INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 21, No. 6, p. 34-40, 2022

RESEARCH PAPER OPEN ACCESS

Effects of inorganic and organic fertilizer with phosphorous supplementation in the growth and yield of Mungbean (*Vigna radiata* L.) & soil properties

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Key words: Mungbean, Chicken manure, Guano manure, Phosphorous, Organic fertilizer

http://dx.doi.org/10.12692/ijb/21.6.34-40 Article published on December 01, 2022

Abstract

Mungbean is economically important crop as protein source substitute locally known as "Monggo". This experimental investigation assessed the response of Mungbean, *Vigna radiata* and the soil characteristics applied with four (4) treatment with four replication such as T_1-Control, T_2- 45-45-45kg NPK ha^{-1}, T_3-20 t ha^{-1} chicken manure + 45kg P ha^{-1}, and T_4 20 t ha^{-1} guano + 45kg P ha^{-1} in RCB design. Comparison of means revealed that all treatments do not give significant differences in plant height, number of leaves, weight of pods, weight of grains, weight of oven dried roots and shoots but only no of pods and nodulation were significant provided by ANOVA . The sufficient soil nutrient availability and high Phosphorous content provided by soil chemical analysis influences the growth and yield, dry matter and root nodules in control pots and at par performance results with the application of NPK, Chicken manure + P, and Guano + P. However soil property analysis after study duration revealed moderately alkaline pH,% 2.4–2.6% SOM, high to excessive P, and high K level indicative that soil condition improves with application of chicken and guano manure with Phosphorous addition compare to NPK + P. Furthermore, an increment of means on the number and weight of pods, weight of grains and dry matter of roots and shoots observed in the potted *V. radiata* L. supplemented with phosphorous rich organic fertilizer specifically chicken manure. Thus, Phosphorous supplementation increases growth and yield in leguminous *V. radiata* L. in this study.

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Introduction

Mungbean is cultivated worldwide in tropical and subtropical regions and the most significant pulse crop (Kumari *et al.,* 2012; Khan *et al.,* 2012). It is an essential annual legume pulse crop with a wide spread that is primarily grown by conventional farmers (Ali *et al.,* 2010). Mungbeans grow best in rich, sandy loam soils with a pH between 6.3 and 7.2 or in soils that are slightly acidic and have good internal drainage. Lime is employed to raise the pH of the most acid-sensitive crop.

The growth of roots may be hampered by dense clays. Mungbeans cannot withstand saline soils, therefore they can show signs of severe iron chlorosis and several micronutrient deficiencies on more alkaline soils (Umata, 2018).

Recently, there has been increased interest in the use of organic resources as fertilizers for agricultural production because they are crucial for long-term crop growth (2009) Tejada *et al.* When compared to conventional fertilizers, organic manures have the potential to increase the soil's fertility, quality, and health while also lowering the buildup of nitrate-N in the soil profile (Yanan *et al.,* 1997).

Organic matter, P, Cu, and Mn levels in the soil had improved when compared to the control. Similarly, when bat guano dust was applied, organic matter, P, and Mn levels in the soil increased when compared to the control (Ünal *et al* 2018).

According to the findings of Omran *et al*, that mungbean should be applied with fertilizer with 40-kilogram N ha-1 and 60kg P 2 O 5 ha-1 in Afghanistan's semi-arid region.

In light of this, this study takes into account the soil amending properties of this excellent natural fertilizer with the following objectives: (1) evaluate the effects of various organic amendments on mungbean growth performance; (2) determine the effects of organic amendments on particular soil chemical properties; and (3) assess plant nutrient uptake under various organic amendments.

Materials and methods

The experiment was conducted at the Greenhouse of Caraga State University, Ampayon, Butuan City on March 2019- April 2019. The soil was taken from the cultivated land of Caraga State University.

Collection and Preparation of Organic manure

Readily available Chicken manure was obtained from Caraga State University, while guano was purchased with the contact person at Barangay Siana, Mainit, Surigao del Norte. Guano was air dried for seven days prior to the treatment.

Experimental Lay out

On a fresh weight basis, the soil utilized in the experiment was weighed to a total of 4kg. In the experiment, 4 treatments were assigned, including: T_1-Control no application, T_2- NPK 45-45-45kg/ha^{-1}, T3-20 t ha^{-1} chicken manure + 45kg P ha^{-1}, and T4-20 t ha^{-1} guano + 45kg P ha^{-1}. Treatment was set up using a random whole block design and reproduced four times. The experiment's pot had a dimension of 5”x5”x8½”. T3 and T4 were modified with 75g of chicken manure and 75g of guano, respectively, prior to sowing, and were then irrigated with 500ml of water. Each pot contained three seeds, which were thinned when the real leaves appeared to prevent nutrient competition. NPK was applied 0.56g in T_2 and this was done during the vegetative growth of mungbean. Weeks after, 0.38g of Solophos was dissolved on 100ml water and applied on T_3 and T_4.

Data Gathering

The height of plant was measured and number of leaf were taken 21 days after sowing and every after 7 consecutive days while the number and weight of pods, number and weight of nodules, weight of grains, weight of oven dried roots and shoot was taken 50 DAS-days after sowing.

Soil Collection and Analysis

Before and after planting, the soil properties of the soil medium were assessed. With a 500 g sampler, soil samples were obtained from the top (0–15cm). Then sieved with a 0.5mm mesh after being air dried for seven days.

The soil sample was given to the Regional Soils Laboratory of the Department of Agriculture's CARAGA Region in Barangay Taguibo, Butuan City, for analysis of soil pH, soil organic matter, P, and K.

Statistical Analysis

The data was analyzed using IBM SPSS Statistics v. 16 and the comparison of means using one way ANOVA and post hoc test of Duncan's Multiple Range Test (DMRT). And soil analysis was subjected to paired sample T-test each treatment to initial soil analysis.

Results and discussion

The data was obtained in sixteen (16) potted mungbean plant experimental units applied with different treatment such as Chicken Manure + P, Guano + P, NPK and control. Table 1 showed the mean of plant height after 21 days of emergence and every 7 consecutive days and was subjected to one way ANOVA and DMRT.

The growth response of *Vigna radiata* L. in terms of height observed higher mean in the treatment control potted soil during week 1 compare to treated units. Which also shows significant difference <0.05 provided by ANOVA and DMRT. However, after 42 days, *Vigna radiata* L. mean height increment by the treatment in this order were NPK > Chicken manure + P > guano + P> control but there has no significant differences in the growth height.

Plant Height

Table 1. The ANOVA and DMRT Analysis of the mean of *Vigna radiata* L. shoot height.

Treatments	Plant Height (cm)			
	21 days	28 days	35 days	42 days
Control (no application)	19.28 ^{b}	36.12	49.68	63.90
N,P,K	18.31^{ab}	36.03	50.41	67.23
Chicken Manure + P	17.61 ^{a}	38.72	53.60	66.04
Guano + P	17.36 ^{a}	34.13	48.06	64.36
p-value*	0.029*	0.197^{ns}	0.246^{ns}	0.892^{ns}

Note: * significance @ alpha <0.05, ** significant difference, ns- no significant difference. Mean with similar letter indicates no significant difference

This indicates that in the initial growth patterns, control group advancing over the other treatment due to the sufficiency of the nutrients in the soil used provided by the soil chemical analysis. Furthermore, during termination after 42 days the rank order of height increase by treated potted *V. radiata* L. is due to the readily absorb NPK and the length of conversion and solubility of the organic matter such as Chicken manure and guano before it will become readily available nutrients to the plants.

Number of Leaves

Table 2. The ANOVA and DMRT Analysis of the mean of leaf number of *Vigna radiata* L..

Treatments	No. of Leaves (pcs.)			
	21 days	28 days	35 days	42 days
Control (no application)	2.25	3.75	4.25	6.75
N,P,K	2.00	3.50	4.00	6.50
Chicken Manure	2.50	3.00	4.50	6.25
Guano	2.00	4.00	4.00	5.75
*p-value	0.248 ^{ns}	0.644 ^{ns}	0.592 ^{ns}	0.248 ^{ns}

Note: * significance @ alpha <0.05, ns- no significant difference, Mean with similar letter indicates no significant difference

Table 3. The ANOVA & DMRT Analysis of the mean of measured parameters of *V. radiata* L.

Parameters	Treatment Name				*p-value*
	Control (no application)	N,P,K	Chicken Manure + P	Guano + P	
No. of Pods (pcs)	6.75^{a}	8.88 ^{ab}	10.75 ^{b}	9.50 ^{b}	0.036
Weight of pods (g)	7.46	9.27	10.86	10.10	0.137
Weight of grains (g)	4.57	6.91	8.40	7.44	0.067
Weight of oven dried roots (g)	1.69	1.63	1.68	1.81	0.856
Weight of oven dried shoots (g)	9.21	9.77	12.06	9.90	0.228
No.of nodules (pcs.)	155.50 ^{c}	135.88 ^{bc}	85.13 ^{ab}	52.50 ^{a}	0.005
Weight of nodules (g)	0.94 ^{b}	0.79 ^{b}	0.36 ^{a}	0.12 ^{a}	0.001

Note: * significance @ alpha <0.05, ns- no significant difference

Mean with similar letter indicates no significant difference

Furthermore, the results in terms of number of leaves presented in table 2, revealed no significant difference in response to all treatment in the period of the experiment. Though the result of the mean as to the number of leaf showed closer average, however, the yield as to no. of pods and weight of grains as presented in Table 3 were varied in means. As shown in Table 3.

The mean of the number and weight of pods, weight of grains and oven dried shoots observed higher and has significant difference to the control group provided by DMRT in potted *V. radiata* L. applied with Chicken Manure + P. The Guano + P application, weight of oven dried roots observed high in this treatment but DMRT reveals no significant difference. NPK application observed lower mean results aforementioned parameters compared to the treatments supplemented with organic manure but higher than the control pots. Moreover, the ANOVA result significant difference below alpha < 0.05 observed only in the number of pods, no. and weight of nodules of potted *V. radiata* L. between treatments.

Table 4. Paired Samples T-test of initial and after respective treatments of the soil properties.

Parameter	Initial	T_1	Sig.	T_2	Sig.	T_3	Sig.	T_4	Sig.
Texture	heavy	Heavy	-	heavy	-	heavy	-	heavy	-
pH	6.99 neutral	7.7 moderately alkaline	0.007	7.6 moderately alkaline	0.003	7.5 moderately alkaline	0.016	7.5 moderately alkaline	0.007
SOM- Soil organic matter (%)	2.1 low	2 low	0.184	2.2 moderately low	0.184	2.4 moderately low	0.035	2.6 moderately low	0.094
Phosphorous (P) ppm	28 high	31.7 high	0.008	37.0 high	0.012	118.0 excessive	0.002	45.3 high	0.024
Potassium (K) ppm	313 high	217.3 medium	0.001	284 high	0.037	467.3 high	0.126	319 high	0.912

Note:* significance @ alpha <0.05

T_1 –Control (no application), T_2 -N, P, K, T_3- Chicken Manure + P, T_4- Guano + P

**Methods and Interpretation: Texture- feel method, SOM-Walkley-Black, pH -Potentiometric, Phosporous-Olsen method, Potassium – exchangeable K (Cold sulphuric Acid Method). (pH; Strongly acidic <5.1, Moderately acidic 5.2–6.0, Slightly acidic 6.1–6.5, Neutral 6.6–7.3, Moderately alkaline 7.4–8.4, Strongly alkaline >8.5), (Phosphorous ; Low <10, Medium 10–25, High 25–50 Excessive >50), (Potassium; Low <150 ppm, Medium 150-250 ppm , High 250–800 ppm , Excessive >800 ppm). DA Caraga RSL; Horneck *et al.*, 2011]

Among the various measured parameters, the weight of grains is the prime importance directly relates to the crop yield i.e. observed in the treatments chicken manure and guano with Phosphorous addition. The result indicates that addition of Phosphorous will increase of yield were observed. A relatively small amount of bat guano is necessary to boost plant development efficiency (Shetty *et al.*, 2013) greater increments in both response variables (Sothearan *et al.*, 2014). Water soluble Phosphate was maximum at 60 days according to Samavat (2015). This indicates the possible rate of absorption in potted *V.radiata* L. of the present study. On the other hand, Chicken dung has more phosphorus compared to the other manures, which is the most critical component in flowering and fruiting development (Barth 2015). Poultry litter was a great match for maximizing mungbean crop grain output (Abbas *et al.*, 2011). The economic study found that the treatment with poultry manure provided the greatest net benefit to mungbean (Naeem *et al.*, 2006).

Furthermore, based on the result and recommendation of Khan *et al.* (1999) that application of P_2O_5 from 60-90kg ha^{-1} is recommended for increasing mung bean production. Increase application of Phosphosorus to 120kg P_2O_5 ha^{-1} levels appear to be optimal for obtaining the best yield of mungbean (Sadeghipour *et al.*, 2010). The mung bean experiments of Prajapati *et al.* (2013) reveals that the application of treatment T5- N, K, P, S (20, 30, 40, 40kg/ha) resulted in significantly better yield and nutrient uptake.

Phosphorus (P) fertilization is the most important mineral nutrient production factor, and enhanced P utilization efficiency and leaf area can be employed to boost leguminous crops (Iqbal Chaudhary *et al.*, 2008).

Soil Characteristics

With the help of soil testing, you can make informed decisions regarding fertilizers and other soil additives for your farm that are both cost-effective and take use of crucial information about key soil properties. Collecting soil samples that appropriately reflect the paddock or area being evaluated is crucial (Baker and Gourley, 2011). The ability of soil to function as a vibrant living system within constraints of land use is the definition of soil health and soil quality. This process, which keeps soil biologically productive, also keeps the quality of the environment and human health (Laishram *et al.*, 2012).

The result of the initial and after treatment of soil properties analysis as to texture, pH, SOM, P, and K was determined and presented in table 4. Comparison of texture both initial and after is heavy while SOM percentage remains low in control group but slight increase to moderately low in T_2, T_3 and T_4. The pH, P and K interpretation used the guide from Horneck *et al.* (2011) and compared from initial and after treatment. Soil pH from neutral to moderately alkaline condition, P content remains high except T_3 i.e. excessive and then K remains high except in control group lowered to medium amount during initial and final respectively.

Furthermore, the paired t-test compares the mean difference of the values to zero which used to evaluate the significant difference before and after treatment in the soil properties as to pH, SOM, P, and K. There is a significant difference and increase from the before and after treatment on pH, and Phosphorous in all treatments with the p-value <0.05. Significant increase of SOM % on T_3 -Chicken manure + P. Further, significant decrease of Phosphorous in T_1 -control and T_2-NPK group but there is no significant difference on the increment in T_3 and T_4. SOM influenced many properties of soils, plus their capacity to hold onto water and nutrients, to offer structure that facilitates effective drainage and aeration, and to reduce topsoil erosion (Robertson *et al.*, 2014). SOM is important for soil health, but its link to production is debatable due to regional variations in the soils, climate, and farming practices (Oldfield *et al.*, 2019). Because of the potential detrimental effects on the quality of surface water, excessive soil phosphorus levels are a cause for concern. As the nutrient absorbed by plants in the highest proportions, potassium is second only to nitrogen. Similar to nitrogen, crops absorb a sizable part of potassium that is accessible to plants each growing season (Spargo *et al.* 2013).

According to Heinrich *et al.* (2018) that, although high soil test P levels do not harm crops, they do raise the chance of off-farm P migration, largely through sediment runoff loss. When phosphorus enters waterways, it may lead to eutrophication, which causes an increase in algae growth and ultimately causes the death of aquatic creatures. Elevated soil test K levels can hinder plants' ability to absorb calcium (Ca) and magnesium (Mg), but they are not environmentally damaging. Since soil organic matter (SOM) serves as a reservoir for nutrients that plants and soil organisms need, increasing SOM levels is frequently the main objective of nutrient management strategies used on organic farms. The organic matter, nitrogen, and phosphorus in the soil were all boosted by poultry manure. As manure levels increased, soil bulk density decreased and moisture content rose (Ewulo *et al.*, 2008).

Conclusion

The application of chicken and guano manure with the addition of phosphorus enhances soil condition and increases soil characteristics such as pH, % SOM, P, and K. With the application of NPK, chicken manure + P, and guano + P, the control pots' growth and yield, dry matter, and root nodules are all affected by the sufficient soil nutrient availability and high Phosphorous content revealed by soil chemical analysis. Additionally, an increase in the means was seen in the potted *V. radiata* L. in terms of the quantity and weight of pods, the weight of grains, and the dry matter of roots and shoots.

Added organic fertilizer, notably chicken dung, which is high in phosphorus. Thus, it is suggested that more research be done on the effect of phosphorus

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