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The effect of herbicides containing the active ingredient paracuate dichloride on weed control and growth of corn (*zea mays* L.)

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Abstract
The presence of weeds in the plant life cycle can affect crop yields by competition between corn plants and weeds which reduces corn production. Control with paraquat herbicide can increase corn yields compared to without control. This research aims to determine the effect of herbicides on weed control and corn plant growth, which was carried out in Bungur Village, Babakan Jawa Subdistrict, Majalengka Regency, West Java. This experiment used a non-factorial randomized block design with seven treatments and four replications. The experiment consisted of five treatments of the herbicide Xone-Quat 138 SL (ba: paraquat dichloride) at doses of 2.25 l/ha, 3.00 l/ha, 3.75 l/ha, 4.50 l/ha, 5.25 l/ha and two treatments with manual weeding and without weeding. The data obtained if there is a significantly different effect will be tested further using a Duncan level of 5%. The results of the research conducted showed that the application of herbicides containing the active ingredient paraquat dichloride at doses of 4.50 l/ha and 5.25 l/ha gave good results for suppressing weeds and the growth of corn plants, but at a dose of 2.25 l/ha it was able to suppress weeds.

Keywords: Paraquat dichloride herbicide, weeds, corn

Introduction

Corn (Zea mays L.) is one of the five main government program commodities which has a strategic role and has high economic value in economic and agricultural development. Corn is one of the second most important food crops after rice in Indonesia with the nutritional value contained in corn, namely 10.3% protein, 4.8% fat, 1.4% ash, 71.5% starch and 2% sugar.(Paramita, 2019) [5].

According toBPS, (2023) there is a decrease in corn productivity, namely 1.65 quintals per hectare with total corn productivity in 2023 of 58.14 quintals per hectare compared to 2022 of 59.79 quintals per hectare.

The growth and productivity of corn plants is influenced by several factors, one of which is weeds. Weeds are competitors for cultivated plants whose presence is undesirable because their growth and development can disturb and damage the main cultivated plants by absorbing water and nutrients in the soil. Based on their characteristics, the government determines that weeds are plant pests (OPT) whose import and spread need to be prevented(Akram *et al*., 2019) [1]. The absorption of nutrients and nutrients, especially in obtaining water, nutrients and light by weeds, results in reduced nutrients and nutrients for cultivated plants so that the growth of corn plants becomes less than optimal. The effects caused by this weed are not immediately visible and occur slowly, but overall the losses caused are very large so control must be carried out.(Conference, 2016). The losses experienced by many weeds in the agricultural sector have encouraged efforts to control weeds. One alternative for controlling weeds is by using herbicides. Control using herbicides can be more effective, efficient, save energy, costs and time compared to other controls that have long time and relatively expensive costs. The effectiveness of herbicide administration is determined, among other things, by the dose of the herbicide.(Guntoro *et al*., 2013) [3].

The herbicide paraquat dichloride is a herbicide that can be used to control weeds from the bipyridylium group, this herbicide is a non-selective herbicide that works by interfering with the photosystem I process and can be used both pre-emergence and post-emergence.(Sumekar *et al*., 2021) [7]. Herbicides containing the active ingredient paraquat dichloride are widely used by farmers so many formulations use this active ingredient, paraquat which is sprayed on the leaves is effective in controlling annual grass weeds and annual broadleaf weeds, the paraquat compound is translocated to all parts of the plant when applied to the leaves quickly decomposes in the soil at a rate slowly developing poisoning(Swasco *et al*., 2014).

Materials and methods

The experiment was carried out at Technopark Babakan Jawa, Majalengka District, Majalengka Regency, West Java from May 2023 to September 2023. This experimental location has an altitude of 146 meters above sea level (masl) measured using the altimeter application version 2.3.14 with climate type C3 according to Oldeman's classification. ±

The materials used in this experiment were corn varieties BISI 99, Herbicide Xone+Quat 138 SL (ba: paraquat dichloride) which had been tested for quality and levels of active ingredients by the laboratory and used urea fertilizer and phonska fertilizer.

The tools used for this experiment were hoes, plastic bags, envelopes, cords, gloves, sticks, bamboo stakes, labels, measuring tape, neat rope, scissors, semi-automatic back spray and T-jet nozzles, measuring cups, pipettes, digital scales, stationery and documentation tools (camera).

The research method used is an experimental method in the field. The experimental design used in this experiment was a non-factorial randomized block design (RAK). The plot size on the experimental land was 4 m x 7 m with a planting distance of 40 x 70 and a distance between beds of 50 cm.

There were 7 treatments tested in this study, namely as follows:

A = Dose 2.25 L/Ha
B = Dose 3.00 L/Ha
C = Dose 3.75 L/Ha
D = Dose 4.50 L/Ha
E = Dose 5.25 L/Ha
F = Manual Weeding
G = Without control

The research consisted of 7 treatments which were repeated 4 times to obtain a total of 28 experimental plots.

Results and Discussion

a. Dry Weight of Comellina Diffusa (Aur-aur) Weed

The results of statistical analysis of the effect of herbicides containing the active ingredient paraquat dichloride on the dry weight of the Comellina Diffusa weed showed a significantly different effect at 3 WAA and 6 WAA. Differences in the effect of treatment were analyzed using the Duncan advanced test at 5% level and can be seen in table 1.

Table 1: Weed Dry Weight Analysis*Comellina Diffusa*

Treatment code	Treatment (ba: paraquat dichloride)	Dose	Observation	
			3 WAA	6 WAA
A	Herbicide Xone-Quat 138 SL	2.25 l/ha	1.28a	1.84a
B	Herbicide Xone-Quat 138 SL	3.00 l/ha	0.71a	3.95c
C	Herbicide Xone-Quat 138 SL	3.75 l/ha	1.46a	1.19a
D	Herbicide Xone-Quat 138 SL	4.50 l/ha	0.71a	3.37bc
E	Herbicide Xone-Quat 138 SL	5.25 l/ha	0.78a	1.28a
F	Manual weeding	-	1.00a	1.65a
G	No weeding	-	2.63b	3.52c

Information: - the average value marked with the same letter symbol in the same column shows no different influence real at the 5% level according to the Duncan advanced test.
- WAA = Week After Application (Herbicide)

Based on table 1, it shows that at 3 WAA that all herbicide treatments were significantly different and smaller than without weeding and at 6 WAA that the herbicide treatment with a dose of 2.25 l/ha was significantly different from the herbicide treatment at doses of 3.00, 4.50 l/ha and without weeding. This shows that the herbicide treatment paraquat dichloride was effective in controlling the comellina diffusa weed 3 weeks after the herbicide application was carried out.

b. Dry Weight of Weed Althernanthera Philoxiroides (Kremah)

The results of statistical analysis of the effect of the herbicide paraquat dichloride on the dry weight of the Althernanthera Philoxiroides weed showed a significantly different effect at 3 WAA and 6 WAA. Differences in the effect of treatment were analyzed using the Duncan advanced test at 5% level and can be seen in table 2.

Table 2: Weed Dry Weight Analysis*Alternanthera Philoxiroides*

Treatment code	Treatment (ba: paraquat dichloride)	Dose	Observation	
			3 WAA	6 WAA
A	Herbicide Xone-Quat 138 SL	2.25 l/ha	0.71a	0.79a
B	Herbicide Xone-Quat 138 SL	3.00 l/ha	0.71a	1.54ab
C	Herbicide Xone-Quat 138 SL	3.75 l/ha	0.71a	0.85a
D	Herbicide Xone-Quat 138 SL	4.50 l/ha	0.71a	0.71a
E	Herbicide Xone-Quat 138 SL	5.25 l/ha	0.71a	1.20a
F	Manual weeding	-	0.71a	0.71a
G	No weeding	-	1.61b	1.87b

Information: - the average value marked with the same letter symbol in the same column shows no different influence real at the 5% level according to the Duncan advanced test.
-WAA = Week After Application (Herbicide)

Based on table 2, it can be seen from observations at 3 WAA that the treatment without weeding was significantly different from all herbicide treatments and manual weeding and at 6 WAA the herbicide treatment with paraquat dichloride at a dose of 2.25 l/ha was significantly different from the treatment without weeding but was relatively the same as all herbicide treatments or by manual weeding.

c. Dry Weight of Phyllanthus Urinaria (Meniran) Weed

The results of statistical analysis of the effect of the herbicide paraquat dichloride on the dry weight of the Phyllanthus Urinaria weed showed a significantly different effect at 3 WAA and 6 WAA. The differences in the effect of treatment were analyzed using the Duncan advanced test at 5% level and can be seen in table 3.

Table 3: Weed Dry Weight Analysis*Phyllanthus Urinaria*

Treatment code	Treatment (ba: paraquat dichloride)	Dose	Observation	
			3 WAA	6 WAA
A	Herbicide Xone-Quat 138 SL	2.25 l/ha	0.71a	1.28bc
B	Herbicide Xone-Quat 138 SL	3.00 l/ha	0.82a	0.86a
C	Herbicide Xone-Quat 138 SL	3.75 l/ha	1.00a	0.84a
D	Herbicide Xone-Quat 138 SL	4.50 l/ha	0.84a	1.12ab
E	Herbicide Xone-Quat 138 SL	5.25 l/ha	0.71a	0.71a
F	Manual weeding	-	0.93a	1.43bc
G	No weeding	-	1.36b	1.52c

Information: - the average value marked with the same letter symbol in the same column shows no different influence real at the 5% level according to the Duncan advanced test.
-WAA = Week After Application (Herbicide)

Based on table 3, it can be seen from observations at 3 WAA that the treatment without weeding was significantly different from all herbicide treatments and manual weeding and at 6 WAA the herbicide treatment at a dose of 2.25 l/ha gave a large average dry weight of weeds and was not significantly different from the herbicide dose. 4.50 l/ha, without weeding and manual weeding but significantly different from herbicide treatment doses of 3.00, 3.75 and 5.25 l/ha.

d. Dry Weight of Agerratum Conyzoides (Bandotan) Weed

The results of statistical analysis of the effect of the herbicide paraquat dichloride on the dry weight of the Agerratum Conyzoides weed showed a significantly different effect at 6 WAA. The differences in the effect of treatment were analyzed using the Duncan advanced test at 5% level and can be seen in table 4.

Table 5: Weed Dry Weight Analysis*Agerratum Conyzoides*

Treatment code	Treatment (ba: paraquat dichloride)	Dose	Observation	
			3 WAA	6 WAA
A	Herbicide Xone-Quat 138 SL	2.25 l/ha	1.06a	0.83a
B	Herbicide Xone-Quat 138 SL	3.00 l/ha	0.71a	0.88a
C	Herbicide Xone-Quat 138 SL	3.75 l/ha	1.08a	1.08a
D	Herbicide Xone-Quat 138 SL	4.50 l/ha	0.71a	0.71a
E	Herbicide Xone-Quat 138 SL	5.25 l/ha	1.44a	1.44a
F	Manual weeding	-	0.71a	0.71a
G	No weeding	-	0.71a	2.63b

Information: - the average value marked with the same letter symbol in the same column shows no different influence real at the 5% level according to the Duncan advanced test.
-WAA = Week After Application (Herbicide)

Based on table 4, it can be seen from the 3 WAA observations that all herbicide treatments with manual

weeding and without weeding were not significantly different and in the 6 WAA observations the treatment without weeding gave a large average dry weight of weeds and was significantly different from all herbicide treatments and manual weeding.

e. Dry Weight of Ipomea Obscura (White Star) Weed

The results of statistical analysis of the effect of the herbicide paraquat dichloride on the dry weight of the Ipomea Obscura weed showed a significantly different effect at 6 WAA. Differences in the effect of treatment analyzed using the Duncan advanced test at 5% level can be seen in table 5.

Table 5: Weed Dry Weight Analysis*Ipomea Obscura*

Treatment code	Treatment (ba: paraquat dichloride)	Dose	Observation	
			3 WAA	6 WAA
A	Herbicide Xone-Quat 138 SL	2.25 l/ha	0.71a	0.71a
B	Herbicide Xone-Quat 138 SL	3.00 l/ha	1.18a	0.91a
C	Herbicide Xone-Quat 138 SL	3.75 l/ha	1.06a	0.71a
D	Herbicide Xone-Quat 138 SL	4.50 l/ha	1.43a	0.71a
E	Herbicide Xone-Quat 138 SL	5.25 l/ha	0.99a	0.71a
F	Manual weeding	-	0.79a	0.94a
G	No weeding	-	0.71a	1.34b

Information: - the average value marked with the same letter symbol in the same column shows no different influence real at the 5% level according to the Duncan advanced test.
-WAA = Week After Application (Herbicide)

Based on table 5, it can be seen from observations at 3 WAA that all herbicide treatments with manual weeding and without weeding were not significantly different and at 6 WAA the treatment without weeding resulted in a large average dry weight of weeds showing a significantly different effect from all herbicide and weeding treatments. manually.

f. Dry Weight of Setaria Verticilata Weed (Ohoe/Kamala)

The results of statistical analysis of the effect of the herbicide paraquat dichloride on the dry weight of the Setaria Verticilata weed showed a significantly different effect at 3 WAA and 6 WAA. The differences in the effect of treatment were analyzed using the Duncan advanced test at 5% level and can be seen in table 6.

Table 6: Weed Dry Weight Analysis*Setaria Verticilata*

Treatment code	Treatment (ba: paraquat dichloride)	Dose	Observation	
			3 WAA	6 WAA
A	Herbicide Xone-Quat 138 SL	2.25 l/ha	0.71a	0.71a
B	Herbicide Xone-Quat 138 SL	3.00 l/ha	0.71a	1.30a
C	Herbicide Xone-Quat 138 SL	3.75 l/ha	0.71a	1.06a
D	Herbicide Xone-Quat 138 SL	4.50 l/ha	0.71a	1.43a
E	Herbicide Xone-Quat 138 SL	5.25 l/ha	0.78a	1.49a
F	Manual weeding	-	0.78a	0.79a
G	No weeding	-	1.5b	2.33b

Information: - the average value marked with the same letter symbol in the same column shows no different influence real at them 5% level according to the Duncan advanced test.
-WAA = Week After Application (Herbicide)

Based on table 6, it can be seen from observations 3 and 6 WAA that the treatment without weeding had a significantly different effect from all herbicide treatments and manual weeding.

g. Dry Weight of Cyperus Iria Weed (Teki Jekeng)

The results of statistical analysis of the effect of the herbicide paraquat dichloride on the dry weight of the Cyperus Iria weed showed that it was significantly different at 3 WAA and 6 WAA. Differences in the effect of treatment analyzed using the Duncan advanced test at 5% level can be seen in table 7.

Table 7: Weed Dry Weight Analysis*Cyperus Iria*

Treatment code	Treatment (ba: paraquat dichloride)	Dose	Observation	
			3 WAA	6 WAA
A	Herbicide Xone-Quat 138 SL	2.25 l/ha	0.71a	0.71a
B	Herbicide Xone-Quat 138 SL	3.00 l/ha	0.71a	0.87a
C	Herbicide Xone-Quat 138 SL	3.75 l/ha	0.71a	1.79b
D	Herbicide Xone-Quat 138 SL	4.50 l/ha	0.82a	0.71a
E	Herbicide Xone-Quat 138 SL	5.25 l/ha	1.00a	1.21a
F	Manual weeding	-	0.71a	0.87a
G	No weeding	-	1.40b	1.73b

Information: - the average value marked with the same letter symbol in the same column shows no different influence real at the 5% level according to the Duncan advanced test.
-WAA = Week After Application (Herbicide)

Based on table 7, it can be seen that in the 3 WAA observations the treatment without weeding had a significantly different effect from all herbicide treatments and manual weeding and at 6 WAA the herbicide treatment with a dose of 2.25 l/ha had a significantly different effect from the herbicide treatment with a dose of 3.75 l/ha and without weeding but was not significantly different from herbicide treatment doses of 3.00, 4.50, 5.25 l/ha and manual weeding.

h. Dry Weight of Arrisarium Vulgarae (Larus) Weed

The results of statistical analysis of the effect of the herbicide paraquat dichloride on the dry weight of Arrisarium Vulgarae weeds showed that it was significantly different at 3 WAA and 6 WAA. The differences in the effect of treatment were analyzed using the Duncan advanced test at 5% level and can be seen in table 8.

Based on table 8, it can be seen from observations 3 and 6 WAA that the treatment without weeding had a significantly different effect from all herbicide treatments and manual weeding.

Table 8: Weed Dry Weight Analysis*Arrisarium Vulgarae*

Treatment code	Treatment (ba: paraquat dichloride)	Dose	Observation	
			3 WAA	6 WAA
A	Herbicide Xone-Quat 138 SL	2.25 l/ha	0.71a	0.71a
B	Herbicide Xone-Quat 138 SL	3.00 l/ha	0.71a	0.93a
C	Herbicide Xone-Quat 138 SL	3.75 l/ha	0.71a	1.08a
D	Herbicide Xone-Quat 138 SL	4.50 l/ha	0.79a	0.86a
E	Herbicide Xone-Quat 138 SL	5.25 l/ha	0.87a	0.94a
F	Manual weeding	-	0.71a	1.00a
G	No weeding	-	1.61b	1.94b

Information: - the average value marked with the same letter symbol in the same column shows no different influence real at the 5% level according to the Duncan advanced test.
-WAA = Week After Application (Herbicide)

Corn Plant Height (cm)

The results of statistical analysis of the effect of the herbicide paraquat dichloride on corn plant height showed a significantly different effect at 5 WAA. Differences in the

effect of treatment were analyzed using the Duncan advanced test at 5% level and can be seen in table 9.

Based on table 9, it can be seen that the effect of the herbicide paraquat dichloride at 1 and 3 WAA had an effect that was not significantly different, but at 5 WAA with herbicide treatment at a dose of 3.00 l/ha, it gave high results and was not significantly different from the dose at 3.75 l/ha but was significantly different. with both doses of 2.25, 4.50, 5.25 l/ha, manual weeding and without weeding.

Table 9: Plant height

Treatment code	Treatment (ba: paraquat dichloride)	Dose	Observation		
			1 WAA	3 WAA	5 WAA
A	Herbicide Xone-Quat 138 SL	2.25 l/ha	67.3a	115.35a	167.48a
B	Herbicide Xone-Quat 138 SL	3.00 l/ha	66.6a	132.10a	176.58b
C	Herbicide Xone-Quat 138 SL	3.75 l/ha	73.0a	122.53a	165.58a
D	Herbicide Xone-Quat 138 SL	4.50 l/ha	74.4a	131.70a	179.10b
E	Herbicide Xone-Quat 138 SL	5.25 l/ha	65.0a	119.83a	171.85a
F	Manual weeding	-	71.1a	125.13a	172.93a
G	No weeding	-	66.5a	139.25a	166.33a

Information: - the average value marked with the same letter symbol in the same column shows no different influence real at the 5% level according to the Duncan advanced test.

-WAA = Week After Application (Herbicide)

Results

The results of statistical analysis of the effect of the herbicide paraquat dichloride on the number of cob seeds, weight per 1000 seeds and weight per plot gave significantly different effects in each treatment. Differences in the effect of treatment were analyzed using the Duncan advanced test at 5% level and can be seen in table 4.15 (Data analysis in attachment 10).

Table 10: Results

Treatment Code	Treatment (ba: paraquat dichloride)	Dose	Quantity of cobs (item)	Weight per 1000 seeds (grams)	Weight per plot (kg)
A	Herbicide Xone-Quat 138 SL	2.25 l/ha	557.00a		7.52ab
B	Herbicide Xone-Quat 138 SL	3.00 l/ha	555.10a		7.95c
C	Herbicide Xone-Quat 138 SL	3.75 l/ha	564.00a		6.68a
D	Herbicide Xone-Quat 138 SL	4.50 l/ha	548.70a		7.68bc
E	Herbicide Xone-Quat 138 SL	5.25 l/ha	626.50bc		6.73a
F	Manual weeding	-	632.50c		6.98a
G	No weeding	-	509.80a		6.84a

Information:- the average value marked with the same letter symbol in the same column shows no different influence real at the 5% level according to the Duncan advanced test.

Based on table 4.15, it can be seen that the effect of the herbicide paraquat dichloride on the number of cobs in the manual weeding treatment gave high results and was significantly different from the treatment without weeding. On weight per 1000 seeds. In terms of plot weight, herbicide treatment with a dose of 3.00 l/ha gave high results and was not significantly different from the treatment with a dose of 4.50 l/ha but was significantly different from other herbicide treatments, manual weeding and no weeding.

Conclusion

Herbicides with the active ingredient paraquat dichloride can control and suppress weeds that grow back on the experimental land, namely weed species Comellina Diffusa, Althernanthera Philoxiroides, Phyllanthus Urinaria, Agerratum Conyzoides, Ipomoea Obscura, Setaria Verticillata, Cyperus Iria, Arrisarium Vulgarae. In this way, it can also have a good influence on the growth of corn plants with a low level of phytotoxicity and greater corn yields compared to the treatment without weeding.

The herbicide treatment with the active ingredient paraquat dichloride which is good for the observed variables is the treatment with a dose of 4.50 l/ha and 5.25 l/ha and on average it gives relatively the same results as all herbicide treatments and manual weeding but is better than the treatment without weeding.

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