**Production of cow manure and CAN-DAP based organic fertilizer composite for the growth of chili plants**

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**Abstract.** Composite fertilizers can provide balanced nutrient availability, improve soil fertility, and enhance crop growth by combining the advantages of organic and inorganic components. In this study, cow manure was utilized as the organic material, providing organic nitrogen compounds, combined with calcium ammonium nitrate (CAN) and diammonium phosphate (DAP), as energy resources for soil microbes, to formulate composite fertilizers with varying compositions. The fertilizers were applied to the chili plant grown on peat soil, and their effects on soil pH, plant height, and leaf number were evaluated. The results showed that fertilizer composition influenced both soil properties and plant growth. The best performance was achieved in variable 6 (50% cow manure, 25% CAN, and 25% DAP), which increased plant height by 80% and leaf number by sixfold compared with the control. Soil pH remained stable within the range of 6.0-6.4, demonstrating the compatibility of the formulations with acidic peat soils. This study demonstrated that balanced cow manure/CAN-DAP composite fertilizers can improve chili plant growth.

# INTRODUCTION

Fertilizer is an important factor in the agricultural industry to support the growth and production process of agricultural products [1]. Over time, the use of chemical fertilizers on plants shows an increasing trend [2]. Long-term use of chemical fertilizers has a negative impact on the soil and environment, and the high price of chemical fertilizers is also a problem for farmers (3) (4). The use of organic fertilizer has cheaper production costs and is more environmentally friendly, but is less popular with farmers because of its slow effect on plant growth, thus affecting the harvest period. Organic fertilizer is fertilizer obtained from the decomposition of organic material originating from plant residues, agro-industrial waste, or animal waste, which contains nutrients for plants [5,6]. Organic fertilizer mixed with other additives can increase its function in meeting the nutritional needs of plants. This process of collaborating organic materials with inorganic additives is called composite fertilizer.

Composite fertilizer can be processed from a mixture of organic fertilizer and inorganic fertilizer with proper composition optimization to provide complete and balanced nutrition for plants. Organic fertilizer has nutrients that are good for the soil, while inorganic materials take up nutrients such as nitrogen, phosphorus, and potassium. Previous researchers have reported the manufacture of composite fertilizer [7], with the collaboration of organic fertilizer and NPK showing an increase in survival percentage, plant diameter, and tuber production. In another study, it was also reported that the manufacture of composite fertilizer was obtained from the collaboration of organic fertilizer from corn straw waste with the addition of SP36 and KCl fertilizer, which showed good results in increasing corn plant production in terms of cob length and corn girth [8].

Animal waste, as a result of livestock businesses, has the potential to be managed into organic fertilizer [9,10]. Improving the quality of organic fertilizer can be done with a combination of inorganic additives, which contain various nutrients needed by plants [11,12]. In this research, a composite fertilizer was created by mixing Cow Manure-Based Organic Fertilizer with calcium ammonium nitrate (CAN) and diammonium phosphate (DAP) fertilizers to produce a high-quality fertilizer for plant growth. Cow manure contains various important nutrients such as nitrogen (N), phosphorus (P), potassium (K), and other micronutrients needed by plants [13]. In the initial stage, cow manure waste is processed into organic fertilizer through composting, while the combination with CAN-DAP is carried out by optimizing the best composition. The quality of composite fertilizer was tested on chili plants to determine its role and relevance in supporting the growth of chili plants.

# METHODOLOGY

**Cow Manure Organic Fertilizer Fabrication Process**

Dry cow manure obtained from livestock waste in Balikpapan City was prepared in a quantity of 20 kg. Cow manure was placed in a large plastic bag and then sealed to facilitate the anaerobic fermentation process. A bio-activator was then added at a ratio of 1% of the total cow manure weight, equivalent to 50 grams. The cow manure and bio-activator were stirred until evenly mixed using a wooden stirrer. Once mixed thoroughly, the fermentation container was sealed tightly to maintain airtight conditions. The fermentation process was carried out for 14 days. After fermentation was complete, the material was dried in the sun for 1 day to remove any remaining water content. At the end of this process, dry organic fertilizer was obtained.

**Production of Cow Manure/CAN-DAP Combination Composite Fertilizer**

CAN-DAP inorganic fertilizer was prepared through a grinding process to form fine fertilizer grains. The cow manure organic fertilizer obtained in the previous stage was weighed and combined with CAN-DAP inorganic fertilizer at varying compositions, with the percentage calculations based on the mass of cow manure organic fertilizer, CAN, and DAP. The composition of the composite fertilizer fabrication is shown in Table 1. The mixture was stirred until a homogeneous fertilizer mixture was obtained. The fertilizer mixture was then placed in a plastic container with each variable composition. The product produced after this process was Cow Manure/CAN-DAP composite fertilizer.

**TABLE 1.** The composition of the composite fertilizer

|  |  |  |  |
| --- | --- | --- | --- |
| Variable | Cow Manure | CAN (wt.%) | DAP (wt.%) |
| 1 | 0 | 25 | 75 |
| 2 | 0 | 50 | 50 |
| 3 | 0 | 75 | 25 |
| 4 | 25 | 25 | 50 |
| 5 | 25 | 50 | 25 |
| 6 | 50 | 25 | 25 |
| 7 | 100 | 0 | 0 |
| 8 | 80 | 10 | 10 |
| 9 | 60 | 20 | 20 |
| 10 | 40 | 30 | 30 |
| 0 | 0 | 0 | 0 |

**Testing composite fertilizer for the growth of Chili plants**

The quality of the composite fertilizer produced in this research was tested by analyzing the growth of chili plants. The planting media were prepared using peat soil placed in a planting container. Chili plant seeds were prepared in each prepared soil container. Cow manure/CAN-DAP composite fertilizer was applied three times at 12-week intervals. The pH value of each planting medium was measured after fertilizer application. Observations and measurements of chili plant growth variables were conducted daily. As a comparison, chili plant media were also prepared using pure organic fertilizer without the addition of CAN-DAP inorganic fertilizer.

# RESULTS AND DISCUSSION

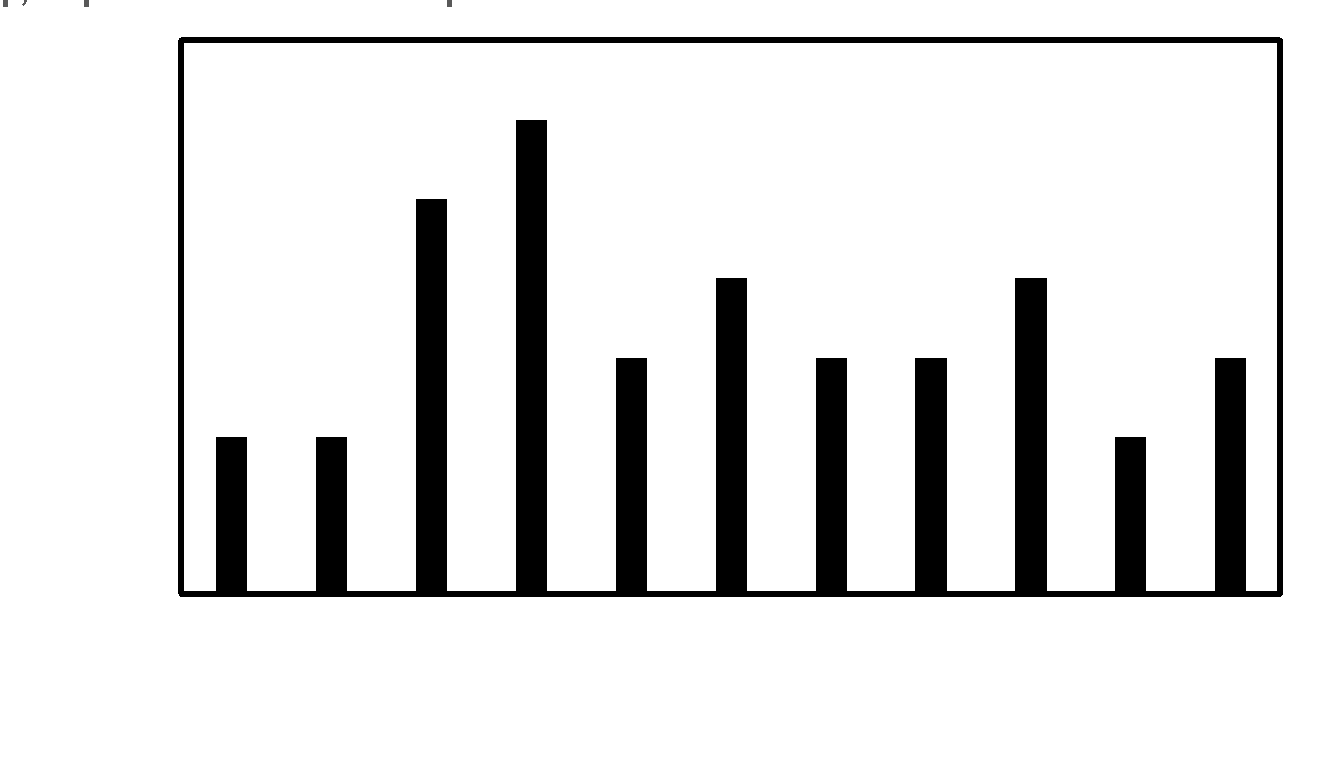
The fabrication of composite fertilizer in this research was carried out by fermenting cow manure at an early stage. Fermentation is carried out to optimize the nutrient content in it, reduce the number of dangerous pathogens, and increase the effectiveness of fertilizer before use. Fermenting cow manure is usually called composting, which is the process of decomposing organic materials from cow manure using decomposing microorganisms. In the decomposition process, microorganisms will reduce the C/N ratio of organic material until it is the same as the C/N of the soil and release nutrients that are important for plants, such as nitrogen, phosphorus and potassium into simpler compounds [14]. The addition of CAN/DAP fertilizer is carried out to support the provision of nutrients for plants. Commercial CAN fertilizer contains 27% N and 12% CaO, while commercial DAP fertilizer contains 12% N and 60% P2O5. These two fertilizers are mixed with dry cow manure and a little water to produce a fertilizer mixture, which is called composite fertilizer. Cow manure/CAN-DAP composite fertilizer is produced in granule form as shown in Figure 1.

A pile of black balls on a yellow plate

Description automatically generated

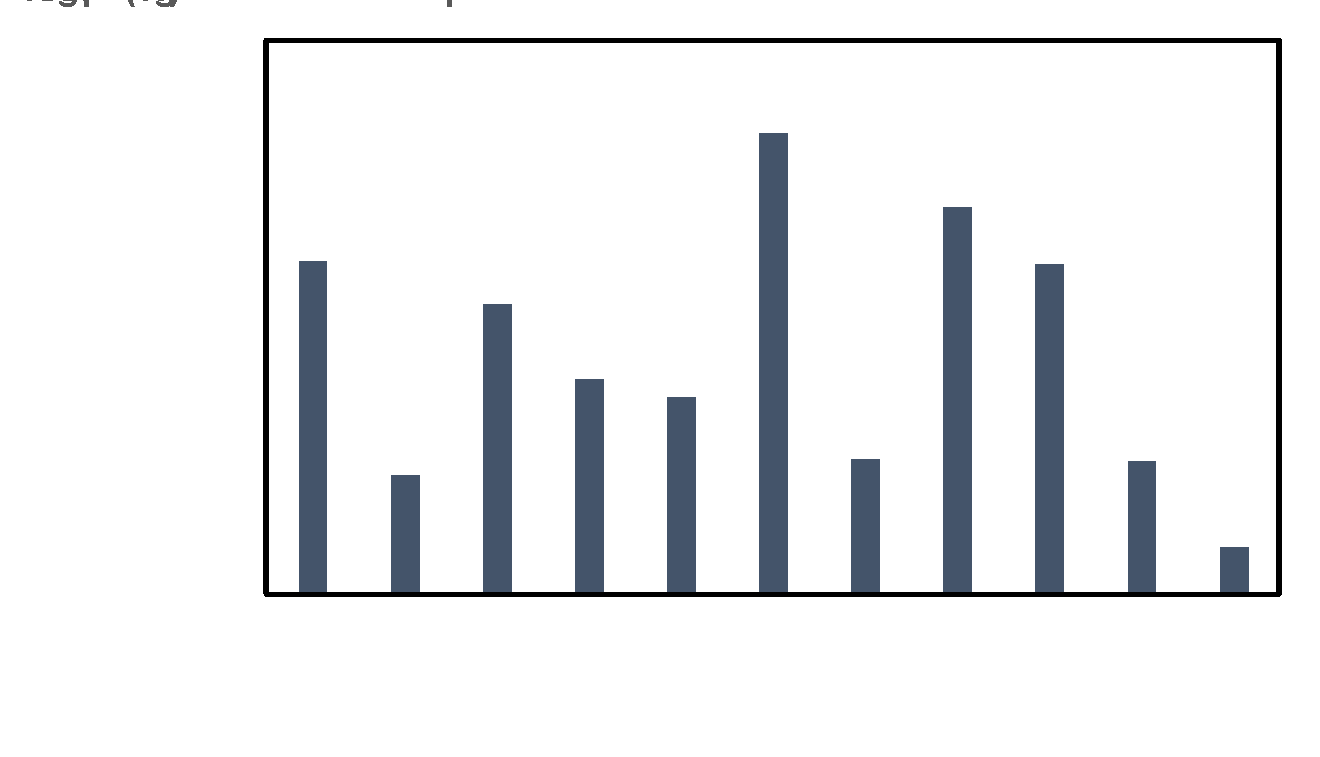
**FIGURE 1.** Cow manure/CAN-DAP composite fertilizer in granular form

The use of fertilizer on soil on agricultural land can affect soil pH conditions. In this case, the pH value specifically influences the availability of nutrients in the soil by controlling the chemical compounds in it (15). As shown in Figure 2, the application of cow manure/CAN-DAP composite fertilizer has minor changes after fertilization. In category 1 (variables 1-3 – varying CAN/DAP), soil pH increased slightly with higher CAN content and decreased slightly with DAP content. This can be explained that CAN contributes calcium cations that form calcium hydroxide and raise the pH. At the same time, DAP releases hydrogen ions from the hydrogen phosphate compound, which lowers the pH.



**FIGURE 2.** pH value after using composite fertilizer on peat soil

In category 2 (variables 4-7), there was a minimal pH change. This indicates that cow manure alone (variable 7) or combined with CAN/DAP does not significantly change soil acidity. In previous studies, it was reported that cow feces organic fertilizer did not have a direct effect on increasing or decreasing the pH value (16). A pH value that is no different from the previous value can be indicated because the acidity of the peat soil is very high, with a pH range of 3.7-5.2 (17). However, category 3 (variables 8-10) showed slight decreases in pH, likely due to nitrification removing alkaline cations in the soil [15]. Overall, the composite fertilizer maintained pH within a suitable range for chili growth, demonstrating compatibility with acidic peat soils.



**FIGURE 3.** The results of the plant height test

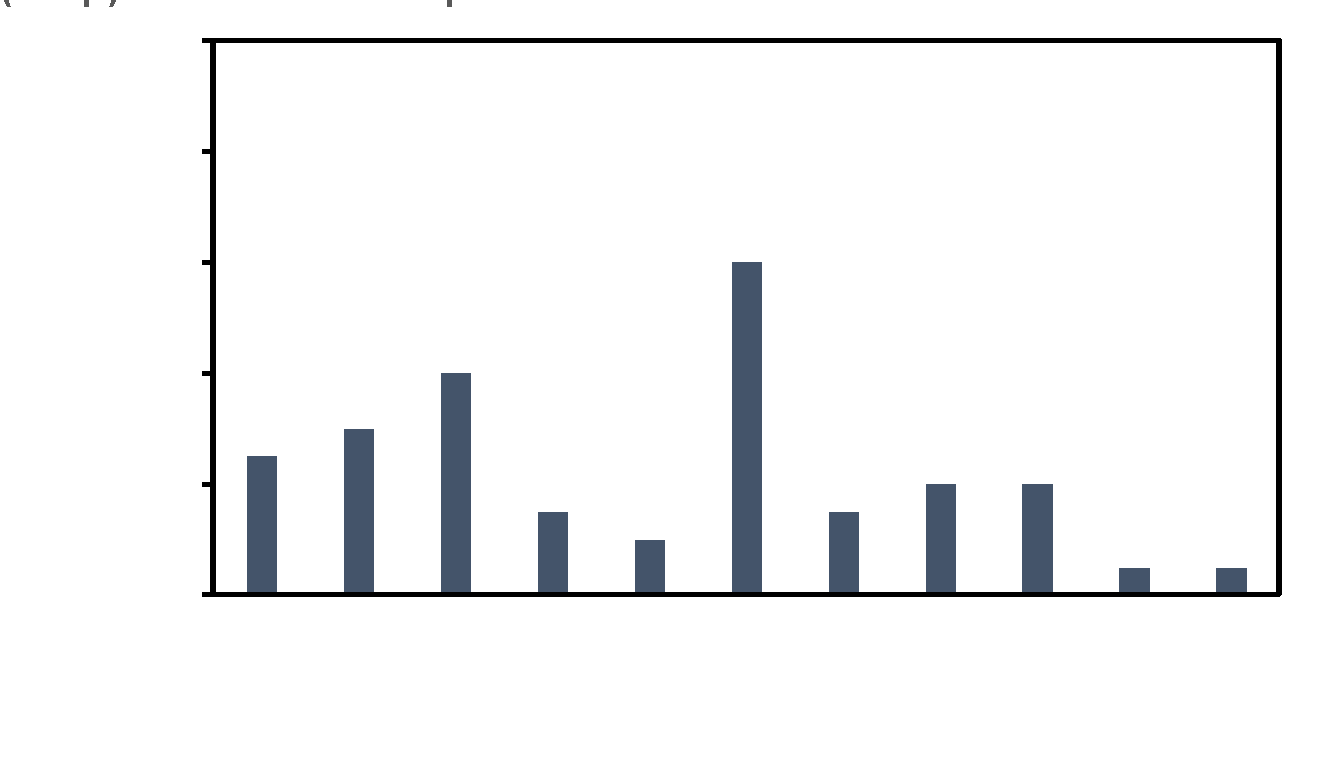
The testing process on chili plants was carried out to determine the suitability of composite fertilizer from a mixture of cow manure, calcium ammonium nitrate (CAN) fertilizer, and diammonium phosphate (DAP) fertilizer to be used as the main choice for agricultural needs. This test was conducted by applying different fertilizer treatments to chili plants, with several variables. The variables measured from plant growth results are plant height and the number of leaves. Chili plant height increases variably depending on fertilizer composition (Figure 3). The control showed a minimum increase compared to the others. The largest increases occurred in variable 6 (50% cow manure, 25% CAN, and 25% DAP), with a percentage increase of 83%, followed by variable 8 (80% cow manure, 10% CAN, and 25% DAP), with a percentage increase of 70%. Analysis shows that a balanced CAN-DAP maximizes plant growth. The comparison of variable 7, which has no addition of CAN/DAP, and category 1 (variables 1-3), which has no addition of cow manure, is shown.



**FIGURE 4.** The process of using composite fertilizer on chili plants

Leaf growth varied with fertilizer composition (Figure 5). The use of composite fertilizer on each chili plant has a varying effect on the number of leaves. Category 1 proves that CAN and DAP induce leaf growth 2-4 times. This suggests that these components affect leaf growth, with a higher concentration of CAN leading to increased leaf growth. In previous studies, it has been reported that very large nitrogen content in CAN can increase significant vegetative growth of plants, which can be measured from the number and area of ​​leaves, as well as the cross-sectional area of ​​the stem [18]. However, too much nitrogen deposits can also cause stunting in plant leaf growth [19].

In category 2, variable 6 experienced an increase in the number of leaves up to 6 times. This increase is the largest of all categories. This phenomenon demonstrates that the optimal combination of organic and chemical fertilizers yields the highest quality for chili growth. In previous studies, it has been reported that the combination of organic fertilizer with chemical fertilizer in the right composition provides the best plant growth effects with increased crop yields [20]. In this research, variable 6 is the best composition of the composite fertilizer variables because it has a balanced composition between the ratio of organic fertilizer and CAN-DAP fertilizer. These results show that the inorganic component alone can improve the growth of leaves. Moreover, the combination with organic fertilizer is promising for improving the quality of agricultural cultivation.



**FIGURE 5.** The results of the analysis of the number of leaves on the use of composite fertilizer

# CONCLUSION

This study investigated the fabrication and application of a composite fertilizer derived from cow manure, calcium ammonium nitrate (CAN), and diammonium phosphate (DAP), with the aim of improving chili plant growth on peat soil. The results showed that fertilizer composition influenced soil pH, plant height, and leaf development. The soil pH after fertilizer application remained within the range of 6.0-6.4, demonstrating the composite formulations were compatible with acidic peat soils. Among the various treatments, variable 6 (50% cow manure, 25% CAN, and 25% DAP) produced the greatest improvements in chili growth compared with the control. This highlights the importance of balancing organic and inorganic components, which cow manure enhances nutrient retention and soil structure, while CAN and DAP provide essential nitrogen and phosphorus for vegetative growth. These findings confirm that combining organic and inorganic fertilizers is more effective than using either type alone.

Composite fertilizer fabrication has been successfully carried out using a combination method of mixing cow manure-based fertilizer with CAN and DAP. The addition of composite fertilizer to planting media has been proven to affect soil pH; namely, a higher DAP percentage will increase soil acidity, and fertilizer with a higher CAN percentage will reduce soil acidity. Meanwhile, cow manure fertilizer does not have a significant effect on soil pH. Based on testing composite fertilizer on chili plants, it shows that variable 6 (50% cow manure, 25% CAN, and 25% DAP) and variable 8 (80% cow manure, 10% CAN, and 10% DAP) are variables with fertilizer composition a balanced composite with the highest percentage of growth in plant height and number of leaves.

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