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USE OF HORSE MANURE COMPOST FOR INTEGRATED NUTRIENT MANAGEMENT IN MUNGBEAN

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ABSTRACT

Excessive use of nitrogen fertilizer in Indonesia along with detrimental effect of high nitrogen application rate to atmosphere, ground and surface water, as well as to quality of harvest has led to attention in the integrated nutrient management (INM) approach. The study is aimed at exploring the possibility of using compost made from horse manure in INM for mungbean production. Compost made from horse manure at rate 0, 50, 70, and 90 g plant^{-1} in combination of NPK compound fertilizer at rate 0, 10, and 20 g plant^{-1} were tested on growth and yield of mungbean using Randomized Block Design field experiment. The result shows that combination of 90 g plant^{-1} manure with 20 g plant^{-1} NPK give the highest yield which is 1.42 ton ha^{-1}. Hence, horse manure compost can be used as organic component in INM to substitute partly inorganic fertilizer.

Keywords: Horse manure; mung bean; integrated nutrient management.

INTRODUCTION

Concerns in excessive use of inorganic fertilizer particularly inorganic nitrogen such as Urea continuously increase, including recently in developing countries like Indonesia. Excessive application of nitrogen use has occurred for the last several decades particularly in rice field, partly because of the fertilizer subsidy given by government. Although the recommended dosage for rice field is 250 kg ha^{-1}, many farmers under intensive rice production system apply much higher than the recommended rate. Rice farmers may use up to 350 kg ha^{-1} in Bogor district [1] or even up to a thousand kg per hectare in Karawang district [2].

Although high rate of nitrogen fertilizer increase yield, it cause low quality of harvest. Application of high level of nitrogen fertilizer in rice caused decrease in grain quality, particularly eating and cooking quality [3], amylose content [4], the length/width ratio, chalkiness, apparent amylose content, gel consistency, and peak-, trough-, and final-viscosity values [5]. There is no much information on the effect of excessive use of Nitrogen on mungbean quality. However, high level of nitrogen on any crop system may detrimental to soil and atmosphere [6,7,8].

High level of nitrogen application increase N_2O and NO emissions to atmosphere. Using information from 846 N_2O emission measurements in agricultural fields and 99 NO emission measurements, Bouwman et al. [9] summarized that N_2O and NO emissions strongly increase along with increase in rate of N application, and soils with high organic C content show higher emissions than less fertile soils. Along with this summary, Snyder et al. [10] clarified that as per unit of crop or food production, intensive crop management systems do not necessarily increase GHG emissions. However, as demand for food is continuously increase, and so food production, it turns out that GHG emission such as NO_2 and N from agricultural field is also continuously increase. Ravishankara et al. [11] show that N_2O emission is currently the single most important ozone-depleting emission and is expected to remain the largest throughout the 21st century.

Applying too much nitrogen into agricultural field can have adverse effect on water quality. Maghanga et al. [12] found that application of high rate of nitrogen fertilizer at tea plantation in the Kenyan highlands and Rift valley has increased nitrate content of 10 rivers within the tea plantation. In Whatcom County, Washington, areas with nitrate concentrations above the maximum contaminant level are areas characterized by heavy agricultural activities [13]. Elevated total nitrogen concentrations (including nitrate, ammonia, and organic forms) in rivers can promote the process of cultural eutrophication in coastal waters, whereby increased production and decomposition of algae, leads to reduced oxygen concentrations [14].

It can be summarize that high rate of nitrogen application may reduce harvest quality, increase GHG emission, and pollute surface and ground water. Hence, the rate of nitrogen application in the agricultural field needs to be reduced. Although application of organic fertilizer such as compost improve soil properties [15], replacing the source of nitrogen nutrient from inorganic to organic fertilizer is not possible as the nutrient content provided by organic fertilizer is limited, or it requires high volume to meet the plant nutrient demand. Hence, combination of organic and inorganic fertilizer, usually called as an Integrated Nutrient Management (INM) is an option to solve the problem. Organic fertilizer in INM not only provide nutrient, but also improve soil bio-physical characteristics.

Horse manure in South Sulawesi, Indonesia is abundantly available, and may become a source of organic fertilizer in an integrated nutrient management. Along with this, mungbean is the third important secondary crop in Indonesia after peanut and soybean [16]. The purpose of this research is, therefore, to access the best combination of horse manure compost and NPK compound fertilizer to growth and yield of mungbean.

MATERIALS AND METHODS

The research was conducted at the experimental farm of Faculty of Agriculture, Hasanuddin University, Makassar Indonesia, from August 2017 to November 2017. The experiment is arranged in Randomized Block Design in two factors. The first factor is NPK compound fertilizer that consists of no inorganic fertilizer as control (N1), NPK 10 g plant^{-1} (N2), and NPK 20 g plant^{-1} (N3). The second factor is compost made from horse manure that consist of no compost as a control (C1), compost 50 g plant^{-1} (C2), compost 70 g plant^{-1} (C3), and compost 70 g plant^{-1} (C4). The treatments are repeated three times (3 blocks); hence, there were 36 experimental units in total. The size of plot was 2 m x 1 m, and the plant distance was 30 cm x 20 cm. The mungbean variety used was VIMA 1, and the seed was obtained from Research Centre for Bean and Tuber Crop, Malang, Indonesia.

The preparation of compost was made by fermenting horse manure for each 40 kg. A mix solution of 40 ml liquid brown sugar, 40 ml bio fermenter EM4, and 400 ml water was poured into 40 kg manure, evenly mixed, and put into a sack for fermentation.

Compost was applied at time of sowing. Two seeds were placed in each hole along with compost at the rate based on respected treatment at depth of 3-4 cm. One week after sowing, the plants were thinned to left only one plant per hole. The plants were kept in optimal condition by watering it as required, and by controlling weed, pest and disease. Inorganic fertilizer of NPK compound was applied at 4 weeks after planting by spreading it at the surface based on the treatment rate.

Parameter measured were plant height, number of leaves, and number of productive branch every week. At harvest, which is at 67 days after sowing, yield components were measured, i.e. number of pods per plant, number of seeds per plant, weight of 1000 grain, and yield. The effect of treatments to those parameters was analysed using Analysis of Variance (ANOVA). If the effect of treatments are significant, the difference between treatments was further tested using Honestly Significant Difference (HSD) test.

RESULTS AND DISCUSSION

The analysis of Variance (ANOVA) indicates that the treatments, both individual (NPK or compost) and interaction of NPK and compost do not affect plant height and number of leaves, at all measurements from 4 weeks after sowing until harvest.

Unlike plant height and number of leaves, number of productive branches was affected by interaction of NPK and compost at 10 weeks after sowing, although it is not affected by the individual treatment, NPK or compost. Further multiple comparison analysis using Honestly Significant Difference (HSD) test shows that NPK 20 g plant^{-1} in combination with compost of 90 g plant^{-1} (N3P4) causes the highest number of productive branches, which is 18.67 branches per plant, while the combination of no NPK with compost of 90 g plant^{-1} (N1C3) results in the lowest number of branches which is 9,90 branches per plant (Table 1).

It seems that both compost and NPK fertilizer as well as their interaction do not affect vegetative growth of soybean until the harvest. As for the number of reproductive branches, it is only affected by the treatments at the later stage of growing.

As for number of pods per plant, the treatment begins to give effect at 8 weeks after sowing. However, only single effect of NPK and compost are significantly affect number of pods per plant, while the interaction is not influencing. Further multiple comparison analysis test shows that moderate rate of NPK at 10 g plant^{-1} (N_2) results in higher number of pods (2.22 pods plant^{-1}) and significantly different from that of NPK rate of 20 g plant^{-1} (1.97 pods plant^{-1}) and that from no NPK (N1) which is 1,66 pods per plant. Application of compost at 90 g plant^{-1} (C_4) caused more pod numbers per plant (2.25 pods per plant) and significantly different from other rates of compost (Table 2).

At 10 weeks after sowing, pods number is affected significantly by NPK but not by horse manure compost, and there is no significant interaction among the two factors. Application of NPK 20 g plant^{-1} (N_3) causes significantly more pods (26.54 pods plant^{-1}) than other rates, where no NPK (N_1) give the fewest pods (20.48 pods per plant) (Table 3).

Table 1. Average number of branches of mungbean at 10 weeks after sowing at various rate of NPK and horse manure compost

Dose of Application (g plant^{-1})	NPK Compound Fertilizer			HSD
Horse Manure Compost	0	10	20	0.05
0	12.43_{y}^{b}	16.81_{x}^{a}	13.05_{y}^{b}	0.23
50	17.14_{x}^{a}	12.14_{y}^{b}	10.48_{y}^{b}	
70	13.00_{x}^{b}	13.33_{y}^{b}	17.10_{x}^{b}	
90	9.90_{y}^{b}	14.81_{y}^{b}	18.67_{x}^{a}	

Notes: figures followed by different letter in row (x, y and z) and in column (a, b and c) indicates that the value is significantly different using HSD test at 0.05.

Table 2. Average number of pods of mungbean at 8 weeks after sowing at various rate of NPK and horse manure compost

Dose of Application (g plant^{-1})	NPK compound fertilizer			Average pod number	HSD
Horse Manure Compost	0	10	20		0.05
0	1.44	1.98	1.54	1.65 c	0.034
50	1.52	2.25	1.48	1.75 bc	
70	2.02	2.33	2.10	2.15 b	
90	1.66	2.32	2.75	2.25 a	
Average	1,66 bc	2,22 a	1,97 b		
HSD 0.05			0.046		

Notes: figures followed by different letter (a, b and c) indicates that the value is significantly different at YSD 0.05.

Table 3. Average number of pods of mungbean at 10 weeks after sowing at various rate of NPK and horse manure compost

Dose (g plant^{-1})	NPK Compound fertilizer		
Horse manure compost	0	10	20
0	17,10	25,24	24,48
50	24,29	20,14	21,43
70	17,29	27,38	29,76
90	23,24	30,19	30,48
Average	20,48 ^{bc}	25,74 ^{b}	26,54 ^{a}
HSD 0.05		0.52	

Notes: Figures followed by different letter (a, b or c) indicates the value is significantly different with HSD at 0.05.

Number of seeds is affected significantly by NPK compound fertilizer and by horse manure compost, but there is no interaction between the two factors. Further multiple comparison analysis test shows that NPK 20 g plant^{-1} (N3) give the highest number of seeds per plant (192.2 seed plant^{-1}), and plot with no NPK (N0) give the lowest number of seeds (147.2 pods plant^{-1}). On horse manure compost treatment, the rate of 90 g plant^{-1} (C_4), give the highest number of seeds (207.6 seeds plant^{-1}), and no compost give the lowest (147.0 seed plnt^{-1}) (Table 4).

Weight of 1,000 grains is affected by NPK but not by horse compost nor by interaction of the two treatments. Multiple comparison analysis test with Honestly Significant Difference (HSD) shows that NPK 20 g plant^{-1} (N3) cause the heaviest grain (64.17 g per 1,000 grain) and significantly different to the other two rates, where the lightest grain (50.08 g per 1,000 grains) is obtained at no application of NPK (Table 5).

Yield is affected by NPK compound fertilizer, horse manure compost, and the interaction of both factors. NPK 20 g plant^{-1} in combination with compost of 90 g plan^{-1} (N_3C_4) gives the highest yield which is 1.42 ton ha^{-1}, and the lowest yield is obtained from plot with no application of NPK or compost (N_0C_0) which is only 0.48 ton ha^{-1} (Table 5).

Similar finding is also reported by Dhaka et.al. [17], where Integrated nutrient management viz. 75% RDF (recommended dose of fertilizer) + 2.5 ton ha-1 VC (Vermicompost) + Rh (Rhizoium) + PSB (Phosphorus Solublizing Bacteria) which is 1.23 ton ha-1 followed by treatments 100% RDF + 2.5 t ha-1 VC (1.205 ton ha^{-1}) and 100% RDF + Rh + PSB (1.20 ton ha^{-1}). They further argue that the combined application of NPK increased availability of major nutrients to plant due to enhanced early root growth and cell multiplication leading to more absorption of other nutrients from deeper layers of soil ultimately resulting in increased plant growth attributes and finally increased yield.

Table 4. Average number of mungbean seeds per plant at various rate of NPK and horse manure compost

Dose of Application (g plant^{-1})	NPK compound fertilizer			Average	HSD
Horse Manure Compost	**0**	**10**	**20**		**0.05**
0	94,5	179.2	167.1	147.0 c	21.75
50	198,3	166.5	168.5	177.8 ab	
70	110,8	166.0	212.1	163.0 b	
90	185.0	216.7	221.0	207.6 a	
Average	147.2 bc	182.1 ab	192.2 a		
HSD 0.05			22.07		

Notes: Figures followed by different letter (a, b and c) indicates that the value is significantly different at HSD 0.05.

Table 5. Average weight of 1,000 grain of mungbean at various rate of NPK and horse manure compost

Dose of Application (g plant^{-1})	NPK compound fertilizer		
Horse manure Compost	**0**	**10**	**20**
0	52.33	65.33	64.67
50	56.00	55.67	61.33
70	45.67	60.00	63.67
90	46.33	62.67	67.00
Average	50,08 bc	60,92 b	64,17 a
HSD 0.05		2.06	

Notes: Figures followed by different letter (a, b and c) indicates that the value is significantly different at HSD 0.05

Table 6. Average mungbean yield (ton ha^{-1}) at various rate of NPK and horse manure compost

Dose of Application (g plant^{-1})	NPK compound fertilizer			Average	HSD
Horse Manure Compost	**0**	**10**	**2**		**0.05**
0	0,48 $_y^c$	1,41 $_x^a$	1,03 $_y^b$	0,97	0.11
50	0,92 $_x^b$	0,78 $_y^b$	0,86 $_y^c$	0,85	
70	0,86 $_y^b$	0,72 $_y^c$	0,98 $_x^b$	0,86	
90	1,01 $_x^a$	1,03 $_y^b$	1,42 $_x^a$	1,15	
Average	0,82	0,98	1,07		

Notes: Figures followed by different letter in rows (x, y and z) or in columns (a, b and c) indicates that the value is significantly different with HSD at 0.05.

CONCLUSIONS

Compost made from horse manure can partly compensate for the Nitrogen requirement of crops usually provided from inorganic fertilizer. Application of NPK compound fertilizer at 20 g plant^{-1} in combination with horse manure compost of 90 g plant^{-1} results in the highest yield of mungbean which is 1.42 ton ha^{-1}. Thus, combination of NPK compound fertilizer and compost made from horse manure can become an option in integrated fertilizer management.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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