

MICROBIAL POPULATION, ENZYME  
ACTIVITY AND VA MYCORRHIZA IN THE  
ROOT REGION OF COCONUT IN  
RELATION TO *IN SITU* GREEN MANURING

GEORGE V. THOMAS

ABSTRACT

*In situ* cultivation and incorporation of green manure legumes in coconut basins improved the microbial activity in the root region of coconut in a slightly acidic laterite soil. Populations of bacteria, fungi, actinomycetes, asymbiotic nitrogen fixing and phosphate solubilising bacteria were significantly increased during the maximum vegetative phase and at 30 days of incorporation of green manures. However, such a proliferation in microflora was not observed at 60 days of incorporation. Dehydrogenase activity also exhibited a similar trend, whereas the activity of urease enzyme did not increase to any significant level. The number of endomycorrhizal chlamydo spores in the root region soil and the intensity of mycorrhizal infection in roots of coconut were high in green manured basins. In general, *Pueraria phaseoloides* had a better beneficial influence on microbial characteristics of coconut root region as compared to *Mimosa invisa* and *Calopogonium mucunoides*.

INTRODUCTION

The coconut palm (*Cocos nucifera* L.) is cultivated in tropical soils characterised by low organic matter content due to the fast rate of degradation of organic materials caused by heavy rainfall, optimum temperature and porous soil texture. Application of organic manures is, therefore, very vital for the maintenance

of soil fertility and productivity of coconut. Organic manuring is seldom practiced by coconut growers mainly due to the non-availability and high cost of farm yard manure. A lot of emphasis is also given for the development of suitable management practices to maintain the productivity of root (wilt) affected coconut palms due to the debilitating nature of the disease. *In situ* cultivation and subsequent incorporation of green manure legumes in coconut basins was found to be a simple and inexpensive agricultural practice to supply organic matter to coconut palms (Thomas and Shantaram, 1984). The major objective of the present study was to elucidate the changes in microbial activity in the root region of coconut during the vegetative growth and subsequent to the incorporation of green manures in the coconut basins.

#### MATERIALS AND METHODS

An experiment to study the performance of green manure legumes in coconut basins and the influence of green manuring on root (wilt) disease of coconut is in progress since 1982 in a cultivator's garden at Vallikunnam (Alleppey District, Kerala). The soil in the plot is laterite with a slightly acidic pH of 5.8. The garden comprises 25 to 30-year-old bearing coconut palms of the WCT cultivar. Green manure legumes were sown in the basins within the radius of 1.8 m from the bole of the palm in two concentric circles in the month of June. They were harvested and incorporated in the respective basins after five months growth. For microbial and enzymatic analyses, soil samples were collected from basins of coconut palms under the treatments of the three promising green manure crops namely, *Pueraria phaseoloides*, *Mimosa invisa* and *Calopogonium mucunoides* and also from the control palms.

The selected basins received on an average 30 kg of green matter per basin. The soil samples were drawn at 0 to 30 cm depth within the basin one m away from the bole of the palm during the vegetative growth of the green manure legumes, after 30 and 60 days of their incorporation to soil. Three replications were maintained for each treatment. The microbial populations were determined following the dilution plating technique (Allen, 1957) using soil extract agar, Martins rose bengal agar, 'Ken-

nights' agar, Waksman medium 77, Sperber's agar and acidified Sperber's agar with streptomycin and rose bengal for enumerating bacteria, fungi, actinomycetes, asymbiotic N<sub>2</sub> fixing bacteria, P-solubilising bacteria and P-solubilising fungi, respectively. Population estimates are based on the colony forming units derived from viable microbial propagules.

Dehydrogenase activity was assayed by the triphenyl tetrazolium chloride reduction procedure (Casida et al., 1964); urease activity was determined by the procedure of Pancholy and Rice (1973) except that the ammonia evolved due to urea hydrolysis was estimated by nesslerisation. In order to assess the mycorrhizal status of coconut palms, soil and root samples were collected 30 days after incorporation of the green manures. The percentage of mycorrhizal infection in roots was determined by clearing root segments in KOH and staining with trypan blue (Phillips and Hayman, 1970). Mycorrhizal spores in the soil were estimated by wet-sieving and decantation technique (Gerdeman and Nicolson, 1963).

## RESULTS

The results revealed that there was a high level of zymogenic response by micro-organisms in the root region of coconut when green manure legumes were cultivated and incorporated in coconut basins (Fig. 1). Populations of major groups of aerobic heterostrophic micro-organisms in soil namely bacteria, fungi and actinomycetes and beneficial microbes like asymbiotic nitrogen fixers and phosphate solubilising bacteria were significantly increased as compared to those in control. The enhancement in the population of phosphate solubilising fungi was, however, not significant. The favourable influence on microbial population was highly significant during the maximum vegetative growth and at 30 days of incorporation of green manure legumes, but not at 60 days of incorporation. Fungi proliferated far more than the other microbial groups. Maximum influence on microbial population was recorded in *Pueraria* treated basins, where the populations showed two to three, five to six and two to three-fold increase for bacteria, fungi and actinomycetes, respectively. The dehydrogenase enzyme activity in the rhizosphere soil of coconut also increased as an effect of cultivation and

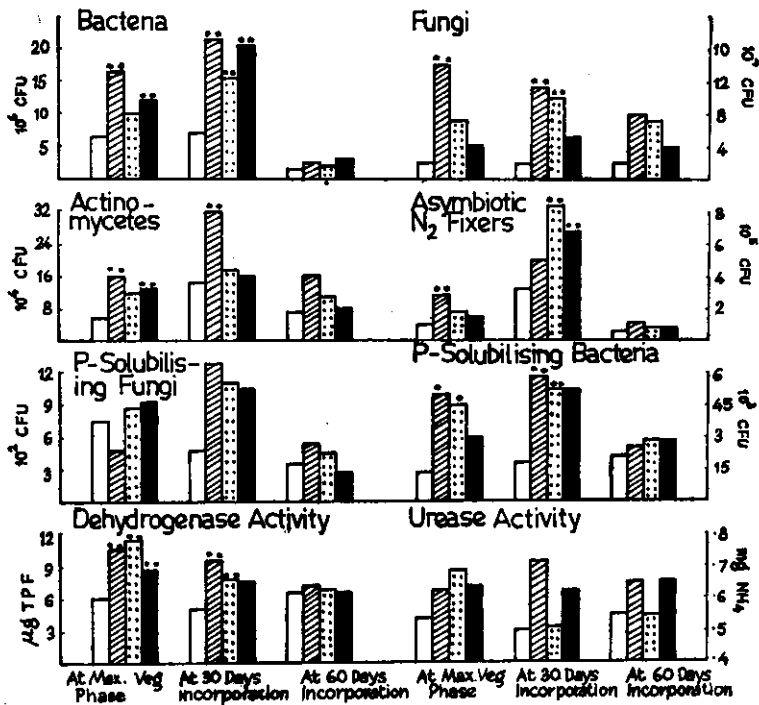


Fig. 1. Periodic microbial/enzymic activity.

incorporation of the green manure legumes. As in the case of microbial population, the increase in dehydrogenase activity was also negligible at 60 days of incorporation. Neither the cultivation nor incorporation of green manure legumes had any significant effect on the soil urease activity.

Table 1. Vesicular-arbuscular mycorrhizae of coconut as influenced by green manuring in basins

Sl. No.	Treatment	Spore count per 50 ml soil	Per cent infection in roots
1.	Control	240	62.7
2.	<i>P. phaseoloides</i>	362	79.4
3.	<i>C. mucunoides</i>	401	73.6
4.	<i>M. imvsa</i>	271	69.7
	LSD at P = 0.01	76	—

It is evident from Table I that the green manuring increased both the intensity of mycorrhizal infection in coconut roots and the number of extramatrical chlamydospores in the basin soil. The basins cropped with *Calopogonium* recorded the highest number of spores, whereas root infection was the highest in coconut palms under the treatment of *Pueraria*. The influence on vesicular-arbuscular mycorrhizae was comparatively less in *Mimosa* treatment.

#### DISCUSSION

The flush in microbial population in the root region of the coconut palm observed during the maximum vegetative growth of green manure legumes, can be attributed to the accumulation of root exudates, sloughed off root tissues and shed leaves of legumes in the region where the roots of the two crops are in close proximity. It is also quite possible that microflora increased as a result of enhanced root exudation from coconut when the green manure legumes were raised in basins. The influence of one crop on the rhizosphere microflora of a neighbouring crop is well known in a mixed cropping system (Shantaram and Rangaswami, 1967; Nair and Subba Rao, 1977). Potty and Jayasanker (1983) observed a favourable alteration in the rhizosphere microflora of coconut when the fodder grass, hybrid napier was grown as an intercrop in a coconut garden. The impact on the root region microflora of coconut was highly significant in the present study since the green manure crops were raised right in the coconut basins.

The proliferation of different groups of micro-organisms at 30 days of incorporation of green manures is indicative of active decomposition of the green matter applied. Plant residues serve both as a carbon and energy source for the multiplication of heterotrophic soil micro-organisms. Such high spurts in soil microflora due to the application of green manures has already been reported (Loshakov et al., 1981). An increase in microbial activity was earlier recorded in sandy soil after a week of incorporation of green manures (Thomas and Shantaram, 1984). The present study further revealed that the decomposition of most of the plant residues were over at 60 days of incorporation. The zymogenic organisms multiplied rapidly in response to

the input of fresh substrates, but they died out after a short period since their high energy requirements were not met with subsequently.

The high level of dehydrogenase activity observed in green manured basins could be the contributions of living legume roots and the activities of proliferating micro-organisms. The soil enzymatic activities could be considered as better indicators of soil biochemical activities (Burns, 1978). The increase in urease activity was not significant at all the three stages of analysis. Zantua et al. (1977) observed that increase in urease activity after the addition of organic materials was temporary and could not be detected after a few days presumably due to the inactivation of the newly formed enzyme.

The present study has also demonstrated that green manure legumes were effective in augmenting the endomycorrhizal symbiosis of vesicular-arbuscular type in coconut. Ocampo et al. (1980) found that non-mycorrhizal plants developed slight infection when mycorrhizal host plants were grown with them. Kormanik et al. (1981) observed that the cover crops like corn, millet and *sorghum* increased endomycorrhizal fungus inoculum in forest nursery soils. Vesicular-arbuscular mycorrhizae are known to improve plant growth by increasing the uptake of phosphorus and other nutrient elements. In the farming systems with perennial tree crops where mycorrhizal inoculation has limitations, the cultivation of green manure legumes can be adopted as a management practice to enhance the endomycorrhizal fungus inoculum.

Significant improvement in the microbial population, biological activity and VA mycorrhizal occurrence in the root region suggest a modification in the soil environment to the benefit of plant growth. The cultivation and incorporation of green manure legumes in coconut basins can, therefore, be considered a simple and less expensive input to build up the soil fertility under the tropical climatic conditions.

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#### DISCUSSION

**Q :** Have you studied the effect of groundnut in coconut gardens?

**Ans:** Groundnut is not considered as a green manure crop.