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The effect of weed control methods on weed growth in lowland rice cultivation under different cropping systems

Abstract. The cropping system in rice cultivation is varied, such as Transfer Planting (Tapin) and Direct Seed Planting (Tabela). The Tabela system has many advantages over the Tapin system, but in this system, the weed population is higher compared to the Tapin system. This study aims to determine the effect of control methods on weed growth in rice cultivation under different cropping systems (Tapin and Tabela). The research was conducted in Babadan Village, Gunung Jati Sub-district, Cirebon Regency, West Java. The method used was a split plot design with 6 treatments and 4 replications. The main plot in this experiment is the weed control method (P) which consisted of 3 levels (p1 = chemically, p2 = manually control by hand weeding, p3 = without weed control). The sub-plot is the planting system (S) with 2 levels (s1 = Tabela and s2 = Tapin). If the results showed a significant difference, then it was analyzed further with the Least Significance Different (LSD) test at 5%. The results showed that chemical weed control with the *Cyhalofop-butyl* 100g/L herbicide at a dose of 1.5 L/ha was able to suppress the growth of *Echinochloa crus-galli, Leptochloa chinensis, Ludwigia octovalvis* and *Fimbristylis miliacea* weeds until 6 weeks after application on both Tapin and Tabela rice cropping systems without causing phytotoxicity effects.

Keywords: Cyhalofop-butyl Herbicide · Direct seed planting (Tabela) · Rice yield · Transfer Planting (Tapin) · Weed · Weeding

Pengaruh metode pengendalian gulma terhadap pertumbuhan gulma pada budidaya tanaman padi sawah dalam sistem tanam yang berbeda

Sari. Pada budidaya tanaman padi terdapat sistem tanam yang sering dilakukan yaitu secara Tanam Pindah (Tapin) dan Tanam Benih Langsung (Tabela). Tiap sistem tanam memiliki kelebihan dan kekurangan. Pada sistem Tabela, populasi gulma cukup tinggi dibandingkan dengan sistem Tapin. Penelitian ini bertujuan untuk mengetahui pengaruh metode pengendalian terhadap pertumbuhan gulma pada budidaya padi pada sistem tanam yang berbeda (Tapin dan Tabela). Penelitian dilakukan di Desa Babadan, Kecamatan Gunung Jati, Kabupaten Cirebon, Jawa Barat. Metode yang digunakan adalah rancangan petak terbagi dengan 6 perlakuan dan empat ulangan. Petak utama dalam percobaan ini adalah metode pengendalian gulma (P) yang terdiri dari 3 taraf (p1 = kimiawi, p2 = pengendalian manual dengan penyiangan, p3 = tanpa pengendalian gulma). Anak petak adalah sistem tanam (S) dengan 2 taraf (s1 = Tabela dan s2 = Tapin). Jika hasil menunjukkan perbedaan yang signifikan, selanjutnya dianalisis lebih lanjut dengan uji BNT (Beda Nyata Terkecil) dengan taraf 5%. Hasil penelitian menunjukkan bahwa pengendalian gulma secara kimiawi dengan herbisida *Cyhalofop – butil* 100g/L dosis 1,5 L/ha mampu menekan pertumbuhan gulma *Echinochloa crus-galli, Leptochloa chinensis, Ludwigia octovalvis* dan *Fimbristylis miliacea* pada sistem pertanaman padi Tapin dan Tabela hingga 6 minggu setelah aplikasi tanpa menimbulkan efek fitotoksisitas.

Kata kunci: Gulma · Herbisida *Cyhalofop butyl* · Penyiangan · Tabela · Tapin · Hasil tanaman padi

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Introduction

Lowland rice cultivation can be done by direct seed planting (Tabela) and transfer planting (Tapin) cropping system. Tapin system is a simple cultivation method with a fairly low risk of yield loss. The weakness of the Tapin system is that the high water usage and labor required (Utami *et al*., 2020; Jamilah, 2013). The Tabela system is a cropping system that can be applied in areas lacking water and labor, but able to increase crop yields per unit area. However, the problem on this system is the emergence of a relatively high population of weeds (Pitojo, 2006).

One of the factors causing rice yield loss is the presence of weeds (Sukman, 1991). If not controlled, weed growth can interfere the main plant due to competition in terms nutrients, water, light, and growing space. Weeds can also be an intermediate host for pests and diseases (Simanjuntak *et al*., 2016). The decline in national rice production caused by weed disturbances is varied 15 - 42% in lowland rice and 47-87% in upland rice (Pitojo, 2006; Badan Pusat Statistik, 2021).

Weed control is an effort to suppress weed growth. There are several methods of weed control, including technical, manual, biological, chemical, and integrated control. Manual weeding is effective for suppressing weed control although it requires relatively more energy, cost, and time. A study conducted by Umiyati (2016) showed that rice plants treated with weed control had an average dry unhulled rice weight of 13.69 kg/plot while rice plants without weed control only produced an average dry yield weight of 11.34 kg/plot.

The chemical control method is a method of applying herbicides. Proficient and accurate herbicide application has more advantages when compared to manual weeding (Kurniadie *et al*., 2020). One of herbicide type that can control weeds in lowland rice plants is herbicide with the active ingredient of *Cyhalofop-butyl*, which is a post-emergence herbicide and belongs to the Aryloxyphenoxypropionate (AOPP) group with the formula $C_{20}H_{20}FNO4$. This herbicide functions by inhibiting ACCase (acetyl CoA carboxylase) (Weed Science, 2011; Sumekar, 2019). According to Umiyati *et al.* (2021), several herbicides, including *Cyhalofop – butyl*, are effective in controlling weeds in rice plants.

The purpose of this experiment is to determine the best weed control in suppressing weed growth in lowland rice cultivation with different cropping systems. Utami *et al*. (2020) revealed that differences in cropping systems along with the use of herbicides led to differences in the dominance and growth of weed in rice plants. Effective weed control simultaneously with the use of a cropping system is expected to suppress weed growth in order to increase crop yields in paddy fields.

Materials and Methods

The research was conducted from June - September 2021 in the rice field of Babadan Village, Gunung Jati District, Cirebon Regency, West Java. The research site was located at an altitude of 11 m above sea level with rainfall of about 259.61 mm/year and an average temperature of 28,22^{o}C

The plot size was 3x4 m with a border width of 30 cm and a distance between plants of 1 m. The materials and tools used in the experiment were herbicides with *Cyhalofop–butyl* 100 g/L as the active ingredient, Ciherang rice variety, water as a herbicide solvent, Urea, TSP, and KCl fertilizers, semi-automatic sprayer with T-jet nozzle type, measuring glass, oven, scale, measuring tape, treatment board, camera, stationery, plastic bag, and hoe.

The design used was a split plot design with with 6 treatments and 4 replications. The main plot was the weed control method (P) which consisted of 3 levels, namely control using herbicides (p1), manual control (p2) which was carried out twice at 21 and 42 day after seeding (DAS), and without control (p3). The sub-plot was a rice planting system (S) which consisted of the Tabela (s1) and the Tapin System (s2). In total, there were 24 experimental plot units **(Table 1**). The herbicide used was a herbicide with *Cyhalofop-butyl* 100 g/L as the active ingredient. It was applied at 15 DAS using a semi-automatic sprayer with a T-jet nozzle pressured 1 kg/cm^2.

Observation of weed dry weight (WDW) growing in each experimental plot, at 3 and 6 week after herbicide application (WAA); rice plants including phytotoxicity (level of plant poisoning) of rice due to the herbicide performed at 1, 2, and 3 WAA; number of tillers at 1, 3 and 6 WAA; and the unhulled rice when the rice plants were harvested at 116 DAS.

Table 1. Herbicide treatment and dosage

Treatment		Description	Dosage and time
Main Plots: Metode Control Method (P)	Sub Plots: Cropping System (S)		
p1	s1	*Cyhalofop butyl* 100 g/L -Tabela	1.5 l/ha
	s2	*Cyhalofop – butyl* 100 g/L – Tapin	1.5 l/ha
p2	s1	Manual weeding – Tabela	21 and 42 DAP
	s2	Manual weeding – Tapin	21 and 42 DAP
p3	s1	No control – Tabela	-
	s2	No control – Tapin	-

Result and Discussion

Early Vegetation Analysis. Vegetation analysis aims to determine the weed biomass on a land. Weed vegetation analysis was carried out before the experiment by using the 0.5 x 0.5 m square method which was thrown 5 times on the experimental field. the results of the analysis can be seen in **Table 2**.

Based on table 2, it can be seen that 7 weeds were found on the land before the experiment started. The dominant weeds on the land were *Echinochloa sp* (30.76%), and the sub-dominant weeds were *Fimbristylis miliacea* (16.26), *Ludwigia octovalvis* (14.48%), and *Leptochloa chinensis* (12.97).

Weed control aims to control weed growth in such a way as to create an optimal environmental condition for the growth of the cultivated plants, so that the competitiveness of cultivated plants is higher than weeds, their growth is more controlled, and they are able to grow well so as to provide maximum results.

Table 2. Vegetation analysis results.

No.	Weed species	Group	SDR value (%)
1.	*Echinochloa crusgalli*	Grasses	30.76
2.	*Cyperus iria*	Sedges	9.58
3.	*Fimbristylis miliacea*	Sedges	16.26
4.	*Ludwigia octovalvis*	Broadleaf weed	14.48
5.	*Paspalum sp*	Narrow leaf weed	9.06
6.	*Leptochloa chinensis*	Grasses	12.97
7.	*Lersea hexandra*	Grasses	6.89
	Total		100.00

Simatupang *et al*. (2015) revealed that the tolerance threshold of rice plants to weeds is if weed cover is below 30% when the rice plants are 45 days after planting. This means that if the level of cover exceeds 30%, then weed control needs to be done to avoid competition that can reduce rice yields.

Weed Dry Weight after application treatments

Weed Dry Weight of *Echinochloa crus-galli*. *Echinochloa crus-galli* is the dominant grasses type weed that grows in the experimental field. The results of the analysis showed that there was no interaction between weed control (P1, P2, P3) and cropping system (S1, S2) on the dry weight of *Echinochloa crus-galli* weeds at observations 3 and 6 WAA (**Tables 3 and 4).**

Table 5 showed that at 3 and 6 weeks after herbicide application in the main plot (P) weed control both chemically using the herbicide *Cyhalofop-butyl* 100 g/L (p_1) or by weeding (p_2) was able to control *Echinochloa crus-galli* weeds. Judging from the time and energy used, weed control using the herbicide which was applied once at 15 days after planting (DAP) was more efficient than manual weeding treatment which was carried out twice (21 and 42 DAP). *Cyhalofop-butyl* herbicide belongs to the Aryloxyphenoxy-propionate (AOPP) which works by inhibiting ACCase (acetyl Co-A carboxylase) which causes weeds to die gradually due to fat loss (Weed Science, 2011).

Statistical results in sub-plots (planting system) did not show any significant difference between the table cropping system (s1) and the transplanting system (s2) on the dry weight of *Echinochloa crus-galli* weeds at both 3 and 6 WAA. This condition could occur because the number of Echinochloa crus-galli weeds in the Tabela system and the Tapin system was statistically the same, so it did not cause significantly different effects.

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Table 3. *Echinochloa crus-galli* anova test table 3 weeks after application

Source of variation	Degree of freedom	Sum of square	Mean square	F value	F 5%	Note
Main Plots						
Replications (K)	3	4.628912	1.542971			
P	2	13.00539	6.502694	12.21273	5.143253	*
Error (P)	6	3.194713	0.532452			
Total	11	20.82901				
Sub Plots						
S	1	0.104783	0.104783	0.090958	5.117355	ns
PS	2	0.050345	0.025172	0.021851	4.256495	ns
Error (S)	9	10.37	1.151995			
Total	23	10.52308				

Table 4. *Echinochloa crus-galli* anova test table 6 weeks after application

Source of variation	Degree of freedom	Sum of square	Mean square	F value	F 5%	Note
Main plots						
Replications (K)	3	0.227054	0.075685			
P	2	7.319099	3.659549	6.016933222	5.14325285	*
Error (P)	6	3.64925	0.608208			
Total	11	11.1954				
Sub Plots						
T	1	0.353793	0.353793	0.220348422	5.117355029	ns
PT	2	0.774116	0.387058	0.241066642	4.256494729	ns
Error (T)	9	14.45	1.605605			
Total	23	15.57835				

Table 5. Average Weed Dry Weight of *Echinochloa crus – galli* during the Treatment of Weed Control Methods and Rice Cropping Systems at 3 and 6 WAA

Treatment	Weed Dry Weight (g m^{-2})	
Weed Control Method	**3 WAA**	**6 WAA**
P_1 (Herbicide *Cyhalofop-butyl* 100g/L)	1.86 a	3.34 a
P_2 (Manual / Weeding)	4.99 a	4.33 a
P_3 (No Treatment)	8.74 b	8.95 b
Cropping System		
Tabela (T_1)	5.48 a	4.91 a
Tapin (T_2)	4.91 a	6.18 a

Description: The same letter in the same column shows no significant difference according to the LSD test with a level of 5%

Weed Dry Weight of *Ludwigia octovalvis*. The results showed that there was no interaction between weed control techniques (P1, P2, P3) and cropping systems (S1 and S2) on the dry weight of *Ludwigia octovalvis* weeds at 3 and 6 WAA **(Tables 6 & 7)**.

Table 8 shows that weed control using the herbicide *Cyhalofop-butyl* 100 g/L (P1) gave a lower dry weight of weed *Ludwigia octovalvis* significantly different from the control treatment (P3), while not significantly different from the manual weeding treatment (P2) at 3 WAA. Observations on 6 WAA, analysis showed that the weed control technique using the herbicide *Cyhalofop-butyl* 100 g/L (P1) was significantly different from manual weeding (P2) and without weed control (P3). Referring to the research of Widayat and Sumekar (2019) which revealed that the use of the herbicide *Cyhalofop-butyl* was effective in controlling weeds *Ludwigia octovalvis* in lowland rice cultivation. In addition, Ludwigia octovalvis weed is a broadleaf weed with a wider leaf surface. Apriyadi *et al*. (2013) revealed that broadleaf plants can receive more

sprayed herbicides than narrowleaf plants that have protected meristem tissue.

The results of the analysis on sub-plots, dry weight of weeds at 3 and 6 WAA, showed that the dry weight of weeds *Ludwigia octovalvis* in the Tablea system (s1) treatment was not significantly different from the Tapin system (S2).

Weed Dry Weight of *Fimbristylis miliacea*. The results of the analysis in **Tables 9 and 10** show that there is no interaction between weed control methods (P1, P2, P3) and cropping systems (S1 and S2) on the dry weight of Fimbristylis miliacea weeds at 3 and 6 WAA.

Table 11 shows that the results of observations on chemical weed control techniques using the herbicide *Cyhalofop-butyl* 100 g/L (P1) produced significantly different results from weed control treatments using weeding (P2) but not significantly different from treatments without weed control (P3) in suppressing the growth of *Fimbristylis miliacea weeds* at 3 WAA. *Fimbristylis miliacea* weed is a

Table 6. *Ludwigia octovalvis* anova test table 3 weeks after application

Source of variation	Degree of freedom	Sum of square	Mean square	F value	F 5%	Note
Main plots						
Replications **(K)**	3	4.093323	1.364441			
P	2	14.64411	7.322056	7.606171	5.143253	*
Error **(A)**	6	5.775881	0.962647			
Total	11	24.51332				
Sub Plots						
S	1	0.515413	0.515413	0.266931	5.117355	ns
PS	2	0.754282	0.377141	0.195321	4.256495	ns
Error **(B)**	9	17.38	1.930884			
Total	23	18.64765				

Table 7. *Ludwigia octovalvis* anova test table 6 weeks after application

Source of variation	Degree of freedom	Sum of square	Mean square	F value	F 5%	Note
Main plots						
Replications **(K)**	3	0.6294	0.2097999			
P	2	19.31842	9.6592107	14.4019774	5.143253	*
Error **(A)**	6	4.024119	0.6706864			
Total	11	23.97194				
Sub Plots						
S	1	2.16992	2.1699201	6.79578313	5.117355	ns
PS	2	0.766292	0.3831462	1.19994213	4.256495	ns
Error **(B)**	9	2.87	0.3193039			
Total	23	5.809948				

Table 8. Average Weed Dry Weight of *Ludwigia octovalvis* during the Treatment of Weed Control Methods and Rice Cropping Systems at 3 and 6 WAA

Treatment	Weed Dry Weight (g m^{-2})	
Weed Control Method	**3 WAA**	**6 WAA**
P_1 (Herbicide *Cyhalofop-butyl* 100g/L)	2.12 a	2.18 a
P_2 (Manual/ Weeding)	4.22 a	6.98 b
P_3 (No Treatment)	11.11 b	12.88 c
Cropping System		
Tabela (T_1)	6.25 a	6.30 a
Tapin (T_2)	5.38 a	5.24 a

Description: The same letter in the same column shows no significant difference according to the LSD test with a level of 5%

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sedge weed where this group has deep rhizomes so it is quite difficult to control manually weeding. Manual weeding control is considered effective if all parts of the sedge weeds are lifted, so they cannot grow back (Mahfudz *et al*., 2015). Observations on 6 WAA showed that weed control using the herbicide *Cyhalofop-butyl* 100g/L (P1) was significantly different from the treatment without control (P3), but not significantly different from the manual weeding treatment (P3). Weed control is very important to do to suppress the growth of weeds in rice cultivation so as to reduce competition between weeds and cultivated plants. One form of association of weeds with cultivated plants is competition for nutrients as growth factors (Moenandir, 1993).

The results of observations on the treatment of the cropping system at 3 and 6 WAA showed that the dry weight of the weeds of *Fimbristylis miliacea* treated with the Tabela system (s1) was not significantly different from the treatment with the Tapin system (S2).

Table 9. *Fimbristylis miliacea* anova test table 3 weeks after application

Source of variation	Degree of freedom	Sum of square	Mean square	F value	F 5%	Note
Main plots						
Replications **(K)**	3	6.810237	2.270079			
P	2	13.35348	6.676738	6.080313	5.143253	*
Error **(A)**	6	6.588548	1.098091			
Total	11	26.75226				
Sub Plots						
S	1	0.228703	0.228703	0.506198	5.117355	ns
PS	2	0.73224	0.36612	0.810351	4.256495	ns
Error **(B)**	9	4.07	0.451804			
Total	23	5.027181				

Table 10. *Fimbristylis miliacea* anova test table 6 weeks after application

Source of variation	Degree of freedom	Sum of square	Mean square	F value	F 5%	Note
Main plots						
Replications **(K)**	3	0.807905	0.269302			
P	2	11.37299	5.686497	10.94855	5.143253	*
Error **(A)**	6	3.116303	0.519384			
Total	11	15.2972				
Sub Plots						
S	1	0.011217	0.011217	0.012513	5.117355	ns
PS	2	0.033027	0.016513	0.018421	4.256495	ns
Error **(B)**	9	8.07	0.896418			
Total	23	8.112002				

Table 11. The Average Weed Dry Weight Of *Fimbristylis Miliacea* During The Treatment Of Weed Control Methods and Rice Cropping Systems at 3 and 6 WAA

Treatment	Weed Dry Weight (g m^{-2})	
Weed Control Method	**3 WAA**	**6 WAA**
P_1 (Herbicide *Cyhalofop-butyl* 100g/L)	0.96 a	1.22 a
P_2 (Manual/ Weeding)	8.00 b	3.12 a
P_3 (No Treatment)	3.31 ab	7.76 b
Cropping System		
Tabela (T_1)	4.82 a	4.10 a
Tapin (T_2)	3.36 a	3.97 a

Description: The same letter in the same column shows no significant difference according to the LSD test with a level of 5%

Weed Dry Weight of *Leptochloa* chinensis. The results of the analysis in **Tables 12 and 13** show that there is no interaction between weed control methods (P1, P2, P3) and cropping systems (S1 and S2) on the dry weight of ***Leptochloa chinensis*** weeds at 3 and 6 WAA.

Observations on the main plot (weed control method) showed that the weed control technique using the herbicide *Cyhalofop-butyl* 100g/L (P1) was more effective than manual weeding (P2) and without control (P3) in suppressing the growth of *Leptochloa chinensis* weeds both on 3 and 6 WAA **(Table 14**). The effectiveness of herbicide with the active ingredient *Cyhalofop-butyl* 100g/L in controlling the weed Leptochloa chinensis in rice cultivation has been previously investigated, where this control can suppress weed growth up to 96% (Guntoro and Fitri, 2013). *Cyhalofop-butyl* herbicide is a selective herbicide that can inhibit fatty acid synthesis and is effective in controlling grass weeds (Fang *et al*., 2020; Umiyati *et al*., 2021).

In sub-plots, differences in lowland rice cropping systems did not affect the dry weight of Leptochloa chinensis weeds at 3 and 6 WAA **(Table 14)**.

Table 12. *Leptochloa chinensis* anova test table 3 weeks after application

Source of variation	Degree of freedom	Sum of square	Mean square	F value	F 5%	Note
Main Plots						
Replications **(K)**	3	1.471465	0.490488			
P	2	21.658	10.829	13.65988	5.143253	*
Error **(A)**	6	4.756556	0.792759			
Total	11	27.88602				
Sub Plots						
S	1	0.499749	0.499749	0.942694	5.117355	ns
PS	2	0.511163	0.255582	0.482113	4.256495	ns
Error **(B)**	9	4.77	0.530128			
Total	23	5.782068				

Table 73. *Leptochloa chinensis* anova test table 6 weeks after application

Source of variation	Degree of freedom	Sum of square	Mean square	F value	F 5%	Note
Main Plots						
Replications **(K)**	3	0.481571	0.160524			
P	2	16.70373	8.351865	17.2921	5.143253	*
Error (A)	6	2.897924	0.482987			
Total	11	20.08323				
Sub Plots						
S	1	0.16875	0.16875	0.205998	5.117355	ns
PS	2	0.028796	0.014398	0.017576	4.256495	ns
Error (B)	9	7.37	0.819183			
Total	23	7.570191				

Table 14. The Average Weed Dry Weight Of *Leptochloa chinensis* During The Treatment Of Weed Control Methods and Rice Cropping Systems at 3 and 6 WAA

Treatment	Weed Dry Weight (g m^{-2})	
Weed Control Method	**3 WAA**	**6 WAA**
P_1 (Herbicide *Cyhalofop-butyl* 100g/L)	1.30 a	1.83 a
P_2 (Manual/ Weeding)	6.41 b	5.40 b
P_3 (No Treatment)	12.19 c	11.18 c
Cropping System		
Tabela (T_1)	7.02 a	6.61 a
Tapin (T_2)	6.26 a	5.66 a

Description: The same letter in the same column shows no significant difference according to the LSD test with a level of 5%

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Total weed dry weight. The results of the analysis showed that there was no interaction between weed control techniques (P1, P2, P3) and cropping systems (S1 and S2) on total weed dry weight at 3 and 6 WAA. Observations on the main plot (**Table 15)** showed that the weed control technique using the herbicide *Cyhalofop-butyl* 100g/L (P1) was more effective than manual weeding (P2) and without control (P3) in suppressing total weed growth in lowland rice fields. These results are in line with the research conducted by Widayat and Sumekar (2019) which explained that herbicides with the active ingredient *Cyhalofop-butyl* at a dose of 50-150 g/ha can control common weeds in rice fields in a transplanting system (tapin). The use of herbicides with the active ingredient *Cyhalofop-butyl* 100g/L was able to control weeds, especially grass groups in rice fields with the Tabela system.

Observation of subplots (cropping system) at 3 and 6 WAA showed that differences in lowland rice cropping systems did not affect the total dry weight of weeds. This condition could occur because in this experiment, weed growth in the plots with the Tabela (S1) cropping system was the same as weeds in the Tapin (S2) system. This condition can occur because there is a period when the land is made inundated and messy so that it affects the growth of weeds. Stagnant water is needed to suppress the germination of weed seeds (Pane, 2003).

Observation of Phytotoxicity (Poisoning) in Rice Plants due to the *Cyhalofop-butyl* 100 g/L Herbicide. Toxicity levels **(Table 16)** were observed by visual assessment of plant populations in tiled plots at 1, 2, and 3 WAA. This toxicity assessment aimed to determine the effect of the application of the *Cyhalofop-butyl* 100g/L herbicide on rice plants. Based on the experimental results, it was found that the use of the herbicide *Cyhalofop butyl* 100g/L at a dose of 1.5 l/ha did not cause symptoms of poisoning to rice plants in both the Tabela system and the Tapin system. This was because the herbicide is a selective herbicide that is only toxic to certain plants or weeds. This selectivity is due to the differential effect of *Cyhalofop – butyl* for rice and weed targets. Rice plants have the ability to produce acetylase enzymes that can tolerate herbicides so the *Cyhalofop – butyl* do not have a negative or toxic impact on rice plants (Apriadi *et al*., 2013; Zimdahl, 2018).

Table 15. The Average of total Weed Dry Weight During The Treatment Of Weed Control Methods and Rice Cropping Systems at 3 and 6 WAA

Treatment	Weed Dry Weight (g m^{-2})	
Weed Control Method	**3 WAA**	**6 WAA**
P_1 (Herbicide *Cyhalofop-butyl* 100g/L)	8.59 a	8.57 a
P_2 (Manual/ Weeding)	23.61 b	19.82 b
P_3 (No Treatment)	33.00 c	40.78 c
Cropping System		
Tabela (T_1)	23.57 a	24.13 a
Tapin (T_2)	19.90 a	21.98 a

Description: The same letter in the same column shows no significant difference according to the LSD test with a level of 5%

Table 16. Observation of Rice Plants Poisoning due to the Effect of *Cyhalofop butyl* Herbicide

	Treatment	Dosage	Observation		
			1 WAA	**2 WAA**	**3 WAA**
p_1 s_1	*Cyhalofop-butyl* 100 g/L – Tabela	1,5 l/ha	0.00	0.00	0.00
p_1 s_2	Manual (Weeding) – Tapin	21 and 42 DAP	0.00	0.00	0.00
P_2 s_1	No Treatment100 g/L – Tabela	-	0.00	0.00	0.00
P_2 s_2	*Cyhalofop-butyl* 100 g/L –Tapin	1,5 l/ha	0.00	0.00	0.00
P_3 s_1	Manual (Weeding) 100 g/L – tabela	21 and 42 DAP	0.00	0.00	0.00
P_3 s_2	No Treatment– Tapin	-	0.00	0.00	0.00

Observation of Rice Growth and Yield

Number of Tillers. Table 17 shows that there is no interaction between weed control and cropping systems on the number of tillers of rice plants at 1, 3, and 6 WAA. The main plots showed that the treatment of the herbicide *Cyhalofop-butyl* 100g/L (p1) was not significantly different from the manual weeding treatment (p2) and was not significantly different from the treatment without weed control (p3). The results of the research conducted by Widayat and Sumekar, (2019) showed that the weed control method using the herbicide *Cyhalofop-butyl* 100g/L (p1) and weeding (p2) did not affect the growth of the number of tillers in rice plants. This is because the herbicide used is a selective herbicide that only affects the target weeds without disturbing the main crop.

Observations on sub-plots also showed the same thing, where differences in cropping systems did not affect the number of rice tillers at 1, 3, and 6 WAA. This condition can occur because the number of tillers is influenced by the genetics of the seeds used. This is in line with the results of research by Anhar *et al*. (2016) which states that the number of tillers and plant height of each variety is influenced by the nature of the varietal genes used.

Plant Height. The results of the analysis at 1, 3, and 6 WAA showed that there was no interaction between weed control (P1, P2, P3) and cropping systems (s1 and s2) on rice plant height **(Table 18).** Treatment of herbicide *Cyhalofop-butyl* 100g/L (p1) showed results that were not significantly different from weed control treatment using weeding (p2) and not significantly different from treatment without weed control (p3). This could be because the main elements needed to support plant growth were fulfilled so that the height of rice plants was higher than weeds and reduced competition. Plant height is also influenced by genetic factors where differences in genetic traits affect different characters or characteristics, so that genotype affects plant height (Yulina *et al*., 2021; Limbongan, 2008).

This condition can occur because the Tabela and Tapin system uses different planting materials. These differences cause differences in the growth of rice plants at the beginning of the planting period. The results of observations of rice plant heights at 3 and 6 WAA showed that the height of rice plants in the Tabela system (s1) was not significantly different from the height of rice plants in the Tapin system (s2).

Table 17. Average Number of Tillers of Rice Plants during the Treatment of Weed Control Methods and Rice Cropping Systems at 1, 3, and 6 WAA

Treatment	Number of Tillers		
Weed Control Method	**1 WAA**	**2 WAA**	**3 WAA**
P_1 (Herbicide *Cyhalofop-butyl* 100g/L)	21.81 a	23.46 a	24.63 a
P_2 (Manual/ Weeding)	22.00 a	22.92 a	24.25 a
P_3 (No Treatment)	21.75 a	22.96 a	23.88 a
Cropping System			
Tabela (T_1)	21.36 a	22.42 a	24.50 a
Tapin (T_2)	22.35 a	23.81 a	24.00 a

Description: The same letter in the same column shows no significant difference according to the LSD test with a level of 5%

Table 18. Average Height of Rice Plants during the Treatment of Weed Control Methods and Rice Cropping Systems at 1, 3, and 6 WAA

Treatment	Plant Height (cm)		
Weed Control Method	**1 WAA**	**3 WAA**	**6 WAA**
P_1 (Herbicide *Cyhalofop-butyl* 100g/L)	75.67 b	85.69 a	114.17 a
P_2 (Manual/ Weeding)	69.28 a	83.14 a	115.14 a
P_3 (No Treatment)	71.75 a	83.46 a	112.34 a
Cropping System			
Tabela (T_1)	69.28 a	85.69 a	114.17 a
Tapin (T_2)	75.67 b	83.14 a	115.14 a

Description: The same letter in the same column shows no significant difference according to the LSD test with a level of 5%

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Table 19. **Average Yield of Rice Plants during Treatment of Weed Control Methods and Rice Cropping Systems**

Treatment	Yield (kg)
Weed Control Method	
P_1 (Herbicide *Cyhalofop-butyl* 100g/L)	11.79 a
P_2 (Manual/ Weeding)	11.59 a
P_3 (No Treatment)	11.56 a
Cropping System	
Tabela (T_1)	11.65 a
Tapin (T_2)	11.64 a

Description: The same letter in the same column shows no significant difference according to the LSD test with a level of 5%

Weight of Dry Milled Unhulled Rice. The results of the analysis showed that there was no interaction between weed control (P1, P2, P3) and cropping systems (S1 and S2) on rice yields (**Table 19**). Observations on the main plot (weed control method) and sub-plots (planting system) did not show any effect on rice yields.

This condition can occur because it is suspected that on the experimental land, the number of weeds is still in small quantities and has not been in conditions that affect the growth of rice plants (threshold). Sastroutomo (1990) in (Widayat and Purba, 2015) revealed that a small amount of weed population will not reduce the main crop yield.

Conclusion

1. Chemical weed control using herbicides with the active ingredient *Cyhalofop butyl* 100 g/L is effective to suppress weed growth in lowland rice fields under the Tapin and Tabela system.
2. There was no interaction between weed control techniques and rice planting systems on weed and rice plant growth.

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