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Research Article
Response of Vegetable Soybean (*Glycin max* L. Merr.) Plant by Application of Integrated Fertilizers in Volcanic Soil

[1]Maria Theresia Darini, [1]Sri Widata and [2]Wahyu Setya Ratri

[1]Department of Agrotechnology, Faculty of Agriculture, Universitas Sarjanawiyata Tamansiswa, Yogyakarta, Indonesia
[2]Department of Agribisnis, Faculty of Agriculture, Universitas Sarjanawiyata Tamansiswa, Yogyakarta, Indonesia

Abstract

Background and Objectives: Vegetable soybean has been developed rapidly due to its capability to fulfilling not only nutritious food but also fodder forage. The research aims to observe the responses of vegetable soybean as a functional food and forage feed in volcanic soil which were planted and fertilized by using cow manure and chemical fertilizers. **Materials and Methods:** The research was arranged in a factorial randomized complete block design with 3 replications. The first factor was 3 various rates of cow manure fertilizer (10, 20 and 30 t ha^{-1}). The second factor was source and dosages of nitrogen: consists of urea dosages (50, 75 and 100 kg ha^{-1}) and Ammonium Sulphate (AS) dosages (100, 150 and 200 kg ha^{-1}). Plant responses that had been observed were: growth components, pod yields and yield of forage feed. **Results:** It obtained that there was no interaction between cow manure rates with nitrogen fertilizer sources on all observational variables. The rate 10-30 t ha^{-1} of cow manure does not affect the growth, pod yields and forage feed. **Conclusion:** The application of cow manure 10 t ha^{-1} rate and nitrogen ammonium sulphate source dosage of 200 kg ha^{-1} increases plant growth, yield of pods functional food and vegetable soybean forage feed.

Key words: Forage feed, number of pod, functional food, vegetable soybean, cow manure

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Corresponding Author: Maria Theresia Darini, Department of Agrotechnology, Faculty of Agriculture Universitas Sarjanawiyata Tamansiswa, Yogyakarta, Indonesia

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Vegetable soybean (edamame) [*Glycine max* (L.) Merr.] is a low input, high nutritional value, short crop cycle and soil-enriching profitable crop. It offers quick economic return and provides health benefits to the consumers. The market demand for edamame has begun to flourish and expand dramatically in recent decades due to increased awareness of nutritional properties and the change in life styles towards healthier food[1]. Then the consumption of edamame can also really contribute to reducing deficiencies in children and eve adults, through its great nutritional content and good health benefits[2].

By product of legumes have potential to contribute significantly to sustainable intensification of livestock production in the tropics, along with the provision of ecosystem services[3]. Prasanthi and Venkateswaralu[4] reported the effect of different planting patterns on fodder quality as compared to sole cropping. The development of genomics and bioinformatics together with genome offer great scope to improve forage feed crops, this opportunity has enormous potention to improve food security and political stability[5].

Market demand for vegetable soybean has increased in the last few decades due to increased awareness of nutritional properties and lifestyle changes towards healthy food[6]. Those legumes have the potential to significantly contribute to the ongoing intensification of animal production in the tropics, along with the provision of ecosystem services[7]. In addition to land conversion, there is also competition between food, feed and biofuels. The availability of biofuel is still related to food and feed production, such as soybeans, corn and cassava[8].

The forages browsed by the livestock can be classified into 2 main groups: ephemeral annual plants, which germinate and remain green for only a few weeks after rain, perennial shrubs and tree fodders. Despite their potential as feeds, little research has determined their nutritive value. *In vivo* evaluation is the best estimation method of feed's nutritional value, however it is very laborious and difficult to standardize with browsing animals. On the contrary, *in vitro* methods are less expensive, less time consuming and allow a better control of experimental conditions than *in vivo* experiments[9]. One factor that determines the merits of the development of cattle is feed. Feed can be classified into sources of protein, energy and crude fiber. Animal feed is the main source of crude fiber.

Therefore, it was necessary to conduct the research on vegetable soybean plant to observe their growth and yield on volcanic soil with the used of integrated fertilizer and it can function as functional food and fodder.

MATERIALS AND METHODS

Study area: The research was carried out in Pakem, Sleman, Special Region of Yogyakarta, August to October 2019.

Land management: The experiment field was made of three blocks, the distance between the block was 50 cm. Each block was made 15 units of experiment plots. Each plot with size 1×1 m^2, planting distance 20×20 cm, so that obtained 25 plants. Plants were fertilized by using cow manure fertilizer with various rates: 10, 15 and 20 t ha^{-1} or equivalent 1, 2 and 3 kg plot^{-1}. Vegetable soybean seed Ryoko 75 var. were planted one seed per hole. After seed germination, plants were treated by supplementary fertilizer from sources of urea nitrogen at various dosages: 50, 75, 100 and AS fertilizer at dosages: 100, 150 and 200 kg ha^{-1}. The urea and ammonium sulphate were applied 50% of dosage and then a month later the remaining 50% was applied to plants.

Plant's physical treatment includes watering once every 2 days and replacing the un grown seeds after 7 days of planting. Pest control was done manually by picking and killing it and then buried. Weeding was done after one month and in accordance with the conditions of the land. Harvesting on 63-days aged pods provided that the seeds in the pods have protruded and hardened (ripe). The growth component was observed in three sample plants (as a representation), meanwhile pods were observed for nine sample plants per plot. Statistical analysis was performed by using variance and followed by Duncan's multiple range test ($p \leq 0.05$)[10].

RESULTS

There was no statistical interaction between the dosage of cow manure fertilizer with nitrogen sources on all observed variables.

Plant height: Plant height was not significantly different neither by the application of cow manure 10-20 t ha^{-1}, nor by application of nitrogen fertilizer at various dosages (Table 1). The application of urea fertilizer at dosages of 50-100 kg and AS dosages of 100-200 kg ha^{-1} showed no significant difference in plant height.

Leaf number plant: Cow manure rate of 10-20 t ha^{-1} did not significantly affect on leaf number plant, but the source and dosage of nitrogen fertilizer significantly caused different leaf number per plant. The application of 75 kg urea fertilizer or 150 kg AS fertilizer, resulted the highest number of leaves per

Table 1: Average of plant height, number of leaves, leaf weight, flowering age and pod numbers

Rates of cow manure and nitrogen dosage sources	Observed parameters			
	Plant height (cm)	Number of leaves/plant	Fresh weight/plant (g)	Blooming period (day)
Cow manure 10 t ha^{-1} (P1)	51.28^{a}	26.76^{a}	40.39^{a}	36.61^{a}
Cow manure 15 t ha^{-1}(P2)	50.96^{a}	25.15^{a}	38.01^{a}	36.78^{a}
Cow manure 20 t ha^{-1} (P3)	49.39^{a}	24.78^{a}	36.84^{a}	36.94^{a}
Urea 50 kg (N_1)	49.22^{a}	25.23^{b}	32.34^{c}	38.67^{a}
Urea 75 kg (N_2)	51.59^{a}	27.87^{a}	39.33^{a}	36.89^{a}
Urea 100 kg (N_3)	50.74^{a}	24.87^{b}	35.34^{b}	38.50^{a}
AS 100 kg (N_4)	49.37^{a}	22.83^{b}	39.45^{a}	36.22^{a}
AS 150 kg (N_5)	52.78^{a}	28.11^{a}	45.54^{a}	35.78^{a}
AS 200 kg (N_6)	49.59^{a}	24.22^{b}	42.45^{a}	35.11^{a}
No Interaction	($p \geq 0.05$)	($p \geq 0.05$)	($p \geq 0.05$)	($p \geq 0.05$)

Numbers followed by the same letter in the same column show no significant difference ($p \leq 0.05$)

Table 2: Average of number of pods, weights pods, plant fresh weights, plant dry weights and pod weights

Rates of cow manure and nitrogen dosage sources	Observed variables			
	No. of pod/plants	Weight of leave ha^{-1} (t)	Dry weight plant^{-1} (g)	Weight of pods/plant (g)
Cow manure 10 t ha^{-1} (P1)	31.09^{a}	3.51^{a}	10.03^{a}	16.85^{a}
Cow manure 15 t ha^{-1} (P2)	29.09^{a}	3.42^{a}	9.51^{b}	16.57^{a}
Cow manure 20 t ha^{-1} (P3)	27.78^{a}	3.51^{a}	8.41^{b}	16.01^{a}
Urea 50 kg (N_1)	25.14^{b}	2.27^{c}	11.24^{a}	14.07^{c}
Urea 75 kg (N_2)	27.09^{a}	2.51^{c}	8.86^{b}	15.67^{b}
Urea 100 kg (N_3)	27.63^{a}	3.53^{b}	9.98^{b}	16.08^{a}
AS 100 kg (N_4)	28.26^{a}	3.18^{b}	9.79^{b}	16.18^{a}
AS 150 kg (N_5)	32.48^{a}	3.55^{b}	11.44^{a}	18.44^{a}
AS 200 kg (N_6)	33.11^{a}	3.82^{a}	10.69^{a}	18.48^{a}
No Interaction	($p \geq 0.05$)	($p \geq 0.05$)	($p \geq 0.05$)	($p \geq 0.05$)

Numbers followed by the same letter in the same column show no significant difference ($p \leq 0.05$)

plant, while lower number of leaves was shown in the application of 50 or 100 kg urea and ammonium sulphate of 100-200 kg ha^{-1}.

Plant fresh weight: Cow manure 10-20 t ha^{-1} did not significantly affect plant fresh weight whereas, the source of nitrogen fertilizer is significantly influence plant fresh weight. The highest plant fresh weight was obtained by giving 75 kg urea fertilizer or ammonium sulphate of 100-200 kg ha^{-1}. Lower plant fresh weight was obtained from the application of 100 kg ha^{-1} urea and given 50 kg ha^{-1} urea, the lowest plant fresh was obtained (Table 1).

Flowering period: Table 1 showed that neither application of cow manure 10-20 t ha^{-1}, nor application of urea and ammonium sulphate at various dosage did not significantly affect flowering period of vegetable soybean. Likewise, the use of urea fertilizer with a dosage of 50-100 kg and AS fertilizer dosage 100-200 kg ha^{-1} was not significantly different on the blooming period of vegetable soybean flowers.

Pod number plant: Pod number per plant presented in Table 2, was not significantly different by the application of cow manure rate of 10-20 t ha^{-1}, but significant differences was obtained when the sources and dosages of nitrogen fertilizer was applied. High number of pods was obtained by application of urea with a dosage of 75-100 kg and ammonium sulphate of 100-200 kg ha^{-1}, while the lowest pod number was obtained when 50 kg ha^{-1} urea was applied.

Pod weight plant: The application of cow manure 10-20 t ha^{-1} resulted no significant difference on pod weight per plant, while the sources and dosages of nitrogen fertilizer significantly affect pod weight. High pod weight was obtained by giving ammonium sulphate dosage 100-200 kg ha^{-1}, while the application of urea at 75-100 kg ha^{-1} resulted lower pod weight and the lowest pod weight was obtained at urea fertilizer at 50 kg ha^{-1} (Table 2).

Plant dry weight: Cow manure rate of 10-20 t ha^{-1} significantly affected plant dry weight of vegetable soybean, so did the sources and dosages of nitrogen fertilizer. High plant dry weight was obtained at 10 t ha^{-1} cow manure rate, while 15-20 t of rate was obtained lower plant dry weight. At the application of nitrogen fertilizer, high plant dry weight was obtained at 50 kg urea dosage or AS fertilizer dosage 150-200 kg ha^{-1}, while other dosages obtained lower plant dry weight (Table 2).

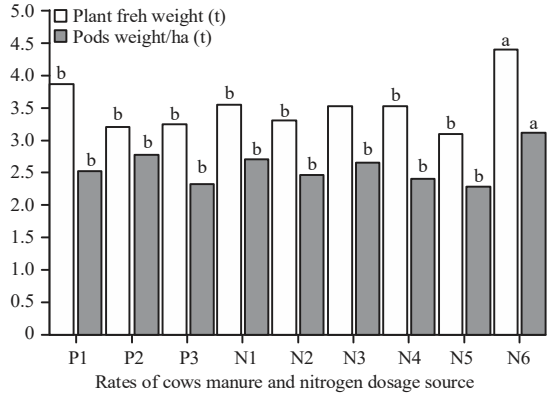

Fig. 1: Plant fresh weight and pods weight t ha^{-1} in different rates of cow manure and nitrogen dosage source

Different letters have different significant level, P1: Cow manure 10 t ha^{-1}, P2: Cow manure 15 t ha^{-1}, P3: Cow manure 20 t ha^{-1}, N1: Urea 50 kg, N2: Urea 75 kg, N3: Urea 100 kg, N4: AS 100 kg, N5: AS 150 kg, N6: AS 200 kg

Pod weight and plant fresh weight per hectare: As shown in Fig. 1, Pod weight and plant fresh weight were not significantly affected by application of cow manure. Source and rate of nitrogen fertilizer influenced both variable, the highest pod weight and plant fresh weight was obtained by the application of 200 kg ammonium sulphate.

DISCUSSION

The rate of cow manure fertilizer has no effect on the variable height of vegetable soybean plants, as well as nitrogen sources (Table 1). However, this is not in accordance with Irfan *et al.*[11] that found that the application of nitrogen dosage of 120 kg ha^{-1} increases the height of the oat feed forage, while Junaedi and Wulandari[12] states that the application of chicken manure fertilizer can increase the height of bean plants, the are different report that the application of cattle manure 20 t ha^{-1} rate gave the highest plant height of maiz[13]. This differs from other research that report the application of ammonium sulphate fertilizer is the best of sources nitrogen for the stem diameter of sorghum plant[14].

The number of leaf of vegetable soybean plants is not affected by the rate of cow manure fertilizer (Table 1). The source of urea nitrogen is 75 kg and ammonium sulphate dosage 150 kg ha^{-1} produces more leaf than other sources. This is not supported by the Donatus[15] report which states that providing a combination of chicken manure with urea can increase the number of leaf of peanut plants.

The rate of cow manure fertilizer has no effect on observed variables, leaf weight of vegetable soybean (Table 1) while nitrogen sources ammonium sulphate dosage 150 kg produces higher plant weights and 50 kg of urea produces lower plant weights. This is not in accordance with Sutrisno and Yurnawan's opinion[16] reported that the combination of organic and inorganic fertilizers could increase the fresh weight of green beans.

Vegetable soybean plants is not affected by the rate of cow manure fertilizer, as well as nitrogen sources both urea and ammonium sulphate. Based on Junaedi and Wulandari's[12] report that the combination of organic fertilizer with 50% NPK accelerates the blooming on melons (*Cucumis melon* L.).

The lowest pod/plant of vegetable soybean yield produced by 50 kg urea, whereas application with other nitrogen sources and dosage yield in higher number of pod. It is not in accordance with the report of Devi *et al.*[17] that the application of a combination of fertilizers increases the weight of soybean pods, as well other research that report the application of combined farm yard manure at 30 t ha^{-1} and nitrogen fertilizer 150 kg ha^{-1} dosages significantly increased the total bulb yield onion plant[18]. The treatment by using chicken manure fertilizer also increased the bean pods yield, while Kamtchoum *et al.*[19] reported that application of 75 kg N fertilizer could increase the production of castor beans. The rate of cow manure fertilizer has no effect on the variable pod weight per plant, however, the nitrogen source is influential. The lowest pod yield produced by plants treated by 50 kg urea, other plants treated by nitrogen sources produced pod higher than that and no different. It is not in accordance with the report of Devi *et al.*[17] that the application of a combination of fertilizers increases the weight of vegetable soybean pods, that the amount of chicken manure increases the number of bean crop pods, as well as another study reported[20,21] that the application of organic fertilizer is the best alternative as a source of nutrient for agronomic parameters of physalis fruits.

The rate of cow manure fertilizer does not affect the variable fresh weight of plants hacter, while the nitrogen source influences (Fig. 1). The lowest fresh plant weights were obtained at 50 kg ha^{-1} of urea. However, another treatment by using various dosages of nitrogen produced different and higher fresh plant weights of vegetable soybean. This is consistent with the report of Irfan *et al.*[11] which states that the application of 120 kg of nitrogen fertilizer per hectare produces a maximum fresh weight of forage, as well as Gusmini *et al.*[22] also reported that cow or chicken manure

combined with nitrogen fertilizer of 14 g m^2 was able to increase fresh weight of forage rice. This is not according to the report Sindhu *et al.*[23] that application of farmyard manure can increased forage yield of *Indigofera tinctoria*, as well as Prasanthi *et al.*[4] reported that the application of organic fertilizer increased soybean weight to 1.6 t ha^{-1}, so did the opinion of Donatus[15] stating that the combination of chicken manure with urea increased the yield of peanut plants. Sutrisno and Yusnawan[16] also reported that combination of organic and inorganic fertilizer increased fresh weight of mung bean, where as Otieno *et al.*[24] reported that organic fertilizer with NPK could increase dry weight of soybean plant. Morya *et al.*[25] reported that the combination of vermicompost with NPK fertilizer can increase the dry weight of soybean plants.

The dosage of cow manure fertilizer has no effect on the variable pod weight ha, while the nitrogen source is influential, the low pod weight ha is obtained at 50 kg urea, other sources of nitrogen pod weight ha^{-1} are higher and no difference occur (Fig. 1).

CONCLUSION

Hence, study concluded that, there is no statistical interaction between the rates of cow manure and nitrogen sources to observe the variable of vegetable soybean plant. The source of urea nitrogen 50 kg ha^{-1} did not increase growth and yield, whereas the rate of cow manure fertilizer or other nitrogen dosages increased growth and yield of vegetable soybean plant. The recommended rate is 10 t of cow manure and 200 kg ha^{-1} ammonium sulphate fertilizer to increase growth, yield included fresh weight of pods and forage feed weight of vegetable soybean plant.

SIGNIFICANCE STATEMENT

Through the cultivation of vegetable soybeans in volcanic soil, two benefits can be obtained, besides being able to harvest fresh pods as functional food it is also forage for animal feed. By application of cow manure and ammonium sulfate fertilizer in volcanic soil the yield of vegetable soybean pods and the fresh weight of forage feed can be increased.

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