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Effect of Vermicompost on the Productivity of Potato (*Solanum tuberosum*), Spinach (*Spinacia oleracea*) and Turnip (*Brassica campestris*)

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Abstract: Present investigations were carried out during 1998-2000 at Shivri farm of Uttar Pradesh Bhumi Sudhar Nigam, Lucknow, India, to study the effect of vermicompost application in reclaimed sodic soils on the productivity of potato (*Solanum tuberosum*), spinach (*Spinacia oleracea*) and turnip (*Brassica campestris*). The soil quality was monitored during the experiment followed by productivity. The treatments were 4, 5 and 6 tonnes/ha of vermicompost as soil application in plots already reclaimed by Vermitechnology. Among the different dosages of vermicompost applied there has been a significant improvement in the soil quality of plots amended with vermicompost @ 6 tonnes per ha. The overall productivity of vegetable crops during the two years of the trial was significantly greater in plots treated with vermicompost @ 6 tonnes per ha. The present investigation showed that the requirement of vermicompost for leafy crops like spinach was lower (4 tonnes/ha), whereas that for tuber crops like potato and turnip was higher (6 tonnes/ha).

Key words: Compost · Vermitechnology · Vermicompost · Vegetables · Soil fertility · Productivity

INTRODUCTION

Intelligent and selective use of organic amendments like vermicompost in reclaimed sodic soils in this study, have proved effective in soil conditioning values and varying degrees of influence on soil properties. Organic amendments like vermicompost promote humification, increased microbial activity and enzyme production, which, in turn, increases the aggregate stability of soil particles, resulting in better aeration [1-4]. Organic matter has a property of binding mineral particles like calcium, magnesium and potassium in the form of colloids of humus and clay, facilitating stable aggregates of soil particles for desired porosity to sustain plant growth. Soil microbial biomass and enzyme activity are important indicators of soil improvement as a result of addition of organic matter [4]. Apart from these, earthworm castings are reported to contain plant growth promoters, such as auxins and cytokinins [5].

The compost prepared through the application of earthworms is called vermicompost and the technology of using local species of earthworms for culture or composting has been called Vermitech [6, 7]. Vermicompost is usually a finely divided peat-like material with excellent structure, porosity, aeration, drainage and moisture holding capacity [8, 9]. The nutrient content of vermicompost greatly depends on the input material. It usually contains higher levels of most of the mineral elements, which are in available forms than the parent material [10, 11]. Vermicompost improves the physical, chemical and biological properties of soil [12]. There is a good evidence that vermicompost promotes growth of plants [13-16] and it has been found to have a favourable influence on all yield parameters of crops like wheat, paddy and sugarcane [7, 17-19].

MATERIALS AND METHODS

Experiments were conducted during 1998-2000 at Shivri farm of Uttar Pradesh Bhumi Sudhar Nigam, Lucknow, India, to study the process of reclamation of sodic soil through the application of vermicompost and thereby to investigate effect of different dosage on vegetables in reclaimed sodic soils.

Cultures of *Perionyx excavatus* Perrier (epigeic) and *Lampito mauritii* Kinberg (anecic) species of earthworms were set up in cement tanks of size 2 m x 1m x 1m (pH 9.5-10) and allowed to stabilise in sodic soil

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by the use of paddy straw and cattle dung at regular interval of 7 days over the soil bed and were used later in the field experiments. Vermicompost was produced by using the process of vermicomposting with the above cultures. Vermicompost was harvested every 45 days at the rate of 350 kg per tank. The experimental area (243 m^2) was divided into 12 plots, each of size 4.5 m x 4.5 m with 4 treatments each in triplicate, applying different dosages of vermicompost. The treatments set up for potato (*Solanum tuberosum*), spinach (*Spinacia oleracea*) and turnip (*Brassica campestris*), were as follows:

1. [C] Control
2. [VC4] Vermicompost @ 4 tonnes/ha
3. [VC5] Vermicompost @ 5 tonnes/ha
4. [VC6] Vermicompost @ 6 tonnes/ha

Soil samples were collected before and after the harvest of vegetables. These were subjected to physico-chemical analysis (pH, electrical conductivity, organic carbon, total Kjeldahl nitrogen) [20]. Exchangeable Sodium Percentage (ESP) or sodicity was also calculated [21]. Total weight of potato tubers (kg/ha), total leaf biomass of spinach (in kg/ha) and total weight of turnip (kg/ha) were recorded.

RESULTS AND DISCUSSION

Table 3-7 show the varying trends observed in the chemical parameters of soil namely pH, electrical conductivity, organic carbon, available nitrogen and sodicity (ESP), during 1998-2000. Decrease in pH (Table 3) of 1.10 was observed in amendment [VC6] followed by 0.63 in [VC5] with significance in amendments [VC4], [VC5] and [VC6] ($P<0.01$) compared to control [C]. There was in reduction in electrical conductivity (Table 4) of 0.17 dSm^{-1} in amendment [VC6] followed by 0.14 dSm^{-1} in [VC4] with significance observed in amendments [VC4], [VC6] ($P<0.01$) and [VC5] ($P<0.05$) compared to control [C]. Increase in organic carbon (Table 5) was 0.82% in amendment [VC6] followed by 0.67% in [VC5] and 0.65% in [VC4] with statistical significance observed in amendments [VC4], [VC5] and [VC6] ($P<0.01$) on organic carbon compared to control [C].

There was an increase of 829.33 kg/ha in available nitrogen (Table 6) in amendment [VC6] followed by 548.70 kg/ha in [VC5] with statistical significance observed in [VC4], [VC5], [VC6] ($P<0.01$). There was reduction of 73.68 in sodicity (ESP) (Table 7) in amendment [VC6] followed by 65.39 in [VC4] with statistical significance observed in [VC4], [VC5], [VC6] ($P<0.01$). Statistical analysis based on composite index (Table 9) indicates that improvement in soil qualities is maximum in amendment [VC6] followed by [VC4] and [VC5] while there is least improvement in [C].

These experiments were conducted to assess the requirements of vermicompost by vegetable crops in sodic soil after bioremediation process to fulfill the needs of the farmers during the transfer of technology at large scale. Among the different dosages of vermicompost applied in the present investigation, there has been a significant improvement in the soil quality of plots amended with vermicompost @ 6 tonnes per ha (Table 3-7). This correlates with the results that application of compost like vermicompost enhances physical and chemical characteristics of soil in potato cultivation [22]. Organic matter through the application of vermicompost increases the bioavailability of phosphorus in the soil effecting plant growth in potato cropping [23]. Compost application also effects nitrogen mineralization in soil [24].

Table 1: Yield (tonnes/ha) (Mean±SD) (Each trial mean of 3)

Amendment	Potato *So. tuberosum*)	Spinach (*Sp. oleracea*)	Turnip (*B. compestris*)
[C]	04.36±1.28	1.40±0.01	4.12±0.18
[VC4]	11.97±0.11	3.09±0.09	4.84±0.08
[VC5]	20.53±0.30	1.85±0.06	4.89±0.06
[VC6]	21.41±0.19	2.10±0.05	5.37±0.07

Table 2: Composite index based on average yield of vegetables

Amendments	Potato	Spinach	Turnip	Composite index	Rank
[C]	4	4	4	12	3rd
[VC4]	3	1	3	7	2nd
[VC5]	2	3	2	7	2nd
[VC6]	1	2	1	4	1st

Soil chemical analysis

Table 3: pH (Mean±SD)

Amendments	Initial (n=10)	Final (n=10)	Decrease in pH
[C]	8.83+0.04	8.61+0.07	0.22
[VC4]	8.94+0.02	8.58+0.01	0.36
[VC5]	9.34+0.05	8.71+0.01	0.63
[VC6]	9.51+0.03	8.41+0.02	1.10

Table 4: Electrical Conductivity (EC) dSm^{-1} (Mean±SD)

Amendments	Initial (n=10)	Final(n=10)	Decrease in EC
[C]	0.40±0.001	0.40±0.001	0.00
[VC4]	0.45±0.001	0.31±0.002	0.14
[VC5]	0.44±0.001	0.43±0.010	0.01
[VC6]	0.47±0.001	0.30±0.001	0.17

Table 5: Organic carbon % (OC) (Mean±SD)

Amendments	Initial (n=10)	Final (n=10)	Increase in OC (%)
[C]	0.21±0.01	0.22±0.04	0.01
[VC4]	0.16±0.02	0.81±0.01	0.65
[VC5]	0.18±0.01	0.85±0.03	0.67
[VC6]	0.15±0.01	0.97±0.02	0.82

Table 6: Available nitrogen (kg/ha) (Mean±SD)

Amendments	Initial (n=10)	Final (n=10)	Increase in Av. N
[C]	377.87±12.93	400.80±22.40	022.93
[VC4]	388.27±12.93	814.40±22.40	426.13
[VC5]	395.73±12.93	944.43±45.18	548.70
[VC6]	336.00±22.40	1165.33±34.22	829.33

Table 7: Sodicity (ESP) (Mean±SD)

Amendments	Initial (n=10)	Final (n=10)	Decrease in Sodicity (ESP)
[C]	96.41±0.17	96.76±0.43	-00.35
[VC4]	97.26±0.07	31.87±1.47	65.39
[VC5]	96.52±0.41	32.22±3.82	64.30
[VC6]	96.74±0.11	23.06±0.35	73.68

(- indicates increase)

Table 8: Test of significance of amendment on soil parameters

Amendment	pH	EC	OC	N	ESP
[C]	H	H	H	H	H
[VC4]	*	*	*	*	*
[VC5]	*	**	*	*	*
[VC6]	*	*	*	*	*

*P<0.01, **P<0.05, H: Homogeneous

Table 9: Composite index based on soil physical and chemical analysis

Amendments	pH	EC	OC	N	ESP	Composite index	Rank
[C]	4	4	4	4	4	20	4th
[VC4]	3	2	2	3	2	12	2nd
[VC5]	2	3	3	2	3	13	3rd
[VC6]	1	1	1	1	1	05	1st

Yields of potato and turnip were significantly higher in plots amended with vermicompost @ 6 tonnes per ha, whereas the yield of spinach was considerably higher in plots treated with vermicompost @ 4 tonnes per ha (Table 1). The overall productivity of vegetable crops during the two years of the trial was significantly greater in plots treated with vermicompost @ 6 tonnes per ha (Table 2).

Experiments on the effect of earthworms and vermicompost on the cultivation of vegetables like tomato (*Lycopersicum esculentum*), brinjal (*Solanum melongena*) and okra (*Abelmoschus esculentus*) have yielded significant results [7, 17]. Vermicompost as an organic input has been applied to grow vegetables and other crops succesfully [7, 17]. Application of composts like vermicompost could contribute to increased availablity of food [25]. The present investigation showed that the requirement of vermicompost for leafy crops like spinach was lower (4 tonnes/ha) which may be due to lesser macronutrient requirement and uptake, whereas that for tuber crops like potato and turnip was higher (6 tonnes/ha) can be attributed to higher macronutrient requirement and absorption (Table 1).

Among the different dosages of vermicompost applied there has been a significant improvement in the soil quality of plots amended with vermicompost @ 6 tonnes per ha. The overall productivity of vegetable crops during the two years of the trial was significantly greater in plots treated with vermicompost @ 6 tonnes per ha. The present investigation showed that the requirement of vermicompost for leafy crops like spinach was lower (4 tonnes/ha), whereas that for tuber crops like potato and turnip was higher (6 tonnes/ha).

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