr (Dimension®). These reductions did not occur early (two weeks after treatment), but only at four and eight weeks. As indicated earlier, pendimethalin has been associated with reduced root numbers in other research trials, but no consistent pattern developed over the years (9).

The underlying story becomes apparent, however, when the number of normally-growing and then abnormally-growing roots are compared (Tables 2 and 3).

Compared with grasses grown in untreated plots, Dimension® and Barricade® use led to the greatest reductions in the number of normal roots in both trial years. Another way of looking at this is by comparing the numbers of abnormal roots observed in these plots. Barricade® and Dimension® use led to more shortened and swollen



Bermudagrass treated with a dinitroaniline herbicide

roots. In some cases, these effects were observed as long as eight weeks after the plots were treated.

Pendimethalin could be thought of as "intermediate" in its effects. This herbicide caused some

Table 1. Number of roots from plugs of common Bermudagrass sod taken from field plots 2, 4, and 8 weeks after treatment and grown on sand for 6 weeks in the greenhouse.

Herbicide	Rate lb ai/A	Weeks after treatment		
		2	4	8
Control	...	37	38	37
Dimension®	.50	34	28	29
Barricade®	1.0	32	30	25
	.50	45	36	33
Pendimethalin	1.0	41	40	28
	1.5	36	33	34
Ronstar®	3.0	38	31	34
	1.5	37	32	41
LSD (0.05)	3.0	37	36	40
			8	

Table 2. Number of normal roots growing from plugs of common bermudagrass sod taken from field plots 2, 4, and 8 weeks after treatment and grown on sand for 6 weeks in the greenhouse.

		Year and week after treatment					
		1989			1990		
Herbicide	Rate	Week after treatment					
		2	4	8	2	4	8
		lb ai/A			no./pot		
Control	...	33	23	36	38	44	38
Dimension®	.50	1	4	23	4	9	23
	1.0	4	3	14	2	5	14
Barricade®	.5	12	11	29	1	6	21
	1.0	2	6	18	1	4	14
Pendimethalin	1.5	25	20	34	29	36	32
	3.0	9	7	31	20	27	35
Ronstar®	1.5	33	20	40	39	37	42
	3.0	34	22	39	36	46	39
LSD (0.05)			10			7	

Table 3. Number of abnormal roots growing from plugs of common bermudagrass sod taken from field plots 2, 4, and 8 weeks after treatment and grown on sand for 6 weeks in the greenhouse.

		Year and week after treatment					
		1989			1990		
Herbicide	Rate	Week after treatment					
		2	4	8	2	4	8
		lb ai/A			no./pot		
Control	...	0	0	0	0	0	0
Dimension®	.50	32	21	7	31	22	4
	1.0	30	24	10	27	27	13
Barricade®	.50	28	19	1	50	37	14
	1.0	36	28	5	43	41	20
Pendimethalin	1.5	9	8	1	8	1	0
	3.0	27	20	1	20	6	1
Ronstar®	1.5	2	7	0	0	0	0
	3.0	3	4	1	0	0	0
LSD (0.05)			9			7	

Table 4. Root fresh weight from plugs of common bermudagrass sod taken from field plots 2, 4, and 8 weeks after treatment and grown on sand for 6 weeks in the greenhouse.

		1989		
		Week after treatment		
Herbicide	Rate	2	4	8
		lb ai/A	mg/pot	
Control	...	1470	1250	1080
Dimension®	.50	260	610	930
	1.0	110	510	680
Barricade®	.50	970	1280	1190
	1.0	450	830	880
Pendimethalin	1.5	1370	1390	1210
	3.0	790	710	1130
Ronstar®	1.5	1330	1210	1210
	3.0	1150	870	1290
LSD (0.05)			530	

		1990		
		Week after treatment		
Herbicide	Rate	2	4	8
		lb ai/A	mg/pot	
Control	...	2390	4690	4120
Dimension®	.50	900	1910	4410
	1.0	510	2170	3550
Barricade®	.50	790	2110	3720
	1.0	300	1460	2690
Pendimethalin	1.5	2230	4110	4500
	3.0	1870	4150	4680
Ronstar®	1.5	2470	4050	5220
	3.0	2290	4630	4640
LSD (0.05)			990	

Table 5. Rainfall amounts by weekly intervals.

Week interval	Rainfall (inches)	
	Year 1	Year 2
0-2	2.1	2.6
2-4	2.0	9.4
4-8	4.8	12.4

reductions in normal root production, and some malformed roots. Its effects did not appear to be as long-lived as those of Barricade® and Dimension®, however.

Based solely on these experiments, oxadiazon (Ronstar®) could be considered the safest material for use on common bermudagrass. Compared with untreated plots, there were no observable reductions in number of normal roots. Also, compared once again with untreated plots, Ronstar® did not damage roots significantly. The only damage noted occurred in 1989.

The more shortened and swollen roots, coupled with fewer normal roots, produced reductions in root fresh weight in these same plots (Table 4).

Compared to untreated plots, Dimension® caused root weight decreases through week four in both years. Barricade® was not as consistently damaging as Dimension®. It did cause some reductions, however. It appeared to be more severe in 1990, as root weight was lower at both four and eight weeks after treatment. In 1989, Barricade® caused problems only at two weeks following application. As with the numbers of roots, pendimethalin could also be considered intermediate in its effects on root weight. It did not behave consistently in both years, as reductions were noted only in 1989. Ronstar® did not cause any negative effects with root weight and of the materials evaluated, based on these results, it would be considered the safest for common bermudagrass.

Injury to rhizomes

The location of the herbicide within the soil profile is also an important factor in the amount of injury that may occur. Turfgrasses that initiate growth from rhizomes, such as bermudagrass, can be injured by preemergence herbicides. Several factors affect the potential for injury, including soil type, moisture conditions and the chemical properties of the herbicide.

Experiments were conducted to determine if several commonly used preemergence herbicides could inhibit common bermudagrass root growth initiated from rhizomes. The study was conducted on two different soil types: a very fine sandy loam and a sandy clay loam. Following herbicide application, soil samples were removed from the 0 in. to 1 in., 1 in. to 2 in., and 2 in. to 3 in. layers of the soil profile. These samples were taken at two, four, and eight weeks after the March herbicide application. To determine if residues were present in these soil layers, each sample was placed in a cup, and a plug of 'Tifgreen' bermudagrass was placed directly on the soil sample. The bermudagrass was grown in this cup in the greenhouse for an additional three weeks, then root weight was determined for each plug.

The results of these experiments suggest that some preemergence herbicides can cause damage to roots initiated from rhizomes. The potential for such damage may be greater in lighter-textured soils and under greater amounts of rainfall.

For example, Barricade® is not considered highly water soluble; special conditions may facilitate this herbicide's causing rhizome damage, however. We normally associate highly water soluble herbicides with significant downward movement through the soil profile.* Root damage in the 2 in. to 3 in. zone of the coarse-textured soil was observed from plots which were treated with Barricade®. No equally significant injury occurred at this same depth in the finer-textured soil, however.

* See the article on pesticide fate by Prof. Richard J. Hull in September 1995 *TurfGrass TRENDS*.

Water also influences herbicide injury. With Barricade®, for example, injury in the coarse-textured soil was not seen in those 2 in. to 3 in. zones until eight weeks after treatment the first year of the study. In contrast, in the second year of the study, injury from Barricade® occurred more rapidly (at two and four weeks following application) in this same soil type. Rainfall patterns at this site are displayed in Table 5, and are the most likely reason we see such differences in the two years' data.

There was no significant evidence of Dimension® being present or causing injury in these areas of the soil profile. It was detected in only the top inch of the soil profile in both soil types, suggesting little potential for downward movement and subsequent root damage.

Oryzalin (Surflan®), on the other hand, was found in concentrations high enough to cause root injury in the 2 in. to 3 in. layer of the coarse-textured soil during the second year of the study. This would again indicate the importance of rainfall in herbicide movement downward. Additionally, the coarser soil type would be more conducive for this herbicide's movement than a finer textured soil. Surflan® is also relatively more water soluble than Dimension®; thus, we may expect some potential for its downward movement.

Pendimethalin was also evaluated for downward movement in these experiments. There was no indication that it was present in the 2 in. to 3 in. soil profile zone in concentrations great enough to cause rooting problems. Pendimethalin tended to cause more damage in the top inch of the soil during the first year of the study, when there was less rainfall. During the second year, pendimethalin did not appear to be present in this top inch of the coarse-textured soil in damaging levels by eight weeks after treatment. This was most likely due to herbicide degradation from the wet conditions experienced during this period. Pendimethalin has been reported to degrade more rapidly under wet conditions (8).

Several conclusions can be drawn from the results obtained in this study. In turfgrasses with a rhi-

zomatous growth habit, such as bermudagrass, root growth can be affected by relatively low concentrations of some herbicides. Soil type and moisture are important moderators of the effects caused by these herbicides, however.

From a sod producer's view, these data would have practical implications concerning harvesting. Where herbicides that tend to affect rooting have been applied, the time interval between their application and sod harvest should be as long as possible. In contrast, high quality sod, which will root quickly, can be harvested without significant delay after treatment with herbicides that cause little or no root damage.

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