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Effect of Varying Soil and Vermicompost Mixtures on Growing Media and Yield and Quality of Sweet Corn

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Abstract. The organic amendment 'vermicompost' has ability to improve soil health and crop quality to a great extent depending on its application amount. In the present investigation, we analyzed the effect of different combination of soil and vermicompost mixture on physical, chemical and biological properties of growing media and on yield and quality of sweet corn grown in pot experiment at Indian Institute of Technology Kharagpur India, during the years 2012 and 2013. The bulk density of the media was lowered from 1.32 g/cc in full soil to 0.53 g/cc in full vermicompost. On the other hand, porosity and water holding capacity of the soil and vermicompost mixture steadily increased from 39.6 to 72.4 % and 31.3 to 175 %, respectively with increasing the proportion of vermicompost from 0 (full soil) to 100% (full vermicomoost) in the mixture. Similarly, soil available N and microbial population increased with increasing application of vermicompost. In the mixture, soil proportion of 30-40% and rest vermicompost (60-70%) can meet the crop nutrient demand throughout the growth stages for increasing yield and quality of the sweet corn through improvement of soil physical, chemical and biological properties.

Keywords: Ascorbic acid, bulk density, microbial population, pore space, sugar, vermicompost

1. Introduction

Vermicompost, the product derived from the accelerated biological degradation of organic wastes by interaction between earthworms and microorganisms [1] is recognized as beneficial organic soil amendment for the maintenance of soil fertility to support crop growth. Earthworms consumed and fragment the organic wastes into finer particles by passing them through a grinding gizzard, and they derive their nourishment from the microorganisms that grow on the organic matter. The process accelerates the rate of microbiological decomposition (humification) of organic matter, to oxidize and stabilize it [2], [3]. Hence, vermicompost is an important source of plant available nutrients [4] and its addition to soil improves physical, chemical and biological properties of soil. Various workers have examined the suitability of vermicompost as plant growth media [5]-[7] and have addressed their potential commercial value. However, soil and vermicompost interaction with increasing ratios of vermicompost application will provide information on changes in properties of the growing media with respect to soil health, crop performance and quality of the product. Keeping these points in view, a control experiment was conducted with the following objectives:

- To analyze the effect of varying vermicompost and soil mixtures on changes in physical, chemical and biological properties of the media
- To assess the effect of the vermicompost and soil mixtures on growth, yield and quality of sweet corn

2. Material and Methods

Control pot experiments were conducted under greenhouse condition in the experimental farm of Agricultural and Food Engineering Department, Indian Institute of Technology Kharagpur (22^o 19' N 87^o

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19’ E), India, in two seasons by growing sweet corn during March 2012 to May 2012 and November 2012 to February 2013. The treatments were consisted of using pure soil, pure vermicompost and mixture of soil and vermicompost at varying ratios as follows:

1. 100% soil: S_{100}
2. 90% soil + 10% vermicompost: $S_{100}+V_{10}$
3. 80% soil + 20% vermicompost :$S_{80}+V_{20}$
4. 70% soil + 30% vermicompost : $S_{70}+V_{30}$
5. 60% soil + 40% vermicompost : $S_{60}+V_{40}$
6. 50% soil + 50% vermicompost : $S_{50}+V_{50}$
7. 40% soil + 60% vermicompost : $S_{40}+V_{60}$
8. 30% soil + 70% vermicompost : $S_{30}+V_{70}$
9. 20% soil + 80% vermicompost : $S_{20}+V_{80}$
10. 10% soil + 90% vermicompost : $S_{10}+V_{90}$
11. 100% vermicompost : V_{100}

All the eleven treatments were replicated thrice in randomized complete block design. In each pot, 5 kg of the material of each treatment were accommodated. Sweet corn seeds were sown and after germination, only one healthy seedling was allowed to grow. A common management was performed particularly for watering throughout the crop growth period. The harvesting of sweet corn was done at milking stage. Observations and chemical analysis were performed on soil fertility, plant growth, and sweet corn yield and its quality parameters. The soil physical properties viz. bulk density, porosity and water holding capacity, and chemical properties like available N content and total microbial count of the growing media were done. In plant, growth parameters recorded were plant height, dry matter production, yield characters like cob dry weight, grains per cob and grain dry weight. The grain quality was studied for ascorbic acid, sugar and crude protein content.

3. Results and Discussion

3.1. Physical, Chemical and Biological Properties of the Growing Media

Physical properties: The physical properties of soil and vermicompost mixture changed with increasing proportion of vermicompost addition with soil (Fig. 1). Bulk density of soil declined steadily with increasing addition of vermicompost. The bulk density was lowered from 1.32 g/cc in full soil (S_{100}) to 0.53 g/cc in full vermicompost (V_{100}). On the other hand, both pore space and water holding capacity of the mixture steadily increased from 39.6 to 72.4 % and 31.3 to 175 %, respectively with increase in ratios of vermicompost from zero to 100% in the soil. The treatment with equal sharing of soil and vermicompost ($S_{50}+V_{50}$) had bulk density of 0.96 g/cc, water holding capacity of 77.7%, and porosity of 59.4%. The addition of finely divided peat like material ‘vermicompost’ increased the porosity of the media and hence decreased the bulk density. Reference [8] also supported high porosity and water holding capacity of vermicompost that helps in better aeration and drainage.

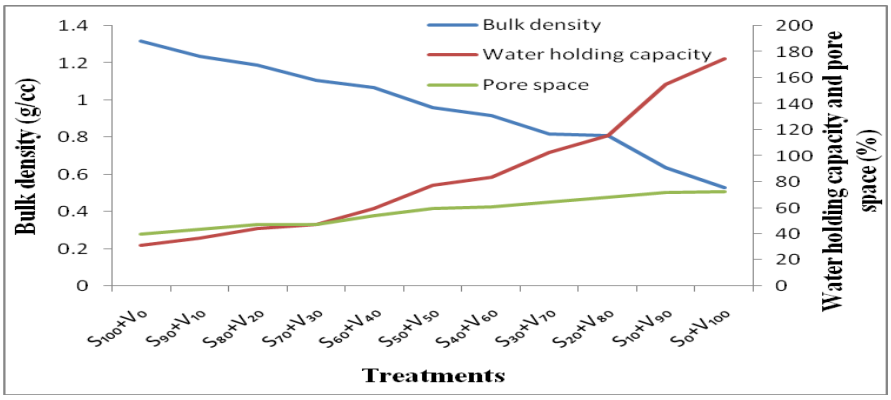

Fig. 1: Effect of varying soil and vermicompost mixtures on bulk density, porosity and water holding capacity of the growing media. S–Soil; V–Vermicompost; The values as subscript indicate the proportion, %

Chemical properties: Available N was recorded in all treatments at 20 days interval during the growing period of sweet corn. It was observed that available N was increased with increasing dose of vermicompost (Fig. 2). Among the treatments, the available N was recorded maximum under 100% vermicompost treatments and minimum in control treatments in all stages of observation. Irrespective of the treatments, during the growing period of sweet corn, the N availability was increased up to 70 days after sowing (DAS) and thereafter declined. At harvest of the crop, the available N content of the growing media were 48, 116 and 212 ppm in S_{100}, $S_{50}+V_{50}$, and V_{100}, respectively. Reference [4] and [9] demonstrated that vermicompost is a valuable soil amendment that offers a balanced nutritional release pattern to plants and provides all the nutrients and micronutrients that can be taken up readily by plants. Reference [10] also reported that mineralizable N was approximately twice as abundant in the organic system as in the conventional one throughout most of the season.

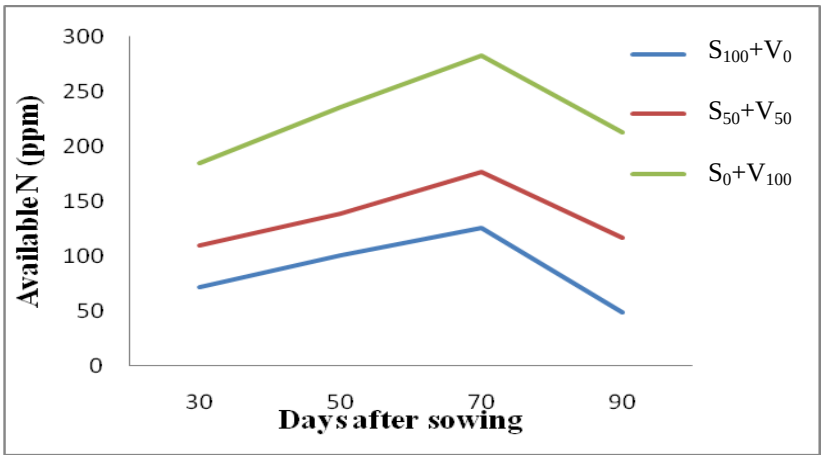

Fig. 2: Effect of varying soil and vermicompost mixtures on changes in available nitrogen content of the growing media at different stages of crop growth. S – Soil; V–Vermicompost; The values as subscript indicate the proportion, %

Biological properties: Both total fungal and bacterial count per gram of sample were increased with increasing addition of vermicompost in soil (Fig. 3). Higher microbial population might be due to incorporation of vermicompost. Reference [11] also observed higher microbial population in the worm casts than the surrounding soil.

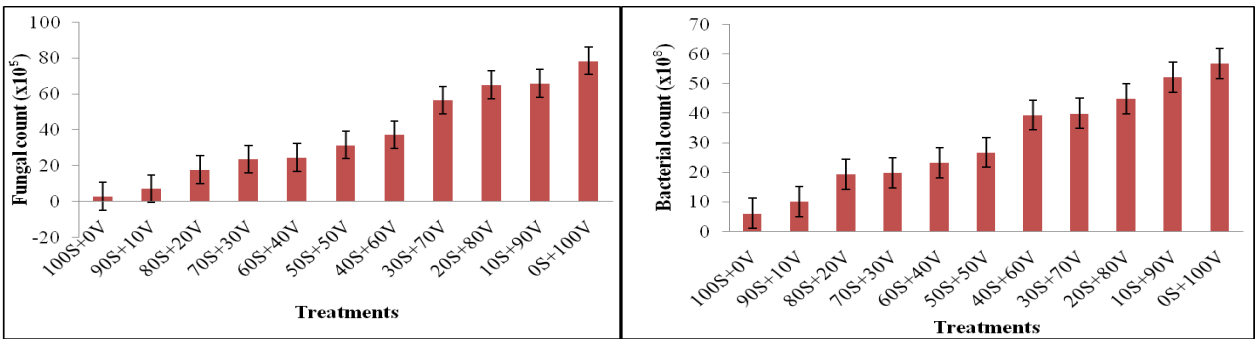

Fig. 3: Effect of varying soil and vermicompost mixtures on fungal and bacterial count per gram of the growing media. S – Soil; V–Vermicompost; The values as subscript indicate the proportion, %

From various experiments, it was found that soil fertility can be maintained adequately under organic management and the added benefits are increased organic matter content and improved soil physical condition, which is also supported by a larger active soil microbial biomass community

3.2. Growth, Yield and Quality of Sweet Corn

The data in Table 1 stated that the total root length increased with increasing rate of vermicompost application in soil. The root volume increased with increasing addition of vermicompost up to 80%. The increase in root dry weight with vermicompost addition was similar trend as of root volume. As compared to pure soil, addition of vermicompost at increasing ratio increased the height of sweet corn, reaching maximum at 100% vermicompost. The stem and cob dry weight increased with increasing rate of

vermicompost application, attaining maximum at 90% vermicompost (S_{10}+V_{90}). For grain yield on dry weight basis, the yield increased continuously with increasing vermicompost application up to 60% (S_{40}+V_{60}) and declined thereafter. From this experiment, it can be stated that the increase in growth and yield parameters of sweet corn are due to greater availability of N at higher doses of vermicompost application in the vermicompost and soil mixture. Reference [12] reported that upon inoculation with effective microorganism and organic fertilizer application, sweet corn showed better grain yield as well as increase in root growth and activity. The increase in grain yield was due to better photosynthetic efficiency under organic fertilizer application.

Table 1: Effect of Varying Soil and Vermicompost Mixtures on Growth and Yield Attributes of Sweet Corn S–Soil; V–Vermicompost; The Values as Subscript Indicate the Proportion, %

Treatments	Plant height (cm)	Stem dry weight (g)	Root length (cm)	Root dry weight (g)	Root volume(cc)	Cob dry weight (g)	Grain dry weight(g)	Number of grains
$S_{100}V_0$	41.7	9.77	30.7	7.94	9	1.01	0	0
$S_{90}V_{10}$	79.7	26.2	35	21.9	48.7	3.88	0	0
$S_{80}V_{20}$	102	49.2	36	24.4	63.3	7.15	1.95	47
$S_{70}V_{30}$	118	64.4	37.7	44.2	98.7	24.3	3.14	50.3
$S_{60}V_{40}$	122	67	42.3	43.4	118	30.1	11.2	155
$S_{50}V_{50}$	126	92.4	44.3	43.5	159	66.5	32	431
$S_{40}V_{60}$	129	94.2	49.3	56.3	189	66.7	44.2	504
$S_{30}V_{70}$	138	91.5	53.7	65.5	313	84.1	44	437
$S_{20}V_{80}$	146	97.8	55	69.5	360	92.7	42.2	419
$S_{10}V_{90}$	154	111	55.7	67.8	320	114	37.7	338
S_0V_{100}	166	106	58	41.7	280	95.8	29.7	222

The quality of sweet corn was assessed in terms of ascorbic acid, sugar, starch and crude protein content (Fig. 4). The ascorbic acid content was increased with increasing dose of vermicompost up to 90% (S_{10}+V_{90}). Reference [13] also reported higher ascorbic acid content in organically produced crop than conventionally grown crop. Similar trend was observed in case of crude protein content. The increasing trend of sugar and starch was observed with increasing addition of vermicompost up to 80% and 70%, respectively.

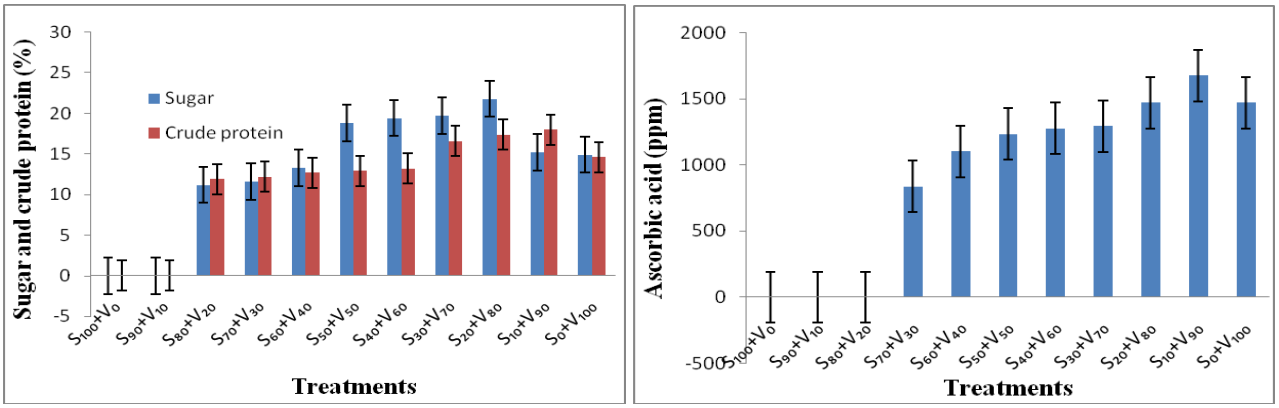

Fig. 4: Effect of varying soil and vermicompost mixtures on changes in sugar, crude protein and ascorbic acid content of sweet corn. S–Soil; V–Vermicompost; The values as subscript indicate the proportion, %

4. Conclusions

From the pot experiment, it was found that increasing dose of vermicompost up to 60-70% in soil and vermicompost mixture resulted higher growth, yield and quality of sweet corn crop as compared to rest combination. Vermicompost was found to be effective in improving soil physical properties viz. bulk density,

water holding capacity, and porosity; nutrient content and its release pattern; and biological properties of soil with regard to microbial count. So, it can be concluded that combined use of soil at 30-40% and rest vermicompost (60-70%) as growing media can meet the crop nutrient demand throughout the growth stages for increasing yield and quality of the sweet corn through improvement of soil physical, chemical and biological properties.

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