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VERMICOMPOST: ROLE OF IMPROVING SOIL HEALTH AND QUALITY PRODUCTION

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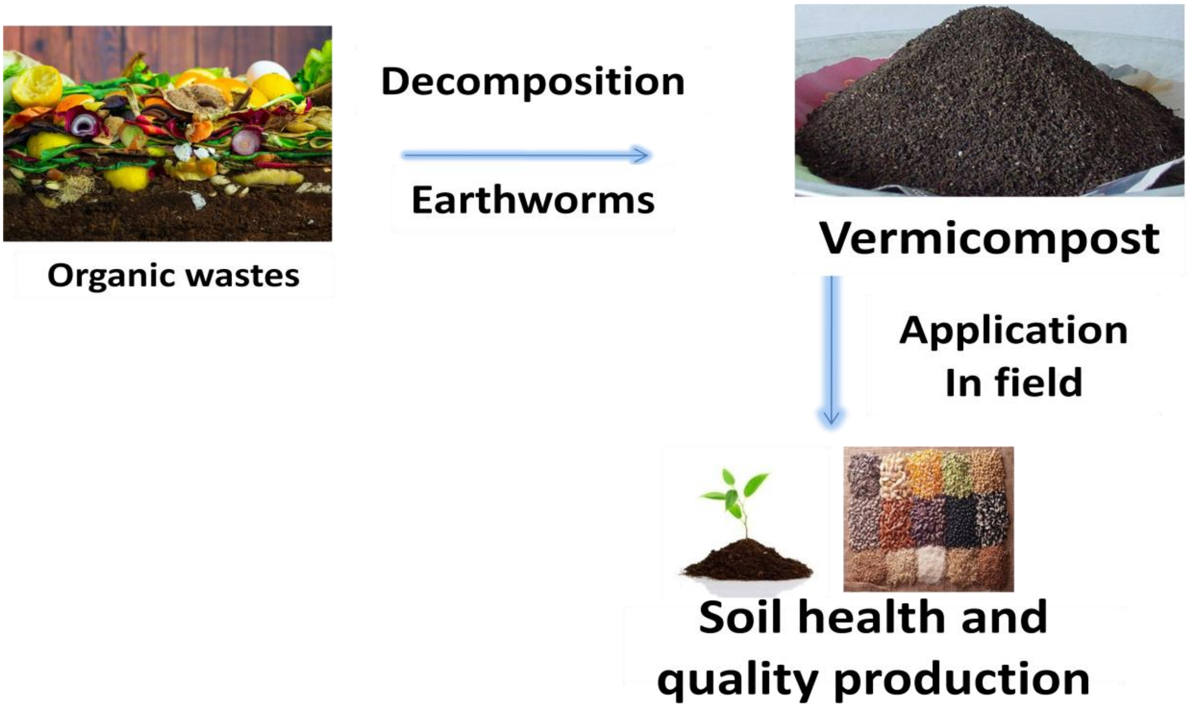
Abstract:

Waste management systems are significantly influenced by socio-economic, political and environmental factors, including population growth, consumption pattern and technological development of waste systems. Thus, in many countries, both energy and waste management systems are changing and follow like vermicomposting process and produced vermicompost used as manures. Vermicomposting is an organic waste decomposition process with the addition of earthworms to aid the waste stabilization process and convert organic materials into humus-like material known as vermicompost. In fact, vermicompost can enhance soil health as physically (aeration, porosity, bulk density and water retention capacity), chemically (pH, electrical conductivity and organic matter content) and biologically (actinomycetes, bacteria & fungi and also increasing their enzymatic activities and populations), such as increases in, as well as the presence of biologically active plant growth-influencing substances such as plant growth regulators or plant hormones and humic acids in the vermicomposts.

Nevertheless, enhanced plant growth could not be satisfactorily explained by improvements in the nutrient content of the soil, which means that other plant growth-influencing materials are also available in vermicomposts. Although vermicomposts have been shown to improve plant growth significantly, the application of vermicomposts at high concentrations could impede growth due to the high concentrations of soluble salts available in vermicomposts. Therefore, vermicomposts should be applied at moderate concentrations in order to obtain maximum plant growth and yield.
Keywords: Vermicompost, Soil health, Quality, Production

Introduction:

Increasing world population has resulted in higher consumption of goods and services that has driven a substantial increase of organic wastes originating from households, industry, and agriculture. Much of the organic wastes are highly infectious as they contain a variety of pathogenic microorganisms. Dumping of organic wastes in open areas generates serious environmental issues such as the accumulation of heavy metals in soil, pollution of ground and surface waters due to leaching and run-off of nutrients. These organic wastes when applied



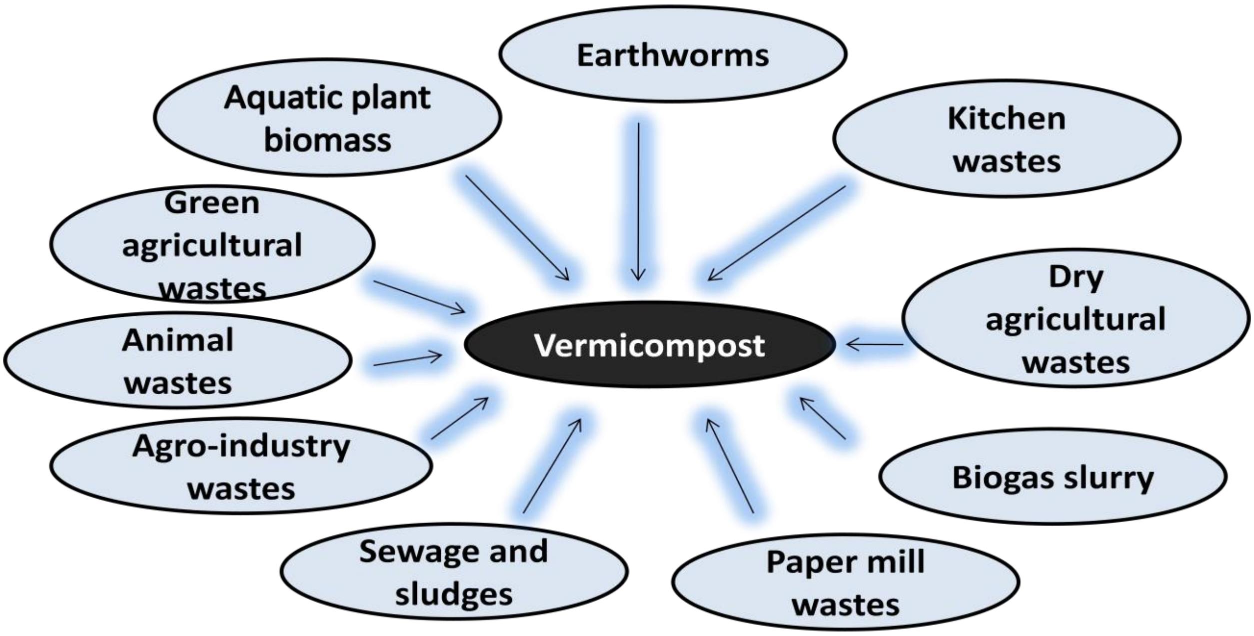
directly to agricultural fields cause soil environment-related problems including phyto-toxicity. These wastes represent a valuable organic resource, which could be recycled and transformed into nutrient rich fertilizer and/or soil conditioner. Moreover growing awareness about adverse effects of agricultural chemicals on human health has increased interest in organic agriculture. Organic agriculture also promotes ecological conservation due to judicious use of natural resources. In demand for safe and sustainable strategies to treat organic wastes includes best known practices of composting and vermicomposting for biological stabilization of solid organic wastes by transforming them into a safer and more stabilized material that can be used as a source of nutrients and soil conditioner in agricultural applications. Vermicomposting is one of the most efficient means to mitigate and manage environmental pollution problems. Recently, many studies are being done to establish vermicompost as one of the preferred organic substitutes to chemical fertilizers. Vermicompost is richer in NPK, micronutrients and beneficial soil microbes (nitrogen fixing and phosphate solubilizing bacteria and actinomycetes), an excellent growth promoter and protector for crop plants than compost.

Earthworms vermicompost is proving to be highly nutritive 'organic fertilizer' and more powerful 'growth promoter' over the conventional composts and a 'protective' farm input (increasing the physical, chemical & biological properties of soil, restoring & improving its natural fertility) against the 'destructive' chemical fertilizers which has destroyed the soil properties and decreased its natural fertility over the years. Vermicompost is rich in NKP (nitrogen 2-3%, potassium 1.85-2.25% and phosphorus 1.55-2.25%), micronutrients, beneficial soil microbes and also contain ‘plant growth hormones & enzymes’. It is scientifically proving as ‘miracle growth promoter & also plant protector’ from pests and diseases. Vermicompost retains nutrients for long time and while the conventional compost fails to deliver the required amount of macro and micronutrients including the vital NKP to plants in shorter time, the vermicompost does (Sinha *et al*., 2009).

Problems of convectional crop production:

- Adopt farming practice intensively and highly use resource and energy
- Applied heavy irrigation, reduce natural water resources
- Adopt intensive tillage, damage soil structure
- Promote monoculture, reduce diversity of ecosystem
- Reduce diversity
- Reduce sustainability

Materials for preparation of vermicompost:



Method of vermicomposting

				
Bed method	**Pit method**	**Lower surface method**	**Upper surface method**	**Plastic method**

Earthworms are used to convert organic waste material into dark brown nutrient rich humus that is a good source of manure for plants. Worms can also degrade specific pollutants and might allow community formation of useful microorganisms. These methods used for vermicomposting are discussed below:

1. Bed method: Vermicomposting is done on the pucca/kaccha floor by making bed (6X2X2 feet size) of organic mixture. This method is easy to maintain and to practice.
2. Pit method: For large scale vermicomposting, pits of sizes 2.5 m × 1 m × 0.3 m under thatched sheds with sides left open are advisable. The bottom and sides of the pit should be made hard with a wooden mallet.
3. Lower surface method: Vermicomposting bed is making below the ground surface. This method is best for vermicomposting process.
4. Upper surface method: Vermicomposting bed is making above the ground surface.
5. Plastic method

Steps involved in vermicomposting:

Prior to the vermicomposting process, it is preferred to assign pre-composting of organic waste (thermophilic composting), which comprises a short period of high temperature for facilitating mass reduction, waste stabilization, and pathogen reduction. Thermophilic composting results in sanitization of organic wastes and elimination of toxic compounds. Although pathogen removal occurs during transit in the worm gut but thermophilic composting prior to vermicomposting is advisable to avoid the earthworm mortality. Then, after some days of high temperature, pre-mature compost is cooled by spreading it as thin layers on vermicomposting beds. Vermicomposting can be done either in containers, pits or piles.

1. **Materials required for vermicomposting:** Carbon and nitrogen-rich organic materials, spade, ground space, stakes, hollow blocks, plastic sheets or used sacks, water (according to the season) and water sprinklers, shading materials, nylon net or any substitute to cover the beds, and composting earthworms.
2. **Site Selection:** Vermicompost production can be done at any place which is having shades, cool and has high humidity. For instance, abandoned cattle shed, or poultry shed or unused buildings or artificial shading could also be provided.
3. **Shredding of organic waste material:** The collected organic waste material should be processed for shredding along with mechanical separation of the metal, glass and ceramics that should be kept aside.
4. **Pre-digestion of organic waste material:** Pre-digestion of organic waste should be done for at least 20–25 days prior by mixing the waste material along with raw material (e.g., cattle dung slurry). Regular watering is required for partially digesting it and making it fit for earthworm consumption. Raw material to be used includes for composting – cow dung, crop residues, farm wastes, vegetable market wastes and fruit wastes. Cow dung should be at least 20–25 days old to avoid excess heat generation during the composting process. Moreover addition of higher quantities of acid-rich substances such as citrus wastes should be avoided. It is important to mix carbonaceous with nitrogenous organic materials at the right proportions to obtain a C: N ratio of about 30:1, as it results in product of highest stability, the best fertilizer-value and with lowest potential for environmental pollution. For example, rice straw and fresh manure are mixed at about

25:75 ratio by weight. When the material with higher carbon content is used with C:N ratio exceeding 40:1, it is advisable to add nitrogen supplements to ensure its effective decomposition.

5. **Earthworm bed preparation:** An hospitable living environment for worms called bedding is prepared. Bedding is a material that provides the worms with a relatively stable habitat with following characteristics:

   i. High absorbency: As earthworms breathes through their skins and therefore bedding must be able to absorb and retain water fairly well. Worms dies if its skin dries out.

   ii. Good bulking potential: Worms respire aerobically and different bedding materials affect the overall porosity of the bedding, including the range of particle size and shape, the texture, and the strength and rigidity of its structure. If bedding material is too dense or packs too tightly, then the flow of air is reduced or eliminated. This overall effect is referred as the material's bulking potential.

   iii. Low protein and/or nitrogen content/high Carbon: Earthworms consume their bedding as it breaks down and it is very important for this process to be slow. High protein/nitrogen levels can result in rapid degradation of bedding and its associated heating, creating inhospitable or fatal conditions. High carbon content is required as earthworms and microbes in the feed mixtures activate microbial respiration and degradation of organic wastes, thereby increasing the loss of organic carbon during the vermicomposting process.

6. **Vermiculture bed:** Vermiculture bed can be prepared by placing a first layer of saw dust, newspaper, straw, coir waste, sugarcane trash etc. at the bottom of tub/container. Newspaper is one of bedding material that high in absorbency whereas for the sawdust the level of absorbency is poor to medium. A second layer of moistened fine sand of 3 cm thick should be spread over the culture bed followed by a layer of garden soil (3 cm). The floor of the unit should be compacted to prevent earthworm's migration into the soil.
7. **Loading of organic waste mixture in bed:** Third layer of the pre-digested organic waste prepared is added. Thereafter a thin layer of cow dung mixture is placed on the surface of waste material as starter food for compost worms. Then compost worms are to be added without spreading them out. Earthworms consume various organic wastes and reduce the volume by 40–60%. Earthworm eats waste equivalent to its body weight, and produce cast about 50% of the wastes, it consumes in a day.
8. **Composting process:** After addition of compost worms wait for at least 15 days for the thermophillic process to end. During this process there is a rapid increase in temperature followed by a gradual decrease. During this period turning to the material 2–3 times at 4–5 days interval is required. Its temperature should be maintained at 30°C, when temperature approaches ambient temperature (<35°C) covering is to be removed and for temperature maintenance, upturning and regular sprinkling of water is advisable. Prominent precautionary measures include; Composting pit should be covered with nylon net or any substitute material to serve as barrier against predators like ants, birds, lizards as it may disturb the activity of earthworm, Blockage of side air vents should be avoided as it can quickly lead to putrefaction and extreme weather conditions such as frost, heavy rainfall, drought and overheating should be avoided. No smell comes out of composting site if the right products or bedding and feed are used. The vermicompost once formed

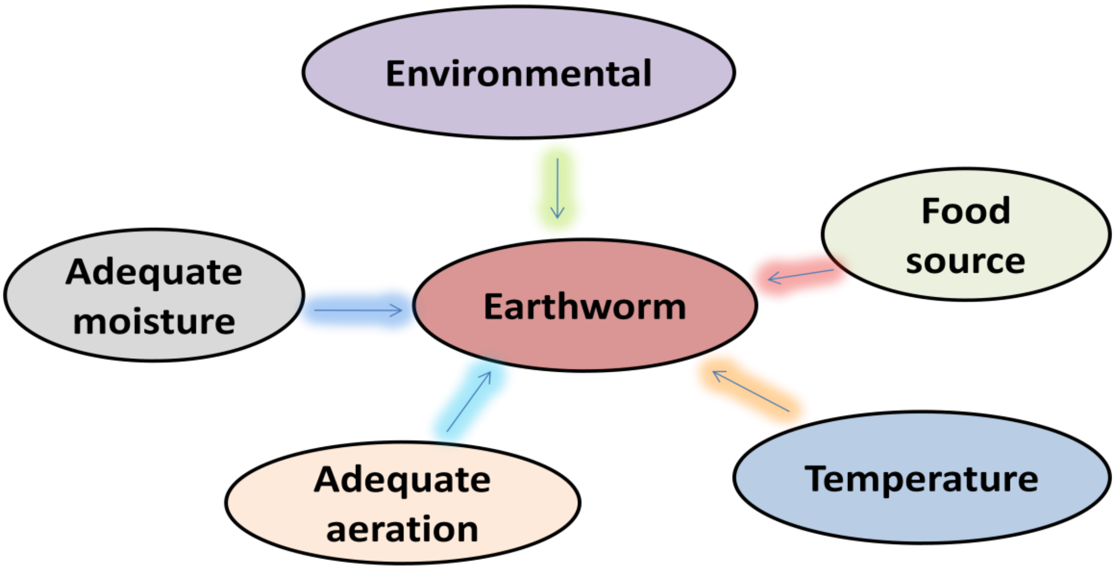
completely will give the smell of moist soil. Maturity could be judged visually also by observing the formation of granular structure of the compost at the surface of the tank. Next step is to make a heap in sunlight on a plastic sheet and keep it for 1-2 hours. The worms will gather at the bottom of heap. After removing vermicompost on top, the worms settled down at the bottom can be carefully collected for use in the next batch of vermicomposting.

Classification of earthworm:

		
Epigeic :	**Anecic :**	**Endogeic :**
Eisenia foetida	***Lumbricus terrestris***	***Lumbricus rubellus***

There are about 3320 species of earthworms all over the world, but hardly 8–10 species are suitable for vermicompost preparation. Earthworms have been extensively utilized for the recycling of a variety of organic wastes like municipal solid wastes wheat straw, sewage sludge, forestry waste, vegetable waste, farmyard manure, sorghum stalk, wheat straw, paddy straw, coir pith. Renowned scientists, Charles Darwin called earthworms as the ‘unheralded soldiers of mankind’, and Aristotle described them as the ‘intestine of earth’, as they could digest a wide range of organic materials. On the basis of morpho-ecological characteristics, earthworms have been classified into three categories: Anecic (Greek word “out of the earth”) – these are burrowing worms that only come to the surface at night to drag food down into their permanent burrows deep within the mineral layers of the soil. Endogeic (Greek word “within the earth”) – these are also burrowing worms but their burrows are typically more shallow and they feed on the organic matter inside the soil, so they come to the surface only rarely. Epigeic (Greek word “upon the earth”) – these worms live on the surface litter and feed on decaying organic matter. They do not have any permanent burrows. These “decomposers” are the type of worm used in vermicomposting. Two tropical species, African night crawler, *Eudrilus eugeniae* (Kinberg) and Oriental earthworm, *Perionyx excavates* (Perrier) and two temperate ones, red earthworm, *Eisenia andrei* (Bouche) and tiger earthworm, *Eisenia fetida* (Savigny) are extensively used in vermicomposting. Most vermicomposting facilities and studies are using the worms *E. andrei* and *E. fetida* due to their high rate of consumption, digestion, and assimilation of organic matter, tolerance to a wide range of environmental factors, short life cycles, high reproductive rates and endurance and resistance during handling. A few other species *Drawida nepalensis*, *Lampito mauritrr*. *Dichogaster* spp., *Polypheretima elongate*, *Amynthas* spp. *Dendrobaena octaedra*, *Eisenia hortensis* have also been used for composting under specific conditions.

Earthworm:- Needs



Steps involve in vermicompost production:

- Selection of suitable earthworm
- Selection of site for vermicompost production
- Container of vermicompost production
- Vermiculture bed
- Earthworm food
- Selection of wastes for vermicompost production
- Putting the waste in the container
- Watering the vermibed
- Harvesting vermicompost
- Harvesting earthworm
- Storing and packing of vermicompost

Suitable species: One of the earthworm species most often used for composting is the Red Wiggler (*Eisenia fetida).* African Nightcrawlers (*Eudrilus eugeniae*) is another set of popular composter. These species are commonly found in organic-rich soils and live in rotting vegetation, compost, and manure piles.

Selection of site: It should be preferably black soil or other areas with less of termite and red ant activity, pH should be between 6 to 8.

Collection of wastes and sorting: for field composting, raw materials are needs in large quantities. The waste available should be sorted in to degradable and non-degradable (be rejected).

Pre-treatment of waste: Lignin rich residues – chopping and subjecting to lignin degrading fungi and later to vermibeds. Crop stalks and stubbles – dumping it in layers sandwiched with garden soil followed with watering for 10 days to make the material soft and acceptable to worm. Agro-industrial wastes – mixing with animal dung in 3:1 proportion and later subjecting it for vermicomposting.

Filling of beds with organic wastes: wastes are to filled in the manner given below and each layer should be made wet while filling and continuously watered for next 10 days. In heaping and composting in special structures, the waste is to be dumped serially as done in pits.

7th Layer- A thick layer of mulch with cereal straw (Top of bed)
6th Layer- A layer of fine soil (Black/garden soil) (Top of bed)
5th Layer- Dung/FYM/Biogas sludge (Top of bed)
4th Layer- Green succulent leafy material (Top of bed)
3rd Layer- Dry crop residues (Top of bed)
2nd Layer- Dung/FYM/Biogas spent sludge (Top of bed)
1st Layer- Coconut coir waste/ sugarcane trash (Bottom of bed)

Except 3rd and 4th layer (which is the material to be degraded) each layer should be 3 to 4 inch thick so that the bed material is raised above the ground level. Sufficient quantity of dry and green wastes is to be used in the beds.

Provision of optimum bed moisture and temperature:

Bed moisture: by watering at regular intervals to maintain moisture of 60 to 80% till harvest of compost. Temperature requirement for optimal results is 20-30°C by thatching (during summer). Monitoring for activity of natural enemies and earthworm and management of enemies with botanicals. Promising products: leaf dust of neem, *Acorus calamus* rhizome dust, neem cake etc.

Harvesting of vermicompost and storage:

Around 90 days after release of worms, the beds would be ready for harvest. Stop watering 7days prior to harvest so that worms settle at bottom layer. Collect the compost, shade dry for 12 hours and bag it in fertilizer bags for storage.

Harvest of worm biomass: the worms are to be collected and used for subsequent vermicomposting.

Vermicomposting technique Sheds: For a vermicomposting unit, whether small or big could be of thatched roof supported by bamboo rafter and purling, wooden trees and stone pillars.

Vermibeds: prepare 90 cm width, 45 cm height and length as per availability of dung and organic waste.

Seed stock: worms @350 per m^3 of bed space should be adequate to start with and build up the required population in about 2 to 3 cycles.

Water supply system: To maintain optimum moisture content (40%) in vermibed, spray &apply water on vermin bed. Frequency & quality is regulated by prevailing climatic conditions.

Collection of vermicompost: When vermin compost is ready for collection, top layers apex somewhat dark granular and it used dry tea leaves have been spread over the layer. Watering should then stopped for 2-3 days and ready compost should be scrapped form top layers or to a depth.

Storage:-It should be stocked separately in bags. Before packing it should be sieved out from 2 cm galvanized mesh. The compost should not be exposed to sun.

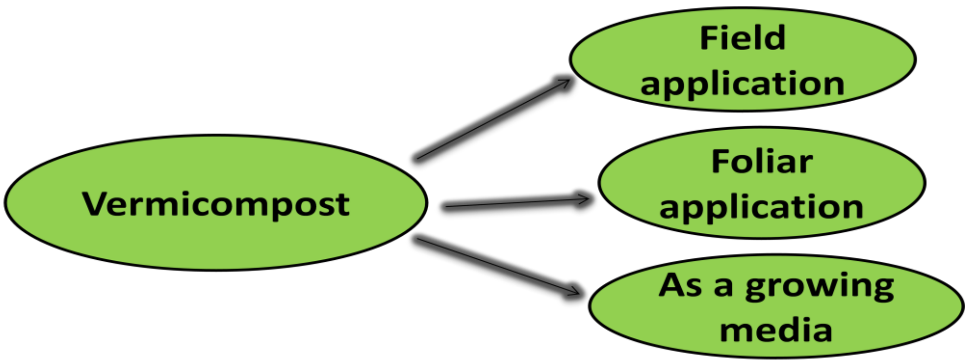
Nutrient content in vermicompost

Nutrient	**Content**			
Organic carbon	9.15-17.98%	30 %	5.09%	-
Total nitrogen	1.5-2.10%	2 %	0.24 %	1.38-1.40 %
Total phosphorus	1.0-1.50%	0.3 %	618 mg/kg	0.332-0.336 %
Total potassium	0.60%	1.8 %	1796 mg/kg	0.425-0.428 %
Calcium	22.67-47.60 meq/100g	-	1411 mg/kg	-
Magnesium		450 mg/kg	370 mg/kg	-
Available sulphur	128-158 ppm	-	-	-
Copper	2-9.5 ppm	45 mg/kg	-	-
Iron	2-9.30 ppm	1600 mg/kg	-	-
Zinc	5.70-11.5 ppm	150 mg/kg	-	-
C:N ratio	-	16	21	-
pH	-	6.8	-	-
Moisture	-	27	-	-
(Kumar *et al*., 2018)		(Arsaln *et al*., 2021)	(Sebastian *et al*., 2021)	(Sharma *et. al*., 2019)

Precautions during vermicompost production:

i. Select a shady spot.
ii. Maintain optimum moisture and temperature conditions.
iii. Avoid spraying of any kind of insecticides and fungicides.
iv. Height of vermicompost bedding material should not exceed 3 – 3.5 feet.
v. To escape the earthworm from hen, birds, etc. cover the vermicompost bed with sieve.

Application method of vermicompost:



Field crops - 5-6 t/ha
Vegetables - 10-12 t/ha
Fruit tree - 8-10 kg/tree depending on age of tree
Flower pot - 100-150 g of vermicompost per pot
Pearlmillet - 2.5 ton/ha
Maize - 3.0 ton/ha + 50% RDF
Paddy - 1.0 ton/ha + 75% RDF
Green gram – 2-5 ton/ha
Soyabean - 3.0 ton/ha
Sunflower - 5.0 ton + 50% RDF
Tomato - 4.0 ton + 50% RDF
Potato - 4.0 ton + 50% RDF
Coriander - 2.5 ton + 50% RDF
Oat - 10 ton + 75% RDF

Vermicompost important for improve soil health:

- Present burning issue in farming is the decline in fertility of soil and fall in productivity levels.
- Use of chemical fertilizers and synthetic pesticides has deteriorated soil health as well causing harm to our natural eco-system by polluting our environment as well as water.
- Now we have reached a situation were productivity levels in soil slowly decreasing day by day.
- Now it's time to go for organic farming and restore soil fertility and maintain soil fertility on sustainable basis so that future generations may not face problems.

Benefits of vermicompost:

1. When added to clay soil loosens the soil provides the passage for the entry of air.
2. The mucus associated with the cast being hygroscopic, absorbs water and prevents water logging and improves water holding capacity.
3. In the vermicomposting, some of the secretions of worms and the associated microbes act as growth promoter along with other nutrient.
4. It improves physical, chemical and biological properties of soil in the long run on repeated application.
5. The organic carbon in vermicompost releases the nutrient slowly and steadily in to the system and enables the plant to absorb these nutrients.
6. The multifarious effects of vermicompost influence the growth and yield of crops.
7. Earthworm can minimize the pollution hazards caused by organic waste by enhancing waste degradation.

Role of vermicompost for improving soil health:

The key role of vermicompost is change in physical, chemical and biological properties of soil by earthworm activities and they thus called as soil managers. It substantially improves soil structure, texture, aeration and prevents soil erosion. It increases the macro-pore space ranging from 50 to 500 µm, resulting in improved air-water relationship in the soil thereby favorably affecting plant growth. It also favorably affects soil pH, its microbial population and soil enzyme activities. Moreover, vermicompost is rich source of nutrients such as nitrates, phosphates and exchangeable calcium and soluble potassium. Apart from adding mineralogical nutrients, vermicompost is also rich in beneficial micro flora such as N-fixers, P-solubilizers, cellulose decomposing micro-flora, etc. It also reduces the proportion of water soluble chemical, which causes possible environmental contamination. Mucus excreted by earthworm's digestive canal produces some antibiotics and hormone-like bio-chemicals thereby boosting plant growth and enhancing the decomposition of organic matter in soil. Vermicompost has been reported to have favorable influence on the growth and yield parameters of several crops like paddy, sugarcane, brinjal, tomato, and okra. Thus, vermicompost acts a soil conditioner and a slow-release fertilizer that ultimately improves soil structure, soil fertility, plant growth and suppresses diseases caused by soil-borne plant pathogens, increases crop yield.

Long term effect of FYM and vermicompost on soil physical properties under pearlmillet-chickpea cropping sequence

Treatments	**Bulk density (Mg/m^3)**	**Hydraulic conductivity (mm/hr)**	**Mean weight diameter (mm)**
Control	1.46	0.51	0.48
100% RND through inorganic fertilizers	1.43	0.53	0.51
100% RND through FYM	1.33	0.64	0.61
100% RND through vermicompost	1.35	0.61	0.59
50% RND through FYM + 50% RND through vermicompost	1.36	0.61	0.60
5 t/ha FYM	1.36	0.60	0.57
3 t/ha vermicompost	1.37	0.58	0.56
2.5 t/ha FYM + 1.5 t/ha vermicompost	1.36	0.60	0.59
SE(m)±	0.009	0.008	0.008
CD at 5%	-	0.024	0.024
(Margal *et al*., 2021)			

The long term effect of FYM and vermicompost under pearl millet-chickpea cropping sequence on soil physical and chemical properties was studied during 2013 to 2018 on fixed site at research farm of Bajra Research Scheme, College of Agriculture, Dhule. The soil physical properties *viz.* hydraulic conductivity, mean weight diameter and soil chemical properties *viz.* soil pH, electrical conductivity, available N in soil, available K in soil were significantly influenced in the treatment of 100% RDN through FYM as compared to the treatment receiving 100% RDF through inorganic fertilizers at the end of 6th cycle of pearl millet-chickpea cropping sequence. The hydraulic conductivity (0.64 mm hr^{-1}) and mean weight diameter (0.61 mm) were significantly increased in the treatment of 100% RDN through FYM. The soil pH (7.40) and electrical conductivity (0.33 dSm^{-1}) were significantly decreased and soil available N (244 kg ha^{-1}) and K (273 kg ha^{-1}) were significantly increased in the treatment of 100% RDN through FYM as compared to the treatment receiving 100% RDF through inorganic fertilizers (Margal *et al*., 2021).

The aim of this study was to assess the changes in chemical and microbial properties and enzymatic activity of soil enriched with vermicompost derived from household waste.

The vermicompost was tested in the rhizosphere of *Larix* decidua seedlings cultivated in 10-L pots in: (i) nursery soil (as the control), (ii) soil with 10% v/v vermicompost, and (iii) with 20% v/v vermicompost. The impact of vermicompost was assessed in terms of soil C/N ratio; bacterial, fungal, and nematode counts; and enzymatic activity. It was found that vermicompost increased the C/N ratio from 21 to 32, as well as the content of nitrate from 78 to 134 mg kg^{-1}, of ammonium from 14 to 139 mg kg^{-1}, of phosphorus from 92 to 521 mg kg^{-1}, and of potassium from 142 to 1912 mg kg^{-1}, compared with the control soil. The abundance of beneficial bacteria was increased (from 8.61×10^7 to 37.9×10^7), along with decreases in microbiological ratios of fungi and bacteria (e.g. fungi/Bacillus from 0.18818 to 0.00425). Addition of vermicompost brought about a change in soil enzyme activity. Vermicompost reduced the activity of alkaline phosphatase only. Both doses of vermicompost led to an increase in the activity of acid phosphatase, inorganic pyrophosphatase, dehydrogenases, β-glucosidase, and urease. Only the higher dose had an effect on increasing the activity of o-diphenol oxidase and proteases. No significant change was observed for nitrate reductase. Also, the presence of antibiotics produced by bacteria was detected depending on the dose of vermicompost, e.g. iturin (*ituC*) and bacillomycin (*bmyB*) were found in soil with a dose of 20% v/v vermicompost. Overall, vermicompost produced from household waste can be an excellent organic fertilizer for larch forest nurseries (Sebastian *et al*., 2021).

- Post harvest analysis of soil after applied of organic fertilizers on wheat

Treatments	OM (%)	NO_3^- N (mg/kg)	P (mg/kg)	K (mg/kg)
Control	0.28	4	3.32	104.67
RF of NPK (120:85:60 kg/ha)	0.35	8	7.11	117.67
VC @ 4 t/ha	0.44	10	8.14	120.00
PSB	0.30	6	6.11	101.00
RF + VC @ 4 t/ha	0.48	11	8.34	121.67
RF+PSB	0.39	8	7.74	116.67
VC @ 4 t/ha+ PSB	0.46	10	8.48	109.67
RF+VC @ 4 t/ha+ PSB	0.58	13	9.4	128.33
LSD (0.05)	0.03	1.7	1.23	7.15
RF- Recommended fertilizers, VC- Vermicompost, PSB- Phosphorus solublizing bacteria (Arslan *et al*., 2020)				

Integrated application of mineral fertilizers, organic amendments and microbial inoculants not only maximize the crop production and economic returns but also improve the soil health. A two years field study was conducted in the farm of Barani Agricultural Research Institute, Chakwal (32º55’33”N, 72º43’30”E) to evaluate the integrated impact of vermicompost and microbial inoculants on wheat yield and economics. Eight treatments i.e., control; recommended dose of fertilizers (160:150:50) NPK in kg ha^{-1}; VC @ 4t ha^{-1}; PSB; Recommended fertilizers + VC @ 4t ha^{-1}; Recommended fertilizers + PSB; VC @ 4t ha^{-1} + PSB; Recommended fertilizers + VC @ 4t ha^{-1} + PSB were tested in the experiment using various combinations of vermicompost (VC) @ 4t ha^{-1} and phosphorus solubilizing bacterial (PSB) as microbial inoculants along with recommended dose of NPK fertilizers (RDF) were applied at the time of sowing. The combined application of VC, PSB and RDF increased the wheat yield 2684 kg ha^{-1} and 3179 kg ha^{-1} while the yield recorded in control was 572 and 887 kg ha^{-1} for two consecutive years. Same trend was observed in other yield attributes i.e. no. of tillers m^{-2} (T8; 348, 352 vs control; 240, 238), spike length (T8; 12 cm, 14 cm vs control; 9.10, 10.9), no. of grains $spike^{-1}$ (T8; 63, 65 vs control; 34, 28) during both years, respectively. It has also mended the soil health by improving the soil OM status (0.58%), NO_3-N (13ppm) and phosphorus (9.4ppm) contents. The economic analysis revealed that maximum net returns were found in integrated nutrient application (RDF, VC and microbial inoculants) i.e., Rs. 67,044 ha^{-1} for 2017-18 and Rs. 1,03,202 ha^{-1} for 2nd year and minimum returns in control (Arslan *et al*., 2020).

Role of vermicompost on enhance quality production:

Vermicompost is the product of the composting process using various species of worms to create a mixture of decomposing organic waste, bedding materials and vermicast; producing compost through the action of earthworm. It is an eco-biotechnological process that transforms energy rich and complex organic substances into stabilized humus-like product. To get rid of accumulation and putrefaction of wastes vermicomposting is very essential, as an option using it for organic fertilizer. It results in the lower emission of pollutant gases such as CH and NH, among other volatile 4 3 compounds. To reduce the use of synthetic fertilizers in agricultural fields using organic sources is essential to save our environment. Moreover, it enhances soil health which is the balance between soil function for productivity, environmental quality. Vermicompost have many outstanding biological properties; rich in bacteria, actinomycetes, fungi and cellulose degrading bacteria and much finer structure than ordinary compost and contain nutrients in forms that are readily available for plant uptake. It releases nutrients slowly and steadily into the system and enables the plants to absorb these nutrients over time, which has the power to correct the soil pH and N concentration in the composted material. Application of vermicompost improves the soil quality as a whole which may be reflected through better crop production. Thus, toxicity of agricultural land and its reduction of crop production toward infertility can be solved by proper accumulation, management and generation organic wastes. It would be good to enrich the soil with organic inputs such as vermicomposts which have various benefits to the soil health and finally increase crop yield and quality, consequently farmers need to be trained about the importance of vermicompost and more field trials with different crops need to be conducted in the future to seriously address soil and crop needs of vermicompost.

- Provide sufficient nutrients for better plant growth
- Suppression of plant diseases and pests
    - Reduce soil borne microbial diseases and insect pests

- Reduce plant parasites nematodes

- Effect of different spacing and organic sources on growth and yield of *zaid* finger millet

Treatments	Plant height (cm)	Dry weight (g)	Fingers length (cm)	Grain yield (t/ha)	Biological yield (t/ha)
20X10 cm+100% RND	92.04	12.41	8.93	2.69	7.31
20X10cm+100% N through VC	92.01	12.46	8.57	2.37	6.66
20X10cm+50% RND + 50% N through VC	93.95	12.82	9.04	2.74	7.41
30X10 cm+100% RND	86.97	11.80	8.52	2.35	6.62
30X10cm+100% N through VC	89.31	12.12	8.05	2.42	6.66
30X10cm+50% RND + 50% N through VC	87.34	12.41	8.85	2.62	7.17
40X10 cm+100% RND	89.24	12.19	8.39	2.28	6.49
40X10cm+100% N through VC	87.65	12.10	8.11	2.09	6.22
40X10cm+50% RND + 50% N through VC	89.97	11.71	8.25	2.15	6.22
SEM(±)	0.988	0.19	0.08	0.04	0.23
CD (p=0.05)	2.06	0.57	0.24	0.14	0.78

RND- recommended nitrogen dose , VC- Vermicompost

(Manojgowda *et al*., 2021)

A field experiment was conducted during *Zaid* season 2020 at Crop Research Farm (CRF), Department of Agronomy, SHUATS, Prayagraj (UP) on sandy loam soil to investigate the effect of different spacing and nutrient sources on growth and yield of *Zaid* finger millet. The treatments consisted of spacing *viz*., 20 cm x 10 cm, 30 cm x 10 cm and 40 cm x 10 cm and nutrient sources *viz*., 100% RDN, 100% N through vermicompost and 50% RDN + 50% N through vermicompost whose effect is observed on finger millet (var. Godra-OT). The experiment was laid out in randomized block design with nine treatments replicated thrice. Study revealed that spacing 20 cm x 10 cm + 50% RDN + 50% N through vermicompost recorded significantly higher plant height (93.95 cm), number of tillers/running row meter (36.69) and plant dry weight (12.82 g) at harvest stage as compared to all the treatment combinations. The spacing 20 cm x 10 cm + 50% RDN + 50% N through vermicompost also recorded significantly higher number of grains/ear head (1912.35), number of fingers/ear head (6.41), fingers length (9.04 cm), grain yield (2.74 t/ha) and biological yield (7.41 t/ha) as compared to all the treatment combinations (Manojgowda *et al*., 2021).

Conclusion:

Chemical fertilizers are produced from “vanishing resources” of earth and crops grown on chemical fertilizers have low and contaminated nutrient value in comparison to grown naturally or organic way. To preserve the agro-ecosystem and protect human health from the harmful chemical fertilizers ‘Ecological Agriculture and Organic Farming’ has to be promoted as the new emerging concept of “Organic Farming” focuses mainly on production of chemical free foods. Organic farming with use of organic fertilizers like “vermicompost” could substitute the chemical fertilizers and can reduce the economic cost and may also lead to organic products which fetches higher price in the market.

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