Microbial and non-microbial technologies for plant and soil health management in coconut

Murali Gopal, Alka Gupta & George V. Thomas
Microbiology Section , ICAR-Central Plantation Crops, Research Institute, Kasaragod-671124, Kerala

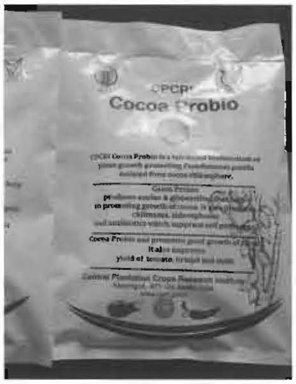
Introduction

Coconut palm is a unique plantation crop cultivated in 2.1 million ha in India. The palm is at once a food crop, an oil-seed crop, a medicinal crop, an industrial crop, a horticultural crop, an ecological crop and most importantly a cultural crop that supports the livelihood of more than 10 million Indians directly and indirectly. Its sustainability translates into sustainability of large swathes of humanity in coastal and hinterlands, Lakshadweep and Andaman and Nicobar islands of India. The two main factors that challenge the sustainability of coconut are the low national productivity as well as cyclical market economy. To address the first challenge, we at ICAR-CPCRI have developed several microbial and non-microbial technologies that can improve the soil and plant health and thereby enhance the productivity in ecologically sustainable manner. The technologies developed are described below.

Bioinoculants

Bioinoculants are carrier-based preparations containing beneficial microorganisms in a viable state intended for seed or soil application and designed to improve soil fertility and help plant growth by increasing the number and biological activity of desired microorganisms in the root environment. Function-specific microbial groups such as nitrogen-fixers, phosphate solubilizers, plant growth promoting rhizobacteria (PGPR) and mycorrhizae are used as biofertilizers in coconut cultivation. These groups of microorganisms are responsible for nitrogen

'KerAM' bioinoculant packet



'Kera Probio' bioinoculant

fixation, phosphate solubilization/phosphorus mobilization and production of plant growth promoting substances.

The microbial inoculants are prepared by formulating living cells of beneficial microorganisms in suitable carriers such as talc or sterilized vermicompost. Biofertilizers/beneficial microbial inoculants improve crop stand by producing and secreting plant growth promoting substances (phytohormones) such as auxins, gibberellins, cytokinins; by stimulating root metabolic activities using bacterial surface components; by stimulation of phytoalexins in roots; by phosphate solubilization, by reducing the soil pH by production of organic acids or other acidic substances; and/or by supplying biologically fixed nitrogen. Consequently, germination, root development, mineral nutrition and water utilization are improved.

Plant growth promoting rhizobacteria (PGPR) are important microbial resources for developing bioinoculants. They are known to possess multiple plant growth promotion properties. PGPRs also influence plant growth by indirect mechanisms such as suppression of bacterial, fungal and nematode pathogens by the production of various metabolites, by induced systemic resistance and/or by competing with the pathogen for nutrients or for colonization space.

'Kera Probio', a talc formulation of the PGPR bacteria Bacillus megaterium with multiple plant beneficial traits, effective for raising robust coconut seedlings was developed at ICAR-CPCRI. The bioinoculant is being sold to farmers when they come to CPCRI for taking coconut seedlings during the months of June to August. Kera Probio has also been found to be effective for vegetable crops such as tomato, brinjal and chilli.

Similarly an Arbuscular Mycorrhizal bioinoculant, 'KerAM', has been developed at ICAR-CPCRI, which is a soil based AMF bioinoculant for coconut seedlings. The bioinoculant contains Claroideoglomus etunicatum, one of the dominant AM species isolated from coconut agro-ecosystem with high potential to increase the growth parameters of coconut seedlings.

Biomass management technologies in Coconut

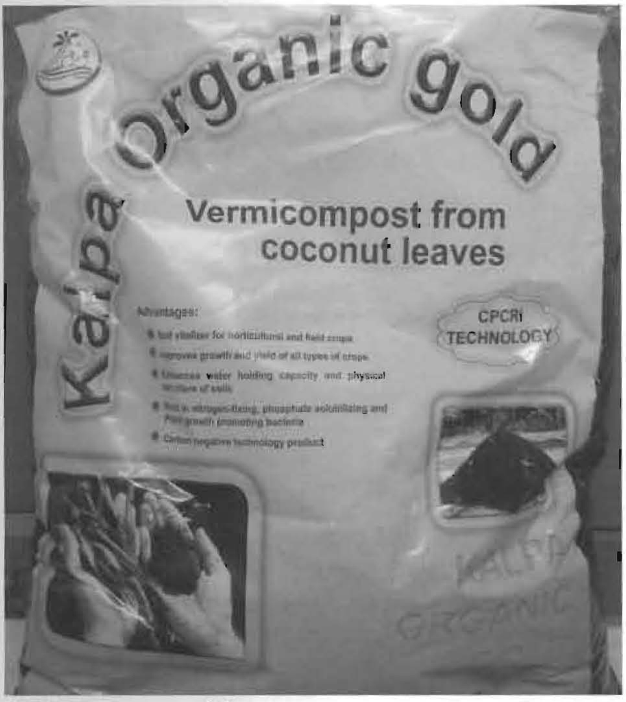
A substantial volume of recalcitrant biomass residue, in excess of 25 MT produced each year from this plantation crop that normally causes ecological and health issues, can be used in agriculture for rejuvenating soil health and fertility, increased crop production, enhanced economic benefits to resource poor farmers and for ecosystem sustainability through recycling technologies developed by at ICAR-CPCRI.

Coconut leaf vermicomposting technology

The natural decomposition of organic by-products resulting from coconut cultivation and the nutrient release is very slow due to the presence of lignin and polyphenols in it. But earthworms, which survive only in organic matter, known as compost worms or manure worms can enhance the decomposition of such organic materials and mediate humus formation. A local strain of earthworm was identified at ICAR-CPCRI, related to African Night Crawler (Eudrilus sp.), which is quite efficient in converting coconut leaves into granular vermicompost. Subsequently, a technology for producing vermicompost from lignin rich and highly recalcitrant coconut leaf litter using this earthworm species was developed at ICAR-CPCRI. It converts coconut leaves into vermicompost in less than three months period

Fallen dry Coconut leaves

Coconut leaf vermicompost



'Kalpa Organic gold'

and compost has C: N ratio of 10-17, 1.8 to 2.1 % N, 0.21 to 0.3 % P and 0.16 to 0.4 % K and organic carbon content of 18-20. As much as 4000 kg of good quality vermicompost can be produced from the wastes generated from 1 ha of healthy coconut garden every year by this earthworm that can meet a considerable percentage of nutrient need of the coconut palm. This technology is considered as an important component of sustainable production technology for coconut. This vermicompost can also be used for improving the productivity of other annuals, vegetables, fruits, flowers as well as cash crops.

Large-scale coconut leaf vermicompost can be produced in pits, thatched sheds, open ground and cement tanks. However, the bed system of compost production carried out in cement tanks was found to be most efficient. The length and breadth of the tanks can be made as per convenience; but, the depth should be less than 1 metre.

Coconut leaves weathered for 2-3 months are to be used. After chopping off the thick base, the rest of the leaf can be put as such or in two pieces. Above this, a layer of cow dung slurry is spread. Three such layers can be accommodated in one metre deep cement tank. The ratio of coconut leaves to cow dung slurry is kept at 10: 1 (e.g. 1000 kg leaves: 100 kg cow dung slurry). Sufficient moisture must be ensured by sprinkling water regularly and the whole substrate is allowed to pre-decompose for 2-3 weeks. At the end of this period, 1000 worms per tonnes of substrate are introduced into the tank.

Depending upon the extent of weathering and pre-decomposition, a maximum of 70% of the substrate would be converted to vermicompost within a period of 60-75 days. Watering is stopped at this stage so that worms move to the bottom. Ready vermicompost can be collected from the top, shade dried and packed. Earthworms accumulated at the bottom can be used for next round of composting.

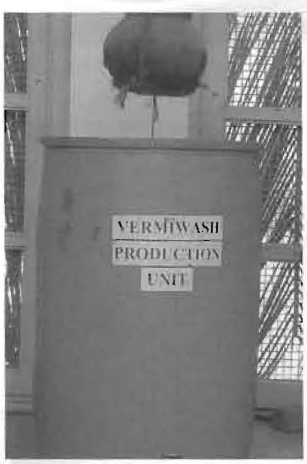
The indigenous earthworm Eudrilus sp. also has affinity for wastes other than coconut leaf wastes. A coconut garden, where other intercrops/ mixed crops are grown, generates leaf wastes from these intercrops also. All these mixture of wastes can be successfully composted using Eudrilus sp. earthworm. It has been found that coconut leaves can be mixed with pineapple waste, banana pseudo stem or gliricidia leaves in 3:1 ratio for effective utilization of other wastes commonly produced in coconut based cropping system.

Vermicompost is a finely divided peat-like organic material with excellent structure, porosity, aeration, drainage and water holding capacity. It has appearance and many characteristics of peat. It can influence a number of soil physical, biological and chemical processes which have their bearing on plant growth, development and yield and is a better source of organic matter than other composts. Application of vermicompost improves the soil aggregation, aeration and water holding capacity; root growth, microbial activity and the overall crop production capacity of the soil.

The vermicompost produced from coconut leaves using the technology developed at ICAR-CPCRI is now available under the trade name 'Kalpa Organic gold'.

Coconut leaf vermiwash: liquid organic manure

Vermiwash (vermin-wash) is the clear brown coloured liquid collected after the passage of water through a column of actively vermicomposting substrate



Coconut leaf Vermiwash production unit

Coconut leaf Vermiwash

Raw coir pith

Composted coir pith

Biochar produced from tender coconut

(Immature) husk

Coir pith

coconut leaf petiole

with earthworms. It is a combination of the washings of the earthworms' body surface along with the leachate of the vermicomposting substrate.

Fresh coconut leaf vermiwash is alkaline and contains major and minor nutrients, growth hormones, humic acid and plant beneficial bacteria. Coconut leaf vermiwash acts as a plant growth stimulator. Application of appropriately diluted coconut leaf vermiwash has shown to increase germination and seedling vigour index of cow pea and paddy seeds in laboratory bioassays. Field trials with cowpea, maize and bhendi in ICAR-CPCRI farm showed its capacity to increase biomass and yield of the crops accompanied by enhanced soil microbial activities.

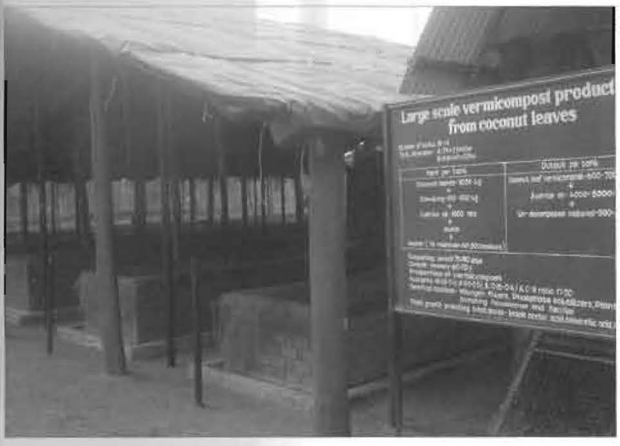
Adoption of this technology by farmers already carrying out vermicompost production involves very less investment. The vermiwash produced in addition to the vermicompost can be used for improving the yield of crops that give quick returns like vegetables, flowers and also export oriented crops like pepper, nutmeg, clove and vanilla.

Vermicompost and liquid vermiwash produced from other crop residues have also been found to be effective as an organic source of fertilizer comparable with inorganic source of fertilizer and biological disease prevention in a number of vegetable crops

Urea-free Coir pith Composting technology

Coir pith is a lignocellulosic waste biomass which accumulates around coir processing factories as a waste material. Though coir pith has a number of beneficial properties, its direct utilization as manure is not advisable as it contains large amounts of lignin and phytotoxic polyphenols.

A simple technology has been developed at ICAR-CPCRI for conversion of coir pith having a C:N ratio of 100:1 to acceptable manure that does not involve addition of urea. The raw coir pith with a C:N ratio



of 100 % is converted to an acceptable manure with a C:N ratio of 21 to 22 within a period of 45-60 days. The quality of coir-pith compost was found suitable for plant growth. The coir-pith compost can thus form an important recycled soil input for crop production.

For composting 900 kg of coir pith, 100 kg of poultry manure, 5 kg urea and 5 kg of lime are required. The technique involves spreading of coir pith in shaded place, with good quality poultry manure, lime and rock phosphate and mixing them properly. The heap should be kept moist by watering regularly and kept covered. Once in 15 days, the whole heap must be turned. After 45-60 days, the coir pith will become dark brown to black colour indicating the completion of composting process. The final product is shade dried and packed.

The coir-pith compost produced by ICAR-CPCRI technology is dark coloured with pH in the range of 6.1 to 6.9 and having up to 500% water holding capacity. The N, P and K content ranges between 1.3 to 1.4, 0.9 to 1.2 and 1.3 to 1.6 %, respectively, and is a good source of micronutrients as well.

Coir pith has property of high porosity and high water holding capacity that makes it a unique input as soil amendment. The addition of coir pith compost improves the physical properties and water holding capacity of soils. In addition to these important physical properties, it contains high concentration of potash which makes it more useful. It helps in better root formation and enhances crop growth and is an ideal medium for raising seedlings.

The coir-pith compost produced using the technology developed at ICAR-CPCRI has been released by the trade name 'Kalpa Soil Care'

Biochar production from coconut based residues

Biochar is a charred solid material obtained from thermochemical conversion of plant derived biomass in an oxygen limited environment. Attempts have been made to produce biochar from coconut leaf petiole, coir pith and immature coconut (tender nut) husk, a waste produced from coir industries and tender nut parlours, respectively, using a charring kiln. The biochars produced from coconut wastes were dark in colour, porous and of less density. Their pH ranged between 7.6 to 10, high potassium content (2.1-3.7%) and organic carbon content between 13-23%. Application of coconut waste biochars improved the soil pH, nutrient and microbiological properties making it highly suitable for the humid tropical soils, particularly those with low pH. ■

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