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FIELD EVALUATION OF CATTLE MANNURE ALONG WITH EFFECTIVE MICROORGANISMS ON GROWTH AND YIELD OF CAPSICUM (*CAPSICUM ANNUM* L.)

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ABSTRACT

The experiment was conducted to evaluate the effect of effective microorganisms (EM) along with cattle manure on growth and yield of capsicum (*Capsicum annum* L.) in field conditions at the Crop farm, Eastern University, Sri Lanka. This study had six treatments with three replicates and it was arranged in a Randomized Complete Block Design. The treatments were inorganic fertilizer application (T1), no fertilizer application (T2) and different rates of cattle manure (5-20 ton/ha) with EM (from T3 to T6). The results shows that there was no significant difference (P>0.05) in canopy height among the treatments upto 20 DAT. However, remarkable variation (P<0.05) was observed at 30 DAT and T4 had highest canopy height. Among the tested treatments, there was no significant difference (P>0.05) in number of leaves per plant at 10, 20 and 30 DAT which was confirmed with *P* values of 0.197, 0.700 and 0.075 and chi-square of 7.33, 3.00 and 10.00 respectively. The diameter of pod was increased upto 3rd picking thereafter it was decreased in most of the treatments. Increasing cattle manure from 5 tons/ha to 10 tons/ha, increased number of pods per plant. The fresh weight of pods, number of seeds per pod as well as dry weights of pods and seeds were high in cattle manure (10 tons/ha) with EM. The present study suggests that cattle manure at the rate of 10 tons/ha along with EM would be the most suitable treatment to obtain high vegetative and reproductive growth of capsicum in sandy regosol.

KEY WORDS: Capsicum, cattle manure, effective microorganisms, inorganic fertilizer

INTRODUCTION

Organic farming plays a vital role in providing quality and quantity of food in sustainable basis and reuses of animal manures and crop residuals into valuable products. To achieve sustainable agriculture, resources must be successfully managed to satisfy changing human needs, to conserve natural resources and to maintain or improve the quality of the environment (Mirani *et al*., 2002). A healthy resilient soil is imperative for sustainable agriculture and is achieved in part through crop rotations and the recycling of organic wastes maintaining adequate soil organic carbon (Parr *et al*., 1992). Organic fertilizers are good sources of nutrients for crop production and improving physical and chemical properties of soil (Chrispaul *et al*., 2010).

High cost and uncertain accessibility of inorganic fertilizer, farmers have over time found widespread use of locally available forms of organic nutrient sources such as livestock manures, green manures, composted materials and household waste and crop residues for crop production (Fening *et al*., 2010). Major problem involved in recycling the waste material is slow release rates of nutrients during decomposition of organic materials (Hseih and Hseih, 1990). Microorganisms can enhance the efficacy of organic systems and these organisms create conditions which favour mutual support and enable them to competing harmful pathogens (Dobereiner, 1994). And also he stated that microbial fertilizer can clean the environment and encourage the productive capacity of land by reducing the amount of chemical fertilizer consumption. Microorganisms are important aspect in agriculture to support for providing plant nutrients and decrease the requirement for inorganic fertilizers. Biofertilizers are organic products containing living cells of different types of microorganisms that have emerged as important component of the integrated nutrient supply system and hold a great promise to improve crop yields through environmentally better nutrient supplies (Chrispaul *et al*., 2010). Application of biofertilizers helps to convert nutritionally important element from unavailable to available form through biological processes.

Effective microorganisms (EM) are a commercially available liquid that contains a variety of lactic acid bacteria, yeasts and phototrophic bacteria. It helps to speed up the decomposition of organic matters and releasing nutrients to the soil. EM has unique ability to minimize the risk factors which may contribute towards the onset of pathological problems in plants and animals (Sajjad-ur-Rahman *et al*., 1999). Inoculation of EM cultures to the soil plant ecosystem can improve soil quality, soil health and the growth, yield and quality of the crops (Kengo and Hui-lian, 2000). EM application increases in soil microorganisms that are beneficial for plant growth that results more rapid organic matter mineralization, suppression of soil borne disease pathogens and increased crop yield and quality (Asia-Pacific Natural Agriculture, 1995). Organic fertilizer with EM technology is simple, sustainable, economically viable, beneficial for farmers livelihoods and environmentally friendly (Sopoit, 2006) and EM enhance yields of organic systems to pollution control (Sangakkara and Higa, 1994). The success of EM in organic systems is attributed to the more rapid breakdown of organic matter, enhanced availability of nutrients and improvements in soil properties (Sangakkara, 1994). Therefore, this study was hypothesized that cattle manure with effective microorganisms improves growth and yield of capsicum (*capsicum annum*) in sandy regosol.

MATERIALS AND METHODS

A study was conducted at the Eastern regions of Sri Lanka in 2011-2012 as a continuation of polybag experiment conducted in 2010-2011 to evaluate field performance of cattle manure along with EM on growth and yield of capsicum. The research area was situated between 81° 34' latitude and longitude and 7° 48' longitude. It comes under the agroecological zones of low country dry zone. Optimum temperature is 31±2°C and annual rain fall is 1600 mm. The soil of experimental site is sandy regosol. The experiment was designed in Randomized Complete Block Design with six treatments and three replicates. Treatments were,

T1: Inorganic fertilizer application as a control
T2: No fertilizer application
T3: Cattle manure (05 tons/ha) with EM

T4: Cattle manure (10 tons/ha) with EM
T5: Cattle manure (15 tons/ha) with EM
T6: Cattle manure (20 tons/ha) with EM

Seed germination of capsicum was tested and it was 85%. After testing the seed germination, seeds were sown in the nursery and agronomic practices were followed as recommended by Department of Agriculture of Sri Lanka (DOA). Field was prepared and leveled. Two weeks before transplanting, different rates (5-20 tons/ha) of cattle manure were applied to the assigned treatments (T3, T4, T5 and T6) as mentioned above. EM solution was diluted with water at the ratio of 1:100**.** Equal amount of diluted solution was sprayed and mixed well with cattle manure and allowed for two weeks to decompose and improve the soil conditions. The healthy seedlings of four weeks were transplanted into field. Diluted EM solutions were also sprayed at the 2nd and 4th week after planting to all plants except plants in T1 and T2. Other agronomic practices were followed as recommended by DOA. Data were recorded at weekly interval and collected data were analyzed using statistical software.

RESULTS AND DISCUSSION

Plant height

The results showed that there was no significant difference (P>0.05) among the treatments in canopy height at 10th and 20th days after transplanting (DAT) as shown in Table 1. However, remarkable variation (P<0.05) was observed at 30 DAT. Cattle manure at 10 tons/ha with EM had highest canopy height compared to inorganic fertilizer applied as a basal fertilizer application. But statistically, there is no variation between both treatments. The height of canopy ranged from 18.66 cm (T2) to 26.33 cm (T4). Cattle manure at 10 tons/ha with EM gave taller plants, while increase beyond 10 tons/ha led to reduce canopy height however, statistically there was no significant variation with 10 tons/ha. It was agreed with Ghofoor and Akhtar (1991) reported that increased fertilization had no significant effect on canopy height of maize cultivar.

Table 1: The canopy height at vegetative stage of capsicum after transplanting

Treatments	Canopy height (cm)		
	10 DAT	**20 DAT**	**30 DAT**
T1	13.63 ± 1.81	17.00 ± 1.15	23.33 ± 2.40 ab
T2	13.10 ± 1.40	15.60 ± 1.85	18.66 ± 1.33 b
T3	15.33 ± 0.60	18.33 ± 0.66	21.66 ± 1.66 ab
T4	15.56 ± 0.29	17.66 ± 1.20	26.33 ± 2.85 a
T5	14.13 ± 1.64	15.66 ± 1.76	24.66 ± 3.93 ab
T6	14.50 ± 0.28	17.33 ± 0.33	23.66 ± 0.66 ab
F value	ns	ns	*

Value represents mean ± standard error of three replicates.
F test: ns – not significant, *- P<0.05
Means followed by the same letter are not significantly different according to Duncan's Multiple Range Test at 5% level.

Number of leaves

Increase in leaf number is commonly found in plant with adequate amount of nutrients availability in soil and it leads to increase the amount of photosynthetic activity. EM increases plant growth by increasing the rate of organic matter mineralization which results in an increase in plant-available nutrients (Asia-Pacific Natural Agriculture, 1995). Combination of cattle manure with EM increases the height of plant and number of leaf per plant of pigweed (Chrispaul *et al*., 2010). In present study, there was no significant difference ($P>0.05$) among tested treatments in number of leaves per plant at 10, 20 and 30 DAT which was confirmed with *P* values of 0.197, 0.700 and 0.075 and chi square of 7.33, 3.00 and 10.00 respectively is shown in Table 2.

Table 2: The number of leaves per plant at vegetative stage of capsicum after transplanting

Treatment	Median at 10 DAT	Median at 20 DAT	Median at 30 DAT
T1	7	6	13
T2	7	5	9
T3	9	8	20
T4	10	7	20
T5	10	7	21
T6	10	6	18
Chi square	7.33	3	10
P	0.197	0.7	0.075

Diameter of pods

The average diameter of capsicum pods was significantly varied ($P<0.05$) among the treatments as shown in Table 3. The diameter was increased upto 3rd picking thereafter it decreased in most of the treatments. At the 3rd picking, diameter of pods was high in T4 (5.63 cm) followed by T6 (5.50 cm). The diameter of pods harvested in cattle manure with EM treated treatments was high compared to that in inorganic and no fertilizer treatments. Application of organic manure with EM helps for long-term sustainable systems with improved nutrient mineralization and plant uptake (Asia-Pacific Natural Agriculture, 1995).

Table 3: Diameter of pods at different time of picking of capsicum

Treatments	Diameter of pods			
	1st picking	2nd picking	3rd picking	4th picking
T1	0 ± 0 d	4.83 ± 0.43 a	4.96 ± 0.38 b	4.16 ± 0.08 c
T2	0 ± 0 d	3.5 ± 0.25 b	3.9 ± 0.11 c	4.03 ± 0.17 c
T3	4.34 ± 0.23 a	4.9 ± 0.33 a	5.3 ± 0.05 a	4.93 ± 0.08 ab
T4	5.18 ± 0.07 c	5.4 ± 0.18 a	5.63 ± 0.14 ab	5.3 ± 0 b
T5	4.56 ± 0.08 bc	5.2 ± 0.25 a	5.4 ± 0.08 ab	5.43 ± 0.08 a
T6	4.77 ± 0.12 b	5.2 ± 0.36 a	5.5 ± 0.15 ab	5.1 ± 0.20 ab
F value	**	**	**	**

Length of pods and peduncles

There were significant differences (P<0.05) among the treatments in length of pods. At the 1st picking, average length of pods was high in 10 tons/ha cattle manure (Table 4). Further, increase of cattle manure from 10 tons/ha to 15 tons/ha there was slight reduction in pod length. In T1 and T2, there were no mature pods at the time of 1st picking. At 2nd picking, capsicum planted in inorganic fertilizer showed longer length than no fertilizer, however shorter than cattle manure applied treatments. Results suggested that the optimum level of organic manures (10 tons/ha cattle manure with EM) required to achieve higher length of pods. Further, it was noted that length of pod peduncles exhibited higher length in T4 (Figure 1).

Table 4: Length of pods at different time of picking of capsicum

Treatments	Length of pods			
	1st picking	2nd picking	3rd picking	4th picking
T1	0 ± 0 b	8.3 ± 0.17 ab	8.3 ± 0.11 b	7.8 ± 0.15 ab
T2	0 ± 0 b	7.56 ± 0.20 b	7.63 ± 0.08 c	7.2 ± 0.05 b
T3	9.56 ± 0.49 a	9.06 ± 0.27 a	8.8 ± 0.05 ab	7.76 ± 0.43 ab
T4	9.96 ± 0.32 a	9.36 ± 0.26 a	9.33 ± 0.08 a	8.46 ± 0.18 a
T5	8.46 ± 1.23 a	8.83 ± 0.68 a	8.8 ± 0.4 ab	8.13 ± 0.13 a
T6	9.6 ± 0.45 a	9.2 ± 0.17 a	9.2 ± 0.1 a	8.4 ± 0.15 a
F value	**	**	**	**

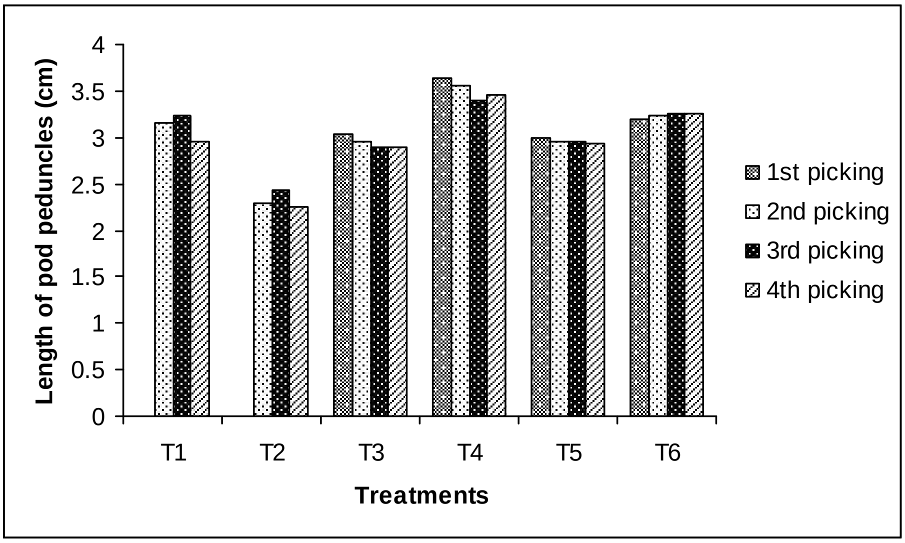

Figure 1: The length of pod peduncles harvested in each treatment.

Fresh weight of pods

The pods are important market component in capsicum. Both fresh and dry pods of chilli are commonly used in many cooking recipes as to achieve a tasty daily food with high in both palatability and nutritious values (Rapatsa and Terapongtanakorn, 2010). In the present study, there was no significant difference ($P>0.05$) in number of pods per plant was confirmed with chisquare value of 9.90 and P value of 0.078. Number of pods per plant varies from 19 (T4) to 5 (T2). Also there was remarkable variation ($P<0.01$) in fresh weight of pods among the treatments. It was high in T4 (251.51) followed by T6 (224.80) (Table 6). Further, increase in application rate from 10 tons/ha to 15 tons/ha there were sudden reduction in fresh weight. The fresh weights of pods were high in cattle manure with EM treated treatments compared to no fertilizer and inorganic fertilizer treatments may be due to supplying nutrient. It may suggest that cattle manure at 10 tons/ha would be the optimum amount to obtain maximum fresh weight of pods per plant.

Table 6: Fresh weight of pods at different time of picking of capsicum

Treatments	Cumulative fresh weight
T1	109.43 ± 3.75 d
T2	97.33 ± 2.90 e
T3	205.07 ± 5.42 c
T4	251.51 ± 1.58 a
T5	211.68 ± 4.58 c
T6	224.80 ± 0.93 b
F value	**

Number of seeds

The hottest portion of chili is found with seeds in each pod, whilst the flesh gives pungent flavour (Hutton and Mealin, 1997). In this study, there were significant differences ($P<0.05$) among the treatment in number of seeds per pod at 1st, 2nd, 3rd and 4th picking. At the 4th picking, it was high in T6 (66.0) followed by T4 (62) as shown in Table 7. Inorganic fertilizer applied treatment and no fertilizer treatments did show any pod formation at the 1st picking. Cattle manure with EM applied treatments has more seeds than inorganic and no fertilizer applied treatments. The hot taste of chili seeds in each pod depended most on the ratio between nitrogen and potassium in soil being applied for crop cultivation (Suksri, 1999).

Table 7: Number of seeds per pods at different time of picking of capsicum

Treatment	Median at 1st picking	Median at 2nd picking	Median at 3rd picking	Median at 4th picking
T1	0	54	56	51
T2	0	51	54	53
T3	54	56	56	52
T4	65	69	68	62
T5	75	63	63	61
T6	65	66	66	66
Chi square	12.67	18	18	12.67
P	0.027	0.003	0.003	0.027

Dry weights of pods and seeds

It is an important issue whether the replacement of organic fertilizers and chemical fertilizers with biofertilizers causes a beneficial increase in dry weight (Levai, *et al*., 2006). In this study, cattle manure with EM application increases the dry weight of pods. It was high in cattle manure applied at rate of 10 tons/ha (Figure 7). Further, increase of cattle manure did not significantly affect (P>0.05) the dry weight of pods and it was noted that there was significant differences (P<0.01) among the treatments in seed dry weight and High dry weight was obtained in T4 (28.29 g) followed by T5 (23.65 g) as shown in Figure 8.

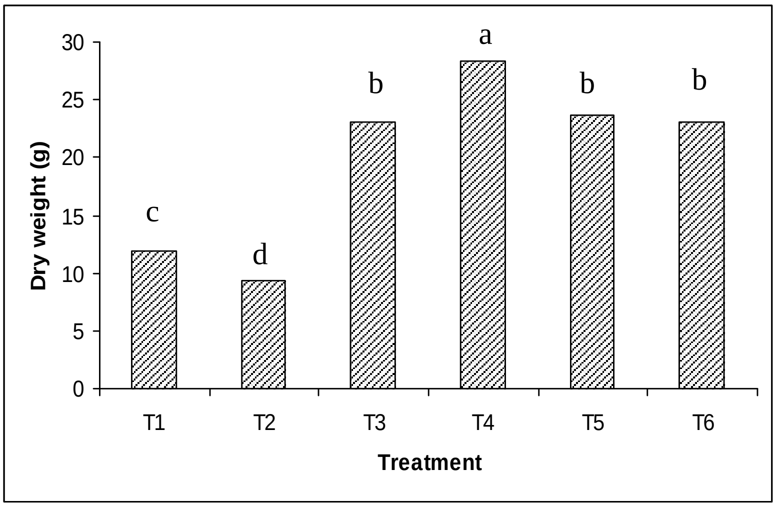

Figure 7: The dry weight of pods per plant in each treatment.

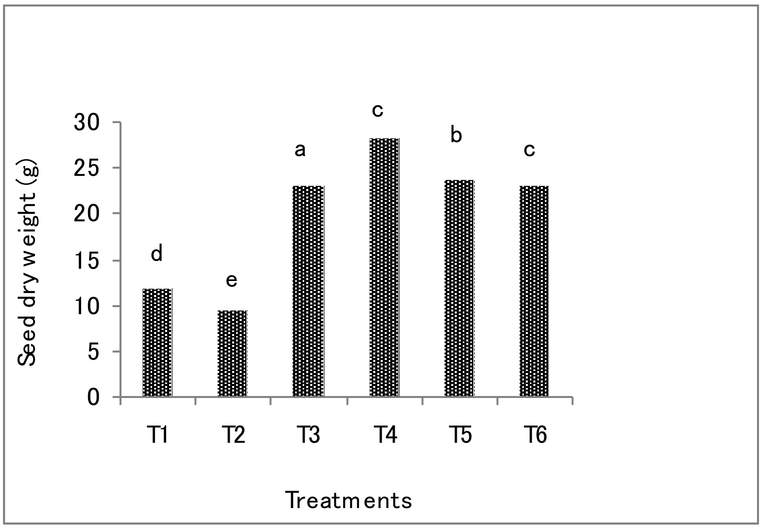

Figure 8: The dry weight of seeds per pod in each treatment.

CONCLUSION

The cattle manure along with EM plays a vital role in vegetative and reproductive growth of capsicum (*Capsicum annum* L.). There was no significant difference (P>0.05) in canopy height among the treatments at the early growing stage. At 30 DAT, T4 had highest canopy height. The number of leaves had significant difference (P<0.05) among the treatments. The diameter of pods was increased upto 3rd picking and thereafter declined. Increasing cattle manure from 5 tons/ha to 10 tons/ha, increased number of pods per plant. The fresh weight of pods, number of seeds per pod and dry weights of pods and seeds were high in cattle manure (10 tons/ha) with EM. The present study suggests that cattle manure at the rate of 10 tons/ha along with EM would be the most suitable treatment to obtain high vegetative and reproductive growth of capsicum in sandy regosol.

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