

The Effectiveness of the “CAFELM” Formulation on the Growth Stage of Bird's Eye Chili

Rani Yosilia^{1*}, Maya Arofa Rahmatuka², Aulia Ulmillah¹, Siti Munawarah Panggabean²

¹Department of Biology, Raden Intan State Islamic University Lampung, Lampung, Indonesia

²Department of Biology Education, Raden Intan State Islamic University Lampung, Lampung, Indonesia

Abstract. The continual use of inorganic fertilizers can lead to decreased soil fertility, lower crop yields, and increased environmental pollution. CAFELM - Compost Ash Fertilizer Enriched with Leachate, Charcoal, and Local Microbes is a mixture of several organic compounds used to treat domestic trash. This study aimed to examine the impact of specific fertilizers on the growth of bird's eye chili. A randomized experimental design with multiple replicates was used for this investigation. The application of the CAFELM formulation fertilizer resulted in significant improvements in plant growth, particularly when treatment T1 was applied (consisting of 80 grams of compost, 3 mL of leachate, 80 grams of wood charcoal, 20 grams of burned ash, and 8 mL local microbe's banana weevil). Additionally, this fertilizer composition proved effective in increasing total phosphorus content.

1 Introduction

Currently, the demand for agricultural commodities such as biopharmaceuticals, vegetables and fruits, and basic foods such as rice and maize is increasing. This rise is due to an ever-increasing population [1]. The size of productive land, however, is not commensurate to the ever-increasing food demand. Land output falls every year as a result of the numerous land use changes. As a result, farmers are vying to administer inorganic fertilizers to plants in quantities that exceed or suggest in the goal of enhancing crop yields [2]. However, extensive fertilization eventually results in a reduction in soil quality, both biologically and chemically, affecting farmers' crop yields [3]. Horticultural items, which include fruits, vegetables, pharmaceuticals, and ornamentals, are one of the agricultural products with development potential. Horticultural crops are excellent products with the potential to increase farmer wellbeing in Indonesia.

Chili is a great example of a horticulture product. Chilies are utilized not only as a culinary element, but also in a variety of sectors such as food, pharmaceutical, and herbal medicine. Chili is occasionally in limited supply due to strong market demand and diminishing chili

* Corresponding author: raniyosilia@radenintan.ac.id

production, which is one of the causes for the market's increase in chili prices. Efforts to boost production can be accomplished by enhancing soil fertility via balanced and integrated fertilization. In a nutshell, the use of inorganic fertilizers must be balanced with the use of organic fertilizers to boost soil fertility and fulfil the nutritional demands of plants [4].

There are various alternative resources that farmers may employ to lessen their consumption of synthetic chemical fertilizers by adopting organic fertilizers. According to research, combining bagasse biochar and bagasse compost can boost cayenne pepper growth and production [5]. Furthermore, burned ash has been shown to increase the quality of soil planting medium [5]. Landfill leachate appears to be a feasible source of nitrogen and potassium for agricultural production [6]. Researchers have found that incorporating biochar into fertile, temperate soils can significantly increase maize yield [7]. Giving local microbe from banana weevils to cabbage might impact its development and yield [8]. Household and organic wastes from various research can be combined into a product. This formulation makes use of natural resources already available and investigates the capacity of novel organic fertilizer formulations to boost plant output.

2 Research Method

This study began with four weeks of composting household trash [9], followed by two weeks of local microbes of banana humps [10]. Collecting leachate from dumpsters at the Tulang Bawang Barat market, as well as wood charcoal and burnt ashes from local residential waste. When everything is ready, each element is blended according to the predetermined combination, namely: Treatment 1 (T1): 80 g compost + 3 mL leachate + 80 g wood charcoal + 20 g burned ash + 8 mL local microbes of banana weevil. Treatment 2 (T2): 90 g compost + 4 mL leachate + 90 g wood charcoal + 25 g burned ash + 9 mL local microbes of banana weevil and (T3) treatment: 70 g of compost + 2 mL of leachate + 70 g of wood charcoal + 15 g of burned ash + 7 mL local microbes of banana weevil. Following that, the created fertilizer formulation was applied to polybags containing Dewata 43 F1 bird's eye chili seeds. In comparison, (T4) received 4 grams/polybag of NPK 16-16-16 fertilizer, whereas (T5) received no fertilizer. A fully randomized design (CRD) was adopted for the treatment. Each treatment was carried out five times. The plant's top is covered in black paranet and watered daily.

2.1 Observation of Parameters and Data Analysis

Data is collected after composting to identify its chemical characteristics and their impact on plants. The T1, T2, and T3 formulations were then tested in the lab for chemical constituents such as C-organic elements, pH, N, P, and K. During the vegetative phase, the number of leaves, leave area, the number of branches, plant height, were all counted. The Shapiro-Wilk test was used to determine normality, while the Levene test was used to determine homogeneity. The gathered plant observation data was then analyzed using Least Significance Different (LSD) 5% to determine differences between treatments.

3 Result and Discussion

3.1 Result

3.1.1 *The acidity (pH) and C-Organic content of the CAFELM formulation*

Previous research [9] has found that the pH levels of organic fertilizers range from 10. Higher-pH organic fertilizers can be beneficial for increasing soil pH in acidic soils and improving nutrient availability, which is essential for plant growth. Nitrogen, phosphorus, and boron are all crucial elements for plant development. Nitrogen is a macronutrient necessary to promote vegetative growth in plants, particularly in roots, stems, and leaves. Insufficient nitrogen levels result in the slow development of plants with yellowish leaves, stunted growth, and small fruits that easily detach. Excess nitrogen can be identified by the appearance of unwanted young shoots. Phosphorus is a mineral that enhances root development. Stronger plant roots enable better access to water sources conducive to healthy growth. Boron serves as an element involved in cell division and stimulates the active development of various parts within the plant. The margins of the leaves wither, dry, and die, and even immature leaves become stunted, indicating boron deficiency in plants.

Aside from these elements, plants require a variety of nutrients throughout the vegetative phase, including potassium, calcium, magnesium, and others. Even though these elements are only required in trace amounts, they have an impact on plant development.

To prevent a decrease in the organic matter content of the soil over time due to mineralization breakdown, it is important to maintain an organic matter content of at least 2% through regular addition during soil preparation. Organic materials rich in carbon can improve soil fertility and provide micronutrients and growth elements that are often lacking in chemical fertilizers. Ideally, fertile soil should have more than 5% organic carbon. Therefore, considering that Lampung province in Sumatra has red-yellow podzolic soil with a c-organic concentration of less than 1% [10], it is crucial to add c-organic through either soil amendments or high-c-organic-content organic fertilizers. Previous research [9] showed that CAFELM formulation fertilizer has a c-organic content in the range of 30s, indicating its potential for enhancing both physical qualities and c-organic levels in the soil.

3.1.2 *CAFELM formulation chemical element content vs single element household waste*

According to a prior study [9], the CAFELM formulation fertilizer had a greater P value than compost obtained from domestic trash. **Figure 1** shows that the increase in P in the CAFELM fertilizer was caused by the inclusion of burned ash, which had the highest laboratory analytical findings when compared to the CAFELM formulation and other ingredients. Apart from element P, burned ash has the highest K and pH laboratory test findings when compared to the others. Single-burned ash can be utilized as an alternate supply of K and P for soil and plants, as well as to assist in raising soil acidity. However, because the C-organic and Nitrogen content of the burned ash is so low that it does not match the organic fertilizer standards, extra ingredients are required to produce the CAFELM formulation. Organic fertilizers need the inclusion of local microbe since they can control soil-borne disease while also improving soil biological characteristics [11].

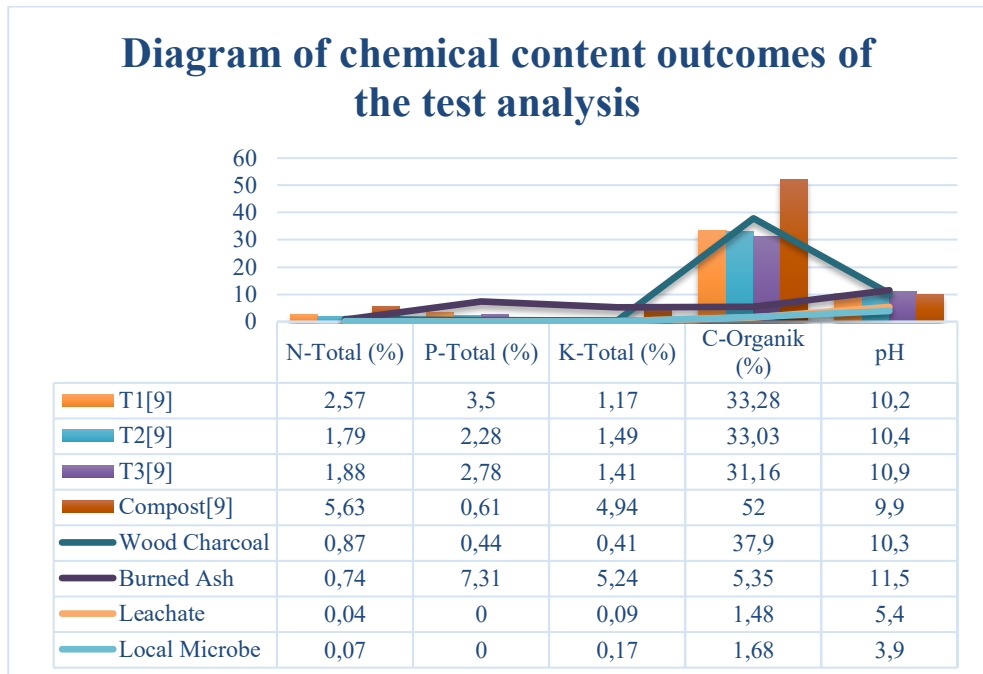


Fig. 1. Analysis of CAFELM formulation chemical element test vi Single element of household waste

3.1.3 The impact of the CAFELM formulation on Dewata 43 FI bird's eye chili growth

Table 1 shows that the best CAFELM formulation combination was treatment 1 (T1), which comprised 80 grams of compost + 3 mL of leachate + 80 grams of wood charcoal + 20 grams of burnt ash + 8 mL of banana weevil local microbe [12]. Almost every plant, including bird's eye chili pepper, requires nitrogen (N). Nitrogen is present in various vital components such as amino acids, proteins, nucleic acids, chlorophyll, and primary/secondary metabolites. Adequate nitrogen supply is crucial for optimal plant growth and resilience against diseases [13]. Insufficient nitrogen can lead to hampered root development and architecture, reduced plant biomass, and impaired photosynthesis [14]. The dry weight of plants and roots was previously obtained for data on the moist weight of plants and roots [9]. Table 1 reveals that treatment 1 (T1) had the highest plant height, whereas treatments T2 and T3 were not significantly different. This is because of the increased N concentration at T1, which aids in stem development. N shortage can cause poor plant development, and the T5 treatment, which was the control treatment, had the shortest plant height in this research. So, there is a potential that the soil used for planting is nitrogen deficient, in which case nitrogen must be added by fertilizers or N-fixing organisms to boost yield.

P has a function in enhancing root growth during the growth process; as shown in **Table 1**, the use of the T1 formulation can enhance the wet weight and dry weight of the roots. Root dry weight is often a better indicator of crop yields compared to root length or density. When nutrient-deficient soils are supplemented with chemical fertilizers, root weight typically increases exponentially. Higher nitrogen levels in the soil may lead to shorter roots but increased quadratic growth in root weight. Well-nourished roots also tend to have more root hairs compared to those growing in nutrient-poor soils. This can enhance water and nutrient absorption by providing essential plant nutrients to the roots rather than relying on inadequate sources within the soil [15].

Table 1. Data collected from plant growth observations

	T1	T2	T3	T4	T5
Plant height (cm)	38.0 ^a	36.6 ^{ab}	36.4 ^{ab}	29.6 ^{bc}	28.8 ^c
Number of branches	4 ^a	3 ^{ab}	3 ^{ab}	3 ^{ab}	3 ^{ab}
Number of leaves	58 ^a	48 ^b	42 ^{bc}	35 ^c	35 ^d
Leave area	4 ^a	3.5 ^b	3 ^{ab}	2.9 ^{bc}	2.4 ^c
Fresh weight of plant (gram)	88 ^a	83 ^{ab}	82 ^{ab}	80 ^b	71 ^c
Fresh weight of roots (gram)	9.2 ^a	8.4 ^{ab}	8.0 ^{ab}	7.5 ^{bc}	5.6 ^c
Dried weight of plant (gram)	63 ^a	50 ^{ab}	48 ^{ab}	43 ^{bc}	36 ^c
Dried weight of roots (gram)	7.5 ^a	6.8 ^a	6.4 ^a	5.9 ^{ab}	3.5 ^b

Note: Please be advised that the numbers denoted by the same letter are not significantly different at a confidence level of 95%.

The availability of N and P in the fertilizer affects the number of branches, the number of leaves, and the leaf area in the T1 to T5 treatments. This indicates that applying organic fertilizer with increased nitrogen and phosphorus content has a favorable effect on plant leaf growth, branching, and leaf width. Plant weight reflects the increase in protoplasm, this occurs due to the size and number of cells increases [16]. The growth of protoplasm takes place through metabolic events in which water, carbon dioxide and inorganic salts are converted into food reserves by the process of photosynthesis. Good metabolism can occur if good plant roots are reflected in high root weight. In addition, the application of fertilizers from organic materials given spurred the development of leaf area. The increase in leaf area means that the ability of the leaves to receive and absorb sunlight will be higher so that photosynthate and dry matter accumulation will also be higher. According to [17], that the addition of leaf area is the efficiency of each unit leaf area of carrying out photosynthesis to increase plant dry weight.

Plant biomass is a measure of the increase in cellular components, which occurs through cell enlargement and division. This growth of cellular components depends on metabolic processes involving water, carbon dioxide, and inorganic salts that are converted into food reserves through photosynthesis [18]. A well-developed root system plays a crucial role in promoting efficient metabolism as indicated by higher root biomass. Additionally, the use of organic fertilizers enhances leaf area expansion. An increase in leaf area allows for greater absorption of sunlight, leading to an increased production of photosynthate and accumulation of dry matter. The leaf area addition is a measure of the plant's ability to carry out photosynthesis and increase its dry weight per unit of leaf area [19].

The concentration of endogenous cytokinin hormones affects the branching pattern. The presence of auxin also impacts the levels of cytokinin hormone [20]. Cytokinin and auxin work together to influence tissue differentiation. Cytokinin, at certain concentrations, promote shoot growth by stimulating cell division and inhibiting root formation while facilitating new shoot production [20].

3.2 Discussion

This CAFELM fertilizer was studied in order to invite or raise public knowledge about using domestic garbage as a source of organic fertilizer. Its goal is to eliminate organic waste in the environment and to invite consumers and farmers to obtain great agricultural yields at reasonable prices. As seen in Figure 1, numerous single constituents, such as compost and

burned ash from home garbage, each have advantages and downsides. As a result, this formulation arises, with the intention of covering each other's shortcomings and strengths in order to achieve even higher growth and yields. In a previous study [9], it was discovered that the CAFELM T1 formulation fertilizer was able to increase crop yields when compared to the description of the bird's eye chili pepper variety, and it was also discovered in this study by combining the data obtained from previous studies that the results for CAFELM T1 showed good plant growth. In T2, the dose formulation that was greater than the T1 formulation did not outperform T1. This is feasible because there is a point known as the optimal threshold, and if there is an excess or deficit of the optimal threshold, the desired outcomes will not be obtained [21], as shown in T2 and T3, where the results are no better than T1.

4 Conclusion and Recommendation

4.1 Conclusion

Several conclusions may be drawn from the foregoing results and discussion:

1. A recommended blend for promoting the growth and development of Dewata 43 F1 bird's eye chili is P1, which consists of 80 grams of compost, 3 mL of leachate, 80 grams of wood charcoal, 20 grams of burned ash, and 8 mL local microbe from banana weevil.
2. The inclusion of compost and burned ash in the CAFELM fertilizer improves its phosphorus content and c-organic levels.
3. CAFELM formulas offer a cost-effective solution for reducing household waste by serving as an alternative to traditional organic fertilizers.

4.2 Recommendation

Further study to enhance this formulation is suggested as follows:

1. Additional research on the CAFELM fertilizer formulation test is required, including a thorough macro and micro nutrient test as well as a test for the microbial content present in CAFELM fertilizer.
2. If we want more consistent outcomes from this CAFELM fertilizer, we must do multi-time and multi-location experiments, as well as effect tests on numerous plants.

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