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Effectiveness of Bispyribac-Sodium 18% and Pyrazosulfuron-Ethyl 10% herbicide mixture for weed control in lowland rice cultivation

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Abstract
Weeds can significantly reduce the productivity of lowland rice (*Oryza sativa*). Therefore, applying herbicide mixtures is necessary to broaden the weed control spectrum. This study aimed to evaluate the effectiveness of an herbicide mixture containing 18% bispyribac-sodium and 10% pyrazosulfuron-ethyl against weeds in rice crops. The research was conducted in Cirebon, West Java using a Randomized Block Design. The experiment involved six treatments consisting of the herbicide mixture at doses of 60, 80, 100, and 120 g/ha, manual weeding, and an unweeded control. Data were analyzed using Analysis of Variance (ANOVA) followed by Duncan's Multiple Range Test (DMRT) at a 5% significance level. The results showed that applying the herbicide mixture at doses ranging from 60 g/ha to 120 g/ha effectively suppressed *Sphenoclea zeylanica*, *Monochoria vaginalis*, *Leptochloa chinensis*, *Cyperus iria*, *Echinochloa crus-galli*, other weeds, and total weeds compared to the control. The treatments caused no phytotoxic effects on the rice plants and successfully maintained crop growth and yield.

Keywords: bispyribac-sodium, herbicide efficacy, lowland rice, pyrazosulfuron-ethyl, weed competition

Introduction
Rice (*Oryza sativa*) is a major food crop commodity that plays a crucial role in supporting the country's economy and serves as a staple food consumed daily by approximately 90% of the Indonesian population (Nurhaliza *et al*., 2025) [15]. Rice productivity itself experienced a decline of 838.27 thousand tons, or 1.55%, in 2024 compared to 2023 (Badan Pusat Statistik, 2025) [1]. Efforts to increase rice production are inseparable from various constraints affecting rice yields, one of which is the presence of weeds that can reduce crop productivity (Umiyati, 2016) [26]. Weeds are among the plant-disturbing organisms that can stunt the growth of cultivated crops. The presence of weeds in rice fields has the potential to cause a decline in rice production yields by approximately 6% to 87% (Farmanta *et al*., 2016) [5]. Weed control in lowland rice fields is generally conducted mechanically through manual weeding; however, this method is considered inefficient in terms of the time and labor required (Simanjuntak *et al*., 2016) [23].

Pamungkas *et al*. (2018) [17] stated that weed control using herbicides offers advantages in economic, time, and labor aspects compared to other methods. However, the use of herbicides with a single active ingredient is often less effective, and repeated application over a long period potentially increases the risk of resistance emergence in the targeted weeds. A viable herbicide application strategy is mixing several active ingredients to improve weed control effectiveness and minimize the risk of resistance (Evar *et al*., 2022) [4]. One of the mixed herbicides that can be applied in lowland rice cultivation areas is a mixture of byspiribac-sodium and pyrazosulfuron-ethyl.

According to Kurniadie *et al*. (2020) [9], byspiribac-sodium is a systemic post-emergence herbicide that works by inhibiting the acetolactate synthase (ALS) enzyme, thereby stunting weed growth. According to a study by Kumar *et al*. (2025) [7], the application of byspiribac-sodium herbicide at a dose of 60 g/ha resulted in higher weed control efficiency compared to other treatments, as well as higher rice yields without causing phytotoxicity. Meanwhile, pyrazosulfuron-ethyl is a selective, systemic, pre-emergence herbicide that functions by inhibiting protein production and amino acid metabolism (Simanjuntak *et al*., 2016). Widayat *et al*. (2021) [23, 30] found in their study that a herbicide with the active ingredient pyrazosulfuron-ethyl at doses of 16-24 g/ha proved capable of suppressing weed presence while producing higher rice yields without causing toxicity symptoms in the rice plants.

Both of these active ingredients share the same mechanism of action, which is the inhibition of amino acid synthesis, but they operate at different stages of weed growth. Byspiribac-sodium is effective as a post-emergence herbicide, whereas pyrazosulfuron-ethyl works optimally as a pre-emergence herbicide. The combination of these two active ingredients presents a novel solution for broad-spectrum, continuous weed control from the pre- to post-emergence phases. Although byspiribac-sodium is commonly used in lowland rice cultivation, studies regarding the effectiveness of its combination with pyrazosulfuron-ethyl are still very limited. Therefore, this study aims to determine the most effective and efficient dose of a mixed herbicide containing byspiribac-sodium and pyrazosulfuron-ethyl for weed control in rice crops. The findings of this study are expected to contribute to scientific development and serve as recommendations for agricultural extension workers and farmers regarding proper and efficient weed control strategies.

Materials and Methods
The research was conducted in Gamel village, Plered District, Cirebon Regency, West Java, from November 2025 to March 2026, using a randomized block design with six treatments and four replicates. Treatments included four dosages of the mixed herbicide byspiribac-sodium 18% and pyrazosulfuron-ethyl 10% (60 g/ha, 80 g/ha, 100 g/ha, and 120 g/ha), manual weeding, and a non-treated control. Data were analyzed using analysis of variance method.

The observed response variables include

Weed observations

Observations on weed dry weight were conducted by harvesting fresh weeds from a 0.5 m x 0.5 m quadrat and separating them by species. The collected weeds were subsequently oven dried at 80°C for 48 hours. Following the drying process, the dry weight of the weeds was measured using an analytical weighing scale. These observations were performed at 3 and 6 weeks after application (WAA).

Rice plant observation

Observations of the lowland rice components included plant height, number of tillers, and milled dry grain yield. Plant height and the number of tillers were observed at 3 and 6 weeks after application (WAA) from 12 sample plants. The crop yield component, specifically the milled dry grain, was harvested from a 2 m x 2 m sampling plot containing a minimum population of 64 hills per plot.

Phytotoxicity

Phytotoxicity levels were assessed visually on the primary crop population within the sampling plots. These observations were conducted at 1, 2, and 3 weeks after application (WAA). The evaluation was based on a scoring system using a 0–4 scale, determined by the percentage of leaf abnormalities or overall growth inhibition. A score of 0 indicates no toxicity (<5%); 1 represents mild symptoms (5–20%); 2 denotes moderate symptoms (20–50%); 3 signifies severe toxicity (>50–75%); and 4 indicates very severe toxicity (>75%), which may lead to plant mortality.

Result and Discussion

Weed Vegetation Analysis

Table 1: Summed Dominance Ratio (SDR)

No	Species	Group	SDR (%)
1	*Spenochlea zeylanica*	Broadleaf	31.08
2	*Monochoria vaginalis*	Broadleaf	20.00
3	*Leptochloa chinensis*	Grass	13.91
4	*Echinochloa crus-galli*	Grass	11.60
5	*Cyperus iria*	Sedge	11.60
6	*Alternanthera philoxeroides*	Broadleaf	5.28
7	*Eragrostis spp.*	Grass	6.50

The weed dominance level in a field can be determined through vegetation analysis by calculating the Summed Dominance Ratio (SDR) (Ndema *et al*., 2024) [13]. The SDR value is obtained by quantifying the population of each weed species within the sampling quadrats (Widiyani *et al*., 2023) [31]. A weed species is considered dominant if its SDR value exceeds 10% (Kurniadie *et al*., 2022) [10]. Table 1 shows that the dominant weed in the experimental plot was *Sphenoclea zeylanica*, with an SDR value of 31.08%. Additionally, several co-dominant weed species were identified, namely *Monochoria vaginalis* (20.00%), *Leptochloa chinensis* (13.91%), *Cyperus iria* (11.60%), and *Echinochloa crus-galli* (11.60%), along with other weed species such as *Eragrostis* spp. (6.50%) and *Alternanthera philoxeroides* (5.28%).

Table 2: Average Dry Weight of Weeds

Species	Observation	Average Weight of Weeds (g/0.5 m²)					
		Bispyribac-Sodium 18% + Pyrazosulfuron-Ethyl 10% (g/ha)				Manual	Control
		60	80	100	120		
Spenochlea zeylanica	3 WAA	0,72 a	0,44 a	0,43 a	0,23 a	1,32 b	1,35 b
	6 WAA	0,92 b	0,45 ab	0,28 a	0,14 a	1,64 c	2,64 d
Monochoria vaginalis	3 WAA	0,42 a	0,34 a	0,36 a	0,41 a	1,07 b	1,47 b
	6 WAA	0,38 a	0,37 a	0,41 a	0,25 a	1,35 b	1,85 c
Leptochloa chinensis	3 WAA	0,25 a	0,14 a	0,19 a	0,13 a	0,76 b	1,15 b
	6 WAA	0,27 ab	0,14 a	0,12 a	0,13 a	0,84 bc	1,41 c
Echinochloa crus-galli	3 WAA	0,81 b	0,89 b	0,37 a	0,32 a	1,34 c	1,85 d
	6 WAA	0,83 a	0,44 a	0,23 a	0,28 a	1,99 b	3,20 c
Cyperus iria	3 WAA	0,29 a	0,24 a	0,21 a	0,21 a	0,72 b	0,83 b
	6 WAA	0,15 a	0,16 a	0,13 a	0,10 a	0,93 b	1,01 b
Other weeds	3 WAA	0,27 a	0,15 a	0,34 a	0,21 a	0,60 ab	0,83 b
	6 WAA	0,32 a	0,14 a	0,25 a	0,24 a	1,06 b	1,58 c
Total weeds	3 WAA	2,75 a	2,18 ab	1,89 ab	1,50 a	5,81 c	7,48 d
	6 WAA	2,87 b	1,69 a	1,41 a	1,13 a	7,81 c	11,69 d

Average Dry Weight of Weeds

Dry Weight of *Spenochloa zeylanica*

Sphenoclea zeylanica is a broadleaf weed belonging to the family Sphenocleaceae. It is classified as an annual weed that thrives in agricultural fields and exhibits greater resilience to environmental conditions compared to sedges and grasses (Maretik *et al*., 2025) [11].

Based on the data presented in Table 2, the application of the mixed herbicide containing 18% bispyribac-sodium and 10% pyrazosulfuron-ethyl at doses ranging from 60 g/ha to 120 g/ha effectively controlled *S. zeylanica*. This was evidenced by the significant difference in the average weed dry weight between the herbicide treatments and the control plot. These findings align with the statement by Kurniadie *et al*. (2019) [8], who noted that weed control utilizing mixed herbicides is considered more effective as it requires lower application doses compared to the use of single herbicides.

The decrease in the dry weight of *S. zeylanica* with increasing doses occurred due to the higher availability of the active ingredients penetrating the weed tissues. This is in accordance with Cuvaca *et al*. (2019) [3], who stated that the application dose affects herbicide effectiveness, as higher doses enhance the absorption and translocation of the active ingredients. The application of an appropriate herbicide dose can sustain weed control efficiency over a longer period. On the other hand, manual weeding still allows for weed regrowth, resulting in an increase in dry weight over time. The unweeded control treatment exhibited the highest weed growth and was significantly different from all other treatments. This confirms that without proper weed control, *S. zeylanica* will continuously thrive in lowland rice fields.

Dry Weight of *Monochoria vaginalis*

Monochoria vaginalis is a broadleaf weed belonging to the family Pontederiaceae. It is an aquatic plant with an annual life cycle, characteristically featuring ovate to oblong leaves (Natsir *et al*., 2022) [12]. The post-hoc test results in Table 2 demonstrate that all dosage treatments of the mixed herbicide (18% bispyribac-sodium and 10% pyrazosulfuron-ethyl) were significantly different from the control, indicating that all tested doses were effective in controlling *M. vaginalis*. The lowest dose of 60 g/ha proved to be effective and was significantly different from the control; thus, it serves as the recommended dose. The combination of these two active ingredients, which both target broadleaf weeds, successfully suppressed the growth of *M. vaginalis*.

The mode of action of both active ingredients contribute to this effectiveness by inhibiting the ALS enzyme, thereby disrupting amino acid biosynthesis in the weeds. The inhibition of this enzyme induces tissue damage in the form of necrosis, causing the weeds to gradually desiccate and ultimately die (Rasyid *et al*., 2022) [4]. Consequently, the application of this mixed herbicide is highly effective in controlling *M. vaginalis*.

Dry Weight of *Leptochloa chinensis*

Leptochloa chinensis is an annual weed belonging to the Poaceae family. *L. chinensis* exhibits high adaptability to both drought and waterlogged conditions (Xu *et al*., 2025). This adaptability enables it to frequently dominate lowland rice fields. Furthermore, its basal growing point is optimally protected by the leaf sheaths and stems, significantly enhancing its survival capacity in the field (Umiyati *et al*., 2020) [27].

Table 2 demonstrates that all dosage treatments of the mixed herbicide (18% byspiribac-sodium and 10% pyrazosulfuron-ethyl) were significantly different from the control. All herbicide treatments also exhibited better control efficacy compared to manual weeding. The lowest dose (60 g/ha) showed no significant difference when compared to the higher doses; thus, it is recommended as it provides optimal and highly efficient weed control. The synergistic effect of these two active ingredients supports the effective control of *L. chinensis*. Byspiribac-sodium itself is a systemic herbicide specifically targeting grassy weeds. Consequently, the combination of these active ingredients effectively controls *L. chinensis* while broadening the overall spectrum of weed control.

Dry Weight of *Cyperus iria*

Cyperus iria is a sedge weed belonging to the family Cyperaceae. This weed thrives in various environmental conditions and frequently dominates lowland rice fields (Umiyati *et al*., 2023) [28]. It spreads rapidly through both seeds and stolons (Purba *et al*., 2025) [18].

The average dry weight data presented in Table 2 indicate that the mixed herbicide treatment (18% byspiribac-sodium and 10% pyrazosulfuron-ethyl) at doses ranging from 60 g/ha to 120 g/ha was effective in controlling *C. iria*, showing significant differences compared to both manual weeding and the control. The lowest dose (60 g/ha) effectively controlled the weed and showed no significant difference from the highest dose; therefore, it is recommended as the optimal dose.

Observations of the average dry weight at 6 weeks after application (WAA) demonstrated that the herbicide treatments continued to suppress weed dry weight. This indicates that the effectiveness of both active ingredients persisted until the end of the observation period. Conversely, the dry weight of *C. iria* in the manual weeding treatment increased by the end of the observation. This aligns with the findings of Ogoudjobi *et al*. (2025) [16], who stated that manual weeding cannot optimally control weeds with robust root systems, as it often triggers regrowth. The application of systemic herbicides provides more effective weed control due to their ability to translocate to the root system, thereby suppressing weed growth more optimally.

Dry Weight of *Echinochloa crus-galli*

Echinochloa crus-galli is an annual weed belonging to the family Poaceae. It is classified as a grassy weed and frequently dominates lowland rice fields (Anwar *et al*., 2012) [2]. *E. crus-galli* exhibits greater adaptability than broadleaf weeds regarding nutrient absorption, water availability, and temperature fluctuations to support its growth and development (Hastuti, 2021) [6].

The data in Table 2 demonstrate that all dosage treatments of the mixed herbicide (18% byspiribac-sodium and 10% pyrazosulfuron-ethyl) were effective in controlling *E. crus-galli*, showing significant differences compared to both the control and manual weeding. Observations at 6 WAA also indicated that all tested herbicide doses were able to maintain their control effectiveness until the end of the observation period. The weed dry weight data revealed that the lowest dose (60 g/ha) efficiently suppressed weed growth without a significant difference from the highest dose; therefore, this dose is recommended for the control of *E. crus-galli*.

This suppression of weed dry weight occurred due to the inhibition of the ALS enzyme by the combination of these two active ingredients. The inhibition of the ALS enzyme disrupts the amino acid biosynthesis process necessary for protein formation, thereby triggering tissue death in the weeds (Rasyid *et al*., 2022) [4]. This aligns with the properties of byspiribac-sodium as a broad-spectrum post-emergence herbicide, particularly in controlling *E. crus-galli* (Rizal & Arbirawati, 2021) [20].

Dry Weight of Other Weeds

Other weed groups found in the lowland rice fields consisted of broadleaf weeds (*Alternanthera philoxeroides*) and grasses (*Eragrostis* spp.). Table 2 shows that the application of the mixed herbicide containing 18% byspiribac-sodium and 10% pyrazosulfuron-ethyl at various dosage levels proved effective in suppressing the growth of both weed groups, showing significant differences compared to manual weeding and the control. The absence of significant differences in effectiveness among the doses indicates that the lowest applied dose (60 g/ha) is sufficiently optimal for weed control. This success is supported by the synergistic capability of both active ingredients in inhibiting weed biomass accumulation compared to the control treatment. This aligns with Sembodo (2010) [22], who stated that low dry weight is a primary indicator of successful control, as it reflects the inhibition of weed growth and development processes.

In addition to effectively suppressing initial dry weight, the mixed herbicide also demonstrated excellent control effectiveness by maintaining weed dry weight suppression until the end of the observation period. This condition contrasts sharply with the results of the manual weeding treatment, which showed an increasing trend in dry weight over time. The increase in biomass in the manual weeding plots indicates weed regrowth; thus, its long-term control effectiveness is considered lower compared to herbicide application.

Dry Weight of Total Weeds

Total weed dry weight represents the biomass accumulation of all weed species within the observation area. The dry weight data in Table 2 indicate that all applied doses of the herbicide mixture containing 18% bispyribac-sodium and 10% pyrazosulfuron-ethyl were effective in suppressing weed growth. The herbicide application proved to be significantly more effective in reducing weed growth compared to both the control and manual weeding treatments. This is in accordance with the findings of Singh *et al*. (2020) [24], who stated that the use of herbicide mixtures can enhance effectiveness while broadening the weed control spectrum, particularly in lowland rice cultivation systems.

Observations at 3 and 6 WAA demonstrated that all doses of the herbicide mixture consistently exhibited a significantly different and superior effect in reducing weed dry weight compared to manual weeding and the control. At 3 WAA, the herbicide mixture applied at a dose of 120 g/ha resulted in the lowest total weed dry weight, which was not significantly different from the 80 g/ha and 100 g/ha doses, but differed significantly from the lowest dose of 60 g/ha. This herbicidal effectiveness was maintained until 6 WAA, where the 120 g/ha dose again recorded the lowest dry weight and remained statistically on par with the 80 g/ha and 100 g/ha doses. Meanwhile, the 60 g/ha dose at 6 WAA showed a significant difference among all treatments. Overall, this confirms that although the effectiveness of the 60 g/ha dose is not equivalent to the higher doses, its application was sufficiently effective in suppressing weed growth compared to without proper weed control and manual weeding up to 6 WAA.

Phytotoxicity

Table 3: Phytotoxicity

Treatment		Dosage (g/ha)	Phytotoxicity		
			1 WAA	2 WAA	3 WAA
A	Bispyribac-Sodium 18% + Pyrazosulfuron-Ethyl 10%	60	0	0	0
B	Bispyribac-Sodium 18% + Pyrazosulfuron-Ethyl 10%	80	0	0	0
C	Bispyribac-Sodium 18% + Pyrazosulfuron-Ethyl 10%	100	0	0	0
D	Bispyribac-Sodium 18% + Pyrazosulfuron-Ethyl 10%	120	0	0	0
E	Manual Weeding	-	0	0	0
F	Control	-	0	0	0

Phytotoxicity indicates the severity percentage of crop injury caused by herbicide exposure (Nugraha *et al*., 2024). Widayat & Sumekar (2022) [14, 29] stated that these toxicity symptoms can be identified through visual observation, manifesting as leaf chlorosis, leaf curling, and other morphological abnormalities. Table 3 demonstrates that the mixed herbicide treatments (18% byspiribac-sodium and 10% pyrazosulfuron-ethyl) at doses ranging from 60 g/ha to 120 g/ha resulted in a phytotoxicity score of 0 and showed no significant differences compared to both the manual weeding and control treatments. This proves that the herbicide applications did not induce any phytotoxic effects on the rice plants. These results were also supported by proper application techniques that avoided direct contact with the rice plants, ensuring the crop remained safe from the risk of herbicide toxicity.

Plant Height

Table 4: Plant height average

Treatment		Dosage (g/ha)	Plant height average (cm)	
			3 WAA	6 WAA
A	Bispyribac-Sodium 18% + Pyrazosulfuron-Ethyl 10%	60	56,00 b	104,50 b
B	Bispyribac-Sodium 18% + Pyrazosulfuron-Ethyl 10%	80	58,25 bc	103,25 b
C	Bispyribac-Sodium 18% + Pyrazosulfuron-Ethyl 10%	100	59,00 bc	102,25 b
D	Bispyribac-Sodium 18% + Pyrazosulfuron-Ethyl 10%	120	61,75 c	105,50 b
E	Manual Weeding	-	51,50 a	94,75 a
F	Control	-	50,25 a	93,75 a

Plant height is a primary parameter for evaluating the vegetative growth of rice. Based on Table 4, the application of the mixed herbicide (18% byspiribac-sodium and 10% pyrazosulfuron-ethyl) at doses ranging from 60 g/ha to 120 g/ha showed significant differences compared to both the manual weeding and control treatments. The highest dose treatment (120 g/ha) resulted in the tallest average plant height, reaching 105.50 cm. Conversely, the control treatment yielded the lowest average plant height at only 93.75 cm. These results align with the findings of Widayat and Sumekar (2022) [29], who reported that the application of mixed herbicides did not negatively affect rice plant height growth up to 6 WAA. The stunted plant height growth in the control plot was attributed to severe competition between the main crop and weeds for essential resources, such as nutrients, water, sunlight, and growing space.

This condition demonstrates that the application of this herbicide is both safe for rice growth and effective in suppressing weed competition. According to Srinithan *et al*. (2021) [25], utilizing mixed herbicides in lowland rice fields broadens the weed control spectrum, resulting in a cleaner field during the crop's critical period, thereby optimizing plant height growth. Overall, the combination of 18% byspiribac-sodium and 10% pyrazosulfuron-ethyl proved to be effective and safe for the height growth of rice plants.

Rice Milled Dry Grain

Table 5: Rice milled dry grain

Treatment		Dosage (g/ha)	Rice milled dry grain (kg/m^2)
A	Bispyribac-Sodium 18% + Pyrazosulfuron-Ethyl 10%	60	4,12 b
B	Bispyribac-Sodium 18% + Pyrazosulfuron-Ethyl 10%	80	3,90 b
C	Bispyribac-Sodium 18% + Pyrazosulfuron-Ethyl 10%	100	3,87 b
D	Bispyribac-Sodium 18% + Pyrazosulfuron-Ethyl 10%	120	4,30 b
E	Manual Weeding	-	3,90 b
F	Control	-	3,29 a

Milled dry grain refers to unhusked rice with a maximum moisture content of 14% and a maximum allowance of 3% for empty grains and impurities (Rizal *et al*., 2022) [21]. The observation data on milled dry grain weight in Table 5 indicate that the application of the herbicide mixture containing 18% bispyribac-sodium and 10% pyrazosulfuron-ethyl at doses ranging from 60 g/ha to 120 g/ha resulted in significant differences compared to the control, but did not differ significantly from the manual weeding treatment. The highest grain weight was achieved with the 120 g/ha dose treatment. The difference in weight is attributed to the high weed population in the control plot, which competed with the rice plants for light, water, and nutrients, thereby reducing crop productivity. This aligns with the statement by Farmanta *et al*. (2016) [5], noting that weeds can reduce rice production yields by approximately 6% to 87%. The low nutrient uptake resulting from the competition between weeds and rice plants decreases the photosynthetic rate during the reproductive phase, which consequently leads to a lower milled dry grain weight.

Conclusion

Based on the research findings, it can be concluded that:

1. The herbicide mixture containing 18% bispyribac-sodium and 10% pyrazosulfuron-ethyl demonstrated a positive effect in controlling *Sphenoclea zeylanica*, *Cyperus iria*, *Leptochloa chinensis*, *Monochoria vaginalis*, *Echinochloa crus-galli*, other weeds, and total weeds up to 6 Weeks After Application (WAA), and did not cause phytotoxicity to lowland rice plants.
2. The application of the herbicide mixture containing 18% bispyribac-sodium and 10% pyrazosulfuron-ethyl at doses ranging from 60 g/ha to 120 g/ha had no negative impact on the growth parameters and yield of the rice crop. The 120 g/ha dose produced the highest crop yield compared to all other treatments.

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