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Study of the Effect of Giving Organic Fertilizer as a Substitution of Chemical Fertilizer for the Growth and Product Components of Corn in Dry Vertisolands

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Abstract. The continuous use of chemical fertilisers causes a decrease in soil quality and crop production. Vertisol soil has sufficient nutrients but cannot be utilised by plants. The provision of organic fertilisers can improve soil quality. This study aims to survey the effect of applying organic fertilisers as a substitute for chemical fertilisers on the growth and yield components of maise in vertisol dry land. This experiment was conducted on vertisol dry land in Mujur Village, Central Lombok Regency, from July to November 2022. The experiment used a Randomized Block Design (RBD) with two factors: organic fertiliser factor P0 (without organic fertiliser), P1 (organic fertiliser 5 t/ha), P2 (organic fertiliser 10 t/ha). Chemical fertiliser factors, K1 (NPK 25%), K2 (NPK 50%), K3 (NPK 75%), K4 (NPK 100%), obtained 12 treatment combinations and three replications so that there were 36 treatment units. The observed parameters included plant height, leaf width, number of leaves, cob weight, length, and diameter. Data were analysed with Factorial RAK ANOVA and further testing using Honest Significant Difference (BNJ) analysis. The results showed that the use of organic fertilisers had a significant impact on all observed parameters. Treatment without organic fertiliser showed a minor effect compared to treatment with organic fertiliser, while treatment P1 (5 t/ha) and P2 (10 t/ha) showed no significant difference except for cob length (P1). The application of NPK fertiliser at 25%, 50%, 75%, and 100% did not significantly impact corn's growth and yield components.

Keywords: Organic Fertilizer; Chemical Fertilizer; Corn Plant; Vertisol Soil.

INTRODUCTION

West Nusa Tenggara is one of Indonesia's provinces and the 6th largest corn producer nationally. Data from BPS for 2021 shows that corn production in this area reaches 1.66 million tonnes with a harvested area of 283,000 ha. Almost the entire area of West Nusa Tenggara Province is suitable for planting corn, but productivity varies in each region. The highest corn productivity was in North Lombok Regency, namely 6.7 tons/ha, and the lowest in Central Lombok Regency, at 3.6 tons/ha [1]. Differences in corn yields are influenced by several factors, including the cultivation technology applied, high-yielding varieties, fertilisers, and water management [2].

Central Lombok is one of the regencies located in the Province of NTB, which has the largest dry land area on Lombok Island. The southern part of Central Lombok is dominated by vertisol soils [3]. This area is the third most common commodity after rice and soybeans, but in the last three years, a decrease in productivity is thought to be caused by a decline in land productivity. The author [4] said farmers mainly cultivate corn on dry land.

Vertisol soil has significant problems, one related to soil management, which is more dominant in physical properties than chemical properties. This is because vertisols have relatively rich nutrient reserves but are not absorbed by plants [5]. According to [6], vertisols are a type of soil that is dark grey to black, clay-textured, and has slickensides and fissures that can periodically open and close. Seeing the problem of vertisol soils, it should focus more on improving the physical properties of the soil so that the nutrients it contains can be utilised by plants, not by increasing the dose of chemical fertilisers.

Nutrients contained in vertisol soils cannot be absorbed optimally by plants. Cation Exchange Capacity is known to be stingy in providing the nutrients plants need. If insufficient water is unavailable, the nutrients will be absorbed by the soil, not plants [7]. It is further said the nature of the swelling of vertisol soils is a characteristic of this order. A lack or excess of water causes the plants on it to die.

Using chemical fertilisers and chemical pesticides in the long term will cause the quality of the soil that was initially fertile to become less productive. The author [8] argues that soil management measures such as fertilisation carried out continuously without information on soil fertility status increase nutrients N, P, and K to be high, which can cause an imbalance of nutrients in the soil. The plant needs so that land productivity decreases. Besides the residue of using chemical fertilisers causing a decrease in the quality of soil and surface water, chemical fertilisers are also expensive for farmers, while expecting subsidised fertilisers to come is often not on time.

The government has reduced chemical fertiliser subsidies in the last five years, potentially reducing crop production. So that production can be maintained and the land remains productive, applying organic fertiliser is an alternative that can be done. Besides being cheaper and easier to obtain, organic fertilisers can improve land quality and prevent environmental pollution. Research on applying organic fertilisers as a substitute for chemical fertilisers has been carried out by [9], who found that liquid organic fertilisers can replace inorganic fertilisers. Other studies also provide information that applying 10 tons/ha of organic fertiliser can potentially replace doses of chemical fertilisers.

Based on the background and previous research, a study has been carried out on applying organic fertilisers as a substitute for chemical fertilisers on Maine's growth and yield components in vertisol dry land.

METHOD

Research time. The experiment was conducted on vertisol dry land, Mujur Village, East Praya District, Central Lombok Regency, from July to November 2022.

Tools and materials. The tools used are hoes, nameplates, rulers, buckets, digital scales, stationery, and tape measure. The materials used were BISI-18 hybrid corn seeds, organic fertiliser/manure, and 250 m2 of vertisol land.

The experiments in this study used a randomised block design (RBD) analysis using a combination of organic fertiliser and NPK fertiliser doses. The following is the dose of organic fertiliser used.

P0: 0 ton/ha without organic fertiliser;

P1: 5 tonnes/ha of organic fertiliser equivalent to 78 g/plant;

P2: 10 tonnes/ha of organic fertiliser equivalent to 156 g/plant.

While the dosage of NPK fertiliser is as follows:

K1: 25% NPK equivalent to 1.07 g/plant;

K2: 50 % NPK equivalent to 2.145 g/plant;

K3: 75 % NPK equivalent to 3.21 g/plant;

K4: 100% NPK, which is equivalent to 4.29 g/plant.

There were 12 treatment combinations; each treatment made 3 (three) replications, and 36 treatment units were obtained. Each treatment unit is 3.6 mx 1.3 m with 36 (250 m2) units.

Experimental Implementation. *Planting preparation*. Land prepared 250 m2. Thirty-six plots were made, each plot measuring 4.68 m2. The experiment was carried out in the third growing season (dry season).

Soil processing. Tillage is carried out with minimal/light tillage using a hoe. Then, the soil is harrowed and combed until it becomes even. Tillage is done a week before planting.

Planting. The corn seeds planted were BISI-18 hybrid seeds purchased at the farm store. One seed is planted in one hole with a distance of 70 cm x 20 cm.

Maintenance. *Irrigation*. Watering is given in the growth (age) phases, 15 HST, 30 HST, 45 HST and the fruiting phase, 60 HST and 75 HST

Fertilisation. According to the treatment, the fertiliser was given 2 times, namely at 10 HST and

35 HST. Urea Fertiliser 2 (two) times, namely: 50% (100 kg/ha equivalent to 1.5 g/tan), 2nd fertilisation (100 kg/ha equivalent to 1.5 g/tan). Phonska NPK fertiliser is only given to fertilisation 1: 25% NPK, 50% NPK, 75% NPK, and 100% NPK.

Harvest. Corn is harvested at 105 HST, marked by the corn husks/leaves that are yellowish and dry, and there is a black mark at the base where the corn kernels attach to the cob.

Observation Parameters. *Plant height*. Plant height was measured weekly since the plants were 2 WAP until flowers appeared (6-8 MST). Plant height was measured using a meter tool, which was used to measure from the base of the stem to the end of the segment.

Number of Leaves. The number of plant leaves is carried out every week from when the plants are 2 WAP until flowers appear (6-8 WAP). The number of leaves is counted by observing the leaves that have opened perfectly.

Leaf Width. Plant leaf width is done weekly since the plants are 2 WAP until flowers appear (6-8 WAP). Leaf width is measured in half the leaf length of the plant.

Long cob (cm). Cob length measurement is done at the time of harvest. Cob length was measured from 3 sample plants per plot using a ruler from the base to the top of the cob.

Weight Cob (cm). Cob weight was measured after harvest using a digital scale. The samples measured were three plants per plot after being dried/sun-dried.

Diameter Cob (cm). The cob diameter was measured at the time of harvest. The diameter of the cob in 3 samples was measured using a calliper.

Data analysis. Observational data were analysed using analysis of variance (ANOVA) Factorial RAK with two factors at a 5% significance level. This analysis aims to determine whether there are differences in growth yields and yields in the combined treatment of organic fertiliser and NPK fertiliser. If there is a difference, a follow-up test can be carried out using the Honest Significant Difference (BNJ) test with $\alpha = 0.05$. This further test aims to determine which treatment gives different results for the growth and yield of corn.

RESULTS AND DISCUSSION

Soil characteristics before the experiment. Before the experiment, soil sampling was carried out to determine the nutrient conditions of the soil used as the corn planting medium. The land used is vertisol land with an area of 250 m2, a farmer's land in Mujur Village, East Praya District, Central Lombok Regency. The results of the soil test are presented in Table 1.

Table 1 – Soil test results before the experiment

No	Parameter	Mark	Criteria
	Physical properties		
1	Texture		Look
	Clay (%)	46,8	
	Dust (%)	26,54	
	Sand (%)	26,67	
2	Specific Gravity (g/cm3)	2.07	Currently
3	Volume Weight (g/cm3)	1,3	Currently
4	Porosity (%)	37.06	Currently
5	Field Capacity (%)	63,73	Currently
	Chemical properties		
1	pH	6,83	Neutral
2	C-organic (%)	1.59	Low
3	N-Total (%)	0.53	Tall
4	P-Available (ppm)	86,11	Very high
5	CEC (meq %)	63.04	Very high

Table 1 shows that the clay fraction was 46.8%, the silt fraction was 26.54%, and the sand fraction was 26.67%, which means that the soil in the experimental location includes a clay texture (vertisol). This is consistent with the characteristics of vertisol soil with a clay content of 35-95%. The content of Cation Exchange Capacity (CEC) is very high, 63.04, indicating the nature of the vertisol soil. This is based on the research [10], who found that high CEC is stingy in providing plant nutrients.

The Effect of Organic Fertilizers on the Growth of Corn Plants. *Plant height*. Giving organic fertiliser can increase the growth parameters of corn. Figure 1 shows the growth rate of corn plants increased with increasing doses of organic and chemical fertilisers. This is in accordance with what [11] stated: fertilisation contributes to the N, P, and K nutrients plants need in the vegetative phase. These nutrients stimulate vegetative growth and central tissues such as stems and leaves. The following shows the trend of increasing plant height in various treatments.

Figure 1 shows the height growth of corn plants during the vegetative phase. Overall, each treatment showed good plant height growth, but the highest corn plants were produced in the P1K4 treatment (organic fertiliser 5 tonnes/ha + 100% NPK).

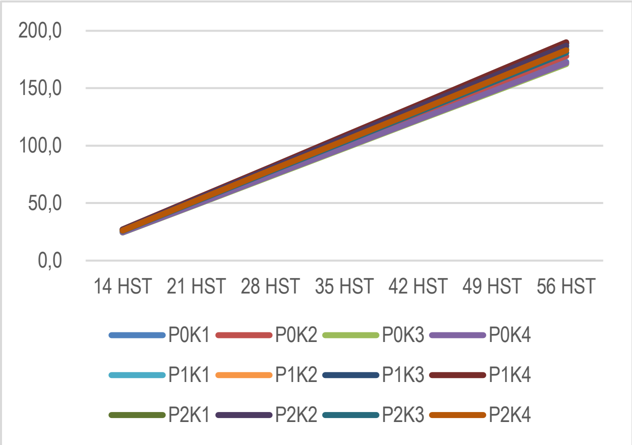

Figure 1 – Effect of fertiliser application on corn plant height

Observations were taken when the corn plants were 14-56 HST. The analysis of variance from stem height showed a significance value of less than 0.05 in the P treatment (organic fertiliser), meaning that at least one organic fertiliser treatment yielded different stem heights in corn plants. Applying organic fertilisers and NPK fertilisers showed a significance value of more than 0.05, meaning there was no difference in the effect on the height of the corn plant stems. Because only organic fertilisers had significantly different effects, further tests were carried out only on organic fertilisers using the BNJ advanced test. The results of corn stalk height growth in all treatments in the study follow.

Figure 2 – The average height of corn plants in all treatments

Based on Figure 2, it is known that the highest growth in corn stalk height was in the P1K4 treatment (5 tons/ha organic fertiliser + 100% NPK) with a height of almost 190 cm, while the lowest corn stalk height was in the P0K3 treatment (0 ton/ha organic fertiliser + 75% NPK) with a stem height of less than 175 cm. A follow-up test was carried out using the BNJ advanced test presented in Table 3 to find out which organic fertiliser treatment gave different stem height yields.

Number of Leaves. Figure 3 shows the growth of the number of leaves of the corn plant in the weekly period.

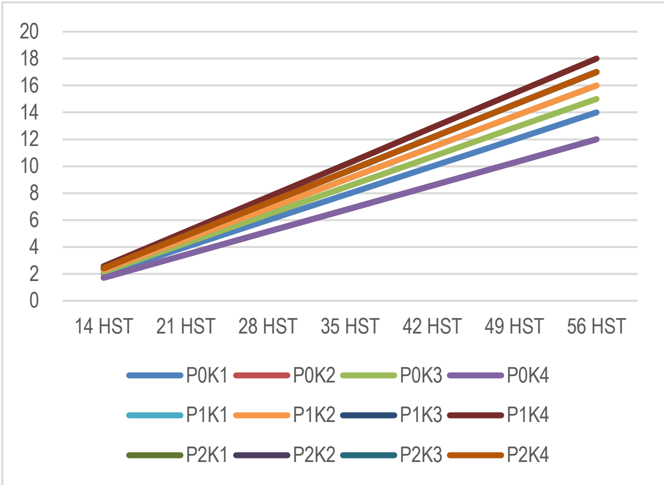

Figure 3 – Observation of the number of leaves of corn plants

Overall, each treatment showed an increasing number of leaves. The increase in the number of leaves is thought to be due to the addition of N elements, which provide nutrients for the growth of corn plants, including the number of leaves. Element N is an essential nutrient for plant vegetative growth, such as roots, stems and leaves. The highest number of leaves was found in P1K4. The analysis of variance from the number of leaves showed that the significance value was less than 0.05 in the P treatment (organic fertiliser), meaning that at least one organic fertiliser treatment produced a different number of leaves on corn plants. The application of organic fertiliser and NPK fertiliser showed a significance value of more than 0.05, meaning that there was no difference in the effect of organic fertiliser and NPK fertiliser on the number of leaves of the corn plant. Because only organic fertilisers had significantly different effects, further tests were carried out only on organic fertilisers using the BNJ advanced test. Following are the results of the number of leaves of corn plants in all treatments in the study.

Figure 4 shows that the highest average number of leaves on corn plants was in the P1K4 treatment (5 tons/ha organic fertiliser + 100% NPK), with a total of about 18 leaves, while the least number of leaves was in the P0K1 treatment (0 tons/ha organic fertiliser + 25% NPK) and P0K2 (0 tons/ha organic fertiliser + 50% NPK) with less than 14 leaves.

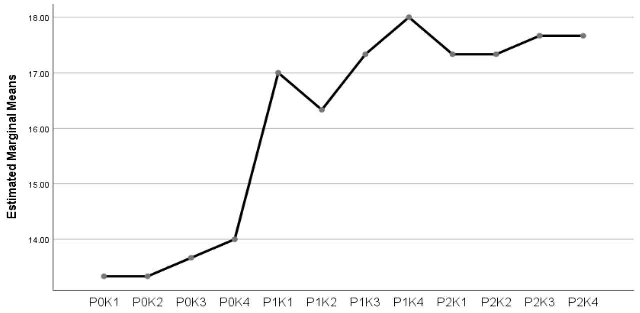

Figure 4 – The average number of leaves in all treatments

A follow-up test was carried out using the BNJ follow-up test, presented in Table 3, to find out which treatment could give results of a different number of leaves.

Leaf Width. Figure 5 shows a corn plant's growth in leaf width over a weekly period.

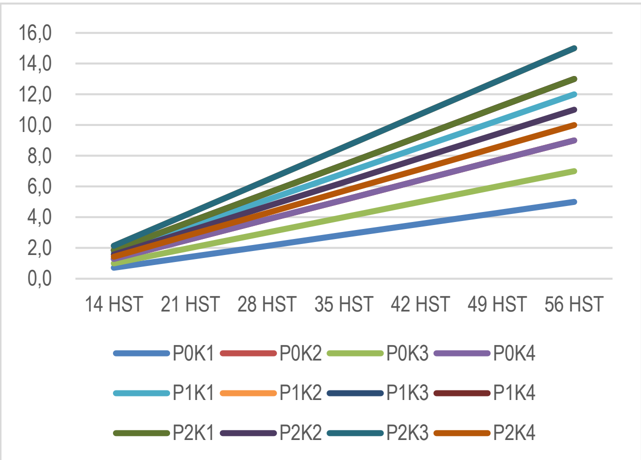

Figure 5 –Wide leaf of the corn plant

Overall, each treatment showed the same trend, namely an upward trend. The widest leaf width was demonstrated in the P2K3 treatment. The analysis of variance from leaf width showed a significance value of less than 0.05 in the P treatment (organic fertiliser), meaning that at least one organic fertiliser treatment produced different leaf width results in corn plants. The application of NPK fertiliser and organic fertiliser shows that the significance value is more than 0.05, meaning that there is no difference in the effect of NPK fertiliser and organic fertiliser on the leaf width of corn plants. Because only organic fertilisers had significantly different effects, further tests were carried out only on organic fertilisers using the BNJ advanced test.

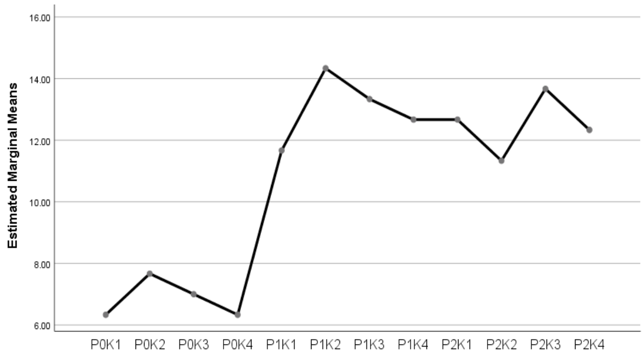

Figure 6 – Observation of the average leaf width in all treatments

Based on Figure 6. shows that the broadest leaf width in corn plants is in the P1K2 treatment (5 tonnes/ha of organic fertiliser + 50% NPK) with a leaf width of more than 14 mm. In comparison, the smallest leaf width is in the P0K1 treatment (0 tonnes/ha of organic fertiliser + 25% NPK) and P0K4 (0 tonnes/ha of organic fertiliser + 100% NPK) with a leaf width of less than 8 cm. Increasing leaf width is possible because adding organic fertilisers provides the carbohydrates needed during plant growth. Carbohydrates will be decomposed into starch and sugar, which liberate carbon dioxide with the help of nitrate bacteria, which also produce nitrogen nutrients. The decomposition of organic matter into dissolved carbohydrates, fats and proteins is translocated to the plant's vegetative points through photosynthesis [12].

Effect of Organic Fertilizer on Corn Yield. *Cob Diameter*. The effect of organic fertilisers on corn yield components used several parameters, namely cob diameter, cob length, and dry cob weight. Observational data was taken when the corn plants were 105 HST. The analysis of variance from the cob diameter showed a significance value of less than 0.05 in the P treatment (organic fertiliser), meaning that at least one organic fertiliser treatment produced different cob diameters in corn plants. The application of NPK and organic fertilisers showed a significant value of more than 0.05, meaning that organic fertilisers and NPK fertilisers did not affect the diameter of the corn cobs. Because only organic fertilisers had significantly different effects, further tests were carried out only on organic fertilisers using the BNJ advanced test.

Figure 7 shows that the broadest cob diameter in corn plants is in the P2K2 treatment (10 tonnes/ha of organic fertiliser + 50% NPK) with a cob diameter of more than 7 cm.

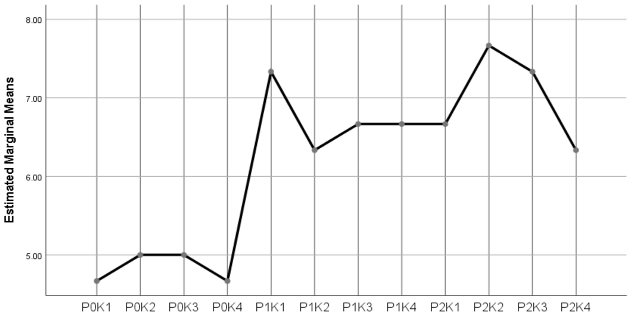

Figure 7 – The average cob diameter in all treatments

In comparison, the minor cob diameter is in the P0K4 treatment (0 tonnes/ha of organic fertiliser + 100% NPK) with a cob diameter of less than 5 cm. Organic fertilisers can provide nutrients for plants even in small amounts but can be absorbed for plant growth and yield. To find out which treatment is capable of giving different cob diameter results, a further test is carried out using the BNJ advanced test, which has been carried out and is presented in Table 3.

Cob Length. The analysis of variance from cob length showed a significance value of less than 0.05 in the P treatment (organic fertiliser), meaning that at least one organic fertiliser treatment produced different cob lengths in corn plants. The application of NPK fertiliser and organic fertiliser showed a significance value of more than 0.05, meaning there was no difference in the effect of organic fertiliser NPK on the length of the corn cob. Because only organic fertilisers had significantly different effects, further tests were carried out only on organic fertilisers using the BNJ advanced test. Following are the results of the length of the corn cob in all treatments in the study.

Based on Figure 8, it is known that the most extended cob length in corn plants was in the P1K4 treatment (5 tons/ha organic fertiliser + 100% NPK) with a cob length of more than 18 cm, while the most petite cob length was in the P2K1 treatment (10 tons/ha organic fertiliser + 25% NPK) with a cob length of less than 14 cm.

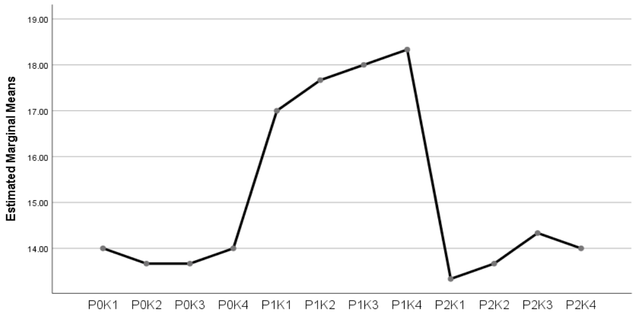

Figure 8 – Average Cob Length in All Treatments

Providing organic fertilisers improves soil properties so plants can maximally absorb nutrients. This is as reported by [13] that sufficient nutrients, water and light lead to maximum photosynthetic processes and photosynthetic results for seed formation and cob length. To find out which treatment is capable of giving different cob length results, a further test is carried out using the BNJ advanced test, which has been carried out and is presented in Table 3.

Cob Weight. The analysis of variance from stem height showed a significance value of less than 0.05 in the P treatment (organic fertiliser), meaning that at least one organic fertiliser treatment gave different dry cob weight results in corn plants. The application of NPK fertiliser and organic fertiliser showed a significance value of more than 0.05, meaning that there was no difference in the effect of NPK fertiliser and organic fertiliser on the dry cob weight of corn plants. Because only organic fertilisers had significantly different effects, further tests were carried out only on organic fertilisers using the BNJ advanced test. The results of corn dry cob weight growth in all treatments in the study follow.

Based on Figure 9, it is known that the heaviest weight of dry cobs in corn plants is in the P1K1 treatment (5 tons/ha of organic fertiliser + 25% NPK) with a dry cob weight of almost close to 270 grams. The lightest dry cob weight is in the P0K2 treatment (0 tons/ha of organic fertiliser + 50% NPK) with a dry cob weight of less than 240 g.

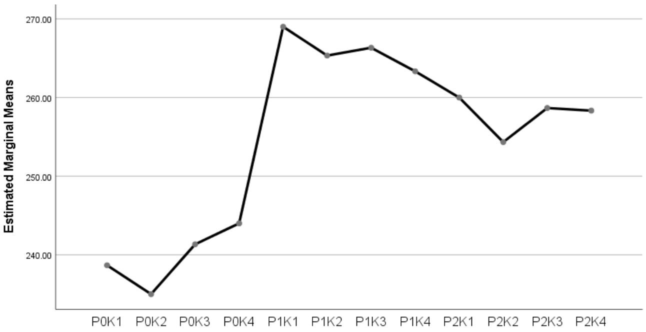

Figure 9 – Average Dry Cob Weight in All Treatments

This result is likely due to the addition of organic fertilisers, which contribute to N elements in the generative phase of corn plants. Authors [14] said that organic fertilisers increase the levels of carbohydrates and sugar in fruit so that it is of better quality (dense and filled).

Table 2 – Summary of Factorial RAK ANOVA

Variable	Significant		
	P	K	P*K
Plant height	s	ns	ns
Number of Leaves	s	ns	ns
Leaf Width	s	ns	ns
Cob Diameter	s	ns	ns
Cob Length	s	ns	ns
Cob Weight	s	ns	ns

Note: s - significant, ns - non-significant at the 5% level

Table 2 shows that applying organic fertilisers has a significant effect (s). In contrast, the treatment of chemical fertilisers does not have a considerable impact (ns), and the combination of organic fertilisers and chemical fertilisers does not show an interaction (ns) on the growth and yield of maise. This is based on the results of research, who found that vertisol land has sufficient nutrients but has physical characteristics and constraints so that these nutrients cannot be absorbed optimally. Applying organic fertilisers that have been carried out in various treatments can improve the soil's physical, chemical, and biological properties so that air and water circulation in the soil improves. Air and water circulation, nutrients and adequate lighting can increase plant growth and yield.

To find out which treatment is capable of giving different dry cob weight results, a further test is carried out using the BNJ advanced test, which has been carried out and is presented in Table 3.

BNJ Advanced Test. The BNJ follow-up test was carried out only on the organic fertiliser treatment because, based on the ANOVA results, only the organic fertiliser treatment showed a significant effect. Table 3 illustrates the results of the follow-up test with BNJ.

Table 3 – The 5% BNJ Follow-up Test for P (Organic Fertilizer)

P	Plant height	Number of Leaves	Leaf Width	Cob Diameter	Cob Length	Dry Cob Weight
P0	174,333	13.5833	6.8333	4.83333	13.8333	239.75
P1	187.75	17.1667	13.00	6.75	17.75	266.00
P2	184,667	17.5	12.5	7.00	13.8333	257,833
BNJ	5.12452	3.406688	2.79683	1.45787	1.45787	11.5414

Note: Numbers followed by the same letter in the same column show no significant difference in the 5% BNJ follow-up test

Table 3 shows that P0 (without organic fertiliser) had a significantly different (lower) effect between organic fertiliser treatments P1 and P2. In contrast, treatments P1 (5 tons) and P2 (10 tons) had the same effect except for cob length. This can be seen in the same code in both treatments. From Table 3 above, it can be said that in addition to cob length, organic fertilisers influence the research parameters, namely plant height, leaf width, number of leaves, cob diameter, and dry cob weight.

CONCLUSIONS

Based on the research results, it can be concluded that:

1) The application of organic fertilisers has a significant effect, while chemical fertilisers and

combinations of chemical fertilisers with organic fertilisers do not show any interaction;

2) For all observed growth and yield variables, Po was significantly different (lower) than P1 and P2 (using organic fertiliser was better than not using organic fertiliser);

3) Treatment with doses of 5 tons/ha (P1) and 10 tons/ha (P2) did not show significant differences in affecting the growth and yield components of corn except for cob length (P1 was the largest);

4) Applying chemical fertilisers with varying doses of 25% NPK, 50% NPK, 75% NPK, and 100% NPK did not significantly influence corn's growth and yield components.

REFERENCES

1. Agriculture and Plantation Office of NTB Province. (2021). *Laporan produktivitas jagung Kab* [Maize productivity report Kab]. Retrieved from https://distan.bulelengkab.go.id/informasi/download/laporan-panen-dan-produksi-jagung-april-2015-september-2016-75.pdf

2. Sutoro, S., & Setyowati, M. (2015). Daya Gabung Umum, Daya Gabung Khusus dan Keragaan Hasil Hibrida Jagung pada Dua Tingkat Pumupukan N [General combining power, specific combining power and yield performance of maise hybrids at two N fertilisation levels]. *Jurnal Penelitian Pertanian Tanaman Pangan, 34*(1), 55. doi: 10.21082/jpptp.v34n1.2015.p55-59 (in Indonesian).

3. Priyono, J., Yasin, I., Dahlan, M., & Bustan, B. (2019). Identifikasi Sifat, Ciri, dan Jenis Tanah Utama di Pulau Lombok [Identification of Key Soil Properties, Characteristics and Types on Lombok Island]. *Jurnal Sains Teknologi & Lingkungan, 5*(1), 19–24. doi: 10.29303/jstl.v5i1.102 (in Indonesian).

4. Jaya, I., Rosmilawati., Suadnya, I. W., Sudirman., & Sudika, I. W. (2019). Inovasi Peningkatan Produksi Jagung dan Pendapatan Petani Jagung di Lahan Kering [Innovations to Increase Maize Production and Farmer Income in Drylands]. *Jurnal LPPM Universitas Mataram*, *1*, 56–64 (in Indonesian).

5. Joseph, B. (2005). Potensi sumberdaya tanah DAS Limboto dan DAS Randangan Kabupaten Gorontalo [Soil resource potential of Limboto and Randangan watersheds of Gorontalo Regency]. *Dalam Prosiding Seminar Agropolitan Komda Suluttenggo di Gorontalo*, 12-15 (in Indonesian).

6. Prasetyo, B. H. (2007). Perbedaan sifat-sifat tanah vertisol dari berbagai bahan induk [Differences in properties of vertisol soils from different parent materials]. *Jurnal Ilmu-Ilmu Pertanian Indonesia*, 9(1), 20-31.

7. Sholihah, N. A., Utomo, D. H., & Juarti, J. (2016). Sifat Fisika Kimia Tanah Ordo Vertisol Pada Penggunaan Lahan Pertanian [Physical and Chemical Properties of Vertisol Order Soils Under Agricultural Land Use]. *Jurnal Pendidikan Geografi, 21*(1), 1–11. doi: 10.17977/um017v21i12016p001 (in Indonesian).

8. Arifin, Z. (2021). Teknik Cepat Uji Tanah Untuk Menentukan Rekomendasi Pemupukan Spesifik Lokasi Di Desa Sentul Kecamatan Kayangan Kabupaten Lombok Utara [Rapid Soil Testing Technique to Determine Site Specific Fertilisation Recommendations in Sentul Village, Kayangan Sub-district, North Lombok District]. *Jurnal Masyarakat Mandiri*, *5*(3), 1012–1023 (in Indonesian).

7. Nurnawati, A. A., Syarifuddin, R. N., & A. Samsu, A. K. (2022). Mengurangi Dosis Pupuk Anorganik pada Tanaman Jagung Ungu dengan Aplikasi Pupuk Organik Cair [Reducing Inorganic Fertiliser Doses in Purple Corn Crops with Liquid Organic Fertiliser Application]. *Agro Bali: Agricultural Journal, 5*(1), 137–143. doi: 10.37637/ab.v5i1.863 (in Indonesian).

10. Setyorini, D., Saraswati, R., & Anwar, K. (2014). *Pupuk Organik dan Pupuk Hayati* [Organic Fertiliser and Biofertiliser]. Retrieved from

https://repository.pertanian.go.id/server/api/core/bitstreams/39bbcfdc-1c24-49d2-9147-870db1dd938d/content (in Indonesian).

11. Zubachtirodin., & Subandi. (2008). Peningkatan Efisiensi Pupuk N, P, K dan Produktivitas Jagung pada Lahan Kering Ultisol Kalimantan Selatan [Improving N, P, K Fertiliser Efficiency and Maize Productivity in South Kalimantan Ultisol Dryland]. *Jurnal Penelitian Pertanian Tanaman Pangan, 27*(1) (in Indonesian).

12. Ashari, S. (1995). *Hortikultura dan Aspek Budidaya* [Horticulture and Cultivation Aspects]. Jakarta: Universitas Indonesia (in Indonesian).

13. Harini, D., Radian, & Iwan Sasli. (2021). Tanggap Pertumbuhan dan Perkembangan Jagung Ketan terhadap Pemberian Amelioran dan Pupuk NPK pada Tanah Ultisol [Growth and Development Response of Glutinous Maize to Ameliorants and NPK Fertilisers in Ultisol Soil]. *Jurnal Agronomi Indonesia (Indonesian Journal of Agronomy), 49*(1), 29–36. doi: 10.24831/jai.v49i1.34284 (in Indonesian).

14. Rosmarkam, A., & Yuwono, N. (2002). *Ilmu Kesuburan Tanah* [Soil Fertility Science]. Jakarta: Kanisius (in Indonesian).