International Journal of Biological, Life and Agricultural Sciences
ISSN: 2415-6612
Vol:7, No:8, 2013

Integrated Use of Animal Manure and Inorganic Fertilizer on Growth and Yield of Vegetable Cowpea (*Vigna uniquiculata*)

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Abstract**—**Field experiment was conducted to investigate the combine use of animal manure and inorganic fertilizer on growth and yield performance of vegetable cowpea. The experiment was laid out in a Randomized Complete Block Design (RCBD) with seven treatments. Poultry manure, cattle manure and goat manure were evaluated with recommended level of inorganic fertilizer for vegetable cowpea. The highest crop yield was obtained by the application of poultry manure combined with the recommended level of inorganic fertilizer. The lowest yield was obtained by the application of goat manure only. In addition, the results revealed that the goat manure and cattle manure were inferior to poultry manure as a source of organic manure for vegetable cowpea cultivation. The animal manure combine with chemical fertilizer gave a higher yield when compared to the sole application of animal manure. The soil analysis showed that the nitrogen content and phosphorus content of poultry manure treated plots were higher than other treatments tested. But potassium content was higher in goat manure treated plots. The results further revealed that the poultry manure has a beneficial effect on crop growth and yield compared with other treatments. Therefore, the combined use of poultry manure with inorganic fertilizer application has been recognized as the most suitable way of ensuring high crop yield.

Keywords**—**Animal manure, inorganic fertilizer, vegetable cowpea, growth and yield performance.

I. Introduction

MODERN agriculture depends on high inputs of chemical fertilizer for crop production. Chemicals certainly provide quick results, but in long-run contributed to soil deterioration, environmental pollution and health hazards [1].

Organic manure plays a vital role to bring stability and sustainability to agriculture and also avoid over dependence of chemical fertilizers [2]. Nowadays, consumer preference is more for organically grown produce because they are free of toxic residues and have concern for environment. Animal manure is a good source for organic fertilizer helps to improve chemical, physical and biological properties of soil and as a source of energy for the soil ecosystem [3]. Research has shown that organic manure will lose approximately one-third of inorganic fertilizer requirement and improve soil organic matter content over a longer period [4]. Furthermore, it is well accepted that the application of organic manure in combination with chemical fertilizer for crop is more useful to obtain high yields [5]. The combined use of organic manures and chemical fertilizer could narrow down the negative nutrient balance substantially; besides improving the soil fertility in many cropping system [6]. Nutrition of vegetable crop is dominated by their shallow rooting habit and rapid growth rate, so that high yields necessitate adequate supply of nutrients throughout the vegetation period. In such situations, the use of animal manures in combination with chemical fertilizer is a viable option to increase crop production [2], [5]. Animal manure consist of animal excreta and bedding material, usually straw, in varying quantities and at varying stages of decomposition [7], [8]. Disposal of litter from large scale animal husbandry unit has become a costly and troublesome affair and the same litter can be easily converted to nitrogen rich soil input and that could replace synthetic nitrogen fertilizers resulting in saving some money. Most of the farmers at Kaluwanchikudy in Batticaloa district (DL_2) have livestock in their farms and facing disposal problem of farm yard manure. Furthermore, majority of the farmers in this area are vegetarian and cultivate vegetable cowpea as a protein source. But, they are using excess amount of inorganic fertilizer than recommended. Hence there is a great potential to use these readily available animal manure to cultivate vegetable cowpea as an alternative source of inorganic fertilizer and farmers can get benefit in eco-friendly. Hence, this study was conducted to investigate the combine use of animal manure and inorganic fertilizer on growth and yield attributes of vegetable cowpea.

II. Methodology

The experiment was carried out (from July 2011 to January 2012) at the Department of Agriculture (DOA) field station at Kaluwanchikudy area in Batticaloa district situated in Low country dry zone (DL_2) agro-ecological zone of Sri Lanka. Soil type of this area is Ragosols and average annual rainfall is 1400mm. The experiment was laid out in a Randomized Completely Block Design (RCBD) with seven treatments. The treatments were randomized in three replicates. The land was prepared and then the area was ridged and divided into 90 x 120cm plots. Seeds of the vegetable cowpea BS-1 cultivar were placed with 30cm spacing between plants and 60cm between rows. The treatments were the seven different fertilizer regimes comprised with animal manure and DOA recommended levels of inorganic fertilizer as given below (Table I).

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TABLE I
DESCRIPTION OF THE FERTILIZER REGIMES (TREATMENTS) USED IN THE EXPERIMENT

Treatments	Fertilizer type and quantities applied to a plot (1.2m ×0.9m)
T_1	Cow dung (1.35kg)
T_2	Poultry manure (1.35kg)
T_3	Goat manure (1.35kg)
T_4	Cow dung (1.35kg), urea (1.89gr), TSP (4.05gr), MOP (10.8gr)
T_5	Poultry manure (1.35kg), urea (1.89gr), TSP (4.05gr), MOP (10.8gr)
T_6	Goat manure (1.35kg), urea (1.89gr), TSP (4.05gr), MOP (10.08gr)
T_7 (control)	Urea (1.89gr), TSP (4.05gr), MOP (10.08gr)

Note: Each experimental plot spanned an area of 1.2m ×0.9m with a distance of 0.3m between adjacent plots separated by trenches.MOP;Muriate of Potash, TSP;Tripple Supper Phosphate.

Fertilizes were applied 3 days before field establishment of vegetable cowpea to minimize the harmful effect of manure. Data were tabulated and analyzed by using Analysis of Variance (ANOVA) procedure of Statistical Analysis System (SAS). Least Significant Difference (LSD) was used to compare differences among the treatment means at p=0.05.

III. RESULTS AND DISCUSSION

A. Yield and Yield Components of Vegetable Cowpea

The higher number of pods per plant was obtained in treatment 4 (cattle manure with inorganic fertilizer). The lowest number of pods per plant was obtained in treatment 1 (only cattle manure). However, there was no significant difference (p=0.05) among treatment 5 (poultry manure with inorganic fertilizer), treatment 6 (goat manure with inorganic fertilizer) and 7, *i.e.* control. Plant receiving the treatment 5 (poultry manure with inorganic fertilizer) was recorded the highest fresh weight of a pod (7.48g) while the lowest fresh weight (5.18g) of a pod was noted in treatment 7, *i.e.* sole application of inorganic fertilizer (Table II).

TABLE II
NUMBER OF COWPEA PODS PER PLANT AND FRESH WEIGHT OF A POD

Treatments	Number of pods per plant	Fresh weight of a pod (g)
T_1	20^{d}	5.29^{e}
T_2	27^{bc}	6.22^{d}
T_3	19^{d}	5.29^{e}
T_4	34^{a}	6.57^{c}
T_5	29^{ab}	7.48^{a}
T_6	29^{ab}	7.13^{b}
T_7	31^{ab}	5.18^{e}
	LSD= 6.0423	*LSD*=0.1464

Note: Means with the same letters/s along the column are not significantly different at p<0.05.Means are the average of three replicates

IV. CORRELATION ANALYSIS

A. Relationship between Growth Parameters, Dry Matter Content and Number of Nodules

When correlation analysis was performed on plant height, stem perimeter, number of leaves, dry weight and number of nodules per plant for the overall data set (Table III) the plant height showed a significant (p<0.01) positive correlation with stem perimeter. Number of leaves per plant showed a highly significant (p<0.0001) positive correlation with plant height. Dry weight of a plant showed a moderately significant (p<0.01) positive correlation with number of leaves. Number of leaves per plant showed a moderately significant (p<0.01) positive correlation with dry weight of a plant. However, nodule number did not show a significant correlation (p=0.05) with growth parameters of vegetable cowpea.

TABLE III
LINEAR CORRELATION COEFFICIENTS OF PLANT HEIGHT (CM), STEM PERIMETER (CM), NUMBER OF LEAVES PER PLANT, DRY WEIGHT OF A PLANT (G) AND NUMBER OF NODULES PER PLANT

	Plant height	Stem perimeter	Number of leaves/plant	Number of nodules/plant	Dry weight/plant
Plantheight	–	0.65**	0.92***	0.30^{ns}	0.66**
Stem perimeter	–	–	0.70**	0.20^{ns}	0.50*
Number of leaves/plant	–	–	–	0.34^{ns}	0.67**
Number of nodules/plant	–	–	–	–	0.28^{ns}
Dry weight/plant	–	–	–	–	–

*Note: *** Significant at p<0.0001, ** Significant at p=0.01,* Significant at p=0.05, ns; non-significant at p=0.05.*

B. Estimation of Yield (kg) per Hectare

The highest crop yield was obtained in treatment-5 by the application of poultry manure combined with the DOA recommended chemical fertilizer while the lowest yield was obtained in treatment. On the other hand, treatment-2 and treatment 6 did not show a significant yield increase over the control (T7). Furthermore, animal manure combined with chemical fertilizer gave a higher yield than the treatments which was applied only animal manure (Fig. 1).

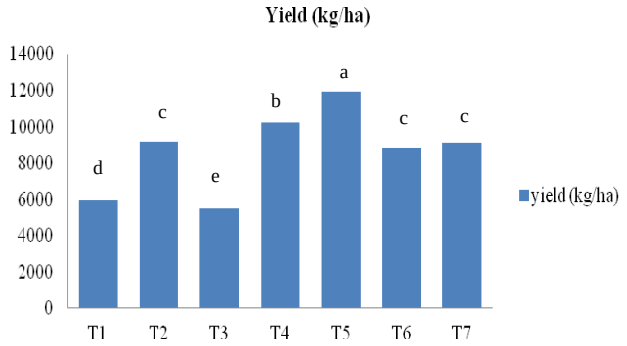

Fig. 1 Variation of yield (kg) per hectare, Values are the means of three replicates

TABLE IV
LINEAR CORRELATION COEFFICIENTS OF NUMBER OF PODS PER PLANT, FRESH WEIGHT OF A POD (G), YIELD PER HECTARE (KG), DRY WEIGHT OF A PLANT AND NUMBER OF NODULES PER PLANT

	Number of pods/plant	Fresh weight/ pod	Yield/ha	Dry weight/ plant	Nodule number/plant
Number of pods/plant	_	0.25^{ns}	0.69**	0.48*	-0.05^{ns}
Fresh weight of a pod	_	_	o.79***	0.67**	0.23^{ns}
Yield/ha	_	_	_	0.77***	0.17^{ns}
Dry weight of a plant	_	_	_	_	0.28^{ns}
Nodule number	_	_	_	_	_

*ns, non-significant at p=0.05; *significant at p=0.05; **significant at p= 0.01; ***significant at p= 0.001.*

When correlation analysis was performed on yield and yield components of vegetable cowpea, fresh weight of a pod showed highly significant ($p<0.0001$) positive correlation with yield per hectare. However, number of nodules per plant did not show a significant ($p<0.05$) correlation with yield components of vegetable cowpea (Table IV).

TABLE V
LINEAR CORRELATION COEFFICIENT OF NUMBER OF PODS PER PLANT, NUMBER OF NODULES PER PLANT AND NITROGEN CONTENT (PPM)

	Number of pods/plant	Nodule number/plant	N content
Number of pods/plant	–	0.0000^{ns}	0.30^{ns}
Nodule number/plant	–	–	0.37^{ns}
N content	_	_	_

*Note: *** Significant at p=0.0001, ** Significant at p=0.01, * Significant at p=0.05, ns; non-significant at p=0.05.*

When correlation analysis was performed on pods per plant, number of nodules and nitrogen content of soil, number of pods per plant did not show significant correlation ($p<0.05$) with number nodules per plant as well as nitrogen content of the soil (Table V).

C. Chemical Analysis of Soil

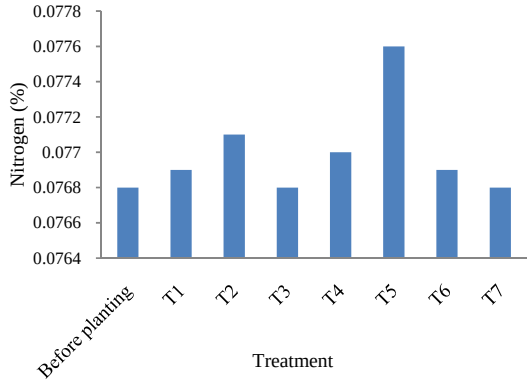

Fig. 2 Total nitrogen content of soil

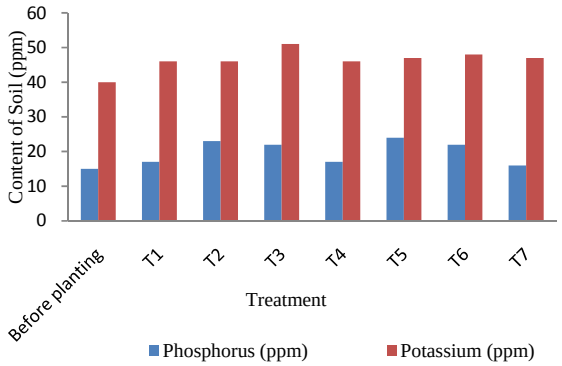

Fig. 3 Available potassium and phosphorus content of soil (ppm)

The soil analysis showed that the total nitrogen content and phosphorus content of poultry manure treated plots were higher than other treatments (Figs. 2 and 3). But potassium content was higher in goat manure treated plots (Fig. 3). Hence the use of poultry manure could be contributing to increase of soil nutrient content [3]. In addition poultry manure also has a very high decomposition rate compared with other animal manures [9]. Hence, the beneficial effect of poultry manure on crop yield in this study is justified. It has been reported that the improved physical condition of soil resulting from the addition of organic matter increased the crop yield compared to use of chemical fertilizer with the same rate [5] reported about the highest microbial activity in the soil when treated with both organic and chemical fertilizers.

V. CONCLUSION

The highest crop yield was obtained by the application of poultry manure combined with the recommended level of inorganic fertilizer. The lowest yield was obtained by the sole application of goat manure. The animal manures combined with chemical fertilizer gave a higher yield than treatment which was applied only animal manure. The results clearly revealed that the poultry manure has a beneficial effect on crop growth and yield compared with other treatments. Interaction effects between organic manures and chemical fertilizers for crop yields were not significant ($p=0.05$) throughout the experiment. Therefore, the combine use of poultry manure with inorganic fertilizer application (DOA recommendation) has been recognized as the most suitable way of ensuring high crop yield.

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