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# The effect of herbicide glufosinate ammonium 150 g/L dose on several weeds and potatoes (*Solanum tuberosum*, L.) yield

**Abstract.** In the last three years, potato production in Indonesia fluctuated every year. One of the factors that cause low productivity of potatoes is weed. The presence of weeds in potato planting areas can inhibit plant growth and affect potato yields. The aim of this study is to determine the effectiveness of herbicide glufosinate ammonium 150 g/L to control common weeds in potato plants. This research was conducted in a farmer field in Lebak Muncang Village, Ciwidey District, Bandung Regency, West Java Province. The experimental design used was a randomized block design with six treatments and four replications. Weed control using the herbicide glufosinate ammonium 150 g/L at a dose of 2.75– 4.50 L/ha was completely (100%) controlled *Eleusine indica, Galinsoga parviflora, Amaranthus spinosus, Richardia brasiliensis,* and total weeds for up to 6 weeks after application without causing symptoms of poisoning and could increase the number of potato tuber per plant and yield of potato per plot.

**Keywords**: Weed · Glufosinate Ammonium · Herbicide · Potato

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## Introduction

Potato (*Solanum tuberosum* L.) is one of the root crops which is a source of carbohydrates that is widely consumed by most people in Indonesia. Potatoes have a fairly complete nutritional value and can be used as a substitute for rice (Robertson et al., 2018; Górska-Warsewicz, 2021). According to the Statistics Indonesia (2020) potato production in 2018 was 1,284,762 tons, in 2019 it increased by 1,314,657 tons, but in 2020 it decreased by 1,282,768 tons. Potato production in Indonesia each year has been recorded to have fluctuated in the last three years. The decrease of potato crop production is caused by various factors, one of which is the presence of weeds.

Weeds are very important in crop production, due to weeds can reduce the quality and quantity of the crops (Prayogo et al., 2017). According to Rao (2000) and Nurmala (2015), weeds can reduce crop yields by 10 to 25%. The presence of weeds on crops can reduce crop yields from 20 to 80% (Umiyati & Kurniadie, 2018). Weed control needs to be carried out to avoid a decrease in quality and quantity of crops (Bravo & Sembayang, 2020). Herbicides are chemical compounds used to inhibit growth and control weeds. The advantage of weed control using herbicides are more effective and efficient in terms of cost, time and labor as compared to other control methods (Lolitasari & Saifuddin, 2019).

Glufosinate ammonium 150 g/L works by inhibiting the synthesis of glutamine from glutamate, which is required for ammonia detoxification which causes ammonia to increase so that it reaches toxic levels in chloroplasts in leaf tissue (Takano & Dayan, 2020; Umiyati & Kurniadie, 2018). Glufosinate ammonium 150 g/L can control both broad leaf and grass weeds in fruit, rubber and oil palm plantations (Zhang et al., 2014; Ruzlan & Hamdani, 2020; Wibawa et al., 2009).

This study was to determine the effectiveness of the herbicide glufosinate ammonium 150 g/L to control weeds, growth and yield of potato.

## Materials and Methods

This research was conducted from September 2021 to January 2022. in a farmer's field in Lebak Muncang Village, Ciwidey District, Bandung Regency, West Java Province at an altitude of 1200 meters above the sea level with the climate type C2 according to Oldeman.

The research design used was Randomized Block Design that consisted of six treatments and each treatment was replicated four times, so that there were 24 experimental units. Herbicide treatment consists of doses of (A) 2.75 L/ha, (B) 3.00 L/ha, (C) 3.75 L/ha, (D) 4.50 L/ha, (E) manual weeding and (F) control. The spray volume was calibrated at 400 L $Ha^{-1.}$ The application of the tested herbicide is carried out in the morning at 08.00 a.m when the weather is sunny and the wind speed is low at 23 **°C**. it was carried out only once before the planting period. Potato tuberss were planted by digging the soil to a depth of 3-5 cm, each hole was filled with one tuber with a row spacing of 30 x 70 cm. Fertilizing was applied twice, the first fertilizer was applied at 3-4 days before planting and the second fertilizing is carried out at 6 WAP (Weeks After Planting).

The observation variables consist of supporting observations (vegetation analysis using the formula relative density + relative dominance + relative frequency divided by three, environmental conditions and also phytotoxicity of potato which was carried out visually on the entire plant population at 1, 2, 3 weeks after planting), whereas the main observations were total weed dry weight on 3 and 6 Weeks After Application (WAA) in each treatment plot using 2 quadrat with the size of 50 cm x 50 cm, plant growth, yield components and yields of potato. The observations of plant height were carried out by taking 20 samples of potato plants at random at 3 and 6 WAP.

## Results and Discussions

During the experiment, the amount of rainfall ranged from 60-520 mm/month, while the optimal rainfall was 200-300 mm/month (Hanan et al., 2015). The average humidity ranges from 74-82% and the temperature ranges from 23.4-24.3 $^{o}$C. Temperature and humidity can affect the growth of potatoes, if the temperature is more than 30 °C then the growth of potatoes will be inhibited. The appropriate humidity for potato is 80% to 90% (Suryana, 2013). The range of Temperature and humidity were suitable for growing potato.

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The results of the vegetation analysis on the land before the experiment was carried out showed that there were 4 species of broadleaf weeds, 2 species of grass weeds and 1 species of sedge weed.

**Table 1. Vegetation analysis**

| No | Weed species | Group of weeds | SDR (%) |
|---|---|---|---|
| **1.** | *Eleusine indica* | grasses | 23.06 |
| **2.** | *Galinsoga parviflora* | Broadleaf | 19.20 |
| **3.** | *Amarhantus spinosus* | Broadleaf | 18.48 |
| **4.** | *Richardia brasiliensis* | Broadleaf | 13.73 |
| **5.** | *Portulaca oleracea* | Broadleaf | 9.56 |
| **6.** | *Cyperus rotundus* | sedge | 8.81 |
| **7.** | *Cynodon dactylon* | grasses | 7.17 |
| | **Total** | | **100.00** |

There were four dominant weeds species, namely one grass weed such as *Eleusine indica* with SDR value by 23.06% and three broadleaf weeds. *Galinsoga parviflora; Amaranthus spinosus;* and *Richardia brasiliensis* with values were 19.20; 18.48; and 13.73%, respectively. Weeds that have an SDR value above 10% are called dominant weeds.

**Phytotoxicity.** Phytotoxicity is the percentage of the degree of poisoning of cultivated plants caused by herbicides. Based on the data presented in Table 2, it shows that there were no symptoms of poisoning due to the influence of the herbicide glufosinate ammonium 150 g/L on the growth of potato plants in 1, 2, and 3 WAP. The toxicity with a score of zero, indicates there is no poisoning or the percentage was only 0-5%.

**Table 2. Phytotoxicity**

| Treatments | Dose (L/ha) | Toxicity Rate | | |
|---|---|---|---|---|
| | | 1 WAP | 2 WAP | 3 WAP |
| A | 2.75 | 0 | 0 | 0 |
| B | 3.00 | 0 | 0 | 0 |
| C | 3.75 | 0 | 0 | 0 |
| D | 4.50 | 0 | 0 | 0 |
| E | manual | 0 | 0 | 0 |
| F | control | 0 | 0 | 0 |

WAP: week after planting

**Dry Weight of *Eleusine indica*.** *Eleusine indica* weeds were the most dominant weeds in experimental fields. Based on the data in Table 3, the average of dry weight of *Eleusine indica* weeds at 3 WAA (Weeks After Application) and 6 WAA showed that the herbicide treatment of glufosinate ammonium 150 g/L at a dose of 2.75 ; 3,00 ; 3.75 and 4.50 L/ha showed a significantly different as compared to the control treatment. Total physiological characteristics included chlorophyll, survival, tillers, fresh weight, and dry weight of *Eleusine indica* weeds can (100%) suppressed by glufosinate ammonium and triclopyr at 2 to 8-fold of the recommended dose (Tampubolon *et al*., 2019).

**Table 3. Average Dry Weight of *Eleusine indica***

| Treatments | Dose (L/ha) | Average Dry Weight of *Eleusine indica* | |
|---|---|---|---|
| | | 3 WAA | 6 WAA |
| A | 2.75 | 0.44 a | 2.98 c |
| B | 3.00 | 0.23 a | 1.31 b |
| C | 3.75 | 0.42 a | 0.94 ab |
| D | 4.50 | 0.05 a | 0.63 a |
| E | manual | 2.88 b | 6.50 d |
| F | control | 5.39 c | 10.73 e |

Description: The average value of the treatment followed by the same letter in the same column indicates no significant difference based on the 5% LSD Test. WAA=week after herbicide application

**Dry Weight of *Amaranthus spinosus*.** Herbicide treatment of Ammonium Glufosinate 150 g/L at a dose from 2.75 until 4.50 L/ha indicate that the herbicide were effective in controlling *Amaranthus spinosus* weeds up to 6 WAA as compared to the control treatment. This was because the entire dose level of the herbicide Ammonium Glufosinate 150 g/L has been absorbed by the leaves so that it enters the site of action which causes weeds to die (Hastuti *et al*., 2017). This can happen because the leaf morphology of the broad leaf group weeds has a growing point of the apical meristem which is very sensitive to herbicides. The wide leaf surface causes the droplets of the applied herbicide Ammonium Glufosinate to be absorbed properly so that it is more effective for controlling *Amaranthus spinosus* weeds as compared to manual weeding.

**Table 4. Average Dry Weight of *Amaranthus spinosus***

| Treatments | Dose (L/ha) | Average Dry Weight of *Amaranthus spinosus* | |
|---|---|---|---|
| | | 3 WAA | 6 WAA |
| A | 2.75 | 0.24 a | 2.04 c |
| B | 3.00 | 0.0 a | 1.53 abc |
| C | 3.75 | 0.0 a | 0.77 a |
| D | 4.50 | 0.0 a | 0.86 ab |
| E | manual | 2.38 b | 4.60 d |
| F | control | 5.46 c | 8.49 e |

Description: The average value of the treatment followed by the same letter in the same column indicates no significant difference based on the 5% LSD Test. WAA=week after herbicide application

**Dry Weight of *Galinsoga parviflora.*** Based on the data in Table 5 the average of dry weight value of *Galinsoga parviflora*, shows that the control treatment has the highest average dry weight compared to the Ammonium glufosinate herbicide treatment at each dose. This is because *Galinsoga parviflora* comes from the family Astraceae whose life cycle is annual weeds. According to Umiyati et al., (2015) annual weeds are weeds that have a life cycle lasting for one year starting from germination, production, to death. Herbicide treatment of glufosinate ammonium at all dose levels is effective in suppressing the growth of *Galinsoga parviflora.*

**Table 5. Average Dry Weight of *Galinsoga parviflora***

| Treatments | Dose (L/ha) | Average Dry Weight of *Galinsoga parviflora* | |
|---|---|---|---|
| | | 3 WAA | 6 WAA |
| A | 2.75 | 0.84 a | 2.33 b |
| B | 3.00 | 0.0 a | 0.51 a |
| C | 3.75 | 0.0 a | 0.25 a |
| D | 4.50 | 0.0 a | 0.41 a |
| E | manual | 1.82 b | 6.97 c |
| F | control | 11.49 c | 12.67 d |

Description: The average value of the treatment followed by the same letter in the same column indicates no significant difference based on the 5% LSD Test. WAA=week after herbicide application

**Dry Weight of *Richardia brasiliensis.*** Based on Table 6, it shows that at observations of 3 and 6 WAA, the treatment of glufosinate ammonium 150 g/L at a dose of 2.75 L/ha until 4.50 L/ha gave a lower average of *Richardia brasiliensis dry weight* at 3 and 6 WAA and significantly different as compared control treatment. According to Umiyati & Kurniadie (2018), application of the herbicide glufosinate ammonium 150 g/L causes the synthesis of glutamine from glutamate to be inhibited, causing ammonia to increase which causes toxic levels in chloroplasts in leaf tissues, so the photosynthesis will stop and weeds will die.

**Table 6. Average Dry Weight of *Richardia brasiliensis***

| Treatments | Dose (L/ha) | Average Dry Weight of *Richardia brasiliensis* | |
|---|---|---|---|
| | | 3 WAA | 6 WAA |
| A | 2.75 | 0.07 a | 1.03 c |
| B | 3.00 | 0.0 a | 0.54 ab |
| C | 3.75 | 0.0 a | 0.0 a |
| D | 4.50 | 0.0 a | 0.35 a |
| E | manual | 0.84 b | 2.28 c |
| F | control | 4.33 c | 5.18 d |

Description: The average value of the treatment followed by the same letter in the same column indicates no significant difference based on the 5% LSD Test. WAA=week after herbicide application

**Dry Weight of Other Weeds.** Based on Table 7, it shows that at observations of 3 and 6 WAA, the average dry weight value of other weeds at the herbicide glufosinate ammonium dose 2.75 until 4.50 L/ha were higher as compared to control treatment. This shows that application of herbicide glufosinate ammonium 150 g/L from 2.75 until 4.50 L/ha was effective to control other weed species. According to Sihombing (2020), herbicide glufosinate ammonium 150 g/L is non-selective and broad-spectrum and can control not only broad leaf but also grass and sedge weeds.

**Table 7. Average Dry Weight of Other Weeds**

| Treatments | Dose (L/ha) | Average Dry Weight of Other Weeds | |
|---|---|---|---|
| | | 3 WAA | 6 WAA |
| A | 2.75 | 1.24 a | 3.80 bc |
| B | 3.00 | 0.14 a | 2.66 abc |
| C | 3.75 | 0.17 a | 2.38 ab |
| D | 4.50 | 0,14 a | 2.18 a |
| E | manual | 2.86 b | 7.04 d |
| F | control | 15.28 c | 19.47 e |

Description: The average value of the treatment followed by the same letter in the same column indicates no significant difference based on the 5% LSD Test. WAA=week after herbicide application

The average of total weed dry weight was presented in Table 8. Table 8 showed that at 3 and 6 WAA the treatment of glufosinate ammonium 150 g/L with a dose of 2.75 g/L ; 3.00 g/L ; 3.75

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g/L ; 4.50 g/L had a lower average of total dry weight than control treatment. This was probably due to systemic type of herbicide glufosinate ammonium 150 g/L which can be translocated to all parts of the weed which causes the weed to be suppressed so that the weed can be controlled properly.

**Table 8. Total Dry Weight of Weeds**

| Treatments | Dose (L/ha) | Total Dry Weight of Weeds | |
|---|---|---|---|
| | | 3 WAA | 6 WAA |
| A | 2.75 | 2.84 b | 12.17 c |
| B | 3.00 | 0.38 a | 6.55 b |
| C | 3.75 | 0.21 a | 4.34 a |
| D | 4.50 | 0.18 a | 4.44 a |
| E | manual | 10.78 c | 27.40 d |
| F | control | 41.96 d | 56.55 e |

Description: The average value of the treatment followed by the same letter in the same column indicates no significant difference based on the 5% LSD Test. WAA=week after herbicide application

**Plant Height** Table 9 showed that at the observations 3 and 6 WAP, the treatment of herbicide glufosinate ammonium 150 g/L at a dose of 2.75 until 4.50 L/ha have higher average of plant height and significantly different than control treatment. This proves that all herbicide treatments doses of 2.75 L/ha to 4.50 L/ha are able to effectively suppress weeds so that they can affect the growth of potato plants as compared to manual weeding treatment.

**Table 9. Average Potato Plant Height**

| Treatments | Dose (L/ha) | Average Potato Plant Height | |
|---|---|---|---|
| | | 3 WAP | 6 WAP |
| A | 2.75 | 6.06 b | 29.12 abc |
| B | 3.00 | 5.99 b | 26.54 ab |
| C | 3.75 | 5.75 b | 31.27 bc |
| D | 4.50 | 6.00 b | 30.26 abc |
| E | manual | 6.48 b | 33.13 c |
| F | control | 4.56 a | 24.60 a |

Description: The average value of the treatment followed by the same letter in the same column indicates no significant difference based on the 5% LSD Test. WAP: week after planting

**Amount, number of potatoes per plant and yield per plot.** The observations on the number of potatoes and weight of potatoes per plant and per plot were carried out at harvest time, which was 90 DAP (Days After Planting). Table 10 showed that the treatment of the herbicide glufosinate ammonium 150 g/L at a dose of 2.75 until 4.50 L/ha had an average value of the number of potatoes per plant, weight of potatoes per plant and weight of potatoes per plot higher than the control treatment. This is because the herbicide glufosinate ammonium 150 g/L can control the growth of *Eleusine indica, Amaranthus spinosus, Galinsoga parviflora, Richardia brasiliensis* and other weeds from 3 until 6 DAA, so the competition between potato and weeds was reduced. The lower the level of weed competition, the more optimal the main crop to grow, on the other hand, if the weed competition is high, the main crop will find it difficult to find nutrients for crop growth (Latifa et al., 2015).

**Table 10. Average Amount of Potatoes and Weight of Potatoes**

| Treatments | Dose (L/ha) | Number of Potatoes Per Plant | Dry Weight Per Plant (gram) | Potato Weight Per Plot (kg) |
|---|---|---|---|---|
| A | 2.75 | 9.30 b | 395.46 bc | 19.75 bc |
| B | 3.00 | 10.25 c | 408.58 c | 20.42 c |
| C | 3.75 | 10.37 c | 394.66 bc | 19.72 bc |
| D | 4.50 | 10.50 c | 409.36 c | 20.42 c |
| E | manual | 9.23 b | 382.32 b | 19.07 b |
| F | control | 6.98 a | 315.66 a | 15.77 a |

Description: The average value of the treatment followed by the same letter in the same column indicates no significant difference based on the 5% LSD Test.

## Conclusion

Weed control using the herbicide glufosinate ammonium 150 g/L at a dose of 2.75 – 4.50 L/ha was completely (100%) controlled *Eleusine indica, Galinsoga parviflora, Amaranthus spinosus, Richardia brasiliensis* and total weeds for up to 6 weeks after application without causing symptoms of poisoning and can increase number of potato tuber per plant and yield of potato per plot.

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