

## Early Establishment of Native Vesicular-Arbuscular Mycorrhizas in Three Vegetable Crops of South India - A Comparative Study

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### ABSTRAK

Status mikroiza resrikula-arbuskula, (VAM) tiga tanaman sayuran seperti tomato, terung dan cili dinilai semasa tempoh awal pertumbuhan dalam keadaan kawasan semulajadi dan juga dalam bekas kultur yang menggunakan tanah tak-steril. Tanah tersebut mempunyai status nutrien yang rendah dan tiada pembajaan semasa 60 d kajian dibuat. Pengkolonian fungi VAM dalam akar adalah maksimum pada 45, 50, dan 60 d selepas percambahan setiap benih terung, tomato dan cili di bawah keadaan padang, dan atas d ke 60 dalam percubaan kultur bekas. Jika tiada masalah, 100 peratus pengkolonian akan diperolehi. Kenaikan dan penurunan arah aliran dalam pengkolonian ini adalah diawasi. Dalam semua kes, bilangan spora asal 3.90 ( $\pm 0.30$ ) g tanah kering ternyata meningkat dalam tanah rizosfera selepas pertumbuhan tanaman. Jumlah spora lebih nyata dalam bekas daripada yang di kawasan lapang.

### ABSTRACT

The vesicular-arbuscular mycorrhizal (VAM) status of three vegetable crops viz., tomato, brinjal and chilli was assessed during the initial establishment period in natural field conditions as well as in pot culture using non-sterile soil. The soil had low nutrient status and no manurial application was made during the 60 d course of the study. VAM fungal colonization in the roots was maximum at 45, 50, and 60 d after the respective germination of brinjals, tomato and chilli seeds under field conditions, and on the 60th d in the pot culture experiment. In no case was 100 per cent root colonization obtained. Ascending and descending trends in colonization were observed. In all cases, the original spore count of 3.90 ( $\pm 0.30$ ) g dry soil increased markedly in the rhizosphere soil after plant growth. Spore number was more pronounced in pot than in field culture.

### INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.), brinjal (*Solanum melongena* L.) and chilli (*Capsicum annuum* L.) are the most widely accepted vegetable crops in South East Asia. Investigations on different aspects of vesicular-arbuscular mycorrhizal (VAM) association with these three popular members of Solanaceae have been carried out by several workers (Sanni 1976; Dehene and Schonbeck 1979; Bagyaraj and Sreeramalu 1982; Sreeramalu and Bagyaraj 1986; Ramachandra and Rai 1987). Bagyaraj and Sreeramalu (1982) observed that preinoculation with VAM fungi would

improve growth and yield of chilli. It is well established that the VAM fungi will manifest their performance to a greater extent in nutrient-deficient or low nutrient status soil (Daft and Nicolson 1966; Mosse 1973; Abbott and Robson 1982). However, the study of VAM fungal infectivity, especially in the early period of growth of these three crops in nutrient deficient soils, has seldom been reported. This study aimed to elucidate VAM fungal infectivity of tomato, brinjal and chilli plants in their early period of establishment in N and P deficient soil, without adding any manure, in both field and pot cultures using non-sterile soil.

TABLE 1  
Physico-chemico properties of soil used in this study

Nature	Moisture content (%)	pH	ECse	(kg/hectare <sup>-1</sup> *)						
				N	PO	KO	Zn	Fe	Cu	Mn
Sandy loam	16.50	7.20	0.20	225 (9.00)	22.50 (0.90)	780 (31.20)	0.20 (0.08)	0.78 (1.00)	25 (0.03)	22.50 (0.90)

\* Figures in parentheses are values in mg kg<sup>-1</sup> soil sample

## MATERIALS AND METHODS

### Field Experiment

The experiments were carried out in N and P deficient alluvial deposits of sandy loam (Table 1) in Bharathiar University campus, Coimbatore. The soil contained VAM fungal spores predominantly of *Acaulospora bireticulata*, Rothwell and Trappe, *A. sporocarpium*, Berch, *Glomus deserticola* Trappe, Bloss and Menge, *G. fasciculatum* Gerdemann and Trappe, *G. geosporum* Nicolson and Gerdemann and *Sclerocystis pakistanica* Iqbal and Bushra, with an average spore count of 3.90 (10.30) g<sup>-1</sup> dry soil. Seeds of tomato cv. Co.1, brinjal cv. RR and chilli cv. K were sown in the field, in the normal planting season (monsoon) of June 1992 without any fertilizer but watered regularly. Five hundred seeds were sown per bed each measuring 2 x 0.5 metre, where three complete randomized beds were maintained for each crop in the open field. Ten randomly selected seedlings per crop were carefully removed from the planting beds, from the first day of germination up to 60d at 5-day intervals. VAM colonization was assessed after staining the root samples following the method of Phillips and Hayman (1970) and using the scoring method of Edathil *et al.* (1994). For every sampling, 100 root pieces (10 pieces of young branches from each seedling) measuring 1 cm each were assessed for VAM colonization and the mean value was expressed in percent colonization. The mycorrhizal spore density was estimated using the modified wet-sieving and decanting method (Gerdemann and Nicolson 1963). VAM fungal species were identified by means of morphological characteristics of the spores and sporocarps using the synoptic keys (Hall 1984; Schenck and Perez 1987; Morton 1988). The number of VAM fungal spores in the soil before sowing the seeds and after the completion of the ex-

periment were estimated. Spore count was made on 100g dry soil and recorded as number of spores g<sup>-1</sup> soil. Each treatment was replicated four times.

### Pot Culture Experiment

Five seeds per crop were sown in pots of 18 cm diameter filled with 6 kg field soil. A total of 140 pots were used for each crop. No fertilizer was added and the pots were maintained under natural light and watered regularly. After germination, seedlings were thinned to one seedling per pot. Ten randomly selected seedlings were carefully removed each time and VAM colonization was assessed at 5-day intervals from day 1 to day 60 after germination. The number of VAM fungal spores in the soil, before and after the experiment, was also determined.

## RESULTS

Under field conditions, tomato and brinjal seeds germinated on day 8 after sowing while chilli seeds germinated on day 13. Percent root colonization of tomato roots on day one was 24.6 (±5.3)%, brinjal 15.75 (±1.5)% and chilli 18.63 (±3.86)%. In all the three crops, arbuscules or vesicles were readily observed from day 5 onwards until the end of the study (60 d). For tomato VAM colonization was maximum (97.5 ± 0.98%) on day 50 after germination and declined thereafter. In brinjal peak colonization was observed on day 55 after germination (87 ± 2.94%). In the case of chilli the peak was attained on day 60 (97.7 ± 1.07%) (Fig. 1).

In pot culture, seeds of tomato and brinjal germinated on day 5 after sowing, and on day 8 for chilli. Percentage root colonization on the day after germination was: in tomato 10.55 (±1.74)%, brinjal 8.54 (±2.89)% and chilli 3.42 (±0.90)%. In pot culture, arbuscules and vesicles

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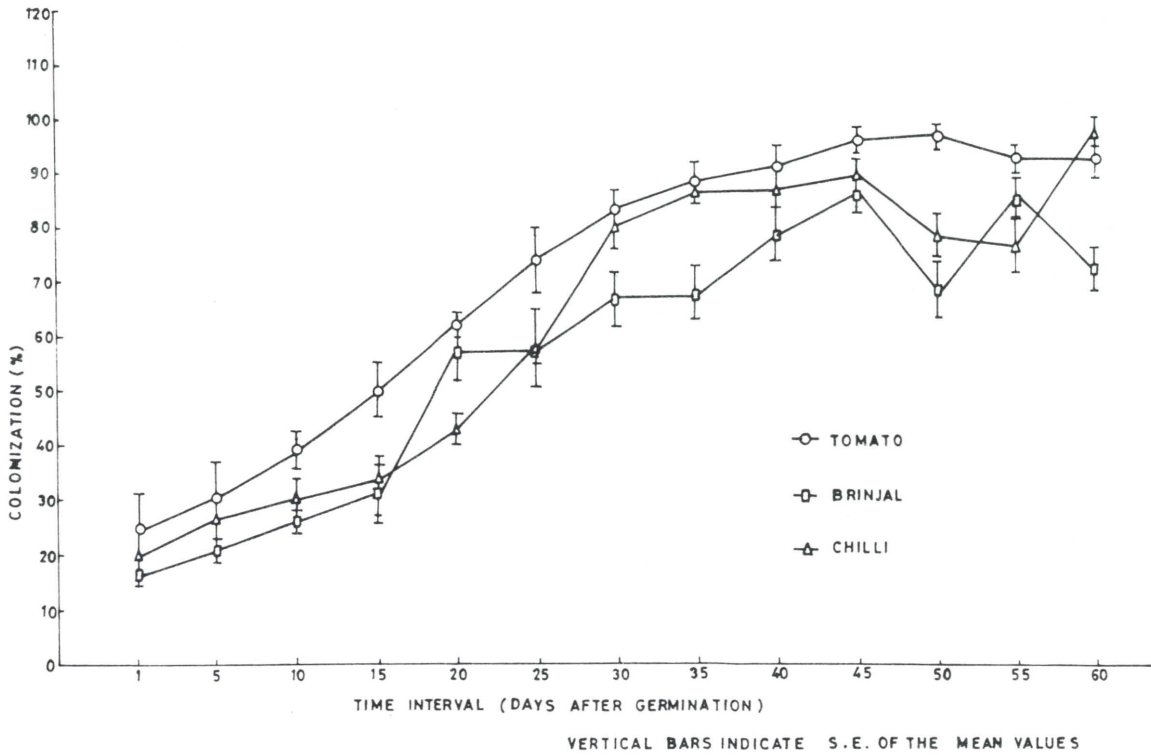


Fig. 1: VAM colonization in various time intervals of plant growth in the field

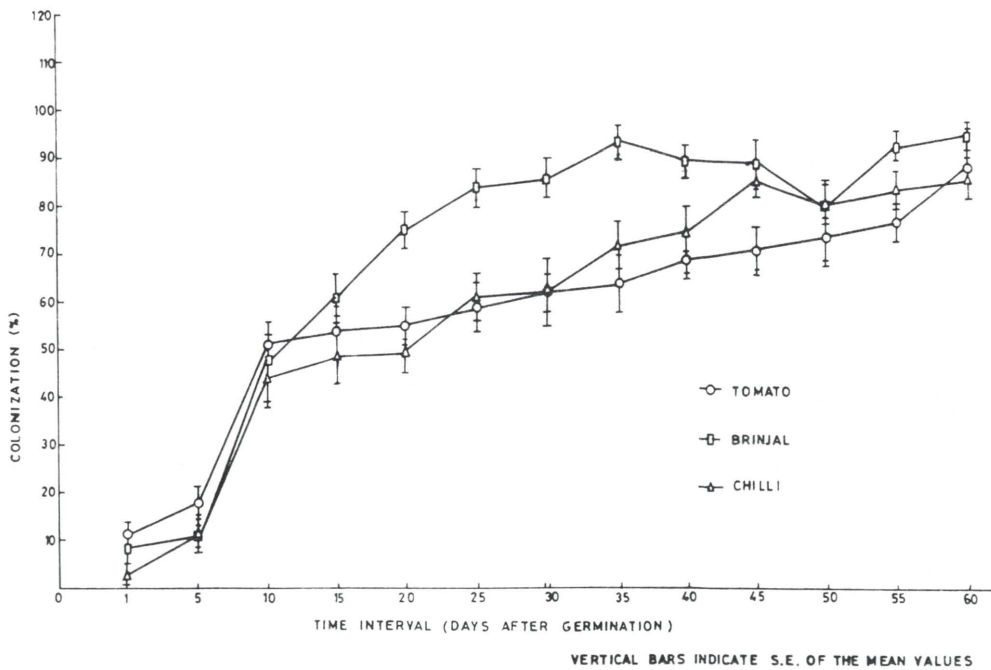


Fig. 2: VAM colonization in various time intervals of plant growth in pot culture

were only visible on day 5 after germination of tomato roots. These structures were uniformly observed later in all the three crops till the end of the experiment (60d). The highest VAM colonization was seen on day 60 in tomato 87.8 ( $\pm 2.54$ ), day 35 to 60 in brinjal 96.1 ( $\pm 1.39$ )% and day 45 to 60 in chilli 87.4 ( $\pm 3.47$ )%. The decline in VAM colonization was only seen on day 35 in brinjal and on day 45 in chilli (Fig. 2). Spore number was seen to increase invariably in the rhizosphere soil in both experiments (Table 2). Spore number in the pot experiment was higher than in the field experiment.

TABLE 2  
Population of VAM spores before and after plant growth

	Pre-growth count		Post-growth count	
	(Spore g <sup>-1</sup> Soil)		(Spore g <sup>-1</sup> Soil)	
	Field and Pot		Field	Pot
Tomato	3.90 ( $\pm 0.30$ )	16.10 ( $\pm 0.98$ )	52.25 ( $\pm 3.98$ )	
Brinjal	3.90 ( $\pm 0.30$ )	9.81 ( $\pm 0.80$ )	63.86 ( $\pm 3.14$ )	
Chilli	3.90 ( $\pm 0.30$ )	26.59 ( $\pm 1.48$ )	43.21 ( $\pm 1.19$ )	

Figures in parentheses denote mean S.D.

## DISCUSSION

Endophytes spread much faster in some plant species than in others and their final infection level may vary considerably (Hayman 1983). Even with optimum host-endophyte combinations 100% infection is never achieved. This is exemplified by the plants in both field and pot cultures not attaining 100% colonization. Sutton (1973) has pointed out that strongly mycorrhiza dependent plants like onions, grown in pots, often reach a maximum of 80% root length infection. He observed the same trend under field conditions, with a final infection ranging from 48-84%. Several reasons have been advanced for these observations. Root compatibility is one of the factors in many host endophyte combinations; the compatibility may be such so as to prevent widespread infection even after the establishment of the fungi in the roots. Also, within the root system of a strongly mycorrhiza-dependent plant,

some roots may not be in a physiologically receptive state, resulting in infections only in the feeder rather than in the main roots (Hayman 1983). This could probably explain the time difference observed in attaining peak colonization in the three crops studied in the field. This difference was not obvious in pot culture in the greenhouse, as conditions were more uniform. Although the seeds under pot cultures germinated earlier than those in the field, probably due to high temperature and humidity, VAM structures were produced later.

In comparison with the observation of Sutton (1973) we obtained a high percent VAM colonization in all the three plants tested (85 to 95%). Under natural (unsterile) conditions the possibility of multiple root infection with many VAM fungal species cannot be ruled out. Edathil *et al.* (1994) observed that percentage VAM colonization increased when a higher number of VAM fungal species infected the host simultaneously. Infection of the plant with more than one endophyte species normally does not cause any antagonism between them (Abbott and Robson 1978). Ross and Ruttencutter (1977) observed higher infection in peanuts and soybean when inoculated with *Glomus* and *Gigaspora* simultaneously than when inoculated with *Glomus* alone. It is relevant to note that efficient mycorrhizal fungi have stimulated plant growth in unsterilized pots (Mosse *et al.* 1969; Abbott and Robson 1977; 1978;) and in the field (Khan 1972; Black and Tinker 1977); Hayman and Mosse 1979; Powell *et al.* 1980). In pot culture the root growth stops or slows down as a result of root saturation due to limited space. This could be attributed to high spore production as observed in the study. Another possibility for increased spore production in the pots was the presence of more moisture in pot than in field soil. This will indirectly reduce a plant's dependence on mycorrhiza; hence the VAM fungi may resort to the production of a large number of spores (Redhead 1975; Barathakumar 1990).

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