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Efficacy of Propanil Formulations on Various Stages of Barnyardgrass

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Introduction

Barnyardgrass is an annual grass believed to have originated in Europe and India. Some of the earliest historical accounts are from Chinese drawings that date back to 1590 (7). The adaptive and prolific nature of barnyardgrass has resulted in it being spread throughout the world in both temperate and tropical zones (5, 7). It prefers wet, muddy, warm, rich soils (2). Barnyardgrass in the United States has been reported to produce between 5,000 and 7,000 seeds per plant. These seeds are reported to be 90% viable in field situations after 3 years, and prefer fairly high temperatures (90° to 99°F) for germination (7).

In a flood, barnyardgrass seedlings will die shortly after germination when they are approximately 0.5 to 1 inch tall. However, if the plant is already established, flooding does not hinder growth (5,7). Therefore, water management practices used in conventional rice production result in ideal conditions for barnyardgrass growth.

Research has shown barnyardgrass reduces rice yields by 25% with a population density of one plant per square foot by competing for nutrients, light, and space (10). Heavy infestations of barnyardgrass have been shown to deplete 60 to 80% of the nitrogen from the soil in crop situations (5,7). These factors have resulted in barnyardgrass being listed as the most common and troublesome weed in rice in Arkansas, Mississippi, and Texas (3).

Propanil is widely used for barnyardgrass control (9). It is a broad-spectrum herbicide, which is rapidly absorbed and translocated from the leaf to the growing point and to other leaves. It has no residual herbicidal properties (15). Research has shown dry-seeded rice to have good tolerance to propanil (13). Smith reported propanil at 6 lb ai/A applied 15 to 55 days after rice emergence did not reduce grain yield (11). The enzyme, aryl acylamidase, located in the leaves of rice plants, rapidly detoxifies propanil by oxidative metabolism and hydrolysis to DCA, *N*-(3,4-dichlorophinyl)glucosylamine, and propionic acid (4, 14). DCA is tightly bound in carbohydrate and lignin constituents of the cell wall. Propionic acid, formed by hydrolysis, is then metabolized to CO_2 by *beta* oxidation (14, 15).

Propanil applications must be timed to barnyardgrass growth stage since weed control with propanil decreases as barnyardgrass size increases (12). Propanil at 3 lb ai/A has been shown to control 3- to 4-leaf barnyardgrass in rice when applied prior to flood. When barnyardgrass is larger and begins tillering, it is difficult to control, even with rates of 9 lb ai/A propanil (9).

Propanil is manufactured in various formulations. Different formulations of herbicides have been shown to influence their effectiveness, which may be caused by differences in foliar absorption of individual formulations (1, 8). Hess et al. reported differences occurring among three emulsifiable concentrate formulations of propanil sprayed on sugar beet leaves in the same manner and examined using an electron microscope (6). The first formulation kept propanil in solution on the leaf surface as the spray solution evaporated. The second had a portion of the propanil crystallized. The third was unsuccessful in keeping it in solution. Field observations showed that the first formulation, which kept the propanil in solution, was more effective in controlling barnyardgrass.

The purpose of the study described in this bulletin was to evaluate several formulations of propanil for rice tolerance, barnyardgrass efficacy at two growth stages, and effect on yield.

Materials and Methods

Experiments were conducted at the Delta Branch Experiment Station, Stoneville, MS, in 1991 and 1992. Soil type was a Sharkey clay (Vertic Haplaquept) with 1.2% organic matter content and pH of 7.4. Plots 8 feet by 15 feet were overseeded each year with barnyardgrass prior to final land preparation and again immediately prior to rice seeding. 'Maybelle' rice in 1991 and 'Lemont' rice in 1992 were drill-seeded 0.75 inch deep in 8-inch rows with a seeding rate of 90 lb/A. Standard southern rice production practices were used to maximize yields. The experimental design was a randomized complete block with a factorial arrangement of treatments replicated four times.

Treatments in 1991 and 1992 contained six formulations of propanil (Cedar Propanil®, Propanil DF®, Stam 80 EDF®, Stam M-4®, Wham®, and Wham DF®) at 4 lb ai/A, a propanil and molinate mixture (Arrosolo®) at 6 lb ai/A, and quinclorac (Facet®) at 0.38 lb ai/A plus 3 pints per acre nonionic surfactant. These herbicides were applied in single applications at an early postemergence timing (E-POST) when barnyardgrass was 2- to 3-leaf and rice was 3-leaf and a late postemergence (L-POST) timing when barnyardgrass was 4- to 5-leaf and rice was 5-leaf. L-POST treatments were made approximately 2 weeks prior to flood. Herbicide applications were made using a CO_2-pressurized backpack sprayer delivering 20 gallons per acre (GPA) carrier volume at a pressure of 26 PSI.

Ratings included rice injury and weed control at 7 and 14 days after treatment (DAT). Ratings were estimated visually on a scale of 0 to 100, with 0 indicating no injury or weed control and 100 indicating dead rice or complete weed control. Entire plots were harvested with a small-plot combine, and rice yield was determined after adjusting to 12% moisture. Data were combined and analyzed over years. There was some significant interaction between year and treatment. However, when interaction was significant, its F-value was still small compared to the treatment F-values. Therefore, year was treated as replication to compare treatments averaged over years. Treatment means were compared using Fisher's Protected LSD test at the 0.05 probability level. Comparisons between timing means were also analyzed by pooling treatment and separating using Fisher's Protected LSD test at 0.05 probability level.

Results and Discussion

Rice injury

Injury symptoms exhibited by rice due to herbicide treatments were leaf burn with associated chlorosis. At 3-leaf applications, no treatment resulted in greater than 10% injury to rice 7 DAT (Figure 1). Facet treatments did not result in any visible injury. Wham was less injurious to rice (7%) than Arrosolo, Cedar Propanil, and Stam M-4 (8 to 10%). Injury symptoms to rice from herbicide applications at the 5-leaf stage were similar to those with 3-leaf applications in that no treatment resulted in greater than 10% injury and Facet did not result in any visual injury (Figure 2). However, with 5-leaf treatments, Propanil DF and Wham DF were less injurious to rice than Arrosolo and Stam EDF. At 14 DAT, there was no visual injury to rice due to any treatment (data not shown).

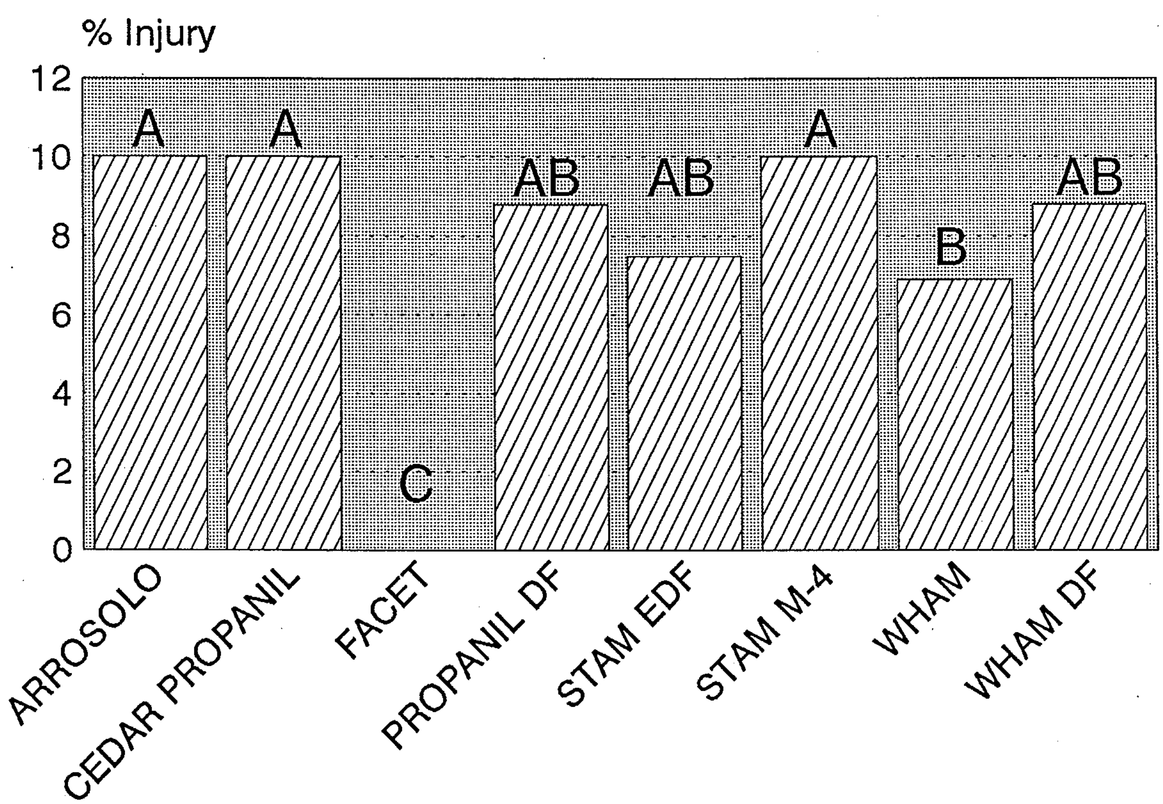

Figure 1. Three-leaf rice injury from herbicide application 7 DAT (P=0.05, LSD).

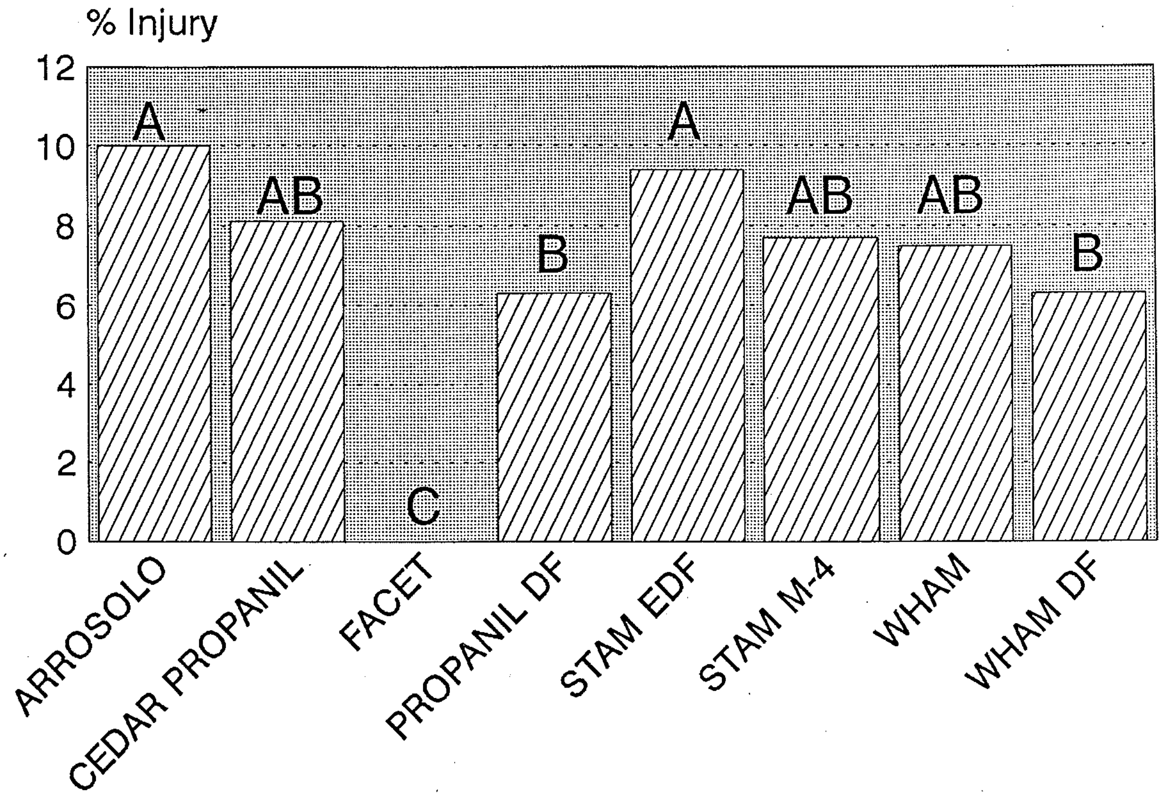

Figure 2. Five-leaf rice injury from herbicide application 7 DAT (P=0.05, LSD).

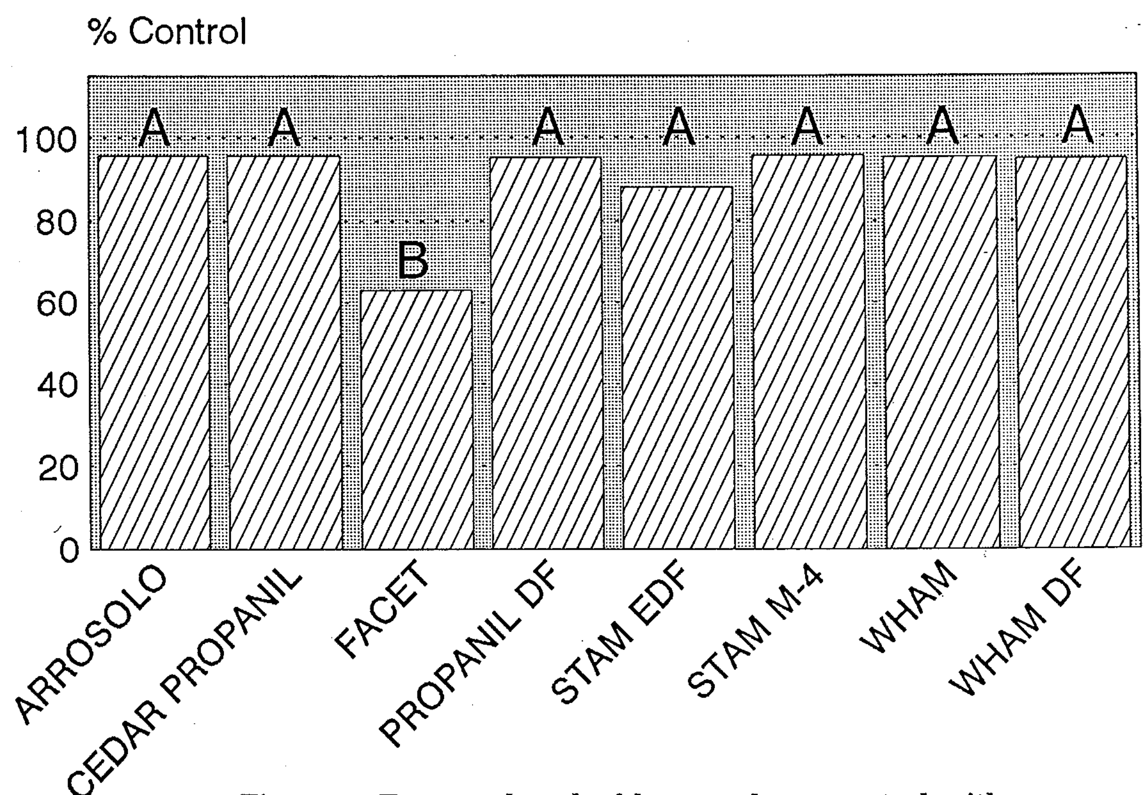

Figure 3. Two- to three-leaf barnyardgass control with various herbicides 7 DAT (P=0.05.LSD).

Barnyardgrass control

At 7 DAT with 3-leaf applications, barnyardgrass control with Arrosolo, Cedar Propanil, Propanil DF, Stam EDF, Stam M-4, Wham, and Wham DF were similar and ranged from 88 to 96% (Figure 3). Control with Facet at 7 DAT was less than these treatments at 63%. By 14 DAT, control with Facet had increased to 99% and was greater control than Cedar Propanil, Propanil DF, Stam EDF, Stam M-4, Wham, and Wham DF and was similar in control to Arrosolo (Fig. 4). There was no difference between Arrosolo and any other treatments. There were no differences among propanil formulations.

Arrosolo applied to 5-leaf barnyardgrass resulted in 80% control and was greater than Cedar Propanil, Facet, Propanil DF, Stam EDF, Stam M-4, and Wham but was similar in control to Wham DF at 7 DAT (Figure 5). Comparison of the propanil formulations showed that Propanil DF did not control barnyardgrass as well as Wham DF, Stam EDF, or Stam M-4. Facet offered the least barnyardgrass control of the treatments evaluated at 7 DAT (Figure 5). At 14 DAT, Arrosolo and Facet were similar in control of barnyardgrass with 84 and 93%, respectively (Figure 6). All other treatments were similar and controlled barnyardgrass 70% or less.

When herbicide treatments were pooled and timing was compared, greater control was obtained 7 and 14 DAT with E-POST applications than with L-POST applications (data not shown).

Yield

Rice yields in general reflect weed control. There was no difference in yield noted among propanil formulations applied to 3-leaf barnyardgrass. With the 3-leaf applications, Facet resulted in yield of 7,980 lb/A, which was higher than all other treatments except Arrosolo at 7,280 lb/A (Figure 7). Arrosolo treatments resulted in similar yields to Facet, Propanil DF, Wham, and Wham DF and greater yields than Cedar Propanil, Stam EDF, and Stam M-4. With treatments made to 5-leaf barnyardgrass, Arrosolo and Facet were similar in yield, with 7,080 and 6,980 lb/A, respectively, and were higher than all propanil treatments (Figure 8). There was no significant difference in yield among treatments with different propanil formulations. Differences did exist between E-POST and L-POST application timings (data not shown). When herbicide treatments were pooled, yields were 6,210 and 5,890 lb/A for E-POST and L-POST, respectively.

In summary, efficacy among propanil formulations

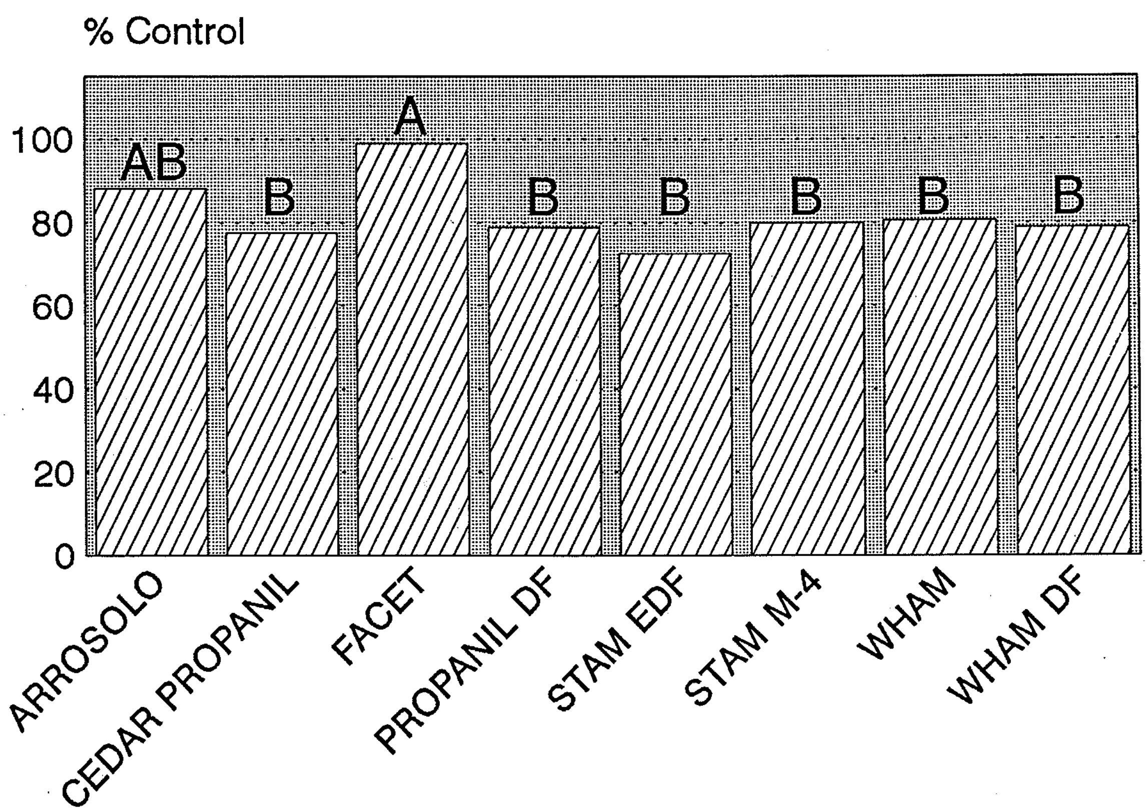

Figure 4. Two- to three-leaf barnyardgrass control with various herbicides 14 DAT (P=0.05, LSD).

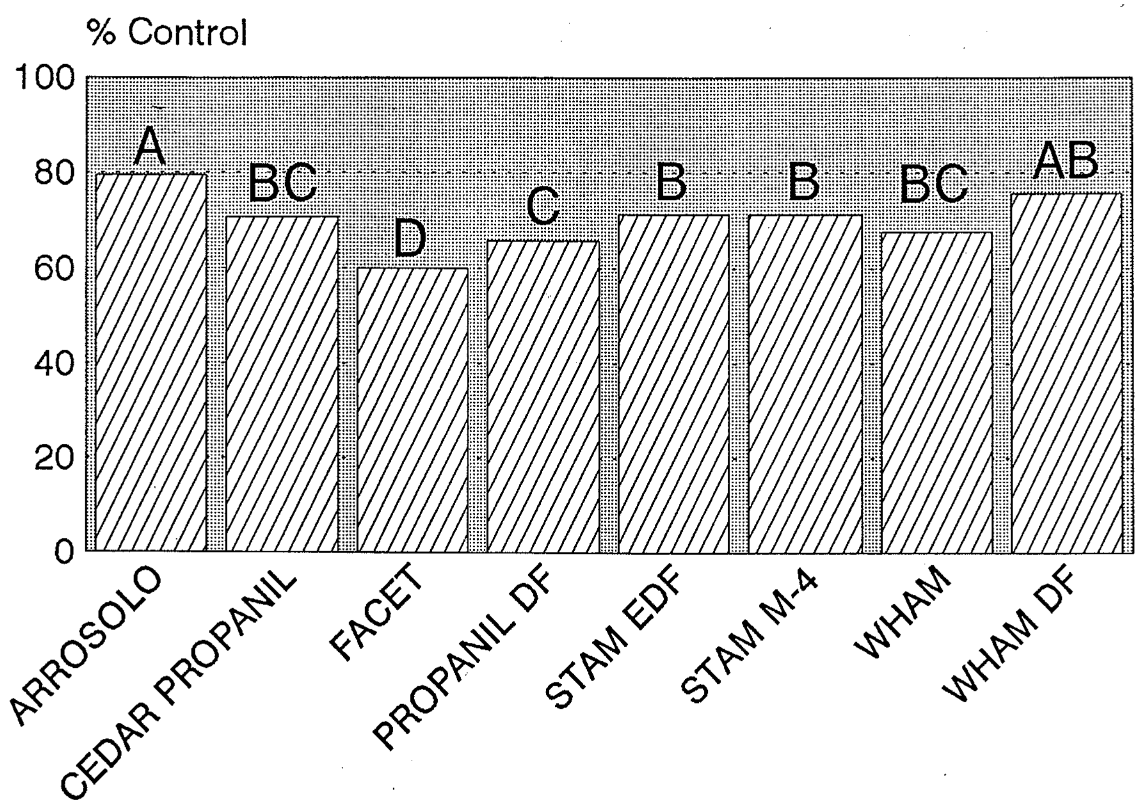

Figure 5. Five-leaf barnyardgrass control with various herbicides 7 DAT (P=0.05, LSD).

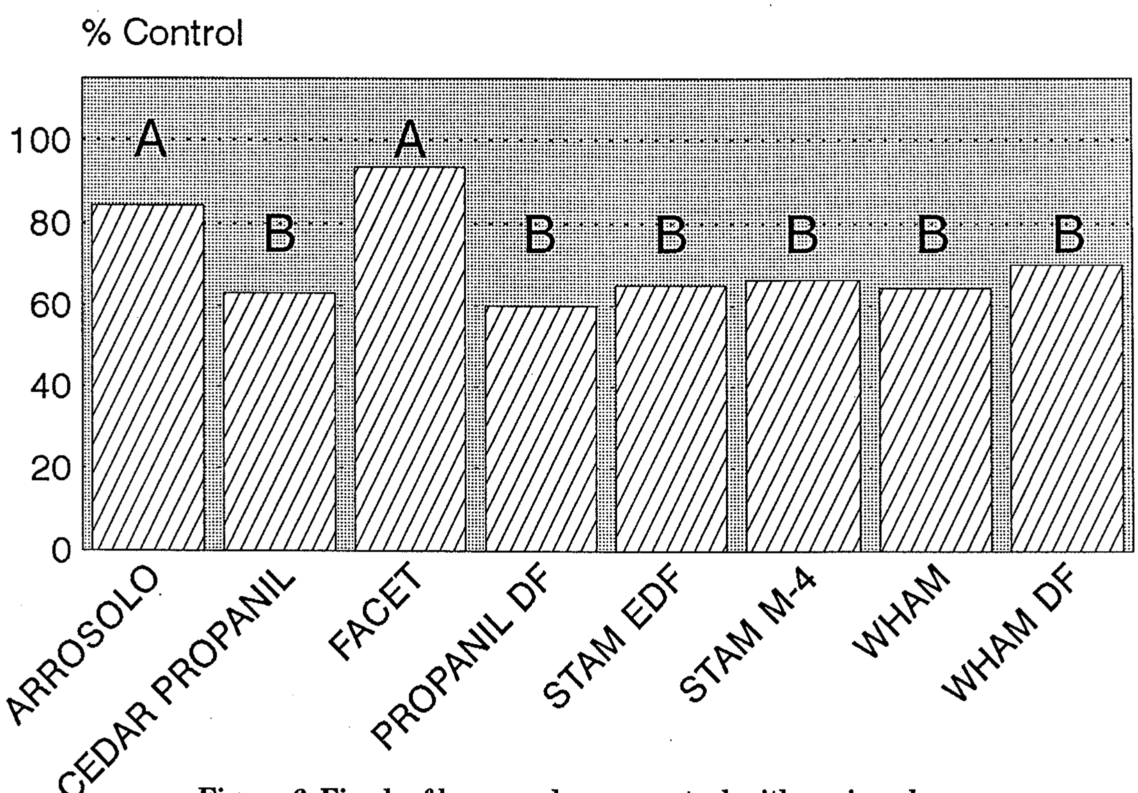

Figure 6. Five-leaf barnyardgrass control with various herbicides 14 DAT (P=0.05, LSD).

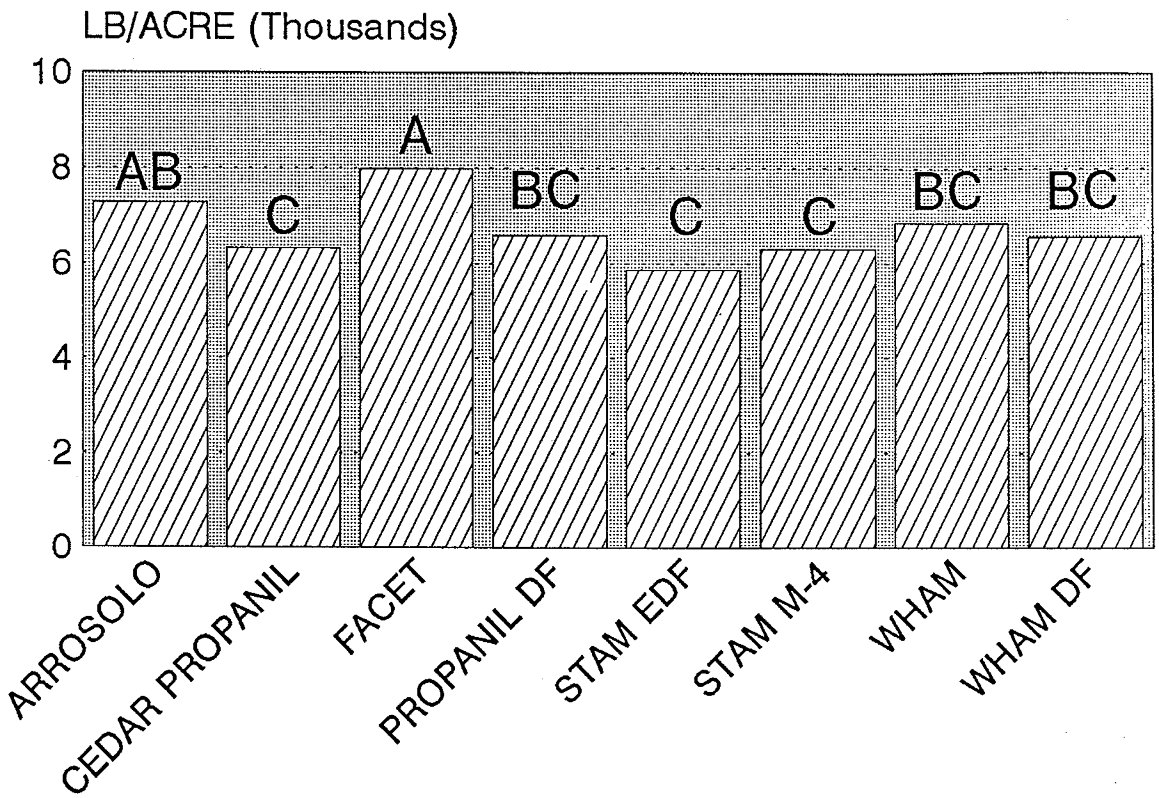

Figure 7. Rough rice yield with various herbicides appied to 3-leaf rice (P=0.05, LSD).

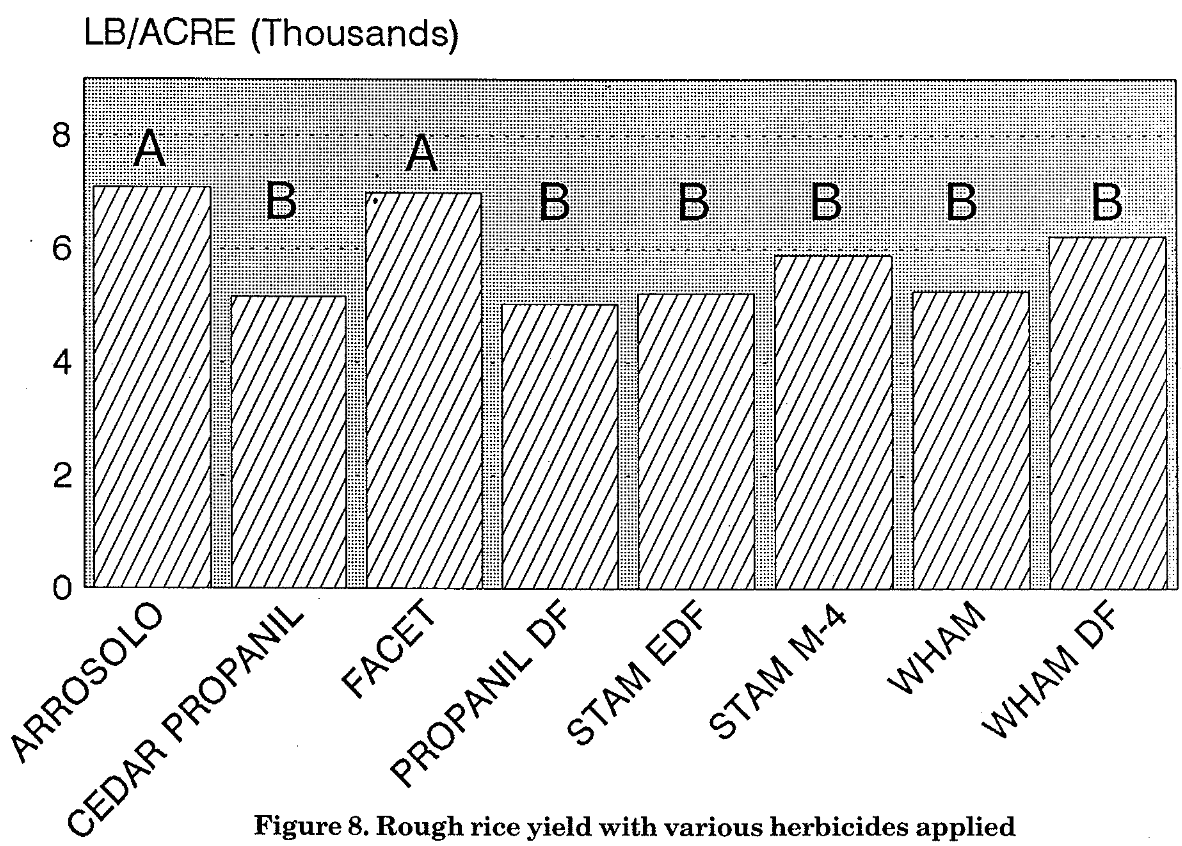

Figure 8. Rough rice yield with various herbicides applied to 5-leaf rice (P=0.05, LSD).

is essentially the same when applied to 3-leaf barnyardgrass at the 4 lb/A rate. However, when applied to 5leaf barnyardgrass, Propanil DF was slower acting than some other propanil formulations, but control was the same among the formulations at 14 DAT. Results of this study show that there is generally no significant difference among the propanil formulations when they are applied with ground application and coverage of the target pest is good. Spray coverage from aerial application was not determined in this study but it could influence control.

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