



## Effect of an isopropylamine glyphosate 200 g/l and 2,4-d dimethylamine 100 g/l herbicide mixture on weeds and young coffee

Yayan Sumekar, Alyaa Tsanaa Safaira, Uum Umiyati

Faculty of Agriculture, Universitas Padjadjaran, Jalan R. Jatinangor, West Java, Indonesia

### Abstract

Weed control is essential because weeds can be a major limiting factor that reduces coffee productivity. This study aimed to evaluate the effectiveness of a mixture herbicide containing 200 g/L isopropylamine glyphosate and 100 g/L 2,4-D dimethylamine on weed suppression and its effect on young coffee plants. The research was conducted in a community coffee plantation in Garut, West Java, using a randomized block design with seven treatments and four replications. The treatments included various dosages of the mixture herbicide (2.25 L/ha to 5.25 L/ha), manual weeding, and an untreated control. Weed dry weight observations were conducted at 4, 8, and 12 weeks after application (WAA), and phytotoxicity was assessed visually. The results showed that the mixture herbicide at dosages from 3.00 L/ha to 5.25 L/ha was effective in suppressing the dry weight of *S. nodiflora*, and all dosages from 2.25 L/ha to 5.25 L/ha effectively controlled *C. dactylon* and other weeds significantly compared to the control, without causing phytotoxicity.

**Keywords:** Isopropylamine glyphosate, 2,4-D dimethylamine, weed, young coffee plant

### Introduction

Coffee (*Coffea* sp.) is a leading plantation commodity that plays a crucial role in supporting the national economy. According to Badan Pusat Statistik Indonesia (2024) <sup>[1]</sup>, Indonesia owned a coffee plantation area of 1.26 million ha with a production of 758 thousand tons in 2023. This coffee production has decreased over the two previous years, where in 2022 a decline of 1.43% was observed, dropping from 786.19 thousand tons to 774.96 thousand tons, and in 2023 it further decreased by 2.10%, representing a drop of 16.24 thousand tons. Utami *et al.* (2020) <sup>[23]</sup> state that declining coffee productivity can be influenced by several factors, one of which is the presence of weeds that compete with the coffee plants. Coffee growth also encompasses two primary phases, the immature phase and the bearing phase. Since the immature phase determines subsequent productivity (Subakti *et al.*, 2021) <sup>[19]</sup>, proper plant maintenance, including weed control, is essential during this stage.

Weeds are plants that grow in an undesirable place or plants that grow outside of where they should be (Badhai *et al.*, 2021) <sup>[4]</sup>. The presence of weeds in cultivated areas can negatively affect crop yield. Globally, the existence of 1800 weed species has resulted in economic losses of USD 32 billion per year and reduced agricultural production by 31.5% (Kubiak *et al.*, 2022) <sup>[8]</sup>. Weeds that interact with crops, including coffee plants, can become gradually detrimental due to competition for growth elements such as sunlight, nutrients, CO<sub>2</sub>, and growing space Faisal *et al.* (2013) <sup>[5]</sup>. According to Widhayasa (2023) <sup>[24]</sup>, weeds also carry out allelopathy, which is the release of allelochemical compounds that can have a negative impact on cultivated crops. Furthermore, weeds that act as alternate hosts for insect pests, nematodes, and pathogens can indirectly become a limiting factor in cultivated crop production (Ladja, 2013) <sup>[11]</sup>.

Perkasa (2020) <sup>[13]</sup> states that herbicide application is one of the most effective control methods for suppressing weed growth. The use of herbicides can help control weeds in a

short time and cover a large area, allowing weeds to be suppressed effectively and efficiently in terms of time, labor, and cost. However, the long-term use of herbicides, particularly those with a single active ingredient, carries the risk of causing weed resistance. Using multiple active ingredients is one approach to preventing weeds from developing resistance. This approach also can broaden the spectrum of weed control, minimize residues on crops, and also improve time and cost efficiency (Shekhawat *et al.*, 2020) <sup>[17]</sup>. One mixture herbicide that can be applied in coffee cultivation areas is the mixture of isopropylamine (IPA) glyphosate and 2,4-D dimethylamine.

Isopropylamine (IPA) glyphosate is a mixture of glyphosate with the isopropylamine salt. This herbicide works systemically and non-selectively. Glyphosate acts by translocating in actively growing areas, disrupting the activity of the enzyme 5-enol-pyruvyl-shikimate-3-phosphate synthase (EPSPS) and preventing the biosynthesis of aromatic amino acids, namely phenylalanine, tyrosine, and tryptophan, which are produced via the shikimate pathway, thereby inhibiting weed metabolism (Kanissery *et al.*, 2019) <sup>[7]</sup>. 2,4-D dimethylamine is a herbicide that works selectively against broadleaf weeds (Obidola *et al.*, 2021) <sup>[12]</sup>. This active ingredient acts as a synthetic auxin that disrupts weed growth. 2,4-D binds to specific receptors within the cell nucleus, which initiates protein degradation and causes deregulation of auxin sensitive genes. This abnormal genetic activation leads to cellular and tissue damage, resulting in weed death (Peterson *et al.*, 2016) <sup>[15]</sup>.

Although the use of herbicides containing glyphosate and 2,4-D is a common practice in weed control in plantation areas, research data regarding the effectiveness and influence of the mixture of these two active ingredients on young coffee plants is still very limited. This research is therefore important to be carried out to obtain an effective and safe herbicide mixture for controlling weeds in immature coffee, because inappropriate or excessively high doses can harm the cultivated plants themselves (Prasetio & Wicaksono, 2017) <sup>[16]</sup>.

**Materials and Methods**

The research was conducted in a community coffee plantation in Tanjung Karya Village, Samarang District, Garut Regency, West Java, from April to August 2025, using a randomized block design with seven treatments and four replicates. Treatments included five dosages of the mixed herbicide IPA glyphosate and 2,4-D dimethylamine (2.25 l/ha, 3.00 l/ha, 3.75 l/ha, 4.5 l/ha, and 5.25 l/ha), manual weeding, and a non-treated control. Data were analyzed using analysis of variance method. If the treatment shows a significant effect, mean separation tests are then performed on the treatment averages at a 95% confidence level.

The observed response variables include:

**Weed observations**

Weed observations were carried out using the quadrant method with a size of 0.5 x 0.5 m at two points within each plot. Weeds were cut exactly at ground level and separated by species. Before the herbicide application, weed samples were collected for vegetation analysis using the sum dominance ratio (SDR) technique. At 4, 8, and 12 weeks after application (WAA), weed samples were collected again for the calculation of dry weight and dried at 80°C for 48 hours or until reaching a constant dry weight.

**Phytotoxicity**

Phytotoxicity was evaluated visually at 4, 8, and 12 WAA using a five-point scale (0–4) based on the percentage of abnormal leaf shape, color, or plant growth. A score of 0 indicates no or negligible toxicity (<5% abnormality), while mild (1), moderate (2), and severe (3) symptoms correspond to 5-20%, 20-50%, and >50-75% abnormality. The maximum score of 4 represents very severe toxicity, characterized by symptoms affecting over 75% of the plant, potentially leading to plant death.

**Result and Discussion**

**Supporting Observation**

**Weed Vegetation Analysis**

Vegetation analysis is fundamental to weed control, as this method is carried out to determine the dominance of weeds in a certain area (Widiyani *et al.*, 2022) [25]. Vegetation analysis is performed by calculating the summed sominance ratio (SDR). An SDR percentage more than 10% indicates that the weed is dominant or co-dominant. In the third year

of the young coffee plantation, four species of grass weeds and six species of broadleaf weeds were found

**Table 1:** Summed Dominance Ratio (SDR)

No	Species	Group	SDR (%)
1	<i>Synedrella nodiflora</i>	Broadleaf	23.68
2	<i>Artemisia vulgaris</i>	Broadleaf	8.00
3	<i>Digitaria sanguinalis</i>	Grass	8.58
4	<i>Cynodon dactylon</i>	Grass	15.65
5	<i>Commelina diffusa</i>	Broadleaf	9.72
6	<i>Crassocephalum crepidioides</i>	Broadleaf	7.02
7	<i>Galinsoga parviflora</i>	Broadleaf	8.48
8	<i>Alternanthera philoxeroides</i>	Broadleaf	6.29
9	<i>Setaria barbata</i>	Grass	5.56
10	<i>Eleusine indica</i>	Grass	7,02

From table 4, it was found that *Synedrella nodiflora* was the dominant weed species in the young coffee plantation area, and *Cynodon dactylon* was the co-dominant weed. The most frequently found weed groups belonged to the Asteraceae family (*Synedrella nodiflora*, *Artemisia vulgaris*, *Galinsoga parviflora*, and *Crassocephalum crepidioides*) and Poaceae (*Digitaria sanguinalis*, *Cynodon dactylon*, *Setaria barbata*, and *Eleusine indica*). This aligns with research conducted in coffee cultivation areas by Permatasari *et al.* (2023) [14], where the most dominating weeds were found to belong to the Asteraceae and Poaceae families. The adaptive characteristics of the Asteraceae and Poaceae families allow them to grow rapidly and invasively, thus often dominating an area (Kurniawan *et al.*, 2022; Utami *et al.*, 2020) [10, 23].

**Main Observation**

**Average Dry Weight of Weeds**

Weed dry weight observation was carried out to assess the significant effect of herbicide application on weeds. The observed dry weight included the dry weight of weeds with SDR more than 10% (*Synedrella nodiflora* and *Cynodon dactylon*), and other weeds.

**Dry Weight of *Synedrella nodiflora***

*Synedrella nodiflora* is a broadleaf weed belonging to the Asteraceae family. According to Tanasale *et al.* (2024) [21], broadleaf weeds frequently dominate with the highest summed dominance ratio because of their greater ability to absorb nutrients compared to other weeds.

**Table 2:** Average Dry Weight of *Synedrella Nodiflora*

Treatment		Dosage (L/ha)	Average Weight of Weeds		
			4 WAA	8 WAA	12 WAA
A	IPA glyphosate 200 g/l + 2,4-D dimethylamine 100 g/l	2.25	7.69 ab	6.10 bc	1.35 ab
B	IPA glyphosate 200 g/l + 2,4-D dimethylamine 100 g/l	3	2.23 a	3.31 ab	0.81 ab
C	IPA glyphosate 200 g/l + 2,4-D dimethylamine 100 g/l	3.75	2.12 a	0.60 a	1.55 ab
D	IPA glyphosate 200 g/l + 2,4-D dimethylamine 100 g/l	4.5	0.36 a	0.55 a	3.78 ab
E	IPA glyphosate 200 g/l + 2,4-D dimethylamine 100 g/l	5.25	1.19 a	0.67 a	3.35 ab
F	Manual Weeding	-	8.90 ab	6.11 bc	7.13 bc
G	Control	-	13.87 b	8.48 c	11.99 c

The results presented in table 2 indicate that the herbicide treatments at dosages of 3 L/ha to 5.25 L/ha were effective in controlling *Synedrella nodiflora*. Treatment B (3 L/ha) represented the lowest effective dosage that showed a significant difference from the control, and it exhibited the most stable results from 4 up to 12 WAA. According to Kurniadie *et al.* (2019) [9], the synergistic interaction in the

mixed herbicide treatment of isopropylamine (IPA) glyphosate and 2,4-D dimethylamine can stimulate biological activity and enhance the control of *Synedrella nodiflora*.

Treatment A, at a dosage of 2.25 L/ha at 4 WAA and 8 WAA, did not show a significant difference compared to the control treatment. This may be attributed to the dosage

being too low to effectively control *Synedrella nodiflora*, which is highly dominant in this coffee plantation. A dose that is too low can result in ineffective weed control, whereas an excessively high dose can trigger the risk of phytotoxicity in the main crop (Situmorang & Afrianti, 2021)<sup>[18]</sup>.

**Dry Weight of *Cynodon dactylon***

*Cynodon dactylon* is a narrow leaf weed (grass) belonging to the Poaceae family. According to Ayuningsih *et al.* (2025)<sup>[3]</sup>, the Poaceae family has characteristics that allow them to grow rapidly in both dry and wet land. This trait often leads to weeds from the Poaceae family dominating a cultivated area.

**Table 3:** Average Dry Weight of *Cynodon Dactylon*

Treatment		Dosage (l/ha)	Average Weight of Weeds		
			4 WAA	8 WAA	12 WAA
A	IPA glyphosate 200 g/l + 2,4-D dimethylamine 100 g/l	2.25	3.15 a	2.07 a	7.06 a
B	IPA glyphosate 200 g/l + 2,4-D dimethylamine 100 g/l	3	1.84 a	0.32 a	3.58 a
C	IPA glyphosate 200 g/l + 2,4-D dimethylamine 100 g/l	3.75	1.33 a	2.42 a	0.00 a
D	IPA glyphosate 200 g/l + 2,4-D dimethylamine 100 g/l	4.5	0.00 a	0.68 a	2.05 a
E	IPA glyphosate 200 g/l + 2,4-D dimethylamine 100 g/l	5.25	0.00 a	0.79 a	0.00 a
F	Manual Weeding	-	4.49 a	4.46 ab	4.71 a
G	Control	-	12.55 b	9.95 b	7.81 b

Based on the results in table 3, all herbicide treatments were effective in controlling the weed *Cynodon dactylon* from 4 WAA up to 12 WAA. All treatments can be considered effective because they showed a significant difference from the control and were better than manual weeding. The treatment with the lowest dosage, treatment A (2.25 L/ha), is the most recommended dosage for controlling this weed. The presence of the non-selective active ingredient,

isopropylamine (IPA) glyphosate, enables this herbicide to effectively control *Cynodon dactylon*. According to Hermanto & Jatsiyah (2020)<sup>[6]</sup>, glyphosate, which is systemic, translocates throughout all parts of the weed especially the roots, thereby effectively controlling narrow leaf weeds.

**Dry Weight of Other Weeds**

**Table 4:** Average Dry Weight of Other Weeds

Treatment		Dosage (L/ha)	Average Weight of Weeds		
			4 WAA	8 WAA	12 WAA
A	IPA glyphosate 200 g/l + 2,4-D dimethylamine 100 g/l	2.25	3.60 a	5.07 a	3.63 a
B	IPA glyphosate 200 g/l + 2,4-D dimethylamine 100 g/l	3	1.07 a	2.80 a	3.65 a
C	IPA glyphosate 200 g/l + 2,4-D dimethylamine 100 g/l	3.75	1.73 a	9.16 a	2.20 a
D	IPA glyphosate 200 g/l + 2,4-D dimethylamine 100 g/l	4.5	1.01 a	4.34 a	3.07 a
E	IPA glyphosate 200 g/l + 2,4-D dimethylamine 100 g/l	5.25	1.27 a	3.13 a	1.24 a
F	Manual Weeding	-	6.90 a	16.62 b	12.63 b
G	Control	-	39.27 b	48.42 c	24.70 c

Table 4 shows that there was a significant effect of the herbicide treatment on broadleaf and grass weeds present in the coffee cultivation area. The herbicide treatments showed a significant difference compared to the control treatment and manual weeding. Treatment A, with the lowest dosage (2.25 L/ha), is the most recommended dosage because it was already capable of effectively controlling the weeds. This is consistent with the research by Andini *et al.* (2022)<sup>[2]</sup>, where the application of a low dosage (50 g/ha) mixture of isopropylamine (IPA) glyphosate and 2,4-D dimethylamine could effectively control broadleaf weeds, grass, and sedges, and

was better than using a single herbicide.

**Phytotoxicity**

Phytotoxicity refers to symptoms arising from the plant's response to herbicides. These symptoms can include chlorosis, necrosis, abnormal growth, or even mortality (Umiyati & Kurniadie, 2018)<sup>[22]</sup>. Based on table 5, the application of the mixed herbicide of isopropylamine (IPA) glyphosate and 2,4-D dimethylamine showed a scoring result of zero (0) for every treatment. This indicates that the herbicide application did not cause any poisoning effect on the main crop.

**Table 5:** Phytotoxicity

Treatment		Dosage (L/ha)	Phytotoxicity		
			4 WAA	8 WAA	12 WAA
A	IPA glyphosate 200 g/l + 2,4-D dimethylamine 100 g/l	2.25	0	0	0
B	IPA glyphosate 200 g/l + 2,4-D dimethylamine 100 g/l	3.00	0	0	0
C	IPA glyphosate 200 g/l + 2,4-D dimethylamine 100 g/l	3.75	0	0	0
D	IPA glyphosate 200 g/l + 2,4-D dimethylamine 100 g/l	4.50	0	0	0
E	IPA glyphosate 200 g/l + 2,4-D dimethylamine 100 g/l	5.25	0	0	0
F	Manual Weeding	-	0	0	0
G	Control	-	0	0	0

Proper application methods and sufficiently mature plant age can reduce the risk of herbicide exposure to the main

crop (Sumekar *et al.*, 2021)<sup>[20]</sup>. The herbicide application, which was only conducted around the coffee plants, ensured

the herbicide only acted on the weeds without causing phytotoxicity. Furthermore, the coffee plants had already reached 3 years of age, meaning the distance between the leaves and the soil surface was sufficiently large and the plants were strong enough, thus better preventing the effect of direct contact with the herbicide.

### Conclusion

Based on the results of this study, the conclusions that can be drawn are as follows:

1. The mixture herbicide of isopropylamine (IPA) glyphosate 200 g/L + 2,4-D dimethylamine 100 g/L at dosages ranging from 3.00 L/ha to 5.25 L/ha was effective in suppressing the dry weight of *S. Nodiflora*.
2. The mixture herbicide of isopropylamine (IPA) glyphosate 200 g/L + 2,4-D dimethylamine 100 g/L at dosages ranging from 2.25 L/ha to 5.25 L/ha was effective in suppressing the dry weight of *C. dactylon* and other weeds.
3. The application of the mixture herbicide of isopropylamine (IPA) glyphosate 200 g/L + 2,4-D dimethylamine 100 g/L did not cause phytotoxicity to the young coffee plant.

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