



Lib.

ROOT INFESTION AND POPULATION DENSITY OF VA
CORRHIZAL FUNGI IN A COCONUT BASED
MULTISTOREYED CROPPING SYSTEM

C. R. RAMESH

Central Plantation Crops Research Institute,
Kasaragod-670 124, Kerala.

Reprinted from: PLACROSYM-V ; 1982 : pp. 548-554
Proceedings of the Fifth Annual Symposium on Plantation Crops,
held at CPCRI, Kasaragod in Dec. 15-18, 1982.
Sharada Press, Mangalore-575 005
November, 1984

ROOT INFECTION AND POPULATION DENSITY OF VA MYCORRHIZAL FUNGI IN A COCONUT BASED MULTISTOREYED CROPPING SYSTEM*

C. R. RAMESH

Central Plantation Crops Research Institute,
Kasaragod-670 124, Kerala

ABSTRACT

Spores of vesicular-arbuscular (VA) mycorrhizal fungi were found in all the soil samples collected from the root zones of plants forming a coconut-based multistoreyed cropping system, namely coconut, cacao, cinnamon and black pepper. Their numbers ranged widely from plant to plant (8-420 spores/100 g soil) and varied remarkably from sample to sample of the same crop. Of the eight species found, *Gigaspora gigantea*, *G. gilmorei*, *Glomus fasciculatus* (clusters), and *G. macrocarpa* were most common, *G. microcarpa* and a flat unidentified spore type were less frequent, whereas *Sclerocystis* sp. and a white unidentified spore type were rare. Usually more than two VA species occurred at the root zone of each crop. Root samples of all the hosts showed extensive infection (80-98%) with internal and external hyphae, and characteristic vesicles and arbuscules.

INTRODUCTION

Fungi of the family Endogonaceae, which form vesicular-arbuscular (VA) mycorrhizae, occur in most cultivated soils throughout the world (Gerdemann, 1968; Hayman, 1978). Their agricultural importance results mainly from their efficiency in nutrient mobilisation and stimulation of crop growth in poor soils. (Mosse, 1973; Tinker, 1975, 1982). Since their population varies greatly in size and species composition (Hayman 1978), ecological studies are fundamental to considerations on the possibilities of increasing the indigenous population or introducing more efficient species or strains (Mosse, 1973) into a field or plantation with a view to improving yield.

Many of the tropical agricultural systems are unique in that they involve plants growing together rather than in monocultures

*CPCRI Contribution No. 249.

which dominate temperate farming. A concept of high intensity cropping system in coconut stands has been conceived and the differences in multiple cropping practices in field and plantation crops with regard to maximum utilisation of solar energy and soil resources have been worked out (Nelliath, 1973; Nelliath *et al.*, 1974; Bavappa and Jacob, 1982). The present study assesses the population of resting spores of VA fungi in relation to a coconut-based multi-storeyed cropping system and to differences in the mycorrhizal infectivity of the crops involved.

MATERIAL AND METHODS

Soil samples, comprising several bulked subsamples were collected from the top 15 and 30 cm (coconut) and 15 cm (cacao, cinnamon and black pepper) of soil in the root regions of coconut, cacao, cinnamon and black pepper in a coconut based multistoreyed cropping system laid out at CPCRI, Kasaragod (Nelliath *et al.*, 1974). For each crop, 10 bulked samples were collected during early summer with the help of a soil augur 1m away from the bole of the coconut palm and 15 cms away from the main stem of other plants. Coconut was planted in a square system 9.6 m apart, pepper was trained on coconut palm, while cacao and cinnamon were planted in single or double hedge (Nelliath *et al.*, 1974).

Recovery of spores: After thorough mixing, 100g of air-dried soil sample was wet sieved (Gerdemann and Nicolson, 1963) through 106 and 250µm sieves. The sievings were suspended in distilled water and recovered on filter paper discs following the procedure described by Sutton and Barron (1972). The filter paper discs were observed under a stereomicroscope and the spores were retrieved. The spore counts were calculated per 100 g of dry soil.

Root infection: To determine the extent of root infection in the host plants, root samples, bulked from 20 samples for each host plant were cut into 1cm bits, fixed in acetic alcohol (1:3), cleared in 10% KOH, and stained in 0.5% trypan blue in lactophenol. The extent of root infection was determined following the technique described by Ambler and Young (1977).

Identification of Endogonaceae species: The Endogonaceae spores recovered from the soils were identified using the keys for

identification given by Gerdemann and Trappe (1974), and by several other authors (Becker and Hall, 1976; Nicolson and Schenk, 1979; Trappe 1977).

RESULTS AND DISCUSSION

Table 1 shows the wide distribution of VA mycorrhizal fungi in different components of the multistoreyed cropping system. Spore numbers varied from crop to crop (8-420 spores/100g soil) and even for the same crop. In pepper, the unidentified flat spore type was found only in five samples out of the ten showing discontinuous occurrence for the same crop. In coconut, flat spore type was found only in two samples taken at 15 cm depth. Eight species of Endogonaceae were found, of which *Gigaspora gigantea*, *G. gilmorei*, *Glomus fasciculata* (clusters), and *G. macrocarpa* were the most common. *Glomus microcarpa* and the unidentified flat spore type occurred frequently, whereas *Sclerocystis* and the white unidentified type were rare. More than two species were associated with each host plant.

Root segments of all the crops analysed showed colonization by VA mycorrhizal fungi with characteristic arbuscules and vesicles. The extent of root infection ranged from 80-98% between crops. No difference in the extent of root infection was noticed within the crop. However, the number of arbuscules was very few or even absent in root samples of cacao.

The present study reveals the variability of the VA mycorrhizal population in the coconut based multistoreyed cropping system. Similar results have been reported in natural communities like rain forests, savannah lands and sand dunes (Crush, 1974, Hall, 1978; Powell, 1976; Koske, 1981). Population levels of dominant species such as *Gigaspora gilmorei*, *G. gigantea*, *Glomus fasciculata* and *G. macrocarpa* did not show any significant variation within the same crop. However, the difference in population levels between the crops may be due to the effect of the host on spore production (Crush, 1974). Colonization of the host root to the extent of 80-98% may be attributed to the perennial nature of the hosts, where the spores produced will have immediate access to fresh roots, and subsequent spread takes place. The knowledge of the

Table 1. VA mycorrhizal populations (mean values of 10 samples bulked for each host) associated with four hosts in a coconut-based multistoreyed cropping system

Crop	VA species ¹ and spore No. ²							
	GG	GGL	GMA	GMI	Flat	Wh	SR	GFS
Coconut	110 (98)*	204 (177)	380 (325)	23 (19)	14 (6)	—	—	57 (34)
Cacao	63.6	63	230	—	20	11	—	53
Cinnamon	66	60	165	—	—	—	17	54
Pepper	52	52	246	17	12	—	—	42

¹*Gigaspora gigantea* (GG); *Gigaspora gilmorei* (GGL); *Glomus macrocarpa* (GMA), *Glomus microcarpa* (GMI); Flat unidentified; Wh, white unidentified; *Sclerocystis* (SR); *Glomus fasciculata* (GFS)

²Number of spores/100 g of dry soil

*Figures in parentheses denote spore no. at 15 cm depth.

species of the endophyte present may be valuable in view of the differences in efficiency reported among endophyte species (Mosse, 1973) and this could facilitate the choice of a VA inoculum. The spore population studies add further dimension to mycorrhizal ecophysiology wherein maximum productivity and stability of mixed communities are considered. The lack of general relation between the size of a spore population and the mycorrhizal infection of the host can be attributed to the presence of non-sporing endophytes (Powell, 1977) or the interaction between mycorrhizal species (Koske, 1981). Mycorrhizal fungi are hard to distinguish morphologically inside the root tissue, and hence it is difficult to estimate how many (if any) non-sporing strains are present in soil. Suggestions of interactions between different species of VA fungi occurring on the same species of host plants are found in the data of some investigators (Cooper, 1976; Hayman and Mosse, 1979; Krukelman, 1975; Mosse, 1975, 1977; Mosse and Hayman 1971; Powell 1977, 1979). Proportion of spore populations may differ with different hosts also. Hence, the present study would open up new areas for studies on interaction between VA fungi in such cropping systems where in the nutrient demands of two or more species growing together concurrently are usually considerably in excess of those of a single species and a competitive situation often occurs. Any theoretical treatment or experimental study of competition for limited soil nutrients must necessarily include mycorrhizal systems. Another consideration in multiple cropping is the mycorrhizal response to shading of one crop by another. Decreasing light intensity is known to reduce mycorrhizal development and mycorrhizal response with VA mycorrhizae.

ACKNOWLEDGEMENT

The author wishes to express his thanks to Dr. K. V. Ahamed Bavappa, Director, and Dr. KKN Nambiar, Head, Division of Plant Pathology, Central Plantation Crops Research Institute, Kasaragod, for their interest in the study.

REFERENCES

- AMBLER, J. R. AND YOUNG, J. L. 1977. Techniques for determining root length infected by vesicular arbuscular mycorrhizae. *J. Soil Sci. Soc. Amer.* **41**: 551-556.
- BAVAPPA, K.V.A. & JACOB, V. J. 1982. High intensity multi-species cropping. *World Crops*, **34**: 47-50.

- BECKER, W. N. AND HALL, I. R. 1976. *Gigaspora margarita* a new species in the Endogonaceae. *Mycotaxon*, 4: 155-160.
- COOPER, K. M. 1976. A field survey of mycorrhizas in New Zealand ferns. *New Zealand J. Bot.*, 14: 169-181.
- CRUSH, J. R. 1974. Plant growth responses to vesicular arbuscular mycorrhizae, VIII. Growth and nodulation of some herbage legumes. *New Phytol.*, 73: 743-749.
- GERDEMANN, J. W. 1968. Vesicular-arbuscular mycorrhizae and plant growth. *Ann. Rev. Phytopathol.*, 6: 397-418.
- GERDEMANN, J. W. AND NICOLSON, T. H. 1963. Spores of mycorrhizal endogone species extracted from soil by wet sieving and decanting. *Trans. Br. mycol. Soc.*, 46: 235-244.
- GERDEMANN, J. W. AND TRAPPE, J. M. 1974. Endogonaceae in the Pacific North-West. *Mycol. Mem.*, 5: 1-76.
- HALL, I. R. 1978. The effects of mycorrhizae on the competitive ability of white clover. *New Zealand J. agric. Res.* 21: 509-518.
- HAYMAN, D. S. 1978. Endomycorrhizae. In: *Interactions between non-pathogenic soil microorganisms and plants*. Ed: Y. R. Dommergues & S. V. Krupa, pp. 401-442.
- HAYMAN, D. S. AND MOSSE, B. 1979. Improved growth of white clover in hill grasslands by mycorrhizal inoculation. *Ann. Appl. Biol.*, 93: 141-148.
- KOSKE, R. E. 1981. A preliminary study of interaction between species of vesicular-arbuscular fungi in a sand dune. *Trans. Br. mycol. Soc.*, 76: 414-416.
- KRUCKELMANN, H. W. 1975. Effect of fertilizers, soils, soil tillage and plant species on the frequency of endogone chlamydospores and mycorrhizal infection in arable soils. In: *Endomycorrhizas*, E. E. Sanders, B. Mosse and P. B. Tinker (Eds.) Acad. Press, London, pp. 512-525.
- MOSSE, B. 1973. Advances in the study of vesicular-arbuscular mycorrhiza. *Ann. Rev. Phytopathol.*, 11: 171-196.
- MOSSE, B. 1975. Specificity in VA mycorrhizas. In: *Endomycorrhizas*. P. E. Sanders, B. Mosse, and P. B. Tinker, Eds. Academic Press, London pp. 468-484.
- MOSSE, B. 1977. Plant growth responses to vesicular arbuscular Mycorrhiza. X. Response of *Stylosanthes* and maize to inoculation in unsterile soils. *New Phytol.* 70: 279-248.
- MOSSE, B. AND HAYMAN, D. S. 1971. Plant growth responses to vesicular arbuscular mycorrhiza. II. In unsterilised field soils. *New Phytol.*, 70: 29-34.
- NELLIAT, E. V. 1973. Multiple cropping or multistoreyed cropping in plantation crops. *J. Plant. Crops (Suppl.)*, 1: 204.
- NELLIAT, E. V., BAVAPPA, K. V. A., AND NAIR, P. K. R. 1974. Multistoreyed cropping: A new dimension in multiple cropping for coconut plantations. *World Crops*, 26: 262-266.

- NICOLSON, T. H. AND SCHENCK, N. C. 1979. Endogonaceous mycorrhizal endophytes in Florida. *Mycologia*, **71**: 178-198.
- POWELL, C. L. 1976. Mycorrhizae in hill country soils, I. Spore-bearing mycorrhizal fungi in thirty seven soils. *New Zealand J. agric. Res.*, **20**: 53-57.
- POWELL, C. L. 1977. Mycorrhizas in hill country soils. II. Effect of several mycorrhizal fungi on clover growth in sterilized soils. *New Zealand J. agric. Res.*, **20**: 59-62.
- POWELL, C. L. 1979. Spread of mycorrhizal fungi through soil. *New Zealand J. agric. Res.*, **22**: 335-339.
- SUTTON, J. C. AND BARRON, G. L. 1972. Population dynamics of endogone spores in soil. *Can. J. Bot.* **50**: 1909-1914.
- TINKER, P.B.H. 1975. Effects of vesicular-arbuscular mycorrhizae on higher plants. *Symp. Soc. exp. Biol.*, **29**: 325-349.
- TINKER, P.B.H. 1982. Mycorrhizae: The present position. *Trans. 12th Intern. Cong. Soil. Scientists*, **5**: 150-166.
- TRAPPE, J. M. 1977. Three new endogonaceae: *Glomus constictus*, *Sclerocystis clavispora* and *Acaulospora scrobiculata*. *Mycotaxon* **6**: 359-363.