Journal of Physics: Conference Series

PAPER • OPEN ACCESS

The influence of granting npk fertilizer and nanosilic fertilizers on the growth of Ganyong plant (*Canna edulis* Ker.)

To cite this article: Yahya Barita *et al* 2018 *J. Phys.: Conf. Ser.* **1025** 012054

The influence of granting npk fertilizer and nanosilic fertilizers on the growth of Ganyong plant (*Canna edulis* Ker.)

Yahya Barita, Erma Prihastanti, Sri Haryanti, Agus Subagio, Ngadiwiyana

*Departement Biology Faculty Sains dan Mathematics Universitas Diponegoro
Jl. Prof Soedharto, SH, Tembalang, Semarang 50275, Indonesia

E-mail : yahya.barita@yahoo.com

Abstract. Ganyong is a herbaceous plant which included in the tuberous plant group. One of the ways to increase the growth of ganyong plants is by combining Nanosilica and NPK. Nanosilica is an fertilizer with nutrient contain nano size of silica. This research was conducted using Completely Randomized Design (CRD) and consisted of 6 treatments with 3 replication were control (without nanosil and NPK fertilizers); (combination 0% nanosilic and 100% NPK); (combination 25% nanosilic and 75% NPK); (50% nanosilic and 50% NPK); (75% nanosilic and 25% NPK) and (100% nanosilic and 0% NPK). Parameters of this research consisted stomata and growth rate: plant height, leaf quantity, leaf color, wet weight and dry weight. Analysis of Variance (Anova) were used to analyze the data, and if significant difference were found, the data tested further by Duncan Multiple Range Test (DMRT) at 95% significant level. The results showed that the combination of Nanosilica and NPK fertilizers affected plant height, dry weight and wet weight of the plant. The combination of 75% nanosil fertilizer and 25% optimal NPK fertilizer increased plant height, dry weight and wet weight on ganyong. The combination of nanosilic and NPK did not affected to amount stomata in ganyong.

Keywords: Ganyong, Nanosilica, NPK fertilizer and growth

1. Introduction

Ganyong is a member of cannaceae plant family that can grow in subtropical and tropical regions [15]. Ganyong (*Canna edulis* Ker.) is a tuber-producing plant that has potential as a functional food plant in the industrial, food and medicine industries. Bulbs of ganyong can be used as an alternative food source and the basic ingredients of instant noodles, biscuits for babies [12].

Ganyong cultivation have been widespread, but there has been no serious and intensive effort to increase production. Ganyong plant growth generally takes 6 to 8 months [15]. Farmers' knowledge of ganyong plants is still very low [6]. The lack of knowledge on ganyong, will make the cost of cultivation continues to increase.

Another obstacle in the ganyong plantation is the lack of balanced fertilizer used. This will certainly have an impact on the production of processed tuber ganyong. Increased production of ganyong, can be done by means of balanced fertilization [6]. Fertilization guarantees optimum nutrient availability to support plant growth, resulting in improved yields.

Fertilizer is a material that must be added to the soil for plant growth and development [14]. NPK fertilizer is usually used to increase the growth of a plant. The N element in NPK fertilizer has the function of preparing amino acids (proteins), nucleic acids, nucleotides, and chlorophyll in plants. The element P in the NPK fertilizer has a function as a storage and energy transfer. The K element in the NPK fertilizer serves as an enzyme activator, and assists in the transport of assimilated results from the leaf to the plant tissue [9].

Silica is a component of micro elements required by monocots such as rice and other plants that are Silica (Si) accumulators. The Si content in soil is considered still widely available for accumulator plants [8]. But farmers do not realize that the lands in the tropical climate tend to experience decaying and rapid desiccation which is characterized by the loss of bases and silica from the minerals in the soil [5]. Therefore, the use of nanosilica fertilizer becomes an alternative solution to fulfil the nutrient elements of ganyong plants. In addition, the selection of nanosilica as leaf fertilizer is to reduce the use of chemical fertilizers which are much more costly.

Silica is known as a beneficial element that protects plants from drought and pathogens without damaging the quality of soil, especially for plants that accumulate Si as in the Gramineae family [10]. According to Yukamgo and Yuwono [23], the provision of silica can reduce water loss from evaporation (transpiration) through stomata. Silica can also make the leaves become more upright so that the capture of sunlight is more optimal. Based on the points above, further research on the effect of NPK and Nanosilica fertilizer on ganyong plants is needed.

2. Methods

The research was conducted at Greenhouse of Diponegoro University which was held for 2 months starting from January to March 2017. Materials used in this study include tubers of ganyong plants with roots 4 and weight of about 15-20 grams obtained from Gunung Pati area, NPK fertilizer, Nanosilica Fertilizer, soil media, water, transparent nail polish and alcohol. This research used tools includes hoe, label, sack, hand spade, sand sieve, soil pH, ground thermometer, hygrometer, 5 kg capacity polybag, camera, digital scales, meter scales, sprayer, spectrophotometer, photomicrograph microscope, cover, insulation, scissors, funnel, tweezers, tissue, label paper, and oven.

The research was arranged in Completely Randomized Design (RAL) with 1 factor treatment were fertilizer, with measured variable that is growth character including plant height, leaf number, leaf color, wet weight, and dry weight, and stomata amount. Each treatment with 3 replications. The bulbs was then homogenized with a range of 4 root and tuber weight of about 15-20 grams. The homogenized bulb was then planted upright, one polybag for one bulb. Planting tubers was done by inserting tubers that were plugged into the soil media in polybags.

Ganyong that had been planted was given fertilizer treatment. NPK fertilizers and nanosilica are prepared. NPK fertilizer concentration made by weighting in accordance with the needs of each treatment. Nanosilica fertilizer made by dissolving it at 1.5 Liter water. The following are combinations of fertilizer; Combination of 100% NPK fertilizer (4.5 g / plant) + 0% Nanosilica fertilizer (P1), 75% NPK fertilizer (3.375 g / plant) + 25% Nanosilica fertilizer (1.25 ml nanosilica dissolved in 1.5 Liter water) (P2), 50% NPK fertilizer (2.25 g / plant) + 50% Nanosilica fertilizer (2.5 ml nanosilica dissolved in 1.5 Liter water) (P3), 25% NPK fertilizer (1,125 g / plant) + 75% Nanosilica fertilizer (3.75 ml nanosilica dissolved in 1.5 Liter water) (P4), and 0% NPK + 100% Nanosilica fertilizer (5 ml nanosilica dissolved in 1.5 Liter water) (P5).

NPK fertilization was applied after the seeds adapted 1 week by sprinkling the NPK fertilizer around the roots evenly. Fertilization of nanosilica fertilizer was given by spraying on the leaves of the plant evenly. Fertilization of combination between NPK and nanosilica was done by sowing NPK first on the soil medium around the roots and then after the leaves grow then done spraying nanosilica.

IOP Conf. Series: Journal of Physics: Conf. Series **1025** (2018) 012054 doi:10.1088/1742-6596/1025/1/012054

Fertilization is done 2 weeks for nanosilica that is on the day 21, 35 and 49. NPK fertilization done 2 times during the research that is at 10 days after planting and day 40.

Plants growth were observed for 2 months. Observation of the research done at the beginning and end of the study and observation of ganyong growth each week. Observations of this study have several parameters such as plant height, leaf count, leaf color, wet weight, dry weight of tubers and stomata count with replica method. The data obtained were then analyzed by Analysist of Variance (ANOVA) at the 95% confidence level to verify the significancy of the results. Significant results proceed to the Duncan area test.

3. Result

3.1. Height Plant

The combination of nanosilic fertilizer and NPK fertilizer to ganyong plants tends to increase growth. This is because there are nutrients used by plants in the process of ganyong metabolism so that growth becomes more optimal ganyong. Parameters observed during the study were plant height, leaf number, dry weight and wet weight.

Table 1. Height Plant Means, Leaf Count, Wet and Dry Weight after gived combination fertilizers for 60 days.

Treatments	Height Plant (cm)	Leaf Count	Wet Weight (g)	Dry Weight (g)
P0 = (0% NS and 0% NPK)	21.1^{b}	4.6^{b}	60.3^{b}	2.9^{b}
P1 = (0% NS and 100% NPK)	39.1^{ab}	7^{ab}	138.6^{ab}	5.2^{b}
P2 = (25% NS and 75% NPK)	41.6^{a}	$8,3^{a}$	130.6^{ab}	6.9^{b}
P3 = (50% NS and 50% NPK)	46.4^{a}	7.3^{ab}	113.6^{ab}	5.7^{b}
P4 = (75% NS and 25% NPK)	49.0^{a}	7^{ab}	239.3^{a}	12^{a}
P5 = (100% NS and 0% NPK)	31.3^{ab}	4.3^{b}	88.6^{b}	4.6^{b}

Description: The numbers followed by different letters in the same column showed significant difference based on the Duncan test at 95% confidence level

The combination of nanosilica fertilizer and NPK fertilizer affecting the height increase of white ganyong plants. Applying fertilizer on ganyong plants become one of the essential nutrients for more optimal growth of ganyong plants. This is in accordance with Rosmarkam [20] statement, that each plant needs nutrients or nutrients (plant nutrients) in order to grow to the maximum. If the plants do not get nutrients then the metabolism of plants becomes disturbed and will not work at all. Therefore, nutrients N, P, and K in plants can not be replaced by other nutrients.

Based on Table 1 it can be seen that the treatment of 5 with 100% nanosilical fertilizer on white ganyong plants did not show significant or equal effect to the control. Likewise with P1 but tends to increase the height of the plant. However, unlike treatment 1 with 100% NPK fertilizer showed relatively higher growth compared to control. The cause of growth of ganyong on treatment 1 is higher, due to the provision of nutrients of macro nutrients to ganyong in the form of NPK fertilizer. This fertilizer is able to meet the nutritional needs needed for the metabolism process so that the growth of plants to be better.

Nutrient fulfillment in the form of NPK fertilization can make the growth of ganyong plants to be better because elements of N, P, and K are nutrients that play an important role in the process of plant growth. This is reinforced by the statement of Traunfeld [22] which states that the NPK elements become nutrients needed by a plant because the N elements play a role in improving the growth of vegetative organs such as leaves, P elements can stimulate root growth and K elements play a role in water transport.

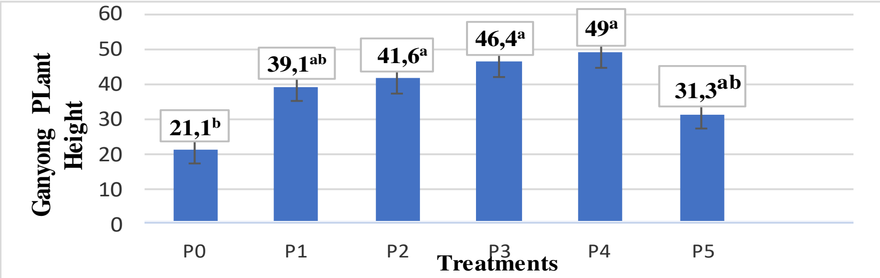

Figure 1. Histogram of Height Means

The highest growth of the ganyong plants in the table is seen in treatment 2, 3, and 4 . The three treatments are a combination of nanosilic fertilizer and NPK fertilizer. Both of these fertilizers when combined can increase the growth of ganyong plants become more dominant compared to other treatments or controls. Treatment 4 in the table, the most optimal treatment that has a very significant effect on the height of plants ganyong that is equal to 49 cm. Combination on the concentration of nanosilica fertilizer is greater than the concentration of NPK fertilizer in treatment 4, thus indicating the role of nansoilika is very important in the growth of ganyong plants. The role of nanosilica occurs in the physiological crops of the ganyong, nanosil can form bonds with epidermal cells on the cell walls, stems, become not fallen (erect) and strong. The silica coating maintains water to reduce the occurrence of transpiration so that the water in the cells can arrange more stem organs. This is in accordance with the opinions of Yukamgo and Yuwono [23], which states that silica associates with cellulose in epidermal cells from leaf cell walls, a thick layer of silica gel capable of strengthening epidermal cell walls and retaining water loss.

According to Hastuti [3] states that, Si absorbed in the leaves form a bond with the epidermis layer, thus forming a strong epidermal layer and make the organ more upright. The upright leaves cause the photosynthesis process to run properly, thus accelerating the formation of shoots and leaves. The surface of the epidermis coated with silica reduces the evaporation of water through stomata, so water can be used for photosynthesis process. Leaves become more optimal to produce photosynthesis and can supply new cell formation so that growth can take place quickly. Sufficient supply of Si on ganyong can increase cell endurance and strength. The Si supply also helps the leaves become more erect in the effect of appropriate nitrogen, phosphate and potassium fertilization conditions, there by increasing the formation of photosyntate in photosynthesis. Sufficient addition of Si can reduce the tendency of ganyong plants in drought conditions This is due to decreased moisture permeability of cell walls of leaf epidermis.

The height gain in plants caused by cell division after absorption of nutrients, the process of carbohydrate division required from the process of photosynthesis for the addition of plant height. As stated by Herdiana [4], the increase in plant height as one of the characteristics of plant growth is caused by the activity of cell division in apical meristem. The increase in plant height begins with increasing shoots that are longer and continued with the development of leaves and stems. Shoot growth in plants undergo three stages, namely cell division, extension, and differentiated or maturation. In the phase of cell division, plants require carbohydrates because the main component of the cell wall is made of glucose (carbon) or in other words that cell division depends on the supply of carbohydrates. While carbohydrates are only produced from the process of photosynthesis involving chlorophyll and N elements play a role in the formation of chlorophyll. In addition, according to Rosman et al. [19] the results of photosynthesis are more widely used for new shoots than to enlarge stems and root growth, since active growth is more prevalent in the shoots of plants.

3.2. Leaf Amount

Data from ANOVA test showed that the combination treatment of NPK and nanosilica in ganyong plants showed significant effect on leaf number. The data of the test results showed that treatment 2 has a relatively higher average leaf number compared to other treatments. The average number of leaf blade on nanosilic fertilizer treatment 0% and NPK 100% (P1) fertilizer 7, nanosilic fertilizer 25% and 75% NPK (P2) treatment 8.3, 50% nanosilic fertilizer and 50% NPK P3) of 7.3, 75% nanosilic fertilizer treatment and 25% of NPK (P4) fertilizers 7, 100% nanosilic fertilizer treatment and 0% NPK fertilizer (P5) of 4.3, had a lower average leaf number compared to control treatment (P0) of 5.3.

This shows that there is a real effect between the combination treatment of NPK fertilizer and nanosilica fertilizer on control or treatment without fertilization. According to Kartika [11], the increase in the number of leaves in a plant is influenced by the uptake of nutrients in the plant. Fertilizer affects the number of leaves, proving the presence of reactions that occur within the cell. Ganyong plants are able to form leaves to produce food in order to keep growing.

Treatment 2 having a significant effect compared with other treatments with an average number of leaves as much as 8.3. Treatment 2 (nanosilica 25% + NPK 75%) has more leaves. The more leaves cause photosynthesis to increase, so the resulting photosynthate increases. Other treatments that have a real effect compared to controls are (P1), (P3), (P4) where these three treatments have relatively large leaf counts when compared to controls. The number of leaves on the fertilizer treated plants tends to increase due to the presence of macro nutrients (N, P, K) and micro such as silica, iron, and manganese that are met within the leaves and can form proteins inside.

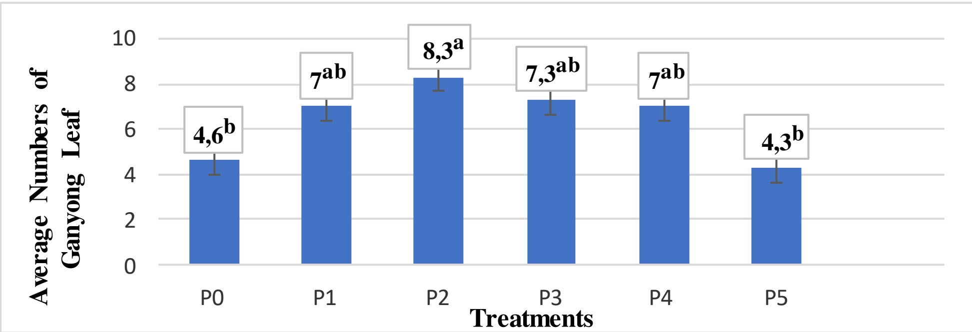

Figure 2. Leaf Number Histogram

This is in accordance with Poerwowidodo [18], which states that protein is the main constituent protoplasm that serves as a center of metabolic processes in plants which will further spur cell division and elongation. When the cell undergoes a cleavage it will form a network which then develops into a leaf. Leaf develops from meristematic cells and form buds that are influenced by nutrient content and absorbed water. The more nutrient absorption the formation of leaf buds becomes increased.

However, in the treatment of 100% nanosilica and 0% NPK (P5) fertilizers have relatively few leaves, due to full nanosilica nutrition allowing leaf cell division ineffective and inhibited. This is consistent with the statements of Mansfield and Atkinson [13] plants that are nourished with excessive concentration resulting in stress in the cells and causing changes in the distribution of assimilates in other organs. Plants response will occur at the cellular and molecular levels.

3.3. Wet Weight

The average wet weight measurement presented in Table 1. showed that the control and treatment of 100% nanosilica fertilizer and 0% NPK fertilizer of ganyong plant had a smaller wet weight compared with the treatment of 1, 2, 3, and 4. In the treatment the addition of nanosilica fertilizer and NPK fertilizer had more wet weight many compared to controls. However, treatment 1,2,3 and 5 did not look different to control. However, data on wet weight showed that 75% nanosilica and 25% npk treatment could increase wet weight more optimally than other treatments.

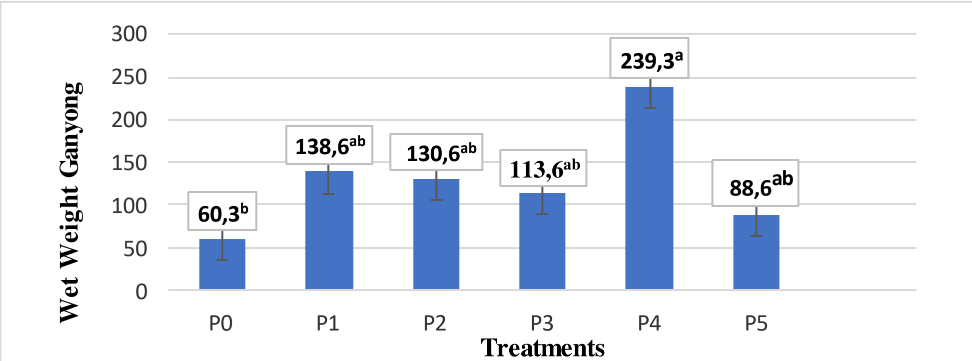

Figure 3. Wet Weight Histogram

Control treatment in the absence of fertilization tends to have less wet weight results due to the absence of nutrients given or absorbed by ganyong plants. Plants given fertilizer treatment tend to increase more than the control. This is due to the presence of nanosilic elements sprayed through the leaves and is absorbed directly for plant growth.

Absorption of water and increased nutrients will increase the water content in the cell which will be used for cell activity one of them for the process of photosynthesis and circulation of photosynthesis results to all parts of the plant. According to Parera [17], the absorption of large amounts of water will encourage cell lengthening and cell enlargement that can increase water content so that wet weight of plants increases.

The wet weight of the treated ganyong plant has a larger mass size than the control treatment. Wet weight of ganyong at higher treatment, due to nutrient absorption and water that occurs inside the plant cells. This is in accordance with the opinion of Nurdin [16] states that the increase in wet weight is influenced by the number of water absorbs and the accumulation of photosynthesis in the leaves to be transransced to all parts of the plant.

3.4. Dry Weight

Based on the results of further duncan test, 75% nanosilica and 25% NPK (P4) treatment had an effect on dry weight and significantly different from other treatment. The influence of dry weight on ganyong plants is due to nutrient uptake given in the form of nanosilica and NPK fertilizers. According to Salisbury and Ross [21] the availability of sufficient nutrients along the growth of the crop, in this case with the application of NPK fertilizer and nanosilica gives the possibility of hoarding components of more dry matter. The least average results were shown in the control treatment or were not given the addition of fertilizer. The high dry weight values can be attributed to the amount of carbohydrates produced in the process of photosynthesis that goes on the plant [16].

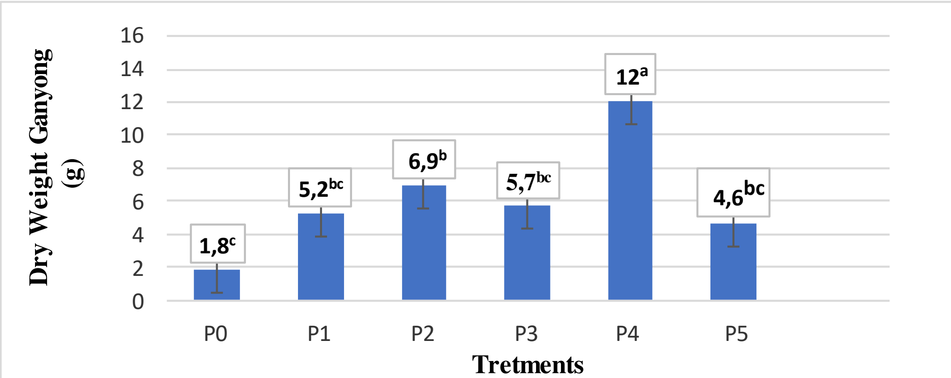

Figure 4. Histogram of Ganyong Dry Weight

The process of photosynthesis in the control treatment is less than the application of NPK fertilizer and nanosilica fertilizer. According to Iriany [7] carbohydrates in the plant is converted into plant proponents, so that dry weight of plants is a combination of multiple process of the body. The elements that existing inside ganyong plants can also increase the efficiency of photosynthesis, so that the resulting photosynthate becomes increased and affect the dry weight.

Nanosilica fertilizers have a silica component as a surface coating of plants so that at the time of transpiration does not occur excessive evaporation. The result of photosynthesis in ganyong plants will be more optimal and the results can be stored. Food reserves can be further optimized stored in the form of carbohydrates and the formation of plant body cells. According to Iriany [7] the increase of photosynthate formed also increases the dry weight of plants because 90% of the dry matter of plants derived from photosynthesis. The use of Nanosilica fertilizer can be used as an alternative to the fertilization of ganyong plants. Because it is able to increase the dry weight of plants, in addition to its relatively few uses can be used as a substitute for the use of organic fertilizers.

3.5. Leaf Colour
Leaf color of ganyong with 0% nanosilic fertilizer and 100% NPK fertilizer (P1), 25% nanosilica fertilizer and 75% NPK fertilizer (P2), 50% nanosilic fertilizer and 50% NPK (P3) NPK fertilizer, 75% nanosilica fertilizer and 25% NPK fertilizer (P4), 100% nanosilic fertilizer and 0% NPK fertilizer (P5) have the same result that is light green leaf color to dark green compared with control which show less optimal result that has the color of light green leaf.

Colors on the leaves indicate the adequacy of nitrogen absorbed by plants. The darker the leaf color indicates that the amount of nitrogen absorbed by the plant increases. Symptoms of yellowish-green or younger leaves are caused by deficiency symptoms. According Hardjowigeno [2] symptoms of deficiency or lack of N will cause the plant to be dwarfed, plant growth is limited, leaves turn yellow and fall. Because N compounds play a role in improving vegetative growth of plants. Plants grown on sufficient soil N leaves are greener in the treatment of P1, P2, P3, and P4.

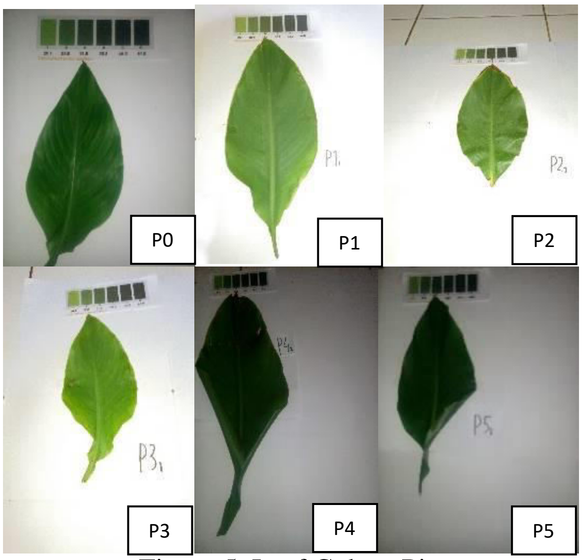

Figure 5. Leaf Colour Picture

Description : P0 = Light Green, P1 = Dark Green, P2 = Dark Green, P3 = Light Green, P4 = Dark Green, P5 = Dark Green

Engelstad (1) states that optimal nitrogen administration can increase plant growth, increase protein synthesis, chlorophyll formation which causes leaf color to be greener and increase root canopy ratio. Therefore, optimal nitrogen administration can increase the rate of plant growth

6. Number of Stomata

Based on Figure 6 it can be seen that the application of nanosilica fertilizer in white ganyong plants can not increase the number of stomata. However, when seen again in treatment 1 shows the highest and highest levels of stomatal stages, compared with other treatments and controls. This means that nanosilica fertilizer tends to increase the amount of stomata in ganyong leaf.

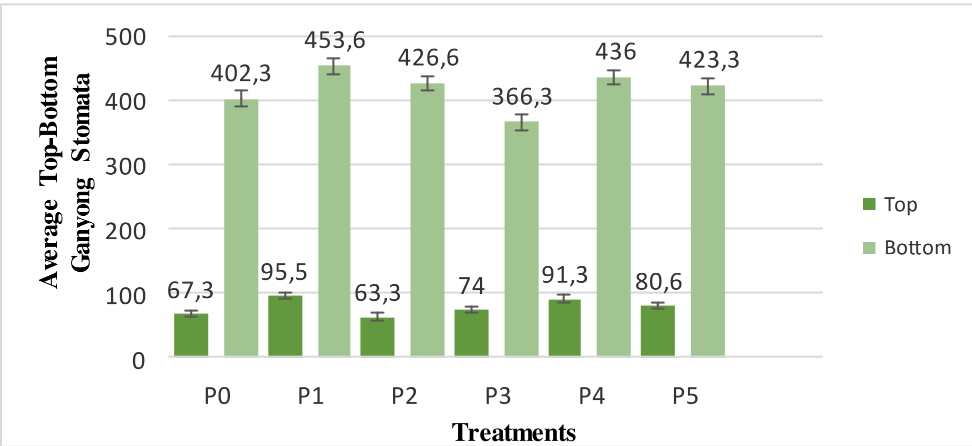

Figure 6. Histogram of Top-Bottom Stomata

This suggests that silica plays a role in the cell differentiation process. Differentiation is one form of adaptation of plants to adjust its function with the environment. The increasing number of stomata is a process of adaptation of a plant to its environmental conditions. Plants treated with nanosilic fertilizers also have larger stomata sizes than controls. This makes the high rate of transpiration due to the water coming out more, thus increasing the nutrient uptake of the soil. The absorbed nutrients will be used for photosynthesis, which will increase the rate of photosynthesis that affects the high growth of ganyong plants.

4. Conclusion

Based on the research that has been done on white ganyong plants with combination treatment of NPK and Nanosilica fertilizer can be concluded that:

1. The application of NPK fertilizer combined with the nanosilica fertilizer hads a significant effect on the wet weight and dry weight and the height of white ganyong plant
2. Treatment of combination of 25% NPK fertilizer and 75% of Nanosilica fertilizer (P4), increased wet weight, dry weight and height of white crop plant.

References

[1] Engelstad, O. P. 1997. *Teknologi dan Penggunaan Pupuk Edisi Ke – 3*. UGM Press. Yogyakarta
[2] Hardjowigeno 1995. *Ilmu Tanah*. Akademi Pressindo, Jakarta
[3] Hastuti, Widi. 2016. *Pemberian Kombinasi Pupuk Daun Gandasil dengan Pupuk Nanosilika terhadap Pertumbuhan Bibit Mangrove (Bruguiera gymnorrhiza)*. Semarang. Universitas Diponegoro.
[4] Herdiana, Nanang. Abdul Hakim Lukman dan Kusdi Mulyadi. 2008. *Pengaruh Dosis Dan Frekuensi Aplikasi Pemupukan NPK Terhadap Pertumbuhan Bibit Shorea Ovalis Korth. (Blume.) Asal Anakan Alam Di Persemaian*. *Jurnal Penelitian Hutan dan Konservasi Alam*. Vol V No. 3 : 289-296.
[5] Husnain, Sri Rochayati, Ibrahim Adamy.2012. *Pengelolaan Hara Silika Pada Tanah Pertanian Indonesia. Balai Litbang Pertanian. Vol 10.*
[6] Imai K, Adachi N, Yoritaka S. 1990. *Studies on matter Production of edible canna : Absorption of mineral nutriens.* Japanese Journal of Crop Science 59 (Extra 2), 89-90
[7] Iriany, R. N. M. Yasin H.G., dan Andi Takdir M. Asal. 2006. *Sejarah, Evolusi, dan Taksonomi Tanaman Jagung.* Balai Penelitian Tanaman Serealia, Maros
[8] Janislampi, K.W. 2012. *Effect of Silicon on Plant Growth and Drought Stress Tolerance*. Logan. Utah State University.
[9] Jayaweera, G.R. and Mikkelsen, D.S. (1991). *Assessment of ammonia volatilization from flooded soil systems.* Advances in Agronomy 45:303-353.
[10] Jones, L.H.P. and K.A. Handreck. 1967. *Silica in soils, plants, and animals p. 107–149. In A.G. Norman (ed.) Advances in agronomy*. Vol. 19. Academic Press, New York.
[11] Kartika, dkk. 2015. *Pertumbuhan Tanaman Ganyong Pada Pemberian Kompos Tandan Kosong Kelapa Sawit Dibawah Tegakan Sawit*. Prosiding Seminar Lahan Suboptimal. Universitas Sriwijaya
[12] Lai Kl, Tsai YZ, Wang TY. 1980. *Studies on the edible canna in Taiwan Botanical characteristic and economical use of edible canna.* Journal of Agricultural Association of China, New Series 111, 1-13
[13] Mansfield, T.A. dan C.J. Atkinson. 1990. *Stomatal Behavior in Water Stressed Plants. Dalam: Alscher dan Cumming (Eds). Stress Response in Plant adaptation and Acclimation Mechanisms*. Wiley Liss Inc., New York.
[14] Masarirambi, M.T., Nkomo, M., Oseni, T.O. and Wahome, P.K. (2013). *Effects of cattle manure application on growth and marketable yield of traditional okra (Corchorus olitorius L.) in Swaziland.* Acta Horticulture 1007:339-345.
[15] National Research Council. 1989. *Lost Crops in Incas: Little-Known Plants of the Andes with Promise for Worldwide Cultivation. National Academy Press.* Washington, DC. p. 27-37.

[16] Nurdin, Syahari. 2008. *Komoditas Jagung Sebagai Sumber Daya Non Migas. Fakultas Pertanian Universitas Hasanudin.* Makasar
[17] Parera. 1997. *Pengaruh Tingkat Konsentrasi Pertumbuha Perbanyakan Tanaman Anggrek Dendrobium melalui Teknik Kultur Jaringan*. Hal: 57-64
[18] Poewowidodo, 1992. *Telaah Kesuburan Tanah*. Angkasa, Bandung.
[19] Rosman, R., S. Soemono dan Suhendra. 2004. *Pengaruh Konsentrasi dan Frekuensi Pemberian Pupuk Daun terhadap Pertumbuhan Panili di Pembibitan*. Buletin TRO XV No. 2, 2004.
[20] Rosmarkam, Afandie dan Nasih Widya Yuwono. 2002. *Ilmu Kesuburan Tanah. Kanisius*. Yogyakarta.
[21] Salisbury, F.B. dan C.W. Ross. 1992. *Plant Physiology. 4rd Ed.* Wadsworth Publishing Company. California.
[22] Traunfeld, John. 2013. *Soil Amendments and Fertilizer*s. Marylands. University Of Maryland.
[23] Yukamgo, Edo dan Yuwono, N. Widya. 2007. *" Peran Silicon sebagai Unsur Bermanfaat pada Tanaman Tebu"*. Jurnal Ilmu Tanah dan Lingkungan. Universitas Gajah Mada. 7 (2): 103-116