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Effectiveness of Various Fertilizers on Hybrid Corn (*Zea mays* L.) in Dry Land



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Abstract

Dry land has significant potential for cultivating hybrid corn. However, its limitations include water scarcity, poor soil physical properties, and limited availability of NPK nutrients. To improve dryland conditions, organic fertilizers, inorganic fertilizers, and organic fertilizers enriched with phosphate-solubilizing bacteria can be applied. The use of organic fertilizers—such as chicken manure and empty oil palm bunches (tankos)—as well as organic fertilizers enriched with phosphate-solubilizing bacteria, can enhance soil quality by improving its physical structure (making the soil looser and more fertile) and chemically increasing nutrient availability, thereby supporting better growth and yield of hybrid corn plants. This study aimed to evaluate the effectiveness of various fertilizer types on the growth and productivity of hybrid corn cultivated on dry land. The field experiment was arranged in a randomized complete block design (RCBD) with four treatments, each replicated six times: recommended chemical fertilizers (A), chicken manure fertilizer (B), organic fertilizer enriched with phosphate-solubilizing bacteria (C), and empty oil palm bunches (tankos) fertilizer (D). The highest yield was achieved using the recommended chemical fertilizer, producing 3.42 kg per plot (13.68 tons per hectare). The second highest yield was obtained with organic fertilizer enriched with phosphate-solubilizing bacteria, yielding 2.98 kg per plot (11.92 tons per hectare). The third-highest yield came from chicken manure fertilizer, producing 2.67 kg per plot (10.68 tons per hectare), followed by tankos fertilizer at 2.2 kg per plot (8.8 tons per hectare). The novel finding of this study is that organic fertilizer enriched with phosphate-solubilizing bacteria, without the addition of inorganic fertilizers, can achieve yields comparable to those obtained with recommended chemical fertilizers. While inorganic fertilizers are effective in increasing hybrid corn yields in the short term, their long-term use may negatively impact the environment and soil fertility. Therefore, organic fertilizer enriched with *Azospirillum* bacteria presents a more environmentally friendly and sustainable alternative.

Keywords: Dry Land, Hybrid Corn, Various Types of Fertilizer

1. Introduction

Hybrid corn is rich in dietary fiber, ranking as the second main source of carbohydrates after rice, and is used as animal feed (Sari et al., 2021). According to (BPS, 2025), the harvested area of hybrid corn in 2024 is 0.26 million ha with a production of 1.52 million tons (5.85 tons/ha), while the harvested area in 2025 is 0.23 million ha with a production of 1.39 million tons (6.04 tons/ha) with a moisture content of 14%. From the data above, it can be seen that the harvested area decreased by 0.03 million ha in 2025, while the achieved production increased. Therefore, increasing hybrid corn production still requires the use of inorganic fertilizers, organic fertilizers, or organic

fertilizers enriched with phosphate-solubilizing bacteria. This research is important because limited water in drylands requires appropriate fertilization strategies to maximize nutrient absorption efficiency. The ever-increasing national demand for corn requires optimizing productivity on marginal land, while scientific information on the most effective fertilizer types for hybrid corn in dryland conditions remains limited.

Throughout its life cycle, hybrid corn still requires nutrients from inorganic and organic fertilizers and a dryland growing environment. According to Mulyani et al. (2014); Mulyani and Sarwani (2013); Hafif (2016), the area of dry land in Indonesia that can be used for

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agricultural land is around 122.1 million hectares consisting of 108.8 million ha of acidic dry land and 13.3 million ha of dry climate dry land, meaning that dry land has quite large opportunities for planting hybrid corn plants. However, dry land presents obstacles that must be considered before it can be developed for corn production, such as the availability of sufficient nutrients for growth and production. These nutrients are obtained from fertilizers.

The long-term, continuous addition of inorganic nutrients results in deteriorating soil physical properties, soil compaction, and soil erosion. This issue causes the humus layer to be washed away, reduces soil water-holding capacity, and leads to less harmonious soil microbiological conditions, resulting in a decline in soil microorganism activity. This condition is caused by a decline in soil organic matter levels, so it is necessary to use organic fertilizers that maintain long-term soil fertility, as they do not damage the soil's physical, chemical, and biological properties (Hakim, 2009). The solution to increasing corn productivity without damaging soil structure is to use organic fertilizers. Organic fertilizers contain macro- and micro-nutrients, which can improve the physical, chemical, and biological properties of soil. The application of organic materials aims to improve soil structure, which has been decreasing over time due to excessive application of chemical fertilizers. Organic materials contain the complete nutrient content needed by plants.

Organic biofertilizers have the advantage of increasing crop production with high enzyme activity and maintaining soil fertility sustainably. Fertilization with organic biofertilizers does not have a negative impact on the environment because it does not pollute the environment (Pratiwi et al., 2016). According to Mezuan et al. (2002) and Obid et al. (2016), organic fertilizers containing microorganisms increase soil biological activity, which is beneficial for improving soil fertility and plant quality. Soil bacteria have an important role in increasing crop production. According to Hayat et al. (2010), soil bacteria can serve as organic fertilizers, increasing plant growth. The results of this study are expected to provide appropriate fertilizer recommendations to increase productivity and improve the efficiency of farmers' production costs.

Research by Sofyan et al. (2019) showed that NPK fertilizer application increased sweet corn plant height and dry weight by up to 25%. Meanwhile, research by Sulaeman & Erfandi (2017) compared organic and inorganic fertilizers on shelled corn in rice fields, finding that the combination of manure and NPK fertilizer produced the best results. Research by Guo et al. (2016) examined the effect of compost on soil chemical properties in corn cultivation, but was conducted in wetlands.

Unlike previous studies, which were generally conducted in rice paddies or areas with adequate water

availability, this study specifically examines the effectiveness of various fertilizers (bio-organic, inorganic, and combinations) on hybrid corn in dryland conditions, which have different characteristics and challenges, particularly in terms of water availability and nutrient uptake efficiency. Furthermore, the focus on modern hybrid varieties responsive to technological inputs distinguishes it from previous studies that primarily used local or composite varieties.

2. Material and Methods

This research was conducted on a farmer's land at Jalan Sukarela KM 7, Palembang, from November 2024 to 2025, with coordinates 2°55'54.4"S 104°43'46.5"E. The field layout used a non-factorial RAK with 4 treatments repeated 6 times: recommended chemical fertilizers (A), chicken manure fertilizer (B), organic fertilizer enriched with phosphate-solubilizing bacteria (C), and tankos fertilizer (D).

The research began with the creation of organic fertilizer enriched with phosphate-dissolving bacteria. The method is as follows: a) Chicken manure is mixed with bran (20 kg: 2 kg) and stirred evenly on a tarp, b) all ingredients are added with water and covered with a tarp. Every 4 days, the fertilizer is stirred, and after 21 days, 20 ml of phosphate-dissolving bacteria is added in a zigzag pattern and stirred again. The finished organic biofertilizer smells of tape and earth, is stored in plastic, and is ready to use.

To make compost from empty oil palm bunches (EFB), chop 20 kg of the EFB until smooth, add 200 ml of EM solution, and sufficient water. Stir the compost every four days, and after 30 days, it is ready.

Land preparation. The land was tilled twice to turn and loosen the soil. Twenty-four plots were created, measuring 2 x 1 m, 25 cm high, with a spacing of 50 cm between plots and 100 cm between replicates, and with a planting distance of 75 cm x 25 cm.

Inorganic fertilizers used include Urea, SP-36, and KCl. Urea: 400 kg/ha (80 g/plot), given 2 times, namely at planting time and 30 HST. SP-36: 200 kg/ha (40 g/plot). KCl: 100 kg/ha (20 g/plot), given at planting time. Types of organic fertilizers are chicken manure (10 tons/ha; 2 kg/plot), organic fertilizer (400 kg/ha; 80 g/plot), and empty oil palm bunch compost (6 tons/ha; 1.2 kg/plot).

Corn seeds: 2 per planting hole, then cover with a little soil until the seeds are covered.

Maintenance includes watering, thinning, weeding, hilling, and pest and disease control. Watering is done twice a day, in the morning and evening, unless it rains. Thinning is done 14 days after planting, leaving one seed per hole. Weeding is done once a week using a hoe. Hilling the soil strengthens the corn plant's root system, and soil is piled around the stem to prevent the plant from collapsing. Pest and disease control is carried out when an attack is

detected, using the appropriate dose of insecticide.

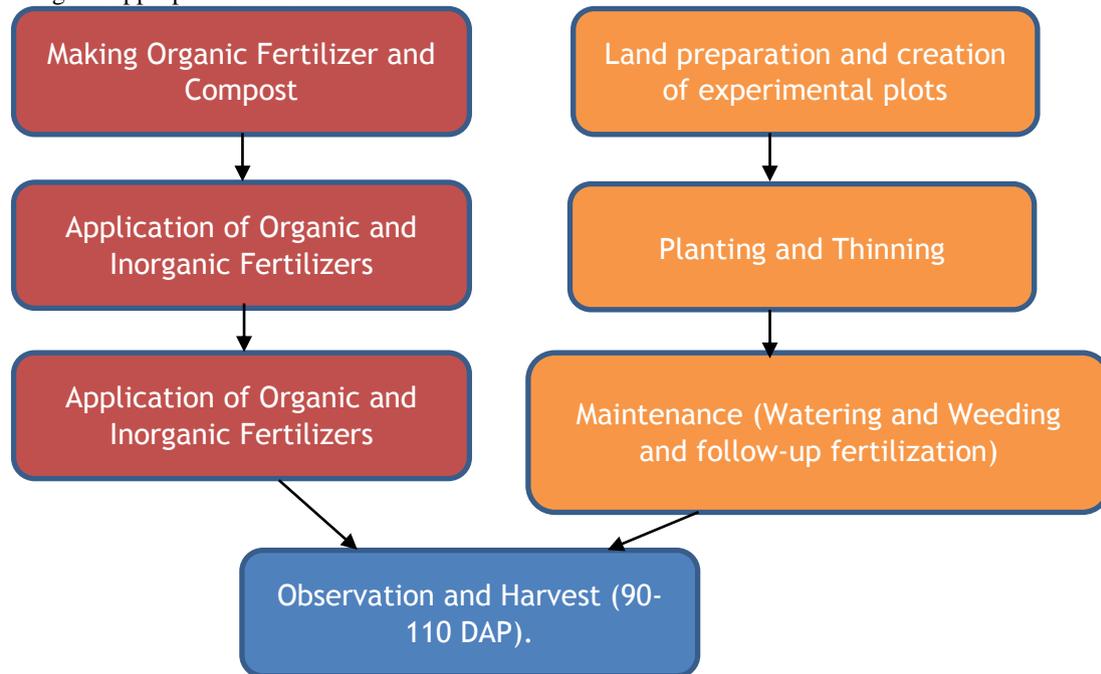


Figure 1. Research Flow Diagram

Hybrid corn plants can be harvested at 90-110 days, with the fruit sheath yellowing, shiny corn kernels, and hard, dense kernels. If the corn kernels are pressed with a fingernail, there will be no mark, and the kernels are easy to select.

2.1. Data analysis

Observational data were analyzed using Analysis of Variance (ANOVA) to determine the effect of the treatment. This test was followed by a further Duncan's Multiple Range Test (DMRT) at the 5% level. The research data were processed using SAS software version 9.0 and Microsoft Excel 2016.

3. Results and Discussion

The results of observations of plant height and number of leaves from 2 MST to 8 MST show that the growth of hybrid corn plants continues to increase, this is because when hybrid corn plants are 2 MST to 8 MST, it is a very active vegetative phase in carrying out photosynthesis to produce energy needed for growth in plant height and number of leaves, in addition, auxin and gibberellin hormones are active in promoting growth. At the age of 2 – 8 MST, corn plants are in a phase of intensive absorption of N and PK nutrients and are supported by roots that continue to develop and expand their area in absorbing nutrients and water.

The results of the analysis of variance showed that the chemical fertilizer treatment had a significant to very significant effect on all observed variables, but no significant effect on the variables number of leaves and weight of shells per plant (Table 1).

The results of the study indicate that inorganic fertilizer remains the best choice for increasing hybrid corn productivity in dryland areas, as evidenced by each observed variable. This finding is consistent with previous research showing that inorganic fertilizer can significantly increase hybrid corn yields (Sutrisno, 2018). Inorganic fertilizer remains the best choice for increasing hybrid corn productivity in dryland areas, but it is important to remember that continuous use can have negative environmental impacts.

Furthermore, organic fertilizer enriched with phosphate-solubilizing bacteria showed promising results and could be an environmentally friendly alternative to increase hybrid corn productivity. Phosphate-solubilizing bacteria can dissolve phosphate bound in the soil, thereby increasing its availability to plants (Ummadi et al., 2023). Organic fertilizer enriched with phosphate-solubilizing bacteria at 400 kg/ha was able to increase the weight of shells per plot by 35.45% when compared to tankos fertilizer of 6 tons/ha, this was because organic fertilizer enriched with solvent bacteria had undergone two decompositions, namely the first decomposition for 21 days and the second when given phosphate-solubilizing bacteria after 21 days containing 1.00% Nitrogen, 2.56% Phosphate, 1.29% Potassium (Marlina et al., 2025) This allows NPK nutrients to be readily available to corn plants, approaching the yield of inorganic fertilizers. The use of organic fertilizers enriched with phosphate-solubilizing bacteria significantly supports sustainable agriculture, as evidenced by the findings of Jiang et al. (2022), which showed that organic fertilizers can maintain productivity while improving soil health parameters over several growing

seasons.

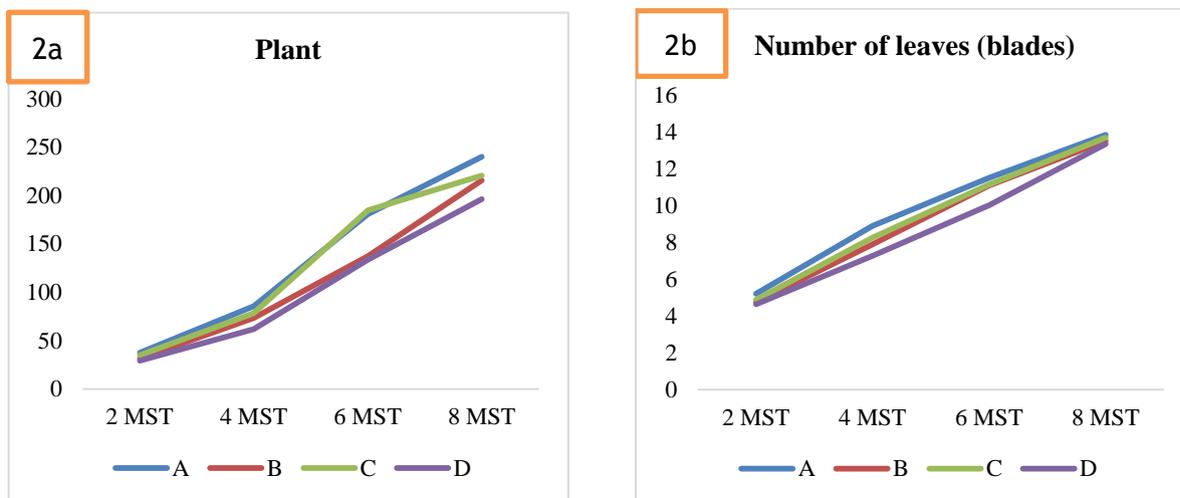


Figure 2. Effect of fertilizer variety on plant height (2a) and number of leaves (2b). Recommended chemical fertilizer (A), chicken manure fertilizer (B), organic fertilizer enriched with phosphate-dissolving bacteria (C), tankos fertilizer (D).

Table 1. Results of the analysis of the diversity of the influence of the use of fertilizer types on the observed variables

Observed Variables	Organic Biological Fertilizer	Diversity Coefficient (%)
Plant Height (cm)	**	5.22
Number of leaves (blades)	tn.	8.27
Length of the cob (cm)	*	3.63
Weight of Cob per Plant (g)	**	7.65
Weight of Shells per Plant (g)	tn.	11.66
Weight of Cob per Plot (kg)	**	14.59

Description: tn= No Significant Effect
 *= Real Impact
 **= Very Real Impact

Table 2. Effect of Fertilizer Varieties on Corn

Treatment	Plant Height (cm)	Number of leaves (blades)	Length of corn cob (cm)	Weight of cob per plant (g)	Weight of kernels per plot (kg)	Production increase (%)
A	240.17 ±9.47 a	13.83 ±0.79	18.67 ±2.21 b	387.50 ± 19.21b	3.42 ±0.12 c	53.45 ±2.65
B	215.67 ±10.49 a	13.50 ±0.75	17.33 ±2.34 ab	33.67 ± 18.20a	2.67 ±0.11 ab	21.36 ±2.21
C	220.75 ±12.32 b	13.67 ±0.58	17.50 ±0.32 ab	358.33 ± 20.1ab	2.98 ±0.32 bc	35.45 ±3.41
D	196.42 ±8.42 a	13.33 ±0.73	17.00 ±0.56 a	320.83 ± 19.2a	2.20 ±0.15 a	35.51 ±2.16
BNJ 0.05	18.94	Mr.	1.55	4.45	2.81	36.45

Note: numbers followed by different notations mean they are significantly different.

Organic fertilizer enriched with phosphate-solubilizing bacteria, without NPK fertilizer application, can potentially approach the yield of corn plants at the recommended NPK dose. This finding confirms that organic fertilizer enriched with phosphate-solubilizing bacteria can overcome the challenges of converting dry land into productive farmland and strongly supports environmentally friendly, sustainable agriculture. This result is supported by Marlina et al. (2025), which shows that bio-organic fertilizers show the potential to replace conventional fertilizers, achieving yields comparable to full-dose NPK fertilization while improving soil conditions in marginal land environments such as tidal lands. This approach offers a sustainable path to converting marginal land into productive agricultural land while maintaining high productivity and reducing environmental

impacts.

Chicken manure organic fertilizer yields lower results than inorganic fertilizers and organic fertilizers enriched with phosphate-solubilizing bacteria. However, it can still be a good choice for improving soil fertility (Hidayat, 2019). Essentially, any organic fertilizer applied to the soil can improve its physical, chemical, and biological properties due to its slow-release and gradual nature, which aligns with the concept of sustainable agriculture. Tankos fertilizer showed the lowest results, but it should be noted that research results can be influenced by many factors, such as fertilizer quality, application rate, and soil conditions (Suryanto, 2017).

4. Conclusion

The best research result was obtained with the recommended chemical fertilizer, yielding 3.42 kg per plot (13.68 tons per hectare). The second-best result was achieved using organic fertilizer enriched with phosphate-solubilizing bacteria, producing 2.98 kg per plot (11.92 tons per hectare). The third-best was chicken manure fertilizer, yielding 2.67 kg per plot (10.68 tons per hectare), followed by tankos fertilizer in fourth place, with 2.2 kg per plot (8.8 tons per hectare). This study offers several key advantages, including a comprehensive comparative

approach that evaluates three categories of fertilizers—organic, inorganic, and combined—providing a thorough assessment of each type's effectiveness. The focus on dryland agriculture adds value by addressing the real challenges of corn cultivation on marginal soils. Additionally, the research utilizes local materials such as chicken manure and oil palm empty fruit bunches (OPEFB) enriched with phosphate-solubilizing bacteria, promoting sustainable agriculture and reducing reliance on imported chemical fertilizers.

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