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Effect of Vermicompost and Vermiwash on the Productivity of Spinach (*Spinacia oleracea*), Onion (*Allium cepa*) and Potato (*Solanum tuberosum*)

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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 and vermiwash in reclaimed sodic soils on the productivity of spinach (*Spinacia oleracea*), onion (*Allium cepa*) and potato (*Solanum tuberosum*). The soil quality was monitored during the experiment followed by productivity. Amongst the combinations of vermicompost @ 6 tonnes and vermiwash (different concentrations), there has been significant improvement in soil qualities in plots treated with vermicompost and vermiwash (1:10 v/v in water), vermicompost and vermiwash (natural) and vermicompost and vermiwash (1:5 v/v in water). The yield of spinach was significantly higher in plots treated with vermiwash (1:5 v/v in water). The yield of onion was significantly higher in plots treated with vermiwash (1:10 v/v in water), whereas the average weight of onion bulbs was significantly greater in plots amended with vermicompost and vermiwash (1:5 v/v in water). The yield of potato and the average weight of potato tubers were significantly higher in plots treated with vermicompost.

Key words: Earthworm · Vermicompost · Vermiwash · Vermitech · Soil fertilility · Plant productivity

INTRODUCTION

The role of earthworms in soil formation and soil fertility is well documented and recognized [1-4]. An approach towards good soil management, with an emphasis on the role of soil inhabitants like earthworms, in soil fertility, is very important in maintaining balance in an ecosystem [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 [4,6]. Vermicompost is usually a finely divided peat-like material with excellent structure, porosity, aeration, drainage and moisture holding capacity [7,8]. 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 [9]. Vermicompost improves the physical, chemical and biological properties of soil [2]. There is a good evidence that vermicompost promotes growth of plants [3,10,11] and it has been found to have a favourable influence on all yield parameters of crops like wheat, paddy and sugarcane [4,12-14]. Vermiwash, a foliar spray, is a liquid fertilizer collected after the passage of water through a column of worm activation. It is a collection of excretory and secretory products of earthworms, along with major micronutrients of the soil and soil organic molecules that are useful for plants [12]. Vermiwash seems to possess an inherent property of acting not only as a fertilizer but also as a mild biocide [15].

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 stabilization of reclaimed sodic soil through the application of vermicompost and vermiwash 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 2m x 1m x 1m (pH 9.5-10) and allowed to stabilise in sodic soil by the use of paddy straw and cattle dung at regular interval of 7 days

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over the soil bed and were used later in the field experiments. Vermicompost and vermiwash were 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. Vermiwash (leachate of earthworm-worked organic matter, soil and vermicompost) was produced using containers (300 litres capacity) fitted with tap at the rate of 7 litres per day. Other organic amendments like farm yard manure (FYM was also used in experiment. The experimental area ($243m^2$) was divided into 27 plots, each of size 3×3 m with 9 treatments, each with 3 replicates, applying combinations of vermicompost and vermiwash. The combinations of vermicompost and vermiwash (as basal application) applied on spinach (*Sp. oleracea*), onion (*A. cepa*) and potato (*So. tuberosum*), were as follows:

[C]	Control
[FYM]	Farmyard manure @ 6 tonnes/ha
[VC]	Vermicompost @ 6 tonnes/ha
[VWN]	Vermiwash (Natural @ 1 kl/ha)
[VW5]	Vermiwash (1:5 v/v in water @ 1 kl/ha)
[VW10]	Vermiwash (1:10 v/v in water @ 1 kl/ha)
[VCVWN]	Vermicompost @ 6 t/ha + Vermiwash (Natural @ 1 kl/ha)
[VCVW5]	Vermicompost @ 6 t/ha + Vermiwash (1:5 v/v in water @ 1 kl/ha)
[VCVW10]	Vermicompost @ 6 t/ha + Vermiwash (1:10 v/v in water @ 1 kl/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, potassium, sodium and calcium) [16]. Exchangeable sodium percentage (ESP) or sodicity was also calculated [17]. Total weight of potato tubers (kg/ha), total leaf biomass of spinach (in kg/ha) and total weight of onion bulbs (kg/ha) were recorded. Average weight (g/piece) of potato and onion were also recorded.

RESULTS AND DISCUSSION

These experiments was conducted to assess the impact of vermicompost and vermiwash (soil application) in combination on some vegetable crops in reclaimed sodic soils to study the productivity levels through such organic farming packages to be offered to the farmers. The yield of spinach was significantly higher in plots treated with vermiwash (1:5 v/v in water) (Table 1). The yield of onion was significantly higher in plots treated with vermiwash (1:10 v/v in water), whereas the average weight of onion bulb was significantly greater in plots amended with vermicompost and vermiwash (1:5 v/v in water) (Table 1-2). This is attributed to better growth of plants and higher yield by slow release of nutrients for absorption with additional nutrients like giberellin, cytokinin and auxins, by the application of organic inputs like vermicompost in combination with vermiwash [3,18-20]. The yield of potato and the average weight of potato tubers were significantly higher in plots treated with vermicompost (Table 1-2). This may be attributed to increased bioavailability of phosphorus by the application of organic amendment in the form of vermicompost [21]. Organic manure like vermicompost and vermiwash, when added to soil, augment crop growth and yield [3]. The yields of spinach and onion in response to diluted vermiwash along with vermicompost was highly significant which may be due to increased availability of more exchangeable nutrients in the soil by the application of vermiwash along with vermicompost [22, 23]. Amongst the various combinations of vermicompost @ 6 tonnes and vermiwash (different concentrations), there has been significant improvement in soil qualities in plots treated with vermicompost and vermiwash (natural), vermicompost and vermiwash (1:10 v/v in water) and

Table 1: Vegetable Yield (Mean±SD) (Each trial mean of 3)

Amendment	Spinach (*Sp. oleracea*) (tonnes/ha)	Onion (*A. cepa*) Bulbs (tonnes/ha)	Onion (*A. cepa*) Average Wt. (g/piece)	Potato (*So. tuberosum*) Tubers (tonnes/ha)	Potato (*So. tuberosum*) Average Wt. (g/piece)
[C]	1.26±0.14	1.83±0.67	29.93±03.52	04.02±0.41	52.51±02.18
[FYM]	3.52±1.78	5.83±1.82	63.60±17.32	08.37±2.50	73.45±06.77
[VC]	3.70±1.28	3.15±1.37	40.76±11.38	12.98±2.39	84.43±02.71
[VWN]	2.70±0.67	2.50±1.54	44.09±07.43	08.09±2.72	67.94±10.33
[VW5]	5.55±1.11	1.96±0.25	30.21±06.88	04.78±0.68	55.21±04.57
[VW10]	4.26±1.60	6.48±1.55	43.04±01.51	07.07±1.75	66.15±03.42
[VCVWN]	1.89±0.29	2.43±0.72	49.60±07.29	08.52±0.64	65.83±08.30
[VCVW5]	1.37±0.28	6.27±2.11	65.37±07.61	11.67±6.05	78.85±19.93
[VCVW10]	5.07±0.44	1.96±0.30	37.33±05.76	09.35±1.60	70.82±04.89

Table 2: Composite index based on average yield of vegetable crops

Amendments	Spinach	Onion	Potato	Composite index	Rank
[C]	9	8	9	26	7th
[FYM]	5	3	5	13	4th
[VC]	4	4	1	9	1st
[VWN]	6	5	6	17	6th
[VW5]	1	7	8	16	5th
[VW10]	3	1	7	11	2nd
[VCVWN]	7	6	4	17	6th
[VCVW5]	8	2	2	12	3rd
[VCVW10]	2	7	3	12	3rd

Table 3: Soil chemical analysis, pH (Mean±SD)

Amendments	Initial (n=10)	Final (n=10)	Decrease in pH
[C]	08.23±0.29	9.37±0.11	-1.14
[FYM]	08.63±0.25	8.07±0.23	0.56
[VC]	09.03±0.15	8.03±0.21	1.00
[VWN]	09.60±0.78	8.89±0.56	0.71
[VW5]	10.13±0.11	9.47±0.15	0.66
[VW10]	09.80±0.26	9.17±0.46	0.63
[VCVWN]	09.70±0.36	8.27±0.15	1.43
[VCVW5]	09.00±0.60	8.13±0.25	0.87
[VCVW10]	09.97±0.67	8.23±0.15	1.74

(- indicates increase)

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

Amendments	Initial (n=10)	Final (n=10)	Decrease in EC
[C]	0.84±0.05	0.66±0.11	0.18
[FYM]	0.67±0.22	0.21±0.04	0.46
[VC]	0.82±0.08	0.13±0.03	0.69
[VWN]	0.76±0.01	0.20±0.11	0.56
[VW5]	0.82±0.04	0.29±0.04	0.53
[VW10]	0.46±0.03	0.18±0.08	0.28
[VCVWN]	0.71±0.05	0.14±0.03	0.57
[VCVW5]	0.84±0.07	0.12±0.01	0.72
[VCVW10]	0.88±0.07	0.23±0.08	0.65

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

Amendments	Initial (n=10)	Final (n=10)	Decrease in OC %
[C]	0.39±0.02	0.33±0.05	-0.06
[FYM]	0.39±0.03	0.55±0.04	0.16
[VC]	0.43±0.01	0.77±0.05	0.34
[VWN]	0.39±0.01	0.45±0.02	0.06
[VW5]	0.26±0.05	0.44±0.05	0.18
[VW10]	0.36±0.03	0.46±0.01	0.10
[VCVWN]	0.20±0.05	0.79±0.08	0.59
[VCVW5]	0.42±0.06	0.66±0.04	0.24
[VCVW10]	0.25±0.01	0.79±0.07	0.54

(- indicates decrease)

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

Amendments	Initial (n=10)	Final (n=10)	Increase in Av. N
[C]	888.53±056.37	738.67±136.78	-149.86
[FYM]	881.07±078.67	1032.00±04019	150.93
[VC]	970.67±034.22	1265.60±064.01	294.93
[VWN]	799.47±149.67	933.87±023.19	134.40
[VW5]	649.07±051.67	785.60±019.41	136.53
[VW10]	813.87±068.43	922.93±025.86	109.06
[VCVWN]	588.80±050.92	928.80±037.08	340.00
[VCVW5]	874.13±067.21	1204.27±142.9	330.14
[VCVW10]	826.67±060.05	1343.73±028.74	517.06

(- indicates decrease)

Table 7: Sodicity (ESP) (Mean±SD)

Amendments	Initial (n=10)	Final (n=10)	Decrease in Sodicity (ESP)
[C]	48.27±4.01	72.79±2.33	-24.52
[FYM]	46.38±5.22	28.35±2.82	18.03
[VC]	56.91±4.77	20.19±4.68	36.72
[VWN]	50.21±1.27	49.35±1.98	00.86
[VW5]	67.37±2.96	58.98±3.25	08.39
[VW10]	51.72±3.50	47.03±0.73	04.69
[VCVWN]	81.37±5.79	28.48±3.20	52.89
[VCVW5]	63.96±5.57	17.63±3.02	46.33
[VCVW10]	69.24±6.19	17.28±4.16	51.96

(- indicates increase)

Table 8: Test of Significance of amendment on soil parameters

Amendment	pH	EC	OC	N	ESP
[C]	H	H	H	H	H
[FYM]	*	H	*	H	H
[VC]	*	**	*	*	**
[VWN]	H	*	H	H	H
[VW5]	*	**	H	*	H
[VW10]	H	*	*	H	H
[VCVWN]	*	*	**	**	**
[VCVW5]	H	**	**	H	*
[VCVW10]	H	**	*	**	**

*Significance at 1% level, **Significance at 5% level, H= Not significant

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

Amendment	pH	EC	OC	N	ESP	Composite index	Rank
[C]	9	9	9	9	9	45	9h
[FYM]	8	7	6	5	5	31	6th
[VC]	3	2	3	4	4	16	4th
[VWN]	5	5	8	7	8	33	7th
[VW5]	6	6	5	6	6	29	5th
[VW10]	7	8	7	8	7	37	8th
[VCVWN]	2	4	1	2	1	10	2nd
[VCVW5]	4	1	4	3	3	15	3rd
[VCVW10]	1	3	2	1	2	09	1st

vermicompost and vermiwash (1:5 v/v in water) (Table 3-9). Organic amendments like vermicompost and vermiwash promote humification, increased microbial activity and enzyme production, which, in turn, bring about the aggregate stability of soil particles, resulting in better aeration [24-27]. 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 [28]. Soil microbial biomass and enzyme activity are important indicators of soil improvement as a result of addition of organic matter [27].

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