



The effect of 138 g/l dichloride paraquat on weeds in unproductive coffee plants

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Abstract

Coffee is an agricultural commodity that is of great economic importance to Indonesia. One factor contributing to declining coffee productivity is the presence of weeds growing alongside coffee plants. Herbicides are chemicals widely used to suppress weed growth. This study aims to determine the effectiveness of paraquat dichloride herbicide in suppressing weed growth in unproductive Arabica coffee plantations and to assess its phytotoxicity on coffee plants. The study was conducted from November 2024 to January 2025 in Tanjungkarya Village, Samarang Subdistrict, Garut Regency, West Java Province. The treatments consisted of five doses of paraquat dichloride: 2.25 l/ha, 3.00 l/ha, 3.75 l/ha, 4.50 l/ha, and 5.25 l/ha, and were compared with manual weeding and a control (without control). The study used a Randomized Block Design with 4 replications. Based on the results, it was found that paraquat dichloride at a dose of 2.25 l/ha was effective in suppressing the growth of total weeds, including the dominant weeds *Synedrella nodiflora*, *Setaria verticillata*, and *Cynodon dactylon*, up to 8 weeks after application, and did not cause phytotoxicity in the coffee plants that had not yet produced fruit.

Keywords: Phytotoxicity, herbicide, coffee, paraquat dichloride

Introduction

Coffee is an agricultural commodity that is of great economic importance to Indonesia. In 2014, the area of coffee plantations reached 1,230,495 ha, with a production of 384,815 tons, worth US\$1,039,340,705 (Directorate General of Plantations, 2015) [4]. The coffee plant is a plantation crop originating from the African continent, specifically from Ethiopia in the 9th century. The coffee plant was introduced to India in the 17th century. Subsequently, the coffee plant spread to Europe by a Dutch national and continued to other countries, including its colonies, such as Indonesia (Panggabean, 2011).

Coffee production in Indonesia in 2023 mostly came from smallholder plantations, accounting for around 99.56 percent, followed by state-owned large plantations (PBN) at 0.36 percent and privately-owned large plantations (PBS) at 0.07 percent. Coffee production from 2021 to 2023 experienced a decline. In 2022, coffee production decreased by 1.43 percent, from 786,190 tons to 774,960 tons. In 2023, coffee production also decreased by 16,240 tons, or a 2.10 percent decline (BPS, 2024).

One of the underlying factors causing declining coffee productivity is the presence of weeds growing alongside coffee plants. Therefore, in order for coffee plants to achieve high productivity, weed control measures are essential (Widiyanti, 2013) [16].

Weeds are plants that interfere with human activities and are generally considered undesirable. In agriculture, weeds are a problem because they compete with crops for resources, reduce crop yields, and can serve as breeding grounds for pests and diseases (Roberts, 2020) [17]. Weed control is divided into five methods: preventive measures, physical or mechanical weed control, biological weed control, cultural weed control, and chemical weed control (Somowiyarjo, 2021). The most common method of weed control used by farmers is herbicide application. This is because herbicide application is considered more effective in killing weeds and more efficient as it can control weeds in a short time

(Ariani, 2016) [1]. Additionally, it is cost-effective and labor-efficient (Guntoro & Fitri, 2013) [6].

Paraquat dichloride herbicide is a contact herbicide and is non-selective. This herbicide is a post-emergence herbicide. The mechanism of action of paraquat dichloride herbicide is through absorption by plants through their leaves (Britt *et al.*, 2003). According to research conducted by Sarbino & Edy (2012) [13], paraquat dichloride herbicide is effective in controlling various types of weeds, with the herbicide used being paraquat dichloride at a concentration of 276 g/l. The application of paraquat dichloride herbicide at 138 g/l on coffee plantations must be studied in terms of the dosage used, so prior research must be conducted.

Materials and Methods

This study was conducted from November 2024 to January 2025 at a plantation owned by one of the farmer groups in Cisaat Village, Tanjungkarya Subdistrict, Samarang District, Garut Regency, West Java Province. The materials used in this experiment were a coffee plantation that had not yet produced fruit, specifically 1 year and 3 months old, the herbicide Paraquat Dichloride 138 g/l, urea fertilizer, TSP, and KCl. The tools used in this experiment included a semi-automatic backpack sprayer with a T-jet nozzle, measuring cups, a digital scale, an oven, scissors, a shovel, plastic sheeting, labels, 0.5 m x 0.5 m quadrants, envelopes, writing utensils, and a camera for documentation purposes.

This experiment used a Randomized Block Design (RBD) consisting of seven treatments, including five levels of paraquat dichloride herbicide dosage at 138 g/l (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), manual weeding (F), and a control without treatment (G). Each treatment was repeated four times, resulting in a total of 28 experimental plots. Each experimental plot consisted of a plot with a planting distance of 2.5 m x 2.5 m. The treatment observed was the application of a 138 g/l dose of the herbicide Paraquat dichloride.

Results and Discussion

After conducting research, it was found that there are three dominant types of weeds found in coffee plants, namely *Setaria verticillata*, *Synedrella nodiflora*, and *Cynodon dactylon*. A detailed discussion of these weeds will be discussed in the next section.

At the dry weight of *Setaria verticillata*, a narrow-leaved weed, observations at 4 and 8 MSA showed that paraquat dichloride herbicide was able to suppress and control the growth of *Setaria verticillata* and was as effective as manual weeding. This was indicated by all herbicide doses applied showing the same response as manual weeding.

The results of this study are due to the fact that herbicides containing the active ingredient paraquat dichloride work by contact and kill the parts of weeds that come into direct contact with them by producing membrane peroxide radicals (H₂O²). Several factors influencing the effectiveness and use of herbicides include the amount of absorption and the quality of herbicide movement, which are influenced by weed type, growth stage, genetics, physiology, anatomy, and leaf morphology (Moenandir, 2010) ^[10]. The effect of paraquat dichloride herbicide on the dry weight of *Setaria verticillata* weeds can be seen in Table 1.

Table 1: Dry Weight of Weeds *Setaria verticillata*

Treatment	Dosage(l/ha)	Dry Weight (gr) Weeds <i>S. verticillata</i>	
		4 week	8 week
a. Paraquat dichloride 138 g/l	2,25	0,28a	0,00a
b. Paraquat dichloride 138 g/l	3,00	0,63a	3,38a
c. Paraquat dichloride 138 g/l	3,75	0,13a	2,05a
d. Paraquat dichloride 138 g/l	4,50	0,20a	0,00a
e. Paraquat dichloride 138 g/l	5,25	0,33a	0,00a
f. Manual weeding	-	6,28a	27,35b
g. Control	-	26,20b	62,28c

Note: Average values followed by different letters in the same column indicate significant differences at the 5% level in Duncan's test. MSA = Weeks After Application.

The dry weight of *Synedrella nodiflora* weeds, which are narrow-leaved weeds, was observed at 4 and 8 MSA. The dry weight of *Synedrella nodiflora* weeds at all doses of

paraquat dichloride herbicide and controlled manual weeding is shown in Table 2.

Table 2: Dry Weight of Weeds *S. nodiflora*

Treatment	Dosage(l/ha)	Dry Weight (gr) Weeds <i>S. nodiflora</i>	
		4 week	8 week
a. Paraquat dichloride 138 g/	2,25	0,58a	5,65a
b. Paraquat dichloride 138 g/	3,00	0,50a	5,98a
c. Paraquat dichloride 138 g/	3,75	0,50a	3,45a
d. Paraquat dichloride 138 g/	4,50	0,00a	1,60a
e. Paraquat dichloride 138 g/	5,25	0,55a	1,68a
f. Manual weeding	-	2,75b	18,78b
g. Control	-	7,45c	37,68c

Note: Average values followed by different letters in the same column indicate significant differences at the 5% level in Duncan's test. MSA = Weeks After Application.

This is likely due to the fact that paraquat dichloride herbicide is a contact herbicide that kills the parts of the weed directly exposed to the herbicide by producing hydrogen radicals (H₂O²) that break down the cell membrane,

enabling paraquat dichloride to poison the *Synedrella nodiflora* weed. Tabel 2.

Moenandir (1993) ^[9] states that several factors related to the effectiveness and use of herbicides are the quantity of absorption and the quality of translocation.

Table 3: Dry Weight of Weeds *Cynodon dactylon*

Treatment	Dosage(l/ha)	Dry Weight (gr) Weeds <i>C. dactylon</i>	
		4 week	8 week
a. Paraquat dichloride 138 g/	2,25	0,13a	0,20a
b. Paraquat dichloride 138 g/	3,00	0,00a	0,00a
c. Paraquat dichloride 138 g/	3,75	0,15a	0,30a
d. Paraquat dichloride 138 g/	4,50	0,00a	0,78a
e. Paraquat dichloride 138 g/	5,25	0,08a	0,00a
f. Manual weeding	-	1,15a	1,05a
g. Control	-	6,15b	38,48b

Note: Average values followed by different letters in the same column indicate significant differences at the 5% level in Duncan's test. MSA = Weeks After Application.

At the dry weight of *Cynodon dactylon* weeds, which are broadleaf weeds observed at 4 and 8 MSA, the paraquat dichloride herbicide tested, including manual weeding, was

able to suppress and control the growth of *Cynodon dactylon* weeds (Table 3). It is suspected that all parts of the weed were poisoned by the paraquat dichloride herbicide

because the application time and dose used were appropriate, making the herbicide effective in controlling the weed.

In terms of total dry weight of weeds, the results showed that all doses of paraquat dichloride herbicide at 138 l/ha

were able to suppress total dry weight of weeds at 4 and 8 weeks after application with no difference in control efficacy between doses (Table 4). Paraquat dichloride herbicide treatment at all doses and manual weeding were lower than the control.

Table 4: Total Dry Weight of Weeds

Treatment	Dosage(l/ha)	Dry Weight (gr) Total Weeds	
		4 week	8 week
a. Paracuat dichloride 138 g/	2,25	2,65a	7,58a
b. Paracuat dichloride 138 g/	3,00	2,40a	11,08a
c. Paracuat dichloride 138 g/	3,75	2,35a	7,10a
d. Paracuat dichloride 138 g/	4,50	2,35a	5,03a
e. Paracuat dichloride 138 g/	5,25	1,73a	2,95a
f. Manual weeding	-	31,65b	71,20b
g. Control	-	112,13c	202,05c

Note: Average values followed by different letters in the same column indicate significant differences at the 5% level in Duncan's test. MSA = Weeks After Application.

These results are in line with the research by Murti *et al.* (2015) ^[11], which states that the application of paraquat dichloride herbicide can control total weeds up to 12 MSA. Thus, the application of paraquat dichloride herbicide to control common weeds in coffee plants shows good effectiveness because it can suppress weed growth. This can occur because paraquat dichloride herbicide is a non-selective contact herbicide. Herbicides can cause damage to cell membranes, effectively inhibiting weed growth (Sumekar *et al.*, 2021) ^[14]. This herbicide can kill all types of weeds in the areas directly exposed to the herbicide solution, as the dosage and application timing used are appropriate, making the herbicide effective in controlling weeds (Hermania *et al.*, 2010) ^[7].

The phytotoxicity of coffee plants can be seen in Table 6. There were no visible symptoms of poisoning due to the application of 138 l/ha of paraquat dichloride herbicide at 1, 2, and MST. There were no differences between coffee plants treated with paraquat dichloride herbicide and those treated with manual weeding or control. Symptoms of plant toxicity, such as changes in leaf shape and color or abnormal growth, were not observed in coffee plants after application. This aligns with Djojsumarto's (2008) ^[5] statement that paraquat dichloride herbicide application should be done between plant rows to avoid poisoning cultivated plants. If applied correctly, weeds will be controlled, cultivated plants will not be poisoned, and the soil organisms will remain safe.

Table 5: Phytotoxicity of Coffee Plants

Treatment	Dosage(l/ha)	Phytotoxicity		
		1 WAP	2 WAP	3 WAP
a. Paracuat dichloride 138 g/	2,25	0	0	0
b. Paracuat dichloride 138 g/	3,00	0	0	0
c. Paracuat dichloride 138 g/	3,75	0	0	0
d. Paracuat dichloride 138 g/	4,50	0	0	0
e. Paracuat dichloride 138 g/	5,25	0	0	0
f. Manual weeding	-	0	0	0
g. Control	-	0	0	0

Explanation WAP = Weeks after planting

Conclusion

The results of the study indicate that the application of the herbicide paraquat dichloride at a concentration of 138 g/l is effective in controlling weed growth in coffee cultivation areas, with phytotoxicity that is tolerable and non-harmful to coffee plants. It is known that the application of the herbicide paraquat dichloride at a dose of 2.25 l/ha is already effective in suppressing weed growth. Therefore, farmers who wish to use this herbicide can apply it at a dose of 2.25 l/ha.

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