International Journal of Botany Studies
www.botanyjournals.com
ISSN: 2455-541X
Received: 09-08-2021, Accepted: 24-08-2021, Published: 09-09-2021
Volume 6, Issue 5, 2021, Page No. 378-382

Efficacy of butachlor herbicide against weeds on paddy cultivation (*Oryza sativa* L.) through transplanting

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Abstract
Rice is the main food commodity in Indonesia. The decline in rice production each year is caused by the presence of weeds. The most critical period of competition between crops and weeds occurs in 25-33% of the first life cycle of rice plants. High competition at the beginning of the growth phase will suppress growth and reduce rice yields. The presence of weeds in the rice paddy ecosystem needs to be controlled. Chemical weed control is considered more effective than other controls. This study aims to determine the efficacy of herbicide with the active ingredient Butachlor in controlling common weeds in rice cultivation. The experiment was conducted in Plumbon, Cirebon. This research was arranged in a randomized block design with 7 treatments and 4 replications. The treatment consisted of a dose of the Butachlor herbicide with levels: 750; 1000; 1250; 1500; 1750 g ha^{-1}, mechanical, and Control (no weeding). The results show that the herbicide Butachlor at 1250-1750 g ha^{-1} was effective in controlling common weeds in rice cultivation, namely *Monochoria vaginalis, Ludwigia octovalvis, Leptochloa chinensis, Echinochloa crus-galli, Cyperus difformis,* and other weeds up to 6 weeks after application without causing phytotoxicity effects on rice plants.

Keywords: herbicide, weeds, paddy, butachlor

Introduction

Rice is a staple food whose needs are increasing as the population increases. According to the Badan Pusat Statistik (2020), rice productivity in 2018 reached 5.2 tons/ha while in 2019 it only reached 5.11 tons/ha. This decline in rice productivity was due to a decrease in rice harvested area and rice production in 2019.

According to Makarim et al. (2000), rice productivity has not been optimal in paddy fields, among others caused by low fertilization efficiency, low levels of micro elements, less than optimal soil physical properties, poor quality seeds, less adaptive varieties, less effective pest and disease control, and suboptimal weed control. According to Pitoyo (2006), the decline in food production, especially rice due to weeds, is still very high, ranging from 60-87%. The most critical period of competition between crops and weeds occurs in 25-33% of the first life cycle of rice plants (Pane and Jatmiko, 2010). According to Halim (2010), weeds in general are all types of plant vegetation that cause disturbances in certain locations to the goals desired by humans. Weeds have the following characteristics: (1) have high reproductive power, (2) have high viability, and (3) have high competitive power.

Weed control is the process of reducing or limiting the number of weeds on an agricultural land so that the main crop can grow optimally.

This control aims to suppress the weed population to a population level that is not economically detrimental and does not at all aim to suppress it completely (Abadi *et al*., 2013). The use of herbicides to control weeds in lowland rice cultivation is considered effective because it is easy and efficient to use compared to other control methods (Barus, 2003).

Weed control using herbicides has several advantages such as relatively shorter control time in large areas, being able to control weeds before weeds grow, and not damaging plant roots (Sukman, 2002).

One of the herbicides that can be used to control weeds in lowland rice is the butachlor herbicide. Butachlor herbicide is a systemic herbicide and is selective in the acetanilide class of the Chloroacetamide group of compounds used to control annual grass weeds and some broadleaf weeds in nurseries or rice plantations (Tomlin, 2010).

The purpose of this study was to determine the effective dose of the herbicide bisachlor in controlling weeds in lowland rice and to determine the effect of using the herbicide butachlor on the growth and yield of lowland rice.

Materials and Methods

The research was carried out in rice fields in Wanakaya Village, Gunung Jati District, Cirebon Regency, West Java in November 2020-February 2021. The materials used in this study consisted of the herbicide butachlor, water as a solvent, Ciherang variety rice plant, Urea fertilizer, fertilizer RSP, and KCL fertilizer. While the tools used are semi-automatic back spray, T-jet nozzles, measuring cups, pipettes, analytical scales, ovens, scales, and quadrants.

The experimental design used in this study was a randomized block design with one factor, namely the dose of the herbicide butachlor which consisted of seven treatments and four replications. Following are the types of treatment: A. Treatment of Butachlor Herbicide with a dose of 750 g ha^{-1}; B. Treatment of Butachlor Herbicide with a dose of 1000 g ha^{-1}; C. Treatment of Butachlor Herbicide with a dose of 1250 g ha^{-1}; D. Treatment of Butachlor Herbicide with a dose of 1500 g ha^{-1}; E. Treatment of Butachlor Herbicide with a dose of 1750 g ha^{-1}: F. Mechanical (mechanical control); and E. Control (no weeding). The experimental plot size was 3 m x 5 m with a spacing of 25 cm x 25 cm.

The rice seeds used were Ciherang variety rice seeds. The seeds were previously planted in nursery plots for 14 days. After the nursery period is complete, the rice is then transferred to the land that has been provided in macak condition. Rice is planted as much as 2-3 seeds per planting hole. Herbicides were applied to the experimental plots three days after the rice was transplanted.

Fertilization was carried out three times with different doses. At the time of planting, fertilization was carried out at a dose of 30 kg N + 45 kg P2O5 + 45 kg K2O per hectare. At the age of 3 weeks after planting, fertilization was carried out at a dose of 30 kg N per hectare and similarly to flower primordia, fertilization was carried out at a dose of 30 kg N per hectare.

Harvesting is done when 90% of the grain population has turned yellow or is 105 days after planting. In the harvesting process, it is important to carefully observe the level of maturity of the rice grains. Harvesting is done traditionally by cutting the stems of the rice plant and then the panicles are threshed.

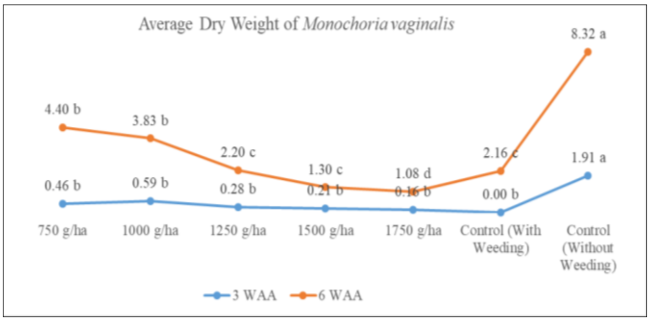
Observation of the dry weight of weeds was carried out by cutting the fresh weeds to the level of the ground, then separating each species. Furthermore, the weeds were dried at a temperature of 80oC for 48 hours or until they reached a constant dry weight, then weighed. The weeds observed in this experiment were weeds that grew when the rice was 3 and 6 weeks after application. Phytotoxicity observations were assessed visually on plant populations in tile plots, observed at 3 and 6 weeks after application based on a scoring system. The components of rice plants observed were plant height and number of tillers. Plant height was measured from the soil surface to the highest leaf and the total number of tillers was counted per clump. Observations were made on 12 plant samples taken at random, measured at the age of 3 and 6 weeks after application.

Data processing in the study was carried out with the ANOVA test. If the results of the data processing show that there is a significant difference, then further tests are carried out on the difference in the average value between treatments using the Tukey test (HSD) at a 95% confidence level.

Results and Discussion

Weed Dry Weight *Monochoria vaginalis*

Weed dry weight data in Figure 1 shows that the herbicide treatment with various doses of the herbicide was able to control the growth of Monochoria vaginalis at 3 and 6 weeks after application. At 3 weeks after application, each treatment of the herbicide butachlor with various dosage levels had relatively the same controllability as the mechanical treatment. At 6 weeks after application, the herbicide treatment of butachlor starting at a dose of 1250 g ha^{-1} was effective in controlling Monochoria vaginalis weeds in rice plantations. Prakash et al. (2013) stated that the herbicide butachlor 1500 g ha^{-1} was able to reduce the density and dry weight of weeds in lowland rice cultivation.



Note: The value at each point followed by the same letter is not significantly different according to the BNJ (Tukey) test at the 5% level

Fig 1: Average Dry Weight of *Monochoria vaginalis*

Weed Dry Weight *Ludwigia octovalvis*

Weed dry weight data in Figure 2 shows that the treatment of the herbicide butachlor with various dosage levels was able to control the growth of Ludwigia octovalvis weeds at 3 and 6 weeks after application. At 3 weeks after application, each treatment of the herbicide butachlor with various dosage levels had relatively the same controllability as the mechanical treatment. At 6 weeks after application, the herbicide treatment of butachlor starting at a dose of 1250 g ha^{-1} was effective in controlling the weed of Ludwigia octovalvis. In line with the opinion of Wang et al. (2013) that the herbicide butachlor is effective in controlling broadleaf weeds.

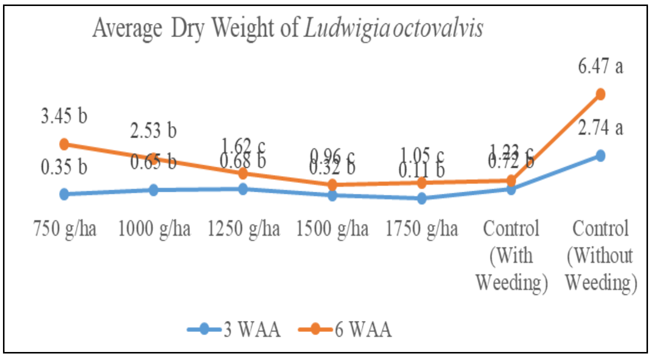


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Fig 2: Average Dry Weight of *Ludwigia octovalvis*

Dry Weight Weed *Leptochloa chinensis*

Weed dry weight data in Figure 3 shows that the herbicide treatment with various doses of the herbicide was able to control the growth of *Leptochloa chinensis* at 3 and 6 weeks after application. At 3 weeks after application, each treatment of the herbicide butachlor with various dosage levels had relatively the same controllability as the mechanical treatment. At 6 weeks after application, the herbicide treatment of butachlor starting at a dose of 1250 g ha^{-1} had the same good controllability as the mechanical treatment. The results of the analysis showed that there was a 42% decrease in biomass in the herbicide treatment data compared to the control treatment (without weeding). This is in line with research conducted by Wang *et. al.* (2013) who found that the presence of the herbicide butachlor was able to reduce biomass by 50% which continued to increase along with increasing the dose of herbicide application.

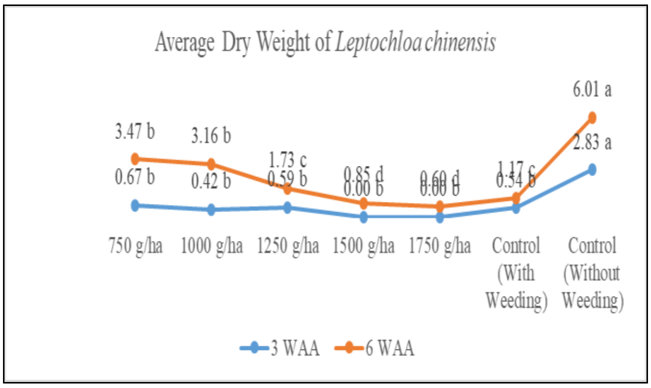

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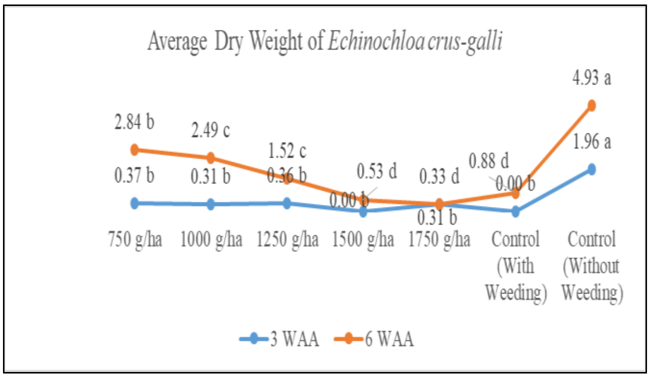
Fig 3: Average dry weight of *Leptochloa chinensis*

Dry Weight Weed *Echinochloa crus-galli*

The dry weight data of weeds in Figure 4 shows that the herbicide treatment with various doses of the herbicide was able to control the growth of *Echinochloa crus-galli* weeds at 3 and 6 weeks after application. At 3 weeks after application, each treatment of the herbicide butachlor with various dosage levels had relatively the same controllability as the mechanical treatment. At 6 weeks after application, the herbicide treatment of butachlor starting at a dose of 1500 g ha^{-1} had the same good controllability as the mechanical treatment. This is due to the ability of the herbicide butachlor which is able to inhibit protein synthesis and RNA synthesis of *Echinochloa crus-galli* through roots and shoots (Chang et al., 1985).



Note: The value at each point followed by the same letter is not significantly different according to the BNJ (Tukey) test at the 5% level

Fig 4: Average Dry Weight of *Echinochloa crus-galli*

Dry Weight Weed *Cyperus difformis*

Weed dry weight data in Figure 5 shows that the treatment of the herbicide butachlor with various dosage levels was able to control the growth of *Cyperus difformis* weed and was as good as mechanical treatment at 3 and 6 weeks after application. Damayanti *et al*. (2017) added that the butachlor herbicide was able to control *Cyperus* spp. in lowland rice cultivation with transplanting system up to 6 weeks after application.

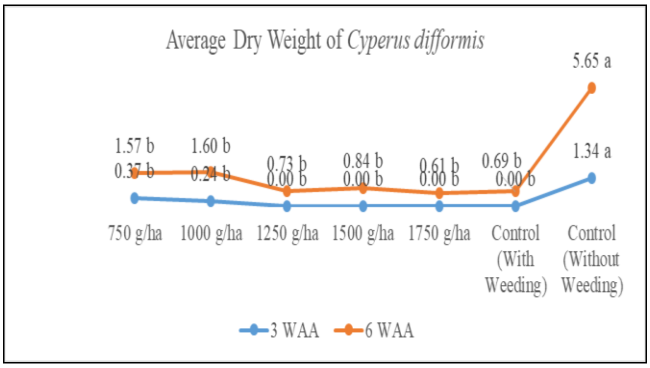


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Fig 5: Average Dry Weight of *Cyperus difformis*

Total Weed Dry Weight

Weed dry weight data in Figure 6 shows that the treatment of the herbicide butachlor with various dosage levels was able to control total weed growth at 3 and 6 weeks after application. At 3 weeks after application, each treatment of the herbicide butachlor with various dosage levels had relatively the same controllability as the mechanical treatment. At 6 weeks after application, the herbicide treatment of butachlor starting at a dose of 1250 g ha^{-1} had the same good controllability as the mechanical treatment. Kasim *et al.* (2017) stated that the application of butachlor at a dose of 1-3 kg ha^{-1} was able to control weeds in rice plantations at a dose of 1 kg ha^{-1} as the optimum dose. Singh *et al.* (2016) added, the application of butachlor 50% EC at doses of 1250 and 2000 g ha-1 was found to be more effective in reducing grass and broadleaf weed populations, the dose is a dose that is smaller than the market sample dose of 4000 g ha^{-1}. The lower dry weight of weeds in the weed control treatment can be attributed to the smaller number of weeds, depletion of weed carbohydrate reserves through rapid respiration (Hill and Santlemann, 1969). This shows that the application of the herbicide butachlor with 2.5-3.5 L ha^{-1} is effective in controlling common weeds in rice cultivation and can replace mechanical systems up to 6 weeks after application.

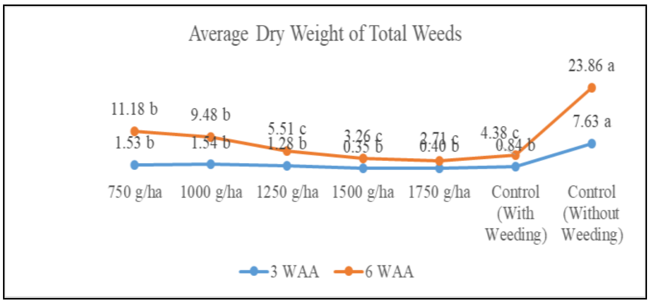

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Fig 6: Average Total Weed Dry Weight

Phytotoxicity

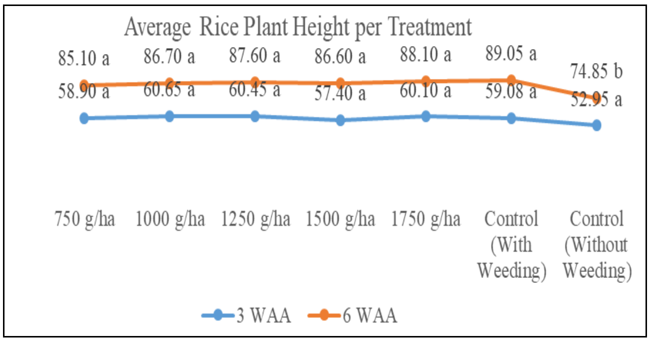
Phytotoxicity data in Table 1 shows that the herbicide butachlor does not cause poisoning in rice plants.

Table 1: Phytotoxicity of Rice Plants

Treatment	Dose g/ha	Phytotoxicity	
		3 weeks after application	6 weeks after application
Butachlor 500 g/l	750	0	0
Butachlor 500 g/l	1000	0	0
Butachlor 500 g/l	1250	0	0
Butachlor 500 g/l	1500	0	0
Butachlor 500 g/l	1750	0	0

Rice Plant Height

The data on rice plant height in Figure 7 shows that the herbicide butachlor affects the height of the rice plant. This is due to the uncontrolled weed population in the control plots which causes competition between weeds and rice plants. According to IRRI (1985), weed competition at the beginning of plant growth will reduce the quantity of crop yields, while the disturbance of weed competition before harvest has a greater effect on the quality of crop yields. This shows that the herbicide butachlor is not phytotoxic to rice plants and has an effect on rice plant height.



Note: The value at each point followed by the same letter is not significantly different according to the BNJ (Tukey) test at the 5% level

Fig 7: Average Rice Plant Height

Number of Tillers

The data on the number of rice tillers per clump in Figure 8 shows that the herbicide butachlor affects the height of the rice plant.

This is due to the uncontrolled weed population in the control plots which causes competition between weeds and rice plants. According to Gardner *et al.* (1991), the number of tillers will be maximized if the plant has good genetic characteristics coupled with favorable environmental conditions. Suparyono and Setyono (1997) added that the high number of productive tillers of rice has the potential to produce high production. This shows that the herbicide butachlor is not phytotoxic to rice plants and has an effect on the number of tillers of rice plants.

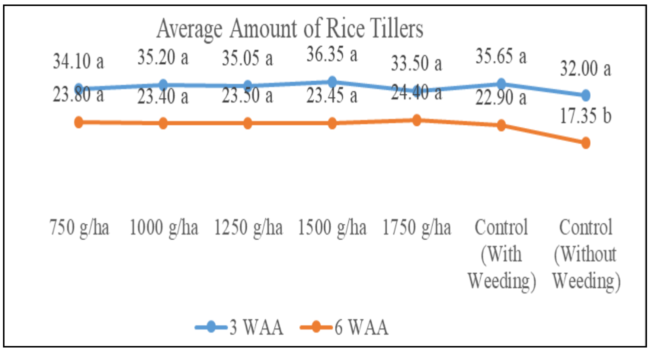


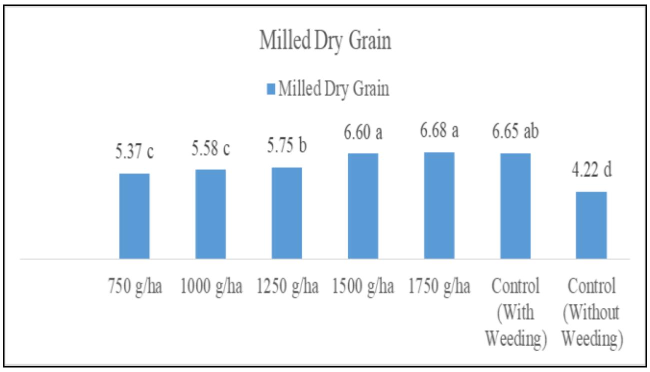
Fig 8: Average Number of Rice Tillers Per Clump

Note: The value at each point followed by the same letter is not significantly different according to the BNJ (Tukey) test at the 5% level

Milled Dry Grain Yield

Data on the yield of dry milled rice in Figure 9 shows that the application of the herbicide butachlor affects rice yields. The herbicide treatment of butachlor starting at a dose level of 1250 g ha^{-1} gave relatively the same yield as the mechanical treatment and the herbicide treatment with a dose level of 1750 g ha^{-1} gave the highest yield. This difference in yield was influenced by the weed population around the experimental plot which caused competition between the main crop and weeds. Pitoyo (2006) states that the presence of weeds can reduce rice yields in the range of 6-87%.

According to Suparyono and Setyono (1993). The presence of weeds causes competition for nutrients, water, space to grow, and sunlight.



Note: The value at each point followed by the same letter is not significantly different according to the BNJ (Tukey) test at the 5% level

Fig 9: Average Weight of Milled Dry Grain

Conclusion

Based on the results of this study, the following conclusions can be drawn

1. Herbicide with active ingredient butachlor at a dose of 1250 – 1750 g ha^{-1} is effective in controlling weeds in rice cultivation up to 6 weeks after application.
2. Herbicides with an active ingredient of butachlor up to a dose of 1750 g ha^{-1} are not phytotoxic to rice plants and the dose is able to provide the highest yields.

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