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Effectiveness of pyrazosulfuron-ethyl 10% herbicide as grass and broad-leaved weed controller on rice paddy cultivation

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Abstract
Controlling weeds with herbicide is the most efficient way due to its advantages, compared with other control measures. Weeds must be controlled as they will compete with rice plants and become the host for pests and diseases, which can reduce the rice yields by 87%. The objective of this research is to investigate effectiveness of pyrazosulfuron-ethyl 10% herbicide in controlling grass and broad-leaved weeds on rice paddy cultivation. It was conducted in Gegesik Village, Arjawinangun Sub-district, Cirebon Regency, West Java. It used group random design with single factor, nine treatments, and four repetitions. The treatments consisted of seven treatments with nine dosages of pyrazosulfuron-ethyl 10% herbicide i.e. dosages of 0.60 kg ha^{-1}, 0.75 kg ha^{-1}, 1.00 kg/ha^{-1}, 1.25 kg ha^{-1}, 1.50 kg ha^{-1}, 1.75 kg ha^{-1}, 2.0 kg ha^{-1}; manual weeding; and no weeding as control group. Pyrazosulfuron-ethyl 10% herbicide is effective in controlling the dominant weeds and the co-dominant weeds on rice paddy plants such grass weeds as species of *Echinocloa*, *Colona*, and *Leptochloa chinensis* and such broad-leaved weed classes as *Monochoria vaginalis* and *Spigelia Anthermia* up to 12 weeks after application (WAA12) observations with the doses of 0.75 kg ha^{-1}-2.00 kg ha^{-1}. At the doses of 0.60 kg ha^{-1}- 2.00 kg ha^{-1} up to WAA3, no symptoms of poisoning in rice paddy plants were observed. Pyrazosulfuron-ethyl 10% herbicide at the dose of 1.75 kg ha^{-1} shows that the height of plant was 55.08 cm while at the dose ranges of 0.6 kg ha^{-1}- 2.0 kg ha^{-1}, it shows that the average milled dry grain weight ranged from 8.20 to 9.97 kg $plot^{-1}$sample.

Keywords: pyrazosulfuron-ethyl 10% herbicide, broad-leaved weeds, weed grass, rice paddy field

Introduction

In recent years, rice paddy yields in Indonesia have increased. The 2018 data of the Central Statistics Agency show that rice paddy production and productivity in Indonesia continued to increase during 2014-2018. The rice yields in 2014 reached 70.84 million tons and 83.03 million tons in 2018 with the calculation of average national consumption of 111.58 kg per capita per year. Meanwhile the rice productivity in 2014 reached 51.35 quintals/hectare and 51.92 quintals/hectare in 2018. The rice production, especially in Indonesia, must continuously be increased since the rice is the staple foodstuff of around 90% of Indonesia's population, and the population continues to increase so that the need for food continues to increase (Andani, 2008) [2].

The successfulness of plant cultivation technique is affected by several factors such as pest, disease, and weed. Weed is one of the factors that causes the low quantity and quality of rice production (Zaman and Noguchi, 2017) [32]. During the period of plant growth, the weeds compete with the rice paddy plants for nutrients, water, light, CO2, and spaces to grow, and therefore humans do some efforts to control them. As the population grows, the level of rice consumption is getting higher and the rice yields must also be increased to secure the food supply for Indonesians. However, several production disturbances are found. One of which is the growth of weeds that have impact on rice yields resulting in losses caused by competition for air, light, nutrient, and growth space. Weeds can disturb rice paddy plants and reduce by 10-25% of grain yields in transplanting systems and more than 50% in direct seed systems. The decline in production caused by grass weeds can reach 86%, even up to 100% if the grass weeds are accompanied with sedges and broad-leaved weeds (Smith, 1983) [27]. In addition, the presence of weed disturbances causes the income of farmers due to the expensive control measures (Guntoro *et al*., 2013) [8].

Weed control in rice paddy plants can be done through such various techniques such as manual, mechanical, physical, biological and chemical controls. According to Pratiwi *et al*. (2016), one of the weed controls considered effective is chemical control using herbicides. The use of herbicides results in a more effective control of weed on various cultured plants. It comprises the largest segment of weed control sale, gorging around 16% of total market for plant protection chemicals (Sharma et. al, 2017) [22]. Chemical control of weed is more recommended than manual weeding since it is cost-effective and labor-independent. With the availability of herbicides and the related wed management technology, it is very much possible to increase rice yield (Mishra and Singh, 2008) [15].

Ankit, *et al*. (2018) [3] explained that pyrazosulfuron-ethyl 10% is categorized as a persistent herbicide, an herbicide having in-soil persistency of 1-3 months. Therefore, administration of various doses of pyrazosulfuron-ethyl makes an impact in total population of bacteria, fungi, and actinomycetes as early as 3 days after application (Kumar *et al*., 2018) [12, 3]. Herbicides should be wisely and appropriately used so that it does not cause environmental pollution and poison either humans or off-target organisms (Umiyati, 2016) [29]. In addition, the inappropriate and continuous use of herbicides may lead to weed resistance. (Umiyati *et al*., 2018). Herbicides are chemicals that can inhibit or kill plants, and they are toxic to weeds. Moreover, the continuous use of the same herbicides with unrecommended dose can also lead to weed resistance to such herbicides faster, decreasing the effectiveness of the herbicides (Hendarto *et al*., 2017) [9]. In applying the herbicides, the safety of the process should also not be ignored to prevent excessive dosage due to its expensiveness, environmental problems, and damage to the plants close to spraying device (Singh *et al*., 2016) [25].

According to Jamilah (2013) [11] herbicides can be applied when the plants have not been planted but the soil has been processed (*pre-emergence*), and after the main plants and weeds have grown, (*post-emergence*). Herbicide use or application is much more efficient because it can control weeds in a relatively short time and covers a large area (Barus, 2003) [4]. Some herbicides that are most often used by farmers to control weed in rice paddy plant are butachlor, pendimethalin, bispyribac sodium, cyhalofop-butyl, and others. Herbicide producers then researched and sold pyrazosulfuron-ethyl 10%, a type of sulfonylurea. It was found that it can effectively control grass weeds, broad-leaved weeds, and sedges in lowland rice cultivation by transplanting and in-field (Ramesha *et al*., 2017, Saini *et al*. 2008) [20, 21].

Pyrazosulfuron-ethyl 10% herbicide is an herbicide with 100 g/kg active ingredients of pyrazosulfuron-ethyl and operates through weed leaves and the soil (Rajkhowa *et al*. 2006) [19]. It can be applied pre-emergence or post-emergence, and is selective in nature. This herbicide is a systemic herbicide. In other words, it can be translocated to all parts of the weed tissues along with metabolic products (IUPAC, 2014) [10].

Based on the effectiveness of weed control using herbicides, herbicide application can be beneficial for Indonesian agriculture. In order to know the effectiveness level and possible side effects of herbicides with the 10% active ingredient pyrazosulfuron-ethyl toward rice crops, further research is needed. Thereby, the effectiveness level, optimal dosage, and side effects that may occur when using the 10% active ingredient pyrazosulfuron-ethyl as an herbicide in rice crops can be identified.

Materials and Methods

The research was conducted in Gegesik farmer's land, Arjawinangun Sub-district, Cirebon Regency, West Java. This experiment lasted from July 2019 to October 2019.

The experiment used one-factor randomized block design (RBD) with nine treatments and four repetitions. The differences between treatments were tested by using the F test, followed by the Multiple Distance test at the level of 95%. There were seven treatment doses of the pyrazosulfuron-ethyl 10% herbicide tested: 0.60 kg ha^{-1}, 0.75 kg ha^{-1}, 1.00 kg ha^{-1}, 1.25 kg ha^{-1}, 1.50 kg ha^{-1}, 1.75 kg ha^{-1}, 2.0 kg ha^{-1}. The weeds were exposed to two different treatments, manual weeding and without weed control (control group).

The herbicide was applied once during H-5 to H-3 days before planting in the morning, sunny weather, and low wind speed. Ciherang variety rice seedlings of 21-days old were planted with 25 cm x 25 cm spacing. Every planting hole contained 2-3 seeds. Fertilization with the composition of 30 kg N + 45 kg P_2O_5 + 45 K_2O per ha was done when plants were 4 days old. At the age of 3 weeks after planting (WAP3) the fertilization with the composition of 30 kg N per ha was applied, and during the flower primordial or at the age of WAP6, that of 30 kg N per ha was applied. Observations were made on weeds and rice plants. The observations of weeds included observations of weeds before application, those of dry weight of weeds after application by using the quadrant of 2.5 m x 2.5 m. Meanwhile, the observations of rice plants included those of plant height, phytotoxicity by taking 10 plant samples and milled dry grain $plot^{-1}$samples. The data were then analyzed by using the software package of SPSS 17 (SPSS Inc., Chicago, Illinois, USA). Analysis of variance (ANOVA) was used to test the experimental treatment effects, followed by the LSD test with the p-value < 0.05 if there were significant differences between the treatments.

Results and Discusssion

Weed Composition before Application

The result of weed vegetation analysis before the application of pyrazosulfuron-ethyl 10% herbicide (Table 1) shows that the compositions of weeds in the experimental field were eight species of weeds, one species of sedges, two species of grasses and three species of broad-leaved weeds. Based on the sum dominance ratio (SDR), the land was dominated by *Echinochloa colona* weeds, a grass weed group with the SDR value of 44.99%. The co-dominant weeds consisted of *Spigelia anthermia* weeds from the broad-leaved group with the SDR of 10.42%, *Monocharia vaginalis* from the broad-leaved group with the SDR value of 13.02%, and *Leptochloa cinensis* weeds included in grass weed group with the SDR of 10.56%. Other weeds found in this experimental field were Ludwegia perennis, and the dominant or co-dominant ones were *Ludwigia octovalvis, Cyperus diformis* and *Lersea hexandra weeds*.

Table 1: Weed vegetation analysis before application\

No	Species Name	SDR (Sum Dominance Ratio) %
1	*Echinochloa colona*	44.99
2	*Spigelia anthermia*	10.42
3	*Leptochloa chinensis*	10.56
4	*Monocharia vaginalis*	13.02
5	*Ludwigia perennis*	6.43
6	*Cyperus diformis*	9.18
7	*Lersea hexandra*	6.16
	Sum	100.00

Observation of Dry Weed Weight after Herbicide Application

Dry Weed Weight of *Echinochloa colona*

Echinocloa colona weed is a type of grass weed which was quite dominant in rice cultivation in the experimental location. *Echinocloa colona* weeds have a large number of small seeds so that they easily spread (Umiyati et. al, 2017). The result of observations and data analysis in Table 2 indicates that the application of pyrazosulfuron-ethyl 10% herbicide starting at dose of 0.6 kg ha^{-1}- 2.00 kg ha^{-1} provided good emphasis on the dry weight of *Echinocloa colona* weeds on WAA4 observations. The WAA8-12 observations show that increasing the dose could increase the effectiveness of pyrazosulfuron-ethyl 10% herbicide in suppressing weed growth compared to manual weeding, and the effective dose was 1.25 kg ha^{-1}- 2.0 kg ha^{-1}. This supports the results by Chopra and Chopra (2003) which stated that pyrazosulfuron-ethyl 10% applied 3-10 days after planting is effective in controlling *Echinocloa colona* and *Cyperus iria* in rice paddy cultivation.

Table 2: Average dry weight of *Echinochloa colona* weeds

Treatments		Dose kg ha^{-1}	Observation of -					
			WAA4		WAA8		WAA12	
A	pyrazosulfuron-ethyl 10%	0.6	1.43	a	10.47	b	10.47	b
B	pyrazosulfuron-ethyl 10%	0.75	2.10	a	10.23	b	10.23	b
C	pyrazosulfuron-ethyl 10%	1.00	0.00	a	10.37	b	10.37	b
D	pyrazosulfuron-ethyl 10%	1.25	0.00	a	0.00	a	0.00	a
E	pyrazosulfuron-ethyl 10%	1.50	0.00	a	0.00	a	0.00	a
F	pyrazosulfuron-ethyl 10%	1.75	0.00	a	7.03	a	7.03	a
G	pyrazosulfuron-ethyl 10%	2.00	0.00	a	3.20	a	3.20	a
H	Manual Weeding	-	9.50	b	10.67	b	18.80	c
I	Control	-	13.19	c	17.77	c	41.37	d

Note: The average value marked with the same letter in the same column shows no significant difference at the level 0f 95% according to the LSD test. WAA: Week after Application.

Dry weight of *Spigelia anthermia* weed

Spigelia anthermia is a broad-leaved weed that grows in moist soil and resistant to shade. The result of statistical analysis shows that controlling weeds with the pyrazosulfuron-ethyl 10% herbicide was effective. Table 3 shows that the pyrazosulfuron-ethyl 10% herbicide at dose of 0.6 0 kg ha^{-1}-2.0 kg ha^{-1} was effective and efficient in controlling broad-leaved weed *Spigelia athermia* up to WAA12 observations compared to manual weeding. It was effective because it suppressed weed growth in low dose of 0, 60 kg ha^{-1}. In addition, it was efficient because controlling the weeds with the pyrazosulfuron-ethyl 10% herbicide could replace the manual weed control requiring a long time and much effort.

Table 3: Average dry weight of *Spigelia anthermia* weeds

Treatments		Dose kg ha^{-1}	Observation of -					
			WAA4		WAA8		WAA12	
A	pyrazosulfuron-ethyl 10%	0.6	0.20	a	6.53	a	8.73	b
B	pyrazosulfuron-ethyl 10%	0.75	0.40	a	9.43	b	9.47	b
C	pyrazosulfuron-ethyl 10%	1.00	0.00	a	5.37	a	5.97	a
D	pyrazosulfuron-ethyl 10%	1.25	0.00	a	1.93	a	3.53	a
E	pyrazosulfuron-ethyl 10%	1.50	0.00	a	0.00	a	2.13	a
F	pyrazosulfuron-ethyl 10%	1.75	0.00	a	6.20	a	6.27	a
G	pyrazosulfuron-ethyl 10%	2.00	0.00	a	1.73	a	2.37	a
H	Manual Weeding	-	1.20	a	4.43	a	9.10	b
I	Control	-	3.40	b	10.27	c	12.97	c

Note: The average value marked with the same letter in the same column shows no significant difference at the level of 95% according to the LSD test. WAA: Week after Application.

Dry Weight Weed *Monochoria vaginalis*

Monochoria vaginalis (Burm. F.) C. Presl is a broad-leaved weed that grows throughout the year, and can be found in rice paddy fields. This weed reproduces through seeds and can grow on swampy soils, especially in rice paddy fields. This weed has roots that is near the soil surface and leaves that cannot compete with other weeds for sunlight and soil nutrients (Fitri *et al*, 2014) [7]. The result of the statistical analysis of *Monochoria vaginalis* dry weight can be seen in Table 4.

Table 4: Average dry weight of *Monocharia vaginalis* weeds

Treatments		Dose kg ha^{-1}	Observation of -					
			WAA4		WAA8		WAA12	
A	pyrazosulfuron-ethyl 10%	0.6	0.00	a	0.77	a	1.09	b
B	pyrazosulfuron-ethyl 10%	0.75	0.00	a	0.47	a	0.00	a
C	pyrazosulfuron-ethyl 10%	1.00	0.00	a	0.00	a	0.00	a
D	pyrazosulfuron-ethyl 10%	1.25	0.00	a	0.00	a	0.00	a
E	pyrazosulfuron-ethyl 10%	1.50	0.00	a	0.00	a	0.00	a
F	pyrazosulfuron-ethyl 10%	1.75	0.00	a	0.00	a	0.00	a
G	pyrazosulfuron-ethyl 10%	2.00	0.00	a	0.00	a	0.00	a
H	Manual Weeding	-	1.64	a	2.37	b	2.78	b
I	Control	-	4.17	b	7.32	c	20.09	c

Note: The average value marked with the same letter in the same column shows no significant difference at the level of 95% according to the LSD test. WAA: Week after Application.

Pyrazosulfuron-ethyl 10% herbicide treatments at the dose of 0.60 kg ha^{-1}-2, 0 kg ha^{-1} were effective in controlling *Monochoria vaginalis* weeds until WAA12 observation, compared to manual weeding. Pyrazosulfuron-ethyl 10% herbicide was effective in controlling broad-leaved weeds by inhibiting protein synthesis and amino acid metabolism. The types of weeds also influence the effectiveness of herbicides. The wider the weed leaves, the more droplets or outpouring of herbicide fluids they will receive, thereby the administration of herbicide at low doses can control the broad leave weeds. (Ramsha *et al*. 2017, Saini *et al*. 2008) [20, 21].

Dry Weight of *Leptochloa chinensis*

Leptochloa chinensis is a grass weed that dominated the research area. This weed grew as tall as rice plants and could even shade rice plants so that it could compete with plants for water and nutrients. The result of statistical analysis shows that the dry weight of *Leptochloa cinensis* can be seen in Table 5 below.

Table 5: Average dry weight of *Leptochloa chinensis* weeds

Treatments		Dose kg ha^{-1}	Observation of -					
			WAA4		WAA8		WAA12	
A	pyrazosulfuron-ethyl 10%	0.6	0.00	a	10.80	b	11.33	a
B	pyrazosulfuron-ethyl 10%	0.75	0.00	a	4.27	a	8.77	a
C	pyrazosulfuron-ethyl 10%	1.00	0.00	a	0.00	a	1.03	a
D	pyrazosulfuron-ethyl 10%	1.25	0.00	a	1.83	a	2.47	a
E	pyrazosulfuron-ethyl 10%	1.50	0.00	a	0.00	a	1.73	a
F	pyrazosulfuron-ethyl 10%	1.75	0.00	a	3.07	a	3.20	a
G	pyrazosulfuron-ethyl 10%	2.00	0.00	a	0.00	a	0.70	a
H	Manual Weeding	-	2.87	a	13.40	b	15.43	b
I	Control	-	2.50	a	28.57	c	39.87	c

Note: The average value marked with the same letter in the same column shows no significant difference at the level of 95% according to the LSD test. WAA: Week after Application.

Based on Table 5, the treatment of pyrazosulfuron-ethyl 10% herbicide at the beginning of the WAA4 observation did not show significant differences in the control group due to *Leptochloa chinensis* weed being a sub-dominant weed in the experimental field and thus still growing in small quantities. Weed control was improved by increase in the herbicide dose, but the difference in dosage was not significant, as reported by (Ramesha et. al 2017) [20]. Moreover, pyrazosulfuron-ethyl 10% herbicide is a systemic herbicide that takes time to absorb to the weed tissue in order to inhibit protein synthesis in the target area, and therefore the result was seen initially on WAA8. As the period of research rolls on, the growth of *Leptochloa cinensis* increases, overtaking the growth of other weeds. However, with the control of pyrazosulfuron-ethyl 10% herbicide, the weed growth was inhibited as seen at the treatment doses of 0.60 kg ha^{-1}- 2.0 kg ha^{-1}, which was able to suppress the growth of *Leptochloa cinensis* weeds on the WAA8 – WAA12 observations.

Total Dry Weight of Weeds

The total dry weight of weeds was the dry weight of all weeds in the experimental field. The result of the total dry weight of weed analysis is presented in Table 6. Table 6 shows that the treatment of pyrazosulfuron-ethyl 10% herbicide with the doses of 1.0 kg ha^{-1}- 2.0 kg ha^{-1} on WAA4 and WAA12 observations had good effects in total weed suppression and was significantly different from the control treatment and manual weeding treatment. The herbicide control treatment at all doses showed a no significant difference from manual control on WAA8 observation. This indicates that controlling with pyrazosulfuron-ethyl 10% herbicide was more efficient than manual weeding. Furthermore, controlling with pyrazosulfuron-ethyl 10% herbicide could replace manual weeding because it was more economically efficient. Whereas manual weeding required much effort and not enough time, controlling weeds by using the pyrazosulfuron-ethyl 10% herbicide needed only one application and could press weeds until WAA12 observations. Angirasan Kumar (2005) also stated that application of pyrazosulfuron-ethyl at the dose of 15 g/ha is effective in decreasing weed biomass at rice paddy field cultivation.

Table 6: Average total weed dry weight

Treatments		Dose kg ha^{-1}	Observation of -					
			WAA4		WAA8		WAA12	
A	pyrazosulfuron-ethyl 10%	0.6	1.63	a	36.20	a	40.80	b
B	pyrazosulfuron-ethyl 10%	0.75	2.50	a	32.00	a	37.40	b
C	pyrazosulfuron-ethyl 10%	1.00	0.00	a	24.83	a	26.60	a
D	pyrazosulfuron-ethyl 10%	1.25	0.00	a	3.77	a	11.00	a
E	pyrazosulfuron-ethyl 10%	1.50	0.00	a	0.00	a	6.33	a
F	pyrazosulfuron-ethyl 10%	1.75	0.00	a	19.27	a	19.73	a
G	pyrazosulfuron-ethyl 10%	2.00	0.00	a	7.27	a	10.13	a
H	Manual Weeding	-	13.57	b	44.53	a	56.40	c
I	Control	-	22.00	c	80.93	b	104.17	d

Note: The average value marked with the same letter in the same column shows no significant difference at the level of 95% according to the LSD test. WAA: Week after Application.

This indicates that the rising of dose could increase the ability of herbicides to suppress the weed growth. The higher dose of herbicide, the more liquid penetrates the weed leaves, the more herbicide is absorbed into the leaves, and the more protein synthesis suppresses and remains longer in the weed tissue.

Observations of Rice Plants

Phytotoxicity Observations

Based on the result of observations made on lowland rice plants, the treatment of pyrazosulfuron-ethyl 10% herbicide did not show any signs of poisoning in rice plants as shown by the visual assessment of rice plants, in which no rice plants had poisoning symptoms after the herbicide application.

Table 7: Phytotoxicity Observation of the pyrazosulfuron-ethyl 10% Herbicide in Rice Plants

Treatments		Dose kg ha^{-1}	Observation of -		
			WAA4	WAA8	WAA12
A	pyrazosulfuron-ethyl 10%	0.6	0.00	0.00	0.00
B	pyrazosulfuron-ethyl 10%	0.75	0.00	0.00	0.00
C	pyrazosulfuron-ethyl 10%	1.00	0.00	0.00	0.00
D	pyrazosulfuron-ethyl 10%	1.25	0.00	0.00	0.00
E	pyrazosulfuron-ethyl 10%	1.50	0.00	0.00	0.00
F	pyrazosulfuron-ethyl 10%	1.75	0.00	0.00	0.00
G	pyrazosulfuron-ethyl 10%	2.00	0.00	0.00	0.00
H	Manual Weeding	-	0.00	0.00	0.00
I	Control	-	0.00	0.00	0.00

The application of pyrazosulfuron-ethyl 10% herbicide did not cause poisoning to the cultivated plants because this herbicide is a selective herbicide that can only poison or control weeds. It does not poison or kill the rice plants so that this herbicide is recommended to farmers to control broad-leaved weeds and grass in lowland rice cultivation. According to Nathan *et al*. (2016), some types of plants such as rice paddy, corn, and cotton are tolerant to herbicides since they contain enzymes that can change toxic substances to a non-toxic one, like nitralase, glyphosate oxidoreductase, phosphinothricin acetyl transferase, and 2.4-D dioxygenase. Furthermore, Lawrence *et al*. (2018) stated that pyrazosulfuron-ethyl 10% does not cause plant poisoning to rice paddy plant, since it is easily degraded by microorganism and thus safe for lowland rice paddy plant.

Rice Plant Height

The result of the rice plant treatment analysis is presented in Table 8. All treatments, including control, showed no different plant heights in WAA3 - WAA6 observations. Both the manual weeding and the herbicide use could reduce the occurrence of competition between weeds and rice plants in utilizing nutrients so that referring to the claim of Simanjuntak *et al*. (2016) [24], the height growth in the rice plant could run optimally. Either in the control treatment or without control the height was lower i.e. 51.72 cm. In addition, Sumardi et.al. (2007) [28] asserted that the height growth of rice paddy plant is influenced by several factors, such as environmental, so that the plant will respond environmental influence to maintain the continuing optimum growth. The plant height is not only influenced by environment but also genes. Sitohang *et al*. (2014) [26] stated that the variety of genetic makeup inherently possessed by plants is one of the causes of uniform plant appearance. Genetic appearance is expressed in various natures of the plant consisting of shapes and functions, resulting in variety. The weed control with the pyrazosulfuron-ethyl 10% herbicide did not cause poisoning in rice plants, and for this reason the plant height growth ran optimally, where the pyrazosulfuron-ethyl 10% herbicide was a selective herbicide that only affected weed growth, but did not affect the rice plant growth. According to Abdulrachman *et al*,

(1996) [1], rice is a plant that is tolerant of chemicals such as pyrazosulfuron-ethyl 10% herbicide because rice plant is able to produce acetolase enzymes that can protect the toxic effects of herbicides.

Table 8: Average height of rice plants

Treatments		Dose kg ha^{-1}	Observation of-	
			WAA4	WAA8
A	pyrazosulfuron-ethyl 10%	0.6	39.28 a	52.82 a
B	pyrazosulfuron-ethyl 10%	0.75	39.74 a	53.35 a
C	pyrazosulfuron-ethyl 10%	1.00	38.20 a	53.67 a
D	pyrazosulfuron-ethyl 10%	1.25	38.79 a	54.86 a
E	pyrazosulfuron-ethyl 10%	1.50	38.76 a	54.59 a
F	pyrazosulfuron-ethyl 10%	1.75	38.47 a	55.08 a
G	pyrazosulfuron-ethyl 10%	2.00	39.40 a	54.86 a
H	Manual Weeding	-	38.96 a	53.37 a
I	Control	-	39.53 a	51.72 a

Note: The average value marked with the same letter in the same column shows no significant difference at the 95% level according to the LSD test. WAA: Week after Application.

Rice Production

The result of analysis on the rice production due to the treatments can be seen in Table 9. The treatment of pyrazosulfuron-ethyl 10% herbicide application on the doses of 0.60 kg ha^{-1} – 2.0 kg ha^{-1} resulted in milled dry grains that were not significantly statistically different from those exposed to control treatment and manual weeding. Although the value of the control treatment with the pyrazosulfuron-ethyl 10% herbicide on the dose of 1,0 kg ha^{-1} gave a high result of 9.97 kg plot^{-1}. This is the consequence of the reduced competition between plants and weeds. The more opportunities for plants to take advantage of growth factors such as water, nutrients, CO2 and place to grow for growth and grain formation, the higher grain yield will be (Pal, *et al*. 2012).

Table 9: Average weight of MDG / plot

Treatments		Dose kg ha^{-1}	weight of MDG / plot
A	pyrazosulfuron-ethyl 10%	0.60	8.30 a
B	pyrazosulfuron-ethyl 10%	0.75	8.87 a
C	pyrazosulfuron-ethyl 10%	1.00	9.97 a
D	pyrazosulfuron-ethyl 10%	1.25	8.80 a
E	pyrazosulfuron-ethyl 10%	1.50	8.30 a
F	pyrazosulfuron-ethyl 10%	1.75	8.20 a
G	pyrazosulfuron-ethyl 10%	2.00	8.87 a
H	Manual Weeding	-	7.90 a
I	Control	-	7.70 a

Note: The average value marked with the same letter in the same column shows no significant difference at the level of 95% according to the LSD test. WAA = Weeks After Application. MDG: Milled dry grain.

Conclusion

Pyrazosulfuron-ethyl 10% herbicide is effective in controlling dominant weeds and co-dominant weeds in rice plants such as *Echinocloa colona*, *Leptochloa cinensis* grass weeds and *Monochoria vaginalis* and *Spigelia anthermia* broad-leaved weeds, up to WAA12 observations with doses of 0.75 kg ha^{-1}-2.00 kg ha^{-1}. Pyrazosulfuron-ethyl 10% herbicide on the doses of 0.60 kg ha^{-1}-2.00 kg ha^{-1} up to WAA3 observations does not show signs of poisoning in rice plants so that rice plants grow normally and rice production remains high.

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