ASSESSMENT OF THE EFFECT OF CATTLE MANURE VERMICOMPOST ON BEAN HEIGHT AND POD COUNT IN THE GREENHOUSE POT EXPERIMENTS

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Abstract— The objective of the study was to assess the effect of cattle manure vermicompost on the bean height and pod count in the greenhouse pot experiments. An experimental research design was used to collect data on the effect of cattle manure vermicompost on the bean height and pod count in the greenhouse pot experiments. Analysis of variance was used to determine if there was a significant effect of cattle manure vermicompost on the bean height and pod count in the greenhouse pot experiments. The least significant difference was used for separation of significant means at $\alpha = 0.05$. The study showed that the vermicompost significantly improved bean height and yields in greenhouse pot experiments ($p < 0.05$). At 40% of cattle manure vermicompost amendment, the plant had maximum height (59.6 to 67.3 cm) and the highest number of pods (31.24 to 34.22). Therefore, cattle manure vermicompost should be used in common bean production to boost growth and yield.

Keywords— Cattle manure vermicompost, bean height, pod count

I. Introduction

The use of vermicompost is gaining popularity, especially as an alternative option to improve the soil fertility and structure and manage diseases and pests in organic farming [1, 2]. The vermicompost is a nutrient-rich soil amendment with high concentrations of macronutrients, including nitrogen (2–3%), potassium (1.85–2.25%), and phosphorus (1.55–2.25%) [3, 4]. The nutrients present in the vermicompost are in soluble forms that are more readily absorbed by the plant roots [2]. Also, it contains beneficial microbial communities, humic acid, and plant growth regulators such as auxins, cytokinins, and gibberellins, which promote plant growth [5, 6]. Besides, vermicompost amendment increases water retention in the soil and fertility, promotes a faster rate of seed germination, and reduces pest attacks, leading to higher yields in crops [1, 7]. Consequently, use of vermicompost such as cattle manure vermicompost (CMV) helps in promoting soil microbial balance and biodiversity and reduces environmental and health risks [8]. Therefore, their use in crop production is viewed as an eco-friendly alternative to chemical fertilizer and pesticide in promoting sustainable agricultural practices [7, 8].

The study was carried out from March to April 2023 at the research greenhouse of the Department of Plant Science of the Faculty of Agriculture of Chuka University, Kenya. The objective of the study was to assess the effect of CMV on the bean height and pod count in the greenhouse pot experiments. An experimental research design was used to collect data on the effect of cattle CMV on the bean height and pod count in the greenhouse pot experiments. Analysis of variance was used to determine if there was a significant effect of CMV on the bean height and pod count in the greenhouse pot experiments. The least significant difference was used for separation of significant means at $\alpha = 0.05$. The study findings showed that CMV significantly improved bean growth parameters and yields in greenhouse pot experiments ($p < 0.05$). At 40% of the CMV amendment, the plant had maximum height (59.6 to 67.3 cm) and the highest pod count (31.24 to 34.22). Therefore, cattle manure vermicompost should be used to boost growth and yields in bean production.

II. Materials and Methods

A. Study Area, Plant Sowing and Treatment Application

The study was conducted from March to April 2023 at the research greenhouse of the Department of Plant Science of the Faculty of Agriculture of Chuka University, Kenya. Plastic pots of 70 mm diameter and 95 mm height containing 0.1 kg of sterile red soil were used in the experiments. The pots were amended with 0 kg (0%), 0.01 kg (10%), 0.02 kg (20%), 0.03 kg (30%), and 0.04 kg (40%) of CMV 48 hours before planting. Pots with 0% amendment of CMV in each treatment served as the control treatment. Three dry bean varieties, namely Katumani B1, Mwitemania, and Kathika, were planted in the pots. All seeds were surface sterilized using 1% sodium hypochlorite for 10 minutes and then air-dried before sowing one seed per pot. Each treatment was replicated three times. The pots were maintained in a greenhouse and lightly watered every second day until the final pod stage.

B. Experimental Design

A 3 x 5 factorial experiment, laid out in a Complete Randomized Design (CRD), was used to determine the effect of CMV on the bean height and number of pods per plant in the greenhouse pot experiments. There were three factors comprising common bean varieties (at three levels) and different CMV concentrations (% by mass (at five levels).

This resulted in 15 treatments, and each treatment was replicated three times.

III. Data Collection

At the final flowering stage, five bean plants were randomly selected from each treatment. The height of the plant was measured in centimeters (cm) from the base of the shoot to the highest tip of the apical bud. The result was recorded in tabular form for analysis. Further, at the final pod stage, the number of pods in each of the plants examined was counted and recorded in tabular form.

IV. Data Analysis

Descriptive statistics was used to summarize data into means, percentages, and standard deviations. The data on the number of pods per plant in the greenhouse pot experiment was first log transformed before being subjected to ANOVA for further analysis. Data on bean height and number of pods per plant in the greenhouse pot experiment were subjected to one-way ANOVA using Statistical Analysis Software (SAS) version 9.4. The ANOVA was used to determine the effect of different concentrations of CMV on bean height and the number of pods per plant in the greenhouse pot experiments at $\alpha = 0.05$. The significant means were separated using LSD at $\alpha = 0.05$.

V. 4. Results

There was a significant ($p < 0.05$) [Table 1] effect of different concentrations of CMV on the growth height of the Kathika, Katumani, and Mwitemania bean varieties. There was a significant ($p < 0.05$) [Table 1] effect of different concentrations of CMV on the growth height of Kathika bean plants. The height for the Kathika variety at different CMV concentrations was significantly different. The highest height (59.75 cm) was observed at a concentration of 40% CMV amendment, followed by 54.75 cm, 43.25 cm, and 35.75 cm at 30%, 20%, and 10% CMV amendment, respectively. The lowest height (15.75 cm) was observed at 0% CMV amendment [Table 2].

Table 1: Analysis of Variance for the Effect of Different Concentration of Vermicompost on Bean Height in the Greenhouse Pot Experiment

Source	DF	Sum of Squares	Mean Square	F Value	P value
ANOVA for the Effect of CMV on Height of Katumani Bean					
Vermicom_percent	4	4970.70	1242.67	303.09	<.0001
Error	15	61.50	4.10		
Corrected Total	19	5032.20			
ANOVA for the Effect of CMV on Height of Kathika Bean					
Vermicom_percent	4	4828.80	1207.20	252.38	<.0001
Error	15	71.75	4.783		
Corrected Total	19	4900.55			
ANOVA for the Effect of CMV on Height of Mwitemania Bean					
Vermicom_percent	4	4142.30	1035.57	295.88	<.0001
Error	15	52.50	3.50		
Corrected Total	19	4194.80			

There was a significant ($p < 0.05$) [Table 1] effect of different concentrations of vermicompost on the growth height of Katumani bean plants. The height for the Katumani variety at different vermicompost concentrations was significantly different. The greatest height (67.25 cm) was observed at 40% CMV amendment, followed by 58.25 cm at 30%, 51.0 cm at 20%, and 37.5 cm at 10% CMV amendment. The lowest bean height (22.5 cm) was observed at 0% CMV amendment [Table 2].

There was a significant ($p < 0.05$) [Table 1] effect of different concentrations of vermicompost on the growth height of Mwitemania bean plants. The height for the Mwitemania variety at different vermicompost concentrations was significantly different. The greatest height (61.0 cm) was observed at a concentration of 40% vermicompost, followed by 52.75 cm, 46.0 cm, and 38.5 cm at 30%, 20%, and 10% CMV amendment, respectively. The least height (18.75 cm) was observed at 0% vermicompost amendment [Table 2].

Table 2: The Effect of Different Concentration of Vermicompost on Plant Height in Greenhouse Pot Experiment

			Height in cm			
Variety of Beans	Verm (%)1	N	Mean	Mean	LSD (α =0.05	Cv (%)
	0	4	15.75 e			
	10	4	35.75 d			
Kathika	20	4	43.25 c	41.85	3.296	5.23
	30	4	54.75 b			
	40	4	59.75 a			
	0	4	22.5 e			
	10	4	37.5 d			
Katumani	20	4	51 c	15.63	1.228	4.85
	30	4	58.25 b			
	40	4	67.25 a			
	0	4	18.75 e			
	10	4	38.5 d			

Mwitemania	20	4	46 c	18.03	1.409	3.86
	30	4	52.75 b			
	40	4	61 a			
Mean			17.598			
LSD (α =0.05)			1.098			
Cv (%)			3.959			

[a]Means followed by same letters are not significantly different at 5% probability level; [1]Cattle Manure Vermicompost.

There was a significant ($p < 0.05$) [Table 1] effect of different concentrations of vermicompost on the number of pods per plant for the Kathika, Katumani, and Mwitemania bean varieties. The number of pods per plant varied significantly across different concentrations, with the highest numbers generally observed at higher concentrations of vermicompost [Table 2].

There was a significant ($p < 0.05$) [Table 3] effect of different concentrations of vermicompost on the number of pods per plant for the Kathika variety. The number of pods per plant at different vermicompost concentrations was significantly different. The highest number of pods per plant (31.69) was observed at a concentration of 40% vermicompost, followed by 26.74, 19.95, and 15.68 at 30%, 20%, and 10% CMV amendment, respectively. The lowest number of pods per plant (7.71) was observed at 0% CMV amendment [Table 4].

Table 3: Analysis of Variance for the Effect of Different Concentration of Vermicompost on Number of Pods Produced per Plant in the Greenhouse Pot Experiment

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**P value**
ANOVA for Effect of CMV on Number of pods of Katumani Bean					
Vermicom_percent	4	1.61	0.4029	115.26	<.0001
Error	15	0.05	0.0034		
Corrected Total	19	1.66			
ANOVA for Effect of CMV on Number of pods of Kathika Bean					
Vermicom_percent	4	0.92	0.2309	159.50	<.0001
Error	15	0.023	0.0014		
Corrected Total	19	0.95			
ANOVA for Effect of CMV on Number of pods of Mwitemania Bean					
Vermicom_percent	4	0.84	0.2091	88.99	<.0001
Error	15	0.04	0.0023		
Corrected Total	19	0.87			

There was a significant ($p < 0.05$) [Table 3] effect of different concentrations of vermicompost on the number of pods per plant for the Katumani variety. The number of pods per plant at different vermicompost concentrations was significantly different. The highest number of pods per plant (34.22) was observed at 40% CMV amendment, followed by 26.44, 20.47, and 12.40 at 30%, 20%, and 10% CMV amendment, respectively. The least number of pods per plant (5.38) was observed at 0% CMV amendment [Table 4].

There was a significant effect of different concentrations of vermicompost on the number of pods per plant for the Mwitemania variety ($p < 0.05$) [Table 3]. The number of pods per plant at different vermicompost concentrations was significantly different. The highest number of pods per plant (31.24) was at 40% CMV amendment, followed by 24.71, 19.87, and 15.68 at 30%, 20%, and 10% CMV amendment, respectively. The least number of pods (7.91) was observed at 0% vermicompost amendment [Table 4].

Table 4: The Effect of Different Concentration of Vermicompost on Number of Pods per Plant in Greenhouse Pot Experiment

			Number of pods			
Variety of Beans	Verm (%)1	N	Mean	Mean	LSD (α =0.05)	Cv (%)
	0	4	7.71 e			
	10	4	15.68 d			
Kathika	20	4	19.95 c	18.28	1.141	3.02
	30	4	26.74 b			
	40	4	31.69 a			
	0	4	5.38 e			
	10	4	12.40 d			
Katumani	20	4	20.47 c	47.3	3.051	4.28
	30	4	26.44 b			
	40	4	34.22 a			
	0	4	7.91 e			
	10	4	15.68 d			
Mwitemania	20	4	19.87 c	43.4	2.819	4.31
	30	4	24.71 b			

	40	4	31.24 a
Mean			44.183
LSD (α =0.05)			1.294
Cv (%)			4.598

[a]Means followed by same letters are not significantly different at 5% probability level; [1]Cattle Manure Vermicompost.

VI. Discussion

The study showed that there was a significant effect of different CMV on bean height and pod count per plant in greenhouse pot experiments [Table 1, Table 3]. This may be attributed to CMV containing nutrients, beneficial microbes, humic acid, plant growth regulators, coelomic fluid, and bioactive substances secreted by earthworms that stimulate rapid growth and increase yield in plants [2, 6]. The results align with previous findings that demonstrated growth, yield, and quality parameters in crops increased significantly in soil amended with vermicompost [3, 6]. On the other hand, bean height and pod count per plant increased with an increase in the concentration of the CMV amendments. The tallest plants and highest number of pods per plant were recorded in pots amended with 40% of CMV. This implies that an increase in the concentration of CMV increased the amount of soluble nutrients and beneficial microorganisms and induced the production of plant hormones in the soil, thus boosting plant growth and development [4, 5]. Also, a high concentration of CMV amendment enhances water retention and soil structure, leading to high growth rates and yields in crops [1]. Supplement of vermicompost in soil is dose dependent for better yield of plant and soil properties [5]. These results conform to the earlier study findings, which revealed that an increase in the amount of vermicompost amendment promoted higher root and vegetative growth and yield in plants [2].

VII. Conclusion

The study findings showed that CMV significantly improved bean growth parameters and yields in greenhouse pot experiments ($p < 0.05$). At 40% of vermicompost amendment, the plant had maximum growth (plant height between 59.6 and 67.3 cm) and the highest number of pods (31.24 to 34.22). Therefore, cattle manure vermicompost should be used in bean production to boost yields.

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