The effect of organic fertilizer chicken on the growth of papaya plants in palm oil plantation: a case study of Naga Sari Village, Mestong, Muaro Jambi District

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Abstract. The use of chemical fertilizers in agriculture has caused soil degradation and is harmful to human health. Organic fertilizers made from animal waste have received worldwide attention because they are not detrimental to health or the environment. This paper describes the effect of using organic fertilizers from chicken manure on the growth of papaya plants. A completely randomized design was used in this study using two factors and three repetitions; the variations of the fertilizers given were 0, 50, 100, 150, and 200 g. This study informed that organic chicken manure had a significant effect on the growth of oil palm and papaya plants. The best growth is oil palm and papaya plants given 200 g of organic fertilizer from chicken manure.

1. Introduction

Soil contamination caused by agricultural chemical fertilizers has been widely reported around the world. The use of chemical fertilizers has resulted in a decrease in soil quality which causes the soil to be contaminated by heavy metals and other hazardous chemicals [1]. The content of chemical fertilizers such as sodium and potassium reduces soil quality [2]. The use of chemical fertilizers also affects the quality of fruit, plants and the environment [3]. The chemical content in chemical fertilizers is reported to have caused an increase in health costs in China from 1990 to 2012 [4].

One of the efforts to prevent pollution and maintain health is to use organic fertilizers. Various studies have reported the potential of organic materials to be converted into fertilizers. One of the potential materials used as organic fertilizer is animal (Chicken) manure [5]. Chicken manure was chosen because it is easier to obtain and has a complete content as organic fertilizer [6]. Chicken manure contains high N, P, K and has lower P and K content than cow and goat manure. Chicken manure is also beneficial for fertilizer on seasonal crops such as papaya [7].

The use of chicken manure as fertilizer for papaya plants is highly recommended, but animal manure is still limited to a monoculture planting pattern. There have not been any studies that reported the effect of using animal manure on the intercropping pattern with oil palms. This planting technique is intended to minimize environmental damage and the minimal benefits of oil palm plantations for the surrounding community. This paper will discuss the effect of using fertilizer from chicken manure and the intercropping pattern of papaya and oil palm on the development and diameter of the resulting papaya fruit.
2. Methodology

2.1. Materials
The research was conducted at the People’s Garden in Naga Sari Village, Mestong District, Muaro Jambi Regency. The altitude is about 30 masl, with a climate type C2 (Oldeman) and red-yellow podsolic soil type. This research was started from March to August 2020. The plant materials used were 6-month-old oil palm (TBM 1) Dumpy variety and California and Pomegranate red papaya seeds, chicken manure organic fertilizer, NPK Mutiara, agricultural tools, namely tractors, hoes, machetes, plastic hoses, tape measure, raffia rope, cutting scissors, sprayer and others.

2.2. Method
The completely randomized design method was used in this study. The study was arranged in 2 factorials with three repetitions. The first factor that was tried was the variety (V)

\[ V1 = \text{California} \]
\[ V2 = \text{Pomegranate red} \]

The second factor that was tried was organic chicken manure (P)

\[ P0 = \text{without applying fertilizer} \]
\[ P1 = 50 \text{ g} \]
\[ P2 = 100 \text{ g} \]
\[ P3 = 150 \text{ g} \]
\[ P4 = 200 \text{ g} \]

Thus, there are ten treatment combinations, and each treatment combination is repeated four times so that there are 40 experimental units in total. Each experimental unit contained three papaya plants.

The data obtained were analyzed statistically by variance; the analysis model used was:

\[ Y_{ijk} = \mu + V_i + P_j + (VP)_{ij} + \sum_{ijk} \]

Observations were made on the growth of young oil palms, including stem circumference, plant height, number of leaves, leaf length, leaf width, number of leaflets and canopy area, which were observed descriptively. Whereas for papaya intercropping, growth components were observed, analysis of papaya plant income and papaya fruit production including plant height, number of leaves, fruit length, papaya fruit diameter and papaya fruit production. To determine the effect of treatment on experimental parameters, analysis of variance was carried out, followed by an analysis of the mean difference using the least significant difference at a 5% confidence interval, initial nutrient analysis and final nutrient analysis.

3. Result and discussion

3.1 Oil palm plant growth
The growth of oil palm and California varieties of papaya and pomegranate as intercrops during the immature plants did not show competition during the plant growth period. It is shown by the data in (Table 1). Plant height, number of leaves, and diameter of oil palms planted in poly-culture with papaya as an intercrop did not show further growth from oil palm plants planted in monoculture. Thus it can be neglected that papaya plants can be planted perceptually in oil palm plantations. Oil palm plants can also be planted in an intercropping system with corn plants without affecting the growth of oil palm plants in an immature plants phase [8].

Table 1. Plant height (cm) of oil palm aged 10 to 20 MST in chicken manure and intercropping on papaya plants of different varieties.

| Varieties | Chicken manure | Average |
|-----------|----------------|---------|
|           | 0 g            | 50 g    | 100 g   | 150 g   | 200 g   |         |
| 10 MST    | 120.25 a       | 148.75 bc | 146.25 b | 168.00 c | 150.50 d | 146.75  |
| Varieties          | Chicken manure | Average |
|-------------------|----------------|---------|
|                   | 0 g            | 50 g    | 100 g  | 150 g  | 200 g  |        |
| Average           |                |         |        |        |        |         |
| Pomegranate       |                |         |        |        |        |         |
| red               |                |         |        |        |        |         |
|                   | a              | b       | a      | b      |        |         |
|                   | 138.75 b       | 135.00 a| 153.75 c| 155.00 c| 140.00 c| 144.50 |
|                   | b              | a       | a      | b      |        |         |
|                   | 129.50 a       | 141.88 b| 150 d  | 161.5 e| 145.25 c|        |
| Varietas          |                |         |        |        |        |         |
| 12 MST            |                |         |        |        |        |         |
| California        |                |         |        |        |        |         |
|                   | 132.50 a       | 158.75 a| 162.50 a| 170.00 b| 156.25 a| 156.00 a|
|                   | a              | b       | c      | d      |        |         |
|                   | 158.75 b       | 158.75 a| 164.50 a| 166.25 a| 153.75 a| 160.40 b|
|                   | b              | b       | c      | a      |        |         |
|                   | 145.63 a       | 158.75 c| 163.50 d| 168.13 e| 155.00 b|        |
| Varietas          |                |         |        |        |        |         |
| 14 MST            |                |         |        |        |        |         |
| California        |                |         |        |        |        |         |
|                   | 162.00 a       | 167.50 b| 170.00 b| 175.00 a| 150.00 a| 164.90 b|
|                   | b              | c       | c      | d      | a      |         |
|                   | 162.50 a       | 146.25 a| 166.25 a| 173.75 a| 162.00 b| 162.15 a|
|                   | b              | a       | c      | d      | b      |         |
|                   | 162.25 b       | 156.88 a| 168.13 c| 174.38 d| 156.00 a|        |
| Varietas          |                |         |        |        |        |         |
| 16 MST            |                |         |        |        |        |         |
| California        |                |         |        |        |        |         |
|                   | 171.75 a       | 177.00 b| 178.25 a| 186.25 a| 156.75 a| 174.00 a|
|                   | b              | c       | c      | d      | a      |         |
|                   | 181.25 b       | 173.75 a| 182.50 b| 186.25 a| 173.75 b| 179.50 b|
|                   | b              | a       | b      | c      | a      |         |
|                   | 176.50 b       | 175.38 b| 180.38 c| 186.25 d| 165.25 a|        |
| Varietas          |                |         |        |        |        |         |
| 18 MST            |                |         |        |        |        |         |
| California        |                |         |        |        |        |         |
|                   | 178.00 a       | 186.25 b| 190.25 a| 192.50 a| 170.00 a| 183.40 a|
|                   | b              | c       | d      | d      | a      |         |
|                   | 183.75 b       | 181.25 a| 188.75 a| 197.00 b| 177.50 b| 185.65 b|
|                   | b              | b       | c      | d      | a      |         |
|                   | 180.88 b       | 183.75 c| 189.5 d| 194.75 e| 173.75 a|        |

3
Varieties

| Chicken manure | Average |
|----------------|---------|
| 0 g            |         |
| 50 g           |         |
| 100 g          |         |
| 150 g          |         |
| 200 g          |         |

Varietas

| Chicken manure | Average |
|----------------|---------|
| 0 g            |         |
| 50 g           |         |
| 100 g          |         |
| 150 g          |         |
| 200 g          |         |

20 MST

| Variety       | 0 g         | 50 g         | 100 g        | 150 g        | 200 g        |
|---------------|-------------|--------------|--------------|--------------|--------------|
| California    | 182.50 a    | 192.50 b     | 196.75 a     | 197.50 a     | 178.75 a     |
| Pomegranate   | 190.00 b    | 186.25 a     | 192.00 b     | 208.75 b     | 183.75 b     |

Average: 186.25 b 189.38 c 194.38 d 203.13 e 181.25 a

3.2. Papaya plant growth

Plant height, plant diameter, and the number of papaya leaves experienced a significant increase in the provision of 150 g Chicken manure/plant for all varieties (Table 2-4). This vegetative growth response proves that it is necessary to add nutrients through fertilizing chicken manure to increase the availability of low nutrients in the soil in areas under palm oil stands (IMMATURE PLANTS) to increase the growth of papaya plants. Recent research also informs that fertilizers play an essential role in regulating biophysical and biochemical functions in plants, the microbes contained in chicken manure can function to increase the elements available to plants [9]. The results of the analysis of soil nutrients (Table 5) show that by giving Chicken manure to the papaya growing media, there is an increase in nutrients N, P and K. These three nutrients are essential for plant growth so that if these nutrients are deficient, they can interfere with plant growth.

Variety analysis showed an interaction of pomegranate papaya varieties with 150 g of Chicken manure significantly affected all vegetative growth parameters at 18 MST and 20 MST. The addition of Chicken manure at a dose of 200 g does not show a significant difference to the provision of Chicken manure 150 g. It shows that although the role of organic fertilizers is vital in supporting plant growth, the excessive provision also harms vegetative growth, as seen in the provision of Chicken manure 200 g, in this case with the addition of the dose to 200 g/plant showed a decrease in growth, although not significant.

Nutrient N plays a vital role in supporting plant growth in the vegetative growth phase. The availability of very high N in the soil is sufficient to support papaya vegetative growth. P elements play an essential role in increasing the work of chloroplasts as absorbers of sunlight in photosynthesis. In addition, P elements also play an active role in transferring energy in cells. The K+ ion facilitates several plant physiological responses, including opening and closing leaf stomata and membrane regulation [10]. Potassium is an activator of many enzymes required to form starch and protein [11]. The opening and closing of the stomata are controlled by K+ through turgor pressure [12]. The osmotic pressure generated by the accumulation of K+ in the cells is also used to encourage leaf expansion [13]. Thus, the physiological process is optimal. The low nutrient content in the soil causes the photosynthetic activity to below, and assimilates are not optimal to support plant growth as experienced by low plant growth without giving Chicken manure.

Table 2. Plant height (cm) of papaya aged 10 to 20 MST in Chicken manure and intercropping on oil palm plants.

| Varieties      | Chicken manure | Average |
|----------------|----------------|---------|
| 0 g            | 14.00          | 16.10   |
| 50 g           |                |         |
| 100 g          |                |         |
| 150 g          |                |         |
| 200 g          |                |         |
| 10 MST California |                |         |
| 14.00          | 16.75          | 17.00   | 17.75 | 15.00 | 16.10 |
| Variety          | Chicken manure | Average |
|------------------|----------------|---------|
|                  | 0 g  | 50 g  | 100 g | 150 g | 200 g |         |
| Pomegranate red  |      |       |       |       |       | 16.00   |
| 12 MST California| 15.25| 18.25 | 17.00 | 15.50 | 14.00 | 16.00   |
| Pomegranate red  | 17.00| 15.50 | 16.00 | 16.00 | 16.00 | 16.10   |
| Average          | 16.13| 16.88 | 15.75 | 15.75 | 15.00 |         |
| Variety          | Chicken manure | Average |
|                  | 0 g  | 50 g  | 100 g | 150 g | 200 g |         |
| Pomegranate red  |      |       |       |       |       | 18.20   |
| 14 MST California| 17.50| 20.00 | 18.75 | 18.25 | 16.50 | 18.05   |
| Pomegranate red  | 18.25| 17.50 | 17.50 | 19.50 | 17.50 |         |
| Average          | 17.88| 18.75 | 18.13 | 18.88 | 17.00 |         |
| Variety          | Chicken manure | Average |
|                  | 0 g  | 50 g  | 100 g | 150 g | 200 g |         |
| Pomegranate red  |      |       |       |       |       | 19.85   |
| 16 MST California| 19.75| 21.25 | 20.50 | 19.75 | 18.00 |         |
| Pomegranate red  | 19.50| 19.00 | 19.50 | 22.00 | 19.00 |         |
| Average          | 19.63| 20.13 | 20.00 | 20.88 | 18.50 |         |
| Variety          | Chicken manure | Average |
|                  | 0 g  | 50 g  | 100 g | 150 g | 200 g |         |
| Pomegranate red  |      |       |       |       |       | 21.95   |
| 18 MST California| 21.75 a| 22.75 a| 21.75 a| 23.25 a| 20.25 a|         |
| Pomegranate red  | 19.25 a| 21.00 a| 21.00 a| 25.00 a| 20.50 a|         |
| Average          | 20.50 a| 21.88 ab| 21.38 ab| 24.13 b| 20.38 a|         |
| Variety          | Chicken manure | Average |
|                  | 0 g  | 50 g  | 100 g | 150 g | 200 g |         |
| Pomegranate red  |      |       |       |       |       | 21.80   |
| 20 MST California| 21.50 a| 21.50 a| 21.50 a| 22.75 a| 21.75 a|         |
| Pomegranate red  | 21.00 a| 21.00 a| 22.00 a| 27.50 b| 22.25 a|         |
| Average          | 21.50 a| 21.50 a| 21.50 a| 22.75 a| 22.75 a|         |
Table 3. Plant diameter (cm) of papaya aged 10 to 20 MST in Chicken manure and intercropping on oil palm plants.

| Varietas    | Chicken manure | Average |
|-------------|----------------|---------|
|             | 0 g            | 50 g    | 100 g | 150 g | 200 g |
| California  | 15.50          | 16.50   | 17.75 | 16.25 | 16.00 | 16.40 |
| Pomegranate | 16.25          | 16.50   | 16.25 | 16.75 | 15.00 | 16.15 |
| Average     | 15.88          | 16.50   | 17.38 | 16.50 | 16.13 |        |
| 12 MST      | 21.75          | 21.75   | 21.00 | 18.75 | 19.75 | 20.60 |
| California  | 19.75          | 19.25   | 19.00 | 19.00 | 19.00 | 19.20 |
| Pomegranate | 20.75          | 20.50   | 20.00 | 18.88 | 19.38 |        |
| Average     | 20.00          | 22.25   | 21.88 | 22.38 | 20.88 |        |
| 14 MST      | 23.00          | 23.50   | 22.50 | 22.50 | 21.25 | 22.55 |
| California  | 21.00          | 21.00   | 21.25 | 22.25 | 20.50 | 21.20 |
| Pomegranate | 22.00          | 22.25   | 21.88 | 22.38 | 20.88 |        |
| Average     | 22.00          | 22.50   | 22.50 | 22.88 |        |        |
| 16 MST      | 25.25          | 26.25   | 24.75 | 26.25 | 23.75 | 25.25 b|
| California  | 22.75          | 22.50   | 23.50 | 24.75 | 22.00 | 23.10 a|
| Pomegranate | 24.00          | 24.38   | 24.13 | 25.50 | 22.88 |        |
| Average     | 24.00          | 24.38   | 24.13 | 25.50 | 22.88 |        |
| Varietas | Chicken manure | Average |
|----------|----------------|---------|
| 18 MST California Pomegranate red | 27.00 a 27.25 a 27.75 a 26.75 a 27.75 a | 27.30 |
| | a a a a a | |
| | 24.50 a 24.25 a 26.00 a 28.75 a 23.75 b | 25.45 |
| | a a ab b a | |
| Average | 26.00 25.75 26.38 28.25 25.75 | |
| Varietas | Chicken manure | Average |
|----------|----------------|---------|
| 20 MST California Pomegranate red | 30.25 b 30.50 b 29.75 a 31.25 a 28.25 a | 30.00 b |
| | a a a a a | |
| | 26.00 a 26.25 a 28.50 a 32.25 a 26.50 a | 27.90 a |
| | a a a a b a | |
| Average | 28.13 a 28.38 a 29.13 ab 31.75 b 27.38 a | |

Note: numbers followed by different letters in the same row and column and the time of observation that is significantly different according to Duncan's test at the 5% level

Table 4. The number of leaves (cm) of papaya aged 10 to 20 MST in Chicken manure and intercropping on oil palm plants.

| Varietas | Chicken manure | Average |
|----------|----------------|---------|
| 10 MST California Pomegranate red | 19.00 18.75 18.00 16.50 16.00 | 17.65 |
| | 16.50 16.25 16.75 16.50 16.25 | 16.45 |
| Average | 17.75 16.25 17.38 16.50 16.25 | |
| Varietas | Chicken manure | Average |
|----------|----------------|---------|
| 12 MST California Pomegranate red | 21.75 21.75 21.00 18.75 19.75 | 26.60 |
| | 19.75 19.25 19.00 19.00 19.00 | 19.20 |
| Average | 20.75 20.50 20.00 18.88 19.38 | |
| Varietas | Chicken manure | Average |
|----------|----------------|---------|
| 14 MST California Pomegranate red | 23.00 23.50 22.50 22.50 21.25 | 22.55 |
| | 21.00 21.00 21.25 22.25 20.50 | 21.20 |
### Table 5. Soil characteristic analysis result.

| No | Sample | pH | C Organic | N Total | P HCl 25\% (mg P₂O₅/100₀) | K HCl 25\% (mg K₂O/100₀) | P Total | K Total |
|----|--------|----|-----------|---------|--------------------------|--------------------------|---------|---------|
| 1  | Soil   | 6.00 | 0.16      | 1.48    | 72.75                    | 16.50                    | -       | -       |

### 3.3. Plant production

Variety analysis showed an interaction between California papaya varieties and 200 g Chicken manure, while there was no interaction for fruit circumference. In general, giving Chicken Manure can increase papaya fruit length and papaya fruit circumference compared to without Chicken manure; giving Chicken manure 200 g shows the best fruit length and circumference for all varieties. This phenomenon shows that papaya plants planted as oil palm intercrops require relatively large amounts of nutrients in the production phase. The nutrient requirements in papaya plants during the productive period are not
much different from those during vegetative growth. It shows that papaya requires nutrients from vegetative growth to production.

The results showed that the treatment of Chicken manure had a significant effect on fruit length at 20 MST, the treatment of varieties had a significant effect on the length of the papaya fruit and the interaction between the two varieties of treatment with Chicken manure had a significant effect on the length of the papaya fruit at 20 MST.

Table 6. Papaya fruit length (cm) at 20 MST in chicken manure and intercropping on oil palm plants.

| Varietas     | Chicken manure | Average       |
|--------------|----------------|---------------|
|              | 0 g            | 50 g          | 100 g         | 150 g         | 200 g         |       |
| 10 MST       |                |               |               |               |               |       |
| California   | 24.00 a        | 27.75 a       | 27.75 a       | 33.35 a       | 35.00 a       | 29.55 b |
| Pomegranate  | 22.50 a        | 24.75 a       | 26.00 a       | 29.50 a       | 32.25 a       | 27.00 a |
| red          | a              | ab            | ab            | bc            | c             |       |
| Average      | 23.25 a        | 26.25 b       | 26.88 b       | 31.38 c       | 33.63 c       |       |

Table 6 shows that the treatment of giving Chicken manure has a significant effect on the length of papaya fruit; giving Chicken manure with a dose of 200 g has the highest average at 20 MST, which is 33.63 cm, and the interaction between 200 g Chicken manure treatment with California has a significant effect on 20 MST, namely 35.00 cm. The length of the California papaya varieties is superior to the red pomegranate varieties. From the results, it was known that the treatment of giving Chicken manure had a significant effect on the circumference of the fruit at 20 MST, the treatment of varieties had a significant effect on the length of the papaya fruit, but the interaction between the two varieties of treatment with Chicken manure had no significant effect on the circumference of the papaya fruit.

Table 7. Papaya Fruit Circumference (cm) at 20 MST in chicken manure and intercropping on oil palm plants.

| Varietas     | Chicken manure | Average       |
|--------------|----------------|---------------|
|              | 0 g            | 50 g          | 100 g         | 150 g         | 200 g         |       |
| 10 MST       |                |               |               |               |               |       |
| California   | 28.25          | 30.50         | 30.25         | 32.50         | 34.00         | 30.90 a|
| Pomegranate  | 30.75          | 34.00         | 34.00         | 35.50         | 36.75         | 34.20 b|
| red          |                |               |               |               |               |       |
| Average      | 29.50 a        | 32.25 abc     | 32.12 ab      | 33.50 bc      | 35.38 c       |       |

Table 7 shows that the treatment of giving Chicken manure has a significant effect on the circumference of the papaya fruit, giving Chicken manure with a dose of 200 g has the highest average at 20 MST, namely 35.38 cm and treatment of red pomegranate varieties has a significant effect on fruit circumference and is superior to papaya varieties. In California, the average pomegranate red variety was 34.20 cm, but the interaction between 200 g Chicken manure treatment and the two varieties had no significant effect on fruit circumference.

Ten untrained panellists carried out organoleptic testing on California papaya varieties and pomegranates. The parameters assessed in the organoleptic test of papaya were taste, colour and texture. Figure 1 histogram of organoleptic test results for papaya fruit giving on chicken manure and intercropping on oil palm plants. Based on the results of the colour test on the average papaya fruit, the panellists assessed a very orange colour, delightful taste and soft texture in the V2P1, V2P3 and V2P4 treatments. From the results of the tests carried out by the panellists, it is found that the organoleptic test can be seen in the following figure:
4. Conclusion
The addition of Chicken manure affects the growth of California papaya and pomegranate papaya; this study also confirms that the more Chicken manure is given, the better fruit length and circumference will be. In addition, this study also informed that the growth of oil palm and papaya varieties of California and red pomegranate as intercrops during the immature plants period did not show competition during the plant growth period. Plant height, number of leaves, and diameter of oil palm plants planted in polyculture with papaya as an intercropping did not show further growth from those planted in monoculture.

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