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The effect of paraquat dichloride herbicide for weed control in immature oil palm plantations

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Abstract
The oil palm plant (*Elaeis guineensis* Jacq) is an annual plant originating from Nigeria, West Africa. Oil palm is an important plantation crop producing food oil, industrial oil, and biofuel. One of the biggest challenges in increasing the potential for palm oil production in Indonesia is weed management. Weeds are unwanted plants because they can compete with plants. This study aims to determine the effectiveness of the paraquat dichloride herbicide for weed control in immature oil palm plants. The research was carried out in an oil palm plantation in Cikelet Subdistrict, Garut Regency, West Java. The experiment used an experimental method with a randomized block design (RBD) consisting of 7 treatments and 4 replications. The treatments consisted of paraquat dichloride herbicide at a dose of 405 g / ha; 540 g / ha; 675 g / ha; 810 g / ha; 945 g / ha; manual weeding and control. The results showed that the herbicide paraquat dichloride dose of 405-945 g / ha proved to be very effective and effective in controlling broad leaf weeds such as *Ageratum conyzoides, Galinsoga parviflora, Richardia brasiliensis, Borreria alata*, and other weeds. The herbicide paraquat dichloride at a dose of 405-945 g / ha at all tested doses did not show any symptoms of poisoning in immature oil palms.

Keywords: Efficacy, Paraquat Dichloride, Weeds, Oil Palm

Introduction
Oil palm (*Elaeis guineensis* Jacq) is an annual plant originating from Nigeria, West Africa (Hartono *et al*., 2014) [6]. Oil palm is an important plantation crop that produces food oil, industrial oil, and bio-fuel (biodiesel). Indonesia is the world's second largest producer of palm oil after Malaysia (BPTP, 2008) [22].

The oil palm industry is growing to be increasingly important for Indonesia, where the oil palm plant has played an important role in the national economy and development, and has made a major contribution to export activities and creates jobs for the community (Ersyad *et al*., 2017) [4]. In Indonesia, the palm oil industry is focused on the upstream sector or palm oil production. This sector is dominated by private companies, followed by smallholders and government plantations (Rianto, 2010) [12].

Pests, diseases and weeds are one of the challenges in increasing oil palm production (Utomo *et al*., 2007) [21]. Oil palm plants are classified as strong plants, but they are not free from pests and diseases and weeds, both those that are less dangerous and those that are harmful (BPTP, 2008) [22].

One of the biggest challenges in increasing the potential for palm oil production in Indonesia is weed management (Sidik *et al*., 2018) [16]. Oil palm plantation areas that are dominated by dangerous weeds or heavy competitors such as *Mikania micrantha*, *Imperata cylindrica, and Asystasia* coromandeliana can reduce production by up to 20% (PPKS, 2010).

Weeds are plants that are not desired to grow because they can compete with cultivated plants (Sidik *et al*., 2018) [16]. This competition has a detrimental effect on cultivated plants in the use of limited resources (Wibawa *et. al*., 2012) [22]. Weeds not only compete for nutrients, but some weeds also contain allelopathic substances that are toxic to cultivated plants (Sidik *et al*., 2018) [16]. Weeds grow aggressively and have high adaptability in using nutrients, water, light and CO2.

Weed control techniques that are commonly used are manual and chemical methods. Manual control requires a lot of labor and a long time. This means that manual control requires a much higher cost when compared to chemical control (Tjitrosoedirdjo *et. al*., 1984). One type of herbicide that is widely used to control weeds on plantation land is paraquat herbicide. Paraquat herbicide is a post-growth herbicide, is inactive when applied through the soil and is not selective (Suntres, 2002) [19]. According to Murti *at. al* . (2016) [9] stated that the herbicide paraquat dichloride at a dose of 414-966 g / ha was able to suppress total weed growth in cassava plantations up to 8 weeks after application. To determine the effect of the herbicide paraquat on weed suppression in immature oil palm plantations, it is necessary to conduct research.

Materials and Methods

The experiment was carried out at a Palm Oil Plantation in Cikelet Subdistrict, Garut Regency, West Java Province from September 2019 to January 2020. The material used in this experiment was the Paraquat diklorida herbicide. The oil palm cultivar used is Marihat Klon (MK) or all recommended oil palm clones in oil palm plantations 1-4 years old. Fertilization using ZA: 750 g / tree; TSP: 300 g / tree; MOP: 1 kg / tree; kieserite 750 g / tree or adapted to cultivar needs and local plantation recommendations.

The experimental design used in this study was a randomized block design with 7 treatments and 4 replications. Data processing is done with a variety analysis method. If the treatment shows a significant effect, then a further test is carried out on the difference in the average value at the 5% confidence level.

Table 1: Experiment Treatment

No	Treatment	Dose (g/ha)
1.	Paraquat dichloride	405
2.	Paraquat dichloride	540
3.	Paraquat dichloride	675
4.	Paraquat dichloride	810
5.	Paraquat dichloride	945
6.	Manual weeding	-
7.	Control (no weeding)	-

Herbicides are applied using a semi-automatic knapsack sprayer and a T-zet nozzle with a pressure of kg/cm^2 (15-20 p.s.i). The volume of water used is 500 l/ha. The application of the herbicide Isopropyl Amine Glyphosate was carried out when weed coverage reached a minimum of 75%. The herbicide application is carried out only once.

Weed observation

Weed biomass sample data in each treatment plot unit were observed in two squares, using a square Amarade measuring 0.5 mx 0.5 m. The layout of the squares is determined systematically.

a. Before application

Weed sampling for biomass, density and frequency data was carried out before the application of the herbicide Isopropyl Amine Glyphosate, which is intended to analyze vegetation using the sum dominance ratio (SDR) technique..

b. After application

Weed sampling for biomass data was carried out at 4, 8 and 12 weeks after application. Examples of weeds taken are target weeds, namely weed species that are the target of the herbicide Isopropyl Amine Glyphosate such as broad-leaved weeds and narrow-leaved gilma. Fresh weeds are cut to the level of the soil surface, then separated each species. Furthermore, the weeds are dried at a temperature of 800C for 48 hours or until they reach a constant dry weight, then weighed.

Phytotoxicity

Toxicity levels were visually assessed against the cultivar population in treatment plots, observed at 2, 4 and 6 weeks after application. The scoring is as follows:

0 = No poisoning, 0 - 5% the shape and / or color of the leaves and or the growth of the oil palm plant is not normal.

1 = Mild poisoning,> 5 - 20% leaf shape and / or color and / or growth of oil palm plants is not normal.

2 = Moderate poisoning,> 20 - 50% the shape and / or color of the leaves and or the growth of the oil palm plant is not normal.

3 = Severe poisoning,> 50 - 75% of the shape and / or color of the leaves and or the growth of the oil palm plant is not normal.

4 = Very severe poisoning,> 75% of the shape and / or color of the leaves and / or growth of the oil palm plant is not normal.

Results and Discussion

Weeds composition before experiment

Vegetation analysis is needed to determine the composition of weed vegetation found on a plant stretch. Based on the results of the vegetation analysis, it was known that the vegetation composition of the target weeds consisted of broad leaf weeds, namely *Ageratum conyzoides* (10.51%), *Galinsoga parviflora* (2.71%), *Richardia brasiliensis* (4.61%), *Borreria alata* (9.18. %), *Chromolaena odorata* (10.55) and *Mikania micrantha* (4.88%), as well as from the grass weed group namely *Axonopus compressus* (15.65%), *Cynodon dactylon* (7.31%), *Digitaria ciliaris* (3.25%) and *Ischaemum timorense* (5.96%). The results of the vegetation analysis at the test site before weeds were controlled with the Paraquat dichloride herbicide or manual weeding are presented in Table 2.

Table 2: Composition of dominant weeds before experiment

Weed name	Summed Dominan Ratio (%)
Axonopus compressus	15.65
Borreria alata	9.18
Chromolaena odorata	10.55
Mikania micrantha	4.88
Ageratum conyzoides	10.51
Mimosa pudica	10.52
Ottochloa nodosa	8.65
Richardia brasiliensis	4.61
Cyperus rotundus	6.24
Ischaemum timorense	5.96
Cynodon dactylon	7.31
Digitaria ciliaris	3.25
Galinsoga parviflora	2.71
TOTAL	100.00

Dry Weight of *Ageratum conyzoides* weeds

Based on statistical tests, the paraquat dichloride herbicide treatment at a dose of 405-945 g/ha can produce low dry weight of *Ageratum conyzoides* weeds and is significantly different from the control treatment at 4 and 8 weeks of observation after application, but not significantly different when compared to manual weeding (Table 3). In line with the research results of Sidik *et. al*. (2020) [17] stated that paraquat dichloride herbicide is very effective in suppressing the growth of broadleaved weeds.

Table 3: Average dry weight of Ageratum conyzoides weeds

Treatment	Observation time (Weeks After Application)	
	4	8
A (Paraquat dichloride 405 g/ha)	0.00 a	0.04 a
B (Paraquat dichloride 540 g/ha)	0.00 a	0.00 a
C (Paraquat dichloride 675 g/ha)	0.00 a	0.00 a
D (Paraquat dichloride 810 g/ha)	0.00 a	0.00 a
E (Paraquat dichloride 945 g/ha)	0.00 a	0.00 a
F (Manual weeding)	0.00 a	0.32 a
G (Control)	4.06 b	6.44 b

Note: The average value marked with the same letter in the same column shows no significant difference at the 5% level according to the Duncan Test.

Dry Weight of *Galinsoga parviflora* Weeds

The results showed that the paraquat dichloride herbicide treatment at a dose of 405-945 g/ha showed a statistically significant difference to the dry weight of *Galinsoga parviflora* weed compared to the control treatment at 4 and 8 weeks after application. Herbicide Paraquat dichloride is a contact herbicide from the pyridine class which is used to control weeds that are applied after growth (Humburg, 1989) [7].

Table 4: Average dry weight of *Galinsoga parviflora* weeds

Treatment	Observation time (Weeks After Application)	
	4	8
A (Paraquat dichloride 405 g/ha)	0.00 a	0.00 a
B (Paraquat dichloride 540 g/ha)	0.00 a	0.00 a
C (Paraquat dichloride 675 g/ha)	0.00 a	0.00 a
D (Paraquat dichloride 810 g/ha)	0.00 a	0.00 a
E (Paraquat dichloride 945 g/ha)	0.00 a	0.00 a
F (Manual weeding)	0.08 a	0.29 a
G (Control)	0.77 b	1.16 b

Note: The average value marked with the same letter in the same column shows no significant difference at the 5% level according to the Duncan Test.

Dry Weight of *Richardia brasiliensis* Weeds

Based on Table 5, it is known that the treatment of paraquat dichloride herbicide at a dose of 405-945 g/ha shows that the average dry weight of *Richardia brasiliensis* weeds is significantly different compared to the control treatment. This shows that the paraquat dichloride herbicide was able to suppress the dry weight of *Richardia brasiliensis* weeds from 4 to 8 weeks after application. This is in line with the opinion of Sembodo (2010) [15], that the right herbicide dose will determine the herbicide activity.

Table 5: Average dry weight of *Richardia brasiliensis* weeds

Treatment	Observation time (Weeks After Application)	
	4	8
A (Paraquat dichloride 405 g/ha)	0.06 a	0.05 a
B (Paraquat dichloride 540 g/ha)	0.09 a	0.03 a
C (Paraquat dichloride 675 g/ha)	0.00 a	0.00 a
D (Paraquat dichloride 810 g/ha)	0.00 a	0.00 a
E (Paraquat dichloride 945 g/ha)	0.00 a	0.00 a
F (Manual weeding)	0.00 a	0.36 a
G (Control)	0.72 b	2.21 b

Note: The average value marked with the same letter in the same column shows no significant difference at the 5% level according to the Duncan Test.

Dry Weight of *Borreria alata* Weeds

The results of statistical analysis showed that the paraquat dichloride herbicide treatment at a dose of 405-945 g/ha was able to suppress the growth of *Borreria alata* weeds in the field. This can be seen from the average dry weight gain of weeds which was significantly different from the control treatment from 4 to 8 weeks after application. According to research Sidik *et. al.* (2020) [17] paraquat dichloride herbicide dosage 375 - 750 g/ha is effective in controlling broadleaved weeds.

Table 6: Average dry weight of *Borreria alata* weeds

Treatment	Observation time (Weeks After Application)	
	4	8
A (Paraquat dichloride 405 g/ha)	0.06 a	0.16 a
B (Paraquat dichloride 540 g/ha)	0.09 a	0.19 a
C (Paraquat dichloride 675 g/ha)	0.00 a	0.00 a
D (Paraquat dichloride 810 g/ha)	0.00 a	0.00 a
E (Paraquat dichloride 945 g/ha)	0.00 a	0.00 a
F (Manual weeding)	0.11 a	0.50 a
G (Control)	5.55 b	8.69 b

Note: The average value marked with the same letter in the same column shows no significant difference at the 5% level according to the Duncan Test.

Other weeds dry weight

Apart from the dominant weeds above, several other weed species were also found, including Mimosa pudica and Cyperus rotundus. Based on Table 7, it can be seen that the treatment of herbicide paraquat dichloride at a dose of 405-945 g/ha can suppress the growth of other weeds. It is seen that the average dry weight of other weeds in the treatment of herbicide paraquat dichloride at a dose of 405-945 g/ha shows a significant difference compared to the control treatment.\

Table 7: Average dry weight of other weeds

Treatment	Observation time (Weeks After Application)	
	4	8
A (Paraquat dichloride 405 g/ha)	0.16 a	0.31 ab
B (Paraquat dichloride 540 g/ha)	0.06 a	0.12 a
C (Paraquat dichloride 675 g/ha)	0.00 a	0.03 a
D (Paraquat dichloride 810 g/ha)	0.00 a	0.00 a
E (Paraquat dichloride 945 g/ha)	0.00 a	0.00 a
F (Manual weeding)	0.25 a	0.87 b
G (Control)	2.46 b	3.77 c

Note: The average value marked with the same letter in the same column shows no significant difference at the 5% level according to the Duncan Test.

Phytotoxicity of Oil Palm Plants

Phytotoxicity is the level of plant poisoning caused by pesticide application. Observation of the level of phytotoxicity was carried out in 3 observations, namely 2, 4, and 6 weeks after application. The following is table 8 showing the average phytotoxicity of oil palm plants due to herbicide applications.

Table 8: Average Phytotoxicity of Oil Palm Plants

Treatment	Observation time (Weeks After Application)		
	2	**4**	**6**
A (Paraquat dichloride 405 g/ha)	0	0	0
B (Paraquat dichloride 540 g/ha)	0	0	0
C (Paraquat dichloride 675 g/ha)	0	0	0
D (Paraquat dichloride 810 g/ha)	0	0	0
E (Paraquat dichloride 945 g/ha)	0	0	0
F (Manual weeding)	0	0	0
G (Control)	0	0	0

The results showed that all treatments of parakuat dichloride herbicide at doses of 405-945g/ha did not cause phytotoxicity in oil palm plants. This is indicated by the results of scoring 0, as in the table. Scoring 0-5% shows no symptoms of poisoning in oil palm plants.

Conclusion

The paraquat dichloride herbicide dosage of 405-945 g/ha has proven to be very good and effective in controlling broad leaf weeds such as *Ageratum conyzoides, Galinsoga parviflora, Richardia brasiliensis, Borreria alata,* and other weeds. The herbicide paraquat dichloride at a dose of 405-945 g/ha at all tested doses showed no symptoms of poisoning in immature oil palm plants.

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