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Glyphosate Application and Potential Eleusine Indica Resistance in Oil Palm Plantations

Abdul Muin, [1]Herry Wirianata [1] and Teguh Nugraha[2]

[1] *Study Program of Agrotechnology,Institut Pertanian Stiper Yogyakarta, Indonesia*
[2]*Alumny of Institut Pertanian Stiper Yogyakarta, Indonesia*

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CORRESPONDING AUTHOR

*E-mail: *her.wirianata@gmail.com*

A B S T R A C T

Eleusine indica is a grass weed in oil palm plantations, especially during the period of immature crops. The application of glyphosate for weed control shows diverse effectiveness. This study aims to determine the age of susceptible weeds in increasing the effectiveness of glyphosate in controlling E. indica. The study tested the application of glyphosate with three levels (486, 729, and 972 g/ha) at three different weed ages (3, 6, and 9 weeks). E. indica was taken from oil palm plantations that were previously glyphosate-depleted, then sprayed with glyphosate according to the dose studied. Each treatment combination is represented by five pots containing five individual weeds. The results showed that the application of glyphosate aged three and six weeks of higher effectiveness controlled E. indica for doses of 486 and 729 g/ha) than a nine-week application for all doses tested. Regrowth of weeds is found mainly the application of glyphosate at the age of a month of weeks. The development of E. indica's resistance to glyphosate needs attention in oil palm plantations.

1. INTRODUCTION

1.1. Research Background

Weeds in oil palm plantations cause losses due to competition in terms of sunlight, nutrients, and living space. The loss of crop production inflicted by weeds is greater (32%) compared to pests (18%) and diseases (15%). However, if control is not carried out, both physically, chemically and biologically, then the loss of this crop production can reach 69.80% [1]. In general, weed control in oil palm plantations is carried out chemically with rotational control (dizziness) [2].

Weed control in oil palm plantations is generally carried out chemically. Herbicides are used repeatedly over a long period with the same mode of action so that weeds become resistant, so controlling them becomes more difficult. Eleusine indica L (grass) is one of the weeds often found in oil palm plantations [3]. Grass belulang is a grass species with keomosom 2n=18, native to Africa and Asia. Photosynthesis of this weed includes C4 plants and proliferates in a state of full sun and hot areas. On the contrary, shading caused by the canopy of staple crops greatly inhibits their growth [4] so this weed is a problem in immature oil palm plantations. The growth of this weed is very aggressive and produces abundant seeds, so it becomes a major problem in the management of the garden. The results of [5] and [6] revealed that striped grasses showed resistance to glyphosate and paraquat compared to sensitive populations. Resistance to glyphosate was found in 57 populations (98.28%) in oil palm plantations in Serdang Bedagai. E.indica is resistant to glyphosate and paraquat herbicides after repeated use for 26 years.

1.2. Literature Review

Glyphosate resistance was first observed in 1996. Originally, glyphosate, which has unique features such as how it works, chemical structure, limited plant metabolism, and low residual activity in the soil, is the cause of limited weed resistance.

Glyphosate inhibits the enzyme 5-enolpyruvatshikimate-3phosphate synthase (EPSP), inhibits plants from producing amino acids by inhibiting the binding of phosphoenolpiruvate substrates with EPSP, suppressing EPSP production, thereby causing death [7]. Glyphosate is widely used to control weeds in perennial crops because it has a broad spectrum, including controlling annual sugars, which often cause problems on the farm. However, the prolonged use of glyphosate in various regions is the cause of continuous selection pressures on weed communities, spurring the evolution of weed biotypes resistant to the herbicide [8]. Grass populations have multiple resistance to glyphosate, gluphonate, paraquat, and herbicides that inhibit

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acetyl CoA carboxylase (ACCase) [9]. [10] reports that worldwide biotype S of E. indica are resistant to mitosis inhibitors, ALS inhibitors, ACCase inhibitors, Photosystem I inhibitors, and EPSP inhibitors.

The dependence on oil palm plantation management to use glyphosate in controlling weeds, including E. indica is very large, so it is necessary to find alternatives to increase its effectiveness by considering the growth stage of these weeds.

1.3. Research Objective

This study aims to show the effect of glyphosate doses given on several stages of weed growth and the potential resistance of E. indica in oil palm plantations.

2. MATERIALS AND METHODS

This study is a factorial experiment consisting of 2 factors and is arranged in a complete randomized design (Completely Randomized Design) with 3 tests. The first factor is the age of the weed Eleusine indica at the application of glyphosate, consisting of 3 levels, namely 3, 6, and 9 weeks after the weed grows. The second factor is the glyphosate dose consisting of 3 levels, namely 486, 729, and 972 g /ha. Each test consists of 5 pots of weeds, each containing 5 weeds of Eleusine indica. Observations are carried out once a week to 8 weeks after application by observing weeds and scoring the level of poisoning in each treatment. Weed poisoning scoring can be seen in Table 1

Table 1. Scoring symptoms of E. indica poisoning against glyphosate

Score	Controlled Weeds (%)	Poisoning criteria
1	100	Dry leaves/ dead weeds
2	96.5-99.0	Most of the leaves dry out
3	93.0-96.5	Weeds begin to dry out
4	87.5-93.0	Satisfactory efficacy/all yellow leaves
5	80.0-87.5	Efficacy is quite satisfactory/ partial yellowing
6	70.0-80.0	Unsatisfactory efficacy
7	50.0-70.0	Slightly damaged weeds
8	10.0-50.0	Meaningless weed damage
9	0	Weeds are not damaged

E. indica resistance was observed based on the regrowth of weeds one month from the time the observation of the influence of glycophate ended (8 weeks after application). Such growth is based on the growth of this weed that survives after the application of glyphosate.

3. RESULT AND DISCUSSION

The results showed a marked difference in the development of symptoms of glyphosate toxicity to E. indica, depending on the lecturer of application and the age of the weed at the time of application. The development of such symptoms also varies between observation times for each treatment combination studied, as shown in Table 2.

Table 2. The development of symptoms of poisoning in E. indica after the application of glyphosate

Age of E.indica and glyphosate dose (weeks and g/ha)	The degree of weed poisoning (weeks after application)							
	1	2	3	4	5	6	7	8
3-486	8.0 d	7,2 e	4.0 b	1,3 a	1.0 a	1.0 a	1.0 a	1.0 a
3-729	2.0 a	1.0 a	1.0 a	1.0 a	1.0 a	1.0 a	1.0 a	1.0 a
3-972	2.0 a	1.0 a	1.0 a	1.0 a	1.0 a	1.0 a	1.0 a	1.0 a
6-486	8.0 d	8.0 f	8.0 c	6.6 c	5.7 c	3.7 c	3.2 b	3.2 b
6-729	6.0 c	3.0 b	1.0 a	1.0 a	1.0 a	1.0 a	1.0 a	1.0 a
6-972	5.0 b	1.0 a	1.0 a	1.0 a	1.0 a	1.0 a	1.0 a	1.0 a
9-486	8.0 d	8.0 f	8.0 c	8.0 d	7.7 d	7.2 d	7.2 c	7.2 c
9-729	6.0 c	6.0 d	4.0 b	3.2 b	2.7 b	2.5 ab	2.2 ab	2.2 ab
9-972	5.0 b	5,2 c	1.0 a	1.4 a	1.4 a	1.5 b	1.3 a	1.3 a

Description: the average followed by the same letter in the column shows between treatments not significantly different based on the Duncan test

Table 2 shows that glyphosate applications in weeds aged three weeks after planting (WAA) caused the most severe symptoms of poisoning. All leaves of this weed dried up from one MSA and experienced complete death for doses of 729 g/ha and 972 g/ha from two WAA to 8 WAA. The application of this herbicide at the age of 6 weeks of weeds showed variations in the development of poisoning rates between doses. The result of these symptoms was slower at the lowest dose (486 g/ha), starting to dry out at 6 – 8 WAA and not dying until the end of the study. The development of these symptoms is almost the same between doses of 729 g/ha and 972 g/ha and weeds faster than other doses, but up to 8 WAA still do not experience complete death, and this has the potential to regrowth. The grass belulang showed glycophate resistance applied at 9 months of age for all doses tested, so the weeds did not experience complete death at the end of the study, thus potentially re-developing more rapidly than before. Therefore, E. indica resistance in oil palm plantations needs attention because it has the potential to cause losses: reduced growth at the beginning of transplanting, losses in juvenile palms, the potential to increase pest and disease attacks, and interfere with fertilizer application. This weed develops rapidly in open conditions (as long as the plant is immature) [11]. Resistant E. indica has the enzyme ESPS synthase, which is less sensitive to glyphosate [12].

E. indica's resistance to glyphosate is also indicated by the regrowth of such weeds. The results showed that such resistance was influenced by the interaction of weed age at application and glyphosate dose, as shown in Table 3.

Table 3. The amount of E. indica per clump that regrows after glyphosate application

Weed age (weeks)	Glyphosate dose (g/ha)		
	486	729	972
3	4.6 a	6.1 a	6.4 a
6	10.3 a	9.3 a	4.6 a
9	87.8 c	66.8 b	63.9 b

Description: the average followed by the same letter indicates a treatment that does not differ markedly based on Duncan's test

Table 3 shows that applications of glyphosate 486 g/ha and 729 at 3 and 6 weeks of E. indica were more effective in suppressing the regrowth of weeds in question than applications aged 9 weeks for all tested doses. This reveals the age of the weed affects its sensitivity to glyphosate. Herbicide resistance is caused by biotransformation, thus affecting the sensitivity of the site of action in weed cells. Glyphosate resistance depends on the dosage of application of the herbicide. Resistant E. indica absorbs and translocates glyphosate in smaller quantities. Herbicide uptake and translocation decrease with the age of weeds, limiting the movement of lethal herbicide concentrations to the site of action [13]

It is also known that the application of all doses of glyphosate tested at nine weeks of age resulted in a much greater amount of E. indica regrowth compared to 3- and 6-week-olds. This result corresponds to the slow and mild development of poisoning symptoms until the end observation. [14] mentioned that structural barriers such as cuticles and cell walls get thicker with the age of weeds so that the penetration and translocation of glyphosate is reduced in the tissues, causing the active ingredients that reach the site of action not to be in lethal concentrations. To avoid the resistance of this weed after the application of glyphosate is interspersed with herbicides with different active ingredients. [15] stated that E. indica is effectively controlled with topramezone in the dinitroaniline resistant.

4. CONCLUSION

Applications of glyphosate 729 g/ha and 972 g/ha at the age of three and six weeks effectively controlled E. indica weeds. However, the application at the age of nine weeks was not effective for as many doses studied due to a structural barrier to the penetration and translocation of glyphosate. The potential of E. *indica* to be resistant to glyphosate is greater with increasing doses of such applications as indicated by the regrowth of E indica.

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