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Residual effect of Organic manure EM Bokashi applied to Proceeding Crop of Vegetable Cowpea (*Vigna unguiculata*) on succeeding Crop of Radish (*Raphanus sativus*)

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Abstract

This study was conducted to assess the residual effect of different organic manure EM Bakashi on yield of radish (Raphanus sativus) on sandy regosol. Immediately after harvesting of vegetable cowpea, radish was cultivated as succeeding crop without disturbing soil. The study was done as pot experiment in a complete random design consisting five treatments. At harvest, diameter and length of tuber, fresh and dry weights of leaves and tuber and total dry matter of radish were recorded and all recorded data were subjected to statistical analysis. The present study revealed that application of EM bokashi may provide significant amount of residual nutrients for cultivation of a short durational succeeding crop and the residual benefits depend on the initial nutrient content of manure. There was significant difference (P<0.05) in tuber diameter, fresh and dry weights of leaves and tuber and total dry matter content between manures. Tuber length was not significantly (P>0.05) varied with manure origin. Radish tuber yield per plant was high (76.98 g) in poultry manure and followed by 57.48 g in goat manure on fresh basis. Results suggest that application of EM bokashi prepared using these two manures could improve soil fertility on sandy regosol.

Keywords: Organic manure, EM Bokashi, residual effect, proceeding crop, succeeding crop.

Introduction

Excessive use of inorganic fertilizer causes environmental and human health problems. Hence the farmers have been practices with eco-friendly cultivation and organic manures added to soil increase the supply of plant nutrients[1]. Use of organic manure in effective manner can serve as substitute for chemical fertilizer without detrimentally yield reduction and can serve to stabilize global crop prices[2]. The common organic manure used world widely in farming system is animal manure such as cattle, goat, poultry, green manures and compost. Animal manure is a valuable input in crop production and can be used as organic fertilizer which contains major and minor elements needed to plant growth[2]. Animal manures are heterogeneous in term nutrient composition with animal species and stage of animal growth[3].

After the establishment of nature farming system, there was a technology introduced by Higa named as effective microorganism which is used as a means of improving soil conditions, suppressing disease and improving the efficiency of organic matter utilization by crops[4]. Numerous studies have been conducted to investigate the efficacy of EM application on crop production in many countries and promotion in crop production was obtained when using EM as foliar application or incorporated with organic manure added to soil[5, 6]. One form of EM application to crops in nature farming system is EM Bokashi which can be prepared using any kind of animal dung[4] and EM fermented compost had significance promotion in crop production[7].

In a cropping system, response of the component crop is influenced by the proceeding crop and inputs applied to them[8]. Organic manure added to soil leaves substantial amount of residual nutrients to succeeding crop beside, it supplying nutrients to the current crop[9]. Some studies have been reported that organic manures have significance residual effects on the soil and succeeding crop[10]. All the ingredients of EM bokashi are biodegradable and its residual nutrient would persist in the soil. With these concerns, there may be a possibility to certain amount of nutrients left in soil which fertilized with EM Bokashi to the proceeding crop of vegetable cowpea. Vegetable cowpea is a leguminous crop which also has fixed nitrogen into soil. Thus there is a scope to cultivate a succeeding crop with the residual nutrients. In Sri Lanka, radish is one of the vegetable that can be grown in all agro ecological regions throughout the year if adequate moisture is available and it is a short duration tuber crop. Therefore, present study was done to evaluate the residual effect of EM Bokashi applied to proceeding crop of vegetable cowpea on succeeding crop of radish in sandy regosol.

Material and Methods

In order to assess the residual effect of organic manure EM Bokashi applied to proceeding crop of vegetable cowpea on yield performance of succeeding crop of radish, an experiment was carryout at the Crop Farm, Eastern University of Sri Lanka during 2009-2010. The experimental site is situated in the

Eastern region of Sri Lanka where the mean annual rainfall ranges from 1600 to 2100 mm, annual mean temperature is from 28°C and 32°C and humidity ranges from 60% to 90%. The previous study was a pot experiment and EM Bokashi was the fertilizer for the proceeding crop at the rate of 300 g per m^2. Three different animal manure EM bokashi such as cattle, goat and poultry manures were prepared two weeks before planting of vegetable cowpea (BS1) using animal manure, rice bran and rice husk at the ratio of 2:1:1 (w/w/w) respectively and EM solution as recommended in EM application manual for APNAN countries[4]. Treatments included T1-Recommended inorganic fertilizer, T2- Non-fertilizer, T3-Cattle manure-EM-bokashi, T4-Goat manure-EM-bokashi and T5-Poultry manure-EM-bokashi.

Immediately after harvesting of vegetable cowpea, radish seeds *cv* beeralu rabu were seeded as succeeding crop. The present study was laid out in a complete randomized design with five treatments. Agronomic practices except nutrient management were followed according to the recommendation of the Department of Agriculture of Sri Lanka. Crop was harvested at correct time of tuber maturity and agronomic parameters such as diameter and length of tuber, fresh weights of leaves and tuber and whole plant of radish were recorded and plant samples were oven dried at 105°C for over night to determine the biomass per plant at the time of harvest. All collected data were statistically analyzed by analysis of variance and the treatment mean separation was done using Duncan's Multiple Range Test at 5% level by using Statistical Analysis System (SAS) soft ware package.

Results and Discussion

Length and diameter of tuber: Tuber length and diameter of radish are presented in table-1. It indicated that there was highly significant difference (P<0.01) in tuber diameter among the treatments. The reason for the variations was due to the various level of residual nutrient from applied manure. Tuberous root is the common edible part of radish and it was observed that plant grown in EM bokashi showed larger tuber diameter compared with chemical fertilizer. It suggested that EM bokashi prepared using animal manure have high residual effect on succeeding crop. Compared with organic manure, the residual amount of nutrients in case of chemical fertilizer may be lower because chemical fertilizer are highly water soluble, and intake by proceeding crop effectively thus has left low amount in soil. Manures with low nutrient content per unit quantity have longer residual effect besides improving soil physical properties compared to fertilizer with high nutrient content[11]. Tuber diameter was high in poultry manure (T_5) followed by goat manure (T_4). Average length and diameters ranged from 14.4 cm to 16.1 cm and 3.8 cm to 5.0 cm respectively. Tuber length was not significantly (P>0.05) varied among different manure EM bokashi.

Table-1
Tuber length and diameter of radish at harvest

Treatments	Tuber length (cm)	Tuber diameter (cm)
T_1	14.6 ± 0.83	4.2 ± 0.16 bc
T_2	14.9 ± 0.56	3.8 ± 0.11 c
T_3	15.0 ± 0.80	4.6 ± 0.12 ab
T_4	14.4 ± 0.70	4.9 ± 0.12 a
T_5	16.1 ± 0.45	5.0 ± 0.07 a
F test	ns	**
CV %	9.1	10.1

Value represents mean ± standard error of four replicates. F test: - ** P< 0.01; ns: not significant, Means followed by the same letter are not significantly different according to DMRT at 5% level.

Fresh weights of leaves, tuber and whole plant: There were significant differences (P<0.01) observed in fresh weights of leaves, tuber and whole plant (table-2). Even though the most common edible part is tuber in radish and top portion (leaves) also used as leafy vegetable. Average fresh weight of leaves ranged from 23.73 g to 34.79 g. Phosphorus (P) and potassium (K) are very essential nutrients beside nitrogen (N) for tuber crops. P is essential early in plant growth, it promotes root growth, enhances nutrient and water efficiency and increases yield[12]. Hence, the function of P mainly associated with higher metabolism of plant. K is essential for the development of root system[13] and K is closely related to N assimilation in plant and can accelerate transport of NO_3^- from root to above ground plant parts[14].

Table-2
Fresh weights of leaves, tuber and whole plant of radish at harvest

Treatments	Fresh weight of leaves (g)	Fresh weight of Tuber (g)	Fresh weight of whole plant (g)
T_1	23.73 ± 0.62 b	42.12 ± 1.43 c	65.85 ± 0.85 c
T_2	23.79 ± 0.80 b	29.27 ± 1.75 d	53.06 ± 1.64 d
T_3	26.79 ± 1.65 b	44.35 ± 1.66 c	71.14 ± 1.21 c
T_4	34.79 ± 1.74 a	57.48 ± 1.50 b	86.73 ± 1.33 b
T_5	29.25 ± 1.77 ab	76.98 ± 1.56 a	111.77 ± 2.56 a
F test	**	**	**
CV %	15.1	8.7	5.0

Value represents mean ± standard error of four replicates. F test: - ** P< 0.01. Means followed by the same letter are not significantly different according to DMRT at 5% level.

Table-3
Dry weights of leaves, tuber and whole plant of radish at harvest

Treatments	Dry weight of leaves (g)	Dry weight of tuber (g)	Plant biomass (g)
T_1	2.45 ± 0.06 b	5.82 ± 0.20 c	8.28 ± 0.14 c
T_2	2.60 ± 0.11 b	3.25 ± 0.19 d	5.85 ± 0.17 d
T_3	4.48 ± 0.28 a	7.41 ± 0.22 c	11.89 ± 0.20 c
T_4	5.71 ± 0.44 a	8.45 ± 0.22 b	14.16 ± 0.51 b
T_5	3.42 ± 0.20 a	9.01 ± 0.18 a	12.43 ± 0.30 a
F test	*	**	**
CV %	19.4	8.8	6.8

Value represents mean ± standard error of four replicates. F test: - ** P< 0.01; *P< 0.05. Means followed by the same letter are not significantly different according to DMRT at 5% level.

In the present study, results indicated that the tuber weight was remarkably differed (P< 0.01) and yield of plant grown in EM manure bokashi were better than inorganic fertilizer. Better performance of EM bokashi was because of combined positive effect of EM on crop and released nutrients via the decomposition of bokashi ingredients such as rice husk, rice bran and manure with time for the subsequent season. The adequate absorption of the nutrients requires for biochemical and physiological activities of plants[15]. Yamada stated that most obvious effect of EM application is root development and root growth[16]. Increase in tuber diameter also contributed for the increase in tuber weight. Average value of tuber weight and whole plant ranged from 29.27 g to 76.98 g and 53.06 g to 111.77 g respectively. It was reported that application of EM bokashi or EM fermented compost improves the crop production and quality of product[17, 7]. In additional to the supply of nutrient by manure, it increases water holding capacity of soil adds humus and makes the soil into porous.

The highest tuber weight was obtained in poultry (T_5) followed by goat manure (T_4). This could possibility due to higher P and K content of goat and poultry manures compared to cattle manure. P_2O_5 content of cattle, goat and poultry are 0.12%, 1% and 2.63 % respectively and K_2O content 0.17%, 2% and 1.4% respectively[11]. It was observed that poultry manure had highest effect on soil available levels of N and P compared to other animal manures[18]. It was proved that the trend in nutrient releasing rate of N and P of all three manures was poultry > goat > cow dung and it has been reported that mineralization of organic N and P increased with time after initial application[19].

Dry weights of leaves, tuber and whole plant: Analysis the data on dry weights of leaves, tuber and total dry matter were found to be significant among treatments (table-3). Three manure types EM bokashi were not significant differed (P>0.05) in terms of dry weight of leaves. Average dry weight of leaves ranged from 2.45 g to 5.71 g. Presented data on the dry weight of tuber shows highly significant difference (P<0.01) among all treatments. This trend was expected given in initial difference in total N, P and K of all three manures. It was clearly showed that residual effects of applied manure vary with type of manure origin, nutrients content, consequently affect the synthesis, and accumulated amount food in tuber of radish.

Cow manure has high value in C:N ratio around 30:1 compared to poultry[20] and negatively correlated with N mineralization [21]. Dry tuber weight was high in T_5 followed by T_4. Finding of present study also agreed with Qian and Schoenau findings who obtained highest yield of Canola in poultry manure and the suggest reason was the narrowest C: N ratio of poultry manure[21]. The observation in biomass was similar to the tuber dry weight of radish. The major part of total dry matter is tuber dry weight. During tuberization, food accumulation occurs in tuber and major part of synthesized are substances partitioned from source (leaves) to sink (tuber) thereby prominent variation in tuber at the harvesting. Increasing yield, quality, dry matter content due to increasing K fertilizer rate has been reported in onion[22].

Conclusion

This study showed that there were significant differences in tuber diameter, fresh and dry weights of leaves, tuber and whole plant. Residual nutrients affect the yield performance of succeeding crop and extend of effects depend on the nutrients content of manure. Radish tuber yield was high (76.98 g) in poultry manure and followed by 57.48 g in goat manure (T_4) on fresh basis. Based on the yield performance of succeeding crop, it was cleared that the application of these two manures in EM bokashi form could be improved soil fertility on sandy regosol.

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