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Effect of various dosage of ammonium glufosinate herbicide on suppressing weeds and growth and yield of corn

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ABSTRACT

Corn is one of the strategic food commodities in Indonesia which is currently widely used as animal feed ingredient. But the average productivity of national corn is still low. This study aims to determine the dose of herbicide ammonium glufosinate 200 g/L which can maintain the growth potential and yield of corn plants. The experiment was carried out at the Ciparanje Experimental Garden of the Faculty of Agriculture, Padjadjaran University, Jatinangor, Sumedang Regency, West Java, with altitude of 750 meters above sea level in November 2017 to March 2018. The experimental method used was a randomized block design consisting of seven treatments which were repeated four times. The treatments tested consisted of: manual weeding, application of different doses of ammonium glufosinate (450, 600, 750, 900, and 1050 g/ha) and unweeded check. The results of the experiment showed that application of ammonium glufosinate 200 g/L herbicide is able to suppress weed growth in corn cultivation. The application of ammonium glufosinate 200 g/L herbicide starting from a dose of 600 g/ha is effective in suppressing weed growth and suppressing the loss of yield of corn due to the presence of weeds.

Introduction

Corn is one of the second strategic food commodities after rice in Indonesia. This crop is most widely used as an animal feed industry. The national demand for corn has increased by 5.19% per year during the period 2004-2013 (Suryana and Agustian, 2014). But this is not accompanied by an increase in national corn production. The total production of corn in Indonesia in 2013 reached 18.5 million tons so that in 2013 Indonesia needed to import large amounts of corn 3.19 million tons. Subsequently quoted from the Ministry of Agriculture, national maize crop production in 2016 has reached 23.2 million tons, making national corn imports in January-September 2016 down to

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62.9%. This figure is indeed not fully able to meet national corn consumption needs, but this shows that the corn commodity has a high potential to be cultivated in Indonesia. According to Nazli et al (2019) research by various government and private institutions has resulted in the technology of corn cultivation with a potential yield of 4.5-10 tons/ha depending on the potential of the land and the production technology applied. While the facts show that the national average productivity in 2013 was 4.84 tons per hectare (Agustian, 2015). One of the causes of the low yield of corn plants is the presence of weeds on corn cultivation. The presence of weeds on corn fields can reduce crop production and crop quality. Weeds left in corn cultivation can reduce yields from 20 to 80% (Wahyudin et al. 2016). According to Cerrudo et al. (2012) corn plants are very sensitive to weed competition in the early stages of growth. Losses due to delaying weed control at the beginning of plant growth until the 10th phase of leaves reduce yields by around 38%. Weed control using herbicides is a very popular way to overcome weed growth. The use of herbsicide has increased quite rapidly to avoid losses due to the presence of weeds, this is because the use of herbicides is considered the most effective and efficient in controlling weeds. One herbicide that is quite effective in weed control is an herbicide with an active ingredient of ammonium glufosinate. Hamill et al. (2000) found that Glufosinate applied alone at the four-leaf stage of corn controlled common ragweed and common lambsquarters, whereas pigweed species were controlled effectively at the eight-leaf stage of corn growth. Herbicides with active ingredients ammonium glufosinate are non-selective herbicides that work in contact and are applied post-growth. Ammonium glufosinate can be used to control broad leaf weeds and grass weeds (Tomlin, 2005). According to Sembodo (2010), the right dose of herbicide will certainly kill the target weeds, but if the dosage is too high it will damage the cultivation plants. Therefore, it is necessary to do research on the effective range of doses to control weed growth in corn cultivation and give a good effect on the growth and yield of corn plants. Bruns and Abbas (2010) reported that application of glyphosate herbicide have no negative effects on corn yields or kernel quality in corn produced in a humid subtropical environment. The aim of this study was evaluate the effects of various dosage of ammonium glufosinate herbicide on weed management and growth and yield of corn.

Materials and methods

The experiment was carried out on the experimental field of the Faculty of Agriculture, Padjadjaran Ciparanje University, Jatinangor District, Sumedang Regency, West Java Province from November 2017 to March 2018. The altitude is 750 meters above sea level. The materials used in the experiment included corn of BISI-18 variety, urea, SP-36, KCl, and Ammonium Glufosinate herbicide with a concentration of 200 g/L. Spraying was done using semi automatic knapsack

sprayer and T-jet nozzles and the spray volume was 500 L/ha. The experiment was carried out using a randomized block design consisting of seven treatments and replicated four times. The experimental unit was a 4 x 6 m plot. The distance between the experimental plots was 50 cm and the distance between groups was 1 m. The treatments tested in this experiment were: A= Ammonium Glufosinate dose 450 g/ha; B= Ammonium Glufosinate dose 600 g/ha; = Ammonium Glufosinate dose 750 g/ha; D= Ammonium gluofsinate dose 900 g/ha; E= Ammonium Glufosinate dose 1050 g/ha; F= Manual weeding; G = Without control.

Ammonium glufosinate herbicide 200 g/L was applied when weed closure reached a minimum of 75 per cent. The herbicide application is carried out once during the experiment, which is 5 weeks after planting. The volume of spray used is 500 L/Ha. Responses observed include: Vegetation analysis of weeds before application, total weed dry weight, plant phytoxicity, growth of corn plants (plant height, leaf area index), yield components (number of seeds and weight of 100 seeds) and yields (seed weight per plant, seed weight per plot and harvest index).

Vegetation analysis is the way to study the composition and vegetation structure or plants colony. Weed vegetation analysis carried out by picking up the weed from destructive plot 1 m2 and grouped per weed species. Dry weight per species measured by means of weighting the dried weed in the oven until reaching constant weight at temperature of 800C. furthermore, the counting of weed Importance Value (IV), Summed Dominance Ratio (SDR), weed diversity index, dominance index (D), weed type and weed species dominance index (D) with following formulas :

a) Weed Importance Value (IV) is value obtained from the calculation:

$$Species\ relative\ density = \frac{Absolutely\ class\ density\ value}{\sum Absolutely\ all\ classes\ density\ value}\ x\ 100\%$$

$$Species\ relative\ frequency = \frac{Absolutely\ class\ frequency value}{\sum Absolutely\ all\ classes\ frequency value}\ x\ 100\%$$

$$Species\ relative\ Dominance = \frac{Absolutely\ class\ Dominance\ value}{\sum Absolutely\ all\ classes\ Dominance\ value}\ x\ 100\%$$

Weed Importance Value (IV) = Relative Density + Relative Frequency + Relative Dominance

b) Summed Dominance Ratio is useful to describe the relation dominance number of a weed type with the other weed in a community.

$$SDR = \frac{Important\ value}{3}$$

The weed type having biggest SDR value means such weed is dominant weed.

Phytotoxicity

The number of samples of coffee plants for observing phytotoxicity is as many as three plants in each experimental unit and determined randomly. Then the toxicity or toxicity level was assessed visually on the cultivar population in the treatment plot unit, observed at 2, 4 and 6 weeks after application, observing the level of plant poisoning according to the regulations of the Directorate of fertilizers and pesticides, Ministry of Agriculture in the following methods:

0 = no poisoning, 0–5% leaf shape or leaf color and or coffee plant growth is not normal.

1= mild poisoning> 5–20% leaf shape or leaf color and or abnormal coffee plant growth.

2= moderate poisoning> 20–50% leaf shape or leaf color and or abnormal coffee plant growth.

3= severe poisoning> 50–75% leaf shape or leaf color and or abnormal coffee plant growth.

4= very heavy poisoning> 75% leaf shape or leaf color and or abnormal coffee plant growth.

Measurement of leaf area index using the gravimetric method is:

a. Make paper size 10 cm x 10 cm, then weigh (eg the results are A gram).

b. Pick all the leaves, put the leaves on the paper provided and draw them.

c. Cut the leaf image and weigh it (for example the result is B gram).

d. Then calculate with the formula.

Leaf area index = B / A x 100 cm^2

Results and discussion

Vegetation Analysis

The results of the vegetation analysis showed nine weed species including different broad leaf and grass weeds. Based on Summed Dominance Ratio (SDR) obtained, Ageratum conizoides weeds from the broad leaf group were able to dominate the experimental plot with a closing rate of

20.28%. The value of Summed Dominance Ratio (SDR) for each type of weeds can be seen in Table 1.

Table 1. The value of Summed Dominance Ratio (SDR) before the study

No.	Weed Type	SDR
1	*Ageratum conyzoides*	20.28
2	*Cleome rutidospermae*	13.60
3	*Brachiaria mutica*	11.74
4	*Digitaria ciliaris*	11.37
5	*Cynodon dactylon*	11.00
6	*Bidens pilosa*	8.78
7	*Borreria alata*	9.15
8	*Eleusine indica*	6.37
9	*Synedrella nodiflora*	7.70
Total		**100**

Total Weed Dry Weight

Observations at three and six weeks after application of herbicide (Table 2) showed differences in weed dry weight between treatments without control with weed control treatment with weeding or the application of ammonium glufosinate herbicide. On observation 3 weeks after application, the application of ammonium glufosinate herbicide at a dose level of 600 g/h –1050 g/ha showed total weed dry weight which was no different from manual weeding treatment, while at 6 weeks after application of weed dry weight at dose treatment 900 and 1050 g/ha at the lowest.

Table 2. Observation of total weed dry weight in 3 and 6 weeks after application

Treatment	Total Weed Dry Weight (g/0.25m^2)	
	3 weeks after application	6 weeks after application
Ammonium Glufosinate 450 g/ha	10.89 b	39.02 b
Ammonium Glufosinate 600 g/ha	5.02 c	15.76 c
Ammonium Glufosinate 750 g/ha	5.88 c	15.20 c
Ammonium Glufosinate 900 g/ha	4.77 c	6.32 d
Ammonium Glufosinate 1050 g/ha	4.79 c	8.33 d
Manual weeding	3.18 c	20.37 c
Without control	28.21 a	77.50 a

The average value followed by the same letters in the same column is not significantly different according to the Duncan Distance Test at the level of 5%.

While weed dry weight total application of herbicide dose 450 g/ha is greater than the treatment of herbicide applications at other doses. The higher the dose of herbicide given, the more emphasis is placed on it and can reduce selectivity. In line with this statement, Hartati et al. (2017) reported that the lower the dose used, the more active ingredients contained and unable to control weed growth properly.

Phytotoxicity

Observation data on plant phytotoxicity levels by herbicide showed in Table 3. Results showed that in the first week and the second week there were symptoms of phytotoxicity in maize plants in the treatment plot of the herbicide application doses of 900 and 1050 g/ha. The application of ammonium glufosinate herbicide dosage 1050 g/ha resulted in the highest phytotoxicity of corn plants, namely up to 30-40% in the first week and 5-20% in the second week. While the treatment application of ammonium glufosinate herbicide dose 900 g/ha showed phytotoxicity in corn plants up to 20% in the first week and 0-5% in the following week. Symptoms of herbicide toxicity are seen with leaves necrosis, scorch around the edges and the presence of leaves that wither and die. Symptoms of ammonium glufosinat phytotoxicity such as necrosis and wilt usually occur within 2-5 days after application, followed by plant death in 1-2 weeks (Perkins, 1990).

Table 3. Plant toxicity by herbicides in various doses.

Treatment	Observation		
	1 weeks after application	2 weeks after application	3 weeks after application
Ammonium Glufosinate 450 g/ha	0	0	0
Ammonium Glufosinate 600 g/ha	0	0	0
Ammonium Glufosinate 750 g/ha	0	0	0
Ammonium Glufosinate 900 g/ha	1	0	0
Ammonium Glufosinate 1050 g/ha	2	1	0

Plant height

Observation of plant height was carried out in 3 and 5 weeks after application of herbicide. The application of ammonium glufosinate dosage 750, 900 g/ha and manual weeding treatment showed a significant effect on the growth of corn plant in 3 weeks after application compared the treatment

application of ammonium glufosinate herbicide dosage 450, 1050 g/ha, and treatment without control. In the observation of 5 weeks after application of herbicide, manual weeding treatment followed by the treatment application of ammonium glufosinate herbicide dose of 3.75 L/ha had the highest number, significantly different from the treatment dose of 450 and 1050 g/ha and without control.

Table 4. Effect of Application of Ammonium Glufosinate Herbicides to Corn Plant Height in 3 and 5 weeks after application.

Treatment	Plant height (cm)	
	3 weeks after application	5 weeks after application
Ammonium Glufosinate 450 g/ha	142.95 a	156.47 a
Ammonium Glufosinate 600 g/ha	148.77 ab	166.48 bc
Ammonium Glufosinate 750 g/ha	159.64 c	172.33 c
Ammonium Glufosinate 900 g/ha	156.73 bc	170.14 bc
Ammonium Glufosinate 1050 g/ha	145.52 a	163.04 ab
Manual weeding	163.75 c	174.27 c
Without control	140.77 a	154.57 a

The average value followed by the same letters in the same column is not significantly different according to the Duncan Distance Test at the level of 5%.

Leaf Area Index

The results of the effect of ammonium glufosinate application on leaf area index showed that the application of this herbicide at the 600–1050 g/ha dosage level and manual weeding gave a significant influence on leaf area index at 6 weeks after application compared to other treatments. The effect of the application of ammonium glufosinate herbicide on leaf area index presented in Table 5.

Table 5. Effect of Application of Herbicide Ammonium Glufosinate on the leaf area index of Corn Plants

Treatment	Leaf area index
Ammonium Glufosinate 450 g/ha	1.67 a
Ammonium Glufosinate 600 g/ha	2.49 b
Ammonium Glufosinate 750 g/ha	2.97 c
Ammonium Glufosinate 900 g/ha	2.70 c
Ammonium Glufosinate 1050 g/ha	2.29 b
Manual weeding	2.92 c
Without control	1.59 a

The average value followed by the same letters in the same column is not significantly different according to the Duncan Distance Test at the level of 5%.

Number of Seeds Rows and Amount of Seeds per Cob.

The results of the variance analysis on the number of seeds rows per ear showed the same number of rows per retal cob at each dose level of herbicide applications with manual control and weeding, while manual weeding showed the number of rows of seeds that were significantly different from the control treatment, 450 and 1050 g/ha (Table 6). According to Wahyudin et al. (2016), competition between corn and weed plants does not affect the number of rows of seeds. This is caused by the predominance of genetic traits in corn which control the nature of the number of rows per ear. The average number of rows of seeds per maize cob on manual weeding and the application of ammonium glufosinate herbicide at a dose of 600, 750 and 900 g/ha showed the numbers according to the description of the variety.

Table 6. Effect of Application of Herbicide Ammonium Glufosinate on the Number of Rows of Seeds and Amount of Seeds per Cob.

Treatment	Number of Row Seed Per Cob	Amount of Seeds Per Cob
Ammonium Glufosinate 450 g/ha	13.71 a	367.75 a
Ammonium Glufosinate 600 g/ha	14.04 ab	432.18 bc
Ammonium Glufosinate 750 g/ha	14.07 ab	456.61 c
Ammonium Glufosinate 900 g/ha	14.32 ab	456.29 c
Ammonium Glufosinate 1050 g/ha	13.79 a	429.75 b
Manual weeding	14.65 b	465.86 c
Without control	13.57 a	364.18 a

The average value followed by the same letters in the same column is not significantly different according to the Duncan Distance Test at the level of 5%.

The parameters of the number of seeds per ear showed significantly different results on manual weeding and the application of ammonium glufosinate herbicide dosage 600–1050 g/ha with the control treatment and application of a dose of ammonium glufosinate herbicide 450 g/ha. According to Sumajow (2016) the amount of light received by corn plants during the flowering phase is an important factor for determining the number of seeds.

Weight of 100 seeds

The results of the variance analysis on the effect of the application of ammonium glufosinate herbicide and manual weeding on the weight of 100 dried corn seeds (Table 7) showed significantly different results on each weed control treatment compared to the control treatment. The highest weight of 100 dry seeds was found in the manual weeding treatment followed by the treatment application of ammonium glufosinate herbicide starting dose 600 g/ha to 1050 g/ha.

Table 7. Effect of Application of Ammonium Glufosinate Herbicide on the Weight of 100 Dried Corn Seeds.

Treatment	Weight of 100 seeds
Ammonium Glufosinate 450 g/ha	24.56 b
Ammonium Glufosinate 600 g/ha	25.77 bc
Ammonium Glufosinate 750 g/ha	26.66 c
Ammonium Glufosinate 900 g/ha	27.02 c
Ammonium Glufosinate 1050 g/ha	24.89 bc
Manual weeding	27.16 c
Without control	23.44 a

The average value followed by the same letters in the same column is not significantly different according to the Duncan Distance Test at the level of 5%.

Yield

The application of ammonium glufosinate herbicide has an effect on dry shelled seed weight per plant. The highest dry shelled seed weight per plant was found in manual weeding treatment, followed by the application of herbicide dose 600, 750, and 900g/ha. The four treatments showed a significantly different number compared to other treatments. The existence of differences in corn yields is thought to be influenced by weed population density which is in line with observations of total weed dry weight in Table 3. The presence of weeds can cause plants to experience nutrient deficiencies due to competition. According to Agrita (2012) nutrient deficiency can cause plant growth and development to be disrupted so that the seed size becomes smaller which results in a weight of 100 seeds and low dry seed per plant weight. Weeding and treatment of herbicides causes weed growth to be disrupted so that corn plants can absorb nutrients optimally, photosynthates produced will be sent to the seeds (Wahyudin et al. 2016). The herbicide application dosage 3 L/ha samapai 4.5 L/ha dose can suppress the weed population so that it suppresses the occurrence of nutrient deficiency in the treatment plot. The effect of the application of ammonium glufosinate herbicide on dry shelled seed weight per plant, dry shelled seed weight per plot, and dry shelled seed weight per hectare of corn crop presented in Table 8.

Table 8. Effect of Application of Herbicide Ammonium Glufosinate on plant yield parameters.

Treatment	Weight of Dry Per Plant Seeds (g)	Dry Seed Weight Per Plot (kg/24m2)	Weight of Dry Piped Seeds Per Hectare (tons/ha)
Ammonium Glufosinate 450 g/ha	93.42 a	10.83 ab	4.52 ab
Ammonium Glufosinate 600 g/ha	111.39 bc	11.99 bc	4.99 bc
Ammonium Glufosinate 750 g/ha	124.16 c	13.04 c	5.43 c
Ammonium Glufosinate 900 g/ha	122.90 c	12.71 c	5.29 c
Ammonium Glufosinate 1050 g/ha	102.46 b	11.45 b	4.77 b
Manual weeding	126.46 c	13.42 c	5.59 c
Without control	92.44 a	10.20 a	4.25 a

The average value followed by the same letters in the same column is not significantly different according to the Duncan Distance Test at the level of 5%.

Conclusion

According to results it could be concluded that application of ammonium glufosinate at the rate of 200 g/L is able to suppress weed growth in corn cultivation. Also the application of this herbicide at the rate of 600 g/ha is effective in suppressing weed growth and managing the loss of yield of corn due to the presence of weeds.

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Conflict of Interest

Authors declare no conflict of interest.

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