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Effectiveness of paraquat dichloride 276 g/l herbicide for weed control and its effect on sweet corn growth and yield

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Abstract
This study aimed to determine the effectiveness of Paraquat dichloride 276 g / l herbicide in suppressing weed growth and its effect on the development and yield of sweet corn plants. This experiment will be conducted from November 2022 – February 2023 at the Ciparanje Garden, Faculty of Agriculture, Padjadjaran University, Jatinangor District, Sumedang Regency. This experiment used a Randomized Block Design (RBD) with seven treatments and four repeats, resulting in 28 experimental plots. The treatment in this study included Paraquat dichloride herbicide treatment 376 g / l (1) dose 1.50 l / ha, (2) dose 2.00 l / ha, (3) dose 2.50 l / ha, (4) dose 3.00 l / ha, (5) dose 3.50 l / ha, (6) manual weeding and (7) control. The results showed that Paraquat dichloride herbicide 276 g / l starting at a dose of 1.50 effectively suppressed the growth of weeds Bidens pilosa, Alternanthera sessilis, Euphorbia hirta, Cynodon dactylon, other weeds at 3 WAA to 6 WAA. Paraquat dichloride 276 g / l herbicide does not cause phytotoxicity in sweet corn plants. It indirectly influences the growth and yield of sweet corn plants by suppressing weed growth so that competition between weeds and sweet corn plants can be avoided and sweet corn plants can grow and produce sweet corn according to their potential.

Keywords: Effective, phytotoxicity, herbicide, sweet corn and paraquat dichloride

Introduction

Sweet corn (Zea mays Saccharata Sturt) is a commodity that is a food source in Indonesia apart from rice (Ainiya *et al*., 2019) [2]. Sweet corn is popular and favored by many Indonesians because it has good taste, high carbohydrate, protein, vitamin, and low-fat content (Syafrullah *et al*., 2020) [13].

Sweet corn is the most imported type of corn. In 2022, sweet corn was imported, namely 1,756,787 tons, from January to September 2022 (BPS, 2022). These conditions can be caused by unmet market demand or the superior quality of imported corn. Therefore, efforts need to be made to increase the production of sweet corn in quantity and quality. Weed control is one of the efforts to increase the quantity and quality of sweet corn yields.

Weeds and sweet corn plants compete in the extraction of nutrients, water, light, and growing space and can produce allelopathy compounds and host pests and plant diseases (Syaifudin &; Adnia Nofa, 2020) [14]. Competition between weeds and corn plants can cause a decrease in corn production by 13-51% (Alvionita *et al*., 2017) [3]. Therefore, it is necessary to carry out effective weed control so that the results of sweet corn production can be maximized and follow its potential.

Weed control in sweet corn cultivation can be done by manual, mechanical, technical, and chemical culture methods (Guntoro *et al*., 2013) [7]. Currently, chemical control using herbicides is one of the most efficient methods and does not take long (Widayat *et al*., 2021) [15]. Paraquat dichloride is a bipyridylium group herbicide, non-selective contact with symptoms of poisoning in the form of wilt, interveinal chlorosis, and dryness in the part affected by the herbicide (Sumekar *et al*., 2021) [12].

This herbicide works in the membrane system of photosystem I, where this system plays a role in producing free electrons to carry out the process of photosynthesis (Murti *et al*., 2015) [10]. Paraquat dichloride molecules damage parts of the cell membrane by binding free electrons in photosystem I and causing the formation of hydrogen peroxide compounds that quickly react with unsaturated fatty acid compounds on the cell membrane, causing cell membranes to be damaged and rupture then water in plant cells comes out, and there is dryness in cells until plant tissue dies (Sumekar *et al*., 2021) [12]. This study aims to determine the effect of Paraquat dichloride 276 g / l herbicide on weed growth suppression and its effect on the growth and yield of sweet corn plants.

Materials and Methods

This research was conducted in the Ciparanje Garden, Faculty of Agriculture, Padjadjaran University, Jatinangor District, Sumedang Regency, West Java Province, from November 2022 to January 2023. The tools used in this study include a semi-automatic knapsack sprayer, T-jet nozzles, ovens, analytical scales, plastic buckets of 10 liters volume, measuring cups of 1000 ml and 100 ml volumes, wooden quadrants measuring 50 cm x 50 cm, tape measure, ruler, caliper, notebook, stationery, paper envelopes, and cameras. The materials used in this study were sweet corn plants paragon cultivar, urea fertilizer, TSP fertilizer, KCL fertilizer, and Paraquat Dichloride herbicide 276 g / l.

The experimental design carried out was a Group Randomized Design (RAK) with seven treatments and four repeats so that 28 experimental units were obtained as follows: A. Paraquat dichloride 276 g / l dose 1.50 l / ha; B. Paraquat dichloride 276 g/l dose 2.00 l/ha; C. Paraquat dichloride 276 g/l dose 2.50 l/ha; D. Paraquat dichloride 276 g/l dose 3.00 l/ha; E. Paraquat dichloride 276 g/l dose 3.50 l/ha. F. Manual weeding (One-time weeding); G. Control (No treatment). Herbicide application is carried out four weeks after planting (WAP). Parameters observed included phytotoxicity of maize plants at 1, 2, and 3 weeks after

application (WAA), dry weight of weeds at 3 and 6 weeks after application (WAA), plant height, stem diameter, and number of leaves of sweet corn plants, as well as yield components such as cob weights and non-cobs, cob diameter and length. The quantitative data obtained are analyzed by a variety of analysis methods. Then if the treatment shows a real different effect, it will be tested further with DMRT (Duncan Multiple Range Test) at the level of 5%.

Results and Discussion

Weed Observation

1. Total dry weight of weeds

Total weed dry weight is the result of observations of the overall dry weight of weed species grown in this study, which include Bidens pilosa, Alternanthera sessili, Euphorbia hirta, Cynodon dactylon, Asystasia gangetica, Cleome rutidosperma, Cyperus rotundus, Setaria palmifolia, Eleusine indica, Mimosa pudica, Phyllanthus niruri and Oxalis latifolia. The observations in Table 1 show that herbicide dose treatment effectively suppresses weed growth, starting from a dose of 1.50 l / ha at 3 WAA and starting from a dose of 2.50 l / ha at 6 WAA. The effective dose can suppress growth in three classes of weeds throughout the treatment plot: broadleaf weeds, grasses, and teki. This Paraquat dichloride herbicide can suppress the growth of these three types of weeds because it is non-selective contact, which means it can kill any weed on the part affected by the herbicide solution (Adiwijaya &; Lusiana, 2022) [1]. In line with the results of research by Murti *et al*., (2015) [10], which showed that Paraquat dichloride effectively suppressed total weeds ranging from doses of 414 g / ha to 966 g / ha or equivalent to doses of Paraquat dichloride 276 g / l at doses of 1.50 l / ha and 3.50 l / ha.

Table 1: Observation of total weed dry weight

Treatment		Dry weight (g)	
		3 WAA	6 WAA
A	Paraquat dichloride 276 g/l dose 1,50 l/ha	20,74 b	37,40 b
B	Paraquat dichloride 276 g/l dose 2,00 l/ha	18,56 b	34,08 b
C	Paraquat dichloride 276 g/l dose 2,50 l/ha	17,95 b	24,69 bc
D	Paraquat dichloride 276 g/l dose 3,00 l/ha	14,98 b	19,11 c
E	Paraquat dichloride 276 g/l dose 3,50 l/ha	9,01 b	14,74 c
F	1x manual weeding	9,03 b	15,42 c
G	Control (No weed control)	121,80 a	203,20 a

Description: The average number marked with the same letter in the same column shows no real difference based on Duncan's Multiple Distance Test at 5%. WAA = week after application

Observation of sweet corn plants

1. Phytotoxicity of sweet corn plants

Table 2: Phytotoxicity scoring results of sweet corn plants

Treatment		Poisoning rate		
		1 WAA	2 WAA	3 WAA
A	Paraquat dichloride 276 g/l dose 1,50 l/ha	0	0	0
B	Paraquat dichloride 276 g/l dose 2,00 l/ha	0	0	0
C	Paraquat dichloride 276 g/l dose 2,50 l/ha	0	0	0
D	Paraquat dichloride 276 g/l dose 3,00 l/ha	0	0	0
E	Paraquat dichloride 276 g/l dose 3,50 l/ha	0	0	0
F	1x manual weeding	0	0	0
G	Control (No weed control)	0	0	0

Description: 0 = No poisoning. WAA = week after application.

The observations in Table 2 showed no poisoning, and no symptoms were found in sweet corn plants after spraying the Paraquat dichloride 276 g / l on weeds in sweet corn fields. This condition can be supported by the ability of plants with biochemical defense mechanisms that can reject foreign chemicals that will enter the plant (xenobiotics) (Lolitasari &; Hasjim, 2019) [9]. In addition, the condition of weeds and how spraying is done can also affect phytotoxicity in corn plants. Spraying is done when the corn is higher than weeds, and using a lid on the sprayer to narrow the area of droplets makes spraying more targeted so that it does not hit the corn plants. So with these efforts, the poisoning of sweet corn plants can be avoided.

2. Sweet corn plant height

Based on the results of the analysis in Table 3, at 3 WAA and 6 WAA, the average height of sweet corn plants was not significantly different from manual weeding treatment at 3 WAA and 6 WAA starting from a dose of 2.00 l / ha which means that the herbicide dose treatment indirectly has a good effect on the height of sweet corn plants. The results also showed that Paraquat dichloride herbicide treatment did not inhibit height growth in sweet corn plants. The shortest plant height was found in the control treatment. This condition is because the presence of weeds in the control treatment continues to increase and causes higher competition, especially in getting growing space. When the number and height of weeds exceed corn plants, it will cause corn plants to be shaded by weeds, and the sunlight obtained is not optimal, so it can inhibit the process of photosynthesis and corn growth, one of which is high corn. Remember, sweet corn plants are C4 plants that require sunlight with high intensity (Primonta *et al*., 2017) [11].

Table 3: The effect of treatment on the height of sweet corn plants

Treatment		Plant Height	
		3 WAA	6 WAA
A	Paraquat dichloride 276 g/l dose 1,50 l/ha	140,70 b	163,63 b
B	Paraquat dichloride 276 g/l dose 2,00 l/ha	158,83 a	188,63 a
C	Paraquat dichloride 276 g/l dose 2,50 l/ha	167,55 a	191,93 a
D	Paraquat dichloride 276 g/l dose 3,00 l/ha	168,43 a	193,70 a
E	Paraquat dichloride 276 g/l dose 3,50 l/ha	160,55 a	193,75 a
F	1x manual weeding	165,88 a	192,78 a
G	Control (No weed control)	120,43 c	142,55 c

Description: The average number marked with the same letter in the same column shows no real difference based on Duncan's Multiple Distance Test at 5%. WAA = week after application.

3. Diameter of the stem of the corn plant

Table 4: The effect of treatment on the diameter of the stem of the sweet corn plant

Treatment		Stem Diameter	
		3 WAA	6 WAA
A	Paraquat dichloride 276 g/l dose 1,50 l/ha	17,51 c	20,76 b
B	Paraquat dichloride 276 g/l dose 2,00 l/ha	18,25 bc	21,12 b
C	Paraquat dichloride 276 g/l dose 2,50 l/ha	19,06 ab	21,81 ab
D	Paraquat dichloride 276 g/l dose 3,00 l/ha	19,66 a	22,90 a
E	Paraquat dichloride 276 g/l dose 3,50 l/ha	19,25 ab	22,38 a
F	1x manual weeding	18,69 abc	21,89 ab
G	Control (No weed control)	13,14 d	16,21 c

Description: The average number marked with the same letter in the same column shows no real difference based on Duncan's Multiple Distance Test at 5%. WAA = week after application.

Based on the analysis results in Table 4, herbicide dose treatment ranging from doses of 1.50 l / ha to 3.50 l / ha at 3 WAA and 6 WAA has a good effect on the growth of sweet corn stem diameter. So, it can be said that the application of Paraquat dichloride herbicide can suppress weed growth well because the competition does not cause a decrease or suppression of the growth of sweet corn plants. In line with the opinion of Zami *et al*., (2021) [16], which states that the higher the number and density of weeds, the higher the competition between weeds and cultivated plants, which can cause suppression of primary plant growth.

Observation of Sweet Corn Plant Yields

Table 5: The effect of treatment on the yield of sweet corn

Treatment		Cob Length Sweet Corn (cm)	Sweet Corn Cob Diameter (mm)
A	Paraquat dichloride 276 g/l dose 1,50 l/ha	28,73 a	56,97 a
B	Paraquat dichloride 276 g/l dose 2,00 l/ha	29,38 a	60,33 a
C	Paraquat dichloride 276 g/l dose 2,50 l/ha	30,08 a	60,75 a
D	Paraquat dichloride 276 g/l dose 3,00 l/ha	30,18 a	60,84 a
E	Paraquat dichloride 276 g/l dose 3,50 l/ha	31,78 a	60,95 a
F	1x manual weeding	31,28 a	59,07 a
G	Control (No weed control)	23,43 b	46,29 b

Description: The average number marked with the same letter in the same column shows no real difference based on Duncan's Multiple Distance Test at 5%. WAA = week after application.

1. The length of the sweet corn cob

Table 5 shows that the dosage treatment of Paraquat dichloride herbicide starting from 1.50 l / ha has a good effect on corn yield. According to Murti *et al*., (2015) [10], the application of herbicides indirectly has a good effect on cultivated plants because it can suppress weed growth to make sweet corn plants avoid competition and can grow well according to their potential. The petite cob length is found in the control treatment, where weeds are not controlled at all, thus affecting the growth and yield of sweet corn. As revealed (Sumekar *et al*, 2021) [12] that weeds that are not controlled can cause a decrease in yield because corn plants must compete with weeds, and this can result in corn plants not getting enough nutrients and not getting maximum results.

2. Diameter of sweet corn cob

Table 5 shows that all doses of Paraquat dichloride herbicide 276 g / l resulted in an average diameter of sweet corn cobs that were not significantly different from manual weeding treatment, which means that herbicide treatment has a good effect. The application of Paraquat dichloride herbicide can indirectly influence corn yields because the weed population has been successfully suppressed so that the main crop does not lack resources to grow and develop. Adiwijaya &; Lusiana, (2022) [1] stated that applying Paraquat dichloride herbicide can suppress weed populations so that competition between weeds and cultivated plants will not significantly affect the growth and yield of cultivated plants.

3. Cob weight corn with husk

Table 6 shows that all dosing treatments of the herbicide Paraquat dichloride 276 g/l resulted in weights of cobs that were not significantly different from manual weeding treatments. These results showed that the treatment of Paraquat dichloride herbicide 276 g / l succeeded in suppressing weed populations so as not to cause a decrease in yield in sweet corn plants. Research by Kefi *et al*., (2022) [8] states that the higher the weed population in corn cultivation plants, the higher the tendency to decrease yields in the weight, length, and diameter of corn cobs, considering that the higher the weed population, the higher the competition that occurs.

Table 6: The effect of treatment on sweet corn yield (cob weight)

Treatment		Cob weight corn with husk (g)	Cob weight without corn husks (g)
A	Paraquat dichloride 276 g/l dose 1,50 l/ha	237,43 a	168,38 a
B	Paraquat dichloride 276 g/l dose 2,00 l/ha	288,35 a	213,85 a
C	Paraquat dichloride 276 g/l dose 2,50 l/ha	294,05 a	223,78 a
D	Paraquat dichloride 276 g/l dose 3,00 l/ha	300,93 a	224,75 a
E	Paraquat dichloride 276 g/l dose 3,50 l/ha	304,03 a	225,98 a
F	1x manual weeding	275,65 a	205,05 a
G	Control (No weed control)	135,70 b	92,08 b

Description: The average number marked with the same letter in the same column shows no real difference based on Duncan's Multiple Distance Test at 5%. WAA = week after application.

4. Cob weight without corn husks

Table 6 shows that all doses of Paraquat dichloride herbicide 276 g/l resulted in cob weights without cobs that were not significantly different from manual weeding treatments. The effect and results that do not differ significantly between all herbicide dose treatments with manual weeding treatment on all components of sweet corn plants occur because weed populations in all treatments are still in safe quantities or still in quantities that do not cause the main crop to lack nutrients, sunlight, water, and growing space so that the photosynthesis process runs optimally. The photosynthesis produced follows their potential for growth and generative development of sweet corn plants. Remembering, if plants get enough sources to grow and develop, the formation of cobs and seed filling will take place well too, and plants can produce corn with a large size and seeds that contain (Dani *et al*., 2014) [6].

Conclusion

Herbicide Paraquat dichloride 276 g / l starting from a dose of 1.50 l / ha effectively suppresses the growth of weeds B. pilosa, A. sessilis, E. hirta, C. dactylon, other weeds, and weeds total up to 6 WAA and has a good influence on the growth and yield of sweet corn plants.

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