The Effects Of Planting Distance Treatment And Zeolite Application As Ameliorants On Growth And Yield Of Bok Choy Plants

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Abstract:

The increasing market demand for Bok choy makes the need to apply a good cultivation system for the optimum growth and productivity of the plants very important. One of the main factors that must be considered in cultivating Bok choy is the treatment of plant spacing in which the soil is often enriched with ameliorants, such as zeolite. The combination treatment of plant spacing and zeolite showed a significant effect on the growth and productivity of Bok choy plants, where the further the plant spacing, the higher the growth rate. However, the same plant spacing treatment did not affect the pH value. The best zeolite treatment was 150 g/1x5 m^2 soil bed, or 300 kg/ha.

Keywords: *Bok choy; Plant spacing; Zeolite.*

1. Introduction

Bok Choy (*Brassica rapa* L) (in North America), or Pak Choi/Pok Choi (in the UK and Australia), is often considered to be similar to Sawi (*Brassica chinensis* var. parachinensis/Choy sum/Caisim) in Indonesia. Although they come from the same Brassica genus, they are different in terms of the size and shape of the leaves and the length of the stem. Both Sawi and Bok choy are green vegetables that the people of Indonesia favor. These vegetables can be used as a main dish or complement other foods. This research was focused more into Bok Choy as it is rich in nutrients and very beneficial for human health. It is known that 100 g of Bok choy contains 2.39 mg of protein, 0.39 mg of fat, 4.09 mg of carbohydrates, 220 mg of calcium, 38 mg of iron and 102 mg of vitamin C (Alribowo et al., 2016). It is very efficacious in preventing chronic diseases such as cancer, cataracts, stroke, congenital disabilities, hypertension and heart disease (Alribowo et al., 2016). Based on the value of Bok Choy, the demand to meet its market

needs is increasing. The latest data showed an increased demand of 727,467 tons for Bok choy in Indonesia (Anonymous, 2021).

The application of a good cultivation system is one of the main factors in improving the production yield and quality of Bok Choy, such as the use of superior seeds, land processing, planting techniques, fertilizer application, good harvesting process, and treatment for pests and diseases. Other considerations for Bok Choy are the age of the seedlings when they are moved to a new soil bed and the treatment of plant spacing that can minimize obstruction and competition from the surrounding plants (H & Sopiany, 2017).

An adequate plant spacing treatment gives a very good effect on the growth and yield of the plants, including height, number of leaves, flowering age, number of fruits, and wet weight (Bani, 2018). For example, in Elephant grass planted with different spacing and number of cuttings, with the addition of kendang fertilizer from chicken manure, there was a significant difference in growth, indicated by significant chane in height, leaf length and leaf width from 1 - 6 weeks old plants (Loliwu, Yan Alpius Mberato, 2021). In general, plant spacing makes the distribution of light to plant leaves is evenly distributed, so that they are able to produce a greater number of leaves, which then increases the amount of photosynthate due to the greater amount of chlorophyll in the leaves and has a significant effect on the net weight of the plants (Alfandi et al., 2017).

Another thing that must be considered is the condition of the physical environment of agricultural land, which includes soil type, water availability, nutrient content, and the climate. The eastern Indonesia's agricultural land generally cosists of a regosol soil type. This type of soil requires ameliorants to improve the physical and chemical quality of the soil, as it does not provide sufficient water and nutrients for plants (Nikiyuluw et al., 2018). Many regosol land is often used as paddy field because they have low porosity that can inhibit drainage, so that water can be stagnant for a long time. However, the condition of regosol land is considered unfavorable for other types of plants because it inhibits root growth. The regosol soil must be treated mechanically and ameliorants must be provided too so that the soil pores and chemical properties can be improved (Putinella, 2014).

Zeolite is one of the materials that can be used as ameliorant. Mineral zeolite can be used as an alternative in the agricultural sector, because zeolite is an alumina silicate

mineral compound with pores containing water molecules and exchangeable cations. The addition of zeolite to the soil can change the chemical properties of the soil for the better, namely: raise the pH value, improve the cation exchange capacity (CEC) value, increase the amount of macro nutrients Ca, Mg, P, K and able to absorb Al, Fe and heavy metal ions that damage the soil (Bani, 2022). Zeolite as a natural mineral and used as a stimulator in organic fertilizer formulas is expected to have the power to restore and preserve soil fertility in several ways: (1) zeolite cation exchange capacity of 200-300 me/100 g, (2) water adsorption power of 10-35% of its total weight, (3) has buffering power against soil pH. In Indonesia, zeolite minerals are found in Cikalong, Tasikmalaya, South Malang and East Nusa Tenggara. Zeolite has the best quality in the world with a zeolite (mordenite) content of 55 – 85% and a CEC value of 115 - 117.6 me /100 g. The ameliorant is applied by direct application to the soil. Providing ameliorants by directly stocked in the planting hole or according to the plant row is the best way, with a composition of 150 - 450 kg of natural ameliorants/ha (Sudaryono et al., 2015). Based on this, the treatment of planting distance with the addition of zeolite as an ameliorant material to increase the production of Bok choy plants needs to be done.

2. Methods

This research was conducted in January 2023 in Tarus Village, Central Kupang Subdistrict, Kupang Regency, East Nusa Tenggara Province. Before sowing, the Bok Choy seeds were soaked in a fungicide (*Captan*) solution for 15 minutes to prevent fungal infection. Due to the small size of the seeds, they were evenly spread directly on a 1 x 1 m^2 soil bed. The soil was watered until wet directly after the seeds were spread. Within 3-4 days, the first cotylyedon leaves would emerge, and after the seedlings had grown for seven days, then they would be ready to be transferred to a

Seeding was carried out for 14 days. In this study, the nursery was conducted twice, the first nursery was conducted two weeks before the seedlings were transferred to the planting area. Basic fertilizer treatment was done after making the beds, followed by fertilization after the plants were 3 days old after the seeds grew. Bok choy seedlings that are 14 days old and have 3 - 4 leaves are transferred to 1 x 5 m beds. To get the same plant length which was transferred into the soild bed, the initial analysis of soil pH was

carried out first and plant measurements were taken when the plants were transplanted at the age of 14 days.

Maintenance included replanting, watering and weed eradication. Replanting was done if there were dead plants and was performed in the afternoon before the plants were 7 days old. Watering was done to fulfill the availability of water for Bok choy plants and was done in the morning and evening. Weed eradication was done manually by hand, so that the Bok choy plants around the weeds are not uprooted.

Bok choy plants can be harvested when they are 35 days after planting, by cutting the part of the plant that is above the ground. Harvesting can also be done by pulling out the plant stem with its roots. Measurement of plant height, leaf length, leaf width, wet weight after transplanting seedlings, when the plants are 21, 28 and 35 days old.

Zeolite samples were taken from Ende district, East Nusa Tenggara. The zeolite minerals were broken into pieces, then ground into fine powder, then sifted with a sieve size ± 100 mesh. The results of the sieve are physically activated through the heating process in the oven at a temperature of 300 - 400^{o}C for 3 hours. Activated zeolite was spread on planting beds with weight variations, namely 50; 100; 250 and 300 grams.

The measurement data of the research was conducted using a Factorial Complete Randomized Design consisting of two factors, namely the first factor (J) = planting distance with 4 levels J_1 (1 cm), J_2 (3 cm), J_3 (5 cm), J_4 (7 cm); the second factor (Z) the ratio of zeolite and soil with 4 levels Z_1 (50 grams), Z_2 (100 grams), Z_3 (150 grams), Z_4 (300 grams). Each treatment combination is given a replicate (U) with 3 levels U_1, U_2, U_3. The mathematical model of the above design is:

$$Y_{ij} = \mu + T_i + K_j + TK_{ij} + U_k + €_{ijk} \quad (1)$$

Where Y_{ij} is the observation result of the addition of zeolite to the jth, at the i-th spacing treatment, at the kth replication, μ is Mean, T_i is Effect of plant spacing at the i-th level, K_j is Effect of zeolite addition at level j, TK_{ij} is the interaction effect of increasing the planting distance to i at the ratio of zeolite and soil at the jth level, U_{kis} is Effect of kth replication, $€_{ijk}$ is Measurement error at the ith planting distance level, at the jth zeolite and soil ratio level, at the kth replication.

The research data were analyzed using Multivariate Analysis (MANOVA) to determine the effect of treatment on the variables observed at the 5% level using SSPS 25 software.

3. Results and Discussion

Based on the results of data analysis from the study, the results of the multivariate test were obtained as shown in Table 1 below.

Table 1. Results of multivariate analysis with SSPS

Effect		**Value**	**F**	**Sig.**
Intercept	Pillai's Trace	.998	73513.010[b]	.000
	Wilks' Lambda	.002	73513.010[b]	.000
	Hotelling's Trace	625.111	73513.010[b]	.000
	Roy's Largest Root	625.111	73513.010[b]	.000
Zeolit	Pillai's Trace	1.028	40.890	.000
	Wilks' Lambda	.059	131.125	.000
	Hotelling's Trace	14.408	422.525	.000
	Roy's Largest Root	14.307	1691.130[c]	.000
Jarak	Pillai's Trace	.643	32.210	.000
	Wilks' Lambda	.357	49.001	.000
	Hotelling's Trace	1.803	70.537	.000
	Roy's Largest Root	1.803	212.812[c]	.000

a. Design: Intercept + Zeolit + Jarak

b. Exact statistic

c. The statistic is an upper bound on F that yields a lower bound on the significance level.

The results of multivariate analysis with SSPST Table 3.1 above shows that the effect of spacing treatment is very significant on the growth and production of Bok choy plants as indicated by the results of the F test calculation (sig 0.00 <0.05). The use of zeolite as an ameliorant has a significant effect on the growth and production of Bok choy (sig 0.00

<0.05). The interaction between spacing and zeolite treatment as an ameliorant also showed good results as can be seen in the intercept (sig 0.00 <0.05). The interaction relationship between the spacing treatment and the administration of zeolite as an ameliorant is shown in Figure 1 below.

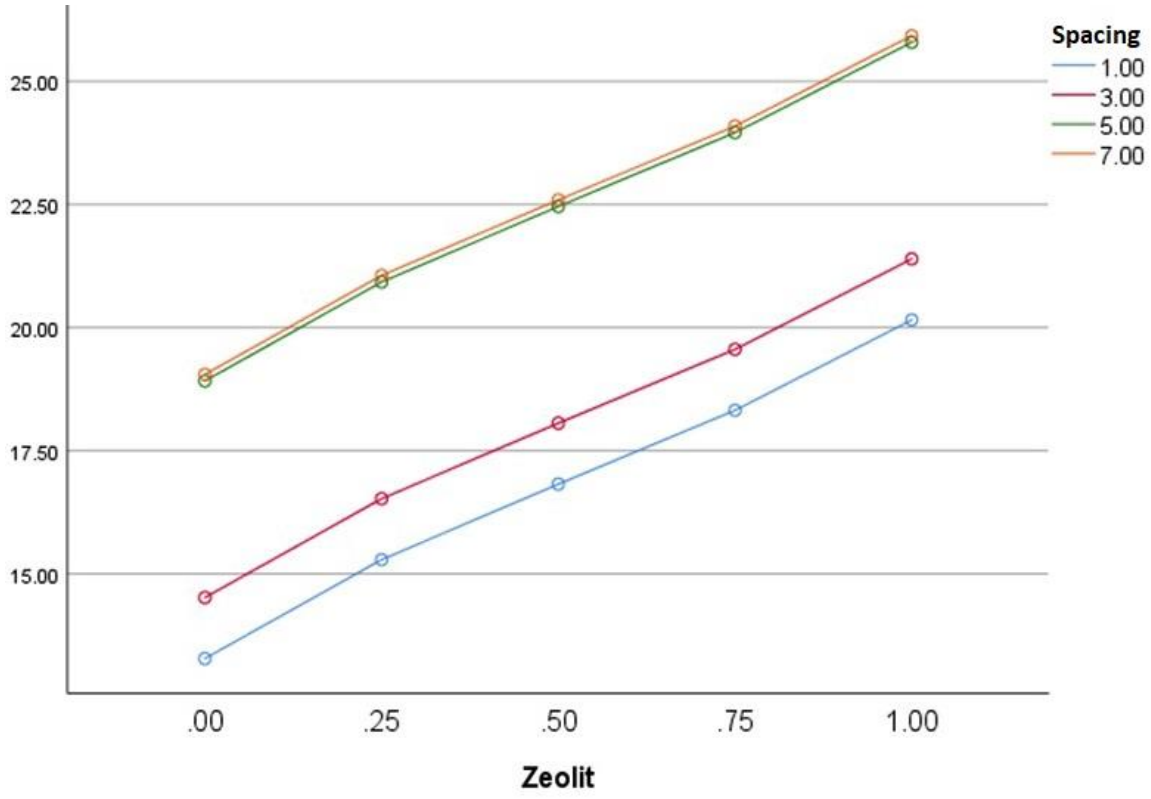

Figure 1. Relationship between spacing and zeolite

Based on Figure 1 above, it can be seen that there is no significant difference between the application of 150 and 200 grams of zeolite per 1 x 5 m bed. Therefore, it is certain that the need for zeolite as an ameliorant is 300 kg / ha. The results of the analysis also showed that the spacing treatment had a significant effect on plant height, leaf length, leaf width and bulk density of Bok choy plants, but had no effect on changes in soil pH values (sig 1.00 > 0.05). While the treatment with the addition of zeolite as amelioran had a significant effect on all variables measured, namely pH, plant height, leaf length, leaf width and plant density of Bok choy (sig 0.00 <0.05).

Based on the results of the analysis, it can be said that determining the ideal spacing is an important factor in the process of cultivating plants because it will greatly affect the

quality and quantity of harvest from plants. In the treatment of spacing that is too tight will result in competition in the absorption of nutrients and a lack of high intensity of sunlight between plants, as well as making the need for more seeds. In the treatment of spacing spacing that is far apart, the competition for absorption of nutrients is smaller as indicated by the high growth rate of Bok choy plants, but has more potential for weeds to grow. Based on direct observations at the study site, it is also known that plant growth density can suppress weed growth, because it reduces the intensity of sunlight, because plant leaves block lighting to the surface of the land, which then results in a decrease in the rate of evaporation which can be observed through soil moisture.

The addition of zeolite succeeded in increasing the pH value which was in tandem with the growth rate of Bok choy. This shows that physically activated natural zeolite is able to provide the nutrients needed by the Bok choy plant. The increase in the pH value along with the increase in the composition of the zeolite is due to the content of the elements Ca and Mg in it, where these two elements shift the position of H+ in the soil colloid and the presence of zeolite in the soil solution results in a hydrolysis reaction that releases OH- ions into the soil.

4. Conclusion

The treatment of spacing with the addition of zeolite as an ameliorant has a significant effect on the growth and productivity of Bok choy plants, where the farther the spacing, the higher the growth rate, but the spacing treatment has no effect on the soil pH value and the composition of the zeolite treatment as an ameliorant is 150 grams per bed, or 300 kg / ha.

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Anonymous. (2021). *Data Produksi Sayuran*. Badan Pusat Statistik. disebabkan oleh beberapa%0Afaktor yaitu pembibitan, pengolahan%0Atanah, penanaman, pemupukan dan%0Apemanenan yang kurang baik, serta%0Aserangan hama dan penyakit. Sistem%0Abudidaya yang baik dapat dijadikan%0Asebagai salah satu acuan dalam%0Apeningkatan p

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