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The Growth of Soybean Plant Due To the Application of Various Dosages of Oxyfluorfen and Pendimethalin Herbicide

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Abstract: *The effectiveness of herbicides in controlling weeds is largely determined by the type and dose of herbicide. This study aim to obtain the types and doses of herbicides to control weeds in soybean plants. The types of herbicides used were: oxyfluorfen and pendimethalin, whereas the used doses were: 0; 0.5; 1.0; 1.5; and 2.0 kg a.i ha^{-1}. The research was designed as a randomized block design with a bifactorial pattern. The observed variables were: leaf area width, dry root weight and dry plant weight. The results indicated that the herbicide dose of 0.5 kg a.i ha^{-1} is capable of increasing leaf area width, dry root weight and dry plant weight.*
Key words*: soybean, herbicide, oxyfluorfen and pendimethalin.*

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I. Introduction

The competition between weeds and soybean plants in terms of nutrients, water and sunlight, will result in abnormal soybean growth followed by interrupted plant physiological processes which in turn have a negative impact on soybean crop yields. The ability of weeds to compete for light and nutrients can limit plant growth[1.2]. Furthermore added that the weed competition in each soybean crop is also influenced by the ability of plants to compete as well as the number and types of associated weed species[3], plant varieties and the level of fertilization[4].

In order to increase the growth and yield of soybean plants, it is necessary to control weeds around the soybean plant. Controlling weeds manually by hands is included as simple controls method yet it is labor and time intensive. By the correct application of herbicides, it can produce relatively less cost and labor method. The application of herbicides to control grass and broadleaf weeds in large planting areas with relatively expensive labor, considered as an effective and efficient way[5.6], and reduces damage to the soil structure[7.8.9.10]. Commonly used herbicides to control weeds in pre-grown condition particularly in soybean crops are oxyfluorfen and pendimethalin[11].

Oxyfluorfen herbicides can control grass weeds and broadleaf[12.13.14.15]. Furthermore, for susceptible species of weeds the immediate response will be followed by the initial symptoms such as discoloration, stunted weed growth, and escalation of toxicity levels of up to 100%[16]. Oxyfluorfen herbicide is utilized when the plant can suppress weed growth[17]. Added that the suppressed growth of weeds due to the application of herbicides can cause its morphology changes, as the result soybean plants will be able to maximize growth and provide higher yield[18].

The application of the pendimethalin herbicide has less negative impact on soybean germination and growth. Furthermore, this herbicide can improve weed control efficiency, reduce weed density, weed dry weight and increase soybean crop yields[19]. The pendimethalin herbicide can control important weeds in soybean cultivation, particularly effective on anually grass and broadleaf weeds[20.21.22], yet it is not effective on perennial weeds[23].

The results of research stated that the application of the pendimethalin herbicide at a dose of 4 - 8 kg a.i ha^{-1} can reduce the dry weight of weeds[24]. Furthermore added that the application of the pendimethalin herbicide at a dose of 1.5 kg a.i ha^{-1} can reduce the percentage of weed coverage and increase the efficiency of weed control. Furthermore, at this dose, the number of pods of per plant, number of seeds per plant, weight of 100 seeds, weight of seeds per plant and dry seeds of soybean per plants can be increased[18].

Oxyfluorfen and pendimethalin herbicides can control weeds in the pre-growth period, therefore soybean plants will be able to increase their growth immediately, which is expected to support the components of soybean yields. The oxyfluorfen and pendimethalin herbicides are considered as pre-grown herbicides which mainly used in soybean cultivation[25].

II. Material And Methods

This research was conducted in Meunasah Manyang Village, Krueng Barona Jaya Subdistrict, Aceh Besar, Aceh, Indonesia. This research had started from May until August 2019. The tools used were watering can, oven, analytical scale, measuring cup and knapsack hand sprayer. The materials used was Devon 1 soybean seeds, the oxyfluorfen and pendimethalin herbicides, label paper, rhyzogin, nitrogem fertilizer (Urea), phosphate fertilizer (SP36), kalium fertilizer (KCl), 2,5 EC deltamethrin insecticide and 0.005% brodifacoum rodenticide, and Leaf Area Meter Type AAM 7.

This study designed as bifactorial randomized block design (RBD) with 3 replications, there were 30 experimental units. The observed factors were the type of herbicide, namely oxyfluorfen and pendimethalin, whereas the herbicide dose were 0; 0.5; 1.0; 1.5; 2.0 kg a.i ha^{-1}. The plot measuring of 2.5 m x 2.5 m each. Soil processing was conducted twice. Each seed was planted in a 3 cm depth hole. Each planting hole contained 3 soybean seeds that had been inoculated with Rhizoplus. For the herbicide application, a 15 liter capacity hands prayer was used with the spraying capacity of 300 L ha^{-1}.

The agronomic treatment such as the application of oxyfluorfen and pendimethalin herbicide were conducted according to the treatment dose at 1 day after planting (DAP). To anticipate pests, deltamethrin insecticides and 0.005% brodifacoum rodenticides were used. The fertilizers used were urea, SP36, and KCl with doses of 50, 60 and 70 kg ha^{-1} respectively. Urea fertilizer was applied in stages, half portion was given at transplanting time, mixed with all SP36 and KCl fertilizers. The remaining half was applied at 30 DAP.

The observed variables were leaf area width, dry root weight and dry plant weight. If there is an effect of treatment on the observed variables, the further test will be conducted using Duncan New Multiple Range Test (α=5) using the SPSS version 16 program.

III. Result And Discussion

Leaf area width

Table 1 indicates that the herbicide types do not differ to the leaf area width of soybean plants. This is because both types of herbicides are suitable for soybean cultivation. Oxyfluorfen and pendimethalin herbicides are recommended in soybean cultivation[11]. Herbicide doses of 0.5 - 1.0 kg a.i ha^{-1} are able to increase the leaf area of soybean plants (Table 1). This is due to the fact that the dosage of 0.5 - 1.0 kg a.i ha^{-1} is close to a selective dose, meaning that the herbicide dose can control weeds without poisoning the soybean plants. The controlled weeds condition can be occurred due to the right dose of herbicide which directly reduce the competition between weeds and soybean plants to absorb nutrients, water, and sunlight. Thus, the formation of plant organ growth can be increased, for example the increasing leaf width area, dry root weight (Table 2) and dry plant weight (Table 3). As stated that the herbicide dose had an effect on plant growth[22.26].

Table 1 Average leaf area width of soybean plants at 21, 35, 49 and 63 DAP due to the type and dose of herbicide

Treatment	Leaf area (m^2)			
	21	35	49	63
Types of herbicides				
Oxyfluorfen	1.39	9.70	15.90	23.72
Pendimetalin	1.55	9.63	16.02	34.33
Herbicide dosage (kg a.i ha^{-1})				
0	1.65b	13.11c	14.98	22.78
0.5	2.32c	13.09b	19.61	21.51
1.0	1.67b	1.22b	21.22	30.33
1.5	0.99a	5.89a	11.01	18.40
2.0	0.73a	6.02a	12.99	17.75

Note: The numbers followed by the same letter are not significantly different based on the Duncan test $\alpha = 0.05$)

Dry Root Weight

Table 2 indicates that the type of herbicide has no effect on dry root weight of soybean plants. This is because the two types of herbicides with different ways of work showing that each herbicide has advantages and disadvantages. Herbicide doses of 0.5 - 1.0 kg a.i ha^{-1} can increase the dry root weight of soybean roots (Table 2). It can also be concluded that the higher the applicated herbicide dose the lower the dry weight of the plant roots. This can be explained that there is soybean plant poisoning response due to increased herbicide doses. The event of plant poisoning begins with the occurrence of herbicide solutions on the surface of the soil profile[27] at the time of herbicide application, which is then absorbed by soybean seeds, thereby affecting root growth, causing swelling emergence of the root tips, hypocotyl thickening, failure of unrolling leaf and wrinkling leaf tissue[28.29.30]. Furthermore, the poisoning effect results in the defection of the root nodules that will lead to the

failure of fixing nitrogen supply, which should be used for various enzymatic processes, for example increasing carbohydrates and protein, to build plant growth. Thus, it takes time for the process of restoring the growth of soybean plants. Such events can also affect the formation of plant organs, for example the reduced leaf area width (Table 1), dry root weight (Table 2) and dry plant weight (Table 3).

Table 2 Average dry weight of soybean plants at 21, 35, 49 and 63 DAP due to the type and dose of herbicide

Treatment	Dry root weight (g)			
	21	35	49	63
Types of herbicides				
Oxyfluorfen	1.1	7.5	15.2	29.6
Pendimetalin	1.0	7.4	13.9	25.0
Herbicide dosage (kg a.i ha^{-1})				
0	1.3c	10.2c	12.8b	25.3
0.5	1.5d	8.0c	17.8c	27.9
1.0	1.0b	7.8b	20.0c	38.9
1.5	0.8a	5.2a	13.5b	19.3
2.0	0.7a	6.1a	8.7a	25.0

Note: The numbers followed by the same letter are not significantly different based on the Duncan test α = 0.05)

Dry Plant Weight

Table 3 indicates that the type of herbicide has no effect on the dry weight of soybean plants. This is due to the fact that the two herbicides were applied pre-grown, thus it is likely that the herbicide solution will be absorbed by the soybean seeds. That if herbicides are applied to the soil, one of the principles of the solution can be absorbed by plants[31]. Herbicide doses of 0.5 - 1.0 kg a.i ha^{-1} can increase the dry weight of soybean plants (Table 3). This is due to controlled weeds without poisoning the soybean plant, therefore it can provide benefits to soybean plants in terms of maximum environmental utilization, this is expressed by an increase in dry plant weight. This phenomenon begins with an increase in the rate of photosynthesis which increases growth through the formation of plant organs such as roots, stems and leaves.

Table 3 Average dry plant weight of soybean plants at 21, 35, 49 and 63 DAP due to the type and dose of herbicide

Treatment	Plant dry weight (g)			
	21	35	49	63
Types of herbicides				
Oxyfluorfen	21.1	50.5	109.4	210.2
Pendimetalin	8.7	44.4	102.4	198.5
Herbicide dosage (kg a.i ha^{-1})				
0	17.2	57.3b	105.2b	222.8
0.5	19.5	65.0c	136.7c	192.5
1.0	26.4	51.1b	157.4c	289.6
1.5	5.9	31.0a	71.0a	156.7
2.0	5.6	33.0a	59.3a	159.9

Note: The numbers followed by the same letter are not significantly different based on the Duncan test α = 0.05)

The escalation value of dry plant weight as well. The event can be occurred related to the escalation value of plant leaf area width (Table 1) which facilitate the increase in the photosynthetic apparatus, the higher the interception value of solar radiation for the photosynthesis process which causes an increase in photosynthate, which is then stored in the storage network thus as to increase plant development and growth. Crop competition against weeds results in low leaf area width values and dry plant weight[1]. The application of herbicides can cause disrupted weed growth therefore plants can absorb nutrients optimally, the resulting photosynthate will be used to increase growth, increased growth can directly increase plant dry weight. Added that the herbicide application is required to minimize competition against weeds, while also minimizing the potential harm, for example, the main crop is poisoned[32.33]. It can be understood that at a relatively lower dose of herbicide 0.5 - 1.0 kg a.i ha^{-1} is capable of stimulating soybean plants growth, if applied at higher doses the stimulating effect is not visible, instead the plants experience poisoning, as in the phenomenon that occurs due to herbicide doses of 1.5 - 2.0 kg a.i ha^{-1}.

IV. Conclusion And Suggestions

Herbicide doses of 0.5 - 1.0 kg a.i ha^{-1} can increase plant leaf area width, dry root weight and dry plant weight. Further research is required on the application of oxyfluorfen and pendimethalin herbicides at doses below 1.0 kg a.i ha^{-1} on the level of plant poisoning and its correlation to soybean crop yield.

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