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Virginia buttonweed (*Diodia virginiana* L.) conforms distinctly to many of the characteristics considered undersirable in turf; consequently making it a weed (Figure 1). It disrupts turf uniformity due to a substantially different leaf width, leaf shape, growth habit and/or color. It is a strong competitor in common bermudagrass [*Cynodon dactylon* (L.)Pers.,] and other warm-season species. Add to this an apparent high degree of tolerance to commonly used herbicides, particularly postemergence herbicides, and one can easily place buttonweed in the 'problem weed' category.

Virginia buttonweed is a spreading, usually pubescent (leaves), warm-season perennial with branched stems 4-24 inches long. Leaves of buttonweed are opposite, sessile, broader at the base and tapering toward the end (elliptic - laneolate) and 0.5 to 3 inches long. The flower is usually white with one to three in each leaf axil or two to six per node. The fruit is pubescent, oblong in shape, about .25 inches long and prominently ridged (1,2).

Virginia buttonweed is evident throughout the South from late spring until frost in lawns, golf courses, moist pastures, ditches and waste areas. We have observed isolated incidences of Virginia buttonweed on golf-course greens mowed regularly at 0.25 inches or less. However, Virginia buttonweed's ability to be competitive in this situation has not been studied.

Virginia buttonweed is a member of the Rubiaceae (Madder) family, which includes 10 genera and 50 plus species. Among the genera of the Rubiaceae are bedstraw (*Galium*), bluets (*Hedyotis* and *Houstonia*), field madder (*Sherardia* and Florida pusley (*Richardia scabra* L.). Poorjoe (*Diodia teres* Watt.) is similar to Virginia buttonweed but is an annual. The stems and leaves of poorjoe are less coarse, and the seed pods are smaller than those of Virginia buttonweed (1). Poorjoe apparently is not a serious problem in high-maintenance turfgrassses but is found on roadsides and pastures.

Preliminary work in 1974 indicated that the rate(s) of 2,4-D or mixtures containing 2,4-D as a single application necessary to achieve fair to good control of Virginia buttonweed were too high to maintain adequate turfgrass (common bermudagrass) quality.

The primary objective of the work reported here was to determine postemergence herbicide efficacy on Virginia buttonweed. Tolerance of common bermudagrass to these treatments also was evaluated.

Materials and Methods

Phenoxy/Dicamba Combinations

Our objective in these studies was to evaluate 2,4-D or herbicide combinations containing 2,4-D for Virginia buttonweed control under field conditions. Specifically we evaluated 2,4-D alone, 2,4-D + dicamba and 2,4-D + mecoprop (MCCP) + dicamba.

Studies were conducted in 1979 at Northwood Country Club, Meridian; MSU Golf Course, Starkville and Bel Air Country Club, Tupelo. All plots were in common bermudagrass turf maintained as golf-course fairway (0.5 inch mowing height).

Plots were 3 x 20 feet arranged in a randomized complete block design replicated four times. Herbicide applications were made with a compressed-air bicycle sprayer. Spray volume was 30 gpa, including 0.25% nonionic surfactant (Multi Film X-77®). Application rates, intervals and number of applications are summarized in Tables 1-5.

Weed-control and turf-tolerance ratings were made at about 14-day intervals following treatment. A scale of 0 to 100 was used with 0 = no control or no turf injury and 100 = complete control of buttonweed or complete turf kill. We assessed control of Virginia buttonweed as excellent (90 or higher), good (80 or better), marginal (70 to 80) or unacceptable (below 70). Turf injury was considered to be unacceptable if the average rating exceeded 25 (25% injury).

2,4-D/Dicamba Ratios

Experiments were conducted in 1980 and 1981 to evaluate the efficacy of different dicamba ratios.

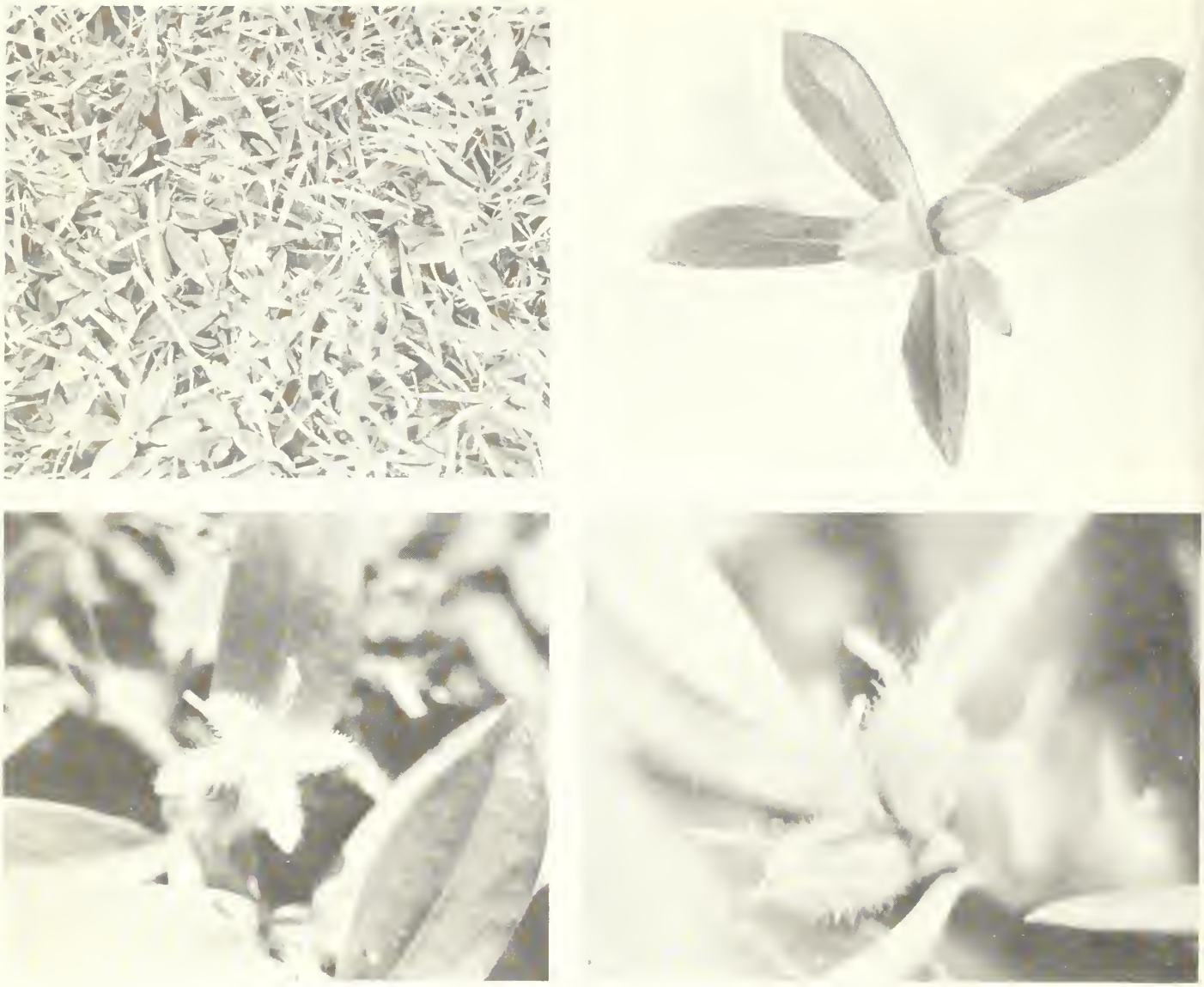

Figure 1. Virginia buttonweed: (A) mature plants in common bermudagrass turf, (B) seedlings - opposite, sessile leaves, (C) white flower (corolla) with inner (upper) surface pubscent, and (D) pubscent, ridged fruit (seed).

These studies were conducted at the MSU Golf Course, Starkville and Columbus Country Club, Columbus.

Our objective was to determine the effect of varying the amount of dicamba in the 2,4-D + dicamba mix on Virginia buttonweed control. Dicamba rates evaluated in combination with 1 lb/acre 2,4-D were 0.50, 0.25, 0.17, 0.12, 0.06 and 0.03 lb/acre. These combinations were compared to 2,4-D (1 lb/acre) or dicamba (0.25 and 0.50 lb/acre) alone.

Application techniques, application parameters and evaluations were the same as previously described.

Results and Discussion

Phenoxy/Dicamba Combinations

Results of studies at all three locations were essentialy the same. Only the data from the Bel Air Country Club are presented (Tables 1,2, and 3).

Virginia buttonweed control with 2,4-D alone was not acceptable (Table 1). The maximum level of control achieved with a normal use rate (1 lb/acre application) rerely exceeded 50%. Regrowth of Virginia buttonweed was observed within two to four weeks after the last application, except when four applications at biweekly intervals (1 lb/acre application) were used. The only significant turf injury occurred following a single application of 4 lb/acre. However, this injury was not observed two weeks later.

The herbicidal activity of 2,4-D + mecoprop + dicamba (Table 1), was better than that of 2,4-D alone (Table 1). The level and duration of control with the addition of mecoprop and dicamba (0.5 + .1 lb/acre) to 2,4-D (1 lb/acre) averaged about 20% better than with 1 lb/acre of 2,4-D alone.

Injury of the common bermudagrass turf was greater with the three-way combination than with 2,4-D alone. However, injury did not persist for more than two consecutive ratings (four weeks) unless the total amount of 2,4-D in the combination exceeded 4 lb/acre.

Virginia buttonweed control with 2,4-D + dicamba was better than with 2,4-D alone or the three-way combination (Table 3). The most striking difference was in the longer

Table 1. Effect of 2,4-D rate, application interval, and number of applications on Virginia buttonweed control at various time intervals after the initial treatment at Bel Air Country Club, Tupelo, MS. First application was made July 18, 1979.

2,4-D Rate	Days of application	Virginia Buttonweed Control[a], 9 DAIT	15 DAIT	30 DAIT	51 DAIT	72 DAIT	86 DAIT
(lb/A)		(%)					
1.0	1	47.5 d	12.5 d	00.0 d	00.0 d	00. d	00.0 c
1.0	1, 15	52.5 d	60.0 b	12.5 c	00.0 d	00.0 d	00.0 c
1.0	1, 30	47.5 d	10.0 d	17.5 b	10.0 cd	00.0 d	00.0 c
1.0	1, 15, 30	50.0 d	57.5 bc	75.0 ab	60.0 a	37.5 b	27.5 b
1.0	1, 30, 72	47.5 d	12.5 d	12.5 c	27.5 b	22.5 b	00.0 c
1.0	1, 15, 30, 51	52.5 d	62.5 b	72.5 b	67.5 a	65.0 a	47.5 a
2.0	1, 15	72.5 c	80.0 a	67.5 b	00.0 d	00.0 d	00.0 c
2.0	1, 30	80.0 b	50.0 c	82.5 a	15.0 c	05.0 d	00.0 c
4.0	1	90.0 a*	17.5 d	00.0 d	00.0 d	00.0 d	00.0 c
Check	0	00.0 e	00.0 e	00.0 d	00.0 d	00.0 d	00.0 c

[a] All means within a column followed by the same letter do not differ significantly according to DMRT at .05 level of probability. Control rating system; 0 = no control, 100 = complete control. DAIT = day after initial treatment

* Indicates unacceptable turf injury (25% or higher discoloration).

Table 2. Effect of 2,4-D + mecoprop (MCPP) + dicamba rate, application intervals, and number of applications on Virginia buttonweed control at various time intervals after the initial treatment at Bel Air Country Club, Tupelo, MS. First application was made July 18, 1979.

2,4-D[a] Rate	Days of application	Virginia Buttonweed Control[b], 9 DAIT	15 DAIT	30 DAIT	51 DAIT	72 DAIT	86 DAIT
(lb/A)		(%)					
1.0	1, 15	72.5 bcd	72.5 de	62.5 d	27.5 f	00.0 e	00.0 e
1.0	1, 30	65.0 d	47.5 f	75.0 bc	65.0 cd	32.5 d	17.5 d
1.0	1, 15, 30	65.0 d	75.0 cd	77.5 ab*	50.0 e	05.0 e	00.0 e
1.0	1, 30, 72	67.5 d	45.0 f	82.5 f	72.5 bcd	72.5 abc	65.0 b
1.0	1, 15, 30, 51	72.5 bcd	72.5 de	77.5 ab	80.0 ab*	65.0 c*	50.0 c*
2.0	1	80.0 ab*	65.0 e	35.0 e	12.5 g	00.0 e	00.0 e
2.0	1, 15	82.5 ab*	82.5 b	70.0 c*	32.5 f	00.0 e	00.0 e
2.0	1, 30	82.5 ab	65.0 e	80.0 ab	65.0 cd	30.0 d	20.0 d
2.0	1, 15, 30	85.0 a	87.5 ab	85.0 a*	62.5 d*	32.5 d	20.0 d
2.0	1, 30, 72	82.5 ab*	65.0 c	82.5 ab*	75.0 abc*	77.5 ab	70.0 b
2.0	1, 15, 30, 51	82.5 ab*	82.5 b	80.0 ab*	72.4 bcd*	72.5 abc	65.0 b
Check	-	00.0 e	00.0 g	00.0 f	00.0 h	00.0 e	00.0 e

[a] Rate of 2,4-D in 2.2 + 1.1 + .22 lb/gal (2,4-D + mecoprop + dicamba) formulation.

[b] All means within a column followed by the same letter do not differ significantly according to DMRT at .05 level of probability. Control rating system; 0 = no control, 100 = complete control. DAIT = day after initial treatment.

* Indicates unacceptable turf injury (25% or higher discoloration).

Table 3. Effect of 2,4-D + dicamba rate, application interval, and number of applications on Virginia buttonweed control at various time intervals after the initial treatment at Bel Air Country Club, Tupelo, MS. First application made July 18, 1983.

2,4-D[a] Rate	Days of application	Virginia Buttonweed Control[b], 9 DAIT	15 DAIT	30 DAIT	51 DAIT	72 days	86 DAIT
(lb/A)		(%)					
1.0	1	87.5 b*	87.5 b*	80.0 c	77.5 b	67.5 c	42.5 e
1.0	1, 15	85.0 bc*	82.5 b	87.5 b	72.5 c	65.0 c	57.5 d
1.0	1, 30	82.5 c*	85.0 b	100.0 a	100.0 a	92.5 a	72.5 c
1.0	1, 15, 30	85.0 bc*	77.5 b*	85.0 b	77.5 b	100.0 a	90.0 b
1.0	1, 30, 72	87.5 bc*	87.5 b*	100.0 a	100.0 a	100.0 a	100.0 a
1.0	1, 15, 30, 51	100.0 a*	100.0 a*	100.0 a*	100.0 a*	65.0 c	42.5 e
2.0	1, 15	100.0 a*	100.0 a*	100.0 a*	100.0 a*	80.0 b	75.0 c
2.0	1, 30	100.0 a*	100.0 a*	100.0 a*	100.0 a*	67.5 c*	70.0 c
4.0	1	100.0 a*	100.0 a*	100.0 a*	100.0 a	80.0 b	67.5 c
Check	-	00.0 d	00.0 c	00.0 d	00.0 d	00.0 d	00.0 f

[a] 2,4-D rate of the 1.25 + .12 lb/gal formulation.

[b] All means within a column followed by the same letter do not differ significantly according to DMRT .05 level of probability. Control rating system; 0 = no control, 100 = complete control. DAIT = day after initial treatment.

* Indicates unacceptable turf injury (25% or higher discoloration).

regrowth time following the final application. This was especially noticeable with the 1 lb + .1 (2,4-D + dicamba) rates of application. Regrowth occurred in four to six weeks following the final application with both biweekly or monthly applications.

When the rate was doubled (2 + .2 lb/acre, 2,4-D + dicamba) control of Virginia buttonweed increased; however, injury to the turf also increased significantly. The level of injury and length of time that injuy persisted make this rate unacceptable.

2,4-D/Dicamba Ratios

Results of studies involving a single application or monthly applications are recorded in Tables 4 and 5, respectively. Overall control in 1980 was better than in 1981. This was especially true when only one application was made. This difference most likely was attributable to higher temperatures and lower rainfall in 1981 than in 1980. These factors contributed to reduced regrowth potential of the Virginia buttonweed. Consequently, ratings were higher (better control) due to the lack of buttonweed regrowth.

The benefit of 2,4-D + dicamba was greater than that of either herbicide alone under the more adverse growing conditions in 1981. The higher dicamba rate (0.5 lb/acre) tended to be better than 2,4-D at 1 lb/acre.

Two applications gave better control than a single application, especially under the more adverse growing conditions. This was particularly noticeable 30 days after the last application.

The level of Virginia buttonweed control increased as the amount of dicamba in the mix (2,4-D + dicamba) was increased. Based on these studies, environmental conditions appeared to be an important factor in the control of buttonweed. The benefit of the addition of dicamba to 2,4-D was greater under the more adverse environmental conditions.

Table 4. Effect of a single application of selected ratios of 2,4-D:dicamba on Virginia buttonweed control at biweekly intervals following treatment. First application was July 18, 1980 (Columbus) or July 16, 1981 (Starkville).

		Virginia Buttonweed Control[a],							
		Starkville 1980[c]				Columbus 1981[d]			
Treatment	Rate	14 DAIT	28 DAIT	42 DAIT	56 DAIT	14 DAIT	28 DAIT	42 DAIT	57 DAIT
	(lb/A)	(%)							
2,4-D + dicamba	1.0 + .03	100.0 a*	80.0 ab	85.0 a	82.5 a	27.5 de	35.0 c	35.0 d	27.5 cd
2,4-D + dicamba	1.0 + .06	97.5 a*	90.0 a	82.5 a	90.0 ac	42.5 cd	82.5 ab	55.0 cd	55.0 a-c
2,4-D + dicamba	1.0 + .12	90.0 a*	70.0 ab	95.0 a	72.5 abc	65.0 abc	77.5 ab	52.5 cd	40.0 bc
2,4-D + dicamba	1.0 + .17	100.0 a*	77.5 ab	87.5 a	92.5 abc	77.5 abc	90.0 a	85.0 ab	67.5 ab
2,4-D + dicamba	1.0 + .25	100.0 a*	82.5 ab	85.0 a	97.5 ab	70.0 ab	82.5 ab	62.5 bcd	52.5 abc
2,4-D + dicamba	1.0 + .50	100.0 a	97.5 a	95.0 a	100.0 a	85.0 a	92.5 a	90.0 a	75.0 a
2,4-D	1.0	95.0 a	80.0 ab	47.5 b	65.0 c	30.0 de	62.5 b	47.5 cd	27.5 cd
dicamba	0.50	82.5 a*	65.0 ab	50.0 b	70.0 bc	50.0 bcd	82.5 ab	70.0 abc	62.5 ab
dicamba	0.25	85.0 a*	50.0 b	50.0 b	67.5 c	12.5 ef	62.5 b	52.5 cd	25.0 cd
Check	-	00.0 b	00.0 c	00.0 c	00.0 d	00.0 f	00.0 d	00.0 e	00.0 d

[a] All means within a column followed by the same letter do not differ at the 0.05 level according to DMRT. Control rating system; 0% = no control, 100% = complete control. DAIT = day after initial treatment.

* Indicates unacceptable turf injury (25% or higher discoloration).

Table 5. Effect of a monthly application of selected ratios of 2,4-D:dicamba on Virginia buttonweed at biweekly intervals following treatment. First applications were made July 18, 1980 (Columbus) or July 16, 1983 (Starkville). The second applications were made 28 days later.

		Virginia Buttonweed Control[a]							
		Starkville 1980				Columbus 1981			
Treatment	Rate	14 DAIT	28 DAIT	42 DAIT	56 DAIT	14 DAIT	28 DAIT	42 DAIT	57 DAIT
	(lb/A)	(%)							
2,4-D + dicamba	1.0 + .03	98.5 ab*	80.0 ab	90.0 a*	97.5 a	32.5 de	42.5 c	82.5 a	75.0 a
2,4-D + dicamba	1.0 + .06	95.0 ab*	80.0 ab	100.0 a*	100.0 a*	55.0 b-d	80.0 ab	92.5 a	85.0 a
2,4-D + dicamba	1.0 + .12	75.0 b	92.5 a	100.0 a*	100.0 a	67.5 ab	87.5 a	97.5 a	87.5 a
2,4-D + dicamba	1.0 + .17	100.0 a	85.0ab*	100.0 a*	100.0 a*	67.5 ab	80.0 ab	95.0 a*	70.0 a
2,4-D + dicamba	1.0 + .25	100.0 a*	90.0 a	100.0 a*	100.0 a	67.5 ab	85.0 a	82.5 a	92.5 a
2,4-D + dicamba	1.0 + .50	97.5 ab*	92.5 a	100.0 a*	100.0 a*	80.0 a	95.0 a	100.0 a*	92.5 a
2,4-D	1.0	95.0 ab	90.0 a	100.0 a*	100.0 a	42.5 cd	82.5 a	97.5 a	87.5 a
dicamba	0.50	77.5 ab*	67.5 ab	85.0 a	97.5 a	47.5 bcd	75.0ab	100.0 a	72.5 a
dicamba	0.25	85.0 ab	52.5 b	80.0 a	85.0 a*	15.0 ef	55.0 bc	95.0 a	82.5 a
Check	-	00.0 c	00.0 c	00.0 b	00.0 b	00.0 f	00.0 d	00.0 b	00.0 b

[a] All means within a column followed by the same letter do not differ at the 0.05 level according to DMRT. Control rating system: 0% = no control, 100% = complete control. DAIT = day after initial treatment.

* Indicates day of additional application(s).

Summary Comments

The best herbicide or herbicide combination of the materials evaluated for Virginia buttonweed control was 2,4-D + dicamba. Changing the 2,4-D/dicamba ratio resulted in a slight change in the level of control. Addition of dicamba above the normal 10:1 ratio does not appear warranted unless adverse environmental conditions exist.

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