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Analysis Of The Effect Of Organic Fertiliser Use On Plant And Soil Quality

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ABSTRACT

Modern agriculture faces a major challenge in maintaining high productivity while preserving the environment. In recent decades, the use of synthetic chemical fertilisers has become a common practice worldwide to increase crop yields (Sari, 2023). This research aims at analysing the effect of organic fertiliser use on plant and soil quality.

This research uses a quantitative method with a field experimental approach. This approach was chosen because it allows researchers to directly measure the effect of organic fertiliser use on soil quality and plants under environmental conditions.

From the results in table 3 regarding the effect of granular and bulk organic fertilisers on plant growth, it shows that the NPK treatment alone produces the highest plant height (33.6 cm) with a production of 17.7 t/ha. In Table 4 regarding the effect of fertiliser treatment on dry weight and stem varieties, the combination of NPK with NPK + 2 t POG organic fertiliser gave a dry weight of grain of 19.5 kg and a dry weight of straw of 21.5 kg. From the results shown in Table 3, it can be seen that the use of bulk (PO bulk) and granular (POG) organic fertiliser has a positive effect on plant growth compared to the control. In Table 4, the combination of NPK with 2 tonnes of straw or granulated organic fertiliser (POG) resulted in an increase in grain dry weight, especially in the NPK + 2 t POG treatment, which reached 19.5 kg dry weight.

From the results of this study, it is clear that the use of organic fertilisers significantly improves soil fertility and crop yields, especially when combined with chemical fertilisers such as NPK. Organic fertilisers not only improve soil physical and biological properties, but also increase the effectiveness of chemical fertilisers.

Keywords: Use of Organic Fertiliser, Plant Growth, Soil Quality

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1. Introduction

Modern agriculture faces a major challenge in maintaining high productivity while preserving the environment. In recent decades, the use of synthetic chemical fertilisers has become a common practice worldwide to increase crop yields (Sari, 2023). However, the long-term use of chemical fertilisers is known to have negative impacts on soil health and the environment, including soil quality degradation, decreased fertility, and water pollution due

to chemical run-off (Suharyanto, 2020). Therefore, attention to more sustainable alternatives, such as organic fertilisers, is increasing in an effort to support environmentally friendly farming systems.

Organic fertilisers, which are produced from natural materials such as plant waste, compost, and manure, are proven to have various benefits in improving soil quality. Organic fertilisers not only provide essential nutrients for plants, but also improve soil physical structure, increase organic matter content, and support the life of soil microorganisms (Rahayu & Gunawan, 2021). Thus, organic fertilisers play an important role in building a healthy soil ecosystem, which directly contributes to improved crop quality.

In the long run, the use of organic fertilisers can have a sustainable positive impact on soil fertility. Soils managed with organic fertilisers have a better ability to retain moisture, bind nutrients, and support soil microbial diversity. These microbes play a role in the decomposition of organic matter, which in turn provides stable and sustainable nutrients for plants. This is in contrast to chemical fertilisers, which usually only provide instant nutrition but leave damaging residues (Permadi et al., 2019).

In addition, the use of organic fertilisers is known to improve crop quality, both in terms of growth, disease resistance, and nutrient content in the crops. Various studies have shown that crops grown with organic fertiliser tend to have stronger root systems, higher photosynthetic rates, and better vitamin and mineral content in fruits or vegetables (Nugroho et al., 2020). Thus, the use of organic fertilisers focuses not only on the quantity of crops, but also on better and healthier quality.

However, challenges in the use of organic fertilisers remain. One of them is the longer time required to see results compared to chemical fertilisers. Organic fertilisers work slower because they require a decomposition process that depends on environmental conditions, such as temperature, moisture and soil microbial activity. In addition, the initial cost of production and distribution of organic fertilisers is often higher, especially on a large scale, so many farmers prefer chemical fertilisers for faster results (Sembiring & Agustina, 2021).

To overcome this challenge, various innovations have been developed to increase the effectiveness of organic fertilisers, such as the combination of organic fertilisers and certain microorganisms that accelerate the decomposition process and improve nutrient availability. In addition, education and counselling for farmers on the long-term benefits of organic fertilisers also need to be promoted to increase the adoption of environmentally friendly practices in the agricultural sector (Herlina et al., 2022).

In the context of sustainable agriculture, the use of organic fertiliser is one of the main solutions to maintain the balance between agricultural productivity and environmental sustainability. This research focuses on analysing the effect of organic fertiliser use on crop and soil quality, hoping to provide stronger scientific evidence on the long-term benefits of organic fertiliser use and its contribution to sustainable agricultural practices.

Thus, through this research, it is hoped that a clearer picture can be obtained on how the use of organic fertilisers not only supports optimal crop growth, but also improves soil quality, which plays an important role in the sustainability of future agriculture.

2. Materials and Method

This research uses a quantitative method with a field experimental approach. This approach was chosen because it allows researchers to directly measure the effect of organic fertiliser use on soil and plant quality under controlled environmental conditions. The research will be conducted on designated farmland and will be divided into two groups: a treatment group with the use of organic fertiliser, and a control group with the use of chemical fertiliser.

This research will be conducted on a farm located in Lubuk Minturun, with representative soil characteristics for the commodities under study. The study lasts for 6 months, from land preparation to harvest, to monitor changes in soil quality and crop growth from the beginning to the end of the agricultural cycle. The population in this study was agricultural land located in the Lubuk Minturun area with similar soil types and the same crop types. The sampling technique was carried out using purposive sampling method, i.e. the land was selected based on the suitability of soil and crop characteristics in accordance with the research objectives. Two groups of samples will be made, namely: Treatment group: Land that is only given organic fertiliser, Control group: Land treated only with chemical fertiliser.

The research procedure starts from land preparation, fertiliser application, soil quality monitoring, plant quality monitoring. The research instruments were soil quality measuring instruments (pH meter, soil organic matter measuring instrument, water absorption measuring instrument and microscope). Plant quality measurement tools (ruler to measure plant height, digital scales).

The data obtained will be analysed using descriptive and inferential statistical methods. The t-test will be used to test the difference in soil and plant quality between the treatment group (organic fertiliser) and the control group (chemical fertiliser). Conclusions will be drawn based on the results of statistical analysis regarding the effect of organic fertiliser on soil and plant quality. These results are expected to provide a deeper insight into the benefits of organic fertiliser in supporting sustainable agriculture.

3. Result

1. Characteristics of Organic Fertiliser

Table 1. Nutrient Content of Manure in Oven-Dried Condition

Source	Nutrient Content					
	Total N	P	K	Ca	Mg	S
Cow	6	1,5	3,0	1,2	1,0	0,9
Horses	7	1,0	5,8	7,9	1,4	0,7
Chicken	15	7	8,9	3,0	8,8	0,3
Sheep	13	2	9,3	5,9	1,9	0,9

Based on Table 1, the nutrient content of manure from different sources (cow, horse, chicken, sheep) shows significant variation in nutrient content. Chicken manure has the highest N content (15%), while the highest K content is found in sheep manure (9.3%). These differences are important for determining the type of fertiliser that best suits the specific needs of the crop.

2. Nutrient Composition of Some Types of Crop Residues in Fresh State

Table 2. Nutrient Composition of Crop Residues at Fresh Condition

Type of plant	Nutrient Content					
	Total N	P	K	Ca	Mg	S
Corn	10	0,06	2,9	0,09	1,33	0,38
Rice straw	7,5	0,02	7,15	0,09	0,55	0,10
Groundnut	28	0,03	4,54	0,85	0,27	0,81
Sugarcane	0,19	0,08	1,81	0,28	0,18	0,36

Based on Table 2, the nutrient composition of fresh crop residues, such as maize, rice straw and groundnut, are also rich in certain nutrients. For example, rice straw contains very high K (7.15%), making it suitable for improving potassium content in soil.

3. The Role of Organic Fertilisers on Soil Fertility

Table 3. Effect of Granulated and Bulk Organic Fertiliser on Plant Growth

No.	Treatment	Plant height (cm)	Number of leaves	Production (t ha)$^{-1}$
1	Control	19,9	7	7,1
2	Bulk PO (300 kg/ha)	23,2	8	9,4
3	POG (500 kg/ha)	22,1	7	10,9
4	NPK	33,6	12	17,7
5	NPK + POG 500 kg/ha	32,6	12	26,4
6	NPK + PO bulk 150 kg/ha	31,8	11	29
7	NPK + bulk PO 300 kg/ha	32,4	12	26
8	NPK + bulk PO 450 kg/ha	31,0	12	20,6
9	NPK + PO bulk 600 kg/ha	38,0	12	29,6

In Table 3, the effect of granular and bulk organic fertilisers on plant growth showed that the NPK treatment alone produced the highest plant height (33.6 cm) with a production of 17.7 t/ha. However, the combination of NPK and organic fertiliser gave better results, as in the treatment of NPK + bulk PO 600 kg/ha which produced the highest production (29.6 t/ha). This suggests that the combination of organic and NPK fertilisers can create synergies that support more optimal plant growth than the use of chemical or organic fertilisers alone.

Table 4. Effect of Fertiliser Treatment on Dry and Wet Weight of Varieties

No.	Treatment	Grain		Straw	
		Wet weight	Dry weight	Wet weight	Dry weight
1	Control	15,22	12,2	30,9	13,7
2	Standard NPK	25,27	19,9	49	21
3	NPK + 2 t straw	26,28	21,2	46,5	20,9
4	NPK + 2 t cow dung	21,45	16,3	39,1	18,2
5	NPK + 2 t POG	24,60	19,5	55,3	21,5
6	50% NPK + 2 t straw	17,72	14,7	31,5	15,2
7	50% NPK + 2 t cow manure	17,67	14,4	32,3	16,5
8	50 NPK + 2 t POG	19,57	17,6	35,3	18,8
9	75% NPK + 2 t straw	21,17	17,1	29,6	17,7
10	75% NPK + 2 t cow manure	18,36	14,8	29,7	16,5
11	75% NPK + 2 t POG	24,09	19,2	51,6	19,6

Table 4 shows the effect of fertiliser treatments on the dry weight and stem weight of varieties. The combination of NPK with organic fertiliser, especially granulated organic fertiliser (POG), gave the best results for grain and straw weight. The NPK + 2 t POG treatment gave a grain dry weight of 19.5 kg and straw dry weight of 21.5 kg. Meanwhile, the use of organic fertiliser alone, without the combination of NPK, resulted in lower production. For example, in the NPK + cow manure treatment, the dry weight of grain and straw was lower than the combined use of POG or straw with NPK.

Discussion

1. Effect of Organic Fertiliser on Plant Growth

From the results shown in Table 3, it can be seen that the use of bulk organic fertiliser (PO bulk) and granules (POG) had a positive effect on plant growth compared to the control, with a significant increase in plant height and number of leaves. For example, the bulk PO treatment (300 kg/ha) increased plant height to 23.2 cm and the number of leaves to 8, compared to the control which was only 19.9 cm and 7 leaves. However, the highest growth was achieved with the use of NPK, with plant height of 33.6 cm and production of 17.7 tonnes/ha.

Combinations of NPK with organic fertilisers, such as the NPK + POG 500 kg/ha treatment, increased yields further, reaching a production of 26.4 tonnes/ha. These results show

that organic fertilisers, while contributing to increased plant growth, can be more effective when combined with chemical fertilisers. Brady & Weil (2008) explain that organic fertilisers improve soil structure, increase water absorption capacity, and prolong nutrient availability, while chemical fertilisers provide immediate nutrients that plants need for rapid growth (Salawati et al., 2022).

Researchers assume that the use of organic fertilisers can have a positive impact on plant growth and soil quality. This is due to the ability of organic fertiliser to improve soil structure, increase water retention, and provide nutrients in a sustainable manner, which in turn supports plant growth better than without organic fertiliser.

2. Synergy of Organic and Chemical Fertilisers in Increasing Yield

The combination of chemical fertiliser (NPK) and organic fertiliser showed a significant synergistic effect. The 600 kg/ha bulk NPK + PO treatment showed the highest production increase of 29.6 t/ha and plant height of 38 cm, much higher than the single fertiliser treatment. This supports the theory that chemical fertilisers provide essential nutrients in a rapidly absorbed form, while organic fertilisers help improve the physical and biological properties of the soil, which in turn increases the effectiveness of nutrient use.

According to Palm et al. (2001), the combination of organic and chemical fertilisers helps to create a more stable nutrient balance, reduce nutrient losses and minimise the negative impacts of excessive chemical fertiliser use, such as soil pollution. In this case, organic fertilisers play a role in slowly providing nutrients and improving the soil's capacity to store water and nutrients, thus supporting more efficient nutrient uptake by plants.

Researchers assume that a combination of chemical fertilisers (NPK) and organic fertilisers will result in improved plant growth and better productivity compared to the use of single fertilisers. This assumption is based on the theory that chemical fertilisers provide nutrients in a form that is quickly absorbed by plants, while organic fertilisers improve soil fertility in the long run, resulting in a better synergistic effect.

3. Improving Soil Fertility and Quality through Organic Fertilisers

The results obtained also support the theory that organic fertiliser plays a role in improving soil organic matter content, which is one of the main factors in improving soil fertility. Tisdale et al. (1993) stressed that the use of organic fertilisers such as manure, crop residues, or compost can increase the humus content in the soil, which serves as a buffer in maintaining water and nutrient balance.

Table 1 and Table 2 show that manure contains essential nutrients such as Nitrogen (N), Phosphorus (P) and Potassium (K), which are necessary for plant growth. For example, chicken manure contains 15% Nitrogen and 8.9% Potassium, which are important in supporting leaf growth and fruit formation in plants.

Marschner (2012) explains that organic fertilisers also support the development of soil microorganisms, which play an important role in decomposition and mineralisation processes, converting organic matter into a form that can be absorbed by plants. These microorganisms help increase long-term nutrient availability and play a role in enhancing soil biological activity.

Researchers assumed that the use of organic fertilisers would contribute to an increase in soil organic matter content and microorganism activity. This is considered important for maintaining long-term soil health and supporting sustainable agricultural practices.

4. Effect of Organic Fertiliser on Dry and Wet Weight of Plants

The use of organic fertiliser not only affects general plant growth but also increases the dry and wet weight of the crop. In Table 4, the combination of NPK with 2 tonnes of straw or granulated organic fertiliser (POG) resulted in increased grain dry weight, especially in the NPK + 2 t POG treatment, which reached 19.5 kg dry weight. Straw dry weight also increased in this treatment to 21.5 kg. This indicates that the use of organic fertilisers, especially in granule form, can improve the quality of crop yields.

According to Fageria et al. (2011), organic fertilisers help to increase the content of nutrients in the crop, such as protein, fibre and sugar, which in turn affects the physical quality of the crop. The combination of organic fertiliser with NPK allows plants to obtain a sustainable source of nutrients, which not only supports vegetative growth but also improves the overall quality of the crop.

Researchers assume that organic fertilisers not only increase the quantity of crops, but also the quality of crops, such as an increase in dry and wet weight of plants. This is related to the ability of organic fertilisers to enrich the nutrient content of crops.

5. Sustainability of Organic Fertiliser Use in Agriculture

The use of organic fertiliser is also in line with the concept of sustainable agriculture. According to Lal (2004), modern agriculture requires an approach that not only increases short-term productivity, but also maintains long-term soil health. Organic fertilisers help maintain soil structure, increase organic matter, and improve water retention, thus keeping the soil fertile for future generations (Desnataliansyah, 2023).

In this study, it was shown that the combination of organic and NPK fertilisers gave optimal results in terms of crop production and improved soil quality, making it a sustainable solution for intensive farming systems.

Researchers assume that the use of organic fertilisers is the right step in supporting sustainable agriculture. Organic fertilisers help maintain the balance of soil nutrients, reduce dependence on chemical fertilisers, and maintain soil health for future generations.

4. Conclusions

From the results of this study, it is clear that the use of organic fertilisers significantly improves soil fertility and crop yields, especially when combined with chemical fertilisers such as NPK. Organic fertilisers not only improve the physical and biological properties of the soil, but also increase the effectiveness of chemical fertilisers. This combination creates a synergy that results in better plant growth, higher production, and optimised crop quality. Thus, the use of organic fertilisers, especially in sustainable farming practices, is highly recommended to increase productivity and maintain long-term soil health.

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