Decrease sensitivity of *Eleusine indica* treated with Paraquat and Glyphosate sub-lethal doses

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**Abstract.** Populations of *Eleusine indica* glyphosate-sensitive weed seeds taken from Polytechnic Negeri Medan Campus. This study aims to examine whether the use of sub-lethal doses of paraquat and glyphosate in three generations can cause a decrease in the sensitivity of the *Eleusine indica* population to each herbicide. This research was carried out at the Universitas Sumatera Utara Campus with a height of ± 25 m above sea level. This study used a paraquat herbicide under the recommended dosage of 200 g.a.i. ha⁻¹ and glyphosate herbicide under the recommended dose 360 g.a.i. ha⁻¹ with three replications. Data analysis using IBM SPSS Statistics 20 software.

1. **Introduction**

Goosegrass [*Eleusine indica* (L.) Gaertn] is one of the weeds of cultivated plants that have high competitiveness, grasses reproduce by using seeds [1]. These weeds are classified as fast-growing weeds so that a full replacement is needed [2]. Control is mostly done to weeds by means of chemical herbicides because the use of these herbicides has more use when compared with the other techniques. The advantages of using herbicides are faster recovery from weed growth, more efficient, more effective and saving labour and time [3].

However, the use of similar herbicides continuously and for a long time in one area can result in the emergence of herbicide-resistant weed populations. Consequences of the use same herbicide, both types of active ingredients and how it works repeatedly in a long period in an area, then there are two possible problems that arise in these areas, the first is the dominance of herbicide-resistant weed populations, secondly the possibility of dominance herbicide-tolerant weeds [4].

The use of paraquat herbicide for weed control is expected to suppress weed growth more effectively and efficiently. Paraquat herbicide is a non-selective contact herbicide [5]. Glyphosate is a non-selective herbicide, which means it controls widely all types of weeds. The herbicide is absorbed through the leaves and is inactive when applied through the soil. Glyphosate translocation occurs in all parts of the plant including parts of plants that are in the soil because glyphosate is a systemic herbicide [6]. Herbicide resistance is a population of weeds that can survive after exposure to herbicides at doses that were previously effective in killing the population. These persistent weed populations emerged due to selection pressure by the use of similar herbicides repeatedly and over a long period [7].
2. Materials and methods

2.1. Source of seeds Eleusine indica
The collection of *E. indica* seeds was taken directly from the Polytechnic Negeri Medan Campus, where weeds had never been exposed to herbicides before. This research was carried out at the Faculty of Agriculture, Universitas Sumatera Utara.

2.2. Breaking seed dormancy
Breaking *E. indica* seed dormancy is first soaked in a solution of potassium nitrate (KNO3) at a concentration of 0.1% for 30 minutes [8]. The purpose of this immersion is to break the secondary dormancy of *E. indica* seeds.

2.3. Germination and transplanting
Media sprouts using topsoil land. Then the topsoil land is sterilized from the seed bank with a temperature of 100°C for ± 3 h. After that the soil is removed from the oven and aerated before being put into a sprout tub with a size of 33 cm x 24 cm. During 3-4 days weed seeds have been germinated, the germination media is sprayed with Decis 25 EC to prevent ants. Watering is done in the afternoon. After the seedlings have 2-3 leaves, the seeds are transferred to a pot of 12 seeds using topsoil, sand and manure media with a volume of 1: 1: 1 is carried out. Then the seedlings are maintained and watering is done in the morning and evening.

2.4. Application of Paraquat and Glyphosate herbicides
Before spraying, the herbicide is calibrated first. Using the electric knapsack sprayer blue nozzle with a spray width of 1.5 m. Water filling for calibration of 2 L of water. The volume of spray obtained in the first-generation stage was 237 L/ha, the second generation 273 L/ha, the third generation 270 L/ha, while the dose-response was 330 L/ha. Using the herbicides glyphosate and paraquat. Respective doses of glyphosate herbicide 0, 135, 270, 540 g.a. i. ha⁻¹ and doses of paraquat 0, 37.5, 75, 150 g.a. i. ha⁻¹. At this last stage the seeds used were *E. indica* sensitive weed seeds, weed seeds that survived in generations 1, 2, and 3. Application with of herbicides glyphosate and paraquat. The glyphosate dose used was 0, 270, 540, 810, 1080, 2160 g.a. i. ha⁻¹ and the paraquat dose of 0, 75, 150, 225, 300, 600 g.a.i.ha⁻¹ was 3 replicates. Spraying is carried out when weeds 3-4 leaves [9]

2.5. Survivor observation
Weed population counts that survive were carried out 21 days after application.

\[
\text{%Survivor} = \frac{\sum \text{population survive}}{\sum \text{Survivor}} \times 100\% \tag{1}
\]

The resistant paraquat weeds tested by the Dose Response were calculated for their resistance index.

\[
\text{Indeks Resistensi (IR)} = \frac{LD50 \text{ Resisten population}}{LD50 \text{ Sensitif population}} \tag{2}
\]

3. Results and discussion

3.1. Selection of the first, second, and third generations using glyphosate herbicide
Based on table 1, it can be seen that by giving an increased dose of glyphosate from first generation (G1) and second generation (G2) there was an increase in the percentage of weeds that survived by 65.5%, while G2 and G3 also increased weeds that survived by 7.1%.
Table 1. Number of survivors of wild population of *Eleusine indica* in each generation after being sprayed with glyphosate at sublethal doses 3 MSA.

| Generation | Rate of Glyphosate (g.a.i.ha⁻¹) | No. plants sprayed | No. survivor |
|------------|----------------------------------|--------------------|--------------|
| Generation 1 | 135                              | 84                 | 2            |
| Generation 2 | 270                              | 84                 | 57           |
| Generation 3 | 540                              | 84                 | 63           |

This is in line with research which states that *Indica* is very difficult to control with the application of glyphosate herbicides. This is because glyphosate cannot inhibit the EPSPS enzyme in the chloroplast tissue so that the formation of chlorophyll is still on going for the process of photosynthesis. This can be seen in populations that are resistant to only withering temporarily when glyphosate application is then refreshed the next day at the trial site.

3.2. Selection of the first, second, and third generations using paraquat herbicide

Table 2. Number of survivors of wild population of *Eleusine indica* in each generation after being sprayed with paraquat at sublethal doses 3 MSA.

| Generation | Rate of Paraquat (g.a.i.ha⁻¹) | No. plants sprayed | No. survivor |
|------------|--------------------------------|--------------------|--------------|
| Generation 1 | 37.5                            | 84                 | 11           |
| Generation 2 | 75                              | 84                 | 27           |
| Generation 3 | 150                             | 84                 | 42           |

Based on table 2, it can be seen that by giving a paraquat dose from the first-generation dose to the second-generation dose, the percentage increase in weeds that survive by 19% and the second-generation dose to the third-generation dose also increases the weeds that survive by 17.9%. This is in accordance which states that the internal factors of plants that affect the toxicity of an herbicide are associated with the level of development of an herbicide. Plants that have different sensitivity to herbicides [1].

3.3. Dose response

Percentage of survival from the results obtained at the dose-response stage using glyphosate herbicides it is known that the higher the dosage, the lower the percentage of weed survival is shown in weeds G0 and G1 percentages of 44.4% and 37.3%, while G2 and G3 the percentage of survival is 41.7 and 33.3 (figure 1).

![Figure 1](image_url)  
Figure 1. Percentage of *E.indica* that survived in G0, G1, G2, and G3 weeds in the dose-response using glyphosate herbicide.
Based on table 3, it is known that *E. indica* has a resistance index (IR) of G1, G2, and G3 respectively 5, 6, and 8. This is in line with previous research which reported that the entire weed population of *E. indica* in the afdeling block of oil palm plantations at PTPN IV Serdang Bedagai Adolina Gardens has developed resistance to glyphosate and paraquat. The level of resistance of weed populations in each Adolina garden afdeling block against glyphosate and paraquat herbicides was different. Weed population of *E. indica*, glyphosate-resistant 57 blocks moderate resistant 1 block. Weed population *E. indica*, resistant to paraquat 55 blocks, and moderate resistant 3 blocks [5].

**Table 3. E.indica Resistance Indexes on G1, G2, and G3 Based on LD50 using glyphosate herbicide.**

| Herbisida | Population | LD50 | R/S |
|-----------|------------|------|-----|
| Glyphosate | G0         | 312  | 1   |
|           | G1         | 1506 | 5   |
|           | G2         | 1820 | 6   |
|           | G3         | 2594 | 8   |

From the results obtained at the dose-response stage using paraquat herbicide, it is known that the higher the dose is given, the lower the percentage of weeds survive (figure 2). In the P0 and P1 weeds, the percentage of survival was 83.3% and 44.4%, while the percentage of weeds P2 and P3 were 25.0% and 16.6%, respectively.

**Figure 2.** Percentage of *E.indica* that survived in P0, P1, P2, and P3 weeds in the dose-response using paraquat herbicide.

Based on table 4, it is known that *E. indica* has a resistance index (IR) in each of P1, P2, and P3 of 2.3 and 7. This is in line with research which states that there is an increased sensitivity *L. Rigidum* population against a new herbicide, pyroxasulfone, at low to high dose levels. This dose was chosen from polygenic resistance controlled by more than one gene as site-not-target metabolic resistance. A dose-response experiment was carried out to determine the level of resistance to pyroxasulfone [10].

**Table 4. E.indica Resistance Indexes on P1, P2, and P3 Based on LD50 using paraquat herbicide.**

| Herbicide | Population | LD50 | R/S |
|-----------|------------|------|-----|
| Paraquat  | P0         | 224  | 1   |
|           | P1         | 549  | 2   |
|           | P2         | 568  | 3   |
|           | P3         | 1500 | 7   |
4. Conclusions
Based on testing weed control using herbicide has more use when compared with the other techniques. In the first generation until third generation, there was an increase in *E. indica* survival against glyphosate and paraquat herbicides. LD50 of glyphosate in the moderate resistance index category (6-8) is found in G2 and G3, while the low resistance index category (2-5) is in G1. LD50 paraquat in the moderate resistance index category (6-8) is found in P3, while the low resistance index (2-5) is in P1 and P3.

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