



## Efficacy of mixed herbicides pretilachlor 323 g/l + penoxulam 13 g/l on weeds, growth, and yield of rice (*Oryza Sativa* L.)

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### Abstract

Weed interference is one of the most significant constraints in rice cultivation, causing substantial yield losses if not properly managed. This study aimed to evaluate the efficacy of a mixed herbicide formulation containing Pretilachlor (323 g/L) and Penoxulam (13 g/L) on weed suppression, crop growth, and rice yield. The research was conducted from January to April 2024 at SPLPP Ciparay, Bandung, using a randomized block design with seven treatments and four replications. Treatments included five herbicide dosage levels (0.50 to 1.50 L/ha), manual weeding, and an untreated control. Weed biomass was measured at 3 and 6 weeks after application (WAA), and phytotoxicity symptoms were assessed visually. Plant height, tiller number, and grain yield were also recorded. The results showed that the herbicide combination significantly reduced biomass of broadleaf, grassy, and sedge weeds compared to the control, with suppression rates above 70%. Additionally, treated plots exhibited higher plant growth and grain yield compared to the untreated control, with performance comparable to manual weeding.

**Keywords:** Penoxulam, pretilachlor, rice, weed

### Introduction

Rice (*Oryza sativa* L.) is a staple food for most Indonesians and Asians. Around 90% of the world's rice production and consumption is centered in the Asia-Pacific region, demonstrating how vital this commodity is to regional food security (FAO, 2021) <sup>[1]</sup>. In Indonesia, rice accounts for more than half of the population's calorie needs and remains the main source of carbohydrates and other essential elements such as starch (accounting for 80-85%), protein, minerals, vitamins and water. (Sabarella, 2023) <sup>[2]</sup>. According to the National Food Agency, the per capita rice consumption of Indonesians in 2023 will reach around 81.23 kilograms per capita per year. With this level of consumption and a large population, Indonesia's national rice demand is very high. The total rice demand for household consumption in 2023 is estimated to be around 22.64 million tons (Ahdiat, 2024) <sup>[3]</sup>. Indonesia is one of the largest rice producing countries in the world. According to data from the Badan Pusat Statistik (2023) <sup>[4]</sup>, total national rice production in the form of milled dry grain (MDG) in 2023 reached 53.98 million tons, a slight decrease compared to 2022 which amounted to 54.75 million tons. After being converted to rice consumption, the total rice production in 2023 was recorded at 31.10 million tons. In recent years, national rice production has shown a stagnant and even declining trend, indicating serious challenges such as limited agricultural land, the impact of climate change, and pest and plant disease attacks.

Rice production can be constrained because it has limiting factors, one of which is the presence of weeds. Weeds are nuisance plants that compete with rice plants in the absorption of nutrients, light, water, and growing space (Ria *et al.*, 2023) <sup>[5]</sup>. If not controlled, weeds can significantly reduce crop yields. Globally, yield losses due to weed competition in rice can reach 10-15% and even up to 86% if weeds are not controlled (Rao, 2022) <sup>[6]</sup>. At the farm level, yield losses due to weeds can reach 10-40%, depending on the type and density of weeds (Farmanta & Rosmanah, 2016) <sup>[7]</sup>.

Weed control strategies are classified into several categories, including mechanical, technical culture, biological, chemical with the use of herbicides, or integrated (Umiyati *et al.*, 2017) <sup>[8]</sup>. Chemical control using herbicides is the most widely used method because it is considered more effective and efficient to reduce weed populations compared to other controls because it can reduce production costs with reduced labor required (Simanjuntak *et al.*, 2016) <sup>[9]</sup>. In general, herbicides are applied with a single active ingredient herbicide. However, if done continuously, it will cause residues in the soil, causing resistance in weeds that interfere with the main crop on the active ingredient. So there is an alternative way to minimize the negative impact on the environment and reduce the dose, namely by mixing active ingredients for making herbicides (Najafi & Ghadiri, 2012) <sup>[10]</sup>. Penoxulam and Pretilachlor herbicides are one of the active ingredients of herbicides that can be used on rice fields.

Penoxulam herbicide is a systemic herbicide from the sulfonamide family. Herbicides made from penoxulam work by inhibiting the enzyme acetolactate synthase (ALS), and are usually absorbed by weeds through leaves or roots, controlling broadleaf weeds, grasses, and teki (Umiyati *et al.*, 2020) <sup>[11]</sup>. Pretilachlor [2-Chloro-N-2,6-diethylphenyl-N-(2-propoxyethyl) acetamide] is a systemic herbicide widely used in rice fields to control weeds. It inhibits cell division by preventing the synthesis of long chain fatty acids and is most effective for controlling broad and narrow leaf weeds, but least effective for controlling grass weeds (Kanda *et al.*, 2023) <sup>[12]</sup>. Selective mixing of herbicides with different active ingredients and modes of action (MoA) for weed control is essential to reduce the emergence of resistant weeds.

The use of the right type and dose of herbicides on paddy fields can provide benefits to farmers, one of which can control weeds that grow as early as possible. So there is a need for research to determine the effect of herbicide doses of Pretilachlor 323 g/l + Penoxulam 13 g/l on rice plants so

as to suppress weed growth in cultivated plants and provide the best effect on rice yield and quality.

### Materials and Methods

This research was conducted from January 2024 to April 2024. The experiment was conducted at SPLPP Ciparay, Bandung Regency, West Java. The experimental method used is the group randomized design method with 7 treatments and repeated 4 times. The treatments observed were the application of herbicide doses of Pretilachlor 323 g/l + Penoxulam 13 g/l, with doses of 0,50 l/ha, 0,75 l/ha, 1,00 l/ha, 1,25 l/ha, 1,50 l/ha, Manual Weeding, Control (no weed control). Data processing was carried out using the analysis of variance method. If the treatment shows a real effect, further tests are carried out on the difference in the average value of the treatment at a real level of 95%.

The observed response variables include:

### Initial vegetation analysis

Initial vegetation analysis was conducted using the Sum Dominance Ratio (SDR) method within 0.5 m × 0.5 m quadrat plots, which were randomly placed in the crop area. The observed weed parameters included dry weight, density, and frequency. Fresh weeds in each quadrat were cut at ground level and separated by species. Each species was then dried in an oven at 80°C for 48 hours until a constant weight was achieved, followed by measurement of dry weight, calculation of density based on individual counts, and determination of frequency by recording the number of quadrats in which each species appeared.

### Weed observations

Weed observations were carried out in each treatment plot using two systematically positioned quadrat plots measuring 0.5 m × 0.5 m. Weed sampling for biomass and total weed population was conducted at 3 and 6 weeks after application (WAA). The sampled weeds were cut at ground level, sorted by species, dried at 80°C for 48 hours or until reaching a constant dry weight, and then weighed.

### Rice plant observations

Rice plant observations included measurements of plant height, number of tillers, and grain yield. Plant height was measured from the base of the stem to the tip of the longest leaf on 10 clumps per plot at 3 and 6 WAA. The number of tillers was counted on 10 randomly selected plants, including only those with fully opened leaves, also at 3 and 6 WAA. Grain yield, in the form of milled dry grain (MDG), was assessed from a 2.5 m × 2.5 m sample plot containing at least 64 clumps.

### Phytotoxicity

Phytotoxicity was evaluated visually at 1, 2, and 3 WAA using a scoring system ranging from 0 to 4. A score of 0 indicated no symptoms (<5% abnormality in leaf shape, color, or plant growth), 1 indicated mild symptoms (5–20%), 2 moderate (20–50%), 3 severe (50–75%), and 4 indicated very severe toxicity, affecting more than 75% of the plant's leaf shape, color, or growth.

### Result and Discussion

**Table 1:** Average Dry Weight of Weeds in Rice Cultivation field

Weed	Treatment Observation	Average Weight of Weeds (g/0.5 m <sup>2</sup> )						
		Dose Pretilachlor 323 g/l + Penoxulam 13 g/l (l/ha)					Manual	Control
		0,50	0,75	1,00	1,25	1,50		
<i>Ludwigia octovalvis</i>	3 WAA	1,02 a	0,75 a	0,74 a	0,80 a	0,66 a	0,97 a	4,38 b
	6 WAA	1,55 a	1,57 a	1,71 a	1,36 a	1,20 a	1,71 a	6,23 b
<i>Monochoria vaginalis</i>	3 WAA	1,27 a	0,95 a	0,84 a	0,96 a	0,94 a	1,19 a	4,01 b
	6 WAA	1,81 a	1,63 a	2,07 a	1,59 a	1,57 a	1,77 a	6,64 b
<i>Spenochlea zeylanica</i>	3 WAA	0,76 a	0,82 a	0,70 a	0,71 a	0,62 a	0,85 a	3,37 b
	6 WAA	1,52 a	1,63 a	1,33 a	1,44 a	1,16 a	1,45 a	5,75 b
<i>Echinochloa crus-galli</i>	3 WAA	1,14 a	0,94 a	1,36 a	0,81 a	0,75 a	1,05 a	3,77 b
	6 WAA	1,88 a	1,50 a	1,40 a	1,09 a	1,06 a	1,84 a	5,78 b
<i>Leptochloa chinensis</i>	3 WAA	0,52 a	0,65 a	0,93 a	0,77 a	0,65 a	0,80 a	2,77 b
	6 WAA	1,40 a	1,41 a	1,01 a	1,05 a	0,90 a	1,43 a	4,67 b
<i>Cyperus spp</i>	3 WAA	0,72 a	0,52 a	0,33 a	0,29 a	0,37 a	0,74 a	3,30 b
	6 WAA	1,60 a	1,38 a	1,36 a	1,35 a	0,78 a	1,61 a	4,74 b
<i>Fimbristylis miliacea</i>	3 WAA	0,72 a	0,63 a	0,59 a	0,52 a	0,53 a	0,74 a	2,53 b
	6 WAA	1,20 a	1,05 a	1,08 a	0,82 a	0,99 a	1,34 a	4,08 b

### Supporting Observation

#### Weed Vegetation Analysis

Weed dominance refers to the ability of a weed species to survive in a particular agroecosystem and compete with other weed species. The level of weed dominance can be measured using the Summed Dominance Ratio (SDR) value, where weeds are considered dominant if the SDR value is more than 10% (Yuliana & Ami, 2020) [13]. The results of vegetation analysis using the *Sum Dominance Ratio* (SDR) technique at the test site before weeds were controlled with Pretilachlor 323 g/l + Penoxulam 13 g/l herbicide or manual weeding found that there were 7 types of weeds of different species, namely three species of broadleaf weeds, namely *Monochoria vaginalis*, *Ludwigia octovalvis* and *Spenochlea zeylanica*. There are two species

of grass weeds, namely *Echinochloa crusgalli* and *Leptochloa chinensis*. Then, there are two species of weeds, namely *Fimbristylis miliacea* and *Cyperus iria*.

**Table 2:** Summed Dominance Rate (SDR)

Weed Name	Goals	SDR (%)
<i>Monochoria vaginalis</i>	Wide Leaves	19,13
<i>Ludwigia octovalvis</i>	Wide Leaves	16,49
<i>Spenochlea zeylanica</i>	Wide Leaves	14,88
<i>Leptochloa chinensis</i> L.	Grass	16,78
<i>Echinochloa cruss galli</i>	Grass	14,98
<i>Fimbristylis miliacea</i>	Teki	9,89
<i>Cyperus iria</i>	Teki	7,85
Total		100

## Main Observation

### Weed Component

#### Average Dry Weight of Weeds

#### Broadleaf weeds (*Ludwigia octovalvis*, *Monochoria vaginalis*, *Sphenoclea zeylanica*)

Controlling broadleaf weeds such as *Ludwigia octovalvis*, *Monochoria vaginalis*, and *Sphenoclea zeylanica* with Pretilachlor and Penoxulam herbicides proved effective in significantly reducing the dry weight of these weeds. Pretilachlor + Penoxulam herbicide treatment at all doses (0.50-1.50 L/ha) was able to suppress broadleaf weed growth compared to the control, but was not significantly different from manual weeding. The use of herbicides will be more effective than manual weeding because, manual weeding can damage all parts of the weeds so that their growth disrupted and requires higher labor costs (Rahman, 2020) [14]. *Ludwigia octovalvis* which is a broadleaf aquatic weed showed a dry weight reduction of more than 70%, similar to the finding in West Java that local populations of *L. octovalvis* remained fully sensitive to penoxulam (ALS inhibitor), without development of resistance, which underscores the continued efficacy of penoxulam on this weed (Evar *et al.*, 2022) [15]. Similarly, *Monochoria vaginalis*, which can be controlled with low doses of Pretilachlor and Penoxulam, is due to the presence of penoxulam which is selective in rice for broadleaf weeds and teki, as these weeds are sensitive to ALS class herbicides (11) Meanwhile, *Sphenoclea zeylanica*, known as a competitive and fast-growing broadleaf weed, also showed similar results with more than 75% reduction in dry weight after herbicide application. This weed can cause rice yield losses of up to 45-50% (Rojas-sandoval, 2023) [16]. With effective control of these broadleaf weeds, rice plants will get more space and nutrients, supporting increased yields.

#### Grass weeds (*Echinochloa crus-galli*, *Leptochloa chinensis*)

Grass weeds such as *Echinochloa crus-galli* and *Leptochloa*

*chinensis* are known to be very competitive in capturing light and nutrients from rice plants. Grass weeds in a density of 10 weed populations per square meter, these weeds can produce up to 34,600 seeds and if not controlled, grass weeds can cause a decrease in the yield of paddy rice production up to about 30% (Travlos *et al.*, 2020) [17]. Based on the results of control with Pretilachlor and Penoxulam herbicides, the dry weight of *Echinochloa crus-galli* and *Leptochloa chinensis* can be reduced by more than 70%. This shows the advantages of using mixed herbicides compared to single herbicides, because single herbicides cannot suppress all types of weeds in the field (Bhuiyan & M.M, 2017) [18]. The active ingredient pretilachlor can play a role in suppressing these weeds because this active ingredient is most effective in suppressing the growth of grass weeds (Chauhan & Johnson, 2010) [19]. This combination herbicide works by inhibiting the growth of grass weeds from the beginning, providing great advantages in weed management in paddy fields.

#### Sedge weeds (*Cyperus spp*, *Fimbristylis miliacea*)

Weeds such as *Cyperus spp.* and *Fimbristylis miliacea* are very difficult to control because they have strong shallow roots and high regeneration ability. Pretilachlor and Penoxulam herbicides proved to be very effective in reducing the dry weight of these weeds. Penoxulam plays a role in suppressing this type of weed because it is an active ingredient that tends to be able to control broadleaf weeds and teki alone (Pratiwi *et al.*, 2016) [20]. This finding is in line with Umiyati *et al.*, (2023) [21] that the mixed herbicide Penoxulam and Pretilachlor can cause a decrease in the dry weight of weeds, namely, *Cyperus iria* and *Fimbristylis miliacea* at 3 WAA and 6 WAA.

#### Plant Height

Table 3: Plant Height

Treatment	Dosage l/ha	Average Height of Rice Plant (cm)	
		3 WAA	6 WAA
A Herbicide Pretilachlor 323 g/l + Penoxulam 13 g/l	0,50	69,42 a	88,25 b
B Herbicide Pretilachlor 323 g/l + Penoxulam 13 g/l	0,75	70,45 a	88,80 b
C Herbicide Pretilachlor 323 g/l + Penoxulam 13 g/l	1,00	70,60 a	89,04 b
D Herbicide Pretilachlor 323 g/l + Penoxulam 13 g/l	1,25	70,04 a	88,76 b
E Herbicide Pretilachlor 323 g/l + Penoxulam 13 g/l	1,50	69,61 a	89,46 b
F Manual Weeding	-	69,38 a	88,81 b
G Control	-	68,60 a	76,17 a

Notes: Mean values marked with the same letter in the same column indicate not significantly different at the 5% level according to Duncan's test.

WAA = Week After Application

Table 3 shows that the herbicide Pretilachlor 323 g/l + Penoxulam 13 g/l at a dose of 0.50 l/ha - 1.50 l/ha at 3 WAA did not give a significantly different effect on the height of paddy rice plants. At 6 WAA the herbicide Pretilachlor 323 g/l + Penoxulam 13 g/l at a dose of 0.50 l/ha - 1.50 l/ha gave a significantly different effect on the average height of rice plants compared to the control treatment but not significantly different from manual weeding.

At 3 weeks after application, the rice was still in its early stages and the weeds were not too big, so the effect of competition was not yet visible. But by 6 weeks, the

weeds (especially tall weeds such as *Echinochloa* and *Sphenoclea*)

in the control plots had grown rapidly and shaded the rice plants thus inhibiting rice growth. This is in line with Caesar *et al.* (2021) [25]. that the presence of weeds in cultivated land will compete with the main crop in obtaining water, sunlight, and nutrients which can cause the growth of the main crop to be inhibited. In addition, this result occurs due to the selective nature of herbicides against rice plants, so it does not affect their growth and development directly. Selective is the ability to control target weeds but not harm or interfere with the growth of the main crop (Aditiya, 2021) [26].

## Number of Vegetative Saplings

**Table 4:** Number of Vegetative Saplings

Treatment	Dosage l/ha	Number of Vegetative Saplings	
		3 WAA	6 WAA
A Herbicide Pretilachlor 323 g/l + Penoxulam 13 g/l	0,50	32,94 a	42,01 b
B Herbicide Pretilachlor 323 g/l + Penoxulam 13 g/l	0,75	32,71 a	42,75 b
C Herbicide Pretilachlor 323 g/l + Penoxulam 13 g/l	1,00	33,40 a	42,32 b
D Herbicide Pretilachlor 323 g/l + Penoxulam 13 g/l	1,25	32,43 a	43,27 b
E Herbicide Pretilachlor 323 g/l + Penoxulam 13 g/l	1,50	33,17 a	43,11 b
F Manual Weeding	-	33,01 a	42,27 b
G Control	-	31,37 a	38,09 a

Notes: Mean values marked with the same letter in the same column indicate not significantly different at the 5% level according to Duncan's Test. WAA = Week After Application

Based on observations at 3 WAA on the number of vegetative tillers of rice plants per clump showed that the herbicide treatment Pretilachlor 323 g/l + Penoxulam 13 g/l at a dose of 0.50 l/ha - 1.50 l/ha did not give a significant difference with the treatment of manual weeding, or control. At 6 WAA observations showed that the control produced the lowest average number of vegetative tillers and was significantly different from the herbicide treatment Pretilachlor 323 g/l + Penoxulam 13 g/l at a dose of 0.50 l/ha - 1.50 l/ha. The difference in the number of tillers shows that the application of Pretilachlor 323 g/l + Penoxulam 13 g/l does not have a negative impact on the

growth of rice plants and is able to suppress weed growth and prevent competition in obtaining growth factors between weeds and rice plants so as to increase the number of vegetative tillers of rice (Aditiya, 2021) <sup>[26]</sup>. According to Purnamasari *et al.*, (2017) <sup>[27]</sup> the occurrence of increased weed competition in cultivated land will compete with rice plants in obtaining growth space and nutrients so that if weed competition becomes dominant it will reduce the number of tillers.

## Rice Milled Dry Grain

**Table 5:** Milled Dry Grain (MDG)

Treatment	Dosage l/ha	Ground Dry Gab ah (g/6.25m <sup>2</sup> )
A Herbicide Pretilachlor 323 g/l + Penoxulam 13 g/l	0,50	3239,49 b
B Herbicide Pretilachlor 323 g/l + Penoxulam 13 g/l	0,75	3293,52 b
C Herbicide Pretilachlor 323 g/l + Penoxulam 13 g/l	1,00	3336,84 b
D Herbicide Pretilachlor 323 g/l + Penoxulam 13 g/l	1,25	3351,66 b
E Herbicide Pretilachlor 323 g/l + Penoxulam 13 g/l	1,50	3358,03 b
F Manual Weeding	-	3262,51 b
G Control	-	2661,97 a

Notes: Mean values marked with the same letter in the same column indicate not significantly different at the 5% level according to Duncan's test.

In Table 5 it can be seen that the herbicide treatment of Pretilachlor 323 g/l + Penoxulam 13 g/l at a dose of 0.50 l/ha - 1.50 l/ha produced higher milled dry grain weight (MDG) of rice and was significantly different compared to the control but not significantly different compared to manual weeding. This shows that treatment with Pretilachlor 323 g/l + Penoxulam 13 g/l herbicide at a dose of 0.50 l/ha - 1.50 l/ha gives equivalent results to manual weeding treatment and can increase the yield of rice plants. This finding is in line with the results of research by Daramola *et al.*, (2020) <sup>[28]</sup> which states that the application of mixed herbicides Pretilachlor and Dimethametrin at a dose of 2.5 kg of active ingredients per hectare effectively controls weeds so as to increase the growth of rice plants and produce grain with an amount almost equivalent to the manual weeding method. In addition, all mixed herbicide treatments were shown to increase the weight of milled dry grain significantly compared to the control, because the competition between rice and weeds was reduced (Lhungdim *et al.*, 2019) <sup>[29]</sup>.

## Conclusion

Based on the results of this study, the conclusions that can be drawn are as follows:

1. The mixed herbicide Pretilachlor 323 g/l + Penoxulam 13 g/l at a dose of 0.50 l/ha - 1.50 l/ha can suppress the

dry weight of broadleaf weeds (*Ludwigia octovalvis*, *Monochora vaginalis*, *Spenochlea zeylanica*), grass weeds (*Leptochloa chinensis*, *Echinochloa crus-galli*), weeds (*Cyperus spp.*) and does not cause phytotoxicity to rice paddy plants, *Fimbristylis miliacea*).

2. The mixed herbicide Pretilachlor 323 g/l + Penoxulam 13 g/l at a dose of 0.50 l/ha - 1.50 l/ha had a good effect on plant height, number of vegetative tillers, and yield of paddy rice.

## References

1. FAO. STATISTICAL YEARBOOK, 2021, 353.
2. Sabarella i. consumption and supply - use balance of rice. in: food consumption bulletin, 2023, 103.
3. Ahdiat A. Indonesia's per capita rice consumption to fall by 2023 [Internet]. Jakarta: Katadata Databoks; Apr 22 [cited 2025 May 14]. Available from, 2024. <https://databoks.katadata.co.id/demografi/statistik/ed1c66426b1f5df/konsumsi-beras-per-kapita-indonesia-turun-pada-2023>
4. Badan Pusat Statistik. By, the rice harvest area will reach around 10.21 million hectares with rice production of 53.98 million tons of milled dry grain (MDG) [Internet]. Jakarta: BPS; 2024 Mar 1 [cited 2025 May 3]. Available from, 2023. <https://www.bps.go.id/id/pressrelease/2024/03/01/2375/>

- pada-2023--luas-panen-padi-mencapai-sekitar-10-21-juta-hektare-dengan-produksi-padi-sebesar-53-98-juta-ton-gabah-kering-giling--gkg-.html
5. Ria RP, Yakup Y, Alfarisi MH, Pertanian JB, Pertanian F. Effectiveness of Various Doses and Application Time of Herbicide 2, 4 D-Dimethyl Amine to Control Weeds in Groundnut Crops (*Arachis hypogaea* L.). Pro 11th Semin Nas Suboptimal Land,2023:6051:163-71.
  6. Rao AN. Weed management role in meeting the global food and nutrition security challenge. *Indian J Weed Sci*,2022:54(4):345-56.
  7. Farmanta Y, Rosmanah S. Identification and dominance of weeds in paddy rice fields in Rejang Lebong Regency, Bengkulu Province. Repos Kementerian Pertan [Internet],2016:1(1):536-40. Available from: <http://repository.pertanian.go.id/handle/123456789/6879>
  8. Umiyati U, Sumekar Y, Widayat D. effectiveness of metsulfuron metil herbisidea on sawah padi farming supplied with organic materials. *Logic*,2017:21(2):49-62.
  9. Simanjuntak R, Puji K, Yudo S. efficacy testing of herbicide active agent ethyl pyrazosulfuron 10% for weeding in rice cultivation (*oryza sativa* l.). *j crop production [internet]*,2016:4(1):31-9. available from: <https://protan.studentjournal.ub.ac.id/index.php/protan/article/download/257/249/0>
  10. Najafi B, Ghadiri H. Weed Control and Grain Yield Response to Nitrogen Management and Herbicides. *J Biol Environ Sci*,2012:6(16):39-47.
  11. Umiyati U, Widayat D, Kurniadie D, Gumiwang. Herbicide penoksulam 25 g/L as teki and broadleaf weed control in transplanting system paddy rice cultivation. *J Kultiv*,2020:19(2):1105-13.
  12. Kanda T, Srivasta R, Yadav S, Singh N, Prajapati R, Singh K, *et al.* Pretilachlor-induced physiological, biochemical and morphological changes in Indian paddy field agroecosystem inhabited by *Anabaena doliolum*. *Environ Res*,2023:238(2):117201.
  13. Yuliana AI, Ami ms. vegetation analysis and potential utilization of weed species in post-cropping corn vegetation. *j agroteknologi merdeka pasuruan*,2020:4(2):20-8.
  14. Rahman M. Herbicidal Weed Control: Benefits and Risks Herbicidal Weed Control: Benefits and Risks. *Adv Plants Agric Res Herbic*,2020:4(5):4-6.
  15. Evar FO, Guntoro D, Chozin MA, Irianto MY. Sulfonyleurea Herbicide-Resistant Study on Broadleaf Weeds in the Lowland Rice Production Center in West Java, Indonesia. *J Trop Crop Sci*,2022:9(02):137-44.
  16. Rojas-sandoval J. *Sphenoclea zeylanica* (gooseweed). CAB Int [Internet], 2023. CABI Compe:51031. Available from: <https://www.cabidigitallibrary.org/doi/abs/10.1079/cabi.compendium.51031>
  17. Travlos I, de Prado R, Chachalis D, Bilalis DJ. Editorial: Herbicide Resistance in Weeds: Early Detection, Mechanisms, Dispersal, New Insights and Management Issues. Vol. 8, *Frontiers in Ecology and Evolution*, 2020.
  18. Bhuiyan MK, mm m. efficacy of pretilachlor 50% + trisulfuran 2% wp for control of. *bangladesh j weed sci*,2017:6(1, 2):7-15.
  19. Chauhan BS, Johnson DE. Growth and Reproduction of Junglerice (*Echinochloa colona*) in Response to Water Stress. *Weed Sci*,2010:58(2):132-5.
  20. Pratiwi R, Sembodo DRJ, hidayat kf. efficacy of penoxulam herbicide on the growth of common weeds in paddy rice cultivation. *j agrotek trop*,2016:4(1):16-21.
  21. Umiyati U, Widayat D, Natasya KP. The Effect of Herbicides and Cultivation Systems on Rice (*Oryza sativa* L.) Yield. *J Plant Protection Indones*,2023:27(1):1.
  22. Hastuti D. weed control of jejagoan (*echinochloa crus-galli*) using bioherbicide from the leaf extract of tembelekan (*lantana camara*). *j pertan science tirtayasa*,2021:3(2):327-38.
  23. Polansky S, Guntoro D. Weed Control in Rice Paddy Crops by Using Herbicides with Mixed Active Ingredients Bentazon and MCPA. *Bul Agrohorti*,2016:4(1):122-31.
  24. Umiyati U, Kurniadie D. Effectiveness of Cyhalofop-butyl in Controlling Weeds in Direct Seeds Rice Cultivation. *Agrotechnology Res J*,2021:5(2):125-30.
  25. Caesar T, Purba E, Rahmawati N. efficacy test of herbicide glifosat on growth and production of some genetically engineered corn varieties. *j online agroecotechnology*,2012:1(1):212-9.
  26. Aditiya DR. Herbicides: Environmental Risks and Beneficial Effects. *Saintekno*,2021:19(1):6-10.
  27. Purnamasari CD, Tyasmoro SY, Sumarni T. the effect of weed control method on paddy (*oryza sativa* l.). *j crop production*,2017:870(5):870-9.
  28. Daramola OS, Adigun JA, Olorunmaiye PM. Challenges of weed management in rice for food security in Africa A review Challenges of weed management in rice for food security in Africa: A review. *Agric Trop Subtrop*,2020:53(3):2020.
  29. Lhungdim J, Devi YS, Devi KN, Chanu YB. Influence of weed control techniques and establishment method on yield and economics of rain fed lowland rice. *J Crop Weed*,2019:15(1):121-6.