Efficacy and Economics of Common Bermudagrass (*Cynodon dactylon*) Control in Peanut (*Arachis hypogaea*)

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ABSTRACT

Field experiments were conducted in 1988 and 1989 to evaluate various postemergence graminicides for common bermudagrass (*Cynodon dactylon* (L). Pers.) control in peanuts (*Arachis hypogaea*). A single application of fluazifop-P [(R)-2-[4[[5-(trifluoromethyl)-2-pyridinyl]oxy]phenoxy]propanoic acid] or clethodim [(E, E)-(±)-2-[1-[[(3-chloro-2-propenyl)oxy]imino]propyl]-5-[2-ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one] controlled approximately 25 to 30% more common bermudagrass than a single application of sethoxydim (2-[1-(ethoxyimino) butyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one) or quizalofop [(±)-2-[4[(6-chloro-2-quinoxalinyl)oxy]phenoxy]propanoic acid]. Two graminicide applications were required for greater than 90% common bermudagrass control. Treatments which provided greater than 90% control included two applications of sethoxydim (0.31 followed by (fb) 0.31 kg ha^{-1}or 0.31 fb 0.16 kg ha^{-1}), fluazifop-P (0.21 fb 0.21 kg ha^{-1}) or 0.21 fb 0.11 kg ha^{-1}), and clethodim (0.28 fb 0.28 kg ha^{-1}). These same treatments provided complete common bermudagrass control when evaluated the following summer. Peanut yield and net return from a single graminicide application generally were not improved with two applications.

Key Words: Economic analysis; net returns; common bermudagrass, *Cynondon dactylon*; peanut, *Arachis hypogaea*.

Common bermudagrass (*Cynodon dactylon* (L.) Pers.) is the most troublesome weed for Virginia peanut producers (4). There are no registered herbicide(s) available for application at planting to provide control in peanut (*Arachis hypogaea* L.) (2, 6). Consequently, postemergence-applied graminicdes are the only control option available.

Common bermudagrass can reproduce vegetatively, from rhizomes and stolons, or by producing seeds (7). The extensive network of rhizomes and stolons makes bermudagrass particularly difficult to eradicate. Cultivation tends to spread the rhizomes and stolons throughout the field (7). Cultivation in peanut also tends to increase the spread of soil-borne disease organisms (8). Common bermudagrass reduces

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[2]Storm® (a mixture of 159 g acifluorfen and 320 g bentazon L-1). BASF Corp., 100 Cherry Hill Rd., Parsippany, NJ 07054.

[3]Agridex (a mixture of paraffin base petroleum oil, polyoxyethylate polyol fatty acid ester and polyol fatty ester). Helena Chem. Co., Memphis, TN.

[4]Dash spray tank adjuvant label, BASF Corp., 100 Cherry Hill Rd., Parsippany, NJ 07054.

[5]X-77 (a mixture of alkylaryl-polyoxyethylene glycols, free fatty acids, and isopropanol). Valent USA Corp., San Francisco, CA.

peanut yield by competition for moisture, sunlight, and nutrients but also reduces harvesting efficiency as peanut fruits become embedded in its extensive root system (6). Consequently, near complete control is desired by producers.

Sethoxydim (2-[1(ethoxyimino) butyl]-5-[2-ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one) was the only herbicide registered for postemergence control of annual and perennial grasses in peanut at the time this research was initiated. Several other herbicides including fluazifop-P [(R)-2-[4[[5-(trifluoromethyl)-2-pyridinyl]oxy]phenoxy] propanoic acid], clethodim [(*E*, *E*)-(±)-2-[1[[(3-chloro-2-propenyl)oxy]imino]propyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one], and quizalofop [(±)-2-[4[(6-chloro-2-quinoxalinyl)oxy]phenoxy] propanioc acid] are also being evaluated for annual and perennial grass control in peanut (5, 6). According to product labels and extension recommendations for various agronomic broadleaf crops, two applications of a postemergence-applied graminicide are usually required for acceptable common bermudagrass control. However, two applications are often considered to be cost prohibitive.

The economic assessment of weed management systems is essential information to maximize profits (9). By using a multidisciplinary approach, weed research encompassing both herbicide efficacy and economic profitability can be examined. This approach identifies efficacious as well as cost-effective weed management systems that benefit producers most.

The objectives of this research were to evaluate various postemergence-applied graminices for efficacy in controlling common bermudagrass, and their effect on peanut yield, and economic profitability.

Materials and Methods

Experiments were conducted near Capron, Virginia on a Norfolk sandy loam (Plinthic Paleudults). The experimental area was maintained as a common bermudagrass pasture for at least 5 years prior to this test. A different site was used each year to ensure a uniform common bermudagrass population. Soil organic matter was 0.8% in 1987 and 1988 and pH was 5.7 and 5.8, respectively. Florigiant peanut in 1988 and NC 7 peanut in 1989 were planted 5 cm deep at a rate of 112 kg ha^{-1} in a well-prepared flat seedbed using conventional equipment . Individual plots were four rows, spaced 91 cm apart and 6.1 m long. Planting dates were May 27, 1988 and May 25, 1989.

Alachlor (2-chloro-*N*-(2,6-diethylphenyl)-*N*-(methoxymethyl) acetamide) was applied at 2.24 kg ai ha^{-1} to all plots to control annual grasses. Aciflourfen (5-[2-chloro-4(trifluoromethyl) phenoxy]-2-nitrobenzoic acid) plus bentazon (3-(1-methylethyl)-(1*H*)-2, 1, 3-benzothiadiazin-4(3*H*)-one 2,2-dioxide) was applied as a prepackage commercial mixture[2] and with a petroleum oil adjuvant[3] at 1.25% of the spray volume (v/v) to control annual broadleaf weeds.

Graminicide treatments consisted of a factorial arrangement of four herbicides and four methods of application, resulting in 16 treatments and a nontreated weedy control. A randomized complete block design with three replications was used. The graminicides were clethodim, fluazifop-P, quizalofop, and sethoxydim. These graminicides were applied as: 1) a single application at the '1X' rate, i.e., the normal use rate as recommended by the manufacturer; 2) sequential applications, as 1X followed by (fb) 1X rate; 3) sequential applications where each application was at the 0.5X rate (0.5X fb 0.5X); and 4) sequential applications, the first at the 1X rate, the second at the 0.5X rate (1X fb 0.5X).

Postemergence-applied graminidices were initially applied when common bermudagrass plants were approximately 15 cm in diameter. Sequential applications were applied approximately 3 weeks later when common bermudagrass was 20 cm in diameter. Gramincides and rates of application are listed in Table 1. Sethoxydim was applied with BCH 81508S[4] at 1.25% (v/v); fluazifop-P and quizalofop were applied with a nonionic surfactant[5] at 0.25% (v/v), and clethodim with a petroleum oil concentrate[3] at 1.25% (v/v). BCH 81508S is an adjuvant for use with sethoxydim and has been shown to improve common bermudagrass control when used instead of a petroleum oil adjuvant (10).

All herbicides were applied with a tractor-mounted sprayer that used compressed air as the propellant at 220 kPa and delivered 187 L ha^{-1}. Data collected included visual estimates of weed control by species, peanut yield, and grade. Visual estimates of common bermudagrass control were made in early August and early September each year and in the summer of the following year for evaluation of regrowth. Visual estimates of weed control were based on a scale of 0% (no control) to 100% (complete control) on the basis of population density and plant vigor. Peanuts were harvested and graded using conventional harvesting equipment.

An enterprise budget was prepared for each plot using budgets prepared by the Virginia Cooperative Extension Service for peanut production. All costs, with the exception of those used for weed control, were based on this budget generator. Herbicide prices were based on an average cost quoted by three suppliers from the peanut-producing area in Virginia. The production costs included cultural and pest management procedures, equipment and labor, interest on operating capital, harvest operations including drying and hauling, and general overhead cost. A net return to land, overhead, and management was calculated for each plot as the difference between the gross receipts and the sum of variable and ownership costs. Gross receipts were calculated for the sale of peanut at $650 for 1000 kg in 1988 and $685 for 1000 kg in 1989.

Five peanut samples were taken at random from the test, shelled, combined, and graded to determine percentage (wt/wt) of sound mature kernels and sound split kernels (3) and used with yield data to determine gross receipts.

Visual estimates of weed control were arcsin transformed prior to analyses of variance. Visual estimates of weed control, peanut yield, and net

Table 1. Influence of postemergence grass herbicides on common bermudagrass control, peanut yield, and net return[a].

Postemergence herbicide treatments	Rate[b]	Common bermudagrass control: Late season	Following summer	Peanut yield	Net return
	Kg ha^{-1}	%	%	Kg ha^{-1}	$ ha^{-1}
Sethoxydim	0.31	32	34	2640	139
	0.31 fb 0.31	92	100	2720	155
	0.16 fb 0.16	81	90	3360	532
	0.31 fb 0.16	90	100	3270	456
Fluazifop-P	0.21	69	56	3390	654
	0.21 fb 0.21	99	100	3250	495
	0.11 fb 0.11	87	88	3200	481
	0.21 fb 0.11	98	100	3690	833
Quizalofop	0.22	44	40	3040	376
	0.22 fb 0.22	79	65	3180	366
	0.11 fb 0.11	79	68	3190	486
	0.22 fb 0.11	80	65	3290	523
Clethodim	0.28	66	72	3370	-
	0.28 fb 0.28	90	100	3060	-
	0.14 fb 0.14	76	72	2740	-
	0.28 fb 0.14	84	80	2950	-
Weedy check	-----------	0	0	2840	283
LSD (0.05)		12	14	510	180

[a]Common bermudagrass was the only weed in the weedy checks, annual grasses and broadleaf weeds were controlled with herbicides. As a result, only common bermudagrass interference influenced peanut yield in these plots.

[b]fb (followed by) indicates a sequential treatment.

returns were subjected to analysis of variance, and means were compared with appropriate Fisher's Protected Least Significant Difference (LSD) Test at the 10% level of probability. Visual estimates of weed control are expressed in their original form for reader clarification. Analyses of variance revealted no significant treatment by year interaction; consequently, data were combined for presentation.

Results and Discussion

Weed Control

Single applications of fluazifop-P and clethodim controlled 69% and 66% of the common bermudagrass, respectively. Applications of sethoxydim and quizalofop were appreciably less effective (32% and 44% control, respectively). For all the gramincides, sequential applications, even at the lower rates, provided at least 79% control. The exception was clethodim applied sequentially at 0.14 fb 0.14 kg ha^{-1} which provided 74% control. York, *et al.* (10) reported better common bermudagrass control with sequential applications of sethoxydim. However, Grichar, *et al.* (6) reported that fluazifop-P and sethoxydim activity was generally not improved with sequential applications compared to one application. Banks, *et al.* (1) reported that two applications of graminicides did not improve johnsongrass (*Sorghum halepense* (L.) Pres.) control as compared with one application.

Highest levels of common bermudagrass control (>87%) were from any of the fluazifop-P sequentials, sethoxydim sequentials of 0.31 fb 0.31 kg ha^{-1} or 0.31 fb 0.16 kg ha^{-1}, and with the clethodim sequential of 0.28 fb 0.28 kg ha^{-1}. Common bermudagrass control from quizalofop was improved with sequential applications but was not equivalent to the better fluazifop-P sequentials.

Except for the clethodim sequential at 0.14 fb 0.14 kg ha-1, there were no differences in level of common bermudagrass control from sequential applications obtained within the same herbicide. Sequential applications at the 1X rate each, 0.5X rate each, or 1X rate fb 0.5X rate were equivalent.

Control was numerically greater with sequential systems where the initial application was at the higher rate except for quizalofop. Control from quizalofop sequentials did not differ with rate of application or system. The greatest control was obtained with fluazifop-P sequentials applied either at 0.21 fb 0.21 kg ha^{-1} (99%), or by 0.21 fb 0.11 kg ha^{-1} (98%). Sethoxydim sequentials provided equivalent control when the initial application was 0.31 kg ha^{-1}. Reducing the second application rate did not reduce control. Clethodim applied at 0.28 fb 0.28 kg ha^{-1} provided control equivalent to the fluazifop-P sequentials. However, reducing the first and/or the second application rate provided control less than the fluazifop-P sequentials. No quizalofop system provided control equivalent to the better fluazifop-P sequentials.

Control evaluated the following summer followed the same trends as evaluations the preceding year. Complete eradication (100%) was obtained with sethoxydim at 0.31 fb 0.31 or 0.31 fb 0.16 kg ha^{-1}, fluazifop-P sequentials at 0.21 fb 0.21 kg ha^{-1} or 0.21 fb 0.11 kg ha^{-1}, and clethodim at 0.28 fb 0.28 kg ha^{-1}. Nearly complete control (88 to 90%) was also obtained with the remaining sethoxydim and fluazifop-P sequential systems. None of the systems that utilized quizalofop reached this level of control. These results correspond with earlier studies where graminicides providing good control of johnsongrass during the growing season also provided similar levels of control the following year (1).

Yield

Peanut harvested from the common bermudagrass weedy-check yielded 2840 kg ha^{-1}. Only four gramicide treatments improved peanut yields. These systems were sequential applications of sethoxydim (0.16 fb 0.16 kg ha^{-1}), fluazifop-P (0.21 fb 0.11), or single applications of fluazifop-P (0.21 kg ha^{-1}) and clethodim (0.28 kg ha^{-1}).

Generally, it would be expected that controlling common bermudagrass would result in significant yield improvement. However, the 1988 and 1989 growing seasons were characterized by abundant and well-distributed rainfall (46 cm and 61 cm, respectively) during June, July, August, and September which may have served to mask weed competition. In addition, the very sandy soils resulted in little yield reductions from common bermudagrass interference with harvesting operations. Grichar and Boswell (6) in Texas also had no yield response to common bermudagrass control. They had also controlled all weeds present in the test except for common bermudagrass.

Net returns

Maximum net return ($833 ha^{-1}) was provided by the fluazifop-P sequential (0.21 fb 0.11 kg ha^{-1}) treatment. The next three most profitable treatments in descending order (though statistically equivalent to each other) were fluazifop-P (0.21 kg ha^{-1}) at $654 ha^{-1}, sethoxydim (0.16 fb 0.16 kg ha^{-1}) at $532 ha^{-1}, and quizalofop (0.22 fb 0.11 kg ha^{-1}) at $523 ha^{-1}. There were only three other treatments that provided greater net returns than the common bermudagrass infested weedy-check. These treatments include fluazifop-P (0.21 fb 0.21 kg ha^{-1}) at $495 ha^{-1}, fluazifop-P (0.11 fb 0.11 kg ha^{-1}) at $481 ha^{-1}, and quizalofop (0.11 fb 0.11 kg ha^{-1}) at $486 ha^{-1}. Clethodim is not registered on any crop and consequently, economic returns could not be calculated for these treatments.

Common bermudagrass continues to spread in Virginia peanut fields and is found in a majority of the fields (author's' observations). It would appear that sequential applications of a postemergence-applied graminicide would eliminate this noxious pest if coupled with eradication programs around field edges.

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