Vermicompost: An effective substitute for chemical fertilisers

Home

The advent of organic farming has made farmers innovative and nature friendly. Vermicomposting, an effective replacement for chemical fertilisers is the most sought after due to its cost-effectiveness and quality of enriching the soil. **Shwetha E. George,** a freelancer based in Kerala writes about the advantages of vermicomposting and feels that more needs to be done to create proper awareness among farmers about vermiculture.

The High Ranges of Central Kerala is known for its highly fertile soil. The planters here now have another reason to cheer. They have come across new natural manure, Vermicompost, which makes the soil healthy. Vermicompost is the compost prepared from the 'faecal castings released by earthworms.' This is an excellent form of natural manure, which is cost-effective, easy to make and effective in promoting waste-management. Vermicompost and its preparation is fast becoming a household activity in most municipalities of Kerala.

Preparation

Inside a bricklayer setting of 25 metres length and five feet breadth, these worms (Eisenia foetida varieties) are randomly placed on the soil bed. Over these worms, waste is laid. This waste can be decayed vegetable remains, palm leaves, dung and rice bran. Around 2,000 worms would require at least 40 baskets of garbage. The bed is watered and then completely covered with sacks. For the next 38 days, the bed must continue to be watered without removing the sack on top. During this time, the worms eat the garbage, working their way from bottom to top. Then the vermibed is allowed to dry for seven days. By then, the worms would have completely eaten through the waste and settled at the bottom. The sacks are removed and the compost, the fine black powder, which is the excreta of the worms, is scooped up manually from the surface of the bed.

"Since the final scooping of the compost powder must be done by standing outside the pit and using only hands, the five feet width is just apt," says Mathew P John, Director of the Sahyadri Research Institute of Eco-Farming, Peermade, which has around 60 cultural units set up throughout the High Ranges. "The sack cloth covering is necessary so that the worms can contain their own drought," And the compost is sieved only if you "are intending to sell."

With 4,000 worms, one can prepare one tonne of compost in 60 days (in the High Ranges preparation period is more due to low humidity level). The current price for vermicompost is Rs 5 a kg. And the costs of making it are also minimal. Around 4,000 worms will cost Rs 2,000, each worm costing 50 paisa. Expenses of infrastructure (these worms can be bred in a brick-setting or tank or a pit) and the labour (seven people for 60 days) can be worked out to another Rs 2000. ``One tonne of compost fetches a price of Rs 5000'', says Mathew. In this case the farmer gets a profit of Rs 1000.

The second time, his expenses are reduced by 60 per cent because he saves on infrastructure. At the end of the 60-day cycle, the worms would have multiplied. He can prepare the next round of compost on the same bed or create a new bed by transferring some of the worms there.

Vermicompost is becoming the principal manure for crops in the region. The market crisis for agricultural produces has also contributed to the popularity of vermicomposting. The manure comes in handy especially for small-holders who do not have the money to buy expensive, chemical fertilizers. The manure is used rampantly for crops like pepper, cardamom and coffee.

The only crop for which the vermicompost is not usable is tea. Because it requires large quantities of manure than can be washed away after application during the rainy season.

The biggest beneficiaries are women who have formed themselves into NGO-trained Self-Help Groups (SHGs). These women can easily prepare the compost in their backyard and sell the excess kilos left after their own use to neighbouring estates or farmers as far as from North Kerala and the coastal belt. Demands from these areas are reported to be as high as 20 tonnes.

The Sahyadri Institute, run by the Peermade Development Society, now intends to set up cultural units in the municipalities of rural Kerala including Perumbavoor, Piravom, Alwaye and Thodupuzha. The NGO-run institutes like these are assisted by the Spices Board and local bodies like grama panchayats, zilla panchayats , which organise seminars and teach farmers the method of vermicomposting. Government agricultural departments also buy these worms in bulk to conduct their own projects on vermiculture. “In fact, with the Supreme Court ruling that one of the criteria to decide on metro status would be the particular district’s level of participation in organic farming, I am hoping for more involvement in this field,” says Mathew.

But the low sense of awareness still remains a problem even within the municipalities that have undergone seminars on vermicomposting. “Neither the Boards nor the local bodies have a procedure to select the farmers who undergo the training,’’ says Mathew, “Not all 100 farmers will be resourceful. The most important factor for any type of organic farming is individual involvement. So if farmers in the group are disinterested, the scheme will not be successful.”

Technical expertise alone does not make organic farming. Unless there is a uniformity of procedure, the advantages of organic farming – low cost, more soil fertility and eco-friendliness - will not come through.

Secondly, the farmer community expects government subsidy even though it is a completely low-cost method. “Times are harsh,” says Mathew. Kerala has never faced an agricultural crisis like this before. Most farmers are dependent on money-lenders and reports of isolated cases of suicides are beginning to pour in. The initial start-up amount of Rs 4000 is not affordable by all. “In fact only a few can cough up that amount on their own.”

After all, by preparing vermicompost, the farmer is making the soil healthy. In turn, he’s supplying healthy crops into the market. The content of organic carbon, the index for the presence of humus in the soil, is around two per cent in the High Ranges, below five per cent in the coastal areas and one per cent in the middle areas. “So the farmers in the High Ranges contribute considerably more towards ecology and food production. He deserves all the support he can get.”

With the right financial support from the Government and a more organized network of cultural units, vermicompost as a form of manure can generate a steady source of income for the impoverished folk of agricultural Kerala.

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Back to Contents

COMPOSTING

VERMICOMPOST AND COIRPITH COMPOST

Composting is largely a biological process in which microorganisms of aerobic (which require air or oxygen for development) and anaerobic (which functions in absence of air or free oxygen) decompose organic matter and lower the carbon-nitrogen ratio of the substrate. Compost is prepared from vegetable and animal refuses collected in the farm or in towns or villages.

Method of composting

The available refuses in the farm are collected and stored till they form sufficient mass for compost making. A trench of suitable size, say, 4-6 m long, 2-3 m broad and 1-1.5 m deep is dug, the accumulated refuse is well mixed, and a layer 30 cm in thickness, is spread all along the length of the trench. This layer is well moistened by sprinkling cowdung slurry and water over it. A second layer (30 cm thick) of the mixed refuse is then spread. The process is repeated till the heap rises to a height of 45 cm to 60 cm above ground level. The top is then covered with a thin layer of earth. After three months of decomposition, the mass is taken out of the trench and formed into a conical heap above the ground, moistened with water, if necessary, and covered with earth. After another month or two, the manure will be ready for application to field.

Vermicompost

Vermi-technology is a process by which all types of biodegradable wastes such as farm wastes, kitchen wastes, market wastes, biowastes of agro-based industries, livestock wastes etc. are converted to nutrient rich vermicompost by using earthworms as biological agents. Vermicompost contains major and minor nutrients in plant-available forms, enzymes, vitamins and plant growth hormones.

Species suitable: *Eudrillus eugineae* has been identified as the best species of earthworm for vermi-technology under Kerala conditions.

Vermicomposting of farm wastes

Pits of size 2.5 m length, 1 m breadth and 0.3 m depth are taken in thatched sheds with sides left open. The bottom and sides of the pit are made hard by compacting with a wooden mallet. At the bottom of the pit, a layer of coconut husk is spread with the concave side upward to ensure drainage of excess water and for proper aeration. The husk is moistened and above this, biowaste mixed with cowdung in the ratio of 8:1 is spread up to a height of 30 cm above the ground level and water is sprinkled daily. After the partial decomposition of wastes for 7 to 10 days, the worms are introduced @ 500 to 1000 numbers per pit. The pit is covered with coconut fronds. Moisture is maintained at 40 to 50 per cent. When the compost is ready, it is removed from the pit along with the worms and heaped in shade with ample light. The worms will move to bottom of the heap. After one or two days the compost from the top of the heap is removed. Put back the un-decomposed residues and worms to the pit for further composting as described above. The vermicompost produced has an average nutrient status of 1.5%, N, 0.4% P_2O_5 and 1.8% K_2O with pH ranging from 7.0 to 8.0. The nutrient level will vary with the type of material used for composting.

Precautions

1. The composting area should be provided with sufficient shade to protect from direct sunlight.
2. Adequate moisture level should be maintained by sprinkling water whenever necessary.
3. Take preventive measures to ward off predatory birds, ants or rats.

Depending on the extent of weathering of leaves used for composting, 70 per cent of the material will

be composted within a period of 60-75 days. At this stage, watering should be stopped to facilitate separation of worms from the compost. Compost can be collected from the top layers, which can be sieved and dried under shade. Earthworms aggregated at the bottom layers can be collected and used for further vermicomposting.

Vermicomposting from coconut leaves
Weathered coconut leaves can be converted into good quality vermicompost in a period of three months with help of earthworm, *Eudrillus* sp. On an average, 6-8 tonnes of leaves will be available from a well-managed coconut garden, which will yield 4-5 tonnes of vermicompost with about 1.2, 0.1 and 0.5% N, P_2O_5, K_2O respectively.

Vermicomposting of household wastes
Select a wooden box of 45 x 30 x 45 cm or an earthen/plastic container with broad base and drainage holes. Keep a plastic sheet with small holes at the bottom of the box. Add a layer of soil of 3 cm depth and a layer of coconut fibre of 5 cm depth above it for draining of excess moisture. Add a thin layer of compost and worms above it. About 250 worms are sufficient for the box. Spread daily vegetable wastes in layers. Cover the top of the box with a piece of sac to provide dim light inside the box. When the box is full, keep the box without disturbance for a week. When the compost is ready, keep the box outside in the open for 2-3 hours so that the worms come down to the lower fibre layer. Remove compost from the top, dry and sieve. The vermicompost produced has an average nutrient status of 1.8 % N, 1.9 % P_2O_5 and 1.6 % K_2O, but composition will vary with the substrate used.

Mass multiplication worms
Earthworms can be multiplied in 1:1 mixture of cowdung and decaying leaves taken in a cement tank or wooden box or plastic bucket with proper drainage facilities. The nucleus culture of earthworms is to be introduced into the above mixture at the rate of 50 numbers per 10 kg of organic wastes and properly mulched with dried grass, straw or wet gunny bag. The unit should be kept in shade. Sufficient moisture level should be maintained by occasional sprinkling of water. Within 1-2 months, the earthworms multiply 300 times, which can be used for large-scale vermicomposting.

Preparation of vermiwash

Method 1

The system consists of a plastic basin having a capacity of 20 litres, a plastic perforated waste-paper basket and a PVC pipe of 5 cm diameter and 30 cm length. The waste-paper basket is covered with a nylon net and placed at the centre of the basin upside down. A hole is made at the bottom of the waste paper basket so that a PVC pipe of 5 cm diameter can be placed into the basin through the hole in such away that one end of it touches the basin. The PVC pipe is perforated so that the leachate from the basin seeps through the waste-paper basket and collects in the PVC pipe, which can be siphoned out by a kerosene pump. In the basin outside the waste-paper basket, a layer of brick pieces are placed and a layer of coconut fibre of 2-3 cm placed above it. After moistening this, 2 kg worms (about 2000) are introduced into it and 4 kg kitchen-waste is spread over it. After one week the kitchen-waste turns into a black well-decomposed compost. Two litres of water is sprinkled over the compost containing worms. After 24 hours, the leachate collected in the PVC pipe is removed by siphoning. The collected leachate is called vermiwash, which is actually an extract of compost containing worms. This is used for soil application and foliar spray in different crops. Vermiwash is honey-brown in colour with a pH of 8.5 and N, P_2O_5 and K_2O content 200, 70 and 1000 ppm respectively. For large-scale collection of vermiwash, a cement tank of size 80 x 80 x 80 cm is constructed. A layer of small brick pieces or gravel is placed at the bottom of the tank. Above it a layer of fibre of 3-4 cm thickness in placed. A definite quantity of biowaste (4 kg) is added to the system along with 2 kg of earthworms. After two weeks, the entire mass of biowaste will turn to brownish black compost. Then add 2 litre of water. Vermiwash is collected through the side tap after 24 hours. Again biowaste is added to the system and the process is repeated.

Method 2

This is a simple and economical technique to collect vermiwash. The system consists of an earthen pot of 10 kg capacity, which is filled, with pieces of stone up to 10 cm height from the bottom. Above this, a plastic net is placed and spread out. Then a thick layer of coir fibre along with humus containing

1500-2000 worms of species *Eudrillus euginae* or *Isenia foetidae* is laid down. The hole situated at the bottom of the pot is fixed with a water tap through which vermiwash is collected. Every day, the kitchen waste is put into the container. Allow the composting process to continue for one week or more till brownish black mask of compost is obtained. Occasionally, two or three tablespoons of fresh cowdung slurry is poured on the humus as feed for the worms. After the formation of compost, soak the entire mask with two litres of water. After 24 hours, about 1.5 litre of vermiwash can be collected. This process can be continued for one or two weeks till the brown colour of wash disappears. The less enriched compost that remains in the pot can be collected and used as fertilizer. Later, the pot can be emptied and set up again to continue the process.

The potential of vermiwash as a biocide either simply or when mixed with botanical pesticides can be very well exploited for household vegetable cultivation.

Recommendation for crops
When vermicompost is applied as organic manure instead of FYM, the quantity of in-organic fertilizers can be reduced to about half the recommended dose.

Coirpith composting
Coirpith, one of the agricultural wastes is produced and heaped in large quantities as waste material from the coir industry. Approximately 2.5 lakh tonnes of coirpith accumulate in Kerala as waste. Coirpith has wide C:N ratio and its lignin rich nature does not permit natural composting process as in other agricultural wastes. *Pleurotus* spp. have the capacity to degrade part of the cellulose and lignin present in coirpith by production of enzymes viz., cellulases and lactases. The C:N ratio of coirpith is reduced from 112:1 to 24:1 as a result of composting. The lignin content also reduces considerably.

Method of composting
Materials required: Coirpith 1 tonne, urea 5 kg, mushroom (*Pleurotus*) spawn 1.5 kg.

Select a shaded place of 5 x 3 m dimension and level it after removing weeds. First spread 100 kg coirpith uniformly. Spread 300 g (one bottle or cover) of *Pleurotus* spawn on this and cover this with a second layer of 100 kg coirpith. On the surface of the second layer, spread 1 kg urea uniformly. Repeat this sandwiching process of one layer of coirpith with spawn followed by another layer of coirpith with urea up to 1 m height. Sprinkle water if necessary to keep the heap moist. Allow the heap to decompose for one month.

The coirpith is converted into good manure after 30-40 days and the lignin content is reduced from 30% to 40%. Another significant change is the lowering down of C: N ratio from 112:1 to 24:1.

This coirpith compost contains macronutrients as well as micronutrients. It has the unique property of absorbing and retaining moisture to about 500-600 per cent. It improves the water infiltration rate and hydraulic conductivity of soil.

Top Back to Contents

BIOFERTILIZERS

The use of biofertilizers is quite important while practising the concepts of integrated plant nutrient management and organic farming. Some of the commonly used biofertilizers in Kerala are as follows.

1. Rhizobium (Bradyrhizobium and Azorhizobium)
It induces better root nodulation and stem nodulation (*Azorhizobium*) in inoculated plants and thereby brings down the requirement of nitrogen fertilizer for the cultivation of pulses, oil seeds and legume green manures. Commercially it is available as carrier based inoculums. Method of application is seed treatment.

2. Azotobacter
Suitable only for upland crops like vegetables, tapioca, plantation and orchard crops. It is available as carrier-based inoculum. It fixes N about 15-20 kg/ha under ideal upland conditions and thereby

reduces the requirement of nitrogen fertilizers by 10-20 per cent. Methods of application are seed treatment, seedling dip and direct soil application.

3. Azospirillum
It is suitable for both upland and wetland conditions and is available as carrier-based inoculum. It fixes N about 20-25 kg per ha under ideal conditions thereby effecting a reduction of 25 per cent in the quantity of N fertilizers required. Treatment with *Azospirillum* also induces better root formation in inoculated plants. Hence this biofertilizer is also recommended for root induction in polybag-raised seedlings of plantation and orchard crops and also for vegetable crops. The isolates of *Azospirillum brasilense* strains AZR 15 and AZR 37 from Kuttanad soils are highly effective for rice, vegetables and nursery plants. The strains AZ 1 and AZ 2 are effective in vegetable and nursery plants.

Method of application

Seed treatment: For treating 5-10 kg seeds, 500 g culture is required. Moisten the seeds by sprinkling water or rice-gruel water. Take 500 g culture in a plastic tray/basin, add moistened seeds, mix well and dry in shade for 30 minutes. This may be sown immediately.

Seedling root dip (for transplanted crops): Slurry of the culture is prepared by mixing 500 g culture with 50 ml of water and the roots are dipped in the slurry for 15-20 minutes before transplanting.

Soil application: Mix the culture with FYM or compost in the ratio 1:25 and apply directly in the soil.

Inoculation for paddy
Mix 2 kg of culture in 60 litres of water and soak the seeds required for 1 ha (60 kg) for 24 hours before sowing. At the time of transplanting, dip the roots of seedlings for 15-20 minutes in the culture slurry prepared by mixing 2 kg inoculum with 40 litres of water. This slurry can be used for treating seedlings required for 1 ha. Another 2 kg culture may be applied to the field along with FYM or compost.

4. Blue green algae(BGA)
Mainly recommended for wetland rice cultivation. However, the use of this biofertilizer is not feasible in acidic soils with pH below 6.0. It is available as carrier-based inoculum and it fixes N about 25-30 kg/ha under ideal conditions.

Method of application: Direct broadcasting in the rice fields @ 10 kg/ha one week after transplanting the seedlings.

5. Azolla
It is suitable for wetland rice cultivation. The required quantity of azolla will have to be raised in the farmers' field itself. Fixes N about 25 to 30 kg / ha.

Method of application: Apply fresh azolla @ 10 t/ha before transplanting the rice seedlings at the time of ploughing.

6. Phosphate solubilising bacteria and fungi
Recommended mainly for upland crops raised in neutral and slightly alkaline soils. Available as carrier-based inoculum. Enables the efficient utilization of cheaper sources of phosphatic fertilizers such as rock phosphate by crop plants in neutral and alkaline soils.
Method of application: Seed treatment and direct application.

7. Vesicular / arbuscular mycorrhiza (VAM/ AM)
Vesicular arbuscular mycorrhiza is mostly recommended for upland especially for raising container and tissue culture plantlets and transplanted crops. It mainly improves the uptake of available P by inoculated plants. There is also an enhanced absorption of water and other nutrients such as N and K and certain micronutrients. Mycorrhiza inoculation can improve the survival and establishment of tissue culture plantlets under field conditions. Also induces better resistance against certain soil borne plant pathogens. It is commercially available as granular inoculum consisting of infected roots and soil with mycorrhizal spores. It is given as soil application.

VAM fungus *Glomus microcarpum* var. *microcarpum* is suitable for tropical tuber crops. The inoculation can be done by placing inoculum (3-5 g/sett) beneath the sett before planting. The rate of spore load in the inoculum should be to the tune of 50 to 400 spores per 100 g soil medium. Method of application is the rooted infected cutting technique.

Application techniques of biofertilizers

1. Seed treatment
Five hundred grams of commercially available inoculum will be required for treatment of seeds for one-hectare area. For this, thick slurry of the carrier-based inoculum is initially prepared by mixing 500 g of the inoculum in 1.25 litre of water. The stickiness of the biofertilizer on seed surface can be significantly improved by using 10% jagerry solution or 5% sugar solution supplemented with 40% boiled and cooled gum arabic solution or rice-gruel water. The required quantity of seed material is then gently mixed with this slurry by taking care not to damage the seed coat. The treated seeds are spread evenly over a gunny bag and dried in shade and sown immediately in moist soil. Under no circumstances, the treated seeds are exposed to direct sunlight for a longer period of time since the UV rays of solar radiation will reduce significantly the population of inoculated bacteria on seed surface.

2. Seedling treatment
This method of application is mainly recommended for transplanted crops. In this procedure, the roots of seedlings to be transplanted are dipped in loose water slurry of the biofertilizer (500 g in 2.5 litre of water) for 20 minutes, prior to transplanting.

3. Soil application
Soil application is generally recommended for all types of biofertilizers except Rhizobium, Bradyrhizobium and Azorhizobium. The method is to apply the biofertilizer after mixing with dried FYM, compost or vermicompost @ 1:25. For crops of six-month duration, the recommended dose is 1-2 kg/ha. This can be increased to 2-4 kg/ha for crops of more than six-month duration. For perennial crops, 10 to 25 g of the biofertilizer is to be applied in the root zone during the first year and 25 to 50 g during subsequent years. This can be done at the time of sowing, transplanting or during intercultivation.

Factors influencing the efficient use of biofertilizers in Kerala

1. Use adequate quantity of organic manure (as per the recommendation for each crop) along with biofertilizer application. This is essential to ensure better survival, growth and activity of the introduced microbial inoculum in acidic soils.

2. Liming is essential if the soil pH is below 6.0. In moderately acidic soils, the application of lime @ 250 kg/ha is recommended along with biofertilizer treatment.

3. Irrigation is essential during summer months after biofertilizer application to ensure the survival of the introduced microbial inoculum in the soil.

4. Since N biofertilizers can supplement only a part of the nitrogen requirement of the inoculated plant, low dose of nitrogen and full doses of phosphorus and potassium as per the recommendation may be applied. This is essential to ensure better plant growth and yield. Similarly, in the case of P biofertilizers, the full doses of nitrogen and potassium should be applied. However, there should be a gap of at least one week between biofertilizer and chemical fertilizer applications.

5. Use only biofertilizers, which are manufactured as per the quality parameters prescribed by the Bureau of Indian Standards. In the case of bacterial biofertilizers, the prescribed standard is that in the final product, the population of the desired bacterium should not be less than ten million per gram of the carrier material and there should not be any contamination with other microorganisms when examined at 1:100000 dilution. Further, it should have a shelf life of at least six months.

6. The commercially available biofertilizer should always be used before the expiry date marked on the culture packet.

7. Topdressing with superphosphate 25 kg/ha 10 days after inoculation of BGA will enhance its growth under field conditions.

8. Since the occurrence of green algae in rice field can affect the normal growth and proliferation of BGA, the population of green
algae should be controlled initially by applying copper sulphate @ 4 kg/ha.

9. In moderately acidic soils of pH around 6.5, root nodulation by Rhizobium and Bradyrhizobium can be improved by pelleting with finely powdered calcium carbonate. (See recommendation under cowpea)

10. Application of P_2O_5 @ 1 kg/ha is recommended once in 4 days in P_2O_5 deficient soils to ensure good growth of azolla. The development of a reddish purple colour in azolla is a typical symptom of P_2O_5 deficiency.

11. Since a floating population of azolla can release its bound nutrients only during decay in the soil, it is essential to incorporate azolla in the soil prior to the transplanting of rice seedlings.

Top Back to Contents

Citation:
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