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The Effectiveness of Fluroxypyr Meptyl and Ammonium Glufosinate Herbicides in Controlling Weeds in The Field Oil Palm (Elaeis quineensis Jacq.)

Warlinson Girsang[1*], Rosmaria Girsang[2], Zamriyetti[2], Renizuida[2], Yehezkiel Hutagalung[3]

[1] Agrotechnology Study Program, Universitas Simalungun Pematangsiantar, Indonesia
[2] Agrotechnology Study Program, Universitas Pembangunan Pancabudi Medan, Indonesia
[3] Graduates of Agrotechnology Study Program, Simalungun University, Indonesia

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Corresponding Author:
Warlinson Girsang
warlinsongirsang@gmail.com

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Abstract: In oil palm plantations, weed control using herbicides is considered more practical than other control methods. This is due to the need for less manpower, shorter control execution times and longer control cycles. The ability of herbicides to control weeds is determined by the type of active ingredients they contain. The aim of the study was to determine the effectiveness of the 2 types of herbicides and the appropriate dosage levels to control weeds in oil palm fields. The research method used a nested design, testing 2 types of herbicides namely *fluroxypyr-mepthyl* and *ammonium glufosinate*. While the second treatment, tested the dose level of each herbicide. The tested dose levels for the herbicide *fluroxypir-mepthyl* were 0.1 l/ha, 0.3 l/ha, 0.5 l/ha, 0.7 l/ha and 0.9 l/ha. While the dose levels of *ammonium glufosinate* herbicide were 2.6 l/ha, 2.8 l/ha, 3.0 l/ha, 3.2 l/ha and 3.4 l/ha respectively. The results showed that the effectiveness of the herbicides *fluroxypir meptyl* and *ammonium glufosinate* to control weeds in oil palm plantations was not significantly different. The most effective dosage level of the herbicide *fluroxypir meptyl* for controlling weeds was 0.9 l/ha (average percentage of weed mortality was 74%). The dosage level of the *ammonium glufosinate* herbicide which resulted in the highest percentage of weed death (74.44%) resulted in an application dose of 3.4 l/ha. Application of the herbicides *fluroxypir meptyl* and *ammonium glufosinate* at all dose levels tested did not show toxicity in oil palm plants.

Keywords: Ammonium Glufosinate; Fluroxypir Mepthyl; Oil Palm; Weeds

Introduction

One of the important problems in the cultivation of oil palm plants is the presence of weeds which interfere with plant growth and development (Hakim et al., 2020; Samedani et al., 2015). The presence of weeds in oil palm plantations results in a decrease in the quantity and quality of fresh fruit bunch production, disruption to plant growth, increased pest and disease attacks, disruption of water use, and in general will increase farming costs (Sarjono & Zaman, 2017). Meanwhile, according to Mukarromah et al. (2014), the presence of weeds in oil palm plantations can inhibit growth and reduce production by around 15-20%.

The main problem caused by weeds is competition in taking nutrients, water and sunlight (Korav et al., 2018; Sembodo, 2010). Several weed control methods have been implemented in plantations. Both manually, mechanically, technical culture, biological, and chemical methods using herbicides (Barus, 2003; Mutsaers, 2019). Chemical control using herbicides is considered more practical and profitable, especially in terms of less labor requirements and shorter implementation (Ervin & Frisvold, 2016).

One of the important considerations in the use of herbicides is to obtain selective control, namely killing weeds but not damaging cultivated plants (Davies, 2001; Davies & Caseley, 1999; Monteiro & Santos, 2022). The

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successful application of a herbicide is influenced by several factors, namely the selection of the type of herbicide, method of application and formulation of the herbicide. Herbicide formulations are forms of herbicides that can affect solubility, volatilization, toxicity to plants and other properties (Pujisiswanto et al., 2022; Sumintapura, 1980).

Given that the herbicides used in oil palm plantations are still limited in number, they may not be sufficient to control weeds in different ecosystems. In this experiment, the comparison of the effectiveness of the herbicide with the active ingredient fluroxypyr-meptyl and the herbicide with the active ingredient ammonium glufosinate were tested. By comparing the tested herbicides, it is hoped that the types of active ingredients and dosage levels that are more effective in suppressing weed growth and the selectivity of each herbicide can be identified so that they do not poison the oil palm plantations.

Method

The research was conducted in the plantations of ± 5 year old oil palm farmers in Nagori Marubun Jaya (369 meters above sea level), Tanah Jawa District, Simalungun Regency. Oil palms were planted using a spacing of 10 m x 7 m. Between the rows of plants, various types of weeds are grown, dominated by broad leaf and grasses weeds. The average rainfall in the study area is 3.331 mm/year with a total of 184 rainy days/year and a temperature range of 20-29 ^{0}C.

The materials used include weed vegetation that grows on oil palm land, *Starane* 290 EC herbicide and *Optimus* 77 SL herbicide, as well as mixing water to dissolve the herbicide. The tools needed consist of a knapsack sprayer, measuring cup, plastic bucket, herbicide mixer, tape measure, treatment label, plastic strap, knife and stationery.

The field experiment used a nested design method with a randomized group trial pattern. The treatments tested consisted of 2 factors, namely the type of herbicide (as the main plot) and the level of application dose (as a sub-plot) (Schabenberger & Pierce, 2001). Two types of herbicides were tested, namely the herbicide with the active ingredient *fluroxypyr mepthyl* (Starane 290 EC) and the herbicide with the active ingredient *ammonium glufosinate* (Optimus 77 SL).

Prior to spraying herbicides, weed vegetation analysis was first carried out which aims to determine the composition of weed vegetation that dominates the land before being controlled with herbicides. Then, 30 experimental plots were prepared. Each plot is 4 m long x 4 m wide. Each experimental plot was labeled and stakes were installed and a rope was attached, the distance between the experimental plots and the distance between the replicates was set at 2 m. The number of trial plots was 10, each of which was repeated 3 times so that there were 30 trial plots in the field.

Calibration to determine the need for herbicides and mixing water, converted from area per hectare to area of 1 experimental plot (Bremer et al., 2022; Rusli et al., 2014; Wibawa et al., 2009). Spraying was carried out using a knapsack sprayer pump with ICI blue polyjet nozzle, flow rate of 1.6 l/minute with a spray width of 1.2 m. Spray volume used is 500 l/ha. Spraying is carried out in the morning, when the weather is sunny and the wind speed is low. Spraying is carried out according to the dose level tested. For herbicides with the active ingredient *fluroxypir-mepthyl* tested dose levels were 0.1 l/ha, 0.3 l/ha, 0.5 l/ha, 0.7 l/ha and 0.9 l/ha, respectively. While the dose levels of the tested herbicides with active *ammonium glufosinate* were 2.6 l/ha, 2.8 l/ha, 3.0 l/ha, 3.2 l/ha and 3.4 l/ha. To determine the effectiveness of the herbicides tested, observations were made on the damage rates of weeds, resistant weeds and poisoning in oil palm plants.

To draw conclusions, the research data were analyzed using a nested design of variance, Yijk: μ+ Ti + βj(i) + ∑ij(k), where: Yijk = observed response, μ = general mean, Ti = influence of factor A i, βj(i) = the effect of the jth factor B nested in the ith factor A, and ∑ij(k) = experimental error. If the treatment effect is significant, proceed with the least significant difference test (LSD) at the 95% confidence interval.

Result and Discussion

Weed Vegetation Analysis Before Herbicide Application

Prior to herbicide control, the results of identification of weed vegetation growing on the study area found 11 types of weed species classified into 8 families. Weed species that grow dominantly, with summed dominance ratio (SDR) values above the average value of *Axonopus compressus* (narrow leaf weeds), *Cyathula prostrata* (broad leaf weeds), and *Clidemia hirta* (broad leaf weeds) respectively.

From Table 1 it is known that before weed control was carried out, the research area was overgrown with 34.50% narrow-leaved weeds, consisting of 30.50% *Axonopus compressus* and 4,00% *Cyrtococcum oxyphyllum*. Broadleaf weeds consist of 7 species with a total SDR of 57.38%. Broadleaf weed species include *Clidemia hirta* (19.75%), *Cyathula prostrata* (18.48%), *Asystasia gangetica* (7.53%), *Melastoma malabathricum* (6.09%), *Synedrella nodiflora* (2.84%), *Borreria setidens* (1.63%) and *Galinsoga parviflora* (1.06%). Weeds from the fern group *Christella normalis* (7.71%) and *Nephrolepis exaltata* (0.40%) were also found.

From the analysis of weed vegetation, it was concluded that the research area prior to herbicide application was dominated by broad leaf weeds (SDR 57.38%), followed by narrow leaf weeds (SDR 34.50%).

Table 1. Types and Weed Dominance Values in the Study Area Before Herbicide Application

Weed Species	Family	SDR (%)	Ranking Dominance
Axonopus compressus	Poaceae	30.50	1
Clidemia hirta	Melastomaceae	19.75	2
Cyathula prostrata	Amaranthaceae	18.48	3
Christella normalis	Thelypteridaceae	7.71	4
Asystasia gangetica	Acanthaceae	7.53	5
Melastoma malabathricum	Melastomaceae	6.09	6
Cyrtococcum oxyphyllum	Poaceae	4.00	7
Synedrella nodiflora	Asteraceae	2.84	8
Borreria setidens	Rubiaceae	1.63	9
Galinsoga parviflora cav	Asteraceae	1.06	10
Nephrolepis exaltata	Nephrolepidaceae	0.40	11
Total		100.00	
Average SDR (summed dominance ratio)		9.09	

Weed Damage Rate After Herbicide Application

The results of analysis of variance data on weed damage due to herbicides at 21 days after application, showed that *fluroxypyr mepthyl* and *ammonium glufosinate* herbicides showed significantly different control results to suppress weed growth. However, at 42 and 63 days after application observations, the percentage of weed deaths due to the two types of herbicides tested was not significantly different. Meanwhile, the influence of the dose level of the herbicides tested on the observations of 21, 42, and 63 days after application showed significantly different percentages of weed damage, as shown in Table 2.

Table 2. Results of Tests for Differences in the Average Percentage of Weed Damage Due to Different Types and Dosage Levels of Herbicide.

Treatment	Weed Damage Percentage (%)					
	21 HSA		42 HSA		63 HSA	
Fluroksipir mepthyl	31.22	b	44.33	a	55.89	a
Amonium glufosinat	41.64	a	49.36	a	54.80	a
Fluroksipir mepthy dose :						
0.1 l/ha	10.78	d	20.78	c	29.89	d
0.3 l/ha	24.22	c	30.11	c	42.78	c
0.5 l/ha	31.67	bc	43.67	b	59.00	b
0.7 l/ha	42.67	ab	60.00	a	73.78	a
0.9 l/ha	46.78	a	67.11	a	74.00	a
Amonium glufosinat dose :						
2.6 l/ha	15.55	d	21.44	c	26.67	c
2.8 l/ha	37.89	c	47.00	b	52.00	b
3.0 l/ha	48.67	b	54.33	b	59.78	b
3.2 l/ha	46.44	bc	55.00	b	61.11	b
3.4 l/ha	59.67	a	69.00	a	74.44	a

Note: Numbers followed by the same letter at the same time of observation do not show a significant difference at the 0.05% test level

Figure 1. Weed vegetation in research land before herbicides aplication

At 21 days after application, the weed damage rate by *fluroxypyr meptyl* 31.22% was significantly different from that of *ammonium glufosinate* 41.64%. At 42 day after aplication weed damage rate by *fluroxypyr meptyl* herbicide increased to 44.33% and 49.36% ammonium *glufosinate herbicide* treatment, both of which were not significantly different. In the last observation (63 days after application) weed damage rate by *fluroxypyr meptyl* herbicide was 55.89% and weed death rate by *ammonium glufosinate* herbicide was 54.80%, both were not significantly different. Rutherford et al. (2011) stated, *glufosinate-ammonium* is a herbicide whose application effect may occur within a few days, but usually the time needed can vary from 1-3 weeks or it can also be 6 weeks in rainy season conditions.

Figure 2. Results of weed control 63 days after application of *fluroksipir mepthyl* herbicide (dose 0.9 l/ha)

If it is related to the weed mortality score according to Nasution (1986), the weed damage/death score by *fluroxypyr meptyl* is not different from the *ammonium glufosinate* herbicide score which is at score 4 (denoted as heavy damage), the percentage of weed damage ranges from 50-75%. This indicates that the two types of herbicide active ingredients tested have not been effective in controlling weeds, which are dominated by broadleaf and narrow leaf groups in oil palm plantations. Herbicides are declared effective in controlling weeds, if the percentage of weed damage reaches 75-100% (scoring 5).

At 21. 42 to 63 days after application, the herbicides *fluroxypir meptyl* at a dose of 0.9 l/ha (the highest dose of the tested dose) and *ammonium glufosinate* at a dose of 3.4 l/ha (the highest dose of the tested dose) resulted in significant weed damage. the largest of all the tested dose level treatments. Observations at 21 days after application, the effectiveness of the herbicide with the active ingredient *fluroxypir meptyl* at the treatment dose of 0.7 l/ha was not significantly different from the 0.5 l/ha and 0.9 l/ha treatments in causing weed death, but still better than the 21 days after application treatment. doses of 0.1 l/ha and 0.3 l/ha. Whereas for the *ammonium glufosinate* herbicide the dose level of 3.2 l/ha showed a significant difference with the dose level of 3.4 l/ha, but not significantly different from the 3.0 l/ha and 2.8 l/ha treatments.

At 42 days after application, the herbicide with the active ingredient *fluroxypir meptyl* at treatment doses of 0.7 l/ha and 0.9 l/ha gave better weed death than the other three dose levels. Whereas the *ammonium glufosinate* herbicide dose of 2.6 l/ha gave the smallest weed death among all treatments, at that time the four herbicide dose levels were able to give better results.

Figure 3. Results of weed control 63 days after application of *amonium glufosinat* herbicide (dose 3.4 l/ha)

At 63 days after application, both the herbicide *fluroxypir meptyl* at a dose of 0.7 l/ha and 0.9 l/ha and the herbicide *ammonium glufosinate* at a dose of 3.2 l/ha and 3.4 l/ha still gave the highest weed damage from among all treatments. This is in line with the opinion of Hermanto & Jatsiyah (2020), herbicides applied in high doses will cause the death of all weeds. However, if herbicides are applied in low doses, they will only kill certain plants and not damage other plants.

To control weeds, the herbicide *fluroxypir meptyl* at a dose of 0.7 l/ha was quite effective because the results were not significantly different from the herbicide *fluroxypir meptyl* at a dose of 0.9 l/ha. Meanwhile, the *ammonium glufosinate* herbicide at a dose level of 3.4 l/ha was the most effective in controlling weeds, because the percentage of weed deaths it caused reached 74.44 percent, which was significantly different from the other treatments.

Resistant Weeds

The results showed that at 63 days after aplication the herbicide *ammonium glufosinate* at a dose of 3.4 l/ha (the highest dose tested) was able to control various types of weeds in oil palm fields. However, doses of 2.6 l/ha, 2.8 l/ha, 3 l/ha and 3.2 l/ha were less effective in controlling *Melastoma malabathricum* weeds (Melastomaceae family). Before the application of *ammonium glufosinate* herbicide, the weed density of *Melastoma malabathricum* was 0.65/m^2 and after application the density of this weed increased to 0.76/m^2. Weed *Melastoma malabathricum* only suffered partial damage to its body. Some of the leaves turn yellow and dry, then grow back even though the growing point is experiencing slow growth. These results indicated that ammonium *glufosinate herbicides* at low doses were less effective in controlling the weed type *Melastoma malabathricum*.

While the effectiveness of the herbicide *fluroxypir meptyl*, the results showed that at 63 days after aplication the herbicide *fluroxypir meptyl* was only able to control broad leaf weeds, but could not control narrow leaf weeds (*Axonopus compressus*, *Cyrtococcum oxyphyllum*) and fern weeds (*Christella normalis*). This is in accordance with what was reported by Chohan et al. (2021), *fluoroxipir-meptyl* is only effective in controlling broadleaf weeds. The way *fluroxypir-meptyl* destroys weeds is by affecting the synthesis of fat and RNA. Disruption of fat synthesis as a component of cell membranes will be followed by disruption of other biochemical processes. Meanwhile, disruption of RNA synthesis will affect the transfer of genetic information. Furthermore, it affects the growth, shape and function of plant organs (stems become bent and leaves curl). *Fluroxypyr meptyl* also affects the ability of plants to carry out nitrogen metabolism and enzyme production in the plant body (Rutherford et al., 2011).

Table 3. Types of Weeds Resistant After Application of *Fluroxypyr meptyl* Herbicide

Weed Type		Weed Density	
Species Name	Family	Before Application	After Application
Axonopus compressus	Poaceae	70.71	86.78
Christella normalis	Thelypteridaceae	6.48	6.90
Cyrtococcum oxyphyllum	Poaceae	3.74	4.49

Weed species *Axonopus compressus*, *Christella normalis*, and *Cyrtococcum oxyphyllum* did not die, even their densities increased after herbicide application. These results indicated that the herbicide *fluroxypir meptyl* was not effective in controlling the 3 types of weeds. This is due to the selective nature of *fluoroxypyr-meptyl*. *Fluroxypyr meptyl* only damages broadleaf weeds and does not damage narrow leaf weeds or ferns (Rutherford et al., 2011).

Poisoning in Oil Palm Plants

The thing that needs to be considered in using herbicides to control weeds in oil palm land is selective control. It is expected that herbicides can kill weeds, but cultivated plants do not experience growth disturbances. Poisoning of plants by herbicides can be caused by too high herbicide doses, or the active ingredients of herbicides that are not selective (Umiyati & Denny, 2019).

Based on the results of observations on the shape of the leaves and the color of the young leaves of oil palm in which the herbicide was applied at each pass, no change in color or shape of the young leaves was found. Visual scoring for oil palm plant poisoning is considered 0 or no poisoning. It can be concluded that the use of the herbicide *fluroxypir meptyl* (Starane 290 EC) with a dose range of 0.1 – 0.9 l/ha and herbicide *ammonium glufosinate* (Optimus 77 SL) with a dose range of 2.6 – 3.4 l/ha did not cause symptoms of poisoning in oil palm plants aged 5 years after planting.

The herbicide *fluroksipir meptyl* is a selective and systemic herbicide capable of controlling broadleaf weeds, applied postemergently (Pawar & Thorat, 2004; Purba et al., 2020; Umiyati & Denny, 2019). Thus the application of the herbicide *fluroxypir meptyl* only affected weed growth by suppressing the development of weed dry weight while the oil palm plants did not show any symptoms of poisoning. *Ammonium glufosinate* herbicide is a selective and systemic herbicide that has a broad spectrum for controlling grass, shrub and broadleaf weeds. The application of *ammonium glufosinate* herbicide only affected weed growth while oil palm plants did not show any poisoning effect.

Oil palm plants in the study area are 5 years old. Therefore the leaves and shoots of plants are relatively far from the surface of the weeds that are sprayed with herbicides. The application technique is carried out directly on weed vegetation, so that oil palm plants are relatively not poisoned. According to Njoroge et al. (2004); Reinhardt (2019), in mature plants, meristematic activity has decreased in line with the slowing growth phase so that plants tend to be more resistant to herbicides.

Conclusion

The effectiveness of the herbicides *fluroxypir meptyl* and *ammonium glufosinate* to control weeds in oil palm plantations was not significantly different. The percentage of weed damage by *fluroxypyr meptyl* herbicide reached 55.89 percent and weed damage by *ammonium glufosinate* herbicide was 54.80 percent. The most effective dose level of the herbicide *fluroxypir meptyl* to control weeds which were dominated by broadleaf weeds in oil palm plantations was 0.9 l/ha (average weed damage = 74%) which was not significantly different from the dose level of 0.7 l /ha (average percentage of weed damage = 73.78%). The most effective dose level of *ammonium glufosinate* herbicide for controlling weeds in oil palm plantations is 3.4 l/ha (average percentage of weed mortality = 74.44%). The types of weeds that are resistant to the herbicide *fluroxypir meptyl* are *Axonopus compressus*, *Christella normalis* and *Cyrtococcum oxyphyllum*. Weeds that are resistant to *ammonium glufosinate* herbicides are the weed species *Melastoma malabathricum*. The application of the herbicides *fluroxypir meptyl* and *ammonium glufosinate* at all dose levels tested did not show toxicity in oil palm plants aged 5 years after planting.

Author Contribution

For research articles with multiple authors, a short paragraph stating the contributions of each should be provided. The following statements should be used "Conceptualization, Warlinson Girsang, methodology, Warlinson Girsang and Rosmaria Girsang; formal analysis, Warlinson Girsang, data curation, Zamriyetti and Yehezkiel Hutagalung; surveillance, Renizuida. All authors have read and agree to the published version of the manuscript." Please refer to the CREDIT taxonomy for an explanation of terms. Authorship should be limited to those who have contributed substantially to the work being reported.

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Conflicts of Interest

The authors declare no conflict of interes

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