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The effect of herbicide isopropylamine glyphosate 480 g/L on weed control in the circle area of immature oil palm (*Elaeis guineensis* Jacq.)

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Abstract
Uncontrolled weeds can reduce the growth and yield of oil palm. Weed control in oil palm plantations is commonly conducted using herbicides due to their effectiveness and efficiency. This study aims to determine the effect of Isopropylamine Glyphosate herbicide 480 g/l at various doses on the control of dominant weeds and the dry weight of weeds in TBM oil palm plant discs. The research was conducted from April to August 2025 at an oil palm plantation in Pakenjeng District, Garut Regency, West Java, using a randomized block design with seven treatments and four replications. Treatments consisted of five herbicide dosage levels. The treatments consisted of five herbicide dose levels (2.25; 3.00; 3.75; 4.50; and 5.25 L/ha), manual weeding, and a control (without weed control). Weed vegetation analysis prior to herbicide application was carried out using the Summed Dominance Ratio (SDR) method, while weed dry weight and phytotoxicity were observed at 4, 8, and 12 weeks after application (WAA). The results showed that the application of 480 g/L glyphosate IPA herbicide significantly reduced the dry weight of dominant weeds, namely *Stachytarpheta jamaicensis*, *Cyperus rotundus*, and *Urena lobata*. The dose of 3.00–5.25 L/ha showed the most optimal and sustainable weed control effectiveness up to 12 WAA, indicated by the very low dry weight of weeds compared to the control and manual weeding treatments. In addition, the application of 480 g/L glyphosate IPA herbicide did not cause phytotoxicity symptoms in TBM oil palm plants. Thus, 480 g/L glyphosate IPA herbicide is effective and safe to use for weed control in TBM oil palm plants.

Keywords: Immature oil palm, glyphosate ipa herbicide, weeds, dry weight, phytotoxicity

Indtroduction

Oil palm (*Elaeis guineensis* Jacq.) is a tropical crop cultivated in various countries, including Indonesia (Ningsih, 2023) [13] and is known as the most productive producer of vegetable oil compared to other vegetable oils (Siswanto *et al*., 2020) [18]. Indonesian palm oil production in 2024 reached 52.76 million tons, consisting of 48.16 million tons of CPO and 4.60 million tons of PKO, indicating a significant increase and confirming Indonesia's strategic role as a major global producer and an important contributor to the national economy (Info Sawit, 2025) [6].

This productivity needs to be maintained through good plantation management, including fertilization, weed control, and pest and disease control (Pardamean, 2021) [14]. Oil palm maintenance consists of the immature plant (TBM) phase, which focuses on vegetative growth, and the mature plant (MT) phase, which focuses on optimizing production (Directorate General of Plantations, 2023) [4]. In the TBM phase (1–4 years old), the plant canopy has not yet fully closed, so high light intensity in the inter-row area triggers weed growth. Margono and Maryani (2021) [11] explain that the presence of weeds in oil palm plantations can directly reduce productivity. Weeds are particularly disruptive due to the intense competition between the main crop and weeds for nutrients in the soil, potentially reducing yields by up to 20% (Rambe *et al*., 2010) [15]. Therefore, weed control during the TBM phase is a critical priority.

Weed control can be carried out manually, chemically, and through technical cultural practices (Simangunsong *et al*., 2018) [17]. Manual methods require greater labor and costs (Tjitrosoedirdjo *et al*., 1984) [20], making chemical control using herbicides the most efficient and commonly used method in Indonesian oil palm plantations (Kurniawan, 2023) [8]. Herbicides, including glyphosate, function to inhibit weed growth at the correct dosage (Mangsokarjo, 2014) [10].

The herbicide isopropylamine (IPA) glyphosate is a non-selective systemic herbicide with a broad control spectrum (Iskandar & Yudiawati, 2022) [7], which works through translocation throughout the weed tissue, so that phytotoxicity symptoms appear relatively later than contact herbicides (Umiyati & Widayat, 2017) [22]. Herbicide effectiveness is largely determined by the application dose. Too low a dose is ineffective, while too high a dose can potentially cause phytotoxicity in cultivated plants (Dani & Arifin, 2023) [3].

Research by Ugot *et al*. (2022) [21] showed that glyphosate IPA at a dose of 3 L/ha effectively suppressed weeds in oil palms. However, differences in weed types and environmental conditions caused weed responses across regions to be inconsistent (Tallo & Wiroatmojo, 2018) [19]. To date, there is no information available regarding the efficacy and optimum dose of glyphosate IPA at 480 g/L on TBM oil palms in Pakenjeng District, Garut Regency. Therefore, this study is important to determine an effective and safe application dose for weed control during the TBM phase.

Material and Methods

The study was conducted from April to August 2025 at an oil palm plantation located in Pakenjeng District, Garut Regency, West Java, Indonesia. The materials used in this study included three-year-old oil palm plants of the Simalungun variety, ZA fertilizer, TSP fertilizer, MOP fertilizer, insecticides, pesticides, and a commercial herbicide (PENTA UP-Z) containing IPA glyphosate at a concentration of 480 g/L. The equipment used consisted of a semi-automatic knapsack sprayer equipped with a T-jet

nozzle, measuring cylinders, a balance, an oven, paper envelopes, a measuring tape, scissors, wooden markers, hoes, stationery, and a mobile phone.

The experimental method employed a randomized block design (RBD) with seven treatments consisting of different doses of IPA glyphosate herbicide: A (2.25 L/ha), B (3.00 L/ha), C (3.75 L/ha), D (4.50 L/ha), E (5.25 L/ha), F (manual weeding), and G (control without weed control). Each treatment was replicated four times.

Initial weed vegetation analysis was conducted as a supporting observation prior to herbicide application. The main observations were carried out at 4, 8, and 12 weeks after herbicide application (WAA), which included weed and plant observations. Weed samples were collected from two quadrat plots measuring 0.5 m × 0.5 m by cutting weeds at the soil surface. The samples were then separated by species and oven-dried at 80°C for 48 hours or until a constant dry weight was achieved, after which they were weighed. Observations included weed dry weight (WDW) and phytotoxicity assessments, which were conducted at 1, 2, and 3 weeks after herbicide application (WAA). Data were analyzed using analysis of variance (ANOVA), and when significant effects were detected, mean differences among treatments were further analyzed using Duncan's Multiple Range Test (DMRT) at the 95% confidence level.

Results and Discussion

Weed Vegetation Analysis

The results of the initial weed vegetation analysis conducted prior to the application of IPA glyphosate herbicide at a concentration of 480 g/L at the research site are presented in Table 1. The composition of dominant weeds was determined using the Summed Dominance Ratio (SDR) technique. Based on the SDR values, *Stachytarpheta jamaicensis*, *Cyperus rotundus*, and *Urena lobata* were identified as the most dominant weed species compared to other weeds. Dominant weeds are defined as weed species with SDR values exceeding 10% (Kusnayadi *et al*., 2021) [9]. The dominance of these three species indicates that they had relatively high distribution and population levels at the research site. In addition, the presence of weeds belonging to the grass and sedge groups reflects the diversity of the weed community, which has the potential to compete with the main crop.

Table 1: Composition of Dominant Weeds

Weed Species	Group	SDR (%)
Stachytarpheta jamaicensis L.	Broadleaf	14,45
Cyperus rotundus L.	Sedge	15,24
Urena lobata	Broadleaf	13,66
Synedrella nodiflora	Broadleaf	9,71
Cynodon dactylon	Broadleaf	8,91
Richardia brasiliensis	Grass	7,80
Digitaria sanguinalis	Grass	9,62
Calopogonium	Broadleaf	8,58
Imperata cylindrica	Grass	4,94
Mikania michrantha	Broadleaf	7,08
Total		100

Dry Weight of *Stachytarpheta jamaicensis* L. Weeds

The results of observation and analysis of variance on the effect of IPA glyphosate herbicide at a concentration of 480 g/L applied at doses of 2.25–5.25 L/ha on the dry weight of *Stachytarpheta jamaicensis* weeds are presented in Table 2. The dry weight of *Stachytarpheta jamaicensis* showed a significant treatment effect, in which the application of IPA glyphosate herbicide at doses of 2.25 L/ha and 3.75 L/ha resulted in the lowest weed dry weight compared to other dose treatments, manual weeding, and the control. At 12 weeks after application (WAA), both doses were able to suppress weed dry weight to 0.00 g, indicating that these doses were effective in providing optimal and sustained weed control. This finding is consistent with the study by Adnan *et al*. (2012) [1], which reported that glyphosate herbicide applied at appropriate doses significantly reduces weed dry weight due to its systemic mode of action by inhibiting the synthesis of essential amino acids.

Table 2: Effect of Herbicide Application on the Dry Weight of Stachytarpheta jamaicensis L. Weeds

Treatment		Dosage l/ha	Dry Weight (g)		
			4 WAA	8 WAA	12 WAA
A	IPA Glyphosate 480 g/L	2,25	0,22 a	0,33 a	0,00 a
B	IPA Glyphosate 480 g/L	3,00	2,49 b	1,30 a	2,10 ab
C	IPA Glyphosate 480 g/L	3,75	0,28 a	2,90 a	0,00 a
D	IPA Glyphosate 480 g/L	4,50	0,03 a	1,45 a	1,00 a
E	IPA Glyphosate 480 g/L	5,25	0,87 a	0,83 a	0,38 a
F	Manual weeding	-	0,26 a	3,30 a	1,85 ab
G	Control	-	3,33 b	4,50 b	5,55 b

Note: Mean values followed by the same letter in the same coloumn are not significantly different at the 5% level according to Duncan's Multiple Range Test (DMRT). WAA = Weeks After Application

Bobot Kering Gulma *Cyperus rotundus* L.

The results of observation and analysis of variance on the effect of IPA glyphosate herbicide at a concentration of 480 g/L applied at various doses on the dry weight of *Cyperus rotundus* weeds are presented in Table 3. The dry weight of *Cyperus rotundus* showed a significant treatment effect, in which the application of IPA glyphosate herbicide at doses of 2.25 L/ha, 3.00 L/ha, and 5.25 L/ha significantly reduced weed dry weight compared to the control treatment. In particular, the doses of 3.00 L/ha and 5.25 L/ha resulted in weed dry weights approaching 0.00 g up to 12 weeks after application (WAA), indicating that these doses were effective in providing optimal and sustained control of *Cyperus rotundus*. This finding is consistent with the study by Mawandha *et al*. (2021) [12], which reported that the application of glyphosate herbicide effectively suppressed the growth of *Cyperus rotundus*, indicating a high level of sensitivity to glyphosate under field conditions in oil palm plantations.

Table 3: Effect of Herbicide Application on the Dry Weight of Cyperus rotundus

Treatment		Dosage l/ha	Dry Weight (g)		
			4 WAA	8 WAA	12 WAA
A	IPA Glyphosate 480 g/L	2,25	0,32 a	0,00 a	0,00 a
B	IPA Glyphosate 480 g/L	3,00	0,00 a	0,00 a	0,00 a
C	IPA Glyphosate 480 g/L	3,75	0,03 a	2,25 a	0,40 a
D	IPA Glyphosate 480 g/L	4,50	0,08 a	1,30 a	0,55 a
E	IPA Glyphosate 480 g/L	5,25	0,08 a	0,00 a	0,00 a
F	Manual weeding	-	0,00 a	3,08 a	4,60 b
G	Control	-	1,07 b	7,15 b	3,08 ab

Note: Mean values followed by the same letter in the same coloumn are not significantly different at the 5% level according to Duncan's Multiple Range Test (DMRT). WAA = Weeks After Application.

Dry Weight of *Urena lobata* Weeds

The results of observation and analysis of variance showed that the application of IPA glyphosate herbicide at a concentration of 480 g/L at various doses had a significant effect on the dry weight of *Urena lobata* weeds (Table 4). All herbicide treatments at doses of 2.25–5.25 L/ha were able to significantly reduce weed dry weight compared to the control treatment, with a consistent reduction observed up to 12 weeks after application (WAA). The doses of 3.00–5.25 L/ha resulted in weed dry weights approaching 0.00 g, indicating that IPA glyphosate herbicide is effective in controlling broadleaf weeds through systemic action of glyphosate. This finding is in line with Riadi (2011) [16], who stated that glyphosate herbicide is effective in controlling various weed species, including broadleaf weeds. In addition, Adnan *et al*. (2012) [1] reported that glyphosate herbicide is capable of controlling weeds up to 42 days after application due to its effective absorption and translocation to the roots, thereby maintaining higher weed control efficacy compared to other herbicides.

Table 4: Effect of Herbicide Application on the Dry Weight of *Urena lobata* Weeds

Treatment		Dosage l/ha	Dry Weight (g)		
			4 WAA	8 WAA	12 WAA
A	IPA Glyphosate 480 g/L	2,25	0,28 a	0,10 a	0,10 a
B	IPA Glyphosate 480 g/L	3,00	0,00 a	0,05 a	0,00 a
C	IPA Glyphosate 480 g/L	3,75	0,00 a	0,00 a	0,28 a
D	IPA Glyphosate 480 g/L	4,50	0,00 a	0,00 a	0,00 a
E	IPA Glyphosate 480 g/L	5,25	0,00 a	0,00 a	0,00 a
F	Manual Weeding	-	0,09 a	0,75 a	0,35 a
G	Control	-	0,89 b	3,48 b	5,53 b

Note: Mean values followed by the same letter in the same coloumn are not significantly different at the 5% level according to Duncan's Multiple Range Test (DMRT). WAA = Weeks After Application.

Phytotoxicity

The results of observation and analysis of variance on the effect of IPA glyphosate herbicide at a concentration of 480 g/L applied at doses of 2.25–5.25 L/ha on oil palm phytotoxicity are presented in Table 5. Phytotoxicity refers to plant damage caused by exposure to certain chemical substances, such as herbicide application (Hastuti, 2021) [5]. The observation results showed that the application of IPA glyphosate herbicide did not cause any phytotoxic symptoms in oil palm plants. This was indicated by the absence of changes in leaf shape and color. These results are in line with previous studies reporting that IPA glyphosate herbicide does not induce phytotoxic effects on immature oil palm plants (Alfandi *et al*., 2021) [2].

Table 5: Observation of Phytotoxicity in Oil Palm Plants

Treatment		Dosage l/ha	Observation		
			4 WAA	8 WAA	12 WAA
A	IPA Glyphosate 480 g/L	2,25	0	0	0
B	IPA Glyphosate 480 g/L	3,00	0	0	0
C	IPA Glyphosate 480 g/L	3,75	0	0	0
D	IPA Glyphosate 480 g/L	4,50	0	0	0
E	IPA Glyphosate 480 g/L	5,25	0	0	0
F	Manual weeding	-	0	0	0
G	Control	-	0	0	0

Note: WAA = Weeks After Application.

Conclusion

The application of herbicide containing isopropylamine glyphosate at a concentration of 480 g/L in the weed circle of immature oil palm (TBM) significantly reduced the dry weight of dominant weeds, *namely Stachytarpheta jamaicensis*, *Cyperus rotundus*, and *Urena lobata*. All tested herbicide doses (2.25–5.25 L/ha) were able to suppress weed growth significantly compared to the control and manual weeding treatments. The doses of 3.00–5.25 L/ha showed the most optimal and sustained weed control effectiveness up to 12 weeks after application (WAA), as indicated by weed dry weights approaching 0.00 g. In addition, the application of IPA glyphosate herbicide at 480 g/L at all tested doses did not cause phytotoxicity symptoms in immature oil palm plants, indicating that it is safe for use in weed management. Therefore, IPA glyphosate herbicide

at 480 g/L is effective and safe as an alternative method for weed control in immature oil palm plantations, with the 3.00 L/ha dose identified as the most effective and efficient rate.

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