Response to growth and production of green beans (Vigna radiata L.) in various cropping spots and fertilizer provision of layer chickens

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Abstract. Agroecology affecting plant growth can be influenced by factors such as plant spacing and growing media. This study aims to determine the effect of plant spacing and chicken manure on the growth and production of green beans. Plants were planted at three spacing plants (20cm x 20cm, 20cm x 30cm, and 20cm x 40cm) while manure was applied at 3.75, 7.50 and 11.25 ton/ha and without manure as a comparison. The treatments were arranged in a randomized complete block design with three replicates. The result showed that the highest diameter of stem was resulted from the application of 11.25 ton/ha of manure combined with the planting space of 20cm x 40 cm. Similarly, the highest number of branch of stem we found at the plot where chicken manure of 11.25 ton/ha with planting space of 20cm x 30cm. The highest production (4,944.4 kg/ha) was resulted from 7.50 ton/ha manure with combined with planting space of 20cm x 40cm. There was an interaction between the treatment of manure and the planting space of soybean. The production of green bean was 24% higher in 7.50 ton/ha manure combined with 20cm x 40cm planting space compared to no manure (control).

1. Introduction
Green beans (Vigna radiata. L) is a food crop and belong to the family of nuts which have long been cultivated in Indonesia. This crop is the third most widely grown nuts plant after soybeans and peanuts [1]. This crop is known as one of the important leguminocae plants, but until now the attention of the community on the cultivation of green beans is still lacking. This lack of attention is caused by the harvest of green beans must be done several times so that farmers think that planting green beans is considered less effective [2].

Rukmana [3] stated that when compared with other nuts, green beans have advantages such as mature, more tolerant to drought, can be planted less fertile and at the same time can fertilize the soil because it can simbiosis with rhizobium bacteria, easy cultivation and pests that attack Relatively little. However, the production of green beans in Indonesia is still low and has not been able to meet domestic needs. One cause of low production of a plant is the low level of soil fertility. One effort that can be made to improve soil fertility is the supply of nutrients through fertilization.

One of the efforts to increase the production of green beans is by improving the quality of cultivated land that can be done by improving the quality of the soil which decreases due to cultivation practices through fertilization. Fertilization is one of the most important factors for plant growth to determine the success of crop production. Fertilization is intended to meet the need for nutrients in
sufficient quantities and balanced with the hope to support vegetative growth and generative plant which leads to high production and good quality.

Fertilizers are all ingredients supplied to the soil in order to improve the physical, chemical and biological properties of the soil. Fertilization is done to provide nutrients needed by plants in each period of growth.

Organic materials ranks first in a series of cultivation plants because this material is used as a basic fertilizer so that the application is done early and in large quantities. Organic compounds or elements are the main ingredients of this fertilizer can be utilized after the process of decomposition in the soil [4]. Organic fertilizer is also called natural fertilizer, because all or most of this fertilizer comes from nature. Animal waste, crop residues, household waste, and stones are the basic ingredients of organic fertilizer [5]. [6] in his research found the organic fertilizer chicken manure that best affect the corn crop is on the treatment of organic fertilizer chicken poo 10 tons/ha).

Manure comes from animal waste that has undergone the process of decomposition or the influence of microorganisms. The signs of mature manure are not sharp (ammonia smell), dark brown, dry looking, not hot when held and loose when squeezed [7]. Melati and Andriyani [8], in his research showed that giving 10 tons of chicken manure/ha can increase vegetative growth and organic soybean production.

Organic fertilizer is a biological buffer that has a function in improving the physical, chemical and biological properties of the soil, so the soil can provide nutrients in a balanced amount. Organic fertilizers are widely used for food crops and animal feed plants are generally of animal waste, among others are chicken manure. From result of Kartika research [9] known that chicken manure of chicken manure give best result to growth and yield of grassy plant of Brachiaria humidicola when compared with cow manure and cow manure. Provision of chicken manure can improve the soil structure that is very short of organic elements and can fertilize spinach plants. That is why the giving of organic fertilizer into the soil is necessary so that the plants that grow on the soil can grow well [10].

Poultry manure is a solid fertilizer that contains lots of water and mucus. Chicken manure includes cold fertilizer because the change from the material contained in the fertilizer becomes available in the soil, takes place slowly. Based on the results of research that has been done [11], it was found that the provision of chicken manure in the observation of the growing kompenen highest average crops and production components produce the highest average weighted berangkasan. Sri Susanti Ningisih in his research found that the provision of chicken manure manure affect the growth and production of mustard plants.

Different plant spacing may affect the efficiency of radiation energy capture for plant growth. At a dense spacing, the transmission of solar radiation on the ground surface is smaller than the more loose spacing. [12] the arrangement of plant spacing of a plant can be more optimal. [13] in his research found that the more distance spacing in the nutrient balance test on elephant grass showed higher growth and production (100 x80).

The distribution of light on the plant canopy becomes an important factor affecting the efficiency of the use of sunlight by plants. One of the factors affecting the distribution of light in the canopy is the canopy structure. Spread of light on the upright leaf canopy is better than the horizontal leaf canopy [14]. At a wide spacing the growth is faster than at a narrow spacing. This is due to the happening of nutrients in the soil and sunlight in the process of photosynthesis.

Setting spacing is expected to affect the increase in green bean production. Use of plant spacing of 30 cm x 20 cm with 2 seeds per hole resulted in optimal production / dry seed ha [15]. [16] in his research found that the spacing of 15 x 30 gave the highest yield of 0.85 tons/ha in green beans.

2. Materials and methods
The treatments in this study were arranged in randomized complete block design (RCBD) with two factors namely 1. fertilizer application with four levels (P0) control, (P1) 1.5 kg/plot = 3.75 ton/ha, (P2) 3.0 kg/plot = 7.50 ton/ha and (P3) 4.5 kg/plot = 11.25 ton/ha, and the second factor namely planting space with three levels i.e (J1) 20cm x 20 cm, (J2) 20cm x 30cm and (J3) 20cm X 40cm.
Therefore there were 12 treatment combinations and each of them was repeated three times. In accordance with the treatment of plant spacing, the number of plant population in the plot varies for (J1) 100 plants or equal to 250,000 plants per hectare, (J2) 70 plants 166,67 plants per hectare and (J3) 50 plants 125,000 plants per hectare. The field was cultivated in accordance two times, a week before planting has done the application of chicken manure laying in accordance with the treatment. By way of placing 2-3 seeds of green beans the hole with the a depth of 3-5cm soil, then covered with loose soil. After plant growth is done the determination of the sample plants.

3. Results and Discussion

From the observations made on the three observation parameters obtained the following results:

| Table 1. Average stem diameter (mm) at the end of observation (6 MST) |
|------------------|------------------|------------------|------------------|------------------|------------------|
| Treatments       | J1               | J2               | J3               | Total            | Average          |
| P0               | 15.92            | 18.54            | 18.67            | 53.13            | 17.71            |
| P1               | 15.58            | 19.11            | 19.34            | 54.03            | 18.01            |
| P2               | 17.16            | 20.34            | 20.99            | 58.49            | 19.50            |
| P3               | 16.75            | 20.67            | 21.33            | 58.75            | 19.58            |
| Total            | 65.41            | 78.66            | 80.33            |                  |                  |
| Average          | 16.35            | 19.67            | 20.08            |                  |                  |

The highest diameter (21.33 mm) was obtained on the application of manure as much as 11.5 ton/ha with spacing 20cm x 40xm (P3J3) with the stem diameter 21.3 mm, when compared with no chicken manure (P0J3). By applying chicken manure it can supply adequate nutrient content in soil required by plants. Prihmantoro (2003) stated that manure contains macro and micro nutrients complete although with a small amount. [17] manure has natural properties and does not damage the soil, providing macro and micro elements. In addition, manure functions to increase water holding capacity, soil microbiology activities, cation exchange rate and improve soil structure. The state of planting media that strongly supports the growth of green bean plants is seen in vegetative growth by showing the diameter of the stem that grows well/large and this makes the system of nutrient transgrtasi and photosynthesis results in green beans plant is good. [18] in her research found that the application of chicken manure 40 ton/ha gave better results on the growth and production of Brachiaria humidicola grass.

| Table 2. Average number of branches at six weeks after planting |
|------------------|------------------|------------------|------------------|------------------|------------------|
| Treatments       | J1               | J2               | J3               | Total            | Average          |
| P0               | 6.30             | 7.00             | 7.00             | 20.30            | 6.77             |
| P1               | 6.30             | 7.70             | 7.00             | 21.00            | 7.00             |
| P2               | 7.30             | 8.00             | 8.00             | 23.30            | 7.77             |
| P3               | 7.30             | 8.90             | 8.00             | 24.20            | 8.07             |
| Total            | 27.20            | 31.60            | 30.00            |                  |                  |
| Average          | 6.80             | 7.90             | 7.50             |                  |                  |

Table 2 shows that most branching is in the application of laying chicken manure 11.50 ton/ha with spacing of 20cm x 30cm (P3J2) with the number of branching as much as 8.9 branches when compared with the treatment without the application of laying chicken fertilizer with spacing (20cm x
30cm) in the treatment (P0J2). Chicken manure and plant spacing affected the number of branches on green bean plants. The emergence of flowers that will later develop into a pod that will contain green bean seeds. The more the number of branching there are green bean plants the more the number of pods and seeds. The height of branching in the application chicken manure as much as 11.5 tons/ha caused by the plants sufficient supply of nutrients and nutrients other nutrients provided by laying chicken manure. Ability of laying chicken breeders to improve the structure of chemically, physics and biology, make the root system to be good, so it can absorb water and nutrients well, which is very influential in support vegetative growth of plants included in the formation of branches. [8] showed that 10 tons of chicken manure/ha increased vegetative growth and organic soybean production. The optimum spacing in support of green bean planting is at 20cm x 30cm. Where at this planting distance, jamah branching more. Treatment of plant spacing is closely related to competition among plants in obtaining growing space such as water, nutrients and sunlight that are essential for photosynthesis. The distribution of light on the plant canopy becomes an important factor affecting the efficiency of the use of sunlight by plants. One of the factors affecting the distribution of light in the canopy is the canopy structure. Spread of light on the upright leaf canopy is better than the horizontal leaf canopy [14]. At a wide plant spacing (optimum) growth faster than at a narrow spacing. This growth includes mula formation of leaves and stems which in this case also includes the process of branching formation. When taaman gets a suitable growing space where the nutrients in the motherland, and enough sunlight, will support the process of photosynthesis, which is needed to produce food for plants (photosynthesis) used by plants for their vegetative and generative growth processes.

Table 3. Average number of grain production (kg / ha)

| Treatments | J1    | J2    | J3    | Total  | Average |
|------------|-------|-------|-------|--------|---------|
| P0         | 2,805.56 | 3,728.40 | 3,986.11 | 10,520.07 | 3,506.69 |
| P1         | 3,458.33 | 2,765.44 | 4,305.56 | 10,529.33 | 3,509.78 |
| P2         | 3,916.67 | 3,851.86 | 4,944.44 | 12,712.97 | 4,237.66 |
| P3         | 4,277.78 | 4,296.30 | 4,000.00 | 12,574.08 | 4,191.36 |
| Total      | 14,458.34 | 14,642.00 | 17,236.11 |         |         |
| Average    | 3,614.59 | 3,660.50 | 4,309.03 |         |         |

From the result of observation, it was found that the highest production was in the application of laying chicken manure of 7.5 tons/ha with spacing 20cm x 40cm (P2J3) obtained by the production amount 4,944.4 kg /ha. Compared to no chicken manure with the same planting space (P0J3) is increased by 24%. Thus, in order to obtain the production of green bean plants, the optimum layer chicken fertilizer is at 7.5 tons/ha with spacing of 20cm x 40cm. There is an interaction between the application of laying chicken manure with the spacing to increase the production of green bean plants. From the results of [19], showed that the increasing of organic fertilizer from 1 ton/ha and the growing spacing of 0.75 x 25 cm in corn plant did not give better result. So it does not mean if if the provision of layers of chicken fertilizer required crop should be given as much as possible, but there is an optimum limit where at doses of 7.5 tons /ha not on the treatment of 11.5 tons/ha, laying chicken manure has supported the growth and production of plants Green beans, if more than the optimum limit, the available nutrient supply will be wasted.

Different plant spacing may affect the efficiency of radiation energy capture for plant growth. At a dense spacing, the transmission of solar radiation on the ground surface is smaller than the more loose spacing. According to [12], the arrangement of plant spacing of a plant can be more optimal. I.J. Abadi, H.T. Sebayang, E. Widaryanto, 2013, in his research showed that the increasingly loose spacing of 75 x 30 showed higher growth and production in sweet potato plants. The right spacing makes the
plants do not shade each other, the growth of the canopy is free so that the competition in obtaining sunlight is very small. This supports the process of photosynthesis is good, so the production of dry matter (carbohydrate) as raw material for the production takes place well and sufficiently available in the plant body.

![Graph showing the increase of production result due to the application of chicken manure and spacing](image)

**Figure 1.** The increase of production result due to the application of chicken manure and spacing can be seen in the following graph.

### 4. Conclusions
This study concluded that:
- Laying chicken fertilizer can increase the production of green kacang plants up to 24% at the optimum dose of 7.5 tons/ha when compared to that without the application of chicken manure.
- The looser spacing (20cm x 40cm) between plants and supports green bean plants for the body and production.
- There is an interaction between the application of laying chicken manure with plant spacing on increasing the production of green bean plants.

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