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Agronomic Characters Evaluation of Garlic (*Allium sativum* L.) Bulbils

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Abstract.

Garlic production is practiced vegetatively through cloves/bulbs. However, naturally garlic also produce bulbils in stem or scape (topset). The agronomic characters of this tiny bulb-like form has been rarely discussed despite its potential for soil borne disease free seed production. This research carried out in March 2019 was aimed to evaluate some of plant morphological characters from garlic bulblets. These bulbils were harvested from Indonesia garlic variety known as Lumbu Hijau. Completely Randomized Block Design was applied throughout 4 treatment combinations e.g immersion duration and dose of growth hormone with 3 replications. Seedling percentage, plant height, number of leaf, fresh weight, dry weight, bulb height, number of clove and number of bulbils were evaluated. Although the result showed that all treatments were not significant for all characters, they showed fairly high percentage of seedling. Plant height (75 DAP) ranged between 26.99 – 30.75 cm with 3-4 number of leaves. Plants were harvested on 120 DAP where fresh weight ranged 55.90 - 68.46 gram/plant. After two months wind dried, bulb diameter range 20.40 – 21.60 cm and bulb height range 15.31 – 16.18 cm were then recorded. This results indicated that more agronomy studies need to be done for improving quality of bublets as a promising alternative in garlic production.

Keywords : agronomic character, bulbils, evaluation, garlic, propagation

1. Introduction

Among all Allium species, garlic (*Allium sativum* L.) is the most important crop after onion or shallot. It consists the main economic organ, bulb, which contain many or few of cloves, and bear leaves, pseudostem and topset which are also edible (Fritsch and Friesen 2002). Like most of Allium species, garlic is propagated asexually through axillary bulb cloves and also bulbils in stem or topset (Kamenetsky and Rabinowitch, 2006). In garlic, bulbils can form on a flower bud that has the same function as a clove bulb, so that it can also be used as a "seed". Bulbil phenomena exists in some plants e.g. when the flowering process is aborted and developmental changes produce new plantlets or bulbils instead of floral organ and seeds, but often form together with seeds in a flower bud (Asker, 2015; Ceplitis and Bengtson 2004). The mature bulbils can be separated physiologically from the parent plant and grow on its own, but sometimes it remains attached to the parent plant (Callaghan *et al.*, 1997). A bulbil consists of one small bud, with one short stem that has fleshy scales (Bell, 2008) and also can appear along pseudostems of plants which are also known as aerial bulbils (Walck *et al.* 2010). Because its lackness of anatomical structure of seeds e.g. protective layer for food reserve, bulbils tend to be more vulnerable against the environment (Dormann *et al*. 2002). However, bulbils may have higher adaptability after generations in the certain harsh environments (Callaghan *et al*., 1992). Bulbils are commonly produced from plants in higher elevation assuming that in these area as well as arid areas, extrem environmental harsness could trigger plant survival mechanisms (Abraham-Juarez *et al*., 2015).

So far, 95% Indonesian garlic consumption has been imported from China. Our garlic local production is still far below domestic demand. Bulbils which is biologically 'younger' cloves can also be an alternative approach in the production of garlic which is economical and free from soil-borne diseases and free from nematode infection or other disease-mosaic virus in particular (Etoh and Nakamura, 1988; Kamentsky, 1997). Moreover, Mathew *et al.* (2005) concluded that within 2 years, garlic propagation through aerial bulbils would result multiplication rate 45 times higher than conventional cloves. Despite its potential utilization as an alternative in garlic production, however, there have not been plenty literatures about garlic bulbils especially their agronomic characters on field. This research was aimed to evaluate agronomic characters of garlic grown from bulbils.

2. Methods

The research was started from March until September 2019 on IVEGRI Margahayu Experimental Field, Lembang, West Java. Bulbils evaluated in this study were harvested from Indonesia garlic variety e.g. Lumbu Hijau in 2018 and had reached its maturity (stored for at least 4 months after harvested). Bulbils were treated in 4 (four) combinations with 3 (three) replications between Dose of Atonik™ immersion e.g. 3 ml/l (D1) and 6 ml/l (D2) and Duration of immersion e.g. 4 hours (P1) and 8 hours (P2). After air dried, treated bulbils were planted on March and harvested on July 2019. Harvested plants were air dried for two months for dry weight observation. Evaluation included percentage of emergence (%), plant height (cm), number of leaves, fresh weight (g), dry weight (g), bulb diameter (mm), bulb height (mm) and number of bulbils.

Fig 1. Bulbils from Lumbu Hijau variety (left); Bulbils in Atonik treatments (right)

3. Results

3.1. Vegetative Growth of Plants

Percentage of germination was recorded two weeks after bulbils planted into seedbed. In average, our study showed relative high percentage of germination (69.33-78.67%; data was not shown). In the previous work, Ceplitis and Bengtson (2004) concluded that bulbils seemingly have higher germination rate than seed. Based on the results of the analysis of variance on plant height showed that the immersion of Atonik growth regulators did not significantly affect the growth of garlic plant height at ages 30, 45, 60 and 75 DAP. The average height of garlic plants aged 30, 45, 60 and 75 DAP is presented in Table 1.

Table 1. Plant height in 30, 45, 60 and 75 Days After Planting (DAP)

Treatments		Plant Height (cm)							
		30 DAP		45 DAP		60 DAP		75 DAP	
D1P1	Immersion with 3 ml/l Atonik for 4 hours	12,72	A	17,25	A	24,83	A	30,75	A
D1P2	Immersion with 3 ml/l Atonik for 8 hours	12,48	A	16,37	A	24,13	A	28,25	A
D2P1	Immersion with 6 ml/l Atonik for 4 hours	12,43	A	15,84	A	23,58	A	27,06	A
D2P2	Immersion with 6 ml/l Atonik for 8 hours	11,40	A	15,50	A	22,55	A	26,99	A

Treatments with same letter within a row are not significantly different

The difference in plant height has not been seen at the beginning of planting (30 DAP). The significant difference also of plant height seen at the age of 30 HST and 75 HST. Based on the results of the statistical tests in our study, D1P1 (3 ml/liter soaked for 4 hours) had the best effect on the height of the garlic plants, even though the figures produced were still not significantly different from D2P1 (6 ml/liter). This shows that giving Atonik at the right concentration can actively stimulate all plant tissues so that it can accelerate the process of plant metabolism in forming vegetative organs so that at the right dose can cause optimum growth. Previous trials using bulbils and cloves of garlic bulbs showed that plants derived from bulbils were shorter (Mhazo *et al*. 2014)

Table 2. Number of leaves in 30, 45, 60 and 75 Days After Planting (DAP)

Treatments		Number of leaves							
		30 DAP		45 DAP		60 DAP		75 DAP	
D1P1	Immersion with 3 ml/l Atonik for 4 hours	2,40	A	3,13	A	3,96	A	4,00	A
D1P2	Immersion with 3 ml/l Atonik for 8 hours	2,33	A	3,10	A	3,43	AB	3,97	A
D2P1	Immersion with 6 ml/l Atonik for 4 hours	2,30	A	3,03	A	3,26	AB	3,83	A
D2P2	Immersion with 6 ml/l Atonik for 8 hours	2,13	A	3,03	A	3,10	A	3,43	A

Treatments with same letter within a row are not significantly different

The results of statistical analysis on the number of leaves are in table 2. The results of the analysis show that the effect of giving the application of Atonik growth regulators was significantly different at the age of 30 HST and 60 HST, although not significantly. Where the D1P1 treatment showed the highest number of leaves at 4.00 leaves and the lowest at D2P2 was 3.43 leaves per plant.

3.2. Crop Production

In this research, plants were harvested at 120 days after planting (DAP), which is longer than usual Lumbu Hijau harvest time. This agreed with previous studies that showed bulbils require a longer growth period than normal tubers (Kajimura *et al*. 2002). The results of statistical analysis showed that the weight per sample, non-sample weight and total weight in Table 3 had no significant differences for all treatments. However, based on the average value, the D1P1 treatment (3 ml/liter soaked for 4 hours) had the highest weight compared to other treatments, namely 3.13 gr for sample weights, 65.33 gr for non-sample weights, and 68, 46 for total weight. There is a tendency that garlic bulbils immersion using Atonik growth regulators get a good response from garlic plants, especially for the addition of tuber weights per plant, although not significantly proven.

Table 3. Fresh weight harvested from bulbils derived plants

Treatments		Fresh Weight (g)					
		Sample		Non Sample		Total	
D1P1	Immersion with 3 ml/l Atonik for 4 hours	3,13	A	65,33	A	68,46	A
D1P2	Immersion with 3 ml/l Atonik for 8 hours	2,93	A	57,33	A	60,26	A
D2P1	Immersion with 6 ml/l Atonik for 4 hours	2,93	A	56,33	A	59,26	A
D2P2	Immersion with 6 ml/l Atonik for 8 hours	2,90	A	53,00	A	55,90	A

Treatments with same letter within a row are not significantly different

The immersion treatment using Atonik growth regulators did not have a significant effect on the diameter of the garlic bulbs (Table 4). In table 4, it can be seen that the D1P1 treatment (3 ml/liter soaked for 4 hours) has the largest tuber diameter of 21.60 mm compared to the D2P2 treatment (6 ml/liter soaked for 8 hours) which is 20.40 mm although not differ significantly. This shows that the immersion treatment using Atonik growth regulators at low concentrations will give a pretty good effect. This because Atonik is one of the growing substances that works at low concentrations, if the Atonik concentration in the plant is still high enough it will act as an inhibitor that inhibits the metabolic process. Thus to obtain maximum plant growth and development, the use of Atonik must be at the right concentration. This opinion is supported by Wiwit (2003) which states that auxin functions to regulate growth and other physiological functions in the body of plants outside the tissue where auxin is formed and auxin is an active ingredient in very low amounts.

Table 4. Bulb diameter and height

Treatments		Bulb Diameter (mm)		Bulb Height (mm)		Dry Weight (g)	
D1P1	Immersion with 3 ml/l Atonik for 4 hours	21,60	A	16,18	A	2,400	A
D1P2	Immersion with 3 ml/l Atonik for 8 hours	21,34	A	15,61	A	2,000	A
D2P1	Immersion with 6 ml/l Atonik for 4 hours	21,31	A	15,45	A	1,933	A

D2P2	Immersion with 6 ml/l Atonik for 8 hours	20,40	A	15,31	A	1,900	A

Treatments with same letter within a row are not significantly different

From the analysis of variance analysis, it can be seen that the immersion treatment using Atonik growth regulators has no significant effect on the dry weight of garlic bulbs. It appears that the D1P1 treatment (3 ml/liter soaked for 4 hours) gives the best effect on increasing the dry weight of garlic bulbs. This shows that soaking using Atonik must be at the right concentration so that it can improve the development of plant roots which will support the physiological processes of plants. Increased dry weight can occur if the results of photosynthesis are greater than respiration. Immersion in Atonik is thought to increase cell wall permeability which will enhance and accelerate the absorption of nutrient elements that play a role in the formation of chlorophyll to increase the dry weight of the tuber. The immersion treatment using Atonik growth regulators also had no significant effect on the formation and amount of bulbils of garlic bulbs (Table 5).

Table 5. Number of bulbils formed (observation of bulbils-to-bulbils cycle)

Treatments		**Number of Bulbils**	
D1P1	Immersion with 3 ml/l Atonik for 4 hours	0,67	A
D1P2	Immersion with 3 ml/l Atonik for 8 hours	0,40	A
D2P1	Immersion with 6 ml/l Atonik for 4 hours	0,33	A
D2P2	Immersion with 6 ml/l Atonik for 8 hours	0,30	A

Treatments with same letter within a row are not significantly different

Bulbil plants in our study resulted bulb and cloves smaller than normal cloves of Lumbu Hijau variety. This finding is similar to Mhazo *et al.* (2014) mentioning that it needs several years of bulbil derived-plants planting to gain good sized bulbs. Moreover, those bulbil derived-cloves have stronger purple color on their skin than normal cloves. We noticed not only cloves derived from bulbil plants, but also the second generation bulbils indicating bulbil-to-bulbils cycle (Figure 2c). However, in this research the second generation produced smaller bulbils than their 'parent' or previous bulbils showed in Fig.1. Another study on tuberose plants concluded that small sized bulbs produced smaller bulbils due to less availability of photosynthates (Ahmad *et al.* 2009)

Fig 2. a.Bulbils derived- plants performance on testing field; b.harvested plants; c. bulbils derived-cloves (left) versus normal cloves (right); sample cloves (left) versus bulbils produced in stem (aerial) of sample plants indicating bulbil-to-bulbils cycle (right)

4. Conclusion

The Atonik immersion with various dosage treatments given the results is not significantly different. The recommended immersion treatment using Atonik is following the D1P1 treatment (3 ml/liter soaked for 4 hours). The highest harvest production of garlic produced by the treatment of D1P1 (3 ml/liter soaked for 4 hours) has the highest weight of 3.13 gr for sample weight, 65.33 gr for non-sample weight, and 68.46 for the total weight.

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