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The comparison of chlorophyll a, b, and the total of maize (*Zea mays saccharata* sturt l) var p-21 by applying fertilizers of nanosilica-npk and nanosilica-manure

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Abstract. The productivity of corn field's crops must be increased in order to supply the market's demands. This study aims to increase the productivity of corn plants by using the proper fertilizers. Fertilizing using silica can increase the resistance of corn plants toward drought pressure, while nitrogen fertilizing can increase the amount of chlorophyll. This study compares the effect of nano silica-NPK fertilizer and manure-nano silica toward the chlorophyll a, b, and to the total amount of chlorophyll consisted in sweet corn plants at the age of 10, 40 and 60 days. The nanosilica-NPK ratio is 100%: 0%, 75%: 25%, 50%: 50%, 25%: 75%, and 0%: 100%, as well as the ratio of nano silica-manure. The total amount of chlorophyll contained in the fertilizers of nano silica-manure tends to be the same as nano silica-NPK fertilization at the age of 10, 40 and 60 days. The amount of Chlorophyll a is higher than the amount of chlorophyll b in all fertilizers. Chlorophyll a, b, and the total amount of chlorophyll tends to decrease in nano silica-manure fertilizer, but in nano silica-NPK fertilizer, the chlorophyll has increased from the 10th to 60th days.

1. Introduction

The Central Bureau of Statistics noted that within the last 10 years (2005-2015), the national corn production had increased by 36.14%. The average increase of corn production per year reached 7.9% during the period 2005-2015 [1]. The productivity of Corn Corps increases every year, but the percentage is low. In recent years Indonesia's climate has experienced extreme changes, a long dry season has created a big impact on the declining of the productivity of various food crops commodities in Indonesia.

Corn is a plant that is resistant to drought. However, excessive drought pressure conditions will directly affect the growth and the production of corn crops. Drought and high environmental temperatures have a negative effect on agricultural production [2].

Many studies recommend the use of silica (Si) fertilizer to overcome drought stress. Tuna et al. [3] recommends Si fertilizer for plants to improve the tolerance of plants under the pressure of both abiotic and biotic factors. Fertilizing using K_2SiO_3 can increase the rate of photosynthesis on plants during drought conditions [4]. Fertilizing using Si is able to maintain the amount of chlorophyll in



drought conditions. Silva et al. [5] reports the use of Si-rich media influences the increasing production of chlorophyll in tomato plants. Further research uses Si in nano size to stimulate the growth of the plant.

2. Materials and Methods

The research was conducted from December (2014) to June (2015) on the field of PT. Tossa Sakti, Kendal. The materials used for the study are the P-21 variety of corn seeds produced by PT DuPont Indonesia, Nanosilica fertilizer, NPK fertilizer, and manure produced by PT Tossa Shakti.

Various fertilizers are applied in this study including N1: 100% combination of nano silica fertilizer and 0% NPK; N2: The combination of nano silica fertilizer 75% and NPK 25%; N3: 50% combination of nano silica fertilizer and 50% NPK; N4: The combination of nano silica fertilizer 25% and NPK 75%; N5: The combination of nano silica fertilizer 0% and NPK 100%. To compare it, treatment is applied by using the same type of concentration, K1: The combination of 100% nano silica fertilizer and 0% manure; K2: The combination of 75% nano silica fertilizer and 25 % manure; K3: The combination of 50 % nano silica and 50% manure; K4: combination of 25 % nano silica and 75 % manure; K5: The combination of 0 % nano silica and manure 100%.

Nanosilica is dissolved in 500 ml water per treatment of corn plants. Fertilizing is done by spraying the leaves and stems of the corn plant. Fertilizing with manure is given on the edge of the corn plant with a distance of 5 cm from the corn plant.

The Analysis of chlorophyll a, b, and the total use of Shimadzu are 1240 UV-Vis Spectrophotometer. The calculation of chlorophyll levels is based on the method proposed by Hendry and Grime [6]:

- i) Chlorophyll a mg / g leaf weight = $12,7 \times A_{663} - 2,69 \times A_{645} \times 10^{-1}$
- ii) Chlorophyll b mg / g leaf weight = $22,9 \times A_{645} - 4,68 \times A_{663} \times 10^{-1}$
- iii) Total chlorophyll is mg / g of leaf weight = $8,02 \times A_{663} + 20,2 \times A_{645} \times 10^{-1}$

3. Results and Discussion

Chlorophyll is a major factor affecting photosynthesis. Photosynthesis is the process of changing inorganic compounds (CO₂ and H₂O) into organic compounds (carbohydrates) and O₂ which involves sunlight. Chlorophyll is the main pigment found in chloroplasts.

The Measurement of chlorophyll level is closely related to the growth and the production of a plant. This is in accordance with the opinion which states that the measurement of physiological characters of a plant such as chlorophyll levels, is one of the approaches to study the effect of water shortages on growth and harvest because this parameter is closely related to photosynthesis rate [7].

3.1 The level of Chlorophyll A

The level of chlorophyll an on day 40 combined with nanosilica and NPK has more optimal results compared to a combination of nano silica fertilizer and manure. The highest level of chlorophyll a is the combination treatment of nano silica-NPK (75% : 25%) while the highest levels of chlorophyll a in the treatment of nano silica 100% without manure. This can be seen in Figure 1.

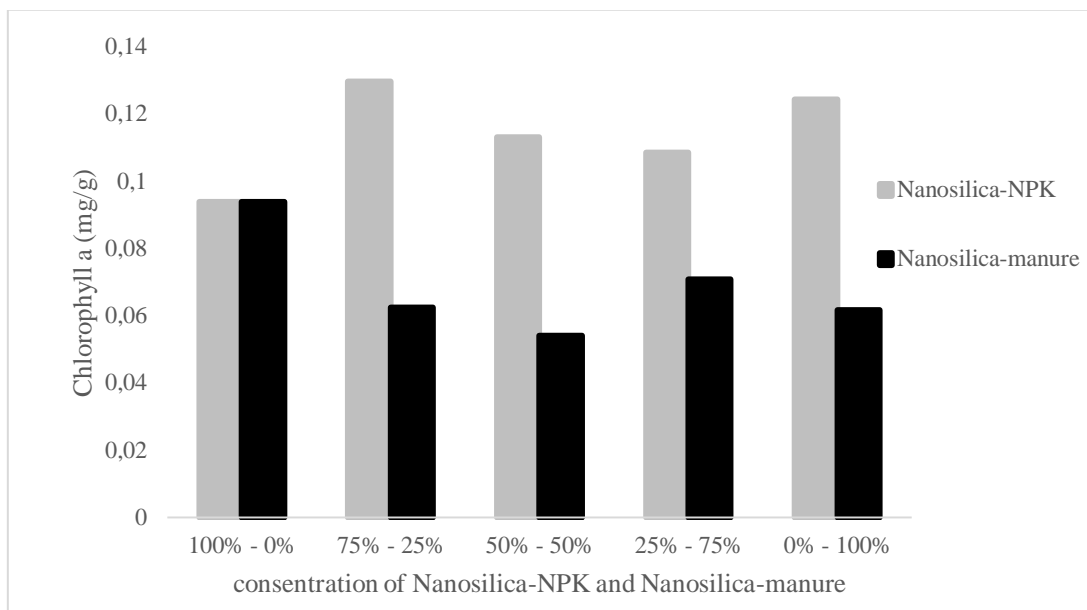


Figure 1.Chlorophyll-a content changes during 40 days

On the 60th day at harvest time, Figure 2 shows that the combination of nano silica-NPK (75%: 25%) and nanosilica-manure combination (50%: 50%) has the highest chlorophyll a.

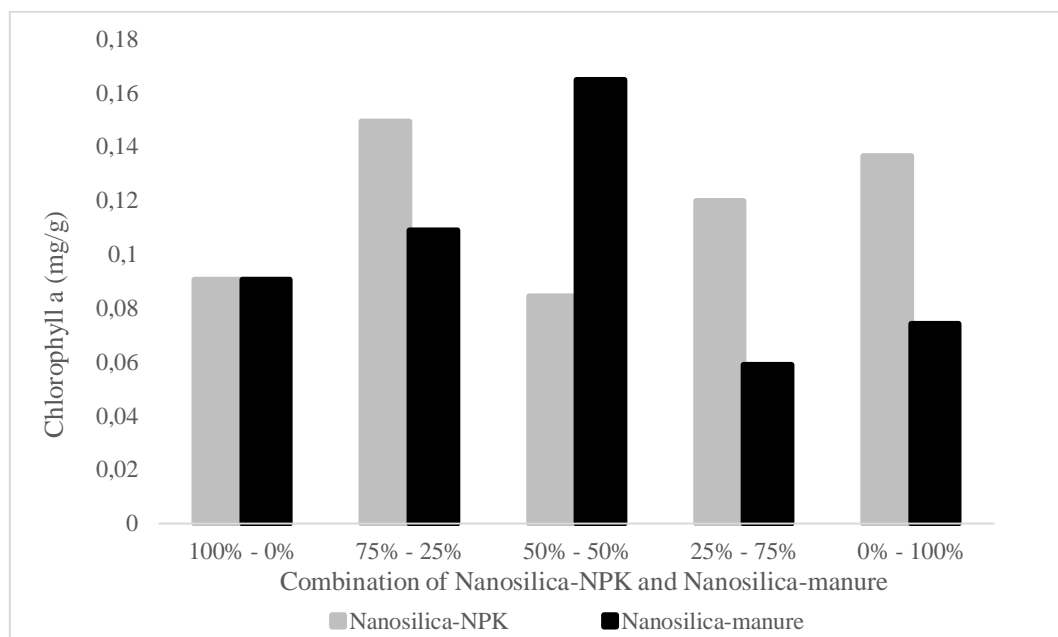


Figure 2.Chlorophyll-a content changes during 40 days

The highest result of the calculation of chlorophyll a combined with the treatment of Nanosilica-NPK at the age of 40 days and 60 days is on a combination of 75% nano silica fertilizer and 25% NPK fertilizer. Si nutrients are useful in supporting the growth of the plants because they can stimulate photosynthesis. The role of Si nutrients for plants is to stimulate photosynthesis and translocate carbon dioxide [8]. Nanosilica is a very small particle fertilizer that will be more easily and quickly absorbed by plants [9].

The level of Chlorophyll is calculated at the age of 10 days (before fertilizing), 40 days and 60 days (after fertilizing). In general, the level of chlorophyll a in both treatments decreases on day 40, but on

the 60th day, there is an increase again. Chlorophyll a in the nano silica-NPK combination treatment is higher than nano silica-manure. This is shown in Figure 3.

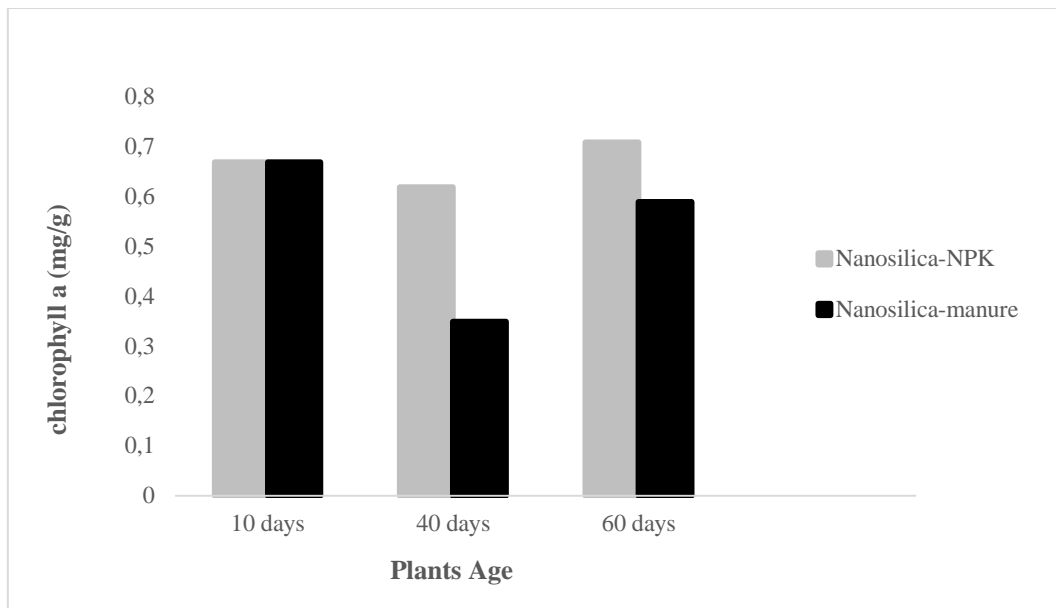


Figure 3. Chlorophyll-a content on corn leaves at 10, 40, and 60 days ages.

3.2 The level of Chlorophyll B

The highest level of chlorophyll B with a duration of 40 days is shown in the nano silica-NPK treatment (0%: 100%) and nanosilica-manure treatment (75%: 25%). This can be seen in Figure 4.

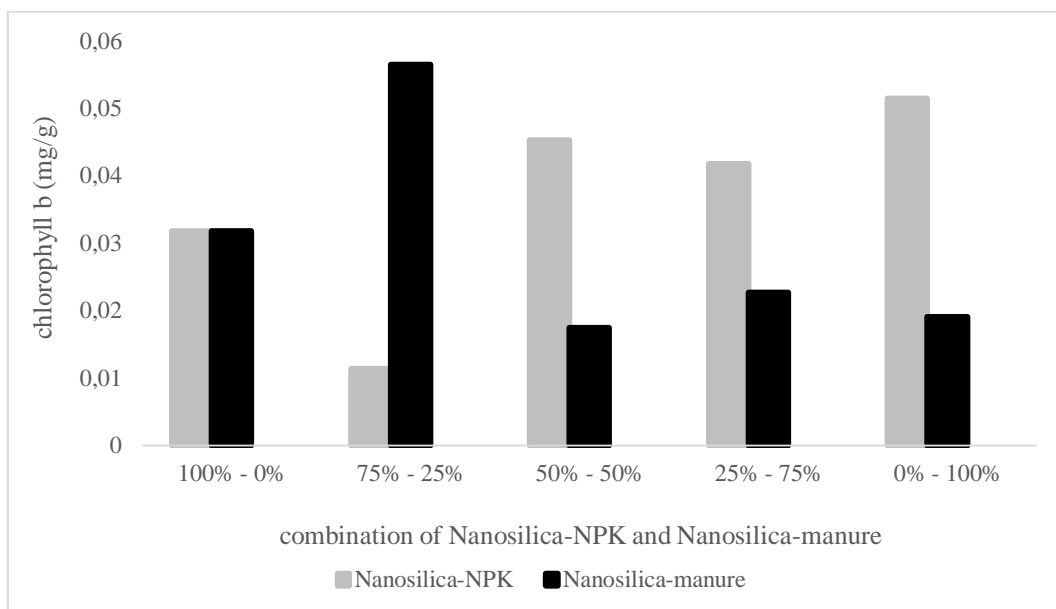


Figure 4. Chlorophyll-b content changes during 40 days

While on the 60th day, the level of chlorophyll b shows that the combination of nano silica fertilizer with NPK has a higher harvest compared to the combination of nano silica with manure. The highest results in the combination of nano silica-NPK (75%: 25%) and nanosilica-manure (50%: 50%), can be seen in Figure 5.

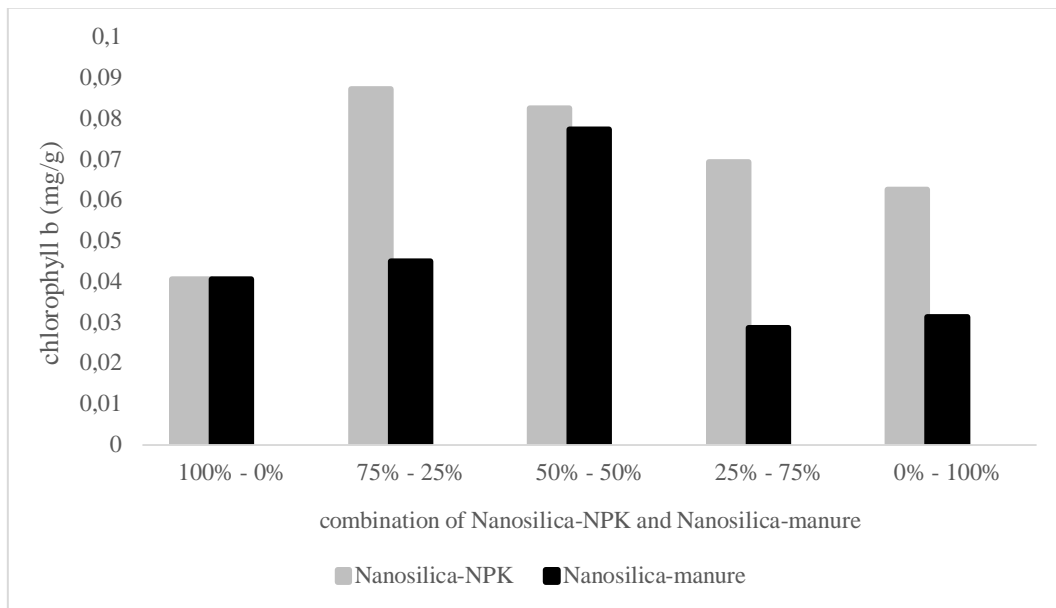


Figure 5.Chlorophyll-b content changes during 60 days

In Figure 5 above, the optimal results are shown in the combination treatment of Nanosilica 75% and NPK 25%. NPK fertilizer also plays an important role in the formation of chlorophyll and photosynthesis. Chlorophyll formation requires nitrogen in sufficient and balanced amounts because nitrogen is a major component in the preparation of chlorophyll [10]. NPK fertilizer is used to fulfill the K^+ element which is important for photosynthesis and sugar transport [11]. Besides the addition of fertilizer, chlorophyll formation is also supported by the presence of sunlight. The application of nano silica fertilizer plays a role in increasing the absorption of sunlight. This is in line with the opinion of Putri et al. [12], silica which accumulates in the leaves causes the leaves to become more upright and stretch well as a result of the leaf surface getting more sunlight. The more amount of chlorophyll in plants, the more optimal photosynthesis process.

Chlorophyll b content in the nano silica-NPK combination treatment at 40 days decreased and increased again at 60 days. Whereas in the nano silica-manure combination, chlorophyll b levels continue to decline from 10 to 60 days. This is shown in Figure 6.

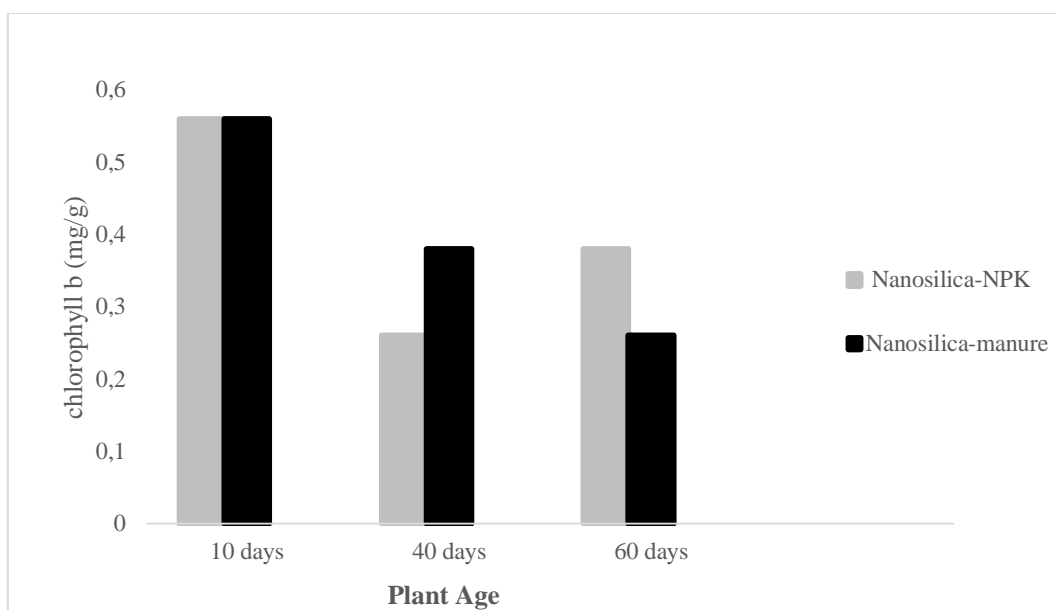


Figure 6.Chlorophyll-b content on corn leaves at 10, 40, and 60 days ages.

3.3 The total Amount of chlorophyll

The combined treatment of nano silica fertilizer with manure in the treatment of 100% nano silica fertilizer and a combination of 25% nano silica fertilizer and 75% manure have the most results. This can be seen in Figure 7.

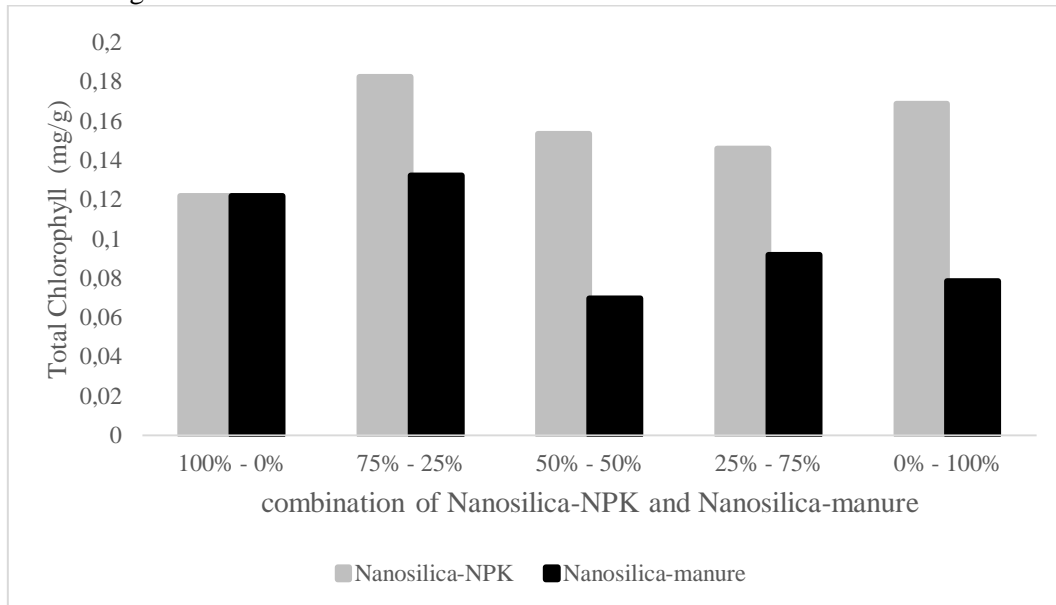


Figure 7.Total chlorophyll content changes during 40 days

The results of chlorophyll combined with nano silica treatment and manure have lower level compared to nano silica treatment and NPK. This is possible because the manure given has not completely decomposed so that the nutrients in the manure cannot be absorbed by the plant, causing the plant to grow slowly. The period of the decomposing process in manure is affected by the texture of the fertilizer itself [13]. Textures shaped like granules and solids are rather difficult to break physically so that it is slow to decompose and the availability of nutrients cannot be absorbed by the plant, causing the long period of growth for plants.

Based on Figure 8, the highest total chlorophyll on day 60 in old plants is found in nano silica-NPK treatments (75%: 25%) and nanosilica-manure treatments (50%: 50%).

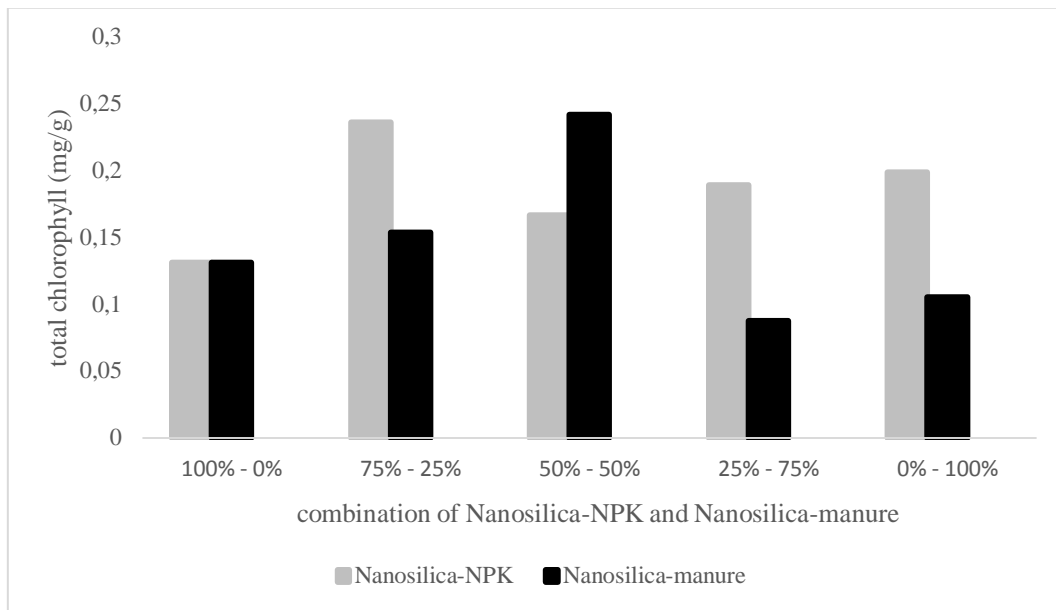


Figure 8. Total chlorophyll content changes during 60 days

The total chlorophyll content in each treatment decreased on day 40, but on the 60th day, there was an increase again. The total chlorophyll content in the nano-silica-NPK combination treatment is higher than the nano silica-manure. This is shown in Figure 9.

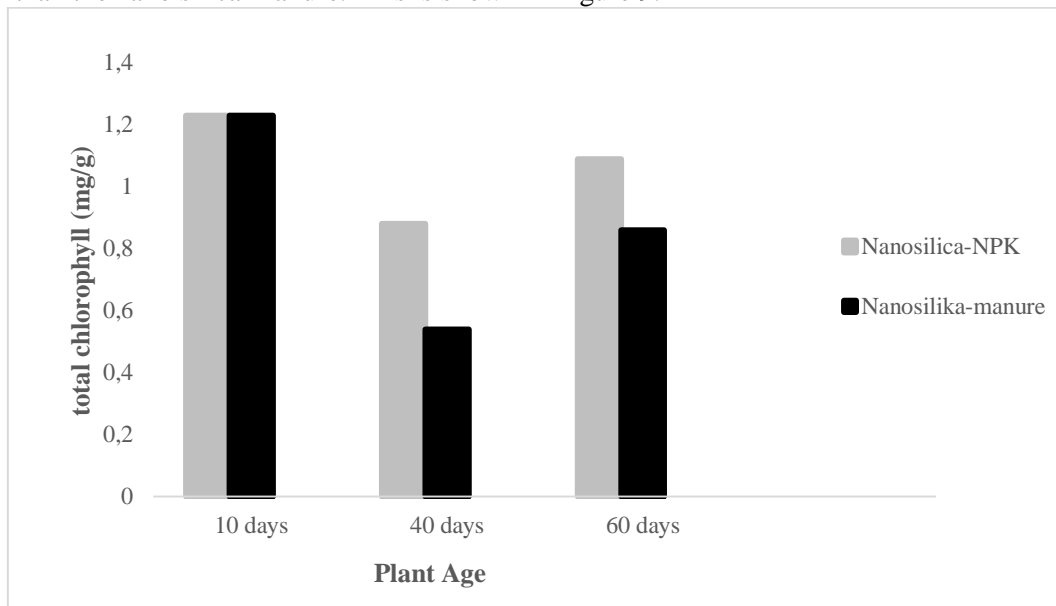


Figure 9. Total chlorophyll content on corn leaves at 10, 40, and 60 days ages.

The use of silica can improve plant architecture and can enhance photosynthesis [14]. The decomposition of silica in the cell wall can also improve plant performance [15]. Nanosilica or nano fertilizer is very easily absorbed by plants; besides, Si element is needed for monocot plants [16, 17] to overcome drought stress. In this case, corn also needs Si for its growth.

4. Conclusion

Nanosilica treatment with additional NPK fertilizer has an effect on total chlorophyll a, b, and chlorophyll. The best combination treatment is in nano silica-NPK with a percentage of 75%: 25%, while in fertilizing nano silica-manure with a percentage of 50%: 50% with a longer time.

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