THE EFFECT OF VERMICOMPOST AND VERMIFOLIAR ON GROWTH AND RELATED CHARACTERISTICS OF FINE BEAN (*Phaseolus vulgaris*)

[1]Nyamowa Joshua

Horticulture Research Institute, P.O Box 810 Marondera, Zimbabwe

Corresponding author: joenyamowa@gmail.com.

+263772965151, +263779138164

Abstract

Recently, there is increasing worldwide use of vermicompost, which are products of a non-thermophilic biodegradation of organic materials through interactions between earthworms and microorganisms as plant growth media and soil amendments. Vermicompost processed commercially from food waste and paper were applied to 3.6m^2 filled plots, at 2.5 t ha^{-1} to evaluate their effects on growth and yield of fine bean at Horticulture Research Institute . The vermicompost were incorporated into the top 10cm of soil whilst vermifoliar was drenched into the soil at dilution rate of 1:10. Treatments included sole vermicompost, equal combinations of vermicompost and vermifoliar, supplementary-chemical (6:15:17) fertilizer based on chemical analyses to equalize the initial fertilizer rates of 600kg ha^{-1}. All four treatments were replicated three times, in a completely randomized block design. Equal combinations of vermicompost and chemical fertilizer increased fine bean growth and yield significantly *($p<0.05$):* including increases of up to 60% in number of pods per plant, 28% in pod length(cm) and 35% in pod weight(g) of standard means. The treatment combination also resulted in supreme quality of fine bean pods as exhibited by uniformity, total absent of strings and a deep green color. Least yields were observed in plots that received sole application of vermifoliar and chemical fertilizers. These responses could be attributed to availability of nutrients throughout the growing season of the crop- as vermi products are slow in releasing nutrients. Based on other laboratory research, the superior yields might have been achieved due to production of plant growth regulators by microorganisms during vermicomposting process.

Keywords: Vermicompost; Vermifoliar; Chemical fertilizers; Earthworms; Fine bean growth and yield

1.0 INTRODUCTION

Green beans are dicotyledonous plants, and members of the family, Fabaceae, forming part of the species Phaseolus vulgaris. The green bean originated from Peru, and spread to South and Central America by migrating Indian tribes. It was introduced to Europe by the Spanish explorers around the 16th century, and spread further throughout the world by Spanish and Portuguese traders. For a long time rare and expensive, this vegetable only became widespread in the 19th century. Nowadays the largest commercial producers of fresh green beans include the United States, China, Japan, Spain, Italy and France. Green beans are popular in many types of cuisines. Digestible, low in calories and filled with vitamins, green beans are ideal for health conscious weight watchers [1].

The long-term use of inorganic fertilizers without organic supplements damages the soil physical, chemical and biological properties and cause environmental pollution. Vermicompost are effective organic fertilizers and bio control agents that have organic nutrition role and increase plants growth [2]. Application of vermicompost is a sustainable technology capable that improve plants growth and yield of them [3]. Vermicompost can improve food quality and safety. Applications of vermicompost singly or in combination with other organic fertilizer have been proved effective to enhance growth and yield of various plants like Soybean and other crops and yield of them increased [4]. Several studies have reported that vermicompost can increase the growth and biomass of some medicinal plants such as chamomile. Vermicompost has found to effectively enhance the root formation, elongation of stem and production of biomass, vegetables and ornamental plants. Observations were made that integration of vermicompost with inorganic fertilizers tended to increase the yield of crops viz-potato, rape seed, mulberry and marigold over other traditional composts [5]. The application of vermicompost rendered better performance in respect of all round growth of mulberry plants in the lateritic soil of South West Bengal [6]. The nutrient level, especially the (macro or micro-nutrients) were found to be always higher than the compost derived from other methods [7]. One of the unique features of vermicompost is that during the process of conversion of various organic wastes by earthworms, many of the nutrients are changed to their available forms in order to make them easily utilizable by plants.

1.1.OBJECTIVES

The overall objective was to evaluate the effect of vermicompost and vermifoliar on growth and related characteristics of fine bean.

2.0 METHODS

2.1 Study site

The research was done at Horticulture Research Centre, Marondera in Zimbabwe (18^0 11'S and 31^0 28'E, altitude 1630 meters above sea level), which is in Agro-ecological Region IIa [14; 15]. Horticulture Research Centre has an average day length of 13.2 hours in summer and 11.1 hours in winter. The mean annual rainfall is approximately 873mm, but this is subject to wide fluctuations and in the last 30 years has varied between 430mm and 1320mm. slightly more than two thirds of the total rainfall normally falls during the months December, January and February. Mean minimum temperature ranges from 19.5^0 C (July) to 24.6^0 C (January). The hottest months extends from September and December with October being the hottest month of the year with maximum temperatures of above 30^0 C [8].

2.2 Experimental design

Fine bean variety Volta, sourced from Prime Seedco in Harare was used in this study. The experiment was done in an open field (13 m × 20m) for three seasons, from January 2017

to April 2018 and was laid out in a Randomized Complete Block Design (RCBD) with four replications. Treatments included sole vermicompost, equal combinations of vermicompost and vermifoliar, supplementary-chemical (6:15:17) fertilizer based on chemical analyses to equalize the initial fertilizer rates of 600kg ha^{-1} once at planting. Vermicompost processed commercially from food waste and paper were applied to 3.6m^2 filled plots, at 2.5 t ha^{-1} .Vermifoliar was applied at 800 liters per hectare 3 weeks after emergence. The gross plot had a total of 148 plants and a net of 56 plants was considered. Plant spacing was 0.45 m × 0.1 m apart. Soil analysis was conducted before and after the study.

Management and data collection

Selective harvesting was done whereby mature pods with minimum of 70mm length were picked. Counts were taken on total number of marketable and unmarketable pods per plot from day 65 to day 87 after emergence. The length of pods (mm) was measured using a ruler while pod diameter (mm) was measured using a vernier calipers. Pod weight (g) was measured using a digital scale from an average of 10 pods. Pod uniformity, color and string availability was determined using a score from 1 to 9: score 1- poor, 3- fair, 5- standard, 7- very good and 9- excellent pod quality.

The plots were kept weed free by manually removing weeds using hand hoes and pulling. Preventative sprays for insects and pests and diseases were done weekly alternating different insecticides (Thunder, Actara and Malathion) and fungicides (Copper Oxychloride, Dithane M45 and Ridomil).

Data analysis

The data was analyzed using Genstat 17th edition [VSN International 2015]. Data from the three experiments were combined and a single analysis was done. Where there were significant differences at $p < 0.05$, means were separated using the Least Significant Difference (LSD).

3.0 RESULTS

There were significant differences ($p<0.05$) on the total number of pods, pod length (cm), pod diameter (mm), fresh weight (t/ha) and quality of fine bean (Volta) in the studies caused by effect of vermicompost and vermifoliar (Table 1). Equal combinations of vermicompost and chemical fertilizers increased fine bean growth and fresh weight significantly ($p<0.05$), including pod number per plant and pod length. Combination of vermicompost and

vermifoliar effect produced outstanding results as witnessed by significant fresh weight, pod number and overally pod quality.

3.1 Pod number

There were differences in total number of pods per plant ($p<0.05$). The results showed that an equal combination of vermicompost and chemical fertilizer gave the highest number of pods harvested over 3 weeks, a number which is over 60% more than the number achieved from conventional fertilizers when applied solely. Application of vermicompost and vermifoliar combined equally seconded the former treatment with supreme number of pods that are competitively commercial. The least number of pods were picked from plots that received sole application of vermicompost and chemical fertilizers (Table 1). The number of pods positively affected the final fresh weight.

Table1. Total number of pods, pod length, pod diameter marketable fresh weight and pod quality on Fine bean Volta as affected by vermicompost and vermifoliar.

Treatment	Pod number	Pod length (cm)	Pod diameter (mm)	Fresh weight (t/ha)	Pod quality
100% vermicompost	53.67[c]	12.48[d]	0.32[a]	11.63[d]	6.87[b]
50% vermicompost and 50% vermifoliar	71[b]	14.85[b]	0.28[b]	15.79[b]	8.07[a]
50% vermicompost and 50% chemical fertilizer	87[a]	17.11[a]	0.28[b]	16.73[a]	6.6[b]
100% Compound C (control)	53.3[c]	12.73[c]	0.33[a]	13.51[c]	5.5[c]
Grand mean	66.25	14.29	0.3	14.39	6.64
%CV	2.1	7.6	3.7	7.8	6.8
P value	<0.01	<0.001	0.003	<0.01	0.001
LSD	2.746	0.24	0.022	14.39	0.897

*Means with the same letter or followed by the same letter are not significantly different according to the LSD value down a column.

3.2 Pod length

An equal application of vermicompost and chemical fertilizer influenced longer pods and this difference was very significant ($p<0.01$). Although a combination of vermicompost and vermifoliar came second in producing long pods, this result was significantly higher than sole application of chemical fertilizer and vermicompost (Table 1).

3.3 Pod diameter

Results of pod diameter as influenced by vermicompost and vermifoliar were significant ($p<0.05$). The thickest pods were observed in plots that received chemical fertilizers with plots that received a vermicompost and vermifoliar achieving thin pods.

3.4 Fresh weight

There were significant differences in total fresh weight (t/ha) ($p<0.05$). The plots that received equal combinations of vermicompost and chemical fertilizer achieved the greatest fresh weight and this was seconded by plots that received vermicompost and vermifoliar.

3.5 Pod quality

Results of pod quality as an effect of vermifoliar and vermicompost were significant ($p<0.05$). Sole application of vermicompost produced the best pod quality with increase in chemical fertilizer significantly reducing pod quality (Table 1).

DISCUSSION

Results in this study revealed the superior effects of equal combinations of vermicompost and chemical fertilizer in increasing pod number per plant, pod length and fresh weight. In fine bean production the number of pods and pod length ultimately affect the total fresh weight. In this study, there was up to 60% increase in pod number per plant and 28% in pod length as compared to crops that received chemicals fertilizers alone. These results are in agreement with Islam *et al* studies that recorded longest length of bush, winged and long bean in vermicompost (20%) followed by compost and control treatment. Again as with the other yield parameters the shortest pod lengths were observed in chemical fertilizer treated plants.

The numbers of pods per plant as influenced by vermicompost were significantly higher. This is in line with vermicompost results conducted in India. In yard long bean vermicompost (20%) and traditional compost (20%) treatments did not show any significant increase in pod number per plant but were significantly different when compared to the control [8]. In vermicompost treatment, pod dry weight of the legumes was significantly higher than in plants from compost and farmer's practice treatments. In the case of pod length both bush bean and yard long bean, did not vary significantly between vermicompost (20%) and traditional compost (20%) treatment but

was significantly lower in the control. However pod length in winged bean varied significantly when grown with vermicompost (20%), traditional compost (20%) and the control [9]. Similar observations showing that pod length in bush bean (Phaseolus vulgaris) was higher in vermicompost treatment than in control and N: P: K fertilizer treatments [10].Contrary to the above observations, pod length in bush bean when treated with vermicompost was not significantly different from compost treatment [11].

The horticultural market appreciates long and thin pods. This can be achieved by application of vermicompost and chemical fertilizer, at the same time achieving best yields. On pod quality, best results were observed on a combination of vermicompost and vermifoliar with increase in chemical fertilizers significantly reducing quality. The reduction was observed with increase in pod strings, uniformity and presence of pale color.

In this study fresh yield results were significant as influenced by vermicompost .With regard to yield, other studies found the highest yield in vermicompost treatment compared to other treatments. Yield in bush bean (Phaseolus vulgaris) was significantly different when treated with vermicompost, compost and farmer's practice [12]. To farmers who want to go organic, they can realize significant yields through application of equal combinations of vermicompost and vermifoliar. Although in this study results show a significant difference between vermicompost and chemical fertilizer and vermifoliar and vermicompost, the later treatment is nearly competitive as it proved better in performance than the control.

5.0 CONCLUSION

A combination of vermicompost and vermifoliar has a positive contribution in pod length (cm), pod number, fresh weight (t/ha) and pod quality of Volta fine bean variety.

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DECLARATION

No part of this work has been published elsewhere.

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