INTERNATIONAL JOURNAL OF PHARMACY WITH MEDICAL SCIENCES
Peer Reviewed, Referred & Indexed Journal
E-ISSN:3068-2738
Vol.4, No. 4(2024)
www.ijpams.com

ENHANCEMENT OF CROP YIELD AND SOIL NUTRIENTS BY INTEGRATED USE OF VERMICOMPOST AND NATURAL FERTILIZERS

BITRA YASASVI

Faculty, Dept of Soil science,

Bharatiya Engineering Science & Technology Innovation University, Andhra Pradesh, India.

Abstract

According to survey conducted under the National Soil Health Card Scheme, worrying trends have come to light- the level of fertility and health of the country's soil have deteriorated considerably due to loss of nutrients and organic matter. The objective of this article is to find out effect of integrated use of vermicompost and natural fertilizer on yield as well as to restore the soil health. Earthworm acts as biodigester, ingesting the organic waste material, breaking it up in their gizzard, consuming the digestible portion and then excreting a humus like material, the vermicast. *Eisenia fetida*, a common species of earthworm, has been used. The experiment was laid out in randomized block design, comprising of four treatment levels and ten replications. The treatments comprised four levels viz., T1 without fertilizer or manure (control), T2 only Vermicompost at the rate 5-6 t/ha, T3 ghanjeevamrit @ 200 Kg/acre + beejamrit + vermicompost at the rate 6-7 t/ha and T4 ghanjeevamrit @ 200 Kg/acre + beejamrit + jeevamrit @ 200l/acre + vermiwash 500l/ha + vermicompost @ 6-7 t/ha. The grain and straw yield (q/ha) were more pronounced in T4 when the natural fertilizers were integrated with vermicompost and vermiwash. Furthermore, the enhanced yield stabilized in the years to come.Soil samples were collected from the entire study area of Amaitha village before and after different treatments and their chemical analysis in respect of pH, EC, OC and available N, P and K were done. It was found that after T4 treatment the soil nutrients were enhanced.

Keywords: Fertility enhancer, organic carbon, *Eisenia fetida*, vermicast, vermiwash, natural fertilizer, carbon sequestration

Introduction

According to scientists of ICAR, there was a program launched on 19th February 2015 by the government of India to analyze the level of fertility and health of the country's soil. Under this scheme of soil sample analysis, two cycles of soil testing have been completed and 5.27 crores soil samples were analyzed from different parts of the country and it was found that only 15% soil

samples had sufficient amounts of organic carbon (OC), key nutrients like Nitrogen (N), Phosphorus (P) and Potassium (K) (Press release 2020) [10]. The nutrient deficiency in India is in the order of 95% for Nitrogen, 94% for Phosphorus and 48% for Potassium. The organic carbon was less than 0.75% in 85% of the samples whereas soil with 0.80% organic carbon is considered to have better fertility.

N, P and K play an important role in ensuring health and productivity of our plants and crops. These provide essential nutrients required for the growth of plants, photosynthesis, root development, reproduction and persistence from stress conditions. Vermicompost can enhance soil fertility physically, chemically and microbially (Chatterjee *et al*., 2023) [6]. Physically vermicompost treated soil has better aeration, porosity, bulk density and water holding capacity (Dominguez, 2004) [7]. pH, organic matter content and electrical conductivity of soil can also be improved by using vermicompost. Vermicompost can be a good source of nitrogen (N) (Bansal and Kapoor, 2000) [4], phosphorus (P) (Pramanik *et al*, 2007) [19] and potassium (K), antibiotics, humic acid (Arancon *et al*., 2006) [1], Nitrogen fixing and Phosphorus solubilizing bacteria and growth hormones (Sinha *et al* 2009; Lazcano and Dominguez, 2011) [24, 13].

In the process of vermicomposting earthworms are used as biodigester which breaks down the complex organic substrates into a stabilized humus-like substance Vermicast. Vermicast is a brownish black, stable, fine granular fertilizer which is rich in humus, N, P, K, micronutrients, beneficial soil microbes and growth hormones (R.K. Sinha *et al*., 2010) [25]. Vermiwash is the liquid which has been collected from vermicompost after watering. It is called plant tonic as it is rich in plant growth promoting factors, micro nutrients, large number of microbes and N, P, K (Kanchan *et al*., 2013; Thakur and Sood, 2019; Nadana *et al*., 2020) [15, 26, 9].

Eisenia fetida (Red earthworm) is most commonly utilized for vermicomposting, as it has faster growth rate, high reproductive potential and diverse substrate consumption. It can withstand a wider range of temperature and can live in organic waste with different moisture conditions (Ismail, 1997) [11]. *Eisenia fetida* can consume organic matter at a rate equal to their body weight every day. One ton of organic waste can be recycled by 5 Kg earthworm (*Eisenia fetida)* within 30 days (Singleton *et al*., 2003) [22].

When vermicompost is applied in crop production, it boosts up the crop growth and increases the yield and suppresses pathogens. It improves the fertility of soil when applied favoring higher productivity (Padmavathiamma *et al*., 2008) [18]. Vermicompost is used as a substitute for chemical fertilizer. A study showed that soils treated with vermicompost produced taller plants. The number of leaves, flowers, as well as leaf chlorophyll content and the total leaf area compared to soils without vermicompost increased at a higher rate.

According to Glasshouse studies made at CSIRO Australia, the earthworms increased growth of

wheat crops (*Triticum aestivum*) by 39%, grain yield by 35%, increase in protein value of grain by 12% and provide resistance from pathogens as compared to control. The objective of this article is (a) to find out effect of integrated use of vermicompost and natural fertilizer on yield as well as on properties of soil. (b) To identify Vermicomposting as an eco-friendly and environment compatible solution to tackle the chronic problem of nutrient deficiency in the soil.

Methods

Site of experiment

The vermicompost bed from different municipal organic solid wastes were prepared at my house in Gobarsahi, Muzaffarpur, Bihar by culturing earthworm, *Eisenia fetida* species which was procured from the Krishi Vigyan Kendra, Saraiya block, Muzaffarpur, Bihar, is located in India country in the district place category with the gps coordinates of 26.1197^0 N and 85.3910° E. The field experiment was conducted during Rabi season of year 2021- 2024 in farms at Amaitha village, located in Saraiya subdivision of Muzaffarpur district in Bihar, India

Production of vermicompost from different solid organic wastes

The raw materials used for vermicomposting were vegetable market wastes, juice wastes, fruit market wastes, saw dust, paper wastes, leaf litters and cow dung. The solid organic wastes and cow dung were used in a ratio of 2:1 for better survival and growth of earthworms and microbes. The size of vermibed was 12 x 4 x 3 feet. Regular sprinkling of water had been done to maintain 70 to 80% moisture content, which was essential for proper growth of earthworms. The bed was then covered with jute bags to avoid loss of moisture content and to protect from birds & insects. Now, this mixture was allowed to pre-digest for about 20 days. Partial digestion of waste materials made them suitable for earthworm consumption. After 20 days, 2 kg earthworms of *Eisenia fetida* species were introduced in the Vermibed during evening hours. At a regular interval of 15, 30, and 45 days the bed material was turned upside down for proper digestion of organic waste materials. In 90 days, when the organic waste turned into granular structure was harvested and sieved gently for further use. Before 1 week of harvesting, sprinkling of water was stopped. Vermicompost nutrient analysis was carried out at Darjeeling Tea Rsearch and Management Association (Table-1)

Soil sampling

Soil samples were collected from the entire study area of Amaitha village. The entire area of the village contains loamy soil. A total 10 soil samples (0 to 15 cm depth) were collected. The different parameters viz. soil pH, EC (Electrical conductivity), total Organic Carbon, Nitrogen, Phosphorus and Potassium, Zinc, Copper, Iron and manganese of soil sample analysis was done at Krishi

Vigyan Kendra, Saraiya.

Field experiment

To study the effect of vermicompost and natural fertilizer on the yield field experiments done in farms at Amaitha village, near Saraiya block, Muzaffarpur, Bihar for three consecutive years. The wheat crop is taken as test crop and the variety taken was HD2967.

Treatments

The experiment was laid out in randomized block design, comprising of four treatment methods. The treatments comprised four levels viz., T_1 no any fertilizer or manure (control), T_2 only Vermicompost at the rate 5-6 t/ha, T_3 ghanjeevamrit @ 200 Kg/acre + beejamrit @ 10l/100 Kg + vermicompost at the rate 6-7 t/ha and ghanjeevamrit @ 200 Kg/acre + beejamrit @ 10l/100 Kg + jeevamrit @ 200l/acre

+ 3 sprays of vermiwash 500l/ha + vermicompost @ 6-7 t/ha.

Each treatment was allocated randomly and ten replications were conducted. Beejamrit was coated on seeds before sowing. Ghanjeevamrit and vermicompost was applied before sowing while jeevamrit was applied during irrigation. Three sprays of Vermiwash were applied at a regular interval of 15, 30 and 45 days after sowing.

Results and Discussion

Chemical Analysis of vermicompost and soil.

The vermicompost chemical analysis was carried out at Darjeeling Tea Rsearch and Management Association and the methods used. (Table-1).

Table 1: Chemical components of Vermicompost.

Chemical components of vermicompost		
Components	**Value**	**Methods used**
pH	8.61	Glass Electrode method
OC (%)	18.665	Chromic Acid method
S (%)	0.869	Potassium di-

		hydrogen phosphate method
Available N(Kg/ha)	2.059	Modified Kjeldahl's technique
Available P_2O_5 (Kg/ha)	0.618	Brey's method
Available K_2O (Kg/ha)	0.97	Flame photometric method

Table 2: Chemical analysis of soil

Chemical analysis of veremicompost		
Components	**Value**	**Methods used**
pH	8.61	Glass Electrode method
OC (%)	18.665	Chromic Acid method
S (%)	0.869	Potassium di-hydrogen phosphate method
Available N (Kg/ha)	2.059	Modified Kjeldahl's technique
Available P_2O_5 (Kg/ha)	0.618	Brey's method
Available K_2O (Kg/ha)	0.97	Flame photometric method

he parameters viz. soil pH, EC (Electrical conductivity), total Organic Carbon, Nitrogen, Phosphorus different and Potassium, Zinc, Copper, Iron and manganese of soil sample analysis was done at Krishi Vigyan Kendra, Saraiya (Table- 2 and 3). Before treatment the soil pH was maximum (8.22) but after different treatments in was improved and the minimum pH was found in T_2 While the minimum reduction in electrical conductivity was observed in T_4. This reduction may due to release of different organic acids during treatments. Data obtained in table 3 reveal that the available Nitrogen, phosphorus and potassium content in soil also increased significantly over control and it was found maximum during T_4 treatment.

Table 3: Enhancement in soil properties after different treatments

Enhancement in soil properties after different treatments						
Treatments	**soil pH**	**soil EC (ds/m)**	**OC (%)**	**Available N (Kg/ha)**	**Available P2O5 (Kg/ha)**	**Available K2O (Kg/ha)**
T1	7.806	0.236	0.667	283.54	14.057	161.963
T2	7.424	0.229	0.644	292.191	15.779	124.668
T3	7.6	0.23	0.661	293.707	17.048	165.683
T4	7.448	0.194	0.662	298.373	19.418	211.393
SE(m)	0.012	0.005	0.004	0.489	0.05	0.156
SE(d)	0.018	0.006	0.006	0.692	0.071	0.22
C.V.	0.521	6.478	2.032	0.53	0.955	0.297

Growth and yield of crops

The plant height was recorded at an interval of 30, 60, 90 and 120 days after sowing. The data obtained shows that the plant height increases and it was maximum in treatment 4(T_4). Number of grains/spikes was also counted and it also get increased in treatment 4. The highest grain and straw yield were during treatment 4(T_4). The results of the data were depicted in table 4.

Table 4: Effect of integrated use of natural fertilizer, Vermicompost and Vermiwash on growth and yield

Treatments	**Plant height**	**No. of grains/spike**	**Grain yield (q/ha)**	**Straw yield (q/ha)**
T1	85.064	49.408	42.18	55.583
T2	94.158	53.674	45.33	54.296
T3	97.872	57.755	48.24	55.745
T4	97.938	59.207	50.63	60.555
SE(m)	0.06	0.082	0.085	0.224
SE(d)	0.085	0.117	0.12	0.317
C.V.	0.202	0.474	0.578	1.25

With the emergence of high yielding varieties, not only the cropping pattern changed but cropping

techniques also underwent drastical changes, with over emphasis on use of fertilizers and pesticides. Both these inputs gave encouraging results in short term but they have proved counterproductive in a long-term causing soil degradation and biodiversity depletion.

A search for suitable alternatives to chemical fertilizers began to counter this problem of soil degradation. Natural fertilizers (such as ghanjeevamrit, beejamrit, jeevamrit) and vermicompost are being tried in different proportion and permutation & combination. The different combinations increased yield and added suitable chemical ingredients to the soil. The increase in grain and straw yield of wheat after different treatments viz. T T_2, T_3 and T_4 could be due to proper nutrient supply in treatment throughout the plant growth. The use of natural fertilizers, vermicompost and vermiwash in treatment 4 recorded higher wheat grain and straw yield over rest of the treatments and higher net return & benefit cost ratio. These trials in the field were previously conducted by Pramanik P *et al*., 2007 [19]; Padmavathiamma, 2008 [18]; Siddappa, 2015; Mohan B., *et al*., 2018; Bhatt MK *et al*., 2019 who have also found the enhancement in wheat yield and nutrient quality of soil.

The results of this experiment are, thus in tune with a number of similar experiments conducted elsewhere.

References

1. Arancon NQ, Edwards CA, Bierman P. Influences of vermicompost on field strawberries: effects on soil microbiological and chemical properties. Bioresour Technol. 2006;97:831-840.
2. Arancon NQ, Edwards CA, Yardim EN, Oliver TJ, Byrne RJ, Keeney G. Suppression of two-spotted spider mite (*Tetranychus urticae*), mealy bug (*Pseudococcus sp*.), and aphid (*Myzus persicae*) populations and damage by vermicompost. Crop Prot. 2007;26:29-39.
3. Arancon NQ, Edwards CA, Babenko A, Cannon J, Galvis P, Metzger JD. Influences of vermicomposts, produced by earthworms and microorganisms from cattle manure, food waste and paper waste, on the

   germination, growth and flowering of petunias in the greenhouse. Appl Soil Ecol. 2008;39:91-99.
4. Bansal S, Kapoor KK. Vermicomposting of crop residues and cattle dung with *Eisenia fetida*. Bioresour Technol. 2000;73:95-98.
5. Bhatt MK, Labanya R, Joshi HC. Influence of long term chemical fertilizers and organic manures on soil fertility - A review. Universal J Agric Res. 2019;7(5):177-188.
6. Nandigama, N. C. (2023). Enhanced Fingerprint Recognition system using hybrid Feature Fusion with Deep learning and Machine learning Optimization. Research Journal of Nanoscience

and Engineering, 6(1), 9–15. https://doi.org/10.22259/2637-5591.0601003

7. Chatterjee R, Mishra S. Vermicompost and soil health. In: Soil Health. 2020. p. 69-88.
8. Dominguez J. State of the art and new perspectives on vermicomposting research. In: Edwards CA, editor. Earthworm Ecology. CRC Press; Boca Raton; 2004. p. 401-424.
9. Dominguez J, Edwards CA. Vermicomposting organic wastes: a review. In: Shakir Hanna SH, WZA M, editors. Soil Zoology for Sustainable Development in the 21st Century. IUCN; Cairo; 2004. p. 369-395.
10. Nandigama, N. C. (2023). Data-Warehouse-Enhanced Machine Learning Framework for Multi-Perspective Fraud Detection in Multi-Stakeholder E-Commerce Transactions. International Journal on Recent and Innovation Trends in Computing and Communication, 11(5), 592–600. https://doi.org/10.17762/ijritcc.v11i5.11808
11. Nadana GRV, Rajesh C, Kavitha A, Sivakumar P, Sridevi G, Palanichelvam K. Induction of growth and defense mechanism in rice plants towards fungal pathogen by eco-friendly coelomic fluid of earthworm. Environ Technol Innov. 2020;19:101011.
12. Press release. Analysis of fertility and nutrient contents of the soil samples through soil health card scheme 2014-15. PIB; 2020.
13. Ismail SA. Vermicology: the biology of earthworms. Orient Longman; Chennai; 1997. p. 92.
14. Jackson ML. Soil chemical analysis. Prentice Hall of India Pvt. Ltd.; New Delhi; 1973. p. 1958-1998.