Tolerance of Bermudagrass to Herbicides

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Highlight: *Herbicides 2,4-D, 2,4,5-T and dicamba applied in spring or fall usually did not reduce yields of bermudagrass. When applied during dry periods, picloram reduced density and yield of bermudagrass. Degree of bermudagrass injury was directly related to rate of herbicide. "Common," "Coastal," and "Coastcross-1" varieties responded similarly to each herbicide studied. Kleingrass, a new forage grass growing in the plot area, was tolerant of all herbicide treatments, including picloram.*

In south Texas, many rangeland areas that have been disturbed and established in bermudagrass (*Cynodon dactylon* (L.) Pers.) pastures are now rapidly becoming infested with seedlings of huisache (*Acacia farnesiana* (L.) Willd.) and honey mesquite (*Prosopis juliflora* (Swartz) DC. var. *glandulosa* (Torr.) Cockerell). Seed of these woody species are abundant on some sites. They germinate and rapidly establish seedlings under favorable conditions. Within 2 or 3 years, the woody plants, especially huisache, may become too large to mow. The field must then either be abandoned or treated by other, more drastic mechanical methods. Annual mowing will not kill the brush, and huisache is resistant to broadcast sprays of 2,4-D [(2,4-dichlorophenoxy)acetic acid] or 2,4,5-T [2,4,5-trichlorophenoxy)acetic acid].

Huisache and honey mesquite are susceptible to picloram (4-amino-3,5,6-trichloropicolinic acid) and dicamba (3,6-dichloro-*o*-anisic acid) (Bovey et al., 1969). Combinations of picloram + dicamba or 2,4,5-T are effective against both species, and dicamba + 2,4,5-T will control honey mesquite (Meyer and Bovey, 1973; Scifres and Hoffman, 1972). Apparently, 2,4-D, 2,4,5-T, dicamba, MCPP (2-[(4-chloro-*o*-tolyl)oxy] propionic acid) and certain combinations of these materials applied for herbaceous weed control did not damage bermudagrass turf at College Station, Texas (McBee, 1966). Reber et al. (1971) found that several bermudagrass cultivars in Illinois were susceptible to picloram; resistant cultivars recovered within 16 months following treatment.

The relative tolerance of "Common," "Coastal," and "Coastcross-1" varieties of bermudagrass to 2,4-D, 2,4,5-T, dicamba, and picloram treated in spring and fall with rates commonly used for herbaceous and woody plant control was evaluated in this study.

Materials and Methods

Granule or spray formulations of the potassium salt of picloram and the dimethylamine salt of dicamba were applied to triplicate plots of 5 by 20 ft in established stands of bermudagrass near College Station, Texas. A randomized block or split-plot design was used. Soil was a Lufkin sandy loam. Sprays of the propylene glycol butyl ether esters of 2,4-D and 2,4,5-T or butoxyethanol ester of 2,4,5-T were also included. Spray formulations were applied in water by a hand-carried boom at 20 gallons per acre. Karbutilate [*tert*-butylcarbamic acid ester with 3-(*m*-hydroxyphenyl)-1,1-dimethylurea] granules were applied on May 15, 1972.

Active ingredient of picloram, dicamba, and karbutilate granules were 2, 10, and 10%, respectively. Herbicides were applied on October 30, 1970; February 17, 1971; May 3, 1971; October 14, 1971; and May 15, 1972. Bermudagrass was harvested in the spring and fall after herbicide treatment. Forage from a 2.8 by 10-foot area was collected from the center of each plot. Oven-dry weights were obtained, and forage yields were converted to lb/acre. Herbicides and rates used are given in the tables that follow.

Results

Picloram granules applied in October 1970 at 2 and 4 lb/acre significantly reduced yields of Coastal and Coastcross-1 bermudagrass when harvested in June and October 1971 (Table 1). Most of the grass harvested in plots treated with picloram at 4 lb/acre was Kleingrass (*Panicum coloratum* L.), which appeared very tolerant of all picloram treatments. Kleingrass is a recent forage plant introduction. A thin stand of Kleingrass volunteered throughout the plot area from a previous planting and appeared to increase in picloram-treated plots.

Picloram granules applied to established Common bermudagrass in October, 1970, produced yields similar to those obtained for Coastal and Coastcross-1 harvested in June, 1971. Picloram at 1, 2 and 4 lb/acre caused yields of 1647, 666 and 86 lb/acre, oven-dry forage, respectively, compared to the control of 2918 lb/acre (data not shown). Rainfall was below normal after treatment (Table 2), and phytotoxic levels of picloram were probably not leached from the root zone. Dicamba granules applied at 1, 2 or 4 lb/acre in October, 1970, did not reduce yield of Common bermudagrass, which produced about 3500 lb oven-dry forage/acre, by June, 1971. The control produced 2918 lb/acre oven-dry forage (data not shown). Yield of Coastal bermuda-

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Table 1. Oven-dry weight (lb/acre) of vegetation on Coastal and Coastcross-1 bermudagrass sites at College Station, Texas, after application of picloram and dicamba granules on October 30, 1970, and harvested at two dates.

Chemical applied	Rate (lb/acre)	Harvested June 10, 1971[1]			Harvested October 7, 1971[1]		
		Coastal	Coastcross-1	Mean	Coastal	Coastcross-1	Mean
Untreated		4295	2954	3624	2024	1642	1833
Picloram granule	1	3215	1468	2342	1959	1129	1544
Picloram granule	2	1598	1597	1598	1656	1083	1370
Picloram granule	4	227	261	244	718	493	605
Dicamba granule	1	5700	2261	3980	2074	1879	1976
Dicamba granule	2	4876	3176	4026	2063	973	1518
Dicamba granule	4	4771	2229	3500	2100	1160	1630
Mean		3526	1992	2759	1799	1194	1496

[1] Least significant differences:

	June 10 data	October 7 data
Between varieties (mean)	2173	207
Among herbicides (mean)	1088	93
Between varieties within the same herbicide	2436	222
Between herbicides within the same variety	1540	130

grass was unaffected in spring and fall harvests, but yield of Coastcross-1 was reduced in the fall harvest in plots receiving dicamba at 2 and 4 lb/acre (Table 1).

Picloram granules at 1, 2 and 4 lb/acre applied to plots in February, 1971, significantly reduced yields of Coastal and Coastcross-1 bermudagrass by June 1971 (data not shown). However, grass in the same plots harvested in October, 1971, had about recovered. Significant reduction in yield occurred only in plots receiving 4 lb/acre of picloram. Dicamba granules did not reduce forage yields on Coastal or Coastcross-1 varieties from either spring or fall harvests. Drought conditions prevailed during the winter of 1970-1971, and injury to the bermudagrass from picloram may have been accentuated since rainfall is important in dissipation of the herbicide from the soil profile. Yield data for Common bermudagrass from plots treated in February, 1971, were similar to plots treated in October, 1970.

Spring applications (May, 1971) of picloram sprays and granules reduced forage growth of Common bermudagrass at most rates when yields were taken 1

Table 2. Rainfall (inches) between treatment date and harvest date at College Station, Texas.

Treatment date	Harvest date	Accumulative rainfall
10/30/70	6/10/71	11.65
	10/7/71	22.58
1/17/71	6/10/71	9.30
	10/7/71	20.23
5/3/71	6/10/71	6.13
	10/7/71	17.06
10/14/71	6/20/72	21.65
	11/9/72	39.04
5/15/72	6/20/72	1.06
	11/9/72	18.45

Table 3. Oven-dry weight (lb/acre) of vegetation on Coastal and Coastcross-1 bermudagrass sites at College Station, Texas, after application of herbicide sprays and granules on May 3, 1971, and harvested at two dates.

Chemical applied	Rate (lb/acre)	Harvested June 10, 1971[1]			Harvested October 7, 1971[1]		
		Coastal	Coastcross-1	Mean	Coastal	Coastcross-1	Mean
Untreated		6430	2979	4704	2498	1748	2123
Picloram spray	0.5	3342	1008	2175	2060	2299	2180
Picloram spray	1	1988	1021	1504	2178	1991	2084
Picloram spray	2	2409	1113	1761	1565	1706	1636
Picloram spray	4	2081	406	1244	742	1035	888
2,4-D spray	1	4740	2727	1600	2534	1441	1988
2,4-D spray	2	4325	2492	3408	2215	1909	2062
2,4,5-T spray	0.5	4600	2234	3417	1795	1542	1521
2,4,5-T spray	1	4896	2596	3746	2589	1873	2231
2,4,5-T spray	2	3782	1926	2854	2301	1447	1874
2,4,5-T spray	4	3027	2026	2526	1725	1403	1564
Dicamba spray	0.5	4264	2377	3320	2460	1597	2028
Dicamba spray	1	4775	2531	3653	1833	1915	1874
Dicamba spray	2	3747	1738	2742	2658	1978	2318
Dicamba spray	4	3263	1652	2458	2357	1885	2121
Picloram granule	1	2252	1288	1770	1750	1540	1645
Picloram granule	2	2351	1579	1965	1125	1892	1508
Picloram granule	4	2708	1491	2100	437	766	602
Dicamba granule	1	4649	2163	3406	1647	2103	1875
Dicamba granule	2	3175	2376	2776	2170	2130	2136
Dicamba granule	4	3061	1721	2391	1197	1815	1506
Mean		3409	1878	2644	1883	1714	1798

[1] Least significant differences:

	June 10 data	October 7 data
Between varieties (mean)	1252	280
Among herbicides (mean)	878	557
Between varieties within the same herbicide	1631	154
Between herbicides within the same variety	1240	788

Table 4. Oven-dry weight (lb/acre) of vegetation on a Common bermudagrass site near College Station, Texas, after application of herbicide sprays and granules at two dates.[a]

Chemical applied	Rate (lb/acre)	Applied October 14, 1971		Applied May 15, 1972	
		Harvested June 20, 1972	Harvested Nov. 9, 1972	Harvested June 20, 1972	Harvested June 9, 1972
Untreated		1336	1869	1883	1589 c
Picloram spray	0.25	1436	1488	1603	1608 c
Picloram spray	0.5	1911	1788	1513	2412 e
Picloram spray	1	2086	2238	1338	2396 e
2,4-D spray	1	1854	1415	1890	1764 cd
2,4-D spray	2	1193	1346	1454	2185 de
2,4,5-T spray	1	1743	1420	1303	1845 cd
2,4,5-T spray	2	1388	1317	1462	1809 cd
Dicamba spray	0.5	1990	1531	1755	1911 cde
Dicamba spray	1	1283	1297	1323	1834 cd
Picloram granule	1	1845	1740	1535	2210 de
Picloram granule	2	2081	1664	1266	1714 cd
Karbutilate granule	1	–	–	1203	1879 cd
Karbutilate granule	2	–	–	1165	1080 b
Karbutilate granule	4	–	–	1100	410 a

[a]Values followed by the same letter in the last column are not significantly different at the 5% level. Values in the first three columns are not significantly different at the 5% level.

month after treatment (data not shown). Degree of injury to bermudagrass depended directly upon application rate of picloram. Four lb/acre of picloram reduced grass yield over 95% of that from untreated plots. Grass treated with picloram sprays of 0.5 lb/acre was injured less than grass treated with higher picloram rates; but grass yield was significantly less than that from untreated plots. Sprays of 2-4-D, 2,4-5-T, and dicamba and granules of dicamba up to 4 lb/acre applied in May, 1971, did not significantly reduce yields of Common bermudagrass.

All herbicides applied in May, 1971, reduced oven-dry forage yields of Coastal and Coastcross-1 harvested 1 month after treatment, although results for 2,4-D, 2,4-5-T, and lower rates of dicamba on Coastcross-1 were not significantly different from those from untreated areas (Table 3). Reduction was greatest with highest rates of picloram. Five months after treatment, picloram spray and granular treatments at 2 and 4 lb/acre and dicamba granules at 1 and 4 lb/acre, significantly reduced yield of Coastal bermudagrass. Granular formulations of picloram at 4 lb/acre reduced yield of Coastcross-1. Forage yields from all other herbicide treatments were similar to untreated plots of Coastal and Coastcross-1 bermudagrass. In 1971, forage yield of Coastal was consistently greater than that of Coastcross.

Yield of Common bermudagrass treated in October 1971 and harvested in June and November, 1972, was not reduced by herbicide treatments (Table 4). Unlike results from picloram applied in October, 1970, picloram applications in October, 1971, at similar rates did not reduce grass yield. Reduced phytotoxicity of picloram applied in October, 1971, compared with that applied in October, 1970, is attributed to more abundant rainfall (Table 2), which may have leached toxic levels of picloram from that root zone and allowed more overall growth of grass. Grass yield tended to be highest on picloram-treated areas, probably because of the benefit of prolonged weed control.

No differences in bermudagrass yields in June, 1972, occurred among treatments applied to Common bermudagrass in May 1972 (Table 4). However, on the same plots in November, 1972, more forage was harvested where sprays of picloram at 0.5 and 1 lb/acre, 2,4-D at 2 lb/acre, and picloram granules at 1 lb/acre had been applied than from other plots. Karbutilate at 2 and 4 lb/acre reduced forage yields, but karbutilate at 1 lb/acre did not.

Fall applications of picloram, 2,4-D, 2,4,5-T, and dicamba in 1971 did not reduce forage yields of Coastal and Coastcross-1 bermudagrass harvested in June, 1972, or November, 1972 (Table 5). Coastal yield was greater in all picloram treatments in June, 1972, than in the untreated plots. Abundant rainfall apparently removed enough residual picloram to allow normal growth.

Except for karbutilate, which caused increased yield of Coastal in June, 1972,

Table 5. Oven-dry weight (lb/acre) of vegetation on Coastal and Coastcross-1 bermudagrass sites at College Station, Texas, after application of herbicide sprays and granules on October 14, 1971, and harvested at two dates.

Chemical applied	Rate (lb/acre)	Harvested June 20, 1972[1]			Harvested November 9, 1972[1]		
		Coastal	Coastcross-1	Mean	Coastal	Coastcross-1	Mean
Untreated		537	772	654	1799	1848	1824
Picloram spray	0.25	888	1324	1106	1469	1875	1672
Picloram spray	0.5	886	720	803	1578	1744	1661
Picloram spray	1	1033	1002	1018	1730	1504	1617
2,4-D spray	1	567	501	534	1322	1544	1433
2,4-D spray	2	601	778	690	1563	1693	1628
2,4,5-T spray	1	542	771	656	1463	1658	1560
2,4,5-T spray	2	626	864	745	1345	1412	1378
Dicamba spray	0.5	715	834	774	1583	1751	1667
Dicamba spray	1	542	637	590	1617	1860	1738
Picloram granule	1	889	1002	946	2013	2065	2039
Picloram granule	2	961	803	882	1428	1399	1414
Mean		732	834	783	1576	1696	1636

[1] Least significant differences:

	June 20 data	November 9 data
Between varieties (mean)	189	633
Among herbicides (mean)	238	385
Between varieties within the same herbicide	359	767
Between herbicides within the same variety	336	546

Table 6. Oven-dry weight (lb/acre) of vegetation on Coastal and Coastcross-1 bermudagrass sites at College Station, Texas, after application of herbicide sprays and granules on May 15, 1972, and harvested at two dates.

Chemical applied	Rate (lb/acre)	Harvested June 20, 1972[1]			Harvested November 9, 1972[1]		
		Coastal	Coastcross-1	Mean	Coastal	Coastcross-1	Mean
Untreated		537	772	654	1799	1848	1824
Picloram spray	0.25	766	815	790	1632	2425	2028
Picloram spray	0.5	496	705	600	1778	1735	1756
Picloram spray	1	734	668	701	1747	1618	1682
2,4-D spray	1	709	878	794	1808	2469	2138
2,4-D spray	2	811	774	792	1413	1607	1510
2,4,5-T spray	1	579	910	744	1549	2954	2252
2,4,5-T spray	2	880	982	931	1826	2387	2106
Dicamba spray	0.5	750	886	818	1877	1660	1768
Dicamba spray	1	706	745	726	1641	2210	1926
Picloram granule	1	588	704	646	1667	1958	1812
Picloram granule	2	631	977	804	1145	1491	1318
Karbutilate granule	1	1006	718	862	1503	1867	1685
Karbutilate granule	2	729	625	677	1390	1110	1250
Karbutilate granule	4	963	506	734	1409	1184	1296
Mean		726	778	752	1612	1902	1757

[1] Least significant differences:

	June 20 data	November 9 data
Between varieties (mean)	155	869
Among herbicides (mean)	279	555
Between varieties within the same herbicide	404	1078
Between herbicides within the same variety	395	786

herbicides applied in May, 1972, resulted in no significant differences in forage yield of Coastal or Coastcross-1 bermudagrass 1 and 6 months after treatment (Table 6). Karbutilate tended to reduce yield of Coastcross at 2 and 4 lb/acre in plots harvested in the fall, but yield was not significantly different from that of the control. Growth of bermudagrass was much greater in the spring of 1971 than 1972 because of more rainfall and favorable temperature between time of treatment and harvest.

Discussion

Herbicides 2,4-D, 2,4,5-T, and dicamba usually did not reduce yield of established Common, Coastal, or Coastcross-1 bermudagrass, regardless of rate or time of treatment. The high rate of 2,4,5-T (4 lb/acre) in spring tended to discolor the grass, but injury was temporary. Picloram at 2 and 4 lb/acre applied during periods of dry weather severely reduced bermudagrass growth. Most of the grass harvested in plots treated with picloram at 4 lb/acre was Kleingrass, which was very resistant to picloram and other herbicides. In most weed and brush control programs, rate of herbicide would seldom exceed 1 lb/acre. Picloram at rates of 1 lb/acre or below sometimes injured bermudagrass but reduced growth was temporary and regrowth sometimes exceeded that of the control, probably a result of weed control. However, in areas of limited rainfall or irrigation (below 20 inches annually), picloram may significantly reduce bermudagrass stand and production the first year after treatment if phytotoxic levels of picloram remain in the root zone. Common, Coastal and Coastross-1 varieties of bermudagrass responded similarly to each herbicide studied.

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