Use of Growth Hormones to Support Improvement of Garlic Production in Central Java

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Abstract. At present around 95% of Indonesia's consumption of garlic needs is fulfilled from imports. In 2019, the need for Indonesian garlic is reported to be 570 thousand tons and can only be fulfilled from domestic production of around 3.36%. Through efforts to increase production, starting in 2017 the Indonesian government has been determined to reduce the dependence of garlic imports and is targeted to gradually become self-sufficient in 2021. The use of growth hormones is believed to be able to help stimulate the growth of garlic bulbs becoming bigger. In the 2017/2018 planting season an assessment of the use of growth hormones in garlic production in Temanggung was conducted. The study used a randomized block design by applying 4 treatments and 5 replications. The treatment consisted of the gibberelin 'Super Gibs' hormone, Patrol, Hormonik and control. The study was conducted in 2 farmers groups of garlic in Glapansari Village, Parakan Sub District of Temanggung District, from December 2017 to April 2018. The results of the study of growth hormone stimulation, showed an increase in yield of 17-56% from control, which not given hormone treatment. The treatment of growth hormone can reach an average yield of 6.68 tons / ha or an increase of 1.30 tons / ha (an average of 24%) from controls, which only achieve an average yield of 5.39 tons / ha. The highest of yield increase was achieved in the treatment of hormonal 'Hormonik' (35% increased) and Patrol (32% increased) of the controls, but between both tended not to be significantly different. While the application of the Super Gibs hormone, has not shown a real and consistent effect on improving garlic yield. The increase in yield on the treatment of growth hormone is due to an increase in the bulbs weight component (an average of 25% increased) and the size of the bulbs diameter (an average of 11% bigger) of garlic produced.

Keywords: garlic, growth hormone, production

1. Introduction
Garlic (Allium sativum L.) is a vegetable plant that is propagated vegetatively (asexual) with high morphological diversity [1]. The adequacy of the dormancy period and the uncertainty of certain parameters such as the interaction between temperature and photoperiod have become the main limits for the determination of the growing season, the development of the area and the cultivation system of garlic that must be applied. A thorough understanding of environmental conditions (temperature and radiation) should be a major consideration in the development of garlic [1].

Most of the consumption needs of garlic in Indonesia is currently fulfilled from imports with the largest volume imported from China. On the other hand, the ability of domestic garlic production is currently only around 3.36% of the total consumption needs of 570 thousand tons / year or around 42
thousand tons / month [2]. In 2017, Indonesia's garlic centers covering an area of 2,146 ha were spread across 13 provinces with an average productivity of 9.09 tons / ha, thus reaching a total production of 19,510 tons [3]. Assuming a productivity of 9.0 tons / ha, to meet the national garlic needs, a minimum planting area of 63,000 ha / year is needed. While the potential land that we have for developing garlic in Indonesia is reported to reach 600,000 ha spread across 200 districts [2]. Based on these considerations, the Ministry of Agriculture is committed to gradually releasing the dependence of garlic imports and targeting self-sufficiency in 2021.

Several efforts towards self-sufficiency targets have begun, including regulations related to the commodity garlic being tightened in order to catch up and realize these self-sufficiency targets. Among the efforts to increase production that have been carried out include an increase in planting area and garlic seed support that has been started since 2017 until now. In 2018 the planting area of garlic has increased planting area by 177% (2,146 to 3,949) and in 2019 is estimated to reach an area of 18,000 ha or an increase of 373% from 2018. Through the addition of the planting area (extensification) it is expected that garlic production will also experience quite a real improvement. In addition to efforts to increase planting areas, increased production of garlic is also pursued through improved cultivation systems (intensification) which include components of quality seeds, balanced fertilization, integrated pest control and others. The application of garlic cultivation intensification was proven to be able to increase the average yield by 19.46% (1.88-35.06%) [4].

Other efforts to increase production through the application of intensification systems can also be done through innovation in the use of growth regulating hormones. In China the use of growth hormones such as auxin, gibberellins, cytokinins and paclobutrazol in rice plants can increase yield by 4.5-11.9% [5]. The use of the hormone GA3 has also been reported to be able to increase the weight and diameter of watermelons [6]. Based on the above considerations, in order to support a program to increase production towards self-sufficiency in 2021 garlic, an assessment of the use of growth regulating hormones in garlic plantations in Temanggung, Central Java has been carried out. The hormones used for this study are gibberellins and paclobutrazol which are contained in commercially available products (Super Gib, Hormonik and Patrol).

2. Methodology
The assessment was conducted in the 2017/2018 rainy season at the location of the garlic development center in Glapansari Village, Parakan Sub District, Temanggung District. The assessment site is at an altitude of about 1,400 m above sea level with Latosol Umbric (Inceptisols) soil type with an average annual rainfall of around 3,000 mm / year and an average temperature of 25-30 °C. The study location is a center for the development of highland vegetables with various vegetable planting patterns (shallots, garlic, chillies, cabbage, mustard greens, etc.) in the rainy season rotating with tobacco in the dry season.

An assessment of the use of growth hormones in garlic was carried out from November 2017 to March 2018, using a randomized block design (RBD) with 4 treatments and 5 replications. The treatment of hormone use consists of (A) Super Gibs, (B) Patrol, (C) Hormonik, (D) control without hormones. The seeds used for this study used local varieties of Lumbu Hijau from Glapansari Temanggung. Plant maintenance such as fertilizing and controlling plant-disturbing organisms is carried out based on Central Java AIAT garlic cultivation recommendations [7]. Fertilization is given in the form of basic fertilizers (organic 20 tons / ha, SP36 150 kg / ha and NPK Phonska 200 kg / ha) and supplementary fertilizers (NPK Phonska 200 kg / ha and ZA 100 + 200 kg / ha). Supplementary fertilizers are also given in the form of liquid organic fertilizer that is sprayed from the age of 15-50 days every 1-2 weeks. Application of growth regulating hormone is done just before the formation, which is at the age of 50-75 HST, given 3 times the application with an interval of administration every 1 week. The administration of growth regulating hormone uses a dose of (1) Super Gib concentration of 5% or 4-5 tablets / ha, (2) Patrol concentration of 40-60% or 10-16 bottles / ha, (3) Hormonik of 1-2% concentration or 0.5-1 liter / ha.
Super Gib is a growth hormone in the form of tablets weighing 5 grams with the active ingredient growth regulator gibberellic acid 20% which can be used for a solution of 60-100 liters. For spray tank with 17 liter volume, 1/6 parts of 1 Super Gib tablet can be used. For the purposes of spraying in 1 hectare it usually takes 400-500 liters of spray solution. 250SC Patrol is a growth hormone in the form of liquid in a brownish-white bottle with the active ingredient plant growth regulator (PGR) paclobutrazol 250 g / liter. For use in fruit and tuber/ bulbs plants, Patrol 250 SC spray solution is made with a concentration of 6-10 ml / liter. Hormone as one of the growth regulating hormone solutions contains active ingredients of organic PGR, especially auxin, gibberellins, and cytokines which are formulated from natural ingredients needed by all types of plants. In addition to PGR content, hormones also contain several essential plant elements such as N 0.06%, P2O5 0.01%, K2O 0.18 ppm, Cu 3.58 ppm, Zn1.56 ppm, B 433.51%, Co 0.28 ppm, Fe 5.28 ppm, Mo <0.20, pH 6.20, protein 0.04%, organic C 4.68%, carbohydrate 5.34% and humic acid 0.95%. For the purposes of spraying use concentrations of 1-2 ml /liter.

Observation of the effect of the use of growth hormone is only carried out on yield parameters such as bulbs diameter, bulbs weight, number and weight of non-seed bulbs classes, weights of weaving and yield conversion data per hectare. Data on plant growth performance are generally observed before the application of hormones. Data were analyzed statistically using the Duncan's Multiple Range Test (DMRT), and discussed in a comparative descriptive manner.

3. Result and Discussion

3.1. General Condition
Assessment of the use of growth regulating hormones carried out in the village of Glapansari Parakan Temanggung, began with planting seeds of Lumbu Hijau varieties on December 20, 2017 and harvested 112 days from planting, namely on April 10, 2018. Based on land evaluation criteria [8] suitability class I-II for garlic plants required rainfall of 350-800 mm. While the condition of rainfall during the period of growth until the harvest in the assessment location is classified as high, which is around 1,300 mm / 3 months with an average daily rainfall of 11.68 mm / day. Daily temperature ranges between 22.69-27.62 °C with an average of around 24.8 °C. At the stage of the formation of garlic bulbs, the cold temperature is still not at the most ideal conditions (18-20 °C), which ranges from 20.48-23.87 °C. While the humidity during the growth period until the harvest is in the range between 79.3-93.12% [9]. The distribution of rainfall, humidity and temperature during the garlic planting period is presented in Figure 1.

![Figure 1. Chart of rainfall, humidity & temperature charts in Glapansari Village, Parakan Sub District, Temanggung District(December 2017 - April 2018) [9]](image-url)
3.2. Plant Growth Condition

Plant growth observed in the study of the use of this hormone consists of 2 main components, namely plant height and the amount of garlic leaves. This growth component data is informed only as a comparison of plant performance in general in 2 locations of hormone use assessment, because this growth data is observed before and shortly after being given growth hormone treatment. Data on plant height and number of leaves were observed at 30 and 60 days after planting. This is done considering the main target of hormone administration is to increase the weight and size of the resulting yield bulbs.

Based on the average growth observation of about 50 plant samples (5 x 10 plants in each hormone use location), it is obtained that the average height of plants at the age of 30 days in location 2 reaches an average of 20.4 cm or slightly more about 3.9 cm tall compared to location 1 which only reached 16.5 cm high. However, at the age of 60 days after planting, plant height at location 1 reached an average of 48.7 cm or slightly higher at around 2.0 cm compared to location 2 which reached an average height of 46.7 cm. Based on the description of the green plant variety [8] the height of this plant is slightly lower (75%) than the standard (63-75 cm), allegedly due to the planting of garlic when it is done off-season (off-season) with rainfall conditions which is quite high. Meanwhile, when viewed from the achievement of the performance of the number of plant leaves, location 1 and location 2 in general are relatively the same as the average difference in the number of leaves 1-2 sheets. The achievement of this number gives an indication that plant growth in general is still in accordance with the description of the variety, which is between 7-8 leaves [10].

![Graph showing plant height and number of leaves](image-url)

**Figure 2.** Average plant height and number of garlic leaves in Glapansari Temanggung 2018

3.3. Plant Growth Condition

The results of observations on the average achievement of results and yield components in assessing the use of growth regulating hormones in Glapansari Village, Parakan Sub District, Temanggung District on MH 2017/2018 are presented in Table 1.
Table 1. Average achievement of garlic results in the study of the use of growth regulating hormones in Glapansari Village of Temanggung District (MH 2017-2018)

| TREATMENT   | Wet Yield Sample (kg/2m²)* | Amount of Rejected Bulbs | Weight of Rejected Bulbs (gr) | Weight per Bulb (gr) | Diameter per Bulb (cm) | Yield (ton/ha) |
|-------------|-----------------------------|---------------------------|--------------------------------|----------------------|------------------------|---------------|
|             |                             |                           |                                |                      |                        |               |
| LOCATION 1  |                             |                           |                                |                      |                        |               |
| SUPERGIB    | 2.17 ab                     | 25.8 a                    | 298.8 a                        | 29.4 ab              | 3.2 a                  | 6.17 ab        |
| PATROL      | 2.40 ab                     | 20.2 a                    | 229.6 a                        | 32.4 b               | 3.4 a                  | 6.58 ab        |
| HORMONIK    | 2.93 b                      | 18.4 a                    | 196.6 a                        | 31.4 b               | 3.4 a                  | 7.82 b         |
| CONTROL     | 1.85 a                      | 18.6 a                    | 205.2 a                        | 25.2 a               | 3.1 a                  | 5.14 a         |
| LOCATION 2  |                             |                           |                                |                      |                        |               |
| SUPERGIB    | 1.67 a                      | 25.0 a                    | 440.0 a                        | 43.2 a               | 4.3 a                  | 5.27 a         |
| PATROL      | 2.60 b                      | 23.6 a                    | 466.8 a                        | 49.0 a               | 4.9 a                  | 7.66 a         |
| HORMONIK    | 1.94 ab                     | 35.6 b                    | 706.6 b                        | 45.8 a               | 4.6 a                  | 6.60 a         |
| CONTROL     | 1.79 ab                     | 22.0 a                    | 466.6 a                        | 40.6 a               | 4.1 a                  | 5.63 a         |

*) Number in the same column at each location followed by the same letter, are not significantly different based on DMRT at the 5% level.

Based on Table 1, it can be seen that the average garlic yield achieved through the application of the intensification system at location 1 is 6.43 tons / ha and at location 2 it is 6.29 tons / ha harvest dry. This result shows that it is still lower than the variety potential based on its description, which is 10-13 tons / ha of dry harvest or 8-10 tons / ha of dried tubers with a shrinkage potential of 43% [10]. Thus the application of intensification of garlic cultivation at the assessment site could only reach a potential yield of around 63-78%.

This is thought to be caused by the planting of garlic at the assessment site which was carried out in the off-season during the rainy season with the average rainfall and humidity during the relatively high growth period (Figure 1). This is justified by the experience of cultivating garlic abroad, that garlic has a very high sensitivity to soil and environmental conditions, especially against too much water and wet soil, which can cause spoilage or low yields. Garlic is unable to produce well when planted in less fertile soil or when there is too much water [11].

When compared with the results of garlic on the standard intensification system without hormones, the average garlic yield on hormone use has increased by 20-52% in location 1 and 17-36% in location 2. But in location 2, one this type of hormone has not been proven to be more effective in improving results than control. Statistically, the use of hormone growth regulators at location 1 had the highest increase in yield and was significantly different to controls, but not significantly different to other types of hormones. At location 2, the use of growth regulating hormones although there are better indications than controls, statistically do not significantly differences. Descriptively, the use of the Patrol hormone tends to give the best results compared to others.

Overall, the application of the garlic cultivation intensification system at the assessment site using growth regulating hormones was able to reach an average yield of 6.69 tons / ha, an increase of about 27% higher than the average yield of existing cooperating farmers, and increased around 66% of the average yield of existing farmers in the development area of the garlic of the village of Glapansari Temanggung. This increase in results is in-line with the report of research conducted by [12], that the application of the gibberellic acid hormone (GA3) is able to spur plant growth and development, as well as proven to increase garlic yield by 56% and potentially increase profits by 66%.

Garlic yield components also observed in the assessment of the use of this hormone are the diameter and weight of the bulbs and the number of rejected bulbs (small bulbs). Based on the resulting bulbs performance, the use of growth regulating hormones did not have a significantly different effect on changes in the diameter of the garlic bulbs in all treatments. However, descriptively, hormone usage indicates an increase in tuber diameter of 1-8 mm. The results of research on the use of
gibberelin in shallots in Bangladesh [13] reported that most parameters showed a tendency to increase with higher gibberelin concentrations. The GA3 100 ppm application gives the maximum bulbs yield (15.23 tons /ha). Another thing is expected to increase the yield parameters due to the use of the hormone gibberelins combined with sulfur fertilizer 30 kg /ha S. Based on the results of research on potato plants, it was reported that plant sensitivity to gibberellic acid (GA) is not the same for all yield and quality variables, where GA can used to change the size distribution of bulbs significantly affect the quality characteristics or other results [14].

Based on the weight data per bulbs, the difference in yield increase per hectare by the use of hormones is thought to be slightly affected by the bulbs weights produced. It is seen that the use of hormones tends to produce heavier bulbs than controls. At location 1 the use of hormonal hormones and patrol produced the heaviest bulbs weights and were significantly different from controls. The use of growth hormone is also not seen to have an effect on reducing the number of rejected bulbs (protolan) tubers produced.

4. Conclusion
The application of the intensification of garlic cultivation at the assessment site was able to increase yields by 99% from existing farmers in the area but only reached 76% of the potential varieties. The use of growth regulating hormones in the intensification pattern can provide a yield increase of 24% from the usual intensification pattern.

Growth regulating hormones containing auxin, gibberellins and cytokinins (Hormonik brands) and paclobutrazol (Patrol brands) are proven to be quite effective in increasing yields by 52% and 36%, respectively.

Need to do a more detailed assessment related to the time and dose of application of the use of growth regulating hormones in garlic plants.

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