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Soybean Response to Quinclorac and Triclopyr

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Nontarget crops may be grown adjacent to rice (*Oryza sativa* L.) fields. Growers and applicators are aware of potential injury to these crops from drift of herbicides used to control weeds in rice. This awareness was born from past experience using the chlorophenoxy herbicides in which drift from aerial applications resulted in injury to cotton (*Gossypium hirsutum* L.) and other susceptible crops or nontarget species. More commonly in the Mississippi Delta, the adjacent crop to rice is soybeans [*Glycine max* (L.) Merr].

Smith (3) reported that 2,4,5-T [(2,4,5-trichlorophenoxy)acetic acid] at 0.05 lb/A, 5% of the use rate, reduced `Lee' soybean yield 30 and 26% when applied to plants at the V5 and R1 growth stages, respectively. Similar applications of 2,4-D [(2,4-dichlorophenoxy)acetic acid] resulted in 19 and 8% yield reductions, respectively.

Propanil [N-(3,4-dichlorophenyl)propanamide] at 5% of its use rate reduced 'Hill' soybean yields 10 and 23% applied at the V6 and R2 growth stages, respectively (1). However, soybean cultivars are known to respond differentially to propanil (4). Even so, optimum weed control in rice culture is generally accomplished by selective herbicides applied aerially.

With the loss of the herbicide 2,4,5-T in rice, research was initiated to find a selective herbicide alternative. Keeping abreast of and evaluating new chemistry that provides selective weed control is a basic objective of weed science research. This effort has resulted in the use of triclopyr [(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid (GrandstandÆ) under a Section 18 emergency exemption as the most effective alternative to 2,4,5-T. Conditional registration has been received for the herbicide quinclorac (3,7-dichloro-8-quinolinecarboxylic acid) (FacetÆ) for use in rice preemergence (PRE) or early postemergence (POE).

With soybeans as the predominant companion crop to rice, there is a potential for drift from applications of these two products when applied to rice. Therefore, experiments were conducted to determine the effects of quinclorac and triclopyr applied at theoretical drift rates on soybeans.

Procedures

Randomized complete block field experiments were conducted at the Delta Branch Experiment Station in 1990, 1991, and 1992. Soil type was a Dundee silt loam. Quinclorac and triclopyr were applied POE at 0, 0.0117, 0.0234, and 0.0469 lb ai/A to `Avery,' `Epps,' and `TV 626' soybeans at the V1 (unifoliolate leaf), V5 (4 trifoliolates), or R1 (initial bloom--10% of plants with blooms) growth stages. The rates 0.0117, 0.0234, and 0.0469 lb ai/A represent theoretical drift rates of 3.1, 6.25, and 12.5%, respectively, of the 0.375 lb ai/A rate used in rice production. These rates were based on spray droplet distribution data gathered from a CessnaÆ 188B Ag-WagonÆ equipped with combination pressure nozzles applying 5 gallons of water per acre 10 feet above the target.

Figure 1 shows that 6% of the total spray droplets collected from the Cessna Ag-Wagon were 100 microns or less in diameter. With a 3-mile-per-hour crosswind, spray droplets 100 microns in diameter will drift up to 409 feet from the target site when falling 10 feet (2). Thus, 6% (0.0234 lb/A) was chosen as a probable drift rate.

Avery, Epps, and TV 626 represented indeterminate maturity group IV, determinate maturity group V, and determinate maturity group VI, respectively. Separate experiments were used to evaluate the effects of each herbicide on each cultivar. Each experiment was replicated three times in 1990, and four times in 1991 and 1992. Plots were maintained weed free each year by hand hoeing.

Avery soybeans were planted in mid-April, and Epps and TV 626 were planted in early to late May (Table 1). Plots consisted of three, 30-inch rows, 40 feet in length in 1990; four rows 35 feet in length in 1991; and four rows 15 feet in length in 1992. Rows two and three of the plots received the treatments applied in water plus 0.25% (v/v) X-77 nonionic surfactant at 5 gallons per acre with a tractor-mounted compressed air sprayer in 1990, and with a carbon dioxide-pressurized back-pack sprayer in 1991 and 1992. Treatment dates are listed in Table 1.

Soybean injury was determined by visually rating the plots beginning one week after treatment (WAT) and weekly thereafter through 5 WAT. The rating scale was 0 = no injury to 100% = plant death.

Yields were determined by combine harvesting the treated rows of each plot. Avery was harvested the first or second week of September, Epps in early October, and TV 626 in late October (Table 1). All data were subjected to analysis of variance procedure by year. Means were compared using Duncan's multiple range test (DMRT) (P = 0.05).

Results

Quinclorac

Visual injury. Visual injury symptoms from quinclorac were apparent within 24 hours of treatment. Initially, the leaflets were cupped downward (Figure 2, left), and soon thereafter the leaf margins appeared serrated Figure 2, center). Leaflets that were not fully expanded at time of application were strapped shaped with parallel venation and severe puckering (Figure 2, right). Leaf puckering persisted for more than 6 weeks after treatment with 0.0469 lb/A quinclorac. There was no apparent injury to the plant leaf petiole or stem tissue. No visual injury symptomology differences were apparent among the three soybean cultivars.

Maximum visual soybean injury resulting from quinclorac each year occurred 2 WAT regardless of soybean cultivar, soybean growth stage, or quinclorac rate (Tables 2-4). Thus, injury ratings 1, 3, and 4 WAT are not presented. Quinclorac applied to R1 Avery soybeans at the V5 stage at 0.0469 lb/A resulted in 46% injury in 1990, 47% injury in 1991, and 53% injury in 1992 (Table 2). The greatest injury to Epps occurred from 0.0469 lb/A applied at the R1 stage in 1990, and at the V5 stage in 1991 and 1992 (Table 3). Injury to TV 626 was highest from 0.0469 lb/A applied at the V5 stage in 1990 and 1991, and at the R1 stage in 1992 (Table 4). Except for 0.0469 lb/A applied at R1 (26%) to Avery in 1990, and 0.0234 lb/A and 0.0469 lb /A applied at V5 and all rates at R1 to Epps in 1991, visual injury was less than 20% 5 WAT.

Injury 2 WAT increased as quinclorac rate increased each year regardless of soybean cultivar. Averaged across growth stages, injury 2 WAT to Avery ranged from 12% at 0.0117 lb/A to 41% at 0.0469 lb/A. Injury to Epps ranged from 7% to 38%, and injury to TV 626 ranged from 9% at 0.0117 lb/A to 28% at 0.0469 lb/A.

Injury to Avery was approximately the same regardless of growth stage in 1990, averaged across quinclorac rates. In 1991 and 1992 more injury resulted from the V5 and R1 applications. Quinclorac was more injurious to Epps when applied at the R1 stage in 1990, and at the V5 and R1 stages in 1991; but injury was about equal for all stages in 1992. TV 626 injury was greatest from the V5 applications all 3 years, but injury from the R1 applications in 1992 were about equal to the injury at the V5 stage.

Soybean yield. compared to the untreated control, quinclorac did not affect Avery and Epps yield in 1991 and 1992 nor TV 626 yield in 1990 and 1991 (Figures 3-5). In 1990, 0.0469 lb/A applied to Avery at all growth stages 1990, yields were significantly reduced (5 bu/A) by 0.0234 lb/A. Epps yield was significantly reduced (12 bu/A) when treated at the R1 stage with quinclorac at 0.0469 lb/A in 1990 (Figure 4). In 1992, TV 626 yields were significantly reduced by 0.0469 lb/A quinclorac applied at the V1 (9 bu/A) and R1 (11 bu/A) stages (Figure 5).

Averaged across growth stages, Avery yields ranged from an 8 bu/A increase in 1992 at 0.0117 lb/A to a 7 bu/A decrease in 1990 at 0.0469 lb/A. Epps average yields were 4 bu/A more than the untreated control in 1990 and 1991 at 0.0117 lb/A, and 5 bu/A less at 0.0469 lb/A in 1992. At 0.0117 lb/A in 1991, TV 626 yields were 5 bu/A greater than the untreated control, and 8 bu/A less at 0.0469 lb/A in 1992. Quinclorac applications to Avery, Epps, and TV 626 at the V1, V5, and R1 stages only reduced yields 1 to 2 bu/A, averaged across years and rates.

Triclopyr

Visual injury. Visual injury symptoms from triclopyr were apparent with 8 hours of application. Initial injury appeared as drooping leaves giving the appearance of diurnal nyctinastic movement (sleeping) commonly seen in cotton at dusk. Subsequently, plants of all cultivars were severely stunted (Figure 6A), by the 12% rate and less frequently the 6% rate. When these rates were applied at the R1 stage, plants often remained stunted until harvest. Soybean stems and leaf petioles were twisted and curved downward and terminal growth was inhibited (Figure 6B). At the higher rates applied at the R1 stage, plant terminals were frequently killed. Within 2 weeks of treatment, plant stems were split and beginning to callus over (Figure 6C). The only leaf symptomology was slight chlorosis, which was not visible 3 weeks after application. Injury from triclopyr closely resembled injury from 2,4,5-T, but there were no adventitious roots formed on the lower main stem.

Similar to quinclorac, maximum visual soybean injury resulting from triclopyr each year occurred 2 WAT in most cases regardless of soybean cultivar, soybean growth stage, or triclopyr rate. Maximum injury was 75, 78, and 64% to Avery, Epps, and TV 626, respectively, from 0.0469 lb/A triclopyr 2 WAT (Tables 5-7). Unlike quinclorac where visual injury was, for most treatments about 20% 5 WAT, triclopyr injury ranged up to 73% at 0.0469 lb/A among the three cultivars.

Injury 2 WAT increased as triclopyr rate increased each year. Averaged across growth stages, injury to Avery ranged from 17 to 63% at 0.0117 to 0.0469 lb/A. Injury to Epps ranged from 6 to 61%, and average injury to TV 626 ranged from 6 to 43% at 0.0117 to 0.0469 lb/A, respectively.

Averaged across triclopyr rates, triclopyr was more injurious to Avery when applied at the R1 stage in 1990 and 1992, and at the V5 and R1 stages in 1991. Triclopyr injury to Epps was greatest when applied at the V1 and R1 stages in 1990, the R1 stage in 1991, and the V5 and R1 stages in 1992. More injury to TV 626 occurred from V1 applications in 1990 and 1991, and the V5 and R1 applications in 1992.

Soybean yield. Compared to the untreated controls, 0.0469 lb/A triclopyr applied to V5 and R1 Avery resulted in significant yield reductions in 1990, 1991, and 1992 (Figure 7). Yield reductions ranged from 18 to 36 bu/A. Except for 1991, the V1 applications at 0.0469 lb/A and the R1 applications at 0.0234 lb/A significantly reduced yields. In 1992, 0.0234 lb/A applied to V5 Avery significantly reduced yields (9 bu/A).

Epps yield was not affected in 1990 (Figure 8). The 12% (0.0469-lb/A) triclopyr rate significantly reduced Epps yield (9 to 46 bu/A) in 1991 and 1992 regardless of growth stage. Applied at 0.0234 lb/A yields were stages in 1991. The 0.0117-lb/A triclopyr rate resulted in significant yield reduction of Epps when applied at the R1 stage in 1991 (10 bu/A), and at the V5 (9 bu/A) and R1 (18 bu/A) stages in 1992.

TV 626 yield was significantly reduced in 1990 by triclopyr applied at 0.0469 lb/A to V5 and R1 soybeans, and at 0.0234 lb/A applied to R1 soybeans (Figure 9). In 1991, only 0.0234 lb/A applied to V1 soybeans and 0.0469 lb/A applied to R1 soybeans resulted in significant yield reductions. TV 626 yields were reduced 10 to 18 bu/A by triclopyr at 0.0234 and 0.0469 lb/A applied to V5 and R1 soybeans, and at 0.0469 lb/A applied to V1 soybeans in 1992.

Avery yields were 4 to 23 bu/A less than the untreated control from triclopyr at 0.0117 to 0.0469 lb/A averaged across growth stages. Average Epps yields ranged from a 1-bu/A increase at 0.0117 to a 29-bu/A decrease at 0.0469 lb/A. Yields of TV 626 ranged from a 1-bu/A increase at 0.0117 to a 15-bu/A decrease at 0.0469 lb/A.

Averaged across rates, triclopyr applications to Avery, Epps, and TV 626 resulted in increasing yield reductions as plant maturity increased. Yields of Avery averaged from 6 to 20 bu/A less than the untreated control from applications at the V1 and R1 stages. The yield of Epps ranged from a 2-bu/A increase at the V1 stage to a 31-bu/A decrease at the R1 stage. TV 626 yields were reduced an average of 2 to 10 bu/A from applications at the V1, V5, and R1 stages.

Discussion

Group IV Avery soybean yields were reduced by quinclorac only 1 out of 3 years from simulated drift rates of 0.0469 lb/A (12.5% of the 0.375-lb/A use rate) at all three growth stages, and by 0.0234 lb/A (6.25% use rate) applied 0.0234 lb/A at the V1 and V5 growth stages, and up to 0.0117 lb/A (3% use rate) at the R1 stage without significant yield reductions. Avery generally appeared slightly more susceptible to quinclorac at the R1 growth stage.

In only one instance, did quinclorac (0.0469 lb/A at the R1 stage in 1990) reduce the yield of the group V cultivar Epps. Drift rates of quinclorac up to 0.0234 lb/A should not have a significant effect on Epps yield regardless of growth stage. The same should hold true for the group VI cultivar TV 626. Only the 0.0469-lb/A rate applied at the V1 and R1 stages in 1992 resulted in significant yield reductions. Epps was generally more tolerant of quinclorac at the V1 and V5 stages while TV 626 was more tolerant at the V5 stage.

Avery could tolerate drift rates of triclopyr up to 0.0117 lb/A, as that rate did not significantly reduce yields regardless of growth stage. Avery plants in the V1 stage tolerated rates of triclopyr up to 0.0234 lb/A, but this rate would probably reduce yields at later growth stages.

Epps was more tolerant of triclopyr at the V1 growth stage. Rates up to 0.0234 lb/A could probably be tolerated without significantly reducing yields. At the V5 and R1 stages, yields were significantly reduced regardless of rate at least 1 out of 3 years.

TV 626 could tolerate triclopyr up to 0.0117 lb/A as yields were not significantly reduced regardless of growth stage. TV 626 yield losses could be expected at higher triclopyr rates regardless of growth stage. Generally, all three cultivars were more tolerant of triclopyr at the V1 stage than at the V5 and R1 stages, and least tolerant at the R1 stage.

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