



Application Of Auxin (NAA) And Gibberellin (GA3) On The Growth And Production Of Shallot (*Allium ascalonicum* L)

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Received: 28-03-2025

Accepted: 29-04-2025

Published: 30-04-2025



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Abstract : Shallots (*Allium ascalonicum* L) is a vegetable commodity that has quite broad market prospects. Shallot production in East Java in 2022 will reach 473,989 tonnes with a productivity of 9.23 tonnes/ha, this number is down 5.3% compared to shallot production in East Java in 2021 which will reach 500,992 tonnes with a productivity of 9.33 tonnes/ha. Increasing shallot productivity is influenced by several factors such as fertilization, use of superior seeds, control of pests and diseases and the provision of growth regulators. Growth regulators are compounds that play a role in stimulating plant growth. Auxin and gibberellin are growth regulators that play a role in cell elongation and division so they can encourage the growth and production of shallots. The aim of this research was to determine the response of growth and production of shallot plants to the application of auxin and gibeerelin. This research was carried out in the experimental field of the Faculty of Agriculture, University of Muhammadiyah Jember in December 2023 – March 2024. This research used a factorial Randomized Group Design (RAK) with Factor 1, namely the length of soaking of tubers consisting of 4 levels, namely A0 (control), A1 (soaked 15 minutes), A2 (soaked 30 minutes), A3 (soaked 45 minutes). Factor 2 is the gibberellin application time which consists of 4 levels, namely G0 (control), G1 (application at 15 DAP), G2 (application at 25 DAP), G3 (application at 15 and 25 DAP). The results of this research show that soaking shallot bulbs before planting with auxin for 15 minutes and application of gibberellin at 15 and 25 DAP (A1G3) can increase the number of roots, bulb diameter, wet weight of tubers planted and wet weight of tubers per plot.

Keywords: Shallots; Auxin; Gibberellin; Plant hormones; *Allium ascalonicum* L

Introduction

Shallots (*Allium ascalonicum* L) are a type of vegetable that is widely used by Indonesian people. As a type of vegetable that economically has broad marketing prospects, shallots are in great demand by many people, especially as a food flavoring, but can also be used as a medicinal ingredient to lower cholesterol levels, as an antioxidant and as an antibacterial [1]. Shallot production in East Java in 2022 will reach 473,989 tonnes with a productivity of 9.23 tonnes/ha, this number is down 5.3% compared to shallot production in East Java in 2021 which will reach 500,992 tonnes with a productivity of 9.33 tonnes/ha. ha [2].

Increasing shallot crop production is determined by many factors such as the use of superior seeds, fertilization, pest and disease control and the provision of growth regulators. Growth regulators are compounds that play a role in stimulating plant growth [3]. The use of hormones has a real influence on increasing shallot productivity [4]. Growth regulators that can increase the growth and production of shallots are auxin and gibberellin (GA3).

Auxin is a growth regulator which plays a role in the process of cell growth and differentiation thereby increasing vegetative growth. The mechanism of action of auxin is that auxin influences the elongation of plant cells, auxin influences the flexing of cell walls, as a result plant cells then elongate due to water entering by osmosis [5]. Gibberellin is one of the hormones that influences plant growth, so if gibberellin is given alone it will have a stronger effect in promoting plant growth compared to auxin. Gibberellin is a compound that can stimulate cell division and elongation or both, so that it can increase plant height, encourage plant growth, produce secondary metabolites, and can increase dry weight [6].

The application of 80 ppm GA3 and NAA sprayed separately on shallot leaves at 40 and 60 DAP was able to increase tuber production by 24.7% and 22.7% higher compared to the control [7]. Soaking shallot bulbs before planting using auxin for 30 minutes at a concentration of 10 ml/l, as well as giving gibberellin once at the age of 30 DAP with a concentration of 10 ml/l, or giving gibberellin twice at the age of 20 and 30 DAP with a concentration of 5 ml /l and 10 ml/l, succeeded in increasing the number of roots, total wet weight per hill, and wet weight of tubers per hill [8]. The aim of this research was to determine the response of the Tajuk variety of shallot plants to the application of the growth regulators auxin and gibberellin.

Methods

This research was conducted at the experimental field of the Faculty of Agriculture, Muhammadiyah University of Jember, in December 2023 – March 2024.

Material

The tools used include rulers, calipers, digital scales, hoes, sprayers, shovels, beakers, knives, seed boxes, micro pipettes, measuring cups, spatulas, spray bottles. The ingredients used include red onion seeds of the Tajuk variety (Thailand Nganjuk), NAA (20 ppm), GA3 (100 ppm and 50 ppm), the active ingredient propineb 70%, the active ingredient insecticide abamectin, NPK, polybags, soil, charcoal husks, manure.

Research design and stages

The research used a factorial Randomized Block Design (RAK) with 2 treatment factors, namely: Factor 1, the length of soaking of shallot bulbs in auxin (NAA), which consists of 4 levels, namely:

A0: control

A1: soaked 15 minutes

A2: soaked 30 minutes

A3: soaked 45 minutes

Factor 2 is the application time of gibberellin (GA3) which consists of 4 levels, namely:

G0: control

G1: application at 15 DAP

G2: application at 25 DAP

G3: application at 15 and 25 DAP

Planting is carried out in polybags measuring 30 x 30 cm with a planting medium composition of manure: soil: husk charcoal (2:1:1). Fertilization is carried out twice at the age of 2 WAP and 4 WAP using NPK fertilizer, each at a dose of 3 gr/polybag/plant. Observation variables included plant height aged 10 to 40 DAP, number of leaves aged 10 - 40 DAP, number of roots, number of tubers, tuber diameter, wet tuber weight per planting, wet tuber weight per plot.

Data analysis

Data analysis uses Analysis of Variance (ANOVA) and if the results show differences, continue with the Duncan Multiple Range Test (DMRT) at 5% level.

Results And Discussion

Plant height

The long soaking treatment of shallot bulbs before planting with auxin had a significant effect on the height parameters of plants aged 30 DAP, so further tests were carried out using DMRT at a level of 5%. The results of further tests are presented in table 1.

Table 1. Duration of soaking tubers with auxin on shallot height:

Treatment	Plant height (cm)
	30 DAP
A0 (control)	35.22 ^c
A1 (soaked 15 minutes)	40.00 ^{ab}
A2 (soaked 30 minutes)	40.27 ^a
A3 (soaked 45 minutes)	38.43 ^{abc}

Note: Numbers followed by the same letter indicate no significant difference in the 5% DMRT follow-up test

Table 1. Shows that the length of tuber soaking using auxin has an effect on plant height parameters at 30 DAP. At 30 DAP, treatment A2 (soaked for 30 minutes) was significantly different from treatment A0 (control), but treatment A2 (soaked for 30 minutes) was not significantly different from treatments A1 (soaked for 15 minutes) and A3 (soaked for 45 minutes). Treatment A2 (soaked for 30 minutes) showed the highest average plant height of 40.27 cm, and treatment A0 (control) showed the lowest average plant height of 35.22 cm. This is because shallots, as a soft bulbous plant, should be soaked with a growth regulator for a short time to prevent saturation which can inhibit their growth [9].

Number of leaves

The treatment of gibberellin application time on shallots had a significant effect on the leaf number parameters at 30 and 40 DAP, so further tests were carried out using DMRT at a level of 5%. The results of further tests are presented in table 2.

Table 2. Application of gibberellin to the number of shallot leaves:

Treatment	Number of Leaves	
	30 DAP	40 DAP
G0 (control)	31.03 ^b	36.03 ^b
G1 (application at 15 DAP)	38.57 ^{ab}	42.17 ^{ab}
G2 (application at 25 DAP)	37.52 ^{ab}	43.90 ^{ab}
G3 (application at 15 dan 25 DAP)	42.57 ^a	45.72 ^a

Note: Numbers followed by the same letter in the same column indicate no significant difference in the 5% DMRT follow-up test

Table 2. Shows that the effect of gibberellin application on leaf number variables occurred at the age of 30 and 40 DAP. Treatment G3 (application at 15 and 25 DAP) was significantly different from treatment G0 (control), but treatment G3 (application at 15 and 25 DAP) was not significantly different from treatment G1 (application at 15 DAP) and G2 (application at 25 DAP). . In the G3 treatment (application at 15 and 25 DAP) the average number of leaves was highest at 30 DAP (43 leaves) and 40 DAP (46 leaves). It is suspected that giving hormones in low concentrations and at the right time can increase the growth of shallot plants. exogenous application of gibberellin can stimulate the growth of young stems and leaves, which can encourage higher photosynthetic activity, causing increased growth in all parts of the plant, including roots [10]. Using Pronas (GA3) twice, at 20 and 30 days after planting, with a concentration of 10 ml/l, showed that the plants reached maximum height and the largest number of leaves [8].

Number of tubers

The long soaking treatment of tubers with auxin and the application time of gibberellin on shallots had a significant effect on the tuber number parameters, so further tests were carried out using DMRT at a level of 5%. The results of further tests are presented in table 3.

Table 3. Duration of soaking tubers with auxin and gibberellin application on the number of shallot bulbs:

Treatment	Number of tubers
Long soaking time for tubers	
A0 (control)	9.73 ^b
A1 (soaked 15 minutes)	11.67 ^a
A2 (soaked 30 minutes)	11.42 ^a
A3 (soaked 45 minutes)	10.70 ^{ab}
Gibberellin application time	
G0 (control)	9.88 ^b
G1 (application at 15 DAP)	10.80 ^{ab}
G2 (application at 25 DAP)	11.40 ^a
G3 (application at 15 dan 25 DAP)	11.43 ^a

Note: Numbers followed by the same letter indicate no significant difference in the 5% DMRT follow-up test

Soaking shallot bulbs before planting for 15 minutes (A1) can increase the number of shallot bulbs at harvest compared to the control (A0) (Table 3.) which is 12 bulbs per cluster, but is not significantly different from treatments (A2) and (A3). This is because auxin plays a role in root formation, increasing root growth and contributing to tuber formation [11]. The number of bulbs and diameter of shallot bulbs can be increased by soaking the bulbs before planting for 30 minutes using a pro-root solution (auxin) [8].

The correct timing of gibberellin application in the vegetative phase of shallot plants influences the number of shallot bulbs at harvest. Application of GA3 can increase the number and size of cells, which results in accelerated growth of new shoots [12]. GA3 which was applied twice at 15 and 25 DAP (G3) produced the most tubers compared to the control, namely 11 tubers per cluster, but was not significantly different from treatments (G1) and (G2). Providing gibberellic acid by spraying the leaves can increase the production of shallot bulbs [13].

Number of roots and tuber diameter

The interaction treatment between the length of tuber soaking with auxin and the application time of gibberellin on shallots had a significant effect on the parameters number of root and tuber diameter, so further tests were carried out using DMRT at a level of 5%. The results of further tests are presented in table 4.

Table 4. The interaction between the length of soaking of tubers in auxin and the application time of gibberellin on the number of roots and diameter of shallot bulbs:

Treatment	Number of roots	Tuber diameter (mm)
A0G0 (control)	78.73 h	21.18 g
A0G1 (0 minutes, application at 15 DAP)	90.67 defg	23.80 cdefg
A0G2 (0 minutes, application at 25 DAP)	87.80 fgh	24.45 bcdef
A0G3 (0 minutes, application at 15 and 25 DAP)	89.53 efgh	25.17 bcde
A1G0 (15 minutes, without application)	100.20 cd	22.20 fg
A1G1 (15 minutes, application at 15 DAP)	109.73 bc	25.84 bcd
A1G2 (15 minutes, application at 25 DAP)	110.67 b	26.18 bc
A1G3 (15 minutes, application at 15 and 25 DAP)	129.40 a	31.19 a
A2G0 (30 minutes, without application)	98.80 de	23.60 defg
A2G1 (30 minutes, application at 15 DAP)	97.13 def	26.52 b
A2G2 (30 minutes, application at 25 DAP)	111.00 b	25.79 bcd
A2G3 (30 minutes, application at 15 and 25 DAP)	118.93 b	29.85 a
A3G0 (45 minutes, without application)	89.40 efgh	23.57 defg
A3G1 (45 minutes, application at 15 DAP)	88.60 efgh	23.21 efg
A3G2 (45 minutes, application at 25 DAP)	84.93 gh	24.14 bcdef
A3G3 (45 minutes, application at 15 and 25 DAP)	91.00 defg	24.96 bcde

Note: Numbers followed by the same letter in the same column indicate no significant difference in the 5% DMRT follow-up test

The interaction of tuber soaking time and gibberellin application time has a significant effect on the number of roots and diameter of shallot bulbs at harvest. Soaking shallot bulbs 15 minutes before planting and applying gibberellin twice at 15 and 25 DAP (A1G3) produced the highest number of roots and the largest bulb diameter, namely 3.1 cm (Table 4.) larger than the description of shallots. The Tajuk variety has a tuber diameter of 2.7 cm. Auxin plays a role in stimulating root formation, where roots are the part of the plant that plays a role in the process of absorbing water and nutrients [14]. The greater the root coverage area, the greater the capacity to absorb water and nutrients. The auxin mechanism in cell development occurs due to increasing sugar levels in the cell vacuole so that the osmotic pressure increases, as a result the plant cells then elongate due to water entering by osmosis [5].

In general, the effect of gibberellin is to increase the action of auxin. Exogenous administration of gibberellin can increase the amount of auxin in plants by stimulating the production of proteolytic enzymes which results in softening of the cell walls [15]. Softening of the cell walls will release the amino tryptophan which is a precursor to auxin so that auxin levels increase. Application of gibberellin at certain concentrations can increase cell division, elongation and enlargement so that it can help the plant growth process [16]. By applying hormones by spraying all parts of the plant, including the leaves, the hormones will be optimally absorbed through the stomata [17].

Wet Tuber Weight (plant) and Wet Tuber Weight (plot)

The interaction treatment between the length of tuber soaking with auxin and the application time of gibberellin on shallots had a significant influence on the parameters of wet tuber weight/plotting and wet tuber weight/plot, so further tests were carried out using DMRT at a level of 5%. The results of further tests are presented in table 5.

Table 5. The interaction of tuber soaking time with auxin and gibberellin application time on plant wet weight and fresh weight per plot:

Treatment	Wet tuber weight (plant) (g)	Wet tuber weight (plot) (g)
A0G0 (control)	68.80 f	482.67 h
A0G1 (0 minutes, application at 15 DAP)	80.00 cde	640.00 cde
A0G2 (0 minutes, application at 25 DAP)	77.07 cdef	617.33 defg
A0G3 (0 minutes, application at 15 and 25 DAP)	80.33 bcd	642.67 cd
A1G0 (15 minutes, without application)	77.93 cde	623.67 cdef
A1G1 (15 minutes, application at 15 DAP)	81.53 bcd	651.67 cd
A1G2 (15 minutes, application at 25 DAP)	83.33 bc	666.67 bc
A1G3 (15 minutes, application at 15 and 25 DAP)	93.60 a	749.00 a
A2G0 (30 minutes, without application)	73.47 def	587.33 fg
A2G1 (30 minutes, application at 15 DAP)	81.27 bcd	661.67 bcd

Treatment	Wet tuber weight (plant) (g)	Wet tuber weight (plot) (g)
A2G2 (30 minutes, application at 25 DAP)	80.20 ^{cd}	642.00 ^{cd}
A2G3 (30 minutes, application at 15 and 25 DAP)	88.00 ^{ab}	704.00 ^b
A3G0 (45 minutes, without application)	76.93 ^{cdef}	615.67 ^{defg}
A3G1 (45 minutes, application at 15 DAP)	71.60 ^{ef}	573.00 ^g
A3G2 (45 minutes, application at 25 DAP)	74.00 ^{def}	592.00 ^{efg}
A3G3 (45 minutes, application at 15 and 25 DAP)	71.60 ^{ef}	573.00 ^g

Note: Numbers followed by the same letter in the same column indicate no significant difference in the 5% DMRT follow-up test

The interaction of tuber soaking time and gibberellin application time had a significant effect on the wet weight of tubers planted and the wet weight of tubers per plot. Red onion bulbs that were soaked for 15 minutes before planting and applied gibberellin twice at 15 and 25 DAP (A1G3) resulted in a wet weight of 93.60 grams of planted bulbs, higher than the control (Table 5.) and higher than the onion description. red Tajun variety which has a planting tuber weight of 80 gr. Treatment (A1G3) also had a very significant effect compared to all other treatment combinations on the wet weight of tubers per plot and produced the largest tuber weight, namely 749 gr. Plant wet weight is the accumulation of plant height, number of leaves and leaf area, so that if the plant wet weight increases, the plant growth will be better [17]. The increase in wet weight in plants is due to the absorption of more water and nutrients and results in increased development of plant organs which has an impact on increased photosynthetic activity [18].

Plants that have wider leaves in the early stages of growth will experience faster growth due to their ability to produce more photosynthate [19]. A greater photosynthate capacity will allow plants to form larger organs, which will then result in greater dry matter production. GA3 is believed to increase biochemical activity in plants, thereby increasing the photosynthesis process. Gibberellins can increase metabolic activity and photosynthesis rate so that the formation of carbohydrates which are beneficial for tuber development also increases [16]. Food produced during the vegetative growth phase will be stored in the tubers, which means that the high yields are caused by carbohydrate reserves stored in the tubers [20].

Conclusion

Soaking shallot bulbs before planting for 15 minutes with auxin and application of gibberellin at 15 and 25 DAP (A1G3) can increase the number of roots, bulb diameter, planting wet weight and fresh weight per plot in heading variety shallots.

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