5

SUMMARY AND CONCLUSION

Biocomposting plays a crucial role in managing the agro based industrial wastes in organic farming. Humic rich product due to the action of microorganisms and earthworms is obtained from organic matter. Excessive use of chemical fertilizers resulted in serious environmental and health risks. To minimize the soil hazards, the present work has been designed to investigate the effect of **"Bioconversion of paddy and coffee husks as organic manure and its effect on plant growth and soil fertility".**

The ultimate goal of sustainable agriculture is to develop farming system that are productive and profitable, conserve the natural resource base, protect the environment and enhance health and safety measures. Hence, recycling of paddy and coffee husk would be a good substitute of organic manures produced by *Pleurotus eous*, *Pleurotus florida*, *Trichoderma asperelloides* and *Eisenia fetida*.

PHASE - I

Microbial population

Total microbial populations of bacteria, fungi and actinomycetes in compost piles indicates significant variations in relation to temperature changes during composting process. The mesophilic phase or moderate temperature phase showed moderate populations and increased microbial populations were observed in thermophilic phase. The maximum population was noted in C6 (Raw coffee husk + 6.5g *Pleurotus eous,* 6.5g *Pleurotus florida*, 7g *Trichoderma asperelloides* + *Eisenia fetida* 5t/ha) followed by C3 (Raw paddy husk + 6.5g *Pleurotus eous,* 6.5g *Pleurotus florida*, 7g *Trichoderma asperelloides* + *Eisenia fetida* 5t/ha) from 20 days to 60 days and then slightly declined on 90^{th} day (Maturation phase) .

Composting

Morphological and physico-chemical composition analysis of the raw and biocomposts of paddy and coffee husks were carried out.

The morphology of raw and biocomposts was analyzed with fourier transform infrared (FT-IR) spectroscopy and field emission scanning electron microscopy (FESEM). The study of characterization revealed the presence of functional groups, better resolutions and vibrational C-O and C-H stretches. Significant disappearance of these functional groups was recorded in biocompost C6 followed by C3. The micrographs of FESEM revealed the surface level changes before and after composting of paddy and coffee husk. Among all the treatments (C1- C6), C6 noted greater surface changes which resulted in porous, more fragmented and flakier texture followed by C3, this is because of active microbial degradation of organic matter and maximum accumulation of minerals in the biocompost. These techniques are used to identify the morphological structure, maturity and stability of biocomposts.

Physico-chemical parameters clearly defined the compost maturity. Among all the 6 different compost treatments, biocompost C6 was found to be efficient due to significant reduction in lignin, cellulose, EC, organic carbon, C:N ratio and increase in nitrogen, potassium, calcium and magnesium followed by C3 in comparison to other treatments and raw samples of paddy and coffee husk.

PHASE - II

Pot Culture Experiments

Biometric characters

To study the efficiency of agroindustrial wastes paddy and coffee husk as organic manure on the growth of some selected plants pot culture experiments were conducted with moth bean (*Vigna aconitifolia* (Jacq.) Marechal) Var. RMO - 40, black gram (*Vigna mungo* (L.) Hepper) Var. CO - 6, fenugreek (*Trigonella foenum-graecum* L.) Var. Lam Selection - 1 on 20, 40, 60 DAS and kalmegh (*Andrographis paniculata* (Burm.f.) Nees) Var. CIM - Megha on 30, 60 and 90 DAS.

Moth bean (*Vigna aconitifolia* (Jacq.) Marechal) Var. RMO - 40

Pot culture experiments of moth bean showed maximum biometric parameters of root length (cm), shoot length (cm), number of leaves, number of nodules, plant fresh weight (g), plant dry weight (g) in T6 followed by T3 and T5 on 20, 40, 60 DAS compared to other treatments and Control.

Black gram (*Vigna mungo* (L.) Hepper) Var. CO - 6

Black gram showed remarkable increase in root length, shoot length, number of leaves, plant fresh weight, dry weight and number of nodules were observed in T6 followed by T3 on 20, 40, 60 DAS when compared to the other treatments and Control.

Fenugreek (*Trigonella foenum-graecum* L.) Var. Lam Selection - 1

The treatment 6 (T6) showed increased root length, shoot length, number of leaves, plant fresh weight, dry weight and number of nodules on all the three days examined (20,40 and 60 DAS) as compared to control and other treatments.

Kalmegh (*Andrographis paniculata* (Burm.f.) Nees) Var. CIM - Megha

Maximum root length, shoot length, number of leaves/plants, fresh weight and dry weight of the plant was noted in treatment T6 followed by T3 on 30, 60 and 90 DAS as compared to other treatments and control.

Yield Characters

The yield parameters of the test plants moth bean, black gram and fenugreek showed maximum number of pods per plant, number of seeds per pod, length of the pod (cm), weight of the pod (g), weight of the seeds per pod (g), fresh weight of the pod (g), dry weight of the pod (g) were recorded in T6 followed by T3 on 90th day and medicinal plant kalmegh also showed similar results on 120 DAS.

The results of phase - II confirmed that vegetative and yield parameters showed positive result and it is due to the application of biocomposts T6 and T3 acted as enriching agents to the soil as well as boosted the plant growth and also improved the plant building structures.

PHASE - III

Biochemical Characters

Among all the treatments, T6 showed the maximum protein, carbohydrate, chlorophyll ‘a’, ‘b’ and total chlorophyll content in the leaves of moth bean, black gram, fenugreek (20, 40, 60 DAS) and kalmegh on 30, 60, 90 DAS. Maximum Leghaemoglobin content in the root nodules were maximum in T6 followed by T3 as compared to other treatments and control.

Protein and carbohydrate content in the seeds of moth bean, black gram, fenugreek (90 DAS) and kalmegh (120 DAS) was noted maximum in T6 and T3 as compared to the control and other treatments. The increase in the biochemical content might be due to the application of biocomposts which enhances physiological and metabolic activities in the plant tissue. As a consequence of this, there was an increase in nitrogen uptake from the soil and it further assimilates the protein and carbohydrate biosynthesis.

Phytochemical Screening

Medicinal plants are rich source of bioactive phytochemicals as they are natural compounds and potentially provide health benefits. While fenugreek and kalmegh are popular from centuries for their medicinal value. Phytochemical screening of plants grown under the best treatment (T6) fenugreek (seed extract) and kalmegh (leaf extract) in methanol revealed the presence of enormous phytochemicals such as alkaloids, flavonoids, sterols, anthraquinone, carbohydrates, saponins, cardiac glycosides, glycosides, terpenoids and phenolic compounds.

PHASE - IV

Antioxidant and antibacterial activity

Results of the above mentioned experiments showed T6 was found to be more influential and effective biocompost as compared to other treatments and control. Therefore, the antioxidant and antibacterial activity was carried out in treatment T6 (best treatment) and control with aqueous and methanol seed extracts of moth bean, black gram, fenugreek and kalmegh (leaves).

Antioxidant activity

Antioxidant activity of the selected plant seed samples was analyzed for free radical scavenging assays (hydrogen peroxide scavenging activity, nitric oxide radical scavenging activity, reducing power assay and DPPH radical scavenging activity) of different extracts. By comparing the aqueous and methanol extracts of the four plants, promising antioxidant activity was shown in methanol seed extracts of fenugreek followed by kalmegh in the best treatment (T6) - (Raw Coffee husk + 6.5g *Pleurotus eous*, 6.5g *Pleurotus florida*,7g *Trichoderma asperelloides* + *Eisenia fetida* (5t/ha) as compared to control and standard ascorbic acid.

Antibacterial activity

Antibacterial activity of moth bean, black gram, fenugreek and kalmegh was carried out with the seeds of best treatment (T6) and control. Aqueous and methanol extracts were examined against gram positive (*Staphylococcus aureus*) and gram negative bacterial species (*Escherichia coli* and *Vibrio cholerae*). Both the extracts showed antibacterial activity in all the plants. Among the two extracts, methanol extracts of fenugreek and kalmegh showed highest zone of inhibition against *Vibrio cholerae* and *Escherichia coli* followed by aqueous extract. The zone of inhibitions were moderately different from each other as compared to the standard antibiotic Streptomycin.

Soil Status

Initial nutrient status in soil

The results revealed that soil pH (6.7), electrical conductivity (4.33 dS/m^{-1}), available nitrogen (158 kg/ha), phosphorus (11.46 kg/ha) and potassium (92.35 kg/ha) were found to be more in T6 treatment as compared to control (6.1, 3.19 dS/m^{-1}, 130 kg/ha, 9.33 kg/ha & 77.61 kg/ha) in moth bean, black gram, fenugreek and kalmegh.

Post harvest nutrient status in soil

Maximum improvement in pH, electrical conductivity, available nitrogen (kg/ha), phosphorus (kg/ha) and potassium (kg/ha) were found in T6 biocompost as compared to control in post harvest soil of moth bean, black gram, fenugreek and kalmegh.

Moth Bean (*Vigna aconitifolia* (Jacq.) Marechal)

Significant increase in pH (7.1), EC (1.20 dSm^{-1}), available nitrogen (190 kg/ha) available phosphorus (15.91 kg/ha) and available potassium (133 kg/ha) was noted in T6 treatment as compared to the control (6.2, 1.62 dSm^{-1},156 kg/ha, 10.30 kg/ha, 90 kg/ha) respectively.

Black gram (*Vigna mungo* (L.) Hepper)

Highest pH (7.3), EC (1.01 dSm^{-1}), available nitrogen (191 kg/ha), available phosphorus (14.03 kg/ha), available potassium (125 kg/ha) was recorded in T6 treatment as compared to the control (6.3, 1.47 dSm^{-1}, 155 kg/ha, 11.01 kg/ha, 81 kg/ha) respectively.

Fenugreek (*Trigonella foenum-graecum* L.)

Among all the treatments, T6 observed the highest pH (7.3), EC (1.05 dSm^{-1}), available nitrogen (195 kg/ha), available phosphorus (15.3 kg/ha), available potassium (130 kg/ha) as compared to the control (6.4, 1.91 dSm^{-1}, 123 kg/ha, 11.2 kg/ha, 84 kg/ha) respectively.

Kalmegh (*Andrographis paniculata* (Burm.f.) Nees)

An increase in pH (7.2), EC (1.13 dSm^{-1}), available nitrogen (174 kg/ha), available phosphorus (13.0 kg/ha), available potassium (99 kg/ha) was registered in T6 treatment as compared to the control (6.3, 1.71dSm^{-1}, 149 kg/ha, 10.0 kg/ha, 83 kg/ha) respectively.

Conclusion

The findings of the present study demonstrate the positive effect of paddy and coffee husk biocompost on enhancing the crop productivity and soil nutrition. Biocomposted paddy and coffee husk produced by the degradation of lignocellulolytic fungi (*Pleurotus eous*, *Pleurotus florida*, *Trichoderma asperelloides*) and *Eisenia fetida* was found to be efficient organic manure. Application of this biocompost has rejuvenated the depleted soil fertility, enriched the available pool of nutrients, maintained the soil quality, conserved more water and biological resources. The study also proved that biocomposted paddy and coffee husk to be a miraculous plant growth stimulator with the supply of plant nutrients. The overall cost production of paddy and coffee husk biocompost is minimal as compared to synthetic and chemical fertilizers. Enhanced growth and development of selected plants is due to the improving action of paddy and coffee husk biocompost.

The present work is not only an alternate solution for the disposal of agro industrial wastes like paddy and coffee husk but it minimizes and reduces the application of excess amount of chemical fertilizer that leads to degradation of soil health and causing environmental pollution. The process of biocomposting is also easy to operate and can be successfully prepared by unskilled small and marginal farmers. Amidst all the environmental pollution and increasing food demand, biocompost can be a solution. In future, there will be a tendency of adopting biocompost by farmers and others. The potentiality of biocompost is still not fully exploited yet. Hence, there is a need to appoint more extension workers to educate the farmers about vermicomposting and its benefits for achieving sustainability. Biocomposting is more economical than synthetic organic fertilizer. So, economic viability, environmental stability and enhancing livelihood quality are the major causes for its worldwide adoption in food production.

The present study confirmed that the application of paddy and coffee husk biocompost (T6 and T3) enhanced the biometric, biochemical, yield parameters, antioxidant, antibacterial, phytochemicals of the test plants moth bean, black gram, fenugreek, kalmegh and soil fertility when compared to other treatments and control due to the improved nutritional, physical, chemical and biological properties of the biocompost. Therefore, the nutrient rich profile of paddy and coffee husk biocompost, proved its appropriateness for agricultural application. Hence, it can be stated that biocomposting of paddy and coffee husk has immense potential for recycling and recovery of plant nutrients from agro industrial wastes.

Recommendations for future study

- Findings from the study demonstrate the positive effect of biocomposted paddy and coffee husk by ligno-cellulolytic fungi and *Eisenia fetida* as efficient organic manure on crop productivity and soil nutrition.
- Biocomposted paddy and coffee husk may be applied to maximize the quantity and quality yield of different crops and soil health in order to establish safe and green environment.
- Paddy and coffee husk biocompost can be used on different crops and medicinal plants in different type of soils.
- Biocompost produced from paddy and coffee husk can be sold to local farmers and gardeners which is an elegant solution to solve the problem of using chemical fertilizers and soil pollution.
- Create large public awareness programmes about organic farming principles, techniques etc. which is of vital to familiarize the essential basics of organic farming among the public. This will certainly generate a positive environment for the expansion of organic agriculture. It will also act as a motivation to non-organic farmers and consumers to follow organic farming.
- Efforts can be made in utilizing the biocompost by identifying the appropriate crops and areas having the potential and prospects for conversion to organic farming.
- Join with some NGOs, provide crop specific, area-specific packages and training to farmers since the problems faced by the farmers vary widely between different crops and locations.
- Involving media with online shopping facilities about organic farming will increase the existing demand for organic products, which will ultimately beneficial to customers in terms of high demand.