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Vegetative Characteristics and Yield Components of Mindoro White Garlic (*Allium Sativum* L.) Applied with Different Gibberellic Acid Concentrations

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ABSTRACT

Garlic is an important ingredient in many cuisines where it is used as spice but also as a fresh vegetable. The experiment was carried out to assess the vegetative characteristics and yield components of garlic (*Allium sativum* L.) with different gibberellic acid concentrations under protective structure during the period of November to February 2022. This was laid out in Randomized Complete Block Design (RCBD) replicated three times.

Results revealed that the vegetative characteristics of garlic bulbs were significantly affected by different GA_3 concentrations. An increasing GA_3 concentration from 50-250 ppm resulted in declining values of plant height but with increasing shoot length and number of leaves per hill. On the other hand, decreading values were observed in-yield components such as bulb size, total number of cloves and weight of bulb. The lowest concentrations of 50 and 100 ppm attained the highest yield (3.52 tons/ha and 3.24 tons/ha), making these the most profitable treatments. Considering the decline in yield with increasing GA_3 concentration application, further investigation regarding the effect of concentrations lower than 50 ppm is recommended.

Keywords: Gibberellic Acid, Mindoro White Garlic, bulb, clove

INTRODUCTION

Garlic (*Allium sativum* L.) often known as “bawang”, is one of the most common food seasonings in the world, for its medicinal, nutritional and other values. Because of its diverse uses, its demand is steadily increasing (Leech 2008). In the Philippines, garlic is one of the most widely grown Allium. Garlic production was primarily centered in the Ilocos region, particularly in Ilocos Norte. However, the native garlic business in the country has been operating at a loss due to the dominance of cheap imported garlic in the local market (Lubang 2018).

Climate and soil condition must be taken into consideration in garlic production. The crop prefers well-drained friable soil that is rich in organic matter (Murray 2015). Producing vegetables beneath protective structures like netting

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minimizes output losses due to insects, illnesses, severe rains, and sunburn, resulting in increased productivity and returns per unit area. Vegetable crops are shielded from biotic and abiotic stressors by protective structures. Aside from protected cropping, application of Plant Growth Regulator (PGRs) reported to increase yields. According to Palupi et al (2021), PGRs play an important role in plant growth and development, because they serve as electors for precursors of various secondary metabolites. Among PGRs, Gas has a variety of effects on plant development, including elongation of stems, internodes, and seed germination, enzyme production during germination, and fruit setting and growth (Gupta & Charabarty 2013). They also play an essential role in various physiological changes, including flower induction, flowering, cell division, and cell expansion (Stephen et al 2005). Gas also acts as a translator of extrinsic environment signals such as temperature, changes in light, and other environmental stressors (Yamaguchi 2008 as cited by Gomes et al 2014).

Although there had been studies conducted on the application of gibberellic acid on garlic (Chattapodhyay et al 2015; Liu et al 2019; Liu et al 2020; Ouzounidou et al 2011; Woldeyes et al 2017), there is no attempt so far made on garlic cultivation here in Region VIII. Moreover, this study aimed to assess the effects of different gibberellic acid concentrations on the vegetative characteristics and yield components of garlic.

MATERIALS AND METHODS

Description of the Study Area

The study was conducted under protective structure in Australian Centre for International Agricultural Research- Good Agricultural Practice (ACIAR-GAP) Project site of Department of Horticulture, Visayas State University, Visca, at Kilim Baybay, City, Leyte from November 2021 to February 2022. Region VIII (Leyte) has a prevailing type IV climate which is characterized by a year-round even distribution of rainfall and brief dry season.

Experimental Material

Mindoro white garlic native variety was used as a test crop for the experiment and GA_3 and its accessions are from Mindoro province.

Treatment and Experimental Design

The experiment was conducted in a randomized complete block design (RCBD) with three replications containing 10 sample plants in each treatment. The area was then measured a total of 60 m^2 (12 m x 5m). Different GA_3 concentrations were designated as follows 50, 100, 150, 200 and 250 ppm.

Experimental Procedure

The area was plowed and harrowed to pulverize soil clods and finally cleaned the land area. Fertilization management for garlic followed a supplementation of organic and inorganic fertilizers. Vermicast was procured at EcoFarmi in Visayas State University, Visca, Baybay City. It was applied basally to each hill before transplanting at a depth of 10 cm and at a rate of 2.5kg/m^2.

Preparation and Application of Gibberellic acid (Ga_3)

One (1) L Stock solution containing 250 ppm was prepared. It was done through dissolving 250 mg of GA_3 in a small quantity of ethanol prior to dilution using distilled water. Other concentrations such as; 50 ppm, 100 ppm and 200 ppm GA_3 was derived through dilution formula of $C_1V_1=C_2V_2$ [(C_1 initial conc) x V_1 (volume to be taken from the stock solution)= C_2 (final conc) x V_2 (final volume). The diluted chemical was sprayed to the leaves of the seedlings until dripping wet and was done in late afternoon at 36 and 56 days after transplanting (Castaneda et al 2001).

Harvesting

Garlic was harvested 120 days after planting. Harvesting was done when the main stem above the bulb softens and 75 percent of the leaves were colored yellow. The plants were pulled individually by hand and the harvested bulbs were sun or air-dried to minimize diseases during storage.

Data Collection

Plant height (cm) per hill. This was taken after harvest by measuring the plant height from the basal part of the leaf sheath (i.e. also top of the bulb) up to the tip of the longest leaf.

Shoot length (cm) per hill. This was taken after harvest by measuring the longest shoot from the upper part of the leaf sheath up to the tip of the longest leaf.

Number of leaves per hill. This was determined by counting the number of leaves of the sample plants per hill.

Bulb size (mm). This was determined by measuring the polar and equatorial diameters of 10 bulbs using Electronic Vernier Caliper at harvest.

Total number of cloves per bulb. This was determined by counting the cloves per bulb of 10 sample bulbs.

Weight of bulb (g). This was determined by weighing the bulb using digital weighing scale (2 decimal places in grams).

Yield in tons per hectare (tons/ha). The yield per plot was recorded and weighed of harvested marketable and non-marketable bulb and was converted to tons per hectare using the formula:

Total bulb yields (tons/ha) = yield (kg) area(m^2) x 10,000m^2/ha 1000 kg/ton

RESULTS AND DISCUSSION

Vegetative characteristics of garlic applied with different GA_3 concentrations showed significant differences (table1). The tallest garlic plant and shoot length were obtained in the control. Increasing GA_3 concentration resulted to decreasing plant height and shoot length but an increasing number of leaves per hill. Runkle 2006 reported that with the over application of PGR, GA synthesis is essentially blocked and can cause forstems become excessively short. Therefore when exogenous GA was applied it promoted mitotic activity in apical zone and generated with increase of axillary meristems. Moreover, these results are in consonance with the report of Marlin et al (2021), Hui et al (2020) and Rahman et al (2006) that a maximum sprouting was obtained in garlic treated with GA_3 and there is no sprouting incidence in untreated garlic. Furthermore Rahman et al (2004) disclosed that GA_3 had a significant influence on the percentages of sprouting incidence of garlic and a maximum number of leaves was observed in higher concentration. In addition, the study revealed that application of GA_3 was partially successful in breaking dormancy and accelerates the sprouting of garlic.

Table 1: Vegetative characteristics of Garlic (*Allium sativum* L.) applied with different GA_3 concentration

TREATMENT	PLANT HEIGHT (CM)	SHOOT LENGTH (CM)	NUMBER OF LEAVES PER HILL
Control	47.53 a	44.87 a	9.60 e
GA_3 50 ppm	45.60 ab	43.33 a	19.40 d
GA_3 100 ppm	44.00 bc	41.47 b	28.53 c
GA_3 150 ppm	42.27cd	39.73 c	33.87b
GA_3 200 ppm	40.47de	37.20 d	37.53 ab
$GA_{3\,2}$50 ppm	39.47 e	35.73 d	40.60 a
CV (%)	1.62	1.45	4.84

Means within the same column in a block followed by a common letter and/or no letter designation were not significantly different from each other using least significant difference (LSD) at 5% level of significance

The yield components of garlic applied with different GA_3 concentrations, revealed significant difference (table 2). The widest bulb size of garlic was obtained in plants applied with 50, 100 and 150 ppm GA_3 concentrations; however, a gradual decrease was observed in increasing concentrations. This is due to induced axillary meristem formation which dramatically promoted an increase in whorls and secondary formation (Lui et al 2019). Contrarily, the most number of cloves was achieved from those plants receiving 250 and 200 ppm GA_3 concentrations. The application of 200 ppm GA_3 concentration was comparable with 150 ppm GA_3 treatment. Likewise plants treated with 150 ppm GA_3 concentration had similar results with 100 ppm GA_3 treated plants. A comparable result was reported by Lui et al (2020) which confirmed that garlic axillary meristem treated with Ga_3 promoted a mitotic activity in the apical zone Therefore, an increased in rate and duration of cataphyll formation was generated and formed twice which caused a sharp rise in clove number per bulb.

Vegetative Characteristics and Yield Components of Mindoro White Garlic

Garlic bulbs harvested from treated plants showed lateral bulbs/cloves formation. According to Lui et al 2019, GA solution promotes an induced lateral formation of secondary plants in garlic. Furthermore, weight of bulb and lateral bulbs/cloves were summed up to the total yield of garlic in tons per hectare basis. Higher yield were obtained from plants applied with 50 (3.52 tons/ha) and 100 ppm GA_3 (3.24 tons/ha). Moreover, garlic plants applied with 100 ppm GA_3concentration showed comparable results with those plants treated with 150, 200 and 250 ppm GA_3. Contrarily lower yield at 250 ppm was obtained due to the remarkable increase in number of axillary meristem and lateral buds in plants applied with higher concentration of GA_3 which may have consumed high amounts of photosynthetic products and energy, and accompanied by the secondary formation and a plant shoot growth, that resulted in the production of smaller cloves and bulb hence total yield decreased (Lui et 2019).

Table 2: Yield components of Garlic (*Allium sativum* L.) applied with different GA_3 concentration

TREATMENT	BULB SIZE (MM)	TOTAL NUMBER OF CLOVES PER BULB	WEIGHT OF BULB (G)	YIELD (TONS/HA)
Control	20.73 c	18.11 c	4.31 c	2.76 c
GA_3 50 ppm	26.40 a	24.22 b	5.50 a	3.52 a
GA_3 100 ppm	25.63 a	26.11ab	5.06 ab	3.24 ab
GA_3 150 ppm	25.10 a	26.67 a	4.66 bc	2.98 bc
GA_3 200 ppm	23.53 b	27.11 a	4.34 c	2.78 c
GA_3 250 ppm	21.78 c	27.65 a	4.02 c	2.57 c
CV (%)	2.23	2.94	5.33	5.30

Means within the same column in a block followed by a common letter and/or no letter designation were not significantly different from each other using least significant difference (LSD) at 5% level of significance

CONCLUSION

Increasing GA_3 concentration from 150 to250 ppm significantly affected the vegetative characteristic of garlic with a declining plant height and shoot length but with increased number of leaves per hill. In terms of yield components, increasing GA_3 concentration resulted to a corresponding decline in bulb size and weight of garlic. Therefore, the lowest concentration 50 ppm and 100 ppm is the most profitable treatment.

RECOMMENDATION

Considering the decline in yield with an increasing concentration of GA_3 50-250 ppm, further studies are recommended using GA_3 concentration lower than 50 ppm. These should also examine the time of GA_3 application, effects of soil amendments in bulb formation of garlic, and timing and frequency of gibberellic acid application together with other varieties of garlic at different agro-climatic

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