Gibberelin and phosphorus application in growth, production and the quality of okra pods (*Abelmoschus esculantus* L. Moench)

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**Abstract.** Okra is one of vegetable most underdeveloped in Indonesia, but request increasing every year. Okra’s is still volatile can’t suplay needs of national okra because quality of soil fertility is decreased so that it effect to production and quality of okra. Efforts to fulfill necessiyu and quality of okra thought of gibberellins and phosphorus fertility application. Gibberellin is a hormone can assist in enlargement and engolation cell in growth and development plants. Phosphorus fertility is an essential nutrient is component of ATP energy in plants. The experimental design used was Randomized Block Design with 2 Factors and 3 Replication. The first Factor is concentration of gibberelin that is Without giving GA3 (G0), 50 mg/l GA3 (G1), 100 mg/l GA3 (G2), 150 mg/l GA3 (G3). The second factor is application of phosphorus fertility that is 75kg/ha SP-36 (P1), 100kg/ha SP-36 (P2), 125kg/ha SP-36 (P3) dan 150kg/ha SP-36 (P4). So there is 16 combination with 3 replication. The data analyzed with Duncan multiple range test and the smallest significant difference test (α, 5%). The result of this study is 100 mg/l GA3 Gibberellin and 150kg/ha SP-36 treatment can increase internode of plants tune of 33, 150kg/ha SP-36 treatment increase height of plant tune of 142.58 cm. The 100 mg/l GA3 Gibberellin and 150kg/ha SP-36 increased the leaf area by 2.03 cm. 100 mg/l GA3 Gibberellin and 150kg/ha SP-36 treatment can increased to pods weight was 154.8 grams and pod production was 6,45 tons. 150kg/ha SP-36 treatment increased to the proteint content of the pods is 2.13%.

**1. Introduction**

In Indonesia, okra plants are widely cultivated for use as vegetables and medicinal ingredients. Although the demand for okra vegetables is still relatively small, domestic demand is increasing every year and domestic okra production has not met the needs of the community. Okra production currently tends to fluctuate and has not been able to meet the national demand for okra vegetables [1]. Okra production in 2013 amounted to 1,317 tons and in 2014 amounted to 1,360 tons, while okra demand in 2015 is projected to reach 1,500 tons. Based on the okra vegetable producer at PT. Mitra Tani Dua Tujuh, the demand for okra on a relatively high export scale has not met the target market demand [2]. Okra seed production was able to produce 1.67 tons / ha [3]. Okra production in several tropical countries was not yet optimum and the quality of the pods was low due to continued decline in soil fertility [4].
One of the efforts to meet the needs and availability of okra is by improving okra cultivation techniques. Provision of balanced fertilizers will be able to increase plant growth, increase crop production and harvest quality. Efforts to increase plant productivity are not only through nutrition, but also through the provision of exogenous hormones such as gibberelin. Phosphorus fertilization and giving gibberellin can help the process of cell division and enlargement. Phosphorus is an essential part of phosphate sugar in respiration and other metabolic processes. Phosphorus can help plants in plant growth, flower growth, seeds and fruit ripening [5]. Giving GA3 with a concentration of 120 ppm gave the best results on growth [6], increasing the percentage of okra seed health [7]. Based on these descriptions, this study aims to determine the combination of treatment and single treatment application of phosphorus fertilizer dosage and gibberelin concentration to increase production and quality of okra pods.

2. Material and Methods

2.1. Material

The research was carried out from November to April 2020 in the Antirogo Experiment Field, the Biosciences Laboratory and the Jember State Polytechnic Seed Technology Laboratory. The materials needed are SP-36, KCL, Urea, manure, and the gibberelin hormone.

2.2. Methods

Phosphorus fertilizer is applied a week before the plants coincide at the time of basic fertilization [3]. Planting okra uses a spacing of 40x60 cm. The application of gibberellin by spraying is carried out in 2 stages, namely the vegetative phase before flowering and the generative phase when the flowers bloom. Harvesting is done when the plants are approximately 50 days old. Harvest pods are carried out 2-3 times a week characterized by pods measuring 6.5-9 cm in length [3].

The research was conducted in the field with an uncontrolled level of environmental heterogeneity as a source of diversity, thus using a randomized block design [7]. The research was compiled based on a randomized block design consisting of two factors, namely the first factor was the dose of P fertilizer, namely, P1 (75kg / ha SP-36), P2 (100kg / ha SP-36), P3 (125kg / ha SP-36) and P4 (150kg / ha SP-36). The second factor is the concentration of the gibberellin hormone, namely: G0 (without the application of gibberellin), G1 (50 mg / l), G2 (100 mg / l), and G3 (150 mg / l). So there are 16 treatment combinations with 3 repetitions. The data obtained was done using the ANOVA test if it showed significant results, then using the DMRT and LSD tests to determine the best treatment [8]. The parameters observed were the number of internodes, plant height, leaf area, pod weight per plant, pod production and pod protein.

3. Results and Discussion

The results showed that gibberellin with a concentration of 150 mg / l showed the highest okra plant, namely 142,58 cm compared to other treatments. Spraying gibberellin with a concentration of 150 mg / l on all parts of the plant significantly affected okra plant height (Table 1).

| Parameter | Concentration of gibberellins (mg/l) |
|-----------|-------------------------------------|
|           | 0     | 50  | 100 | 150 |
| plant height (cm) | 115,17 | 135,08 | a | 135,83 | a | **142,58** | a |

Information: Nominal in the same column that followed by the same alphabet in each variable was not significant based the LSD test at 5% level.

Plant height increases due to increased cell division and elongation resulting in increased plant height. Plants that are applied gibberellin can increase the length of the stem because gibberellin plays
a role in plant growth as an increase in the length of the plant segment caused by the cells that increase in size and increase in number [9].

Table 2. Effect of phosphorus and gibberellin fertilizers on growth and production of okra pods

| Phosphorus dose (SP-36 kg/ha) | Concentration of gibberellins (mg/l) | Internodes | Leaf Area | Pod Weight per Plant (gram) | Pod Production per Ha (ton) |
|-------------------------------|--------------------------------------|------------|-----------|----------------------------|----------------------------|
|                               | 0  | 50  | 100        | 150        | 0  | 50  | 100        | 150        | 0  | 50  | 100        | 150        |
|                               |    |     |            |            | Internodes |            |            |            | Pod Weight per Plant (gram) |            | Pod Production per Ha (ton) |            |
| 75                            | 25,67 | cd  | 28,83 abc  | 25,83 cd  | 22,00 d | 130 | abc  | 150,59 abcd | 122,56 abcd | 85,18 d | 5,42 ab | 6,27 a | 5,11 abc | 3,55 c |
| 100                           | 25,50 | cd  | 32,50 ab  | 26,33 cd  | 29,00 abc | 90,44 | cd  | 146,74 abcd | 122,37 abcd | 112,75 bcd | 3,77 bc | 6,11 a | 5,10 abc | 4,70 abc |
| 125                           | 26,33 | cd  | 26,33 cd  | 27,83 bc  | 26,33 cd | 119,94 | abcd | 133,10 abcd | 123,90 abcd | 124,37 abcd | 5 | abc  | 5,55 ab | 5,16 abc | 5,18 abc |
| 150                           | 29,33 | abc | 27,17 bc  | 32,50 a  | 31,50 ab | 152,87 | a  | 85,66 d | 154,80 a | 138,11 ab | 6,37 a | 3,57 c | 6,45 a | 5,75 a |

Information: Nomina in the same column that followed by the same alphabet in each variable was not significant based the DMRT test at 5%.

Phosphorus 150 kg / ha and gibberellin100mg / l gave the best results increase internode of plants tune of 33. Giving the right dose of phosphorus to okra plants can increase internode of plant. This occurs because phosphorus is one of the macro nutrients which is important in the metabolic process of plant growth and as a source of energy for cell division and enlargement. Phosphorus that is absorbed by plants is mobile so it is easy to translocate photosynthate products to young tissues through the phloem, the availability of phosphorus in the soil can meet phosphorus needs and increase the results of photosynthesis in plant growth [10]. Application of gibberellin can lead to increased cell division and growth which will lead to stem elongation and an increase in the number of plant segments [11].

In leaf area, the interaction of phosphorus application of 100 kg / ha SP-36 and gibberellin 100 mg / l also showed the largest increase in leaf area. The application of phosphorus fertilizer can help cell enlargement and division, thereby increasing leaf area. Increasing the surface area of okra leaves can also increase the efficiency of receiving sunlight in the photosynthesis process. The broad and flat leaf surface allows an increase in the amount of chlorophyll produced and sunlight can be captured more optimally for photosynthesis in plant growth and development [12, 13]. Giving the hormone gibberellin to okra plants can spur cells to expand or expand so that the leaf size increases. Gibberellin can stimulate cell expansion through stimulation of cell wall enzymes, namely Xyloglucan Endotransglycosylase (XET), which has the ability to break bonds in cell wall-forming molecules, namely hemicellulose, so that the cellulose microfibrils move, causing the cell walls to enlarge or expand [14].

Giving phosphorus 150 kg / ha and gibberellin 100 mg / l gave the highest yield, namely 154.8 grams of pod weight per plant and 6.45 tons / ha of pod production. This happens because the
application of phosphorus in plants helps in increasing the process of photosynthesis, respiration and produces energy which is useful in increasing the yield of photosynthate and translocation of photosynthate products in the tissue so that pod formation can be optimal and also affects pod weight. The P element can accelerate the ripening process and help transport carbohydrates from branches and leaves to fruit so that the fruit that is formed becomes fuller and has optimal weight [15]. The hormone gibberellin can also affect cell addition, flowering and fertilization and induce fruit cell division so that the effectiveness of fruit size can increase [16, 17].

| Table 3. Effect of phosphorus (SP-36) on pod protein |
|---------------------------------|
| Parameter | Phosphorus dosage SP-36 (kg / ha) |
|-----------|---------------------------------|
| Pod protein (%) | 75 | 100 | 125 | 150 |
|           | 1,98 | C   | 2,05 | b   | 2,12 | a   | 2,13 | a   |

Information : Nominal in the same column that followed by the same alphabet in each variable was not significant based the LSD test at 5% level.

Based on table 3, it can be seen that the addition of phosphorus fertilizer (SP-36) 150 kg / ha increased the protein content of the pods by 2.13%. However, giving phosphorus 150 kg / ha with 125 kg / ha did not give significant results on increasing the protein of okra pods, so that to optimize the phosphorus expenditure 125 kg / ha was sufficient to increase the protein content of okra pods. Phosphorus as the main component in the constituent nucleic acids. Nucleic acids are made up of nucleotides. Nucleotides act as information systems in the formation of protein structures and other cellular components. Ribosomal RNA (rRNA) is one of the ribosome components that plays a role in protein synthesis [18, 19].

4. Conclusion
Recommendations for the application of phosphorus and gibberellin to increase growth and production of okra pods are based on the results of research giving phosphorus 150 kg / ha SP-36 and a gibberellin concentration of 100 mg / l because it can increase the number of internodes, pod weight per plant and pod production. Meanwhile, to improve the quality of the pods, the protein content of okra provides 125 kg / ha of phosphorus SP-36.

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