

Potential of corn cob compost in corn fertilization on alfisol soil

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Abstract. Corn cobs as waste material after the seeds are removed have not been utilized so they have the potential to become pollutants. Alfisols as marginal land require improvement materials for cultivated land. The study aims to examine the potential of corn cob compost on the growth and yield of corn on alfisol soil. The study used a Randomized Block Design with a single factor, namely treatment with six levels, namely inorganic fertilizer (doses of 350, 125, and 100 kg.ha⁻¹) and corn cob compost with doses of 2.5; 5.0; 7.0; 10.0; 12.5 tons.ha⁻¹. Repeated three times. The application of corn cob compost did not differ from the application of inorganic fertilizers on the number of cobs (fruit.m⁻²), seed weight (g.m⁻²), chlorophyll a, b, and total content (µgg⁻¹). The inorganic fertilizer treatment showed the highest seed weight of 550.2 kg.ha⁻¹. Corn cob compost dose of 7.5 tons.ha⁻¹ increases the number of cobs per m², weight of 100 seeds, number of seeds per m². Corn cob compost has the potential to replace inorganic fertilizers in corn cultivation on Alfisol soil.

1 Introduction

Climate change is a global issue that significantly impacts agricultural production. However, agricultural activities rely on chemical fertilizers, causing the formation, accumulation, and concentration of mineral salts in fertilizers that cause compaction layers and long-term soil degradation [1], [2]. High compaction reduces porosity and aeration, increasing soil density and penetration resistance [3]. Furthermore, it can limit the absorption of water and nutrients so that there is a decrease in root and plant growth and crop yields. One effort that can be made is to reduce the use of chemical fertilizers with organic fertilizers or compost [4].

Compost can be sourced from organic plant waste such as corn cobs. Compost can increase plant growth, crop yields, and fruit quality because of the balanced supply potassium, nitrogen, phosphate and supply micronutrients such as zinc, manganese, boron, copper, and iron [5], [6]. Corn (*Zea mays*) is used as a food ingredient. In addition, corn also produces by-products such as leaves, stems, roots, cobs, and skins. Some of these by-products have been used such as leaves as animal feed [7], cigarette wrappers [8], and snack wrappers [9]. Meanwhile, corn cobs have been widely used as raw materials for ethanol and biogas production [10]. However, the use of corn cobs as compost has not been widely carried out

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because of its low biodegradability. The main product of corn (cobs and seeds) is 70% corn husks and seeds and 30% cobs [11]. Most corn cobs are discarded as waste and have yet to be utilized. Corn cobs in Indonesia accumulated 9,016,686 tons in 2018 and have the potential to increase [12].

Corn cobs contain 45–55% cellulose, 25–35% hemicellulose, and 20–30% lignin [13], which have the potential as soil organic matter [14]. Corn cobs contain cellulose, which can act as a carbon source and, if decomposed, can improve the structure and water-holding capacity of the soil [15]. Using these materials as fertilizers reduces fertilization costs, is a sustainable crop cultivation that increases profits, is environmentally friendly, and maintains food security [16]. Corn, as one of the staple crops in Indonesia, in addition to being a food ingredient (30%), is also used as animal feed (60%) and fuel and industrial raw materials (10%) [17]. In recent years, Indonesia's corn exports have increased until 2022, reaching 162,033 tons [18]. However, corn production 2023 fell to 14.77 tons from 16.53 tons or down 10.61% from the previous year. This is related to the decrease in the original corn harvest area of 2.76 million ha (2022) to 2.48 million ha (2023).

Corn is one of the food supply commodities and plays a role in increasing the national economy so that production increases are carried out through various efforts, especially fertilization. The widely used fertilizer is inorganic fertilizer because it is practical, and the increase in yield is evident in a relatively short time—however, the use of inorganic fertilizers in the longterm results in a decrease in soil quality. Continuous use of inorganic fertilizers for ten years can reduce soil pH by 0.84, while using organic fertilizers increases the pH by 0.18 [19]. Inorganic fertilizers do not increase organic matter, essential for maintaining soil fertility and nutrient availability [20]. One type of soil that can be used for corn cultivation is alfisol, which contains moderate to low organic matter and acidic to neutral soil pH with low to high cation exchange capacity [21]. Alfisol soil often experiences decreased fertility because it is easily degraded due to low organic matter content [22]. The use of organic fertilizers is expected to increase soil fertility. Corn waste compost at a dose of 5.1 tons.ha⁻¹ can increase plant height and the number of leaves [23]. The novelty of this research is that corn cobs are used as compost to support the growth and yield of corn in alfisol soil. This research examines corn compost's effect on corn growth and yield in alfisol soil.

2 Material and methods

The research was conducted on agricultural land in Sukosari Village, Jumantono District, Karanganyar Regency, Indonesia with an astronomical location of 07°38'07.01"S 110°57'00.0"E with an altitude of 198.7 meters above sea level. The research was conducted in May-August 2022. The study used a one-factor randomized block design, namely the corn cob compost fertilizer dose. There are six levels, namely control with inorganic fertilizer (Urea 350; SP-36 125 and KCl 100 kg.ha⁻¹), a dose of corn cob compost 2.5, 5, 7.5, 10, and 12.5 tons.ha⁻¹). Each treatment was repeated three times so that there were 18 experimental units.

The implementation of the research with the preparation of corn cob compost (chopping the cobs with a machine, after it is soft, bran and molasses are added, and EM4 is stirred until homogeneously mixed, finally fermented for 45 days), land processing (the soil is hoed until loose, leveled, made into beds measuring 300x80 cm, making planting holes with a dibble, spreading essential fertilizer using 10.8 tons⁻¹ of cow manure), planting (2 Pertiwi 3 variety corn seeds are planted in each hole), fertilization treatment (compost is given 14 and 28 days after planting(DAP), spread and buried in the soil), maintenance (manual irrigation every day, weeding together with hoeing using a trowel, and manual control of plant pest organisms), harvesting (plant leaves and cobs have dried) and post-harvest (drying cobs without husks, removing seeds and drying seeds to a water content of 14%, drying cobs and

seeds in the sun). Observation variables include the number of leaves, chlorophyll content (spectrophotometry method), plant biomass (obtained after the plants are dried in a 60°C oven for 72 hours to constant weight), number of cobs, and seed weight (weighed with a digital scale). Data analysis using SPSS through the F test or variance analysis at the 5% level, if significant, a real difference test is carried out with DMRT at the 5% level.

3 Results and Discussion

3.1 Number of leaves

The corn cob waste compost dose significantly affected the number of corn leaves 4-13 weeks after planting (WAP) (Table 1). The number of leaves in the 2.5 ton.ha⁻¹ compost dose treatment was not significantly different from the 10 ton.ha⁻¹ dose treatment but significantly different from other treatments. The number of leaves at 6-13 WAP showed that the inorganic fertilizer treatment significantly differed from other treatments. The application of corn cob compost to corn has yet to increase the number of leaves. Treatment did not show a different effect between doses of corn cob compost. This occurs because adding corn cob waste fertilizer will increase the nitrogen, phosphorus, and potassium nutrient content, especially nitrogen, silica, and organic matter in the soil [9]. Nitrogen has the highest influence on leaf growth and development and the number and area of leaves formed [24]. Hence, the chlorophyll content produced is also higher for plants to assimilate sufficiently during vegetative growth [25]. Corn cobs with high Si content can restore chlorophyll levels in Mg-deficient plants to levels comparable to those in Mg-sufficient plants by modulating sugar metabolism and subsequent hormonal changes [26]. Silica can also improve the process of photosynthesis exchange that occurs in leaves, thus increasing the number of leaves [27].

Table 1. Number of corn leaves (Leaf) 1-13 WAP.

Weeks After Planting (WAP)	Treatments (tons.ha ⁻¹)					
	Inorganic	2.5	5	7.5	10	12.5
1	3.33	3.00	3.00	3.17	3.00	3.17
2	5.00	4.83	4.33	4.67	4.67	5.17
3	7.00	6.83	6.33	5.67	6.17	6.83
4	8.67 a	7.17 c	6.33 d	6.33 e	6.00 cd	8.17 b
5	7.67 a	5.83 c	5.50 e	6.00 de	6.17 cd	7.17 b
6	9.33 a	6.83 b	6.17 b	6.67 b	6.50 b	7.33 b
7	8.83 a	8.67 b	7.33 b	7.67 b	6.83 b	7.83 b
8	9.50 a	9.17 b	7.00 b	9.00 b	8.00 b	8.50 b
9	10.17 a	9.67 b	8.83 b	10.00 b	7.83 b	8.50 b
10	10.67 a	10.17 b	9.17 b	10.17 b	8.33 b	9.67 b
11	9.33 a	8.33 b	8.17 b	8.83 b	7.67 b	8.33 b
12	8.67 a	7.50 b	7.67 b	8.33 b	7.67 b	8.17 b
13	7.50 a	7.67 b	7.83 b	8.00 b	7.67 b	7.67 b

Note: numbers followed by the same letter in the same column indicate no significant difference according to the 5% DMRT.

3.2 Chlorophyll content

Leaves can photosynthesize because there are chloroplast organelles. An indicator that chloroplasts function as expected is the chlorophyll content. Chlorophyll formation requires components of light, nitrogen, manganese, and phosphorus—analysis of chlorophyll content in leaves that have fully expanded before maximum growth (6 WAP). The application of NPK fertilizer or corn cob compost from a dose of 2.5 to 12.5 tons ha⁻¹ did not significantly affect the chlorophyll content, indicating that the availability of light, nitrogen, and Mg nutrients from fertilizers at the experimental location in a balanced condition as a chlorophyll former. This suggests that the capacity and efficiency of corn photosynthesis are not different [28], [29]. Chlorophyll a (Khla) and chlorophyll b (Khbl) range from 177-183 µg.g⁻¹ and 428-451 µg.g⁻¹, respectively; the number of molecules (Khbl > Khla) means that chlorophyll synthesis is relatively standard. The most excellent absorption of Khbl in light with wavelengths between 400-450 nm and 620-670 nm [30]. Chlorophyll b acts as a photosynthetic antenna, collecting light and transferring it to the reaction center (Khla). In the reaction center (photosystems 2 and 1), light energy excites Khla electrons, entering the electron transport chain so that energy (ATP and NADPH) is formed [31].

Table 2. Leaf chlorophyll content.

Treatments (tons.ha ⁻¹)	Chlorophyll a	Chlorophyll b	Total chlorophyll
Inorganic	0.18	0.45	0.63
2.5	0.18	0.43	0.61
5	0.18	0.45	0.63
7.5	0.18	0.44	0.62
10	0.18	0.43	0.60
12.5	0.18	0.44	0.62

3.3 Corn yield

The number of cobs per m² can also be used to determine corn productivity. The application of corn cob waste fertilizer to corn showed no significant effect on the number of Cobs per m² (Table 3). The number of cobs in the application of compost doses of 2.5 tons.ha⁻¹ to 10 tons.ha⁻¹ can exceed the number of cobs compared to inorganic fertilizers. The effective dosage of plants will significantly impact the number, size, and weight of corn cobs [32]. In addition to the dose given, fertilizer content can also be a factor that affects cob weight. The selection of fertilizer content is essential to improve the quality and quantity of the harvest. One of the contents that can affect the number of cobs is potassium. The amount of potassium absorbed by plants dramatically affects the number of cobs and the formation of seeds [33]. Corn growth below optimum (number and biomass) results in cob formation and seed filling. The seed weight achieved in this experiment was very low; the highest was only 550.2 kg, achieved by inorganic fertilizers and several doses of corn cob compost fertilizer. The formation of cobs in only two out of 6 plants resulted in crop production. In addition to forming cobs, small cobs, and irregular seed rows, seed filling was also an obstacle [34].

Low nutrient availability decreased corn production (crop losses ranging) between 10-50% each year [35]. Seeds result from photosynthate remobilization from biomass, biomass where photosynthate accumulation results from photosynthesis, and the three components are correlated with very low fertilizer doses (Figure 1). The administration of corn cob waste fertilizer doses did not significantly affect the weight of 1000 seeds at harvest (Table 3).

Observations of the weight of 1000 seeds can be used to indicate the size of the endosperm in the seeds. Based on research, the compost dose of 12.5 tons.ha⁻¹ with an average of 193.57 g has yet to be able to meet the average standard according to the Pertiwi 3 variety. The standard weight of 1000 seeds of the Pertiwi 3 variety is 283.87–298.83 g. The weight of 1000 seeds in the treatment using compost doses of 12.5 and 7.5 tons.ha⁻¹ showed a higher weight of 1000 seeds than inorganic fertilizers. Imperfect cob formation can impact corn production, causing dry cobs, small cobs, and irregular seed rows. N deficiency is one of the limiting factors for corn productivity because depletion of nutrients and organic matter in the soil can limit soil productivity and production, resulting in the loss of corn harvests each year, ranging from 10-50% [35]. Phosphate is also an essential factor that must be met to increase corn productivity. Phosphate can accelerate root growth and form a sound root system from young plant seeds, accelerate flowering, increase grain production, and act as a source of protein, fat, and cell nuclei [36].

Table 3. Corn yield.

Variables	Inorganic	2.5	5	7.5	10	12.5
Number of Cobs Per-m ²	5.67	6.67	8.67	7.33	6.67	5.00
Weight 1000 Seeds	174.37	156.53	162.47	188.50	158.47	193.57
Number of Seeds Per Per-m ²	506.67	611.67	409.67	739.33	577.00	490.67

4 Conclusion

The application of corn cob compost did not differ from the application of inorganic fertilizers on the number of cobs (fruit.m⁻²), seed weight (g.m⁻²), chlorophyll a, b, and total content (µg.g⁻¹). The inorganic fertilizer treatment showed the highest seed weight of 550.2 kgha-1. Corn cob compost dose of 7.5 tons.ha⁻¹ increases the number of cobs per m², weight of 100 seeds, number of seeds per m². Corn cob compost has the potential to replace inorganic fertilizers in corn cultivation on Alfisol soil.

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