EFFECT OF LIQUID ORGANIC FERTILIZER PAITAN LEAF EXTRACT(*Tithoniadiversivolia*) ONTHE GROWTH AND YIELDSOF SOYBEAN PLANT (Glycine max (L.) Merrill)ON RAINFED LAND

ABSTRACT

Soybeans (*Glycine max* (L.) Merrill) are the third main food commodity after rice and corn. Until now, soybean productivity at the farmer level is still low, with an average of 1.3 Mgha^{-1} with a range of 0.6-2.0 Mgha^{-1}, while the potential yield can reach 3.0 Mgha^{-1}. This very large productivity gap provides an opportunity to increase production through increasing productivity at the farmer level. This research aims to determine the effect of POC of paitan leaf extract (*Tithoniadiversifolia*) and the best concentration on the growth and yield of soybeans on rainfed land.This research was carried out in March – June 2021 in GunungPanjang Village, TanjungRedeb District, East Kalimantan Province, Indonesia. Data analysis uses Analysis of Variance, if there is a significant difference, then continue using the Duncan's Mutiple Range test at the 5% level. The research used a Completely Randomized Block Design with five treatments, namely t0 (control), t1 (25%), t2 (50%), t3 (75%), and t4 (100)% with 5 replications. The results showed that the concentration of *Tithoniadiversifolia* leaf extract did not differ significantly on the number of productive branches, total pods, total branches, flowering time, filled pods, empty pods, weight of 100 grains, yield, and potential yield except plant height. The t2 concentration (50%) gives the highest average yield potential, namely 3.22 Mgha^{-1}.

Keywords: Soybeans (*Glycine max* (L.) Merrill), Liquid Organic Fertilizer, Concentration, Tithoniadiversifolia, RainfedLand

INTRODUCTION

Soybeans (*Glycine max* (L.) Merrill) are a type of legume plant that has great potential as a source of vegetable protein. Its position is very important in food needs because it is widely consumed by the public and contains high nutritional value. As a source of protein, it ranks first among legumes.

In Indonesia, soybean is the main food crop commodity after rice and corn. Until now, productivity at the farmer level is still low, with an average of 1.3 Mg.ha^{-1} with a range of 0.6-2.0 Mg.ha^{-1}, while the potential yield can reach 3.0 Mg.ha^{-1}. This very large productivity gap provides an opportunity to increase production through increasing productivity at the farmer level (Adisarwanto, 2014; Aldillah, 2015; Dzuhrinia and Noor, 2017).

Needs continue to increase from year to year linearly with the increase in population, while the production achieved has not been able to keep up with these needs (Rohmah and Saputro, 2016; Sari, et al. 2014.).

The utilization of dry land is one of the strategies for increasing national production and is greatly influenced by cultivation techniques. Most farmers still rely on rain as a water source for cultivation activities (Fauzi and Puspitawati, 2018).

One of the things that influences production is the availability of nutrients needed by plants. There are many methods used to meet the availability of nutrients in the soil, including through fertilization which aims to increase the chemical content. Fertilization can be applied directly into the soil, and can also be applied through the leaves (Tamba et al., 2017).

Liquid fertilizer is easier for plants to use because the elements contained are easily decomposed so they can be used more quickly for plant growth. The advantage is that the nutrient content is varied, namely containing macro and micronutrients, nutrient absorption is faster because it has been dissolved (Febrianna et al., 2018; Felicia, 2017). When compared to inorganic fertilizers, they generally do not damage the soil and plants even if they are used as often as possible. Apart from that, this fertilizer also has 18 binding ingredients so that the fertilizer solution applied to the soil surface can be directly used by plants (Manuel and Sandryan, 2017). A good fertilizer to use to increase growth is fertilizer made from basic ingredients that contain macro and micronutrients because it can increase the vegetative and generative growth of plants (Anggraeni, 2017).

Providing paitan (*Tithoniadiversifolia*) leaf extract can reduce Al, and increase soil pH, organic matter, soil N, P, K, Ca, and Mg nutrient content, thereby increasing plant productivity. The results of Hastari's research (2019) show that administering a 25% concentration of liquid organic fertilizer

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containing *Tithoniadiversifolia* leaf extract is more efficient in increasing the number of leaves, fruit weight per plant, wet weight, and dry weight of the plant.

Rainfed land is a potential resource for developing soybeans because most of it has not been utilized optimally. Paitan (*Tithoniadiversifolia*) is an annual weed that can be used as organic fertilizer for food crops. The biomass can be used as green manure, mulch, or compost to increase the physical and biological fertility of the soil. The leaves and stems are used as organic fertilizer to increase seed growth and yield. With various concentrations of liquid organic fertilizer (POC) Paitan leaf extract is expected to increase growth and yield in soybean plants (Suastika, 2018; Winardi, 2014).

This research aims to determine the effect of POC of paitan leaf extract (*Tithoniadiversifolia*) and the best concentration on the growth and yield of soybeans on rainfed land.

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METHODS

2.1. Time and place

This research was carried out from March – June 2021 in GunungPanjang Village, TanjungRedeb District, East Kalimantan Province, Indonesia.

2.2. Material

The materials used are soybean seeds, compost, EM4, molasses, coconut water, and the *Tithoniadiversifolia*paitan plant. The tools used in this research were hoes, machetes, stakes, buckets, measuring cups, plastic barrels, hand sprayers, meters, rulers, stationery, labels, markers, electric scales, and raffia rope.

2.3. Experimental design

The research method that will be used in this study is a Completely Randomized Block Design (CRBD) with one factor, namely the treatment of paitan leaf extract (*Tithoniadiversifolia*) consisting of 5 replications, namely: t0 = 0%, t1 = 25% POC, t2 = 50% POC, t3 = 75% POC, t4 = 100% POC

2.4. Research procedure

2.4.1. Making a concentration of POC solution of paitan leaf extract *Tithoniadiversifolia*. Before application, POC is diluted until the volume reaches 1000 ml for each concentration. At a concentration of 25%, dilution is carried out by adding 250 ml of POC 750 ml of water, and so on.

2.4.2. Giving POC paitan leaf extract (Tithoniadiversifolia). The application of liquid organic fertilizer was carried out 7 times (Sari, et al. 2014) with an interval of every 7 days and applied 3 weeks after planting.

2.4.3. Land Preparation. The land is cleared of weeds, then this is done using a hoe, loosening, and measuring the land according to the area of land needed, then making a bed 130cm x 130cm wide with a height of 10 cm.

2.4.4. Seed Preparation. The seeds to be cultivated are the Anjasmoro variety (Balitkabi, Malang), then soaked for 24 hours in soil from land that has been planted with legumes.

2.4.5. Planting Seeds. This is done in single strokes, approximately 2-3 cm deep, with 2 seeds per planting hole, then covered with soil.

2.4.6. 20 kg plot^{-1} compost fertilizer is applied before planting begins by mixing it in the bed during land processing.

2.4.7. Watering is carried out in the morning and evening at several growth phases that require a lot of water, namely during germination (0-5 DAP), early vegetative stage (15-20 DAP), flowering period, and formation of 19 seeds (35-65 DAP). The phase that requires a little water is only carried out in the morning, and when the seeds are ripe, watering is stopped (Irfan, 2018; Khadijah et al., 2017; Khadijah, 2017).

2.4.8. Weeding was carried out during the planting period until completion of data collection at 21-day intervals which was carried out manually (Felicia, 2017).

2.4.9. Pest and disease control. This is done by sanitizing the land at 21-day intervals.

2.4.10. Harvest. The criteria for plants that are ready to harvest are characterized by pods that are more than 90% brownish, stems that have dried out, and leaves that have fallen off. Harvesting is done by uprooting the plant and removing the pods from the plant. After harvesting, it is dried in the sun for 2-3 days. Next, shelling and cleaning the seeds from dirt is carried out (Lestari, 2016; Sofiah, 2018).

2.5. Data Collection

2.5.1. Plant Height (cm). Measured from the soil surface to the tip of the top leaf carried out at weeks 1, 3, and 5.
2.5.2. Total Number of Branches (branches). Observation of the total number of branches was carried out at week 6 by counting the number of branches that produced pods and branches that produced empty pods.
2.5.3. Number of Productive Branches (branches). Observations on the number of productive branches were carried out at weeks 6, 9, and 12 by counting the number of branches that produced pods.
2.5.4. Flowering Time 80% (days). Observations were made by calculating the age of the plants from planting until the plants formed flowers, namely 80% of the population in each treatment plot.
2.5.5. Total Number of Pods (pods). Observations were made at harvest by counting the total number of empty and filled pods per plant. Calculations are made in pods per plant.
2.5.6. Number of Pods Contained (pods). Observations were made at harvest by counting the total pod contents per plant.
2.5.7. Number of Empty Pods (pods). Observations were made at harvest by counting the total empty pods per plant. Calculations are made in pods per plant.
2.5.8. Weight 100 grains (grams). Observations were made by counting and selecting 100 seeds at random and then weighing them.
2.5.9. Yield Potential ($Mgha^{-1}$). The potential results studied can be calculated using the following formula.
Potential Yield = (Weight per plot (kg) x 10,000 m^2):(Plot area (m^2)

2.6. Analysis Method

Data analysis uses analysis of variance. If there is a real difference, then continue using Duncan's mutiple range test at the 5% level.

RESULTS AND DISCUSSION

3.1. Research Result

3.1.1. Plant Height Age 1, 3, and 5 Weeks after Planting (WAP).

The results of the analysis of variance in plant height 1 week after planting showed that the POC treatment of *Tithoniadiversifolia* leaf extract was not significantly different. Meanwhile, plant height at 3 and 5 WAP showed significant differences (Table 1).

Table 1. Plant Height aged 1, 3, and 5 Weeks After Planting (cm)

Treaments	Average (cm)		
	1 WAP	3 WAP	5 WAP
t_0 (0%)	3.13	25.68 a	61.00 a
t_1 (25%)	3.53	33.40 ab	69.00 b
t_2 (50%)	3.27	31.20 b	68.00 b
t_3 (75%)	3.40	35.54 b	69.66 b
t_4 (100%)	3.60	36.66 b	70.02 b

Note: Numbers followed by different letters in each column of the same observation are significantly different based on the Duncan Test at the 5% level; WAP = weeks after planting

3.1.2. Total Number of Branches, Productive Branches (branches) Age 6, 9, and 12 WAP, and Flowering Time

The results of the analysis of variance in the number of total branches, and productive branches, the height of plants aged 6, 9, and 12 WAP, and the flowering time of 80% showed that the POC treatment of *Tithoniadiversifolia* leaf extract was not significantly different (Table 2).

Table 2. Number of Total Branches, and Productive Branches Aged 6, 9, and 12 Weeks After Planting (Branch), and 80% Flowering Time (Days After Planting)

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Treatments	Average Total Branches (branches)	Average Productive Branches (branches)			Flowering Time 80% (Days After Planting)
	6 WAP	6 WAP	9 WAP	12 WAP	
t_0 (0%)	12.52	6.80	8.06	9.06	35.00
t_1 (25%)	12.26	6.40	8.54	9.34	35.40
t_2 (50%)	13.26	5.94	9.32	10.80	34.80
t_3 (75%)	12.78	6.54	9.28	10.14	35.00
t_4 (100%)	12.86	5.00	7.92	9.46	34.40

3.1.3. Total Number of Pods, Filled Pods and Empty Pods (Pods), Weight of 100 Pods (g), Yield (g), and Potential Yield

The results of the analysis of variance in the total number of pods, filled pods, empty pods, weight of 100 grains (g), yield (g) and yield potential (Mg ha^{-1}) showed that the POC treatment of *Tithoniadiversifolia* leaf extract was not significantly different (Table 3).

Table 3. Total number of pods, filled pods and empty pods (pods), weight of 100 grains (g), yield (g), and potential yield (Mg.ha-1).

Treatments	Average Number of Pods			Weight of 100 Grains (g)	Yield (g)	Potential Yield (Mg ha^{-1})
	Total	Filled Pods	Hollow Pods			
t_0 (0%)	56.42	46.80	9.86	15.74	487.60	2.84
t_1 (25%)	57.66	48.34	9.34	16.48	544.80	3.22
t_2 (50%)	63.12	55.02	8.14	17.82	540.00	3.22
t_3 (75%)	60.12	51.34	9.10	16.22	552.20	3.10
t_4 (100%)	61.48	52.60	9.20	16.00	530.40	3.16

3.2. Discussion

3.2.1. Plant Height

Based on Table 1, shows that giving POC *Tithoniadivesifolia* leaf extract with increasing concentrations can significantly increase plant height at the age of 3 WAP and 5 WAP, the best plant height was found at t4, namely with an average of 70.02 cm. This is because POC contains quite high levels of nitrogen, so with increasing N supply the amount of N is more available for plant growth (Nugroho and Jumakir, 2020). Plant growth and production will reach optimum if the supporting factors supporting growth are in an optimal state, the elements are balanced, and the right dose of fertilizer and the required nutrients are available to the plant (Bustami et al., 2012 in Ramayana, et al., 2023).

The nutrients N, P, and K are macronutrients that are widely absorbed by plants, especially in the vegetative phase (Manik et al., 2018), and nitrogen is a nutrient that is very necessary for plant vegetative growth (Iskandar, 2013 in Ramayana, et al., 2021; Nurdin, et al., 2010 in Ramayana, et al., 2022). In the vegetative phase, plants need nutrients to support their growth, one of which is increasing plant height. In this phase, plants need protein to build their bodies which is taken from nitrogen. Therefore, in the vegetative phase, plants need a lot of nutrients, especially N (Suryani et al., 2016).

3.2.2. Number of Total Branches and Productive Branches

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Based on Table 2, shows that giving POC *Tithoniadivesifolia* leaf extract did not significantly differ from the average number of total branches and the number of productive branches at the ages of 6, 9, and 12 WAP. However, there is a tendency for t2 to provide the best number of productive branches of the plant. It is suspected that giving excessive amounts of fertilizer no longer increases plant growth but instead, plant growth becomes less than optimal (Satria, 2015).

There is a tendency that the greater the concentration of liquid organic fertilizer given, the greater the number of branches formed. This is caused by the element N content which can stimulate the vegetative growth of plants, especially the branches that form (Tisdale and Nelson in Sirende et al., 2016). N to form leaf chlorophyll so that the photosynthesis process is hampered (Manik et al, 2018). In the vegetative phase, plants need nutrients to support their growth, one of which is increasing the number of leaves. In this phase, plants need protein to build their bodies which is taken from nitrogen. Therefore, in the vegetative phase, plants need a lot of nutrients, especially N (Suryani et al., 2016). N to form leaf chlorophyll so that the photosynthesis process is hampered (Manik et al, 2018). In the vegetative phase, plants need nutrients to support their growth, one of which is increasing the number of leaves. In this phase, plants need protein to build their bodies which is taken from nitrogen. Therefore, in the vegetative phase, plants need a lot of nutrients, especially N (Suryani et al., 2016; Ademiluyi, 2015 Ramayana, et al., 2021). However, the higher the concentration is given, the number of branches decreases, this is due to the growth-inhibiting properties of the nitrogen element.

3.2.3. Flowering Time

Based on Table 2, shows that giving POC *Tithoniadivesifolia* leaf extract was not significantly different. Plants entering the generative phase, especially flowering, require sufficient phosphorus nutrients. Element P is very necessary for the process of assimilation, and respiration and is needed for the generative development of plants, namely accelerating the flowering and fertilization processes. According to Puspitasari and Elfarisna (2017) the flowering and fruiting process, phosphorus, and potassium are some of the nutrients needed for generative growth.

Calcium content has a close role in apical growth and flower formation, it also functions in cell division, regulation of cell permeability and regulation of water systems in cells, seed germination, development of stamens, and development of rhizobium root nodules (Astiningrum et al., 2012).

3.2.4. Total Number of Pods, Filled Pods and Empty Pods

Based on Table 3, shows that giving POC *Tithoniadivesifolia*leaf extract was not significantly different. There was a tendency for the number of total pods and pods containing the best plants to be found at t2, as well as a smaller number of empty pods. Apart from containing the N element, pod productivity is influenced by the P element (phosphorus), which is very important for the formation and filling of the pods, which ultimately leads to seed formation.

This shows that this concentration can increase the number of filled pods. This is thought to be due to the sufficient nitrogen and phosphorus content contained in it which is very important for the formation and filling of the pods and ultimately for seed formation. This increase is related to the function of the nitrogen contained in it, which according to Lakitan (2020) plays a role as a constituent of protein and chlorophyll. The phosphorus element contained in it can increase pod formation and accelerate pod maturity and the magnesium element plays an important role in phosphate nutrition and acts as a carrier of phosphorus, especially in the seeds (Syaifudin, et al., 2019). According to Fadli, et al., (2016), the dose given more than the plant's needs has no effect but is still within tolerance limits so it does not damage the plant.

3.2.5. 100 Grain Weight, Yield, and Yield Potential

Based on Table 3, shows that giving POC *Tithoniadivesifolia* leaf extract was not significantly different. Statistically, the difference was not significant, but the best weight of 100 plant grains was obtained at t2. It is suspected that good growth and development of plant vegetative organs requires elements such as N, P, K, Mg, and Ca which are sufficient to be able to support good plant generative development (pod formation). According to Puspitasari and Elfarisna (2017) and Rasyid (2017), during reproductive growth plants need the elements N, P and K. Seeds will form in pods at the same time as they continue until they ripen. During pod enlargement and seed filling, a lot of K is required. Providing fertilizer according to the dosage and needs can increase yields, whereas excessive application will reduce plant yields (Bustami et al., 2012 Ramayana et al., 2023). Increasing fertilizer concentration will

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not increase crop yields once they reach the optimal point. It is suspected that high fertilizer doses can cause the soil solution to become concentrated so that it is difficult for the roots to absorb it (Nuryani et al, 2019 in Ramayana, et al, 2023).

CONCLUSION

1. Giving POC Paitan (*Tithoniadiversifolia*) leaf extract was significantly different for the height of plants aged 3 WAP and 5 WAP, but was not significantly different for the number of total and productive branches, flowering time, total number of pods, filled pods, empty pods, yield, and potential results.
2. Application of Paitan (*Tithoniadiversifolia*) leaf extract POC with a concentration of 50% provides optimal soybean yield potential on rainfed land, namely 3.22 Mg.ha^{-1}.

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