



Vegetative Growth Response of Soybean (*Glycine max* L. Merrill) After Applied Several Plant Growth Regulators (PGRs)

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Doi: [10.31186/aa.25.1.11-16](https://doi.org/10.31186/aa.25.1.11-16)

ABSTRACT

ARTICLE INFO

Keywords:

Glycine max L.Merril, vegetative growth, plant growth regulators (PGRs)

Article history:

Received: August 31, 2020

Accepted: June 29, 2022

Published: June 30, 2022

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Vegetative growth of plants can be influenced by internal factors including hormones (Plant Growth Regulators). The purpose of the study is to determine the growth response of soybean (*Glycine max* L.Merril) after application of some plant growth regulators (PGRs). The research was conducted from March to May 2020 at the Center for the Protection and Quality Testing of Food Crops and Horticulture, Department of Agriculture and Livestock, North Sulawesi Province. The research method used was Completely Randomized Design (CRD). There were four levels of extract concentration applied, namely P0: Control, P1: onion extract, P2 bamboo shoot extract, and P3: banana weevil extract with each concentration of 300 g/L. Each treatment was carried out with five replications. Data of the growth parameters were analyzed with ANOVA (Analysis of Variance) and continued with LSD 0.05 test. Results of the study showed that the application of PGRs from extracts of onion, bamboo shoots and banana weevil give the increase of growth in height of plants in 15 days after planting, fresh weight, dry weight and root volume of soybean (*G. max*). Application of PGRs couldn't give any effect in high, number of leaves and ratio of canopy roots 27 days after planting.

INTRODUCTION

Plant growth is the event of increasing plant size, which can be measured by the increase in height and height of plant organs. The success of plants to grow and develop is influenced by internal and external factors. Internal factors consist of the rate of photosynthesis, respiration, differentiation, hormones and genetic factors, while external factors include light, temperature, water, organic matter and nutrient availability. Growth factors that are achieved will cause the photosynthesis process

to take place and produce photosynthate that function for the process of plant growth (Ramadan *et al.*, 2016).

Hormones are one of the factors that affect plant growth. Hormones, naturally present in plants are often in less than optimal conditions. Plant growth is the event of increasing plant size, which can be measured by the increase in height and height of plant organs. The success of plants to grow and develop is influenced by internal and external factors. Internal factors consist of the rate of photosynthesis,

ISSN: 1410-3354 / e-ISSN:2615-7136

Cited this as: Mangais, R., H.L. Rampe, P. Siahaan. 2022. Vegetative growth response of soybean (*Glycine max* L. Merrill) after applied several plant growth regulators (PGRs). Akta Agrosia 25(1):11–16. doi: 10.31186/aa.25.1.11-16

respiration, differentiation, hormones and genetic factors, while external factors include light, temperature, water, organic matter and nutrient availability. Growth factors that are achieved will cause the photosynthesis process to take place and produce photosynthate that function for the process of plant growth (Ramadan *et al.*, 2016).

Hormones are one of the factors that affect plant growth. Hormones, naturally present in plants are often in less than optimal conditions, so it takes an external source (Exogenous Growth Regulatory Substances) to produce a maximum response. Exogenous growth regulatory substances are often called plant growth regulators (PGRs). According to Leovici *et al.* (2014) one of the efforts that can be done to improve the quality of plant growth is the application of PGRs. The quality of plant growth and development is largely determined by the presence of PGRs.

PGRs is a non-nutrient organic compound that affects the physiological processes of a plant (Widyastuti dan Tjokrokusumo, 2006). Physiological processes that are influenced by PGRs include cell enlargement, abscess, cambium activity, plant organ enlargement and encouraging cell division (Harahap, 2012).

The use of natural PGRs is a good alternative because it is easily obtained, relatively inexpensive and safe to use for the environment. There are various types of substances that can be used as natural PGRs such as onion as a source of auxin, bamboo shoots as a source of gibberalin and banana weevil as a source of cytokinins (Lindung, 2014). ZPT can enhance efficient use of solar energy and nutrients, due to increased activity plant physiology. Auxins, gibberalins and cytokinins interact with each other in stimulating plant growth and development, including seed germination. This study aimed to provide information about the growth response of soybean (*Glycine max*) after application of several plant growth regulators (PGRs).

MATERIALS AND METHOD

This research was conducted through January - March 2020 in the Department of

Biology FMIPA Sam Ratulangi University. Measurement of plant growth parameters was carried out at the Kalasey Biological Agents Laboratory (LAH) Laboratory for the Protection and Quality Testing of Food Crops and Horticulture (BPPMTPH), Agriculture and Animal Husbandry Office, North Sulawesi Province.

This study used a Completely Randomized Design (CRD) with four treatments in five replications. The concentration of extract for each treatment was 300 g/L which was applied by direct watering to the plants and repeated every five days. The treatment given were: P0: control, P1: onion extract; P2: bamboo shoot extract ; and P3: banana weevil extract. The stages of work in this study include the selection of soybean seeds of the Detap I variety, preparation of planting media by mixing garden soil, rice husks and manure with a ratio of 10:2:1, making natural ZPT extracts, planting and rearing care, data collection carried out up to 27 DAPs and data analysis. Data of the growt parameters were analyzed with ANOVA (Analysis of Variance) and continued with LSD 0.05 test.

RESULTS AND DISCUSSION

Plant Height

The results showed the height of soybean treatment P1, P2 and P3 at the observation of 15 DAPs showed significant differences when compared with control treatments. Observations at 27 DAPs showed no difference in all treatments (Table 1).

Each PGR has a different function, such as auxin plays a role in encouraging cell elongation to the growth of plant height, differentiation of xylem and phloem tissue and root formation (Siregar *et al.*, 2015). Meanwhile according to Kurniati *et al.* (2019) bamboo shoots contain gibberellins which stimulate cell division and stimulate the activity of proteinase and amylase enzymes that play a role in the germination process, as well as cytokinins in banana weevils stimulate cell division, enlargement of the stem, inhibit apical dominance and accelerate elongated growth.

The data showed that the tallest plant was at

Table 1. LSD Test Results for Height of Soybean (*G. max*) Plant Height

Treatment	Plant Height (cm) \pm SD	
	15 DAPs	27 DAPs
P0 (control)	27,20 \pm 3,70 a	60,74 \pm 8,84 a
P1 (onion extract)	35,00 \pm 5,40 b	83,40 \pm 2,45 a
P2 (bamboo shoot extract)	36,10 \pm 2,19 b	83,60 \pm 15,58 a
P3 (banana weevil extract)	35,40 \pm 3,31 b	84,00 \pm 11,05 a

Note: SD = Standard Deviation; the number followed by the same letter is not significantly different based on the LSD 0.05 test.

15 DAPs (36.10 cm), on day 27 after planting, the highest plant was treated with banana weevil extract (84.00 cm). The results of the LSD test obtained showed that the three treatments were not different, this indicated that the three treatments had the same effect on plant height. ZPT extract must be able to increase plant height increase in accordance with Maretza (2009), that plant height growth is influenced by cytokinin hormones contained in banana weevil, cytokinins will stimulate cell division by increasing the rate of protein synthesis which can accelerate the extension of time. growth. The application of the three PGRs was not significantly different from the control treatment, this was presumably because the PGR given did not work at the right concentration.

Number of Leaves

Data on the observation of the number of leaves of soybean showed that the treatment did not influence the number of leaves in both the observation of 15 DAPs and observation of 27 DAPs (Table 2).

The application of the three extract treatments gave no different effect on increasing the number of leaves of soybean plants. This is different from the opinion of Trisna *et al.* (2013) which states that growth regulators are able to penetrate plant tissues and accelerate physiological processes so as to trigger the process of increasing the number of plant leaves.

The research data showed a tendency to increase the number of leaves in the onion extract treatment at 27 DAPs to be better, compared to the extract treatment at 15 DAPs. PGRs application should be able to increase the number of leaves, as suggested by Siregar *et al.* (2015) that the higher the stem, the more leaves on the stem as evidenced by the application of PGR from onion extract. The results of this study were different from the study of Tarigan *et al.* (2017) which stated that the application of onion extract gave better results on the percentage of pepper cuttings when the emergence of shoots, shoot length, number of leaves. The results obtained were different, presumably due to the given PGRs no longer working at the right concentration.

Root Volume

The root is one of the plant organs which is very important in providing water and minerals for the process of photosynthesis. Measurement data on root volume can be seen in Table 3. The results showed that soybean root volume of treatments P1, P2 and P3 on the observation of 27 DAPs showed significant differences when compared with control treatments. In accordance with the opinion of Artanti (2007) which stated that hormones have several roles in supporting plant life including encouraging

Table 2. LSD test results number of leaves and root volume of soybean (*G. max*) plants

Treatment	Number of Leaves (Strands) \pm SD		Root Volume (ml) \pm SD
	15 DAP	27 DAP	27 DAP
P0 (control)	4,80 \pm 0,45 a	10,80 \pm 1,92 a	1,70 \pm 0,45 a
P1 (onion extract)	5,60 \pm 0,55 a	11,60 \pm 2,07 a	6,30 \pm 2,17 b
P2 (bamboo shoot extract)	5,80 \pm 0,45 a	11,60 \pm 2,07 a	6,50 \pm 1,66 b
P3 (banana weevil extract)	5,80 \pm 0,84 a	10,80 \pm 1,30 a	5,30 \pm 2,11 b

Note: SD = Standard Deviation;

root primordia. Husniati (2010) explained that auxin triggers cell division, so it is needed for root formation.

Roots that are spread out and supported by sufficient water and nutrients will increase root volume. Good root growth will affect the state of other organs. Increasing the number and length of roots will increase the absorption of water and nutrients by plants, so that the photosynthetic activity of plants goes well for the growth of plant vegetative organs. Photosynthate which is transplanted into the roots will be used for the needs of root growth, while photosynthate into the canopy is for the growth of the shoots, especially shoots (Tarigan *et al.*, 2017). The increase in root volume is caused by the PGRs application. This is in accordance with the opinion of Muslimah *et al.* (2016) that the application of auxin can stimulate the formation and development of adventitious roots. The results of the LSD test showed that the application of the three treatments did not have a different effect on the root volume of the *G. max* plant, this indicated that the three types of PGRs gave the same effect on the increase in root volume.

Fresh Weight

Fresh plant weight is the result of metabolic activity and the wet weight is affected by tissue water content, nutrients and the results of its metabolism (Anni *et al.*, 2013). Data from observations of fresh plant weight at 27 DAPs are shown in Table 3. The results showed the fresh weight of soybean in treatment P1, P2 and P3 at 27 DAPs showed significant differences when compared with control treatments. The results of the LSD test showed that the three treatments of onion extract, bamboo shoot extract, banana weevil extract, each containing the hormones auxin, gibberalin and cytokinin were not different, this showed that all three had the same effect on increasing plant fresh weight. According to Lahadassy (2007) that to achieve optimal fresh weight, plants need energy and nutrients so that an increase in the number of cell sizes can reach optimal levels and allow an increase in optimal

Table 3. LSD test result for fresh weight of soybean (*G. max*) Plants

Treatment	Average Fresh Weight (gram) \pm SD
P0 (control)	14,11 \pm 2,19 a
P1 (onion extract)	24,11 \pm 9,79 b
P2 (bamboo shoot extract)	24,63 \pm 3,98 b
P3 (banana weevil exctrct)	22,76 \pm 4,98 b

Note: SD = Standard Deviation; the number followed by the same letter is not significantly different based on the LSD 0.05 test

water content. The application of PGR from natural ingredients containing the hormones auxin, gibberalin and cytokines stimulates an increase in the number and size of cells, thereby optimizing the absorption of water and nutrients which will lead to the addition of fresh weight.

The administration of onion extract (P1) and banana weevil extract (P3) containing the hormones auxin and cytokinin increased cell elongation and enlargement which affected plant fresh weight. This is in accordance with the research conducted by Kamillia *et al.* (2019) showed that the application of shallot extract affected the fresh weight of the roots of the cempedak plant compared to the application of mung bean extract and coconut water. Research conducted by Muvidah *et al.* (2017) stated that soaking mung bean (*Phaseolus radiatus*) seeds in banana weevil extract with a concentration of 75% had a significant effect on plant wet weight.

Dry Weight

The results showed the dry weight of soybean in treatment P1, P2 and P3 at 27 DAPs showed significant differences when compared with control treatments (Table 4). The results showed that the three treatments had the same effect on increasing the dry weight of soybean plants. This shows that the application of the three types of PGRs can help optimize the absorption of nutrients by plants so that plant growth is better and can increase photosynthesis results.

The amount of photosynthate produced causes the dry weight to increase. This increase is an indicator that soybean plants are growing

Table 4. LSD test result for dry weight of soybean (*G. max*)

Treatment	Dry Weight (gram) \pm SD
P0 (control)	1,96 \pm 0,30 a
P1 (onion extract)	3,64 \pm 1,70 b
P2 (bamboo shoot extract)	3,70 \pm 0,61 b
P3 (banana weevil exctrct)	3,47 \pm 0,74 b

Note: SD = Standard Deviation; the number followed by the same letter is not significantly different based on the LSD 0.05 test

well. The results showed that the dry weight of soybean plants was higher when applied with PGRs, PGRs derived from shallots or bamboo shoots or banana weevil.

Root Canopy Ratio

Root canopy ratio is one of the important factors in plant growth which reflects the ability in nutrient absorption in plants. The results of the study showed that the treatment did not influence the root canopy ratio at 27 DAPs observations (Table 5). The role of roots in plant growth is as important as the canopy, if the canopy functions to provide carbohydrates through photosynthesis, then the root function is to provide nutrients needed in plant metabolism. The amount of nutrients that can be absorbed by plants depends on the opportunity to get these nutrients in the soil (Alfionita *et al.*, 2019).

The results showed that the root canopy ratio in the control was not significantly different from all treatments even for the onion extract, banana weevil extract or bamboo shoot extracts. (Table 5). It is suspected that application the three types of plant growth regulators (PGRs) were used by plants for canopy and root formation in relatively equal

proportions. According to Astuti *et al.* (2015) root canopy ratio is an important factor in plant growth which reflects the ability in nutrient absorption in plants. The canopy and root dry weight results show absorption of water and nutrients by the roots which are transplanted to the plant canopy.

CONCLUSION

PGRs application from onion extract, bamboo shoot extract and banana weevil extract gave no different effect on soybean plant growth parameters (*G. max*), but all three gave different effects on the control treatment.

ACKNOWLEDGMENT

Thank you to Jusak Wongkar and Susan Wowiling for providing laboratory facilities at the Biological Agency Laboratory, Center for Food Crops and Horticulture Protection, Agriculture and Animal Husbandry Office, North Sulawesi. Thank you also to Kevin Tatanude and Rivaldo Sahilatua who helped during the research.

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Table 5. Results of data analysis of soybean (*G. max*) root canopy ratio

Treatment	Canopy Dry Weight (g)	Root Dry Weight (g)	Ratio	Root Canopy Ratio (g) \pm SD
P0	1,74	0,23	0,89 : 0,11	8,09 \pm 1,55 a
P1	3,25	0,39	0,88 : 0,12	8,05 \pm 2,45 a
P2	3,29	0,41	0,89 : 0,11	8,24 \pm 1,31 a
P3	3,09	0,39	0,89 : 0,11	7,93 \pm 0,51 a

Note:SD = Standard Deviation;

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