African Journal of Agricultural Research Vol. 5(14), pp. 1794-1798, 18 July, 2010
Available online at http://www.academicjournals.org/AJAR
DOI: 10.5897/AJAR09.107
ISSN 1991-637X ©2010 Academic Journals

Full Length Research Paper

Effect of vermiwash and vermicompost on soil parameters and productivity of okra (*Abelmoschus esculentus*) in Guyana

Abdullah Adil Ansari[1]* and Kumar Sukhraj[2]

[1]Department of Biological Sciences, Kebbi State University of Science and Technology, Aliero, Kebbi State, Nigeria.
[2]Department of Biology, University of Guyana, Georgetown, Guyana.

Accepted 2 July, 2010

Present investigations were carried out during the year 2006 - 2007 at University of Guyana, Georgetown focusing on recycling organic waste using vermitechnology and use of vermicompost and vermiwash obtained from the vermitech in varied combinations for exploring the effect on soil and productivity of Okro (*Abelmoschus esculentus*) in Guyana. The soil quality was monitored during the experiment along with plant growth parameters of Okra. The study revealed that combination organic fertilizers vermicompost and vermiwash combination compared with control and chemical fertilizers had great influence on plant growth parameters. The average yield of Okro (*A. esculentus*) during trial showed a significantly greater response in comparison with the control by 64.27%. The fruits were found to have a greater percentage of fats and protein content when compared with those grown with chemical fertilizers by 23.86 and 19.86% respectively. The combination treatment vermiwash and vermicompost combination was also found to have a significant influence on the biochemical characteristics of the soil with marked improvement in soil micronutrients. The combination treatment was the found to be better suggesting qualitative improvement in the physical and chemical properties of the soil, which is substantiated by composite, index {Rank 1 for vermicompost and vermiwash combination with composite index of 9}. This biological method of crop cultivation is sustainable and improves soil health rather than conventional methods based on the earlier observations.

Key words: Organic waste, vermicompost, vermiwash, soil fertility, okra, Guyana.

INTRODUCTION

Vermitechnology is the use of surface and subsurface local varieties of earthworm in composting and management of soil (Ismail, 2005). Darwin (1881) has made their activities the object of a careful study and concluded that ‘it may be doubted if there are any other animals which have played such an important part in the history of the world as these lowly organized creatures’. It has been recognized that the work of earthworms is of tremendous agricultural importance. Earthworms along with other animals have played an important role in regulating soil processes, maintaining soil fertility and in bringing about nutrient cycling (Ismail, 1997). Earthworms have a critical influence on soil structure, forming aggregates and improving the physical conditions for plant growth and nutrient uptake. They also improve soil fertility by accelerating decomposition of plant litter and organic matter and, consequently, releasing nutrients in the form that are available for uptake by plants (Curry, 1987).

Vermicomposting is the biological degradation and stabilization of organic waste by earthworms and micro-organisms to form vermicompost (Edwards and Neuhauser, 1988). This is an essential part in organic farming today. It can be easily prepared, has excellent properties, and is harmless to plants. The earthworms fragment the organic waste substrates, stimulate microbial activity greatly and increase rates of mineralization.

These rapidly convert the waste into humus-like substances with finer structure than thermophilic composts

*Corresponding author. E-mail: ansari_adil@hotmail.com.

but possessing a greater and more diverse micro-bial activity (Elvira et al., 1996; Atiyeh et al., 2000). Ver-micompost being a stable fine granular organic matter, when added to clay soil loosens the soil and improves the passage for the entry of air. The mucus associated with the cast being hydroscopic absorbs water and prevents water logging and improves water-holding capacity. The organic carbon in vermicompost releases the nutrients slowly and steadily into the system and enables the plant to absorb these nutrients. The soil enriched with vermin-compost provides additional substances that are not found in chemical fertilizers (Kale, 1998).

Vermiwash is a liquid that is collected after the passage of water through a column of worm action and is very useful as a foliar spray. It is a collection of excretory products and mucus secretion of earthworms along with micronutrients from the soil organic molecules. These are transported to the leaf, shoots and other parts of the plants in the natural ecosystem. Vermiwash, if collected properly, is a clear and transparent, pale yellow coloured fluid (Ismail, 1997). The regular inputs of feed materials for earthworms can be in the form of agro waste, kitchen waste and nitrogen rich materials such as cattle dung, goat dung and pig manure (Ismail, 2005). Vermiculture is the culture of earthworms and vermicast is the fecal matter released by the earthworms (Ismail, 1997).

Many agricultural industries use compost, cattle dung and other animal excreta to grow plants. In today's society, we are faced with the dilemma of getting rid of waste from our industries, household etc. In order for us to practice effective waste management we can utilize the technology of vermicomposting to effectively manage our waste. This process allows us to compost the degradable materials and at the same time utilize the products obtained after composting to enhance crop production in Guyana, and eliminate the use of chemical fertilizers. As indicated by Ansari and Ismail (2001), the application of chemical fertilizers over a period has resulted in poor soil health, reduction in produce, and increase in incidences of pest and disease and environ-mental pollution. In order to cope with these trenchant problems, the vermin-technology has become the most suitable remedial device (Edwards and Bohlen, 1996; Kumar, 2005). Therefore organic farming helps to provide many advantages such as; eliminate the use of chemicals in the form of fertilizers/pesticides, recycle and regenerate waste into wealth; improve soil, plant, animal and human health; and creating an ecofriendly, sustain-able and economical bio-system models (Ansari and Ismail, 2001). In Guyana as many as 75% of the agricultural industries mainly use chemical fertilizers, weedicides and pesticides for cultivating plants. Guyana exports agricultural products to Antigua, Barbados, Dominica, Grenada, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suri-name, Trinidad and Tobago, US and UK. If the level of chemical fertilizers and pesticides are too high in the agricultural products, then producers would have to face the dilemma of having their produces dumped and lose their money (Budhan, 2004). The objective of the study was to assess the plant productivity by the use of organic fertilizers in different combinations and the effect on soil physical and chemical parameters in comparison to control and chemical fertilizers.

MATERIALS AND METHODS

The present work was carried out during the year 2005 - 2006 at the University of Guyana, Georgetown to effectively recycle the organic waste like grass clippings and cattle dung. The locally available earthworm species *Eisenia fetida* was used for the purpose.

Cultures of *E. fetida* species of earthworms were set up using large baskets for the production of vermicompost. The basal layer of the vermi-bed comprised of broken bricks followed by a layer of coarse sand (10 cm thick) in-order to ensure proper drainage. A layer (10 cm) of loamy soil was placed at the top. 100 locally collected earthworms were introduced into the soil. Fresh cattle dung was scattered over the soil and then it was covered with a 10 cm layer of dried grasses. Water was added to the unit in-order to keep it moist. The dried grass along with cattle dung was turned once a week. After 60 days, vermicompost units were regularized for the harvesting of vermicompost every 45 days. Approximately 1 kg per unit was collected at every harvest. Vermicompost produced was subjected to physicochemical characterization.

Vermiwash (leacheate of earthworm-worked organic matter, soil and vermicompost) was produced using buckets. A tap was fixed on the lower side of each bucket. The bucket was placed on a stand to facilitate collection of vermiwash. 5 cm of broken pebbles were placed at the bottom of the buckets followed by 5 cm layer of coarse sand. Water was then allowed to flow through these layers to enable the settling of the basic filter unit. A 15 cm layer of loamy soil was placed on top of the filter bed.

Approximately 300 earthworms were introduced into the soil. Dried grass and cattle dung was placed on top of the soil. Approximately 0.5 liters was collected on a daily basis. Vermiwash produced was subjected to physicochemical analysis. Initial and final soil samples, Vermiwash, vermicompost and cattle dung were subjected to physiochemical characteristics (Homer, 2003). Chemical analysis of samples was done at the Guyana Sugar Corporation Central Laboratory.

Okra (*Abelmoschus esculentus*) was grown with the following treatments (Table 1):

The pot experiments were placed using randomized block design with replication for each treatment. The trial was run for six weeks, which is the usual period for seedling growth after transplanting. The pots were filled with sterilized dry soil (5 kg). The initial soil samples were subjected to soil chemical analysis. Application of treatments to the plants was as follows:

i) Before seedlings are planted.
ii) Three weeks after seedlings are planted.
iii) Before flowering (Approximately 5 weeks after planting).

The following growth parameters were recorded at harvest (after 6 weeks):

i) Number of leaves per plant.
ii) Plant Height (cm).
iii) Stem Circumference (cm).
iv) Marketable fruit yield (g).

On the sixth week the plants were taken out of the pot and the

Table 1. Quantity used in treatments.

Treatment	Quantity/ plant
Control	No additions
Cattle dung	100 g
Chemical fertilizers	15.30 g
Vermiwash	100 ml
Vermicompost	100 g
Vermiwash + Vermicompost	100 ml + 100 g

Table 2. Physiochemical properties of vermiwash and vermicompost (Mean $\pm$ SD).

Parameter	Vermiwash	Parameter	Vermicompost
pH	7.11 ± 0.02	pH	6.12 ± 0.03
Total salts (ppm)	9841.67 ± 123.32	Total salts (ppm)	3148.67 ± 48.58
Total nitrogen (%)	0.02 ± 0.002	Total Nitrogen (%)	1.11 ± 0.05
Organic carbon (%)	0.18 ± 0.020	Organic carbon (%)	9.77 ± 5.05
Available phosphate (ppm)	48.86 ± 0.13	C/N ratio	8.80
Calcium (ppm)	192.4 ± 30.22	Available phosphate (ppm)	597.67 ± 0.58
Magnesium (ppm	142.53 ± 38.90	Calcium (ppm)	322.33 ± 24.91
Potassium (ppm)	245.67 ± 9.50	Magnesium (ppm	137.33 ± 19.50
Manganese (ppm)	0.04 ± 0.02	Potassium (ppm)	2428.33 ± 326.28
Iron (ppm)	2.21 ± 0.04	Manganese (ppm)	0.69 ± 0.01
Copper (ppm)	0.35 ± 0.01	Iron (ppm)	0.11 ± 0.01
Zinc (ppm)	0.03 ± 0.01	Copper (ppm)	0.01 ± 00
		Zinc (ppm)	2.13 ± 0.05

above listed growth parameters were measured. The fruits of the plant for each treatment were analyzed for (protein and fat content) nutritional values. These biochemical analyses (Homer, 2003) were done at the Government Food Analytical Food Chemistry laboratory (Ministry of Health). The soil chemical analysis data was subjected to composite index analysis.

RESULTS AND DISCUSSION

The physiochemical properties of vermiwash and vermicompost listed in Table 2 is in agreement with the work done by Ismail (2005) and Lalitha et al. (2000). The Carbon: Nitrogen ratio was reduced to 8.80 by process of vermicomposting, which is indicative of completion of composting process. The micronutrients are available in significant quantity. The liquid extract obtained through earthworm worked soil is referred to as vermiwash. The assessment of vermiwash indicated the presence of micronutrients in significant quantity (Kale, 1998; Ismail, 2005).

The number of leaves observed after week six, was maximum for plants treated with chemical fertilizers, followed by vermiwash and vermicompost (Table 3). The maximum number of leaves observed with chemical fertilizers can be accounted for by the fact that chemical fertilizers are high in nitrogen, which is responsible for rapid plant growth. The plant height observed after week six, was maximum for vermiwash and vermicompost followed by chemical fertilizers and vermiwash (Table 3).

The stem circumference observed after week six, was maximum for plants treated with chemical fertilizers, followed by vermicompost, vermiwash and vermicompost and cattle dung (Table 3). The maximum circumference of stem in chemical fertilizers can be accounted for by the fact that chemical fertilizers have a greater percentage of available salts such as nitrate, phosphate and potassium, which significantly increases plant growth. The marketable yield of the fruits per plant in chemical fertilizers was maximum followed by vermiwash and vermicompost, vermicompost and cattle dung (Table 3).

The yield was comparable in chemical fertilizers and vermiwash and vermicompost. The plant growth in verminwash and vermicompost and vermicompost may be due to the impact of microbes in bio- fertilizers (Lalitha et al., 2000; Ansari, 2008a; b).

The fat content of fruits was maximum in vermiwash and vermicompost followed by vermicompost and verminwash. The protein content of fruits was maximum in verminwash and vermicompost followed by vermincompost and cattle dung (Table 3). The biochemical

Table 3. Plant growth parameters at harvest (after 6 week period) (Mean ± SD).

Treatments	Plant height (cm)	Number of leaves per plant	Stem circumference (cm)	Marketable fruit yield (g/plant)	Biochemical analysis	
					Fats (%)	Protein (%)
Control	31.67 ± 03.79	09 ± 2.53	2.23 ± 0.84	24.69 ± 17.27	0.52 ± 0.10	3.41 ± 0.25
Cattle dung	36.00 ± 03.46	10 ± 2.89	2.50 ± 0.02	31.636 ± 8.81	1.78 ±1.02	6.37 ± 0.38
Chemical fertilizers	44.33 ± 10.02	14 ± 3.05	3.77 ± 1.42	75.43 ± 22.10	2.68 ± 0.81	5.73 ± 0.88
Vermiwash	42.33 ± 02.52	11 ± 0.00	2.47 ± 0.29	30.36 ± 11.43	3.00 ± 0.00	6.35 ± 0.15
Vermicompost	39.33 ± 05.86	12 ± 2.31	3.17 ± 0.06	59.04 ± 36.26	3.15 ± 0.21	6.82 ± 0.51
Vermiwash and Vermicompost	45.83 ± 05.62	13 ± 1.15	3.10 ± 0.17	69.11 ± 32.47	3.52 ± 0.24	7.15 ± 0.35

Table 4. Soil chemical analysis (mean ± sd).

Treatments	Decrease in pH	Increase in OC %	Increase in N %	Increase in Mg (ppm)	Increase in Ca (ppm)	Increase in Zn (ppm)
Control	-0.06	-0.07	-0.01	-0.39	-2.45	-1.50
Cattle dung	0.11	0.27	0.35	0.73	1.79	5.12
Chemical fertilizers	0.91	-0.15	0.65	0.35	1.15	0.86
Vermiwash	0.03	0.14	0.40	0.90	4.07	0.73
Vermicompost	0.40	0.64	0.43	0.64	3.40	10.24
Vermiwash and vermicompost	0.28	0.73	0.55	1.00	5.00	15.62

qualities of the fruits grown in vermiwash and vermin-compost indicated higher nutrient quality, which may be attributed to the presence of plant growth promoters like gib-berellins, cytokinins and auxins (Krishnamoorthy and Vajranbhiah, 1986). The vermiwash is a major contributor of micro-nutrients to soil. Vermicompost and vermiwash are also enriched in certain metabolites and vitamins that belong to the B group or provitamin D which also help to enhance plant growth (Lalitha et al., 2000; Ansari, 2008a; b).

The initial soil samples drawn from the soil used in experimental pots, showed the pH of soil 7.97, organic carbon 1%, available nitrogen 0.1%, magnesium 5 ppm, calcium 11 ppm, and zinc 10.44 ppm. The maximum increase in pH was observed in chemical fertilizers, ver-mincompost and vermiwash and vermicompost (Table 4). The maximum increase organic carbon percentage was observed in vermiwash and vermicompost, followed by vermicompost and cattle dung. Control and chemical fertilizers did not show any increase in organic carbon, but instead showed a decrease, which is attributed to the deficiency of organic carbon in the chemical fertilizers (Table 4). The organic carbon in vermicompost releases the nutrients slowly and steadily into the soil and enables the plants to absorb the available nutrients (Lalitha et al., 2000; Ansari, 2008a; b). The maximum increase in available nitrogen percentage was observed for chemical fertilizers followed by vermiwash and vermicompost and vermicompost (Table 4). The maximum increase of available nitrogen in chemical fertilizers can be accounted for because of the highest percentage of available nitrate it contained. Using vermiwash and vermicompost may attribute the significant increase in nitrogen of the soil by using vermiwash and vermin-compost due to the presence of nitrogen fixing bacteria, which increase the nitrogen content of the soil (Lalitha et al., 2000; Ansari, 2008a; b). The maximum increase in magnesium was observed for vermiwash and vermin-compost, followed by vermiwash and cattle dung (Table 4). The maximum increase in vermiwash and vermin-compost is due to greater availability of Mg^{2+} in vermin-compost and vermiwash (Ansari, 2008a; b). The maximum increase in calcium was observed for vermin-wash and vermicompost, followed by vermiwash and vermincompost (Table 4). Calcium increase in vermiwash and vermicompost is due to the availability of Ca^{2+} in vermicompost and vermiwash. The maximum increase in zinc was observed for vermiwash and vermicompost, followed by vermicompost and cattle dung (Table 4). The treatment vermiwash and vermicompost was highly significant with improvement of soil physical and chemical properties. This is established by composite index (Table 5).

The vermiwash and vermicompost were found to improve the trace element content of the soil. However the combination of these biofertilizers was found to be more effective in improving soil micronutrients content.

Table 5. Composite index based on soil chemical analysis**.**

Treatments	pH	OC	N	Mg	Ca	Zn	Composite index	Rank
Control	6	6	6	6	6	6	36	5th
Cattle dung	4	3	5	3	4	3	22	4th
Chemical fertilizers	1	5	1	5	5	4	21	3rd
Vermiwash	5	4	4	2	2	5	22	4th
Vermicompost	2	2	3	4	3	2	16	2nd
Vermiwash and vermicompost	3	1	2	1	1	1	9	1st

Bio-fertilizers (vermiwash and vermicompost) contribute macronutrients and micronutrients in amount that is required by plants. According to Lalitha et al. (2000), applications of organic fertilizers have an emphatic effect on plant growth and production. The soil enriched with vermicompost provides additional substances that are not found in chemical fertilizers (Kale, 1998; Ansari and Ismail, 2008). Data clearly indicate a better performance of Okra using the combination of vermiwash and vermicompost. Results are in agreement with those obtained by earlier workers (Lalitha et al., 2000; Ismail, 2005; Ansari, 2008a; b; Ansari and Ismail, 2008).

ACKNOWLEDGEMENTS

The authors express their gratitude to University of Guyana, and Central Laboratory, Guyana Sugar Corporation Inc. for the facilities and support rendered.

REFERENCES

Ansari AA (2008a). Effect of Vermicompost and Vermiwash on the Productivity of Spinach (*Spinacia oleracea*), Onion (*Allium cepa*) and Potato (*Solanum tuberosum*). World J. Agric. Sci., 4(5): 554-557.

Ansari AA (2008b). Effect of Vermicompost on the productivity of Potato (*Solanum tuberosum*), Spinach (*Spinach oleracea*) and Turnip (*Brassica campestris*). World J. Agric. Sci., 4(3): 333-336.

Ansari AA, Ismail SA (2008). Reclamation of sodic soils through vermitechnology. Pakistan J. Agric. Res., 21(1-4): 92-97.

Ansari AA, Ismail SA (2001). A Case Study on Organic Farming in Uttar Pradesh. J. Soil Biol. Ecol., 27: 25-27.

Budhan R (2004). Diversifying Agriculture: Guyana's Biodiversity for Food Security. Government Information Agency, Georgetown Guyana.

Darwin C (1881). The Formation of Vegetable mould through the action of worms, with observations on their habitats. Murray, London.

Edwards CA, Bohlen PJ (1996). Biology and Ecology of Earthworms. (3rd ed), Chapman and Hall, London. p. 426.

Homer F (2003). Soil Analysis Manuel. Central Analytical and Environmental Monitoring Services, Agriculture Research Department, LBI, Guyana. pp. 100.

Ismail SA (1997). Vermicology: The Biology of Earthworms. Orient Longman Ltd., Chennai, India.

Ismail SA (2005). The Earthworm Book. Other India Press, Mapusa, Goa. pp. 92.

Kale RD (1998). Earthworm Cinderella of Organic Farming. Prism Book Pvt Ltd, Banglore, India. p.88.

Kumar A (2005). Verms and Vermitechnology. Vedams eBooks (P) Ltd, New Delhi India. pp. 110-034,

Lalitha R, Fathima K, Ismail SA (2000). The impact of biopesticide and microbial fertilizers on productivity and growth of *Abelmoschus esculentus*. Vasundara the Earth. (1-2): 4-9.