# Vetiver Waste Fertilizer As A Growth Catalyst On Mung Bean

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# VETIVER WASTE FERTILIZER AS A GROWTH CATALYST ON MUNG BEAN

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**Abstract**

Mung bean (Vigna radiata) is extensively cultivated in tropical and sub-tropical Asia and a resource of seed protein. It is also easily adapted to various environments. Fertilizer has an important role in increasing production and quality of crop cultivation. The fertilizers must meet national standards and their effectiveness must be proven. The purpose of this study is to analyse the use of vetiver waste fertilizer as growth catalyst on mung bean. This research method used completely randomized design (CRD) and descriptive qualitative method. This research was conducted by observing three types of sample, namely the mung bean without fertilizer, half-decomposed fertilizer, and decomposed vetiver waste fertilizer. The sample of mung bean without fertilizer was used as a reference for standardization of mung bean growth. In addition, this study discusses the difference of using vetiver waste fertilizer on plant physical characteristics. The results showed that from the samples taken, mung bean with half-decomposed fertilizer were more stunted than the other two samples. Meanwhile, from the calculation using CRD is obtained that value F calculate < F tables. It means that even though special treatment is given, it does not have significant effect on the Mung bean growth due to it will continue to grow even if there is no fertilizer application. However, plants with decomposed vetiver waste fertilizer have rapid growth with stronger plant physical characteristics. It is indicated by more water contained in the mung bean with decomposed vetiver waste fertilizer. From these results, it is shown that the use of vetiver waste fertilizer is effective as catalyst in the growth of mung bean. This research is expected to be a reference for future research. It can be concluded that vetiver waste fertilizer can stimulate the growth of mung bean and potentially effective for the development of other plants.

Keywords: Agricultural, Catalyst, Mung bean, Vetiver waste fertilizer.

## 1. Introduction

Fertilizer has an important role in increasing the production and quality of crop cultivation. To meet quality standards and ensure the effectiveness of fertilizers, the fertilizers produced must be tested. Fertilizers can be classified into several categories based on origin, chemical, and physical characteristics. According to its origin, fertilizers can be divided into natural and artificial fertilizers. Based on the chemicals, it can be classified into organic and inorganic. From its physical characteristics, it can be divided into solid and liquid fertilizer. Generally, fertilizers that are often used by farmers are urea, ZA (Zwavelzure Amonim), SP36 (Super Phospate), KCI (Potassium Chloride), ZK (Zwalvera Kali), NPK PHONSKA (Nitrogen Phospate Potassium), and Dolomite (Lime Carbonate) [1, 2]. However, the use of urea is minimized and started to be replaced by organic fertilizers. It is because organic fertilizers can affect the physical characteristics and chemical properties of the soil, such as the stability of aggregates and the ability to hold groundwater so that it can maintain water needs for plants.

The increase in soil aggregate stability by organic fertilizers is caused by the presence of gum polysaccharides obtained from soil bacteria, the presence of hyphae and fungal growth from actinomycetes and soil particles [3, 4]. Besides, organic fertilizers also play a role in increasing physical, chemical, and biological fertility of the soil so that it can improve the efficiency of inorganic fertilizers such as urea. The quality and composition of organic fertilizers varies depending on the compost base material and the manufacturing process. The use of legume plants in the form of alley cropping and cover crops as well as in-situ organic matter needs to be intensified to support the use of non-commercial organic fertilizers and restore soil fertility [5].

Vetiver grass are plants that require constant light and are able to grow on land that has a very wide pH range from 3.5 (very acidic) to 11.5 (very alkaline). In order to produce high oil content and quality, vetiver should be planted in sandy soil with an altitude of more than 750 m ASL [6]. Previous research on vetiver plants showed that this plant functions as soil conservation because it can reduce the level of soil erosion and heavy metals contamination such as Zn, Cu, and Fe [7, 8]. In addition, other studies also show that vetiver plants can also be used as compost and raw material for paper and handycraft industries, while the roots are used for woven crafts and insect repellent [9]. As for further research, it is found that this plant has an economic value that can contribute to the country's foreign exchange products from its oil, namely vetiver oil. Essential oil produced from the roots of vetiver plant is widely used as a binder in perfume production because of its strong fixing power as well as raw material for cosmetics and medicines [10].

Meanwhile, a research conducted by Emenecker and Strader related to plant growth and development showed the influence of plant hormones. Plant hormones play a role in regulating the growth, development, and response of plants to biotic and abiotic stress. The types of plant hormones that play a comprehensive role in plant growth and development (especially in the stages of root lengthening and seed germination) are Auxin and Abscisic Acid (ABA) [11]. Moreover, the research on growth inhibition in plants shows that one of the things that inhibits plant growth and development is the content of lead (Pb) in the soil. For plant types such as mung bean, the inhibiting factors for seed development and growth are influenced by saline oil, so that Plant Growth Promoting Rhizobacteria (PGPR) and Silicon (Si) are needed to reduce the effects of salinity stress [12]. The factors that affect the quality of mung beans are Relative Humidity (RH), light, and Plasma-Activated Water (PAW), this is because the higher the RH value indicates higher water absorption and conductivity, compared to the lower RH value. Induction of light helps increase plant water transport and antioxidant production in mung bean growth. Also, PAW affects the growth of mung beans because it has active components in PAW, such as NO-2 -, NO-3, and H2O2 [13, 14].

## 2. Research Method

This study used the CRD method with the following formula:

Fully Randomized Design (FRD) [15]:-

$$t(n-1) \geq 15 \quad (1)$$

$$FK: \frac{y_{...}^2}{nxt} \quad (2)$$

$$JKT : \sum_{i=1}^{t} \sum_{j=1}^{n} Yij^2 - FK \quad (3)$$

$$JKP : \sum_{i=1}^{t} \frac{Yi^2}{n} - FK \quad (4)$$

$$JKG : JKT - JKP \quad (5)$$

$$KTP : \frac{JKP}{t-1} \quad (6)$$

$$KTG : \frac{JKG}{t(n-1)} \quad (7)$$

$$F\ Count : \frac{KTP}{KTG} \quad (8)$$

Therefore, the various effects of treatment on green bean plants are the following (Table 1):

**Table 1. The various effects of treatment on green bean plants**

| Source of diversity (S.K) | Degree of freedom (d.b) | Sum of squares (J.k) | Middle square (K.T) | F Count | F table | |
|---|---|---|---|---|---|---|
| | | | | | 0.05 | 0.01 |
| **Treatment** | *t*-1 | JKP | KTP | | | |
| **Attempt Error** | *t*(*n*-1) | JKG | KTG | | | |
| **Total** | *tn*-1 | JKT | | | | |

where: *t*: Much Treatment, *n*: Many Repetitions, *i*: Number of Treatments, *j*: Number of Observations, FK: Correction Factors, JKT: Total Sum of Squares, JKP: Sum of Squares between Treatments, JKG: Sum of the Squares of the Error, KTP: Middle Square Treatment, KTG: Middle Square Error, F Count: F Value of Analysis Calculation Results

This study used a completely randomized design (CRD) and descriptive qualitative method. CRD is the simplest design, suitable for laboratory research, greenhouses or experiments that have homogeneous experimental materials. The advantage of this method is that the experimental design plan is relatively easy, statistical analysis is very simple, and it is flexible in the number of treatments or repetitions [15]. CRD is applied in this study because the material is relatively homogeneous, namely using cotton as a growing medium and a limited number of treatments. We conducted direct observations on the growth of mung bean stem for five days indoor. Mung bean seeds were placed in three Petri dishes with different treatments. The first treatment is conducted without using vetiver waste fertilizer. The second treatment used half-decomposed vetiver waste fertilizer. The third treatment used vetiver waste fertilizer that had been decomposed. Planting mung bean seeds using cotton media with a weight of 2 grams in each petri dish. For the second and third treatment using fertilizer weighing 1 gram measured using Nankai ART: 177-21 scales. The fertilizer is grinded using a Miyako blender (3 in 1) BL - 102 PL, with room temperature ranging from 19 to 20°C and humidity ranging from 62 to 65%. Stem measurements were carried out using the Microscope Micrometer Calibration Ruler.

## 3. Results and Discussion

The use of fertilizer is one of the most important factors to increase plant productivity [16]. Vetiver waste is used as an organic fertilizer for plants. It is shown by the results of this study. In the first treatment, which was carried out without applying vetiver waste fertilizer, the growth of mung beans was normal. It is because the main food source is in the seeds (endosperm) and can be obtained through water. The second and third treatments with vetiver waste fertilizer showed different results. The second treatment used half-decomposed vetiver waste fertilizer showed the growth of mung bean seeds was inhibited. The third treatment with decomposed vetiver waste fertilizer showed the fastest growth.

The stem length in the first and second treatment was 40 and 18 mm. Meanwhile, the third treatment was 45 mm. Observation on stem water content showed that the third treatment had more water content than the first and second treatments. However, the third treatment had a faster leaf growth than the first and second treatments. In addition, observations on the roots showed that the roots of mung beans in the third treatment were stronger than the first and second treatments.

This study captures that fertilization using vetiver waste can increase plant growth [17, 18]. Nutrition at the growth stage is very important for mung bean to improve the plant performance in terms of growth, yield, and quality of mung bean (Krishnaveni et al. 2004). Seeds still require low amounts of nutrients because they are able to absorb their needs from the cotyledons.

Factors that influence the growth of mung beans are light intensity, nutrients, water, humidity, and temperature [19]. Nutrients is obtained through fertilization. Table 2 shows the growth data of mung beans without using vetiver waste fertilizer.

The first day of planting without fertilizer did not show any changes in plant length with a temperature of 19.7°C and humidity of 65%. On the second day, there was a change in temperature which increased to 20.1°C but there was no change in humidity, which was still 65%. Changes occurred in plant length, where the first day the plant length was 0 mm but on the second day the plant length became 6 mm. On the third day, the room temperature and humidity decreased to 19.2°C and 62%. However, the growth in plants continued to increase. The length of the plant which was previously only 6 mm increased to 15 mm. On the fourth day the temperature remained stable, namely 19.2°C, with a humidity that increased by 1%. The length of the plant was enlarged by 12 mm, where the plant size was 27 mm.

On the fifth day, the temperature and humidity increased to 20.1°C and 64%. On the fifth day, the length of the plant increased to 40 mm.

From the table 2, based on the results of mung bean growth showed that the growth of mung bean plants without fertilizer can grow normally. Meanwhile, the plant growth without fertilizers was better than the half-decomposed fertilizers. In addition, it differs only a few millimetres in size from plants that use decomposed fertilizers. With this comparison, it can be a consideration for the farmers to use vetiver waste fertilizers (6 months of decomposition). From the data shown in Table 2, it can be different from the results of other studies or even in its application. It is because several factors such as light intensity, temperature, and water availability in plants.

**Table 2. Sample growth data without fertilizer.**

| Days to | Temperature | Humidity | Plant Length |
|---|---|---|---|
| **Day 1** | 19.7°C | 65% | 0 mm |
| **Day 2** | 20.1 °C | 65% | 6 mm |
| **Day 3** | 19.2 °C | 62% | 15 mm |
| **Day 4** | 19.2 °C | 63 % | 27 mm |
| **Day 5** | 20.1 °C | 64% | 40 mm |

In this study, in general the three plants with different treatments were still able to grow. It is because these plants are treated indoors with stable temperatures and humidity. Suitable environmental conditions are always needed for plants to grow. However, the environmental conditions in which the plants are located are always changing. If the plant can still grow, the environmental changes that occur are still within the tolerance limit of the plant. However, plants often experience extreme environmental changes that can cause decreased productivity and even death. It shows that each plant has a limiting factor and tolerance to the environment [20, 21].

This research was conducted with the same light treatment. It causes plant growth to remain normal without being affected by lighting constraints. Because plants are placed without direct sunlight, they grow quickly and avoid etiolation. Etiolation is plants that are not exposed to light, so auxin stimulates the elongation of cells so that they grow longer, but are less healthy, thin, and pale. On the other hand, a lot of auxin light is damaged so that plant growth is inhibited. The broken auxin that is dispersed to the darker side of the plant is caused by a lack of light. The growth of the stems decreases and becomes shorter. However, the plants are sturdier, the leaves are fully grown, and greener. The process of photosynthesis in plants requires light for the formation of chlorophyll. Contrariwise, chlorophyll is damaged if the light intensity is too high [22]. The role of fertilizers in the effectiveness of plant fertility is quite significant. The addition of fertilizers plays a role in improving the physical characteristics of the soil by reducing density and binding water for plant growth needs [23]. In this study, vetiver waste fertilizers were classified into two types, namely half-decomposed (decomposed for 3 months) and decomposed fertilizers. We analysed a comparative impact of the two fertilizers. The following is a display of half-decomposed fertilizers (see Fig. 1).

The positive effect of fertilizers is to stimulate the growth of sprouts [24]. In this study, we analysed the growth process of mung bean with half-decomposed vetiver waste fertilizer. Organic fertilizers have a significant impact to increase growth (See Table 3).

**Fig. 1. Half-decomposed vetiver waste fertilizer.**

**Table 3. Sample growth data with half-decomposed.**

| Days | Temperature | Humidity | Plant Length |
|---|---|---|---|
| **Day 1** | 19.7 ˚C | 65% | 0 mm |
| **Day 2** | 20.1 ˚C | 65% | 3 mm |
| **Day 3** | 19.2 ˚C | 62% | 11 mm |
| **Day 4** | 19.2 ˚C | 63 % | 13 mm |
| **Day 5** | 20.1 ˚C | 64% | 18 mm |

In the first day, there was no growth occurred in the temperature and humidity of 19.7˚C and 65%. In the second day, a growth of 3 mm occurred in the temperature of 20.1˚C and humidity of 65%. In the third day, the growth continued to increase to 11 mm. The temperature and humidity were 19.2˚C and 62%. In the fourth day, the length reached 13 mm. Therefore, the temperature and humidity in the fourth day were 19.2˚C and 63%. After five days of observing mung beans with half-decomposed vetiver waste fertilizer, the final result showed 18 mm in length with average growth of 9 mm. The growth was in the average temperature of 19.6˚C and humidity of 63.8%.

Compared to the growth of mung beans without using fertilizer and decomposed fertilizer, the mung beans growth with half-decomposed fertilizer is the slowest grow. It happened because half-decomposed organic fertilizer did not work optimally. Fertilizer that is intended to increase the crop yields shows the opposite because of the nutrients in half-decomposed organic fertilizer [25].

The addition of fertilizer such as bio-fertilizer can affect plant growth [26]. In addition, we conducted this research by observing the growth of mung bean by using fertilizer. The test was conducted within five days by measuring the air temperature, humidity, and the length of the plant. In this research, we used the Air Quality Monitor to measure the temperature and humidity. The results of the test are shown in Table 4.

The test was conducted in five days and consecutively checked every 10.23 AM to see the growth of the mung beans, temperature, and humidity. On the first day, the plant length was 0 mm with air temperature of 19.7˚C and humidity of 65%. The second day, the length of the plant grew by 7 mm while humidity remains the same as the first day. However, the temperature changed and increased by 0.4˚C, which made it changed from 19.7˚C to 20.1˚C. On the third day, the plant length grew by 16 mm, which made it became 23 mm. Nevertheless, the temperature and humidity had decreased significantly by 0.9˚C and 3% which made it became 19.2˚C and 62%. On the fourth day, the length of the plant grew by 8 mm, which made it became 31 mm with the same temperature as the third day. However, the humidity increased by 1%, which made it became 63%. On the last day, the final plant length grew by 14 mm, which made it became 45 mm. The air temperature on the last day increased significantly by 0.9˚C and made it changed to 20.1˚C that was same with the temperature on the second day. The humidity was increased by 1%, which made it became 64%. As seen on the Table 4, the usage of vetiver waste fertilizer shows a significant increased growth in the mung bean than the half-decomposed vetiver waste fertilizer and without using fertilizer. The mung bean sprout can grow up to 45 mm in five days with the help of this bio-fertilizer. It is in-line with the results of Mishra et al. that stated bio-fertilizers is an essential supporting component that play vital role in plant growth [27].

**Table 4. The results of mung bean growth with fertilizer.**

| Day | Temperature | Humidity | Plant Length |
|---|---|---|---|
| **Day 1** | 19.7˚C | 65% | 0 mm |
| **Day 2** | 20.1˚C | 65% | 7 mm |
| **Day 3** | 19.2˚C | 62% | 23 mm |
| **Day 4** | 19.2˚C | 63% | 31 mm |
| **Day 5** | 20.1˚C | 64% | 45 mm |

Mung beans contain protein isolate (MuPI) with a concentration of 8S globulin (80%), which shows homology (68%) and structural b-conglycinin. This content provides benefits to ward off free radicals and fight cancer cell lines [28, 29]. Meanwhile, during the mung bean sprouts growth, its seeds utilize energy sources obtained from water and food reserves stored in the endosperm to produce a higher succinic acid content [30]. Then, without using fertilizer when the mung bean seeds grow into sprouts, the external factor that affects their growth is water. The more water absorbed by the roots, the faster growth of mung bean stem. It can also affect the size of the stem. Stem that grows without using vetiver waste fertilizer and using vetiver waste fertilizer have different water content. It is due to the texture of fertilizers that have decomposed completely and half-decomposed have different textures and shapes. Fertilizer that has decomposed completely has a smoother texture. Therefore, stem without vetiver waste fertilizer have sufficient water content in the stem. Meanwhile, stem with vetiver waste fertilizers that have undergone a decomposition process have more water content in the stems. On the other hand, stem that use vetiver waste that has not gone through a complete decomposition process to become fertilizer have less water content in the stems (Fig. 2). It affects the quality and size growth of mung bean stem.

Vetiver waste fertilizer that has undergone a decomposition process helps the stem to maintain moisture and water availability. Also, it reduces the duration of evaporation of water into the air due to sunlight. On the other hand, vetiver waste that has not undergone a perfect decomposition process as fertilizer inhibits the absorption of water needed by the stem. It is because the vetiver waste still has the property of absorbing water and has a salt content. Therefore, the water that should be absorbed by the stem is locked in the half-decomposed vetiver waste fertilizer [31, 32].

**(a). Without fertilizer** **(b). Half-decomposed fertilizer** **(c) Vetiver waste fertilizer.**

**Fig. 2. Comparison of stems of mung bean stem.**

### Complete randomized design of mung bean plants

This study used a completely randomized design method to determine the significance of the effect of using vetiver fertilizers on the growth of green beans, with the following calculations:

Fully Randomized Design (FRD)

$$4(n-1) \geq 15$$

$$n = \frac{11}{4} = 2.75 = 3$$

So at least a lot of repetition of green bean growth observations that must be done is as many as 3 experiments

The value of the Correction Factor (FK) carried out is as follows:

$$FK: \frac{y\ ...^2}{nxt} = \frac{(137)^2}{12} = 1564.083$$

Meanwhile, to find out the Sum of Squares of Errors (JKG), first, you must calculate the value of the Total Squares (JKT) and the Sum of Squares between Treatments (JKP) as follows:

$$\begin{aligned} JKT &= (0)^2 + (15.5)^2 + (0)^2 + (0)^2 + (38)^2 + (10{,}5)^2 + (3)^2 + (15)^2 + (7)^2 \\ &\quad + (0)^2 + (35.5)^2 + (11.5)^2 - FK \\ &= 3470 - 1564.083 \\ &= 1905.917 \\ JKP &= (45)^2 + (26)^2 + (38.5)^2 + (27.5)^2 - FK \\ &= \frac{4939.5}{3} - 1564.083 \\ &= 82.417 \\ JKG &= 1905.917 - 82.417 \\ &= 1823.5 \end{aligned}$$

Then the Middle Square (KT) calculation stage is carried out and consists of two types, namely the Treatment Middle Square (KTP) and the Error Middle Square (KTG) as follows:

*Middle Square:*

$$KTP = \frac{82.413}{3} = 27.472$$

$$KTG = \frac{1823.5}{8} = 227.9375$$

The F value of the Analysis Calculation Results is as follows:

$$F\ Count : \frac{KTP}{KTG} = \frac{27.472}{227.9375} = 0.1205$$

Therefore, the analysis of the various treatment effects on the growth of green bean plants obtained the value of F count <F table namely 0.1205 <4.07 and 7.59. Thus, it was found that different treatments for seeds such as fertilizer application did not significantly affect the growth of mung bean plants. This is because there are other factors that affect plant growth namely water, air, soil, humidity, light, and maintenance.

## 4. Conclusion

From the results of this study, it can be concluded that the use of vetiver waste fertilizer on mung bean plants is considered effective. It is supported by the results of the differences between plants that use half-decomposed and decomposed vetiver waste fertilizer. Based on the reference for plants that do not use fertilizers, the difference in stem length is 5 mm and 27 mm, with an average temperature and humidity of 19.6°C and 63.8%. The physical condition of plants that use vetiver waste fertilizer has more nutrient availability so that growth can be faster with maximum nutrient absorption. Also, this study also identified that not all plants that were given special treatment (applying fertilizers) would experience significant changes in the plant's growth.

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