RHIZOSPHERE MICROFLORA IN CROP-MIXED COCONUT SOIL

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ABSTRACT

A study conducted at the Central Plantation Crops Research Institute (CPCRI), Kasaragod, India on the rhizosphere microflora of coconut intercropped with perennial spice crops viz. cinnamon, nutmeg and clove has shown that there is qualitative and quantitative shift in the fungal and bacterial flora of the intercropped coconut when compared to that of monoculture. Rhizosphere of the coconut becomes obviously richer quantitatively and qualitatively in fungal flora when intercropped with tree spices indicating a trend of positive complimentation. In the case of the bacterial population, though there has been a decrease in the total population, the fraction of nitrogen fixers and phosphate solubilizers recorded increases. This may be due to the disturbance caused by the introduction of new crops into the coconut garden and it would be worthwhile to study the system periodically to know the trend of population shift till it reaches equilibrium.

INTRODUCTION

The concept of crop mixing is gaining wide popularity with the coconut cultivators of Kerala. At CPCRI, Kasaragod an experiment, Agr. IV (231) is in progress to study the profitable utilization of the large number of annuals, biennials and perennials as inter-mixed crops. Perennial crops, when thus grown, emanate lingering mutual interactions. In the rhizosphere this results in quantitative and qualitative changes of the microflora. Earlier, attempts have been made to study such effects with intercrops like cacao and fodder grasses (Nair and Rao, 1970; Potty and Jayasankar, 1976). The present study has been taken up to register the microbial status of the coconut rhizosphere when intercropped with perennial spices viz. cinnamon, nutmeg and clove. This work is significant because these tree spices supply some of the important export commodities of the country.

MATERIALS AND METHODS

Soil sample

Premonsoon soil samples from a coconut garden intercropped with tree spices from the experimental block Agronomy IV (231) were collected last January 6, 1977. Soil samples were collected from a depth of 50 cm and a lateral distance of 1 m from the hole. One composite sample per tree made by pooling samples of each quarter was collected. The soil type was red, sandy loam. Samples were collected from basins of the intercrops in a similar fashion, but the lateral distance was kept at 50 cm. For control, similar samples from a coconut monoculture situated nearby were collected. Five samples/treatment were subjected to analysis.

The roots, along with the soil adhering to them, were stored in the freezer compartment of a refrigerator for use in the microflora study.

The rest of the soil was air-dried for estimating the pH, organic matter content, available phosphorus and potash.

Moisture estimation

The soil sample was transferred to a preweighed soil moisture can and the moisture estimation was done by the gravimetric method.(Anon. 1974).

Acidity

The pH of a 1:2 soil-water suspension (5 g of sample soil mixed with 10 ml deionised water, stirred and kept for .5 hr) was determined using a Beckman model pH meter.

Organic matter

Organic matter was estimated by the colorimetric method outlined by Dutta et al. (1962).

Phosphorus and potassium

Available P (Bray 1) was estimated using the method of Bray and Kurtz (1945) while available K was estimated using N ammonium acetate method of

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Stanford and English (1949).

Enumeration of bacteria

For studying the bacterial population, dilution plating method (Potty and Jayasankar, 1976) was followed. Roots were gently tapped to shake off the loosely adhering soil. Tiny bits (0.5 – 1 cm) were cut and immersed in sterile water (10 ml) columns. These were thoroughly shaken and serial dilutions were prepared for plating. From the tubes containing the roots, bits were removed and the water evaporated to find out the weight of soil that has been suspended. Dilutions were plated on the solid soil agar (Lockhead and Thexton, 1947) in petri dishes and were spread by glass spatula. Plates were incubated in inverted positions under room temperature. After 48 hr these were replated on the Sperber's agar (1958) and mannitol agar to detect phosphate solubilizers and nitrogen fixers, respectively. The replicator was fashioned by stretching a sterile velvet pad over a circular plastic hairbrush with a handle. Bacterial count was taken after 48 hr. Representative colonies were isolated and purified by repeated plating and single colony isolation on nutrient agar. Purified cultures were maintained on nutrient agar slants with the bacterial growth fully submerged in sterile paraffin.

Enumeration of fungi

Soil adhering to the root was shaken loose and collected and small weighed amounts were plated onto Martin's Rose Bengal agar by the Warcup (1950) direct plating method. Phosphate solubilising organisms were replated into Sperber's agar by replica plating technique.

RESULTS AND DISCUSSION

The information of moisture, organic matter content and available nutrient status (Table 1) was collected to supplement the data on bacteria and fungi. When subsequent surveys are conducted, these information would be of use in studying their influence on the population dynamics of the soil flora. The present data relate to the premonsoon period.

Studies on bacteria (Table 2) reveal that the total bacterial count is less in crop-mixed coconut soils compared to that of the rhizosphere of the spices as well as that of pure coconut stand. This may probably be due to the fact that introduction of the new crops has

Table 1. Soil analysis data

Crop	Moisture (%)	pH	Organic matter (%)	Available P (ppm)	Available K (ppm)
	Average (range)	Average (range)	Average (range)	Average (range)	Average (range)
Coconut pure stand	8.8 (8.5-9.4)	5.1 (4.0-5.2)	0.75 (0.59-0.79)	415 (77-606)	40.0 (29-52)
Intercrop cinnamon rhizo	8.6 (8.5-8.7)	5.4 (4.8-6.3)	0.628 (0.59-0.69)	86 (61-96)	37.4 (21-52)
Intercrop nutmeg rhizo	8.1 (7.3-8.5)	5.3 (5.1-5.6)	0.626 (0.45-0.81)	51 (31-70)	16.2 (11-27)
Intercrop clove rhizo	7.9 (7.3-8.5)	4.7 (4.5-4.8)	0.63 (0.58-0.67)	44 (39-48)	45.0 (41-53)
Coconut rhizo when intercropped with cinnamon	9.4 (8.9-11.4)	5.2 (5.1-5.4)	0.70 (0.49-1.04)	143 (100-182)	50 (38-86)
Coconut rhizo when intercropped with nutmeg	8.6 (8.0-9.3)	4.8 (4.6-5.7)	0.63 (0.42-0.92)	110.6 (90-129)	43.4 (36-64)
Coconut rhizo when intercropped with clove	8.6 (7.7-9.3)	4.8 (4.5-5.0)	0.656 (0.53-1.00)	86 (64-101)	62 (39-81)

Table 2. Rhizosphere bacteria

Source (crops)	Total No. bacteria (per gm soil)	Phosphate solubilizers	Nitrogen fixers
Coconut pure stand	1,940,000	173,333	226,000
Intercrop cinnamon rhizo	1,620,000	538,000	728,000
Intercrop nutmeg rhizo	1,435,000	350,000	531,000
Intercrop clove rhizo	810,000	134,000	98,000
Coconut rhizo when intercropped with cinnamon	855,000	273,900	396,500
Coconut rhizo when intercropped with nutmeg	215,000	10,000	180,000
Coconut rhizo when intercropped with cloves	361,700	156,700	143,000

caused an imbalance in the microbial equilibrium. However, the data reveal that the populations of the nitrogen fixers and phosphate solubilizers are on the increase in the rhizosphere of intercropped coconut. Lockhead and Thexton (1947) have shown that bacteria which are able to utilize inorganic nitrogen and amino acids are stimulated in rhizospheres, while those requiring hormones or growth factors are stimulated to a much lesser degree. Periodical sampling and study of these soils alone can give the final picture as to when the host-microbe interactions attain equilibrium. This experiment provides an ideal system for such studies. In addition, effect of seasonal changes which may affect the soil properties and thus the microflora is also worth investigating.

In the case of fungi, it is apparent from Table 3 that quantitatively, the fungal microflora are more abundant in the rhizosphere of the spice crops than that of coconut. When spice crops are grown as mixed crops, the status of the coconut rhizosphere shows improvement. Qualitatively also, coconut rhizosphere is better when crop-mixed with cinnamon or nutmeg, pointing towards a positive complimentation. The added enhancement in the cinnamon mixed coconut plot may be due to the fact that cinnamon is better established than the

Table 3. Rhizosphere fungal flora

Source (crops)	No. of colonies per gram	Species of fungi isolated
Coconut	156	**Aspergillus niger, *Trichoderma viridae, *A. candidus, A. fumigatus, Penicillium brefeldianum*
Cinnamon	869	**A. candidus, A. fumigatus, *P. nigricans, P. verruculosum, *Trichoderma viridae,*
Nutmeg	5120	**A. fumigatus, *A. niger, *P. brefeldianum, P. frequentens, Trichoderma viridae*
Clove	1645	**A. niger, *Trichoderma viridae and an* unidentified Basidiomycete
Coconut + cinnamon	418	*Monascus ruber, *Penicillium javanicum, *A, niger, A. fumigatus, *P. implicatum, Paecilomyces lilacinus *A. foetidus, *P. nigricans, *A. fumigatus, *Trichoderma viridae*
Coconut + nutmeg	600	**A. candidus, *A. niger, *A. flavus, Fusarium solani, P. brefeldianum, P. javanicum, *P. verruculosum, Trichoderma viridae*
Coconut + clove	1085	**A. niger, *A. foetidus, *Trichoderma viridae*

*Fungi having phosphate solubilizing action

other two crops. Here again, periodical sampling till these spice crops grow fully, shall reveal the extent of complimentation the spice crops may afford to coconut and vice versa. Rhizosphere microbiological studies on monoculture spice crops (not grown as intercrops) would also be rewarding in understanding the nature of mutual interaction.

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