accomplishment of germination and directional pollen tube growth. This is being investigated.

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Occurrence and distribution of arbuscular mycorrhizal fungi in coastal sand dune vegetation of Goa

Coastal sand dunes are of great ecological significance. They act as barriers against the action of waves and tides[1]. Dune vegetation helps in the formation and stabilization of sand dunes. The beaches of Goa are famous for scenic beauty. The dimensions of tourism development on the beaches are surely affecting the dune system and any further damage to the fragile dune system will cause disaster by erosion or accretion of the coastal belt. Arbuscular mycorrhizal (AM) fungi play a very important role in dune stabilization, uptake of water and nutrient by plants and binding sand grains[2]. Mycorrhizal plants are effective colonizers of disturbed habitats and the lack of mycorrhizal fungi exerts profound influence on species composition[3]. Through close mutual interaction between plants and soil organisms these ecosystems create conditions that allow the systems to persist. Severing the close links between plants and soil has contributed to degradation of many ecosystems and restoring these links is an important step towards rehabilitation[4]. Since native AM fungal flora is well adapted to the conditions of its natural occurrence due to its long process of evolution, it can be of immense use for various plants compared to exotic AM species. The understanding of mycorrhizal association with dune plants and their distribution in the soil is necessary for wise management of fragile habitats.

The present study represents an attempt to establish the qualitative and quantitative distribution of AM fungal spores in sand dune vegetation. The study was taken up in one of the smallest states of India, Goa, situated along the west coast of India lying between latitude 15°48′00″ and 14°43′54″N and longitude 74°20′13″ and 73°40′33″E (ref. 1). The coast is approximately 120 km in length. Colva beach, a famous tourist site located in south Goa, was selected for the survey. Rhizosphere soil samples were collected from nine host plants, viz. *Achyranthus aspera* L., *Calotropis gigantea* R. Br., *Casuarina equisetifolia* Forst., *Cocos nucifera* L., *Fluggea* sp., *Hyptis suaveolens* Poit., *Ipomoea biloba* Forsk., *Lantana camara* L. and *Vitex trifolia* L. selected for the study. Samples were collected in March 1999.

Routinely three root zones of each plant were sampled at a depth of 0–25 cm. Soil samples collected from individuals of a species were mixed to form a composite sample. These composite soil samples were used for the enumeration of spores. Hundred grams of composite sample was assayed for spore count using wet sieving and decanting procedure[5]. Each composite sample was processed three times. Estimation of spore density was carried out according to the procedure given by Gaur and Adholeya[6]. Spores were mounted in polyvinyl alcohol-lacto-glycerol (PVLG), examined for their various characteristics and identified using the standard keys[7]. For soil analysis, rhizosphere soils of all the host plant species along with the sub samples were mixed to form a composite sample and this was analysed for pH, total N, total P and total K.

Physio-chemical properties of soil samples indicated that the soil was slightly alkaline (pH 7.6) with 0.04% total N, 0.016% total P, and 0.045% total K.

Average mean spore count was 725 spores + 15 sporocarps/100 g rhizosphere soil. Maximum mean spore density recorded was in *C. nucifera* (1156 spores + 60 sporocarps/100 g soil), followed by *C. equisetifolia* (864 spores + 4 sporocarps/100 g soil). Minimum mean spore density was observed in *L. camara* (408 spores + 16 sporocarps/100 g soil).

The AM fungal spores obtained belonged to the five genera, viz. *Acaulospora*, *Gigaspora*, *Glomus*, *Sclerocystis* and *Scutellospora*. The identified species of AM fungi include *Acaulospora bireticulata* Rothwell and Trappe, *A. scrobiculata* Trappe, *A. spinosa* Walker and Trappe, *Gigaspora coralloidea* Trappe, Gerdemann and Ho, *G. gregaria* Schenck and Nicol., *G. margarita* Becker & Hall, *Sclerocystis sinuosa* Gerdemann and Bakshi and *Scutellospora verrucosa* Walker and Sanders. *G. coralloidea* was found to be the most frequently occurring fungus (89%), followed by *S. verrucosa* (67%),

Table 1. Frequency distribution of AM fungi in selected host plants

AM fungi	*Vitex trifolia*	*Cocos nucifera*	*Ipomoea biloba*	*Fluggea* sp.	*Lantana camara*	*Achyranthes aspera*	*Casuarina equisetifolia*	*Hyptis suaveolens*	*Calotropis gigantea*	Frequency (%)
Acaulospora bireticulata	+	–	–	+	–	–	–	+	+	44
Acaulospora scrobiculata	+	–	–	–	+	–	–	–	+	33
Acaulospora spinosa	+	+	+	+	+	+	–	+	+	89
Gigaspora coralloidea	+	+	–	+	+	+	+	+	+	89
Gigaspora gregaria	–	–	–	+	–	–	–	–	+	22
Gigaspora margarita	–	+	+	+	–	–	–	+	–	44
Sclerocystis sinuosa	–	–	–	–	–	+	+	+	+	44
Scutellospora verrucosa	–	+	+	+	–	+	–	+	+	67

+ = Present; – = absent.

G. margarita and *S. sinuosa* (44%), (Table 1). Maximum number of AM fungal species was observed in root zone soil of *C. gigantea* (6 spp.) and least number of species was found in *C. equisetifolia* (2 spp.); (Table 1). Spores of *Acaulospora* sp. dominated the root zone soils of six selected host plants with percentage spore density/100 g soil ranging from 33 to 51%.

The coast of Goa has a beautiful stretch of sandy shores and beaches which attract a large number of tourists from home and abroad. A well-planned development of beaches is essential for the ecological importance of sand dune vegetation.

It is now widely accepted that AM fungi contribute significantly to plant growth and survival[8]. The prevalence of AM fungal propagules in temperate maritime sand dunes has also shown to contribute to the effectiveness of mycorrhizal plants as pioneer dune colonizers, thereby contributing to the stabilization of the sand dunes[9]. It is apparent that the mycorrhizal status of early successional plants is governed by AM fungal species availability, composition and inoculum (spores, external mycelia and mycorrhizal roots) potential.

Stabilization of disturbed ecosystems like coastal dunes is dependent upon successful establishment of the most effective plant community. As mycorrhizal plants serve this purpose, there is great potential for land reclamation programme in manipulating symbiotic association to accelerate the success of more desirable plants[10]. Our study shows the presence of rich diversity of AM fungi in the rhizosphere soils of coastal dune vegetation. *A. spinosa* and *G. coralloidea* are the most frequently occurring species. Successful revegetation would depend on selecting and maintaining these essential mycorrhizal fungi and developing methods to re-inoculate these fungi in disturbed beaches in south Goa.

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