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Effect of EM-Bokashi on vigorous seed production in vegetable cowpea *(Vigna unguiculata L.)*

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Abstract: The experiment was conducted to study the effect of EM-Bokashi on seed performance in vegetable cowpea (*Vigna unguiculata* L.). Results showed that the seeds harvested from animal manure EM-bokashi recorded significant increases in their vegetative and reproductive growth parameters than those from chemical and non-fertilized plants. Among the seeds harvested from different types of animal manure Bokashi, seeds in goat manure EM-bokashi showed high dry weights of stem, number of nodules, pod weight and plant biomass. Hence, it could be concluded that the use of animal manure with EM in vegetable cowpea cultivation could give the healthy seeds as planting material for obtaining high pod and seed yields and also for favourable health and environment.

Key words: Animal manure, effective microorganism, vegetable cowpea seeds, sandy regosol

Introduction

Vegetable cowpea (*Vigna unguiculata*) is widely cultivated in the Eastern region of Sri Lanka and other Asian countries. In conventional agriculture, chemical fertilizers are an important component however in recent years the safety and health of food has becoming a major concern due to overuse of chemicals for food production and its negative impacts on human health and environment (Pimentel, 2005). Most agricultural practices affect soil quality by altering the soil properties and have led to a decrease in soil microbial populations resulting in decreased crop productivity (Valarini *et al*., 2002). Therefore, organic materials hold great promise as a source of multiple nutrients and ability to improve soil characteristics (Moller, 2009). Since the effect of organic nutrients on crop yield is long term and not immediate, farmers are reluctant to use organic fertilizers in their cropping system and use of EM (effective microorganisms) along with organic materials possibly be an effective technique for stimulating release of nutrients from organic sources (Javaid, 2009). Application of EM is known to enhance crop growth and yield in many crops, both leguminous and non-leguminous (Sheng and Lian, 2002; Javaid, 2006, 2009; Khaliq *et al.,* 2006; Daiss *et al.,* 2008) High quality seed is a major factor in obtaining a better crop growth and their development even under adverse conditions (FAO, 2007). This experiment was aimed to study the influence of EM-Bokashi on vigorous seed formation for crop growth of vegetable cowpea on sandy regosol.

Materials and Methods

In the previous experiment, the vegetable cowpea plants *cv. Bushitao* were grown in non-fertilizer, inorganic fertilizer and also three different types of fermented organic matters with EM. Subsequently seeds were obtained and used in this study to evaluate the seed performance of vegetable cowpea. The present experiment was carried out in the Eastern region of Sri Lanka in 2010/2011. Inorganic fertilizer recommended by the Department of Agriculture was applied for vegetable cowpea cultivation. The manure fermented with EM (EM-Bokashi) was separately made from rice bran, rice husk and animal manure (cattle manure, goat manure and poultry manure) at the ratio of 1:1:2 (w/w/w). They were mixed together and added EM solution. EM-bokashi (300 g/m^2) was applied as basal

and top dressing as recommended by kyan *et al.* (1999).

The collected seeds from the previous experiment as mentioned above were planted at 60 cm x 20 cm spacing in the field without any fertilizer application (Table 1). The treatments were assigned in a randomized complete block design with five blocks. The other agronomic practices were done as recommended. The growth measurements in each plot (2.6 m^2) were taken at two weeks intervals. All the plant samples were oven dried at 105 ^oC, subsequently their dry weights were taken. Data collected were analyzed using SAS statistical computer package and treatment means were compared by using Tukey's Studentized Range (HSD) Test at 5% level.

Table 1: The seeds obtained from the previous experiment.

Treatments	Seeds harvested from the plants grown in different fertilizer regimes
T1 (control)	Non fertilizer application
T2	Chemical fertilizer application
T3	Cattle manure EM-bokashi application
T4	Goat manure EM-bokashi application
T5	Poultry manure EM-bokashi application

Results and Discussion

Leaf weight per plant

The highest dry weight of leaves was obtained in T4 treatment at the different growing periods (Table 2) and also the results showed that seeds from the animal manure EM-bokashi treatments (T3-T5) had higher value than the chemical and non-fertilizer (T2 and T1). There were significant differences among the treatments on dry weight of leaves (Table 2). Both T4 and T5 generated heavier leaf dry matter than the other treatments throughout the plant life. However, among the all treatments, seeds from goat manures EM-bokashi (T4) showed highest value at different growing periods. This may due to combination of goat and EM able to increase higher rate of growth and photosynthetic activity in leaf. In the present study, the seeds from animal manure EM-bokashi showed no significant different in leaf area among the treatments at the 4^{th} week, but the following week interval, T4 showed significant ($P < 0.05$) difference than the other treatments. The result is supported with Hsieh and Hsieh (1990) who reported that goat manure EM-bokashi had high mean leaf area than other EM-bokashi due to having higher amount of potassium than the other treatments. Potassium compounds are important in plant nutrition because they have a marked influence upon the development of leaves (Lucius, 2001).

Table 2:
Effect of the source of seeds on leaf dry weight of vegetable cowpea.

	Vegetative stage		Flowering stage	Maturity stage
Treatments	**2 week**	**4 week**	**6 week**	**10 week**
T1 (control)	0.18 ± 0.01b	0.73 ± 0.06b	07.85 ±0.02b	06.95 ± 0.29b
T2	0.19 ± 0.01b	1.05 ± 0.02a	08.06 ± 0.38b	08.95 ± 0.20ab
T3	0.19 ± 0.01b	1.28 ± 0.06a	08.21 ± 0.37b	09.00 ± 0.56ab
T4	0.26 ± 0.01a	1.31 ± 0.06a	10.29 ± 0.48a	10.66 ± 0.47a
T5	0.23 ± 0.01ab	1.29 ± 0.01a	09.56 ± 0.33ab	09.15 ± 0.38a
F test	*	*	*	*
CV%	9.23	8.44	7.84	8.42

Values represent the mean ± standard error. F test: *- $P < 0.05$. Means with the same letter in each column are not significantly different at 5% level, according to Tukey's Studentized Range (HSD) Test.

Stem weight per plant

Result revealed that weight of stem per plant was increased in all the treatments compared to the control treatment (Table 3) and T5 showed high fresh weight among all the treatments at the 10th week. T4 had the high values in dry weight at the different stages except maturity stage. This was similar to the finding of Javaid *et al.* (2000) who found that the stem fresh weight was enhanced by EM application with any farm yard manures.

Table 3:
Effect of the source of seeds on stem dry weight of vegetable cowpea.

	Vegetative stage		Flowering stage	Maturity stage
Treatments	**2 week**	**4 week**	**6 week**	**10 week**
T1 (control)	0.082 ± 0.006c	0.316 ± 0.01b	6.28 ± 0.51	07.01 ± 0.52c
T2	0.089 ± 0.003bc	0.433 ± 0.03ab	7.12 ± 0.39	11.32 ± 0.64b
T3	0.094 ± 0.004bc	0.530 ± 0.05a	7.34 ± 0.09	12.56 ± 0.42b
T4	0.107 ± 0.003a	0.583 ± 0.02a	7.97 ± 0.28	18.25 ± 0.82a
T5	0.101 ± 0.004b	0.540 ± 0.02ab	7.75 ± 0.41	18.48 ± 0.95a
F test	*	*	ns	*
CV%	8.32	12.57	8.39	8.23

Values represent the mean ± standard error. F test: ns –P > 0.05;*- P < 0.05, **-P < 0.01 Means with the same letter in each column are not significantly different at 5% level, according to Tukey's Studentized Range (HSD) Test.

Number of nodules per plant

Number of nodules per plant in T4 was considerably higher compared with other treatments throughout life cycle of the plant (Table 4). This may be due to high amount of potassium present in goat manure. This result agrees with Lucius (2001) who found that potassium stimulates the formation of carbohydrates in the nodules and thereby makes them better fitted to support the nitrifying bacteria.

Table 4:
Effect of the different treatments on nodulation of vegetable cowpea.

	Number of nodules per plant			
Treatments	**2 week**	**4 week**	**6 week**	**10 week**
T1 (control)	1.33 ± 0.33b	07.00 ± 0.57d	17.00 ± 2.00b	09.33 ± 0.33b
T2	2.67 ± 0.33ab	08.00 ± 0.57d	19.33 ± 0.66b	10.67 ± 0.66ab
T3	3.67 ± 0.33a	14.00 ± 0.57b	20.33 ± 0.33b	13.67 ± 0.66a
T4	4.00 ± 0.57a	19.33 ± 0.33a	28.33 ± 0.66a	14.00 ± 1.00a
T5	2.67 ± 0.33ab	11.67 ± 0.33c	20.33 ± 0.33b	13.00 ± 1.00ab
F test	*	**	**	*
CV%	23.83	5.69	8.71	11.46

Values represent the mean ± standard error. F test: * -P < 0.05;**- P < 0.01. Means with the same letter in each column are not significantly different at 5% level, according to Tukey's Studentized Range (HSD) Test.

Root weight per plant

EM combined with animal manures treated seed's plants increased weight of root per plant (Table 5) than other treatments and goat manure EM-bokashi had high value. The effect of dry weight on different treatments and there were significant ($P < 0.05$) different among the treatments at the 2nd and 4th weeks thereafter no remarkable variation. Inoculation of effective microorganism can increase the available nutrition for plant roots and improve photosynthesis (Muthaura, 2010).

Table 5:
Effect of the different treatments on root dry weight of vegetable cowpea

	Vegetative stage		Flowering stage	Maturity stage
Treatments	**2 week**	**4 week**	**6 week**	**10 week**
T1 (control)	0.031 ± 0.004b	0.15 ± 0.03b	1.19 ± 0.27	1.62 ± 0.38
T2	0.045 ± 0.003ab	0.22 ± 0.03b	1.37 ± 0.16	1.88 ± 0.46
T3	0.054 ± 0.003ab	0.26 ± 0.02ab	1.59 ± 0.31	2.34 ± 0.45
T4	0.059 ± 0.002a	0.35 ± 0.016a	1.69 ± 0.05	2.51 ± 0.45
T5	0.051 ± 0.003ab	0.20 ± 0.03b	1.51 ± 0.02	2.40 ± 0.42
F test	*	*	ns	ns
CV%	12.81	19.17	25.05	28.49

Values represent the mean ± standard error. F test: ns –$P > 0.05$;*- $P < 0.05$. Means with the same letter in each column are not significantly different at 5% level, according to Tukey's Studentized Range (HSD) Test.

Pod weight

Significant variations in pod length as well as dry weights of green pod were observed among the treatments (Table 6). EM increased the pod number and weight as reported by Hussain *et al.* (1994). The present result is due to seed sources of vegetable cowpea that could improve plant growth and yield. The seeds collected from plants fertilized with animal manure EM-Bokashi, exhibited better plant performance.

Table 6:
Effect of the different treatments on green pod and plant biomass

Treatments	**Pod length (cm)**	**Pod fresh weight (g)**	**Pod dry weight (g)**	**Plant biomass (g)**
T1 (control)	21.20 ± 0.29b	19.82 ± 0.23d	1.68 ± 0.02b	36.29 d
T2	22.58 ± 0.22ab	23.45 ± 0.25b	2.18 ± 0.29ab	59.21 c
T3	22.15 ± 0.96b	21.41 ± 0.49c	2.52 ± 0.49b	77.65 b
T4	24.72 ± 0.45a	25.10 ± 0.45a	3.01 ± 0.20a	101.64 a
T5	23.12 ± 0.54ab	22.86 ± 0.46bc	2.62 ± 0.39ab	85.91 b
F test	*	**	*	*
CV%	3.69	2.35	16.84	13.21

Values represent the mean ± standard error. F test: * -$P < 0.05$;**- $P < 0.01$. Means with the same letter in each column are not significantly different at 5% level, according to Tukey's Studentized Range (HSD) Test.

Plant biomass

The effect of source of seeds on plant biomass is showed in Table 6 and there was significant difference ($P<0.05$) on plant biomass among the treatments. The seeds collected from plant grown in goat manure EM Bokashi exhibited significantly ($P < 0.05$) high plant biomass and pod yield followed by seeds from poultry manure. This finding is supported by Yan and Xu (2002) who reported that the pod dry weight of peanut in EM-bokashi fertilizer treatment was significantly higher than that in chemical fertilizer treatment. EM application has proved beneficial in increasing crop growth and yield in mungbean and vegetables (Sangakkara and Higa, 1994). The present results also indicated that seeds collected from plant grown in EM-bokashi treatments expressed more plant biomass than chemical and non-fertilizer application treatments. Plant biomass is an important parameter that influences on yield of the crop especially legumes that are grown for food, feed and green manuring. The results revealed that seeds collected from plants grown in EM-bokashi treatments remarkably showed high ($P<0.05$) plant biomass than those in chemical and non-fertilizer treatments and also seeds from goat manure with EM-bokashi significantly ($P<0.05$) enhanced biological yield among the seeds harvested from different types of animal manure EM-Bokashi treatments.

Conclusion

Application of animal manure treated with EM solution especially goat manure-EM-bokashi as a substitute of inorganic fertilizers gave the healthy seeds as planting material. The vigorous seeds are a major factor in obtaining a good crop growth and their development ultimately achieves optimal biological and economic yields. Therefore, this organic cultural practice as a substitute of inorganic cultivation can be adapted by farmers for producing good crop with lesser health and environmental problems.

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