INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 22, No. 3, p. 62-69, 2023
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Classification of Clove sizes as planting material to the bulb yield of Garlic var. Ilocos white

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Article published on March 17, 2023

Key words: Clove sizes, Growth, Native variety, Planting materials, Yield

Abstract

Garlic is one of the highly valued crops in the Philippines. However, low production yield is the main constraint, specifically in the native varieties that could not satisfy the demand. Among the limiting factors are the use of unsuitable clove size as planting materials. The results revealed that clove sizes significantly influenced the growth of garlic. Large clove size and extra-large clove size obtained average plant vigor with ratings of 5.83 and 6.33, respectively. Significant differences were also found in both fresh and dry bulb weights, with the largest clove size yielding the heaviest weights at 19.36g and 16.67g, respectively. Moreover, large and extra-large clove sizes produced the highest number of cloves per bulb with an average of 19.87 and 19.33 respectively. However, no significant differences were observed in yield per plant and yield per hectare. Consequently, large clove sizes employed as planting material increased the vigor, bulb weights, and the number of cloves with no significant effect on the yield. The study showed that planting large clove sizes (2.0-2.50g) is more promising as planting materials of native varieties like Ilocos white.

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Introduction

Garlic (*Allium sativum* L.) is the foremost alliaceous vegetable plant and one of the main vegetable crops worldwide (Nasir *et al*., 2017). It ranks second to the onion as the most widely cultivated *Allium* species distributed from boreal areas to tropic regions (Mhazo *et al*., 2014). The wide adaptation and distribution of garlic are due to its pungent characteristics that caught the attention of humans, especially for culinary purposes. The garlic bulbs are made up of Allicin content which is the active constituent that produces a pungent flavor after crushing (Lanzotti, 2006). Aside from culinary purposes, garlic is one of the oldest folklore medicines used during ancient times to cure various diseases (Cardele *et al*., 2010). According to Rahman (2003), garlic also contains 65% water, 28% carbohydrates, 1-4% sulfur compounds, 2% proteins, 1.5% fibers and 1-1.5% free amino acids. Garlic usually can be consumed fresh or processed by food industries contributing to its economic importance in the world (Lima *et al.,* 2019). The world production of garlic reached 28.49 million tons from 1,546,741 hectares of land last 2018. Among the top ten garlic producers, China is the largest producer accounting for over 78% of the world's total production with 22.27 million tons. While other major producing countries were Bangladesh, Egypt, India, the Republic of Korea, Spain, the USA, Uzbekistan, Russia, and Myanmar (FAOSTAT, 2018).

In the Philippines, there are major garlic-producing provinces namely; Ilocos Norte, Ilocos Sur, Batanes, Nueva Vizcaya, Nueva Ecija, Batangas, and Occidental Mindoro (Manila Times, 2017). The country also recorded seven local varieties such as Ilocos White, Batanes Red, Ilocos Pink, Mexican, VFTA 275 M76, Ilocos Tanbolters, and Miracle (DA-INREC, 2019). Among these varieties, Ilocos White is the most common variety planted for commercial production in the country with a potential yield of 3.5 tons per hectare (Department of Agriculture, 2019). However, there is still lower productivity with an average of 3.4mt/ha compared to 27mt/ha compared to China (Dy, 2018). In fact, the country's 2015–2017 average annual production level of 8,547 mt was enough to meet only 11.5 percent of the domestic demand for garlic, estimated at 67,366 mt (PSA, 2015; PSA, 2021). This low productivity is usually experienced by developing countries like the Philippines which is among the 13th most populated countries in the world (World Population Review, 2020). According to Tabour and Zelleke (2000), and Cherith *et al.* (2008), the low productivity is mainly due to various biotic and abiotic stresses, including low soil fertility, unsuitable clove size, planting density, irrigation schedule or shortage of rainfall, and lack of improved varieties resistant to major diseases and insects. Meanwhile, In Ethiopia, unsuitable clove size is one of the main factors limiting the productivity of garlic (Gedamu, 2005; Abdulkadir, 2014). Productivity enhancement is the only option to increase agricultural production (Pabuayon *et al*., 2013).

Garlic is completely sterile and it is propagated asexually in the forms of bulbs or bulbils (Kamenetsky *et al*., 2004). Garlic clones are routinely exchanged among farmers and are grown vegetatively (Ipek *et al*., 2008) However, the common practice is using bulbs since most of the cultivars could not produce bulbils. Garlic is reproduced by vegetative means in which plant characteristics such as clove weight or size used for propagation have a significant impact on bulb size, yield, and product quality (Memane *et al*., 2008). Jones and Mann (1963) and Brewster (1994) reported that the relationship between the size of cloves planted and the size of bulbs harvested has a linear relationship in that bulb size increased markedly as the size of planted cloves increased. Hossain *et al.* (2003) reported that planting large-sized cloves resulted in the highest total dry matter content. Furthermore, large clove size produced higher garlic quality and improved bulb yield of the harvest (Castellanos *et al.,* 2004). According to Lencha and Buke (2017), large bulbs produce vigorous plants that establish faster and have better development due to the higher carbohydrate and mineral reserves within the clove compared to those from smaller bulbs.

No doubt the use of large-sized cloves increases the yield significantly but it also enhances the cost of production by affecting the seed quantity whereas small-sized bulbs result in a lower yield with a lesser cost of production (Nasir, 2018). Hence, the yield potential of the garlic plant depends on the extent of vegetative growth attained before the formation of the bulb commences (Ahmed *et al.*, 2007). There is a great need to standardize the size of garlic cloves used for propagation in order to get cost-effective results in garlic production (Castellanos *et al.,* 2004). This study aimed to assess the effect of different clove sizes as planting materials on the growth and yield of Ilocos White Garlic.

Material and methods

Experimental materials

Ilocos White garlic was obtained from Ilocos Agriculture, Aquatic, and Natural Resources Research and Development Consortium (ILAARRDEC), Batac City, Philippines. The garlic cloves were separated from each other without removing the outer sheet. The cloves were weighed using a kitchen weighing balance according to each treatment namely; small (1.0-1.49g), medium (1.50-1.99g), large (2.0-2.50g), and extra-large (2.51-3.0g).

Experimental location

The experimental field area was located at the College of Agriculture, Don Mariano Marcos Memorial State University- North La Union Campus (DMMMSU-NLUC), Sapilang, Bacnotan, La Union, Philippines. The study was conducted from November 13, 2021, to February 26, 2022. The area was divided into 1.5m x 2.0m per plot using a Randomized Complete Block Design (RCBD) with 3 blocks and 4 treatments. The distance between every plot is 1 m with a total area of 63.75m^2.

Land preparation, Planting, and Fertilizer application

The field was prepared following the tillage method. The planting area was plowed and harrowed twice or more until the soil reached the desired texture and moisture content ready for planting. The garlic was sown in an upright position at 1 to 3cm depth by using a dibble to insert two-thirds of the length of the clove. The planting distance was 15cm x 15cm with a total of 117 hills per bed. The bed was covered with rice straw 2-3cm thick after planting to minimize the emergence of weeds. Fertilization was done by basal application of complete fertilizer (80-60-60) to the field before the levelling process at 13.5 g per plot. The side-dress application of complete fertilizer (14-14-14) was applied when the bulb started germinating at 129g per plot following the general recommended rate of the Bureau of Plant Industry (BPI).

Weeding, Irrigation, Harvesting, and Post-harvest

Weeding was done twice a week or as needed. Weeds within the bed were manually removed. Irrigation was done 1-2 days before planting to guarantee sufficient moisture content. The flooding method was used to irrigate the plants. The plants are irrigated until 70 days after planting every 3 days intervals or depending on the soil moisture. Harvesting was done 100 days after planting or when 75% yellowing of the leaves was observed. The bulb along with the undesirable debris was manually pulled to ensure a clean harvested bulb. Immediately after harvesting, the harvested bulbs were sun-dried for 4-6 days. The bulbs were then placed in a clean brown bag and hung at a clean and dry ambient room temperature to prevent pest infestation.

Statistical analysis

The data gathered was subjected to Analysis of Variance (ANOVA) in Randomized Complete Block Design (RCBD). The significant difference between treatment means was tested using the Least Significant Difference (LSD) at a significant level of 0.05 (5%). A STAR application was used to analyze the data.

Result and discussion

Result

The growth and yield parameters of the Ilocos white garlic variety as affected by different clove sizes were shown in Table 1. The results showed that different clove sizes used as planting materials have no significant effect on the following parameters of the Ilocos white garlic variety namely; plant height, leaf width, leaf length, number of leaves per plant, bulb diameter, clove length, clove width, weight per clove, yield per

plant, and yield per hectare (Table 1). On the other hand, the plant vigor rating of garlic as affected by different clove sizes showed significant differences. Large and extra-large clove sizes both obtained the highest vigor, scoring average, respectively.

Table 1. Growth and yield parameters of Ilocos white garlic variety.

Treatment	Growth and Yield Parameters						
	Plant height (cm) ^{ns}	No. of leaves/plant ^{ns}	Leaf width (cm) ^{ns}	Leaf length (cm) ^{ns}	Plant vigor rating ^{ns}	Bulb fresh weight (kg) *	Bulb dry weight (g) *
Small	32.99	4.73	0.76	27.57	1.84	5.87^{b}	5.07^{b}
Medium	41.73	5.74	0.91	32.82	2.67	11.39^{b}	9.36^{b}
Large	44.37	6.43	1.16	37.26	5.83	19.36^{a}	16.67^{a}
Extra large	42.09	6.07	0.97	34.45	6.33	13.39a^{b}	10.63a^{b}
CV (%)	40.29	5.73	0.94	33.02	4.17	19.67	20.29

Means with the same letters are not significantly different from each other at 5% level.

Table 1. Cont...

Treatment	Growth and Yield Parameters						
	Bulb diameter (mm) ^{ns}	No. of cloves/bulb *	Clove length (cm)^{ns}	Clove width (cm)^{ns}	Weight /clove (g)^{ns}	Yield per plant (kg) ^{ns}	Yield per ha (ton/ha)^{ns}
Small	21.40	8.03^{c}	1.88	0.86	0.46	0.006	0.41
Medium	26.63	12.63^{b}	2.17	0.88	0.59	0.012	0.90
Large	30.93	19.87^{a}	2.47	0.95	0.72	0.019	1.94
Extra large	29.50	19.33^{a}	2.32	0.87	0.66	0.010	1.11
CV (%)	22.29	13.95	14.84	11.07	16.36	32.6	39.84

Means with the same letters are not significantly different from each other at 5% level.

Both fresh and dry bulb weights showed a significant difference among treatments. Large clove size obtained the highest bulb weight with 19.36 g and 16.67 g in fresh and dry respectively. Furthermore, there is also a significant difference between treatments in the number of cloves per bulb. Among the treatments, planting large clove sizes produced the most cloves per bulb (19.87), while planting small clove sizes produced the fewest (8.03).

Discussion

Garlic is considered the second most important crop next to onion due to its economic uses. Several researchers from different major garlic-producing countries have tried to increase production volume through innovative farm practices. Among these are the use of different clove sizes or weight for propagation that may also significantly affect the bulb size, yield, and quality of the garlic (Castellanos *et al.*, 2004; Memane *et al.*, 2008; Lencha *et al.*, 2017; Nasir *et al.*, 2017).

In the present study, most of the agronomic parameters of the Ilocos white garlic variety such as plant height, leaf width, leaf length, number of leaves per plant, bulb diameter, clove length, clove width, weight per clove, yield per plant, and yield per hectare have shown no significant difference even it used different clove sizes. The results were similar to the report of Gedamu (2005) and Abdulkadir (2014), that the number of leaves and height of garlic plants was not significantly impacted by the size of the garlic cloves. This might be because garlic's plant height is possibly due to genetic traits and cannot be altered by utilizing different clove sizes. Furthermore, Gedamu (2005) and Abdulkadir (2014), found that garlic leaf width was heritably determined and could not be changed by using different clove sizes.

Gedamu (2005) also claimed that the genetic control of garlic's leaf length prevented clove sizes from having a substantial impact on leaf length. According to some researchers, the growth and yield of garlic may not be mainly affected by using clove sizes but may be due to some genetics and environmental factors such as photoperiod, temperatures, and the plant's phenological stage (Chen *et al.*, 2013; Atif *et al.*, 2019).

However, both fresh and dry bulb weights showed a significant difference among treatments (Table 1). Large clove size obtained the highest bulb weight with 19.36 g and 16.67 g in fresh and dry respectively. Meanwhile, small clove sizes obtained the lowest bulb weight with 5.87g and 5.07g in both fresh and dry bulbs, respectively. According to Desta *et al.* (2021), the highest average bulb weight resulting from the planting of large-sized cloves may be attributable to the greater amount of reserve nutrients in large-sized cloves. Similar results to Rahman and Das (1985), that the largest bulb weight was attained by planting cloves that were greater in size.

There was a significant difference between treatments in the number of cloves per bulb (Table 1). Among the treatments, planting large-size clove sizes produced the most cloves per bulb (19.87), while planting small-sized clove sizes produced the fewest (8.03). The results suggested that increasing the size of the cloves used for planting increased the number of cloves each plant yielded. Rahim *et al.* (2004) claims that the use of large-sized cloves as planting material encouraged rapid vegetative development and subsequently led to a higher clove number per bulb due to enhanced production of assimilates and translocation to the cloves.

According to a related investigation by Ahmed *et al.* (1996), higher nutritional stores in cloves allowed young garlic plants to grow and develop more vigorously. According to numerous studies, garlic plants that reached higher vegetative development sooner may have produced more cloves per bulb (Rahim *et al.*, 1984; Bhuiya *et al.*, 2003; Adekpe *et al.*, 2007).

Conclusion

All clove sizes, from smallest to largest, had different effects on garlic growth and yield. The performance of Ilocos White garlic may be determined by the amount of food stored in the cloves, which is proportional to their size. Planting large clove sizes (2.0-2.50g) may significantly improve plant vigor, bulb weight, and the number of garlic cloves. This concludes that larger clove sizes are more promising as planting materials.

Recommendation

According to the study's findings, clove size has a significant impact on the growth and yield of native Ilocos white garlic. The larger the clove size, the more food is stored, which may help sustain garlic growth. As a result, planting large sizes ranging from 2.0-2.50g has the potential to produce a higher yield.

Acknowledgement

The researchers would like to express their heartfelt gratitude to the University Research and Extension Office of the Don Marino Marcos Memorial State University for technical and financial support.

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