CHAPTER 8

SUMMARY AND CONCLUSION

Various waste materials such as industrial, agricultural and domestic waste substances are accumulated everywhere throughout the country. Wide range of microorganism including fungi, bacteria and cyanobacteria are available for degradation of waste and this degradable waste material can be used as useful products in different ways. Cultivation of cyanobacteria is inexpensive when compared to other microorganism hence recycling the waste by using cyanobacteria in order to get pollution free environment and useful products from waste will be an economical and purposeful one.

The present investigation was studied on biodegradation of lignocellulosic waste by using three marine cyanobacteria such as Phormidium sp (BDU-2), Oscillatoria sp (BDU-5) and Anabaena azollae sp (ML-2) were selected for degradation of coir waste.

8.1 Findings of the Study

Physical and chemical constituents of coir waste treated with cyanobacteria were monitored at regular intervals. The biochemical constituents of coir waste such as organic carbon, cellulose, hemicellulose and lignin were gradually reduced on 60 days of incubation with three different
species of Marine cyanobacteria. Maximum reduction was found out in *Anabaena azollae sp.* followed by *Oscillatoria sp.* Initially fast reduction was also observed in *Anabaena azollae* treated coir waste, compared to other cyanobacterial species. Only limited reduction was noted in *Phormodium sp* between 20 to 40 days of incubation.

The Hemicellulose degradation of coir waste by three marine cyanobacteria was found to be faster when compared with other biochemical constituents of coir waste. *Anabaena azollae sp* showed 92% degradation of hemicellulose followed by *Phormidium sp* degraded 87% of hemicellulose. C: N ratio of the compost was considered as an index for assessing the maturity of compost. The C: N ratio was decreased from 2\textsuperscript{nd} week onwards. A better final reduction was noted on 60\textsuperscript{th} day. Higher amount of reduction was noted with *Anabaena azollae* coir waste and slow reduction was observed in *Phormidium sp*.

The rate of degradation of coir waste was faster in all treatments comparing to that of control. The degradation of cellulose was in the order of 12% reduction for *Oscillatoria* treated coir waste, followed by 6-10% reduction from the initial value of cellulose by other treatments. The lignin content decreased in all treated coir waste compared to that of control. The lignin content was also reduced to around 50-70% after 60 days period of degradation process by cyanobacteria.

Microorganisms reduce the cellulose and total carbohydrates into reducing sugar for their growth, the reducing sugar is utilized which in turn gets oxidized. The formation of reducing sugar was highly observed in
Anabaena azollae. The rapid degradation of coir waste indicates the presence of reduction in sugar and alcohols. The TLC pattern of coir waste with different cyanobacterial species was confirming the degradation and release of intermediate products. The poor degradation was observed in Phormidium species. This was due to the presence of large number of intermediate products.

Three different species of cyanobacteria treated coir waste manures were applied for the growth of black gram plants. Various physical and chemical parameters of soil at the experimental site before planting and after harvest were analyzed. Application of coir waste manure increased the pH, silt, bulk density and water holding capacity of soil after harvest. The maximum reduction of sand and clay in the soil was observed in coir waste treated Phormidium sp after harvest of plant. The moisture and specific gravity were found to be higher in soil of Anabaena azollae treated coir waste manure when compared with other treatments.

Coir waste treated with Anabaena azollae and Phormidium showed a significant increase N,P and K content without any significant change in the P,K and Ca content. There was no significant change in N,P, K and Ca content in coir waste treated with Oscillatoria. Among the three species, Anabaena azollae treated coir waste manure showed best organic manure activity on the soil. This manure improves soil tilth, infiltration rate and soil water holding capacity contributing to increase nutrient up take by the crop being an important source of raw or partially decomposed organic matter. Thus from the above results, Anabaena azollae treated manure was selected for the growth of two black gram varieties.
The functional relationship between different N levels and chlorophyll content of two black gram varieties at harvesting stage indicated that with the increasing levels leaf chlorophyll and nitrogen content increased linearly. The chlorophyll and leaf nitrogen content were found to be slightly higher in coirwaste manuring plants than cowdung manuring plants.

Response of N,P and K uptake to the applied N fertilizer paralleled the response of plant nutrient concentration (%). Total uptake of N, P and K varied due to nitrogen treatment variations. Plants treated with 60kg N ha\(^{-1}\) had the highest N, P and K uptake irrespective of both the varieties. Upto 60kg N ha\(^{-1}\) all the nutrient uptake increased, but further increase of organic fertilizer decreased the N, P and K uptake gradually. Among the varieties ATD mash 3 always showed better uptake of these nutrients compared to ATD mash 1.

The morphological characteristics of black gram such as height, number of leaves, number of branches and leaf area were measured. The maximum growth of the plant was observed using coir waste manure in both fertile soil and drought soil. This was due to storage of nutrients and moisture in the coir waste. It also enhances the water holding capacity of soil and increases the bulk density of soil. The poor growth was observed in control plant (without manures) in fertile soil. The plant died on 35\(^{th}\) day in drought soil. This was due to unavailability and poor translocation of nutrients needed for growth of the plants. Plants need nutrients which were absorbed from the soil, water and manures.
The high content of chlorophyll (123mg/g) was observed in cow dung plant on the flowering of the plant in drought soil (Figure 5.2.b). The coir waste treated plant showed the high amount of chlorophyll up to 40th day on drought soil. The yellow color appearance of leaves on 26th day of drought soil was observed. This was due to poor availability of chlorophyll content of plant. Blue green algae such as Anabaena azollae treated coir waste supply nitrogen to the soil via symbiotic nitrogen fixation. It enhances the carbohydrate contents of leaves and delays leaf senescence. The high protein content was observed in vermicompost and coir waste treated plants at initial stage but gradually declined in the maturity stage.

The high content of protein was observed at maturity stage in cow dung treated plants in both fertile and drought soil. This was due to sudden decline in the pH of the soil, which enhanced the nitrogen content of soil. This nitrogen serves as a raw material for the production of protein. Methionine is one of the essential sulphur containing amino acids. It is found mostly in legumes. The methionine content was slowly increased up to 24 days of growth in both drought and fertile soil in plants treated with different organic manures. But it was suddenly reduced on the flowering stage of all plants except in seaweed treated plant. The methionine content of black gram reduced rapidly in plants treated with cow dung in drought soil.

Root nodule is an important site for nitrogen fixation. The maximum number of root nodules plants supplied with seaweed manure in fertile soil. The addition of organic manure in the soil enhanced the symbiotic relationship between microorganisms in the soil. On the other hand the lowest number of nodules was obtained from the cow dung treated plant. This could
be associated with toxicity of manganese, which was reported to reduce black
gram nodulation at low pH. The plant died since there was no nodulation in
test plants.

The black gram treated with different manures in drought soil had
fewer amounts of root nodules per plant. This was due to poor symbiotic
association between organic manure and less amount of nutrients in drought
soil. The lowest number of root nodules was observed in cow dung manure.
The maximum number of root nodules was observed in coir waste treated
plants. The coir waste manure helps to enhance translocation of nutrients in
soil. Thus the coir waste manure acts as a good soil conditioner.

The nitrogen fixing enzymes such as nitrate reductase and nitrite
reductase activity in the fertile soil and drought soil of black gram with
organic manures were analyzed. Nitrate reductase was found to be higher in
seaweed manure plant, when compared with other treated plant. The
maximum amount of Nitrite reductase was observed in Vermicompost treated
plant in fertile soil. Control plants showed the least amount of nitrite and
nitrate reductase activities. The maximum amount of nitrate reductase and
nitrite reductase was observed in coir waste treated plants in drought soil. The
nitrate and nitrite reductase activities were gradually decreased from 21st day
on wards. It implies the supply of nitrogen to the soil.

The nitrogenase activity was analyzed from the root nodules of
black gram by GC-MS. Nitrogenase activity was found to be higher in coir
waste treated plants in fertile soil. The Nitrogenase activity was not calculated
in drought soil due to insufficient amount of root nodules. Observation in this
study suggested a significant interaction between organic manures and nodules. Nodulation of black gram is one of the determinant factors for the yield of black gram.

The phytochemical components present in the root nodule of black gram were analyzed by GC-MS. The root nodules of black gram treated with seaweed manure had a high concentration of 1,2- Benzenedicarboxylic acid, diisooctyl ester and a low concentration of propane, 1, 1, 3-triethoxy. The phyto-component of 4-Methylheptanamide, N, N-dimethyl-, Tetradecanal, and 1,2-Benzenedicarboxylic acid, diisooctylester were identified only in the seaweed manure treated sample.

In root nodule of black gram treated with vermicompst, the content of Ethylbenzene, Pentane, 1,1-diethoxy (1,1 Bicylopropyl) -2-octanoic acid, 2-hexyl 1-methyl ester and Desulphosiningrin were identified.

The root nodule of black gram treated with coir waste (Table 7.3 and Fig.7.3) had a high concentration of Oleic Acid, 9,12-Octadecadienoic acid and Phthalic acid, butyl undecyl ester. This was due to supply of phytochemicals from coir waste. The coconut contain high amount of oleic acid and octanoic acid. The specific phyto component, Octanoic acid was identified in coir waste treated black gram which showed anti microbial activity. Propane -1, 1, 3 triethoxyl derivatives were found in all samples. The maximum peak area (6.81) was observed in Coir waste treated sample and cow dung treated sample. Benzene dicarboxylic acid (phthalic acid) was observed indifferent forms. The maximum peak of Phthalic acid, butyl undecyl ester (9.13) was observed in Coir waste treated sample.
The root nodule of black gram treated Cow dung had a low concentration of Oleic Acid, 9, 12-Octadecadienoic acid and Phthalic acid, butyl undecyl ester. No specific Phyto components were found in the cow dung treated sample.

Hexanoic acid ethylester was observed in vermicompst treated sample and coir waste treated sample. The saturated fatly acid, oleic acid was observed in all the samples. The maximum peak (7.04) was observed in coir waste treated plants. The Lactose content showed a peak of 3.47 in coir waste treated sample and cow dung treated sample.

8.2 Conclusion

From this study, it is observed that there is a positive linear relationship between black gram and organic manures. Coir waste has very good water holding capacity and hence acts as a mulching agent in drought prone areas. This enabled the translocation of nutrients from manure to the plant. Organic manure releases certain specific phytochemicals that might be beneficial to root nodulation thereby nitrogen fixation. Further work is needed to substantiate this finding.