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# EFFECTS OF ALMIX 20WP ON SELECTED SEDGES AND BROADLEAF WEEDS IN RICE

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**Abstract**

An investigation was conducted to assess the efficacy and crop tolerance of Almix 20WP, a herbicide premix of metsulfuron-methyl and chlorimuron-ethyl, for controlling sedges and broadleaf weeds in flooded rice fields. Treatments included various rates of Almix 20WP, 2,4-D, Bentazone-sodium, Bispyribac-sodium, and a tank-mix of Almix 20WP (40 g/ha) with 2,4-D (1000 g/ha). Almix 20WP at 60 g/ha significantly reduced weed biomass and density. Bentazone-sodium treated rice yielded the highest grain (7975.0 kg/ha), with the tank-mix of Almix 20WP and 2,4-D provided the second-highest (7962.5 kg/ha). Almix 20WP showed excellent control of weeds like *Cyperus difformis*, *Fimbristylis miliacea*, and *Ludwigia octovalvis*, with the tank-mix enhancing control of *Cyperus iria*. Thus, Almix 20WP at 40 g/ha is recommended for flooded fields to control sedges and broad leaf weeds.

## Introduction

Weed infestations are recognized as a severe biological constraint to crop production (Bhowmick *et al.* 2024). Recently, use of herbicides have been appeared as one of the effective methods of controlling weeds. Rice yield losses due to weed competition was 5-85% in Malaysia (Dilipkumar *et al*. 2020). Weeds are becoming more challenging to control, and the emergence of resistant weeds is fast becoming a significant problem (Hasan *et al.* 2023, 2024, Motmainna *et al.* 2023). Sixteen weed species were reported in Malaysia that are resistant to many pesticides (Chuah and Sahid 2010, Juraimi *et al.* 2012, Zakaria *et al.* 2018).

Weeds are a significant issue for rice producers around the world, especially *Ludwigia octovalvis* (Jacq.) P.H.Raven, *Sphenoclea zeylanica* Gaertn., *Fimbristylis miliacea* (L.) Vahl, *Cyperus iria* L., *Cyperus difformis* L., and various others. *Cyperus difformis* and *C. iria* are extremely invasive and responsible for yield reduction of economically important crops, particularly rice (Tian *et al.* 2020, Motmainna *et al.* 2021a, Awan *et al.* 2022). *Fimbristylis miliacea* is a highly problematic weed that can reduce grain yield by up to 42% in Southern and Eastern Asian rice fields (Begum *et al.* 2008, Motmainna *et al.* 2024). Sedges have become prominent weeds in rice fields, particularly when pesticides are employed to manage grass weeds but are ineffective against sedges.

Introducing premixes herbicides could help to improve the weed control spectrum, provide additional control to the currently available chemicals, and perhaps reduce herbicide resistance weeds problem. Almix 20WP is a premixture herbicide containing Metsulfuron-methyl and chlorimuron-ethyl developed by Corteva Agriscience LLC, formerly called DuPont. It is used to

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prevent the growth of rice field weeds, mainly broadleaf and sedge weeds. It functions as a systemic herbicide with both contact and residual soil activity, allowing it to suppress weeds for a prolonged period. Identifying resistant weed species to herbicides and using herbicide mixtures to manage the resistant biotype weeds should be considered in the weed management systems. Before making a final recommendation, the effects of various herbicide mixtures in terms of synergistic and antagonistic effects on crops and weeds should be evaluated. In view of the above, the current study was conducted to evaluate the effectiveness of weed control, crop tolerance, mixing compatibility, and effective use rates of a new premix herbicide combination of metsulfuron-methyl and chlorimuron-ethyl in rice fields under flooded conditions.

## Materials and Methods

The investigation was carried out in Kepala Batas, Pulau Pinang, between April to August 2021. Rice (MR220) was cultivated using the direct-seeding (DSR) method with a seeding rate of 160 kg/ha. A total of four replications were utilized for the randomized complete block design (RCBD). The plot size was of 5 m x 5 m. Trial plots were separated with a levee and 1m inter-row gap to minimize potential spray drift. Almix 20WP and tank-mix of Almix 20WP with 2,4-D was applied at 21 days after sowing (DAS) as per label recommendation in a flooded field of about 7 cm, and water was maintained for at least one week. The other herbicides 2,4-D, Bentazone-sodium, and Bispyribac-sodium were applied at 15 DAS, where water was partially drained from the field before applying treatments to expose and control weeds and re-flooded within 24 hours after application. A Motorized Knapsack sprayer was used with 270 L/ha spray volume. For maintenance of non-target weed species, Cyhalofop was sprayed at a dosage of 1500 ml/ha at 10 DAS. The rice trials were conducted using local farming practices and management. Table 1 represents the details of experimental treatments.

**Table 1. Herbicide application details with spraying window.**

| Treatments | Active compound | Rate (per ha) | Application time (DAS) |
|---|---|---|---|
| T0 | Control | - | - |
| T1 | Metsulfuron-methyl + chlorimuron-ethyl | 40 g | 21 |
| T2 | Metsulfuron-methyl + chlorimuron-ethyl | 50 g | 21 DAS |
| T3 | Metsulfuron-methyl + chlorimuron-ethyl | 60 g | 21 DAS |
| T4 | Metsulfuron-methyl + chlorimuron-ethyl + 2,4-D | (40 + 1000) g | 21 DAS |
| T5 | 2,4-D | 1800 g | 15 DAS |
| T6 | Bentazone-sodium | 1100 mL | 15 DAS |
| T7 | Bispyribac-sodium | 210 mL | 15 DAS |

Means having same letter within the column is not significantly different at p=0.05%. Here, T0: Control; T1: Almix 20WP (40 g/ha); T2: Almix 20WP (50 g/ha); T3: Almix 20WP (60 g ha); T4: Almix 20WP + 2,4-D (40 + 1000 g /ha); T5: 2,4-D (1800 g $ha^{-1}$); T6: Bentazone-sodium (1100 ml/ha); T7: Bispyribac-sodium (210 ml/ha).

Crop injury observation made at 1, 3, 7, 14, 21, and 28 days after application (DAA) in terms of visible phytotoxicity on rice seedlings by percentage of injury (Hasan *et al.* 2021). Weed control evaluations were made at 14, 28, and 42 DAA. The dry weight of each species was observed at 42 DAA. Henderson and Tilton's method was used to calculate weed control efficiency (Hasan *et al.* 2023). The collected data were statistically analysed by using ARM8 and StatMart software owned by Corteva Agriscience.

**Results and Discussion**

The effectiveness of premix Almix 20WP and other herbicides showed significant differences to control weed (Table 2). Almix 20WP provided very good control against *C. difformis* (93.5%), *F. miliacea* (92.25%), *L. octovalvis* (91.25%), and *S. zeylanica* (92.0%) at recommended dose (40 g/ha). Almix 20WP with the maximum dose (60 g/ha) effectively controlled *L. octovalvis* (98.75%), followed by *S. zeylanica* (98.50%), *F. miliacea* (98.50%), *C. difformis* (97.25%) and *C. iria* (88.25%). The tank-mix of Almix 20WP and 2,4-D showed above 90.00% weed control efficacy and no significant difference when compared with Almix 20WP. For *C. iria*, Bentazone-sodium 1100 ml/ha represented the highest control (98.25%), compared to the other applied treatments. The application of Almix 20WP+2,4-D showed the highest control of 96.00% in *S. zeylanica* and 93.50% in *C. iria.*

**Table 2. Efficacy of Almix 20WP and other herbicides against sedges and broadleaf weeds of rice.**

| | Weed control efficiency (%) | | | | |
|---|---|---|---|---|---|
| Treatments | *Cyperus difformis* | *Cyperus iria* | *Fimbristylis miliacea* | *Ludwigia octovalvis* | *Sphenoclea zeylanica* |
| T0 | 0.00a | 0.00a | 0.00a | 0.00a | 0.00a |
| T1 | 93.50cd | 72.00b | 92.25bc | 91.25bc | 92.00b |
| T2 | 94.75cd | 83.00c | 94.25bc | 95.00c | 96.25b |
| T3 | 97.25cd | 88.25cd | 98.25c | 98.75c | 98.50b |
| T4 | 94.75cd | 93.50de | 94.50bc | 94.25c | 96.00b |
| T5 | 65.00b | 88.75cd | 88.50b | 96.75c | 90.00b |
| T6 | 94.50cd | 98.25e | 95.75bc | 95.00c | 92.00b |
| T7 | 81.25c | 88.75cd | 89.00b | 85.00b | 92.00b |

Means having same letter written the column is not significantly different at p = 0.05.

All the tested herbicides had a high level of selectivity toward rice and did not cause any significant damage (Table 3). Almix 20WP at 40 g/ha showed slight injury of 2.5% at 7 DAA, reaching a maximum of 3.75% at 14 DAA. This is not significantly different from the untreated control statistically and fully recovered at 28 DAA. The application of 2,4-D exhibited comparatively higher injury symptoms than other herbicides and control. The phytotoxicity of 2,4-D was significantly reduced by the tank-mix application of 2,4-D with Almix 20WP. No injury symptoms were recorded in rice plants by the application of Bentazone-sodium. Ntanos *et al.* (2000) reported slight phytotoxicity in rice plants by the application of Cyhalofop-butyl and Propanil. Table 3 represented the rice yield in treated plots and no significant difference was observed across treatments. The maximum yield of grain 7975.50 kg/ha was recorded in Bentazone-sodium treated rice followed by 7962.50 kg/ha, 7450.00 kg/ha and 7410.00 kg/ha in the tank-mix of Almix 20WP + 2,4-D, Almix 20WP at 40 g/ha and 2,4-D, respectively. The lowest rice yield (1970 kg/ha) was recorded in control plot. The non-significant yield differences among herbicide treatments validate that all evaluated herbicides are agronomically safe, effective, and offer flexibility in weed management without compromising rice yield. This finding supports their practical utility in sustainable rice production systems. The consistent yield performance across treatments provides flexibility in herbicide selection, enabling farmers to diversify weed management practices based on the specific weed flora, resistance history, and environmental

conditions of their fields. Such diversified management is fundamental to integrated weed management (IWM) and the long-term sustainability of chemical weed control strategies.

The population of weeds present in the test plots was homogenous within the treated plot. Grassy weed species were evenly distributed within the trial plot, namely *E. crus-galli* and *L. chinensis*. These weeds were controlled by applying Cyhalofop at 1500 ml/ha. Other broadleaf species that were not targeted but present in the field were *Monochoria vaginalis* (Burm. f.) C.Presl, *Sagittaria guyanensis* Kunth and *Bacopa rotundifolia* (Michx.) Wettst. In this study, Almix 20WP exhibited more than 97% weed control on selected weeds except *C. iria* (88.25%) at the highest application rate. An increased concentration of herbicides causes changes in plant development, physiology, and metabolism, leading to phytotoxicity and reduced yield (Motmainna *et al.* 2021b, Hasan *et al.* 2022). Based on this result, the tank-mix of Almix 20WP and 2,4-D caused significantly higher weed control. This may be explained by the fact that, when used in combination, herbicides with various modes of action efficiently suppress the weeds. Herbicides may behave differently depending on the type of weed they are intended to control. It hinders the production of valine, isoleucine, and leucine by blocking the activity of the enzyme acetolactate synthase (ALS). Consequently, the suppression of amino acid synthesis inhibits the process of cell division. There was no observable sign of resistance development of Almix 20WP as similar efficacy was observed on another ALS group, Bispyribac, and did not show a significant difference as compared to other mode of action groups.

**Table 3. Phytotoxicity of Almix 20WP at different intervals.**

| Treatments | % crop injury (DAA) | | | | | | Grain yield (kg/ha) |
|---|---|---|---|---|---|---|---|
| | 1 | 3 | 7 | 14 | 21 | 28 | |
| T0 | 0.00a | 0.00a | 0.00a | 0.00a | 0.00a | 0.00a | 1970.0a |
| T1 | 0.00a | 0.00a | 2.50ab | 3.75abc | 1.25a | 0.00a | 7450.0b |
| T2 | 0.00a | 0.00a | 3.75abc | 6.25bcd | 1.25a | 0.00a | 7320.0b |
| T3 | 0.00a | 0.00a | 7.50bc | 8.75cd | 3.75a | 0.00a | 7140.0b |
| T4 | 2.00b | 6.25b | 8.75c | 6.25bcd | 1.25a | 0.00a | 7962.5b |
| T5 | 3.50b | 8.75b | 15.00d | 10.00d | 6.25a | 2.50b | 7410.0b |
| T6 | 0.00a | 0.00a | 0.00a | 0.00a | 0.00a | 0.00a | 7975.0b |
| T7 | 0.00a | 1.25a | 3.75abc | 1.25ab | 0.00a | 0.00a | 7407.5b |

The study found that there were no statistically significant variations in rice grain production among the treatments. The control plot had the lowest yield due to the presence of a high density and biomass of weeds, which negatively impacted the rice yield. Implementing weed control strategies decreased the number of weeds and their overall biomass and enhanced the plant's ability to utilize available resources effectively. The current label recommendation for Almix 20WP is 40 g/ha with 270 l/ha water volume applied about 3 weeks after seeding. Applying this product on the flooded field at about 7 cm depth and maintaining it for at least 7 days is recommended to obtain maximum weed control efficacy. This, in turn, led to improved growth parameters and yield attributes, finally resulting in a better crop yield.

Based on the results, Almix 20WP can provide good control of sedges and broadleaf weed species, especially *C. difformis*, *F. miliacea*, *L. octovalvis*, and *S. zeylanica*. The mixture of Almix 20WP with 2,4-D provided additional control against *C. iria*. This product can still be a potent

alternative tool for weed management practice and should be applied appropriately as per the herbicide resistance management recommendations.

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