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The effectiveness of the atrazine + nicosulfuron herbicide on weed suppression and Its effect on corn (*Zea mays L.*) crop yield

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Abstract
The presence of weeds in corn plantations can result in loss of corn yield, so we need to do an effective and efficient weed control effort. This study aims to determine the effect of the mixture of Atrazin + Nicosulfuron herbicide on weeds in maize (*Zea mays* L.) plantations. This research was conducted in the Pamulihan Subdistrict, Sumedang District from April to June 2017. The experimental design used was a Randomized Block Design (RCBD) with 6 treatments that were repeated 4 times, namely: Atrazine + Nicosulfuron with a dose level of 1.5 l / ha, 2.0 l/ha, 2.5 l/ha, 3.0 l/ha, manual weeding and without control. The results showed that the mixture of Atrazin + Nicosulfuron herbicide doses of 1.5 – 3.0 l/ha was effective in controlling broadleavedweeds such as *Richardia brasiliensis*, *Panicum repens*, *Cynodon dactylon*, *Cyperus rotundus*, total weeds. The mixture of Atrazin + Nicosulfuron herbicide dose 1.5 - 3.0 l / ha shows no symptoms of poisoning in maize. mixture of Atrazin + Nicosulfuron herbicide at a dose of 3.0 l/ha was able to provide the highest corn crop yield of 3443.80 g / plot.

Keywords: atrazine + nicosulfuron herbicides, weed, phytotoxicity, corn

Introduction
The presence of weeds in corn plantations can affect the growth and yield of plants. Weeds can cause competition for plants in the form of competition of nutrients, water, and light and release of allelopathy. The results showed that the yield of corn lost due to competition with weeds up to 95% (Violic, 2000) [11]. Various efforts that can be done in controlling weeds in corn cultivation are preventive, mechanical, technical, biological, chemical and integrated culture (Fadhli and Tabri, 2018) [3]. Weed control by using herbicides is very attractive to farmers, especially for large enough land. The use of herbicides is sought so as not to negatively influence the cultivation of plants so that efforts are sought to find compounds that are selective and the right way and application (Sukman and Yakup, 2002) [8].
The use of herbicides as weed control has weaknesses in agricultural crops. According to Duke *et al*. (1991) [2], Vencill *et al*. (2002) [10] the use of similar herbicides continuously for a long time, can cause weed resistance. One alternative that can be done to eliminate weed resistance is by mixing several active herbicide ingredients (Rao, 2000) [6]. Besides that according to Zimdhal (2007) Mixing of herbicides can broaden the spectrum of weed control and can reduce the dose of herbicide lower than the dose of herbicide applied separately.
Some herbicides used to control weeds in maize cultivation include herbicides with active ingredients atrazine and nicosulfuron. Atrazine herbicide belongs to the triazine group that can be applied pre-growth or post-growth by inhibiting electron transport in photosystem II, while nicosulfuron herbicide is a selective systemic herbicide, can control grass weeds both anula and perennial, weeds puzzles and broad-leaf weeds in plants corn. Mode of action of nicosulfurin is to inhibit the activity of the synthesis of the acetolactate enzyme so that it inhibits cell division and plant growth (Vencill *et al*. 2002) [10]. Mixing the two herbicides is synergistic so it does not cause poisoning to corn plants. To see the effectiveness of the atrazine + Nicosulfuron herbicide mixture in controlling weeds in maize cropping, research is needed.

Materials and Methods
The experiment was carried out on the farmers' land in Pamovery Subdistrict, Sumedang Regency, West Java Province, Indonesia. The trial period will start from April 2017 to June 2017.
The experiment was carried out by an experimental method with 6 treatments and 4 replications as presented in Table 1. The experimental unit was a plot with a size of 8.4 m x 4.8 m. The distance between units is in the form of galengan with a width of 1 m and planting distance between 40 cm x 70 cm. Grouping is based on field conditions. Determination of the layout of each treatment plot in a group is done in such a way that the target weed distribution is relatively evenly distributed. The experimental design used was a Randomized Block Design. To test the mean values of different treatments used Duncan's further test at a 95% confidence level.

Table 1: Treatment experiments

Kode	Treatment	Dose (l/ha)
A	Atrazin + Nicosulfuron	1,5
B	Atrazin + Nicosulfuron	2,0
C	Atrazin + Nicosulfuron	2,5
D	Atrazin + Nicosulfuron	3,0
E	Manual weeding	-
F	No Weeding (Control)	-

The herbicide used in this experiment was the trademark V-ORYZAE 48/4 WP. The herbicide was applied using a semi-automatic knapsack sprayer and a T-zet nozzle with a pressure of 1 kg / cm^2 (15-20 p.s.i). The volume of water

used is 500 l / ha. Application of herbicides is only done once when the plants are 15-28 days after the plants move. Responses observed in this experiment included weed dry weights at 3 and 6 weeks after application, symptoms of plant poisoning or phytotoxicity, plant height at 3, and 6 at weeks after application, and dry grain harvest.

Results and Discussion

Weed Dry Weight *Richardia brasiliensis*

Based on the results of statistical analysis about the effect of the mixture of Atrazin + Nicosulfuron herbicide on the average dry weight of Richardia brasiliensis weeds classified in the broad leaf group are shown in Table 2.

Table 2: Effect of Mixed Doses of the Atrazine + Nicosulfuron Herbicide on Average Dry Weight of Weed *Richardia brasiliensis* at 3 and 6 weeks after application

Treatment	Observation time	
	3 weeks after application	6 weeks after application
A (Atrazin + Nicosulfuron 1,5 l/ha)	0.00 c	0.00 c
B (Atrazin + Nicosulfuron 2,0 l/ha)	0.00 c	0.00 c
C (Atrazin + Nicosulfuron 2,5 l/ha)	0.00 c	0.00 c
D (Atrazin + Nicosulfuron 3,0 l/ha)	0.00 c	0.00 c
E (Manual weeding)	2.08 b	3.34 b
F (No Weeding (Control))	3.38 a	9.65 a

Note: The average value followed by the same letter shows no significant difference according to Duncan's Multiple Range Test at the 5% level.

Mixed dose of herbicide Atrazin + Nicosulfuron has an effect on suppressing the dry weight of weed Richardia brasiliensis on observations of 3 MSA and 6 MSA, so that it is significantly different from manual and control weeding treatment. The suppression of weed populations due to the application of herbicides can be in the form of morphological changes in weeds that result in changes in weed shape or total weed death. The use of herbicide mixture of the active ingredients Atrazin and Nicosulfuron is more efficient because it uses two active ingredients with lower dosages compared to a single herbicide dose. According to Uswatun (2003), the administration of a mixed herbicide can reduce the use of the dose given but does not reduce the effectiveness of the herbicide in suppressing weeds.

Weed Dry Weight *Panicum repens*

Based on the results of statistical data analysis in Table 3 shows that Panicum repens weeds treated with various doses of herbicide and manual weeding showed a significant difference with the control treatment on observations 3 and 6 weeks after application.

Table 3: Effect of mixture dosages of the herbicide Atrazin + Nicosulfuron on average dry weights of *Panicum repens* weeds at 3 and 6 weeks after application

Treatment	Observation time	
	3 weeks after application	6 weeks after application
A (Atrazin + Nicosulfuron 1,5 l/ha)	0.00 b	0.00 c
B (Atrazin + Nicosulfuron 2,0 l/ha)	0.00 b	0.00 c
C (Atrazin + Nicosulfuron 2,5 l/ha)	0.00 b	0.00 c
D (Atrazin + Nicosulfuron 3,0 l/ha)	0.00 b	0.00 c
E (Manual weeding)	2.01 a	4.99 b
F (No Weeding (Control))	2.53 a	9.51 a

Note: The average value followed by the same letter shows no significant difference according to Duncan's Multiple Range Test at the 5% level.

Based on Table 3 it can be seen that the dose of the herbicide mixture Atrazin + Nicosulfuron at a dose of 1.5 l/ha - 3.0 l/ha effectively and efficiently suppresses the dry weights of weeds. This is in line with the opinion of Zimdhal (2007) that compound herbicides are more effective than single herbicides in suppressing weed growth and can broaden the control spectrum.

Weed Dry Weight *Cynodon dactylon*

Cynodon dactylon weed is a type of weed that has a fairly high adaptability. This weed propagates vegetatively using stolons or stems that spread above the soil surface. Based on the data in Table 4 on observations 3 and 6 weeks after application, the control treatment and manual weeding have higher weed dry weights compared to the mixture treatment of the Atrazin + Nicosulfuron herbicide. This is because the administration of a mixture of the herbicide Atrazin + Nicosulfuron is better done because the dose used is lower than that of a single herbicide from a different group (Kristiawati, 2003) [5].

Table 4: Effect of Mixed Doses of Atrazine + Nicosulfuron Herbicide on Average Dry Weight of *Cynodon Dactylon* Weed at 3 and 6 weeks after application

Treatment	Observation time	
	3 weeks after application	3 weeks after application
A (Atrazin + Nicosulfuron 1,5 l/ha)	0.49 b	0.76 bc
B (Atrazin + Nicosulfuron 2,0 l/ha)	0.08 b	0.46 c
C (Atrazin + Nicosulfuron 2,5 l/ha)	0.05 b	0.54 bc
D (Atrazin + Nicosulfuron 3,0 l/ha)	0.00 b	0.15 c
E (Manual weeding)	0.38 b	1.57 ab
F (No Weeding (Control))	1.08 a	2.27 a

Note: The average value followed by the same letter shows no significant difference according to Duncan's Multiple Range Test at the 5% level.

Weed Dry Weight *Cyperus rotundus*

Based on statistical tests the low average number of dry weights of *Cyperus rotundus* in the mixture treatment of the herbicide Atrazin + Nicosulfuron dose 1.5 – 3.0 l/ha showed

an emphasis on Cyperus rotundus weeds in observations 3 and 6 weeks after application (Table 5). This shows that the dose of the herbicide has suppressed the growth of these weeds. In the opinion of Rao (2000) [6], that at certain doses of herbicides can control weed germination. The process of death of weed sprouts begins with abnormal appearance of weeds.

Table 5: Effect of dosage of Atrazine + Nicosulfuron herbicide mixture on the average dry weight of *Cyperus rotundus* weeds at 3 and 6 weeks after application

Treatment	Observation time	
	3 weeks after application	3 weeks after application
A (Atrazin + Nicosulfuron 1,5 l/ha)	0.34 b	0.00 b
B (Atrazin + Nicosulfuron 2,0 l/ha)	0.08 b	0.29 b
C (Atrazin + Nicosulfuron 2,5 l/ha)	0.00 b	0.00 b
D (Atrazin + Nicosulfuron 3,0 l/ha)	0.00 b	0.00 b
E (Manual weeding)	0.62 ab	1.55 a
F (No Weeding (Control))	1.24 a	2.21 a

Note: The average value followed by the same letter shows no significant difference according to Duncan's Multiple Range Test at the 5% level.

Table 6: Effect of dosage of Atrazine + Nicosulfuron herbicide mixture on average total weed dry weights at 3 and 6 weeks after application

Treatment	Observation time	
	3 weeks after application	3 weeks after application
A (Atrazin + Nicosulfuron 1,5 l/ha)	0.10 c	0.22 c
B (Atrazin + Nicosulfuron 2,0 l/ha)	0.08 c	0.12 c
C (Atrazin + Nicosulfuron 2,5 l/ha)	0.01 c	0.07 c
D (Atrazin + Nicosulfuron 3,0 l/ha)	0.01 c	0.02 c
E (Manual weeding)	0.65 b	1.78 b
F (No Weeding (Control))	1.59 a	3.24 a

Note: The average value followed by the same letter shows no significant difference according to Duncan's Multiple Range Test at the 5% level.

Total Weed Dry Weight

Total weed dry weight is the sum of the total weed, namely, Richardia brasiliensis weed, Cynodon dactylon, Cynodon dactylon, Cyperus rotundus, and all weeds present in each experimental plot. Table 6 shows that in observations 3 and 6 weeks after application the total weed dry weights in the control treatment and manual weeding showed significantly different from the treatment of the herbicide mixture Atrazin + Nicosulfuron at a dose of 1.5 – 3.0 l/ha. This is because in the control treatment there is no suppression of weeds by herbicides so that the total weeds that grow in the control treatment more and manual weeding treatment causes regrowth of puzzle weeds and grass faster so that the total number of weeds is higher. It also shows that the mixed herbicide treatment is more effective in suppressing the growth of all weeds, both broad leaf, weed and grass weeds (Hasanuddin, 2013) [4].

Corn Plant Components

Phytotoxicity of Corn Plants

Observation of the level of phytotoxicity or poisoning of plants by herbicides is carried out three times at 1, 2 and 3 weeks after application by following the system issued by the Pesticide Commission (1997).

Table 7 shows that the plants did not experience poisoning due to herbicide treatment both at the lowest and highest doses at the time of observation 1-3 weeks after application, so it did not affect the growth and yield of corn.

Table 7: Observation of phytotoxicity of maize aged 1, 2 and 3 weeks after application

Treatment		Dose (l/ha)	Observation time		
			1 weeks after application	2 weeks after application	3 weeks after application
A	Atrazin + Nicosulfuron	1,5	0,00	0,00	0,00
B	Atrazin + Nicosulfuron	2,0	0,00	0,00	0,00
C	Atrazin + Nicosulfuron	2,5	0,00	0,00	0,00
D	Atrazin + Nicosulfuron	3,0	0,00	0,00	0,00
E	Manual weeding	-	0,00	0,00	0,00
F	No Weeding (Control)	-	0,00	0,00	0,00

Corn Plant Height

The effect of mixed dose of Atrazin + Nicosulfuron herbicide on the average height of rice plants at 3 and 6 weeks after application can be seen in Table 8. From Table 8, observation of 3 weeks after application shows that the treatment of Atrazin + Nicosulfuron herbicide mixture at a dose of 1.5 - 3.0 l/ha shows a significantly higher average plant height compared to the treatment without weeding (control). While the results of observations 6 weeks after application showed that the treatment of the herbicide mixture Atrazin + Nicosulfuron with a dose of 1.5 – 3.0 l/ha showed an average rate of plant height that was significantly different compared to the control. This is due to the lower competition between weeds and maize, providing opportunities for plants to be able to utilize growth factors more optimally so that their growth is better.

Table 8: Effect of Atrazine + Nicosulfuron herbicide mixture dose on average height of rice plants at 3 and 6 weeks after application

Treatment	Observation time	
	3 weeks after application	3 weeks after application
A (Atrazin + Nicosulfuron 1,5 l/ha)	68.36 a	147.23 ab
B (Atrazin + Nicosulfuron 2,0 l/ha)	68.60 a	148.10 a
C (Atrazin + Nicosulfuron 2,5 l/ha)	68.79 a	148.58 a
D (Atrazin + Nicosulfuron 3,0 l/ha)	68.83 a	149.29 a
E (Manual weeding)	67.75 a	146.14 ab
F (No Weeding (Control))	66.09 b	144.48 b

Note: The average value followed by the same letter shows no significant difference according to Duncan's Multiple Range Test at the 5% level.

Competition of plants and weeds at the beginning of growth is one of the critical periods for the growth and yield of corn. Application of the Atrazin + Nicosulfuron herbicide mixture to corn at the age of 15 days after planting reduces competition between corn and weeds. According to Zimdahl (1980) competition between corn and weeds that occurs only for 2 weeks after planting has not reduced yields, but if the competition takes place between 3 to 5 weeks after planting the yield will decrease by 15-22%. After the age of 5 weeks after planting corn plants can compete with weeds.

Dried Corn Seed Weight per Plot

Effect of dosage of Atrazine + Nicosulfuron herbicide mixture on the average number of dry weight of corn seeds per plot can be seen in Table 9. From Table 9 shows that the treatment of Atrazin + Nicosulfuron herbicide mixture 1.5 – 3.0 l/ha shows the average number the average dry weight of corn seeds per plot was higher and significantly different compared to the treatment without weeding (control) and not significantly different from the manual treatment. The highest yield of dry corn seeds was found in the treatment of the herbicide mixture Atrazin + Nicosulfuron 3.0 l/ha that is equal to 3443.80 g/plot. Manual treatments and herbicides cause weeds to grow in the cornfield so that the corn plant can grow well.

Competition between plants and weeds in obtaining nutrients, water and sunlight causes disruption of photosynthesis. According to Seriminawati *at. al.* (2005) good growth and is supported by the absorption of nutrients that are sufficient to result in photosynthates produced will increase and be stored in storage networks so that it affects the development and growth of plant parts which will ultimately increase crop yields.

Table 9: Effect of Mixed Doses of the Atrazine + Nicosulfuron Herbicide on Average Weight of Dry Seed Corn/Plot

Treatment	Corn seed weight (g/plot)
A (Atrazin + Nicosulfuron 1,5 l/ha)	3188.00 ab
B (Atrazin + Nicosulfuron 2,0 l/ha)	3270.80 ab
C (Atrazin + Nicosulfuron 2,5 l/ha)	3395.80 ab
D (Atrazin + Nicosulfuron 3,0 l/ha)	3443.80 a
E (Manual weeding)	3006.00 bc
F (No Weeding (Control))	2670.80 c

Note: The average value followed by the same letter shows no significant difference according to Duncan's Multiple Range Test at the 5% level.

Conclusion

1. The herbicide mixture Atrazin + Nicosulfuron dose 1.5 – 3.0 l/ha effectively controls weed *Richardia brasiliensis, Panicum repens, Cynodon dactylon, Cyperus rotundus, and* Total Weed
2. The herbicide mixture Atrazin + Nicosulfuron dose 1.5 – 3.0 l/ha does not show symptoms of poisoning in plants.
3. Atrazin + Nicosulfuron herbicide mixture with a dose of 3.0 l/ha is able to provide the highest corn crop yield of 3443.80 g/plot.

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