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The Effect of Types Planting Media and the Growth Regulatory Substances of Sprouts Extract on the Growth and Yield of Long Bean (Vigna unguiculata L.)

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Abstract

Long bean production in East Java has declined in the last three years because of the decreased soil fertility and the failure of pod formation. The addition of organic matter to the soil planting medium and spraying ZPT bean sprout extract are some efforts to increase the supply of nutrients and overcome flower fall. This study aimed to determine the interaction between the treatment of the planting media and ZPT of bean sprout extract toward growth and yield of long bean plants. The study was conducted factorially using a completely randomized design (CRD) in 3 replications. The first factor is the type of planting medium namely M0: soil; M1: soil+ compost; M2: soil+ chaff charcoal; M3: soil+ cocopeat. The second factor was the concentration of ZPT bean sprout extract, namely T0 control; T1: 10%; T2: 20%; T3: 30%. There was a very significant interaction between the treatment of the planting media and the bean sprout extract ZPT on the variable number of pods per plant and wet weight of pods per plant. The best treatment was the combination of the type of soil and compost growing media with ZPT bean sprout extract 20%. The main effect of the type of planting media treatment showed that the results were not significantly different for all observed variables. The ZPT treatment of bean sprout extract significantly affected the variables of flowering age, harvest age, and pod length per plant, the best treatment was the concentration of ZPT bean sprout extract 20%.

Introduction

Long beans (*Vigna unguiculata* L.) is a seasonal plant that contains many nutrients (Togatorop et al., 2021). East Java Province is one of the producers of long bean commodities. Based on data from the Central Statistics Agency (2021) that long bean production in East Java has continued to decline in the last three years. The production value of long beans from 2019 to 2021 is 45,015 tons/ha, 39,878 tons/ha and 38,070 tons/ha, respectively. So that the value of long bean production in East Java has not been able to meet market needs. Therefore efforts to increase the value of long bean production are needed, one of which is by way of intensification.

Intensification is an effort to increase crop yields so they can produce high (Ihsan et al., 2016). The decline in long bean production was due to a lack of soil fertility due to damage to soil aggregates. If the soil aggregate is good, it will create a good environment for plant growth through a high degree of porosity and water absorption. Intensification efforts can be made by adding organic matter to the soil planting medium to increase the supply of nutrients and to improve the physical, biological and chemical properties of the soil (Augustien & Suhardjono,

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2017). The treatment of good planting media has the characteristics of not being too dense, being able to store water and nutrients, and not bringing in sources of plant diseases (Dewi et al., 2020). So that the right planting medium can increase the growth of long bean plants until harvest. The types of planting media used are soil, compost, husk charcoal, and cocopeat. The compost used comes from organic materials that have gone through a decomposition process. According to Nurmalasari et al., (2021) that compost contains essential nutrients that are good for plants, and if mixed with soil media can improve soil properties. The use of husk charcoal mixed with soil can improve the physical and chemical properties of the soil and increase the availability of phosphorus content in the soil. Charcoal husks are able to store water properly so that the water needs for long bean plants can be met. Besides that, the use of cocopeat as a planting medium is because it contains quite a lot of nutrients and is able to absorb water well and has the pH needed by plants (Nasution & Tammin T, 2022).

Long bean plants often experience flower loss where it can cause failure in the process of forming pods (Ujianto & Yakop, 2012). So that it produces pods that are not suitable and can reduce the productivity of long bean plants. Further intensification efforts that can be done by giving growth regulators. Growth regulators are plant hormones that have physiological and biochemical properties similar to plant hormones which at low concentrations can encourage or inhibit plant growth and development so that plants can grow more optimally (Putih et al., 2021). One of the growth regulators derived from organic materials is bean sprout extract. Bean sprout extract contains the hormone gibberellins as much as 39.94 mg/L (Pamungkas & Nopiyanto, 2020). The addition of the hormone gibberellin to plants can reduce flower loss (Atika et al., 2018). Giving the hormone gibberellin plays a role in the flowering process and reduces flower abscission so that the number of flowers can increase (Yasmin & Wardiyati, 2014). According to Triani et al., (2020) that spraying gibberellin 200 ppm with a spraying frequency of 2 times can increase the number of flowers by 58.82% when compared to no treatment. According to Pertiwi et al., (2014) that spraying gibberellins had a significant effect on the variable percentage of flowers turning into pods and the number of pods on soybean plants.

The application of growth regulators from bean sprout extract and the use of soil planting media, compost, husk charcoal and cocopeat give the impression of being environmentally friendly because the ingredients are organic. Provision of bean sprout extract has a significant effect on the appearance of buds and the appearance of flowers on cayenne pepper plants (Miftakhurrohmat & Dewantara, 2020). In addition, the use of soil planting media, compost, husk charcoal, and cocopeat contains nutrients that are good for plants and can improve soil physical properties (Pratiwi et al., 2017). Therefore, it is necessary to do research on the use of types of planting media and the effect of giving growth regulators of bean sprout extract on the growth and yield of long bean plants so that the information obtained is accurate.

Methods

The research was conducted from January 2023 to March 2023 at the Greenhouse Agrotechnopark, University of Jember. The seeds used were the kanton tavi variety long bean seeds produced by PT. East West Seed. The study was carried out in a factorial manner using a completely randomized design (CRD) in 3 replications. The first factor is the type of planting medium which consists of 4 levels, namely soil (M0), soil + compost (M1), soil + chaff charcoal (M2), and soil + cocopeat (M3). The second factor was the concentration of ZPT bean sprout extract which consisted of 4 levels, namely control (T0), 10% (100 mL/L) (T1), 20% (200 mL/L) (T2), 30% (300 mL/L) (T3).

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The preparation of bean sprouts extract with a concentration of 100% was started by preparing 1000 grams of mung bean sprouts for 48 experimental units. Sprouts bean sprouts crushed with a blender or mash until it produces a smooth texture. The finely ground bean sprouts are added to water until it reaches 1000 ml which is placed in a bucket. The mixture between bean sprouts and water is homogenized then closed tightly. The bean sprout extract is fermented for 24 hours and then it can be applied immediately. After that, to make a bean sprout extract solution with a concentration of 10%, take 100 ml of the stock solution and then dilute it with the addition of water to a volume of 1000 ml. In addition, to make a 20% concentration solution, take 200 ml of stock solution and then dilute it to a volume of 1000 ml. Dilution of 30% bean sprout extract solution by taking 300 ml of stock solution which is then added with water until the volume becomes 1000 ml.

Implementation of research using the type of planting media soil, compost, husk charcoal, and cocopeat. Provision of planting media is done with a volume ratio of 1: 1 for the soil and the type of planting media. Before planting, long bean seeds were treated by soaking in boiled water for 2 hours. Planting seeds per polybag consists of one seed with a spacing of 30cm x 80 cm. When the plants were 21 HST and 28 HST, ZPT was sprayed with bean sprout extract with a spray volume of 83 mL/plant for each treatment. Spraying is done in the area of plant roots and leaf axils. Furthermore, the fertilization of the long bean plants was carried out in stages, the initial fertilization was by giving basic cow manure as much as 289 g/polybag at 0 HST. Follow-up fertilization by applying NPK Mutiara 16:16:16 fertilizer to long bean plants aged 14, 28 and 42 HST. The dose of NPK Mutiara 16:16:16 fertilizer given at 14, 28, and 42 HST was 3.4 g/plant. Long bean plants are attacked by snoring flies on the long bean leaves with white spots and white grooves. So that 1 mL/L emamectin benzoate insecticide was given which was sprayed on the affected part of the leaf. The first harvest of long beans is done when the plants are 48 HST. The characteristics of the long bean plant are ready to be harvested, namely the long bean pods are of maximum size, the seeds in the pods do not stick out, and are easily broken.

The observed variables consisted of plant height, number of leaves, root length, number of pods per plant, pod length per plant, fresh weight of pods per plant, fresh weight of stover and dry weight of stover observed at 59 HST or at the end of the observation. As for the observational variable, the age of flowering can be seen from which treatment appears to flower the fastest and the age of harvest is done when the plants are more than 50% ready for harvest. The observational data were analyzed using variance analysis. If there is a significant difference between treatments then further testing is done using Duncan's multiple range test at the 5% level.

Results and Discussion

The results of the research showed that the interaction between the types of planting media and the ZPT of bean sprout extract was very significantly different in the variables of number of pods per plant and wet weight of pods per plant. The main effect of the type of planting media showed no significant difference to all variables. The main effect of ZPT from bean sprout extract showed a very significant difference to the variables of flowering age, harvest age, and pod length per plant.

Table 1. Results of Soil Chemical Analysis

Sample	Parameter	Content	Unit	Criteria
Soil (M_0)	N-Total (%)	0,04	%	Very low
	P_2O_5 Olsen	62,10	ppm	Very high

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	K_2O	0,75	me/100 g	Very high
Soil + Compost (M_1)	N-Total (%)	0,06	%	Very low
	P_2O_5 Olsen	44,71	ppm	Currently
	K_2O	0,66	me/100 g	Very high
Soil + Chaff Charcoal (M_2)	N-Total (%)	0,05	%	Very low
	P_2O_5 Olsen	59,08	ppm	Height
	K_2O	0,55	me/100 g	Very high
Soil + Cocopeat (M_3)	N-Total (%)	0,05	%	Very low
	P_2O_5 Olsen	42,39	ppm	Currently
	K_2O	0,73	me/100 g	Very high

Source: Soil Laboratory, Faculty of Agriculture, Jember University

Based on Table 1. the results of soil chemical analysis show that the availability of N-Total (%), P_2O_5 Olsen (ppm), and K_2O (me/100 g) has various criteria. Determination of criteria is based on the soil chemical properties assessment criteria of the Soil Research Institute (1983), the N-Total value of the four types of planting media is <0.10 so the assessment criteria are low. P_2O_5 Olsen on the type of soil planting media (M_0) >60 ppm until the assessment criteria are very high, in the type of soil planting media and chaff charcoal (M_2) of 46 ppm – 60 ppm so that the assessment criteria are high, for the type of soil and compost planting media (M_1) as well as soil and cocopeat planting media types (M_3) of 26 ppm – 45 ppm so the assessment criteria are moderate. K_2O from the four types of planting media >60 ppm so the assessment criteria are very high. This influences the interaction of the type of planting medium combined with the ZPT of bean sprout extract on the growth and yield of long bean plants. The interaction between the types of planting media and the ZPT of bean sprout extract showed a very significant difference to the variables of number of pods per plant and wet weight of pods per plant.

Table 2. Effect of interaction between types of planting media and ZPT of bean sprout extract on the number of long bean pods per plant

Type of Planting Media	**ZPT Bean Sprout Extract**			
	T0 (control)	**T1 (10%)**	**T2 (20%)**	**T3 (30%)**
M0 (Soil)	6.33 A	7.33 AB	7.00 C	8.67 B
	b	ab	ab	a
M1 (soil + compost)	7.33 A	7.67 B	11.33 A	10.33 A
	b	b	a	a
M2 (soil + chaff charcoal)	7.33 A	8.67 A	10.67 A	9.67 AB
	b	b	a	ab
M3 (Soil + Cocopeat)	6.67 A	7.33 AB	8.67 B	7.67 B
	b	ab	a	ab

Information:
1. Numbers followed by capital letters are read vertically, i.e. comparing the effect of the treatment of the planting media type factor (M) on the same ZPT concentration level of bean sprout extract (T).
2. Numbers followed by non-capital letters are read horizontally, i.e. comparing the effect of ZPT factor treatment on bean sprout extract (T) at the same level of planting media type (M).

The number of pods per plant shows a yield parameter that is often used in research on long bean plants. Based on Table 2. the results of analysis of variance show that the treatment of

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soil and compost planting media with 20% ZPT extract of bean sprouts (M_1T_2) had the highest yield when compared to other treatment combinations for the variable number of pods per plant of 11.33 pods. According to Sutedjo (2008) that compost can improve the physical, chemical and biological properties of soil thereby increasing soil fertility. Based on Table 1. the results of chemical analysis on soil and compost planting media consist of N-Total 0.06% and P_2O_5 44.71 ppm. The nutrients N and P in the planting medium play a role in the formation of long bean pods. The available P nutrient causes the photosynthesis process to run smoothly and the plant absorbs N elements so that the number of pods increases. The types of soil and compost planting media combined with 20% ZPT bean sprout extract differed very significantly in the variable number of pods per plant. This is in line with the results of Utami's (2022) research that giving bean sprout extract at a concentration of 20% in soil and compost planting media to soybean plants had a significant difference in the number of pods per plant of 35.40 pods.

Table 3. Effect of interaction between types of planting media and PGR of bean sprout extract on fresh weight of pods per plant

Type of Planting Media	**ZPT Bean Sprout Extract**			
	T0 (control)	**T1 (10%)**	**T2 (20%)**	**T3 (30%)**
M0 (Soil)	70.67 B	96.67 AB	89.00 C	92.33 B
	a	a	a	a
M1 (soil + compost)	86.00 AB	74.67 B	194.67 A	103.67 AB
	bc	c	a	b
M2 (soil + chaff charcoal)	80.33 AB	96.33 AB	132.00 B	126.33 A
	c	bc	a	ab
M3 (Soil + Cocopeat)	99.67 A	107.67 A	106.67 BC	103.33 AB
	a	a	a	a

Information:
1. Numbers followed by capital letters are read vertically, i.e. comparing the effect of the treatment of the planting media type factor (M) on the same ZPT concentration level of bean sprout extract (T).
2. Numbers followed by non-capital letters are read horizontally, i.e. comparing the effect of ZPT factor treatment on bean sprout extract (T) at the same level of planting media type (M).

The wet weight of pods per plant indicates the amount of water and organic matter contained in the pods. Based on Table 3. the combination of treatment types of soil and compost planting media with a ZPT concentration of bean sprout extract of 20% (M_1T_2) shows the highest average value for the variable wet weight of pods per plant of 194.67 grams. In this case, the combination of soil and compost planting media with a ZPT concentration of 20% bean sprout extract (M_1T_2) shows the best results, but if you want to get more efficient results you can give a combination of soil planting media types with a ZPT concentration of 0% bean sprout extract (M_0T_0). The combination of soil and compost planting media combined with 20% ZPT of bean sprout extract produced the best value because it was more able to provide the best response to the wet weight of the pods. Based on Table 1. The results of soil chemical analysis show that the types of soil and compost planting media contain the nutrient potassium in the form of K_2O with very high criteria, namely 0.66 me/100 g. According to Arista et al. (2015) that the nutrient content K in the planting medium plays a role in increasing pod weight. The potassium nutrient content in the planting medium combined with exogenous hormones in ZPT can increase the water absorption capacity of plants so that it has an effect on increasing pod weight, preventing flower drop and fruit loss (Rosalyne, 2019). The interaction between the two treatment

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combinations occurs because the nutrients in the planting medium and the phenolic compounds in the ZPT are able to activate metabolic reactions well, thus stimulating plant growth (Rihana et al., 2013). The nutrient content and phenolic compounds in ZPT are able to inhibit the internode without inhibiting the function of the apical meristem. This influences the plant growth process to run well so that plant nutrients will be used for the generative phase which affects the number of pods and the wet weight of the plant pods.

The main effect of the type of planting media treatment showed that the results were not significantly different for all observed variables. It is assumed that the nutrient content of each type of planting media provided has almost the same percentage. The types of planting media provided were different but showed no significant difference for each plant. If the nutrient content is optimal, it will increase plant growth. However, the nutrients in the form of N, P, K that are absorbed by plants are not able to activate meristem cells and affect the photosynthesis process. Based on Table 1, the results of the soil analysis show that the N element in the form of N-Total from the four planting media treatments has very low assessment criteria. According to Waskito et al., (2017), plants with low N content have low chlorophyll content, which affects the metabolic activity of the plant. The lower the N nutrient in the planting medium, the slower the metabolic process and this will affect the growth rate.

The main effect of the ZPT treatment of bean sprout extract showed a very significant difference to the variables of flowering age, harvest age, and pod length per plant.

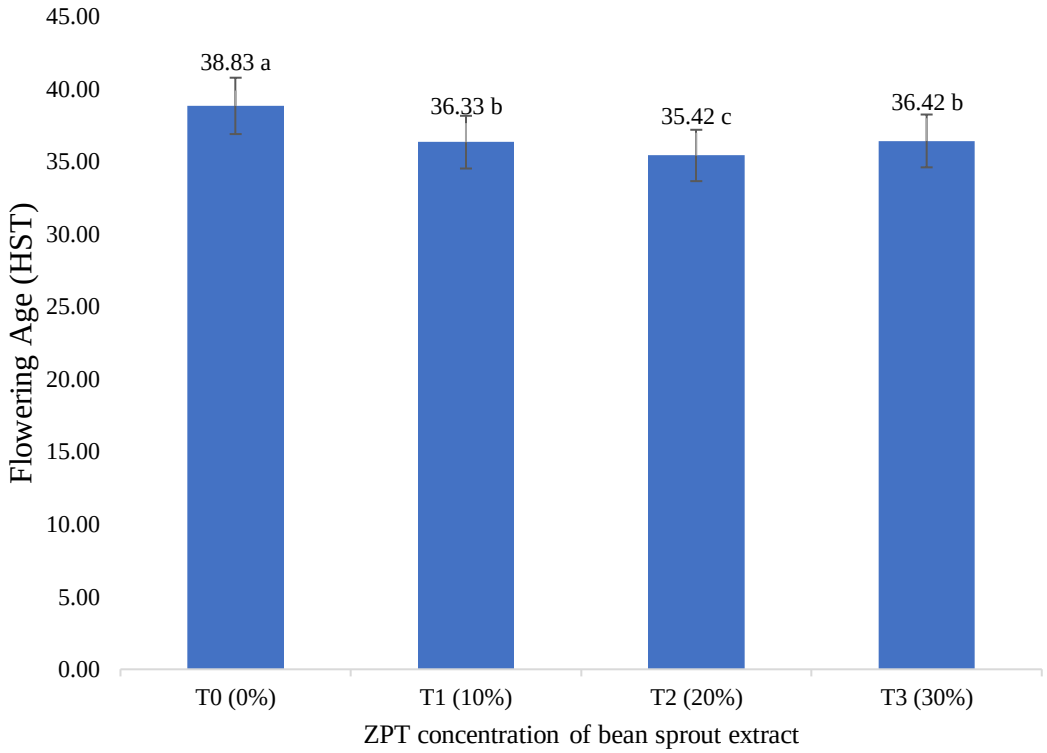

Figure 1. Effect of ZPT bean sprout extract treatment on long bean flowering age

The flowering age of long bean plants is a variable that has a significant effect on the provision of growth regulators from bean sprout extract. ZPT treatment of 20% bean sprout extract (T_2) gave the best average results for the long bean flowering age variable, namely 35.42 HST. Based on the results of the Duncan Multiple Distance Test, 5% growth regulator treatment with 20% bean sprout extract (T_2) was significantly different from the ZPT treatment with

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0% bean sprout extract (T_0), ZPT treatment with 10% bean sprout extract (T_1) and ZPT treatment with 30% bean sprout extract (T_3). So the recommendation given to get the best flowering age is that it is best to give ZPT treatment with bean sprout extract with a concentration of 20% (T_2). This is thought to be because the ZPT of bean sprout extract concentration of 20% is in accordance with the hormone needs of long bean plants to increase flowering time. According to Kurniawan et al., (2023) ZPT of bean sprout extract contains the hormone gibberellin of 39.94 ppm. The gibberellin hormone can play a role in stimulating the genetic and physiological characteristics of long bean plants, thereby encouraging flowering (Gardner and Heddy, 1991).

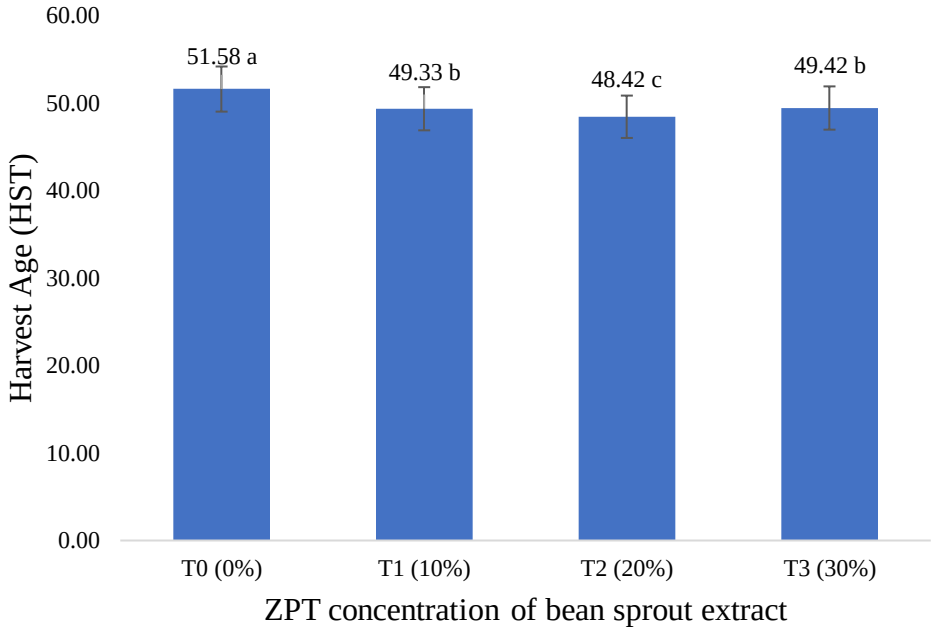

Figure 2. The effect of the type of planting media treatment on long bean harvesting age

ZPT treatment of 20% bean sprout extract (T_2) gives the best average harvest age for long beans, namely 48.42 HST. Based on the results of the Duncan Multiple Distance Test, 5% ZPT treatment with 20% bean sprout extract (T_2) showed a significant difference to the ZPT treatment of 0% bean sprout extract (T_0), 10% ZPT treatment of bean sprout extract (T1), and 30% ZPT treatment of bean sprout extract (T_3). So the recommendation given to get the best harvest age is that it is best to give ZPT treatment with bean sprout extract with a concentration of 20% (T_2). This is in line with the results of research by Utami (2022) that giving bean sprout extract to soybeans at a concentration of 20% has a significant effect on harvest age. Bean sprout extract contains the hormone gibberellin which plays an important role in supporting cell elongation (Gardner and Heddy, 1991). The gibberellin hormone can increase the content of the auxin hormone in plants so that it can reduce flower drop and increase the number of flowers and pods. The auxin hormone contained in the ZPT of bean sprout extract will release Ca^{2+} into pectin compounds. The pectin compounds will dissolve, causing the cell walls to become soft, making it easier for water to enter and increasing water absorption. The absorbed water will be used in cellular metabolic processes as material for photosynthesis and the formation of new cells (Abror and Noviyanti, 2019).

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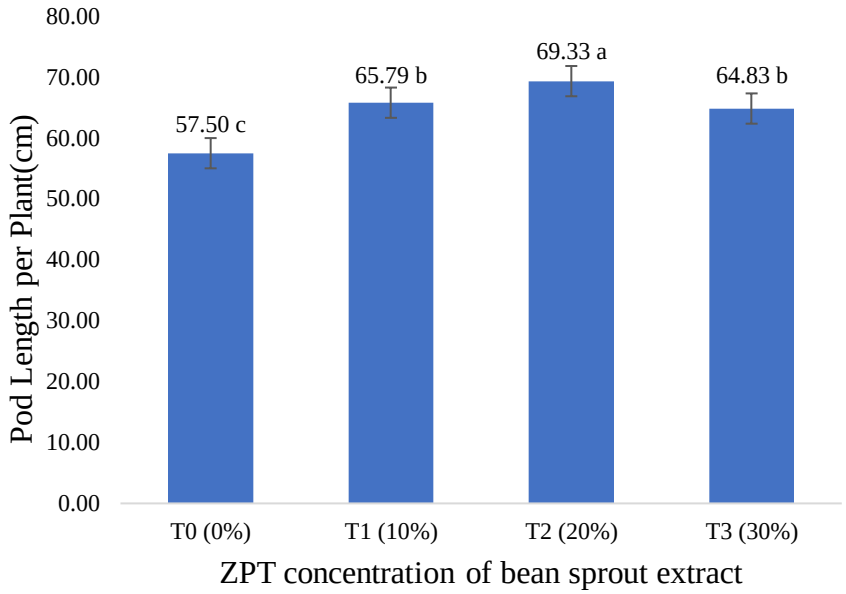

Figure 3. Effect of growth regulator treatment of bean sprout extract on pod length of long bean harvest

The length of the pod is one of the important characters as a parameter for the development of long beans. Based on the results of analysis of variance, the ZPT treatment of bean sprout extract was very significantly different to the pod length variable per plant. ZPT treatment of 20% bean sprout extract (T_2) gave the highest average pod length of 69.3 cm. Based on the results of the Duncan Multiple Distance Test, 5% ZPT treatment with 20% bean sprout extract (T_2) showed a significant difference to the ZPT treatment of 0% bean sprout extract (T_0), ZPT bean sprout extract 10% (T_1), and ZPT 30% bean sprout extract (T_3). The results of the length of long bean pods given ZPT from bean sprout extract were more influential compared to those not given ZPT from bean sprout extract. This is because the ZPT hormone from bean sprout extract will stimulate the photosynthesis process. The results of photosynthesis are reducing sugars which will be used as an energy source in plants which will form roots, stems and leaves. The results of photosynthesis will be stored in the roots, stems, leaves, some will be transferred to the pods of the plant (Agustina, 2015). The success of pod length is influenced by supporting environmental factors so that the photosynthesis process can run well (Dewi, 2015). These environmental factors include the availability of nutrients, water, temperature, light and organic materials that suit plant needs.

The ZPT treatment of bean sprout extract was not significantly different for the variables of plant height, number of leaves, root length, fresh weight of stover, and dry weight of stover. Providing ZPT with bean sprout extract will have an optimal effect if it is given according to needs (Rajiman, 2018). Providing plant growth regulators in low concentrations can encourage plant growth and development so that plants can grow more optimally (Rahmadhani, 2021). However, giving growth regulators in high concentrations will inhibit plant growth (Muddarisna et al., 2013). Based on the results of the analysis of variance, the main effect of ZPT from bean sprout extract on the variables of flowering age, harvest age and pod length per plant was that the ZPT treatment of bean sprout extract was 30% (T_3) produced a lower average compared to the ZPT treatment with 10% bean sprout extract (T_1) and ZPT 20% bean sprout extract (T_2).

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This is in accordance with the opinion of Sodiqin et al., (2017) that giving ZPT in high concentrations causes the hormones to be unable to be absorbed by plant cells so they cannot work optimally. Apart from that, something that needs to be paid attention to is the timing of giving ZPT bean sprout extract to long bean plants. Spraying ZPT extract of bean sprouts on long bean plants is carried out at 21 HST and 28 HST. Where the application of ZPT from bean sprout extract is carried out during the initial generative phase, which causes the vegetative phase to stop and hormone absorption is less than optimal, thus affecting the growth of plant height, number of leaves, and root length. According to Yasmin et al., (2014) that the addition of exogenous hormones during the generative phase will transport nutrients and hormones from the vegetative part to the generative part of the plant which will affect the long bean pods resulting in cell enlargement which affects the size of the long bean pods.

Conclusion

There was an interaction between the treatment of the type of planting media and the bean sprout extract ZPT which had a very significant effect on the variable number of pods per plant, the wet weight of the pods per plant, so that the best treatment was the combination of the type of soil and compost growing media with ZPT bean sprout extract 20% (M_1T_2). The type of planting media treatment had no significant effect on all observed variables. The ZPT treatment of bean sprout extract had a very significant effect on the variables of flowering age, harvest age, and pod length per plant so that the best treatment was the concentration of ZPT bean sprout extract 20% (T2).

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