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Propanil Tolerant BARNYARDGRASS Confirmed in Mississippi

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Introduction

In recent years, plant species that exhibit resistance or tolerance to herbicides have been increasing in number and frequency throughout the world (10). These tolerant biotypes occur in areas where similar classes of herbicidal chemistry are used repeatedly, resulting in selection pressure biased toward resistant biotypes of a species. There is no evidence that herbicide resistance has resulted from genetic mutation.

The first confirmed report of resistant biotypes of weeds occurred in 1970 with triazine-resistant common groundsel (*Senecio vulgarie* L.) (13). In 1973, a trifluralin-resistant biotype of goosegrass (*Eleusine indica* L.) was discovered in South Carolina (12). Since their initial discovery, herbicide-resistant weeds have been identified throughout the southeastern United States (10). In Mississippi, biotypes of johnsongrass [*Sorghum halepense* (L.) Pers.] have been confirmed resistant to fluazifop-P and sethoxydim (3). There have also been reports of MSMA- and imazaquin-tolerant common cocklebur (*Xanthium strumarium* L) biotypes (2). Propanil-tolerant barnyardgrass [*Echinochloa crus-galli* (L.) P. Beauv] has been confirmed in Arkansas (6), and was first reported in Mississippi in 1992 but was not confirmed.

Barnyardgrass is an annual grass and is believed to have originated from Europe or India. Some of the earliest historical accounts are from Chinese drawings that date back to 1590 (8). The adaptive and prolific nature of barnyardgrass has resulted in the spread of this weed throughout both the temperate and tropical zones (8,9).

Barnyardgrass grows best in wet, muddy, warm, rich soils (4). Seed production has been reported to be between 5,000 and 7,000 seeds per plant and they may remain 90% viable for up to 3 years in the field (8). Ideal conditions for seed germination are 90° to 99° F. Under flood conditions, the seed will die soon after germination, however, if the plant is already established, flooding does not hinder growth (8,9). Therefore, water management practices used in conventional rice production in the southern United States result in ideal conditions for the establishment and spread of barnyardgrass.

Research has shown that barnyardgrass, at a population density of only one plant per square foot, reduces rice yield 25 percent by competing for nutrients, light, and space (15). Heavy infestations of barnyardgrass deplete 60 to 80 percent of the soil nitrogen and host the viruses that produce tungro and dwarf disease in rice (8,9). Barnyardgrass has been deemed the most common and troublesome weed for rice producers in Arkansas, Mississippi, and Texas (7).

Propanil is widely used for barnyardgrass control and has been the primary herbicide used in Mississippi rice production since the mid-1960's (11,14). Therefore, it is not surprising that with propanil's widespread continuous use and barnyardgrass's prolific seed production populations of propanil-resistant barnyardgrass would increase.

Propanil is a broad-spectrum herbicide, which is rapidly absorbed and translocated through the plant and has no residual herbicidal properties (17). Research has shown dry-seeded rice to have good tolerance to propanil (18). Smith reported propanil at 6 lb ai/A applied 15 to 55 days after rice emergence did not reduce grain yield (15). The enzyme, aryl acylamidase, located in the leaves of rice plants, rapidly detoxifies propanil by oxidation and hydrolysis to DCA, N-(3,4-dichlorophinyl)gluco-sylamine, and propionic acid (1, 19). The DCA is tightly bound in carbohydrate and lignin constituents of the cell wall. The propionic acid, formed by hydrolysis, is further metabolized to CO_2 by beta oxidation (19, 20). The mechanism of tolerance to propanil found in the resistant biotypes of barnyardgrass from Arkansas is the presence of relatively high concentrations of this same enzyme (5).

The effectiveness of propanil decreases as barnyardgrass size increases (16). Propanil at 3 lb ai/A controls 3- to 4-leaf barnyardgrass in rice when applied prior to flood. When barnyardgrass is larger and begins tillering, it is difficult to control with 9 lb ai/A propanil (14). Furthermore, propanil efficacy on barnyardgrass is reduced when applied at temperatures below 60° F (17). Propanil incorrectly applied could be mistaken for resistance to the herbicide, therefore, any reported resistance must be confirmed.

The objectives of this study were to: **(1)** confirm or deny suspected propanil-resistant biotypes of barnyardgrass found in Mississippi, and **(2)** test the levels of tolerance and evaluate alternative herbicides for control.

Materials and Methods

Objective 1

Seeds were collected in September 1993 from four sites reported to have propanil-resistant barnyardgrass in Bolivar and Sunflower Counties, Mississippi. Seeds were stored at room temperature for approximately 6 months. All seeds tested were scarified for 30 seconds using a mechanical scarifier and planted 0.5 inch deep in 4-inch-diameter plastic pots containing a silt loam soil.

After seedling emergence, barnyardgrass was fertilized with a water soluble fertilizer at the rate of 78 pounds of nitrogen per acre. Plants were thinned to 10 plants per pot and maintained in a greenhouse with air temperatures controlled at 75 °F ± 5 °F (night) and 95 °F ± 5 °F (day). Light was supplemented using metal halide lamps and day length maintained at 14 hours. Plants were treated when the barnyardgrass had 3 to 4 leaves using a stationary table, traveling nozzle system delivering 20 gallons of spray solution per acre.

The test was designed as a randomized complete block with a factorial arrangement of treatments, replicated four times. The main effect, biotype, labeled as MF-East, MF-South, BF, and TS, was tested with two rates of propanil, 0 and 4 lb ai/A. Visual ratings of percent weed control (0 to 100%) were taken at 1 and 2 weeks after treatment (WAT). Analysis was performed and means were separated using Duncan's multiple range test at the 95% confidence level.

Objective 2

The barnyardgrass biotype found to have resistance to propanil after completion of the first objective, referred to as tolerant, and a known susceptible biotype, were further evaluated to determine the levels of tolerance. Procedures used for the establishment and treatment of plants were the same as those used for Objective 1.

MF-East and MF-South were both tolerant to propanil. However, because they were from the same farm, they were considered the same population and only MF-East was selected for further evaluations.

The test design was a randomized complete block with a factorial arrangement of treatments, replicated four times. Herbicide treatments consisted of 0, 2, 4, 8, and 16 lb ai/A propanil, 0.38 lb ai/A quinclorac (Facet 75DF®, 0.5lb/A) and 0.07 lb ai/A fenoxaprop (Whip 360®, 1.0 pt/A). Visual control ratings (0 to 100%) were made 1 and 2 weeks after treatment (WAT). Analysis of variance was performed and means were separated using Duncan's multiple range test at the 95% confidence level.

The experiment was repeated. There was an experiment-by-treatment interaction, therefore data were not pooled and are presented by experiment.

Results and Discussion

Objective 1

Propanil applied at 4 lb ai/A controlled the susceptible biotype 90% 1 WAT (Figure 1). Two of the suspected tolerant biotypes, MF-East and MF-South (collected from Sunflower County), at 1 WAT showed little response, 8% and 12% injury respectively, to the same rate of propanil. The biotypes BF and TS (from Bolivar County) responded similarly to the known susceptible biotype — 94% and 93% control, respectively.

At 2 WAT, control of the biotypes MF-East and MF-South was only 3% and 6%, respectively, while the susceptible biotype was controlled 95% (Figure 2). The biotypes BF and TS were also completely controlled by propanil. The existence of propanil-tolerant barnyardgrass in Mississippi was confirmed for biotypes MF-East and MF-South. The suspected tolerance of the biotypes labeled BF and TS was probably due to other factors that limit the effectiveness of propanil, such as the size of the barnyardgrass or ambient air temperature at the time of treatment.

Objective 2

At 1 WAT, all rates of propanil resulted in less control of the tolerant biotype of barnyardgrass than of the susceptible biotype (Figures 3, 4). The susceptible biotype was controlled with 8 lb ai/A propanil — 82% and 99% for Experiments I and II, respectively. Control of the tolerant biotype did not differ from the untreated check until the highest level of propanil, 16 lb ai/A, was used; even then, control was only 20% and 38% for the two experiments. This was similar to the control achieved when 2 lb ai/A propanil were applied to the susceptible biotype. Thus, the tolerant biotype was about eight times more tolerant of propanil than the susceptible biotype.

Tolerant barnyardgrass was more rapidly affected by Facet than the susceptible biotype. At 1 WAT, control of the propanil-tolerant biotype with Facet was 63% and 92%, while control of the susceptible biotype was 30% and 66% for Experiments I and II, respectively (Figures 3 and 4). In Experiment II, 1 WAT, propanil-tolerant barnyardgrass was controlled 92% with Whip 360, while the susceptible barnyardgrass was only controlled 51% (Figure 4).

Greater control of susceptible biotypes than of tolerant biotypes occurred 2 WAT with all rates of propanil except for the 2 lb ai/A propanil treatment in Experiment I (Figures 5 and 6). At 2 WAT, the response of tolerant barnyardgrass treated with the highest rate of propanil, 16 lb ai/A, did not differ from the untreated check. Adequate control of the tolerant barnyardgrass was achieved with both Facet and Whip 360 at 2 WAT.

Summary and Conclusion

In general, propanil-tolerant barnyardgrass was confirmed in Mississippi. The biotype tested does not show cross resistance to Whip 360 or Facet. In fact, just the opposite occurred — the tolerant biotype of barnyardgrass was more susceptible to treatments of Facet and Whip 360 than was the biotype susceptible to propanil. Therefore, where suspected cases of propanil-tolerant barnyardgrass exist, other herbicides should be an effective alternative for control.

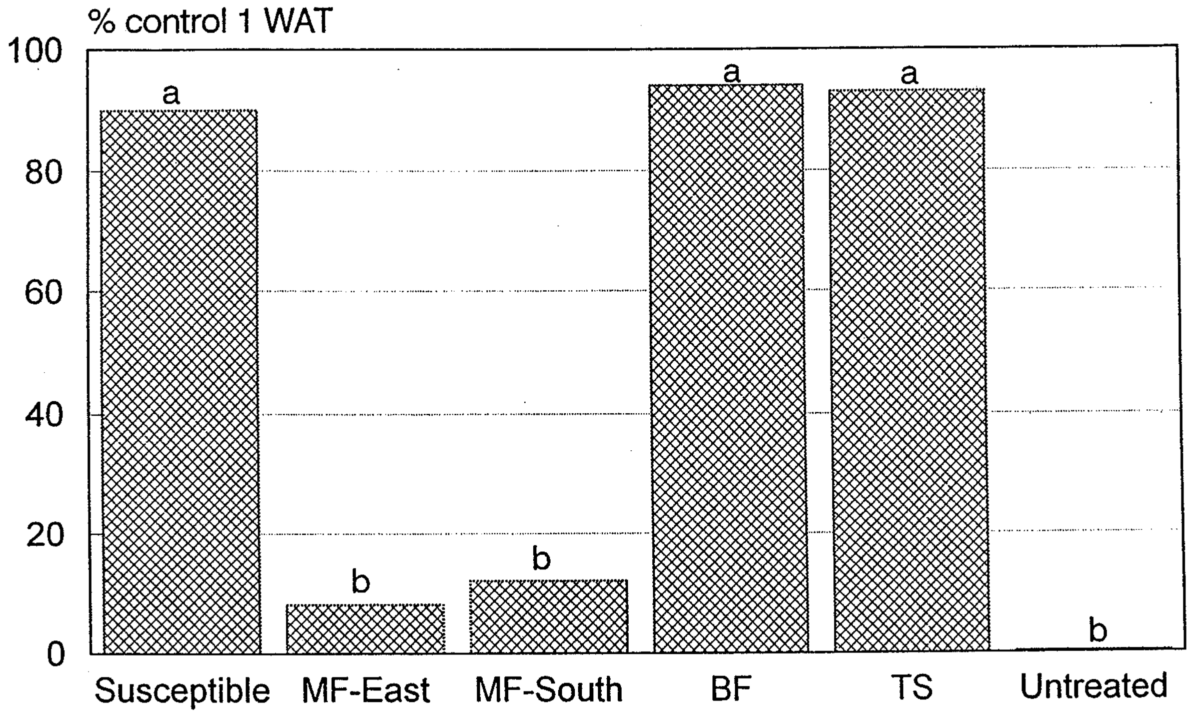

Figure 1. Control of 3- to 4-leaf barnyardgrass biotypes with 4 lb ai/A propanil averaged over experiments. Duncan's MRT; p = 0.05.

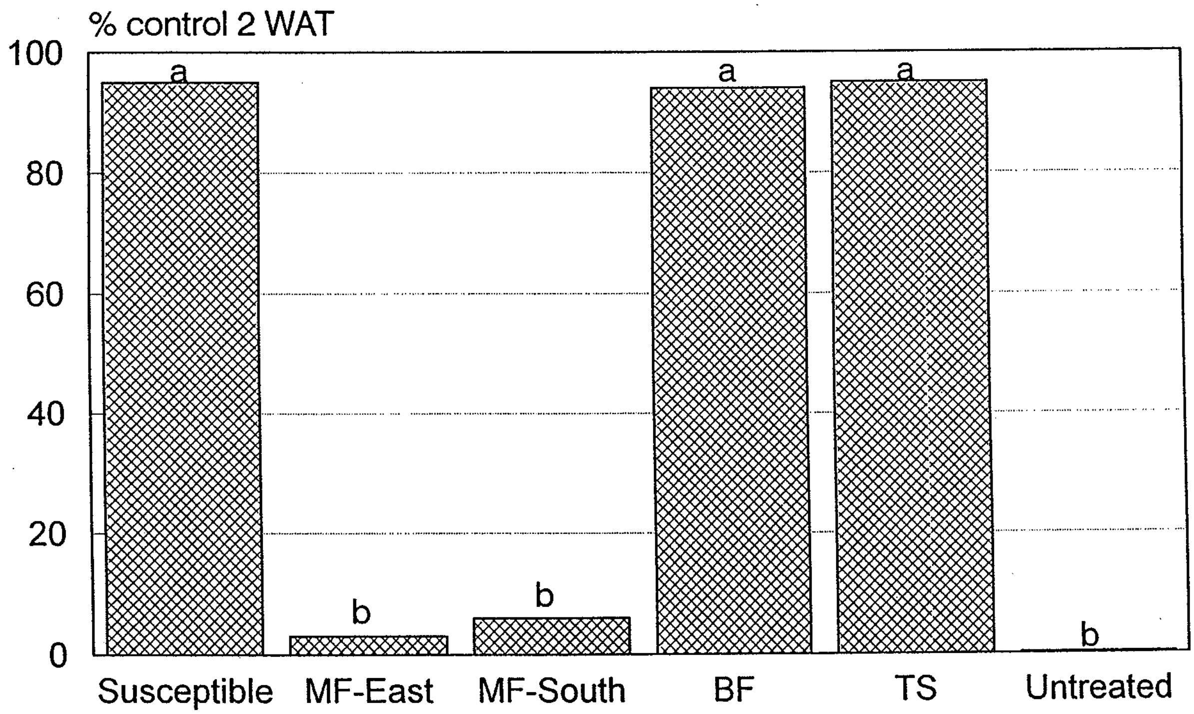

Figure 2. Control of 3- to 4-leaf barnyardgrass biotypes with 4 lb ai/A propanil averaged over experiments. Duncan's MRT; p = 0.05.

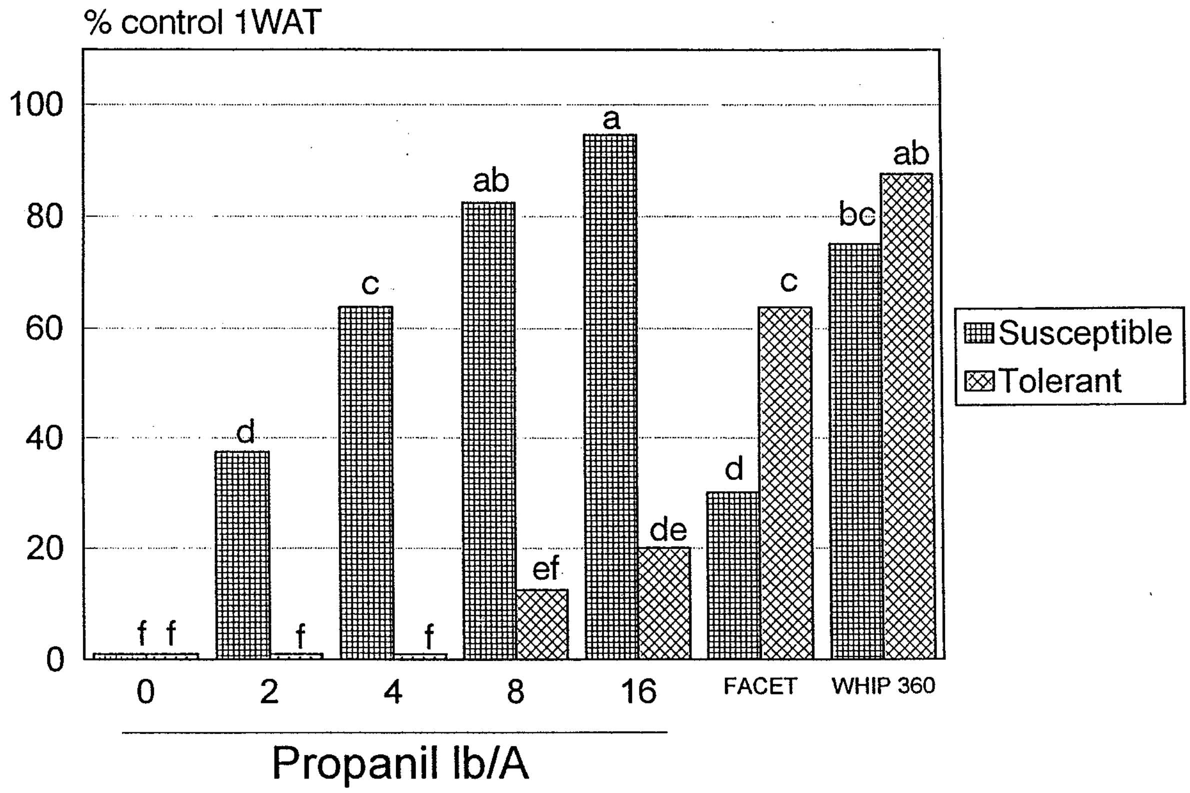

Figure 3. Control of 3- to 4-leaf barnyardgrass biotypes with various rates of propanil, Experiment I (WHIP 360 @ 0.07 lb ai/A; FACET @ 0.38 lb ai/A). Duncan's MRT; p = 0.05.

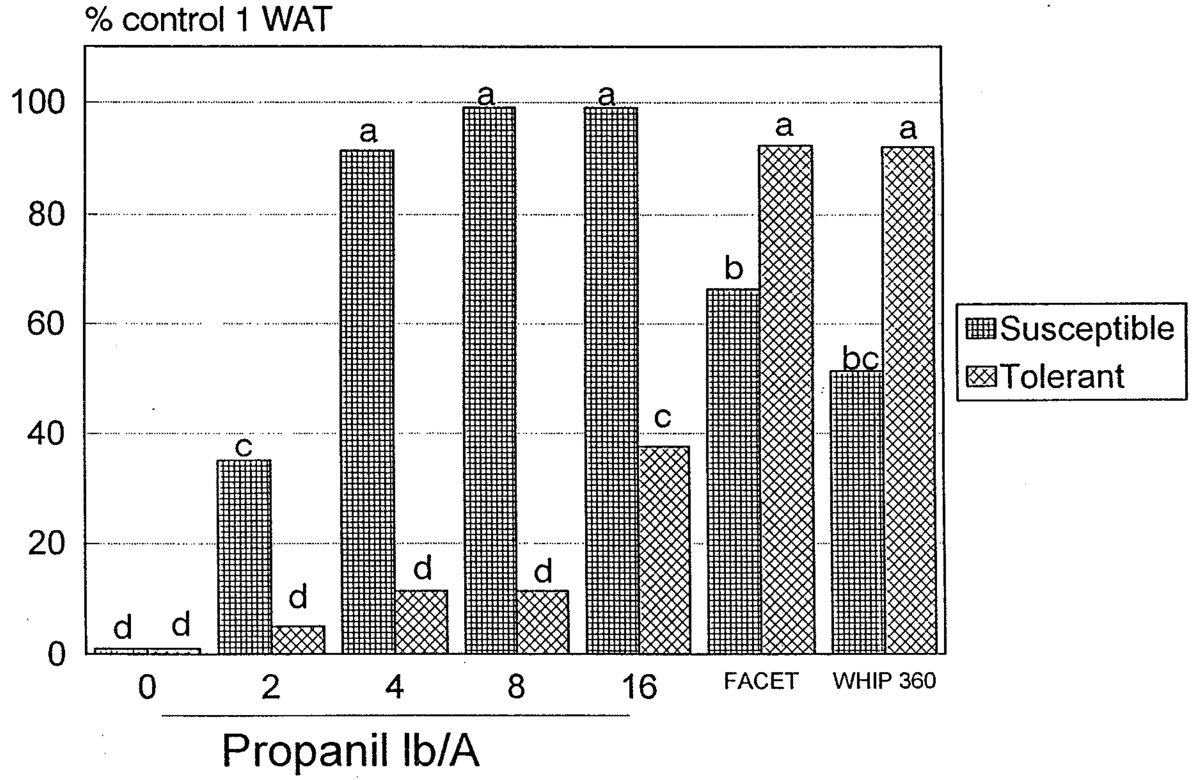

Figure 4. Control of 3- to 4-leaf barnyardgrass biotypes with various rates of propanil, Experiment II (WHIP 360 @ 0.07 lb ai/A; FACET @ 0.38 lb ai/A). Duncan's MRT; p = 0.05.

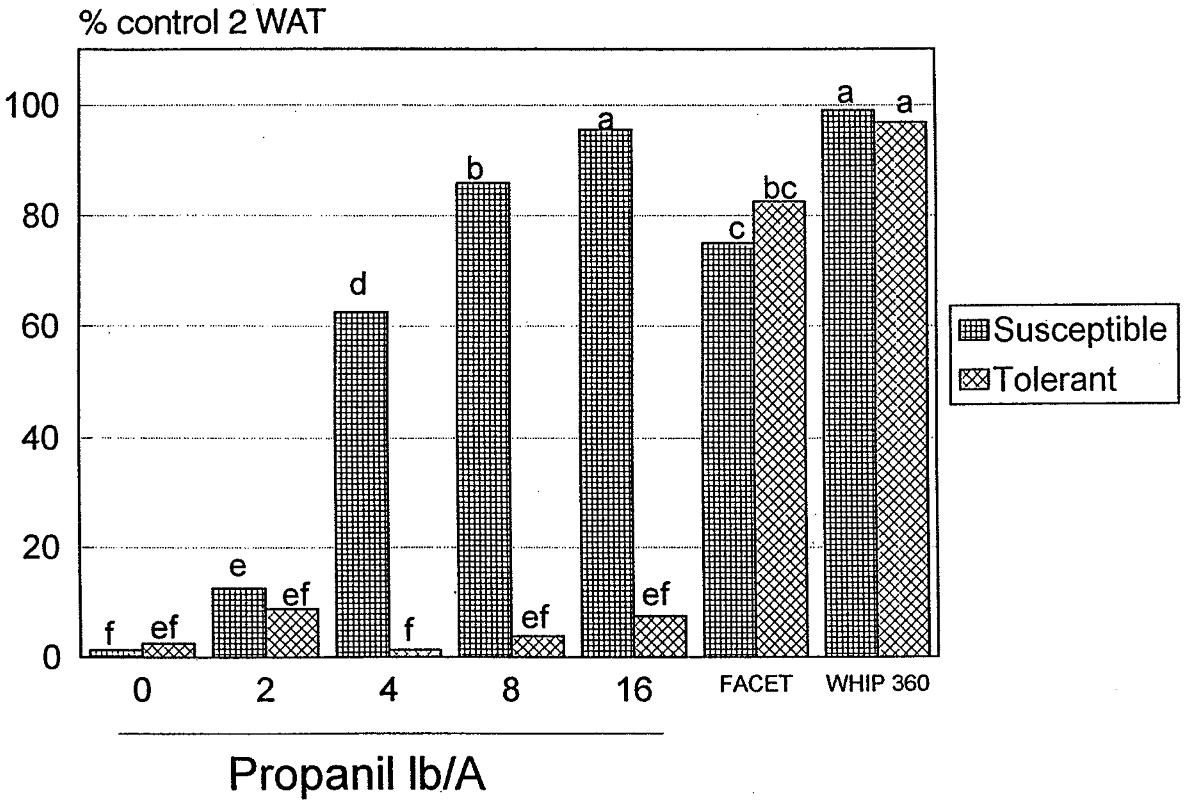

Figure 5. Control of 3- to 4-leaf barnyardgrass biotypes with various rates of propanil, Experiment I (WHIP 360 @ 0.07 lb ai/A; FACET @ 0.38 lb ai/A). Duncan's MRT; p = 0.05.

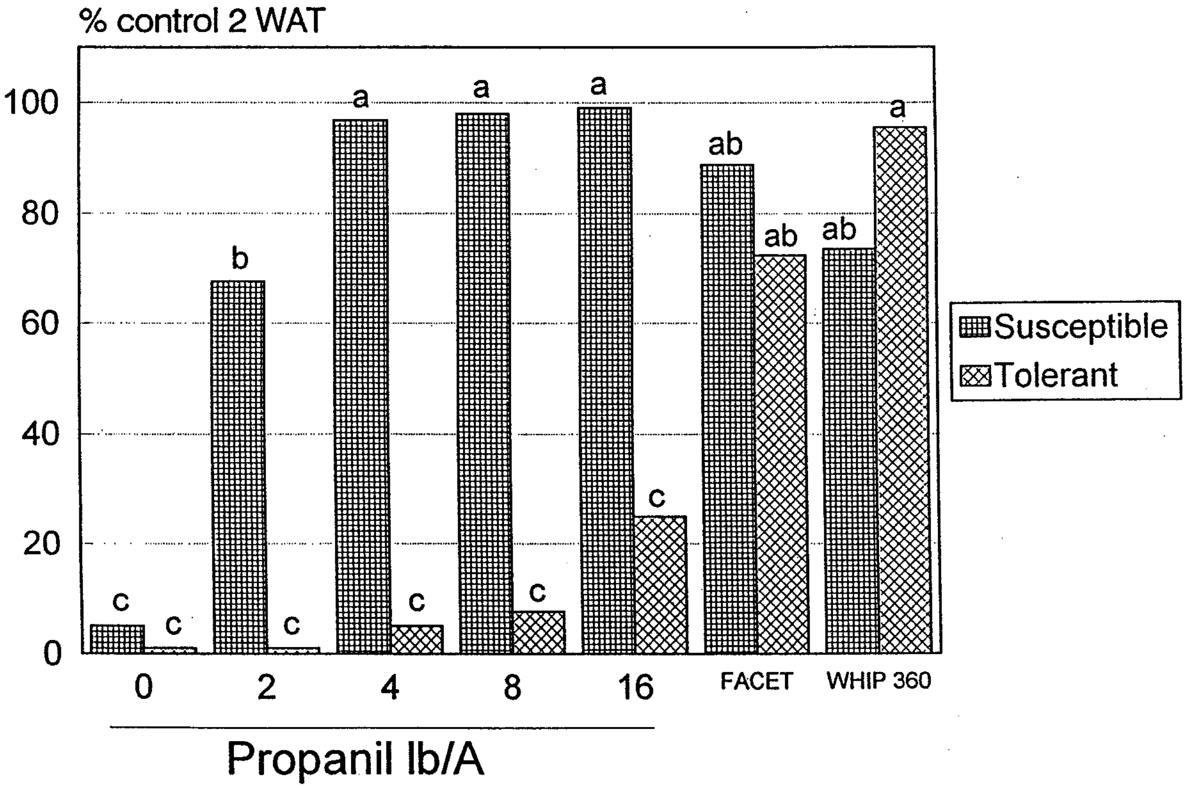

Figure 6. Control of 3- to 4-leaf barnyardgrass biotypes with various rates of propanil, Experiment I (WHIP 360 @ 0.07 lb ai/A; FACET @ 0.38 lb ai/A). Duncan's MRT; p = 0.05.

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