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THE OCCURRENCE OF MYCORRHIZAS AND *ENDOGONE* SPORES IN THE RHIZOSPHERES OF PLANTS GROWING AROUND UNIVERSITY CAMPUS ISLAMABAD.

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Abstract

The incidence of mycorrhizas in the roots and *Endogone* spores in rhizosphere soil of 73 plants growing around University Campus Islamabad was investigated. Vesicular-arbuscular mycorrhizas were of general occurrence in all plants examined except the members of the families Amaranthaceae, Chenopodiaceae, Palmae, Zygophyllaceae, Nyctaginaceae, Oxalidaceae, Vitaceae, Celastraceae, Acanthaceae and Spindaceae. Ectotrophic mycorrhizas were found in *Nerium indicum, Mentha longifolia, Sida cordata, Buxus papilosa, Cleome viscosa,* and *Bramia monnri.* Ectoendomycorrhizas were found in the members of Oleaceae. Members of Euphorbiaceae showed intensive vesicular-arbuscular mycorrhizal infection in their roots. Most of the soil samples contained *Endogone* spores, including some from rhizospheres of non-mycorrhizal plants. Out of eight types of *Endogone* spores known to occur in soils of Pakistan, four types were recovered in the present study, the yellow vacuolate, non-endosporic type being predominant.

Introduction

Present information suggests that most of the plants growing under natural conditions, possess mycorrhizae, Relatively few are completely non-mycorrhizal, but some possess partially or sporadically infected root systems. Vesicular-arbuscular (V.A.) mycorrhizal fungi (*Endogone* spp.) have been reported on a number of plants ranging from Bryophyta to Angiosperms, which are usually not colonized by ectomycorrhizal fungi (Gerdemann, 1968).

Despite its ubiquitous occurence in most soils and its significance in plant nutrition, little is known about the distribution of *Endogone* and variations in the degree of development of VA mycorrhiza in different habitats. Khan (1974) made, a general survey for the occurence of mycorrhizas in halophytes, hydrophytes and xerophytes and of *Endogone* spores in their rhizosphere soils. In the present paper the occurrence of mycorrhiza and of *Endgone* spores in adjacent soil of plants growing around the Islamabad University campus, is described.

Material and Methods

Plants along with roots and some soil were collected from sandy loam, and rocks around the university campus. Most of the plants were collected from April to September. Care was taken not to break the thinnest roots because they are commonly the place where best development of endophytes occur. The plants were placed in large plastic bags and within 24 hr. roots were fixed in formalin-acetic acid-alcohol (5:5:90).

For mycorrhizal estimations, the fixed root segments were cleared in 10% KOH at 90°C for 30 mins to 1hr. and stained with 0.05% trypan blue in lactophenol

as described by Phillips & Haymann (1970). Twenty five root segments from each plant were examined on a dissecting microscope and percentage of infected root segments was recorded.

Endogone spores were recovered from the soil samples by floatation and adhesion technique (Sutton & Barron, 1972) and counted as described by Khan (1971). Three soil samples from around three plants growing on the same site were examined for each species.

Results

Types and numbers of Endogone spores.—The results are presented in Table 1. Three types of *Endogone* spores were predominant in most of the rhizosphere soils studied. They were identified following Mosse & Bowen (1968a) as yellow vacuolate, non-endosporic (150-260μm) red brown laminate (145-190μm) and bulbous reticulate (90-231μm), in diameter. Some plant rhizospheres contained yellow vacuolate, endosporic type of spores in addition to above mentioned types. Rhizosphere samples of the plants belonging to Amaranthaceae, Oleaceae, Chenopodiaceae, Palmae, Zygophyllaceae, Vitaceae, Celasteraceae, Buxaceae, and Acanthaceae, contained none or very few spores. The rhizosphere samples of all other plants contained two to three spore types; the yellow vacuolate, non-endosporic type predominated. Sporocarps were observed in the rhizosphere of *Solanum xanthocarpum*, *Accacia modesta*, *A. arabica* and *Delbergia sisso*.

Mycorrhizal Infection.—Vesicular-arbuscular mycorrhizas were of general occurrence in all families studied except Amaranthaceae, Chenopodiaceae, Palmae, Zygophyllaceae, Spindaceae, Vitaceae, Celastraceae, Nyctaginaceae and Oxalidaceae (Table. 1). Ectomycorrhizal infection was observed in *Sida cordata*, *Mentha longifolia*, *Buxus papilosa*, *Bramia monnieri*, *Cleome viscosa*, whereas ectendomycorrhizal infection was observed in *Olea cuspidata*, *O. europaea*, (Table, 1). Despite the absence of mycorrhizal infection *Endogone* spores were recovered from the rhizosphere soil of *Dodonea viscosa*, *Boerhavia diffusa*, *Oxalis corniculata*, *Elusine indica*, (Table, 1).

TABLE 1. Occurrence of Mycorrhizas and *Endogone* Spores in the Rhizosphere of Plants Growing Around University Campus Islamabad.

Family, genus, species	Type of infection	Root pieces infected %	Range and mean of *Endogone* spore counts/50g soil
Acanthaceae			
Adhatoda vesica Nees.	Endo	21	20—41 (30)
Justicia peploides T. Anders.	—	0	0
Amaranthaceae			
Achyranthus aspera L.	—	0	0—3 (1)
Amaranthus spinosis L.	—	0	0
A. virdis, L.	—	0	0
Degera muricata (L.) Mart.	—	0	0
Pupalia lappacea (L.) Juss.	—	0	0—5 (2)

Family, genus, species	Type of infection	Root pieces infected %	Range and mean of *Endogone* spore counts/50g soil
Apocyanacae			
Carisa opaca Stapf ex Haines	Endo	26	17—24 (20)
Nerium indicum Mil.	Ecto	67	31—43 (37)
Asclepidiaceae			
Calotropis procera R. Br.	Endo	21	25—31 (28)
Tylophora hirsuta Wight	Endo	88	58—65 (62)
Boraginaceae			
Cynoglossum lanceolatum Forsk.	Endo	80	12—28 (20)
Buxaceae			
Buxus papilosa C. K. Schn.	Ecto	30	0—5 (2)
Canabinanceae			
Canabis stivus L.	Endo	47	18—23 (20)
Capparidaceae			
Cleome viscosa L.	Ecto	43	9—12 (10)
Caesalpinoideae			
Bauhinia acuminata non Linn.	Endo	30	16—28 (22)
Cassia mimosoides L.	—	0	10—19 (14)
Celastraceae			
Gymnosporia royleana Wall.	—	0	0
Chenopodiaceae			
Chenopodium album L.	—	0	0
C. murale L.	—	0	0
Commelinaceae			
Commelina benghalensis L.	Endo	95	31—43 (37)
Compositae			
Artimesia scoparia Waldst & Kit.	—	0	12—25 (18)
Bidens biternata (Lour) Merr. & Sherff.	Endo	79	8—23 (15)
Conyza ambigua Dc.	Endo	83	9—25 (17)
Filago pyramidata L.	Endo	66	16—26 (21)
Saussurea candicans Clarks.	—	0	4—8 (6)

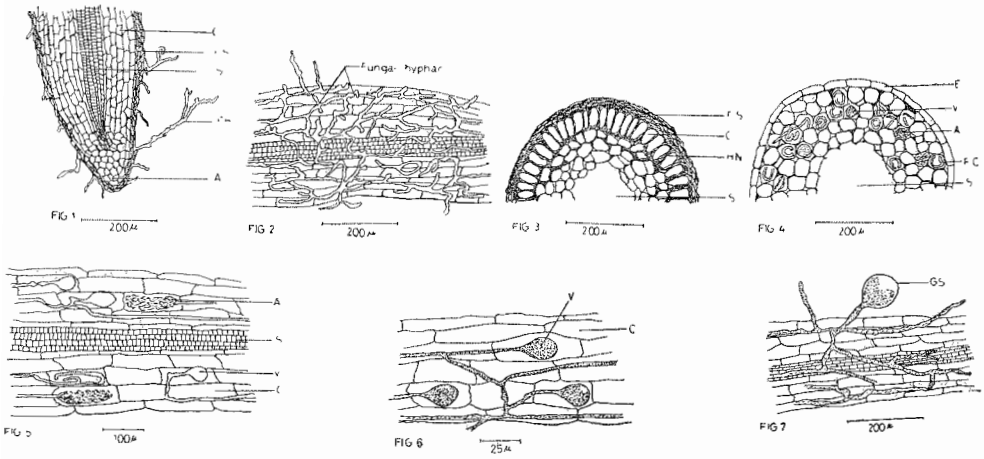
Endo = Endomycorrhiza.
Ecto = Ectomycorrhiza.

Family, genus, species	Type of infection	Root pieces infected %	Range and mean of *Endogone* spore counts/50g soil
Convolvulaceae			
Evolvulus alsinoides L.	—	0	3—18 (10)
Ipomoea pilosa Sw.	Endo	88	7—15 (11)
Cyperaceae			
Cyperus elusinoides Kunth.	—	0	0
C. niveus Ritz.	Endo	66	21—37 (29)
Euphorbiaceae			
Euphorbia hirta L.	Endo	95	0—10 (5)
E. indica Lamb.	Endo	83	33—45 (39)
E. prostrata Ait.	Endo	91	79—99 (89)
Phyllanthus niruri L.	Endo	81	31—42 (36)
Graminae			
Dicanthium annulatum Stapf	Endo	56	45—68 (61)
Eleusine indica (L.) Gaertn.	—	0	0—15 (7)
Saccharum munja Roxb.	Endo	82	22—46 (34)
Labiatae			
Anisonales indica (L.) O. Ktze.	Endo	23	17—27 (22)
Leucas cephalotes Spring.	Endo	61	9—17 (13)
Mentha longifolia L. Hud.	Ecto	96	15—25 (20)
Malvaceae			
Abutilon indicum Sweet.	Endo	65	23—51 (37)
Hibiscus mutabilis L.	—	0	6—12 (9)
Malvestrum tricuspidatum Ait.	—	0	19—39 (29)
Sida cordata (Burm. f.) Borss.	Ecto	23	12—42 (27)
Mimosaceae			
Acacia arabica Willd.	Endo	62	3—11 (7)
A. leucophloe Willd.	Endo	25	0—5 (2)
A. modesta Willd.	Endo	48	13—27 (20)
Nyctaginaceae			
Boerhaavia coccinea Mill.	—	0	5—23 (14)
Oleaceae			
Olea cuspidata Wall.	Ectendo	87	0
O. europiaea L.	Ectendo	66	0
Oxalidaceae			
Oxalis corniculata L.	—	0	5—23 (14)

Family, genus, species	Type of infection	Root pieces infected %	Range and mean of *Endogone* spore counts/50g soil
Palmae			
Phoenix dactylifera L.	—	0	3—11 (7)
Papilionaceae			
Alysicarpus vaginalis (L.) Dc.	Endo	91	22—28 (25)
Dalbergia sisso Roxb.	Endo	30	2—12 (7)
Desmodium motorium Merrill.	—	0	12—18 (15)
Indigofera cordifolia Heyne ex Roth	Endo	32	16—24 (20)
Rhyncosia capitata (L.) Dc.	—	0	11—14 (14)
R. minima (L.) Dc.	—	0	38—58 (48)
Polygalaceae			
Polygala arvensis L.	Endo	86	32—68 (50)
Polygonaceae			
Polygonum barbatum L.	Endo	74	25—38 (36)
P. plebejum R. Br.	—	0	30—45 (37)
Rhamnaceae			
Zizyphus jujuba Mill.	Endo	23	8—15 (11)
Z. nummularia (Burm. f.) Wight & Arn.	Endo	33	19—30 (25)
Scrophulariaceae			
Bramia monnieri (L.) Penn.	Ecto	79	14—28 (21)
Solanaceae			
Solanum nigrum L.	Endo	90	16—26 (46)
S. xanthocarpum Schrad & Wendl.	Endo	25	42—50 (46)
Withania somnifera Dunal.	Endo	38	18—25 (21)
Spindaceae			
Dodonea viscosa Jacq.	—	0	19—32 (25)
Tiliaceae			
Triumfetta rhomboidea Jacq.	Endo	40	23—38 (30)
Umbelliferae			
Psamegeton biternatum Edgens	Endo	44	24—42 (33)
Verbinaceae			
Phyla nodiflora (L.) Green	Endo	93	29—46 (36)
Vitaceae			
Vitis trifolia L.	—	0	0
Zygophylaceae			
Tribulus terristris L.		0	3—11 (7)

In *Mentha longifolia* an extensive ectomycorrhizal infection was observed. Whole root surface including apical portion was covered with fungal hyphae (Fig. 2 & Fig. 1 respectively). Hartig-net was also observed (Fig. 3). The cortical cells of the root of *Polygala arvensis* contained large arbuscules and fungal coils (Fig. 4). Entire cell lumen was filled with fungal hyphae. Fig. 5 shows the mycorrhizal infection in roots of *Euphorbia indica* whereas Fig. 6 and Fig. 7 show the same in roots of *Commelina benghalensis* and *Triumfetta rhomboidea*, respectively.

In *Euphorbia indica, E. prostrata, Solanum nigrum, Phyla nodiflora* very large number of vesicles traversing the cortex were found whereas in *Cyperus niveus, Polygonum barbatum, Commelina banghalensis, Phyllanthus niruri, Cyanoglossum lanciolatum* comparatively smaller number of vesicles were observed. In *Le-ucas cephalotes, Euphorbia hirta* and *Conyza ambigua* extensive arbuscular infection with no vesicles was observed.



EXPLANATION OF FIGURES

Fig. 1. Apical portion of root of *Mentha longifolia* convered with fungus hyphae. C, Cortex; FS, fungal sheath; S, stele, FH, fungal hyphae; A, apex.

Fig. 2. Surface view of root of *M. longifolia* with large number of fungal hypae.

Fig. 3. Portion of TS of ectomycorrhizae of *M. longifolia*. Note the enlongated cortical cells (c) and the Harting-net (HN). FS, fungal sheeth, S, stele.

Fig. 4. Portion of TS of endomycorrhiza of *Polygala arvensis*. Note the cortical cells filled with arbuscules (A), fungal coils (FC) and vesicles (V). S, stele; E, epidermis.

Fig. 5. LS of the endomycorrhizae of *Euphorbia indica*. Cortical cells show arbuscules (A) and vesicles (V). S, stele; C, cortex.

Fig. 6. Cortical cells (C) of endomycorrhiza of *Commenlina benghalensis* showing vesicles (V).

Fig. 7. Surface view of endomycorrhizae of *Triumfetta rhomboidea* with germinating *Endogone* spore (G.S.). Note the contraction of cytoplasm from the spore wall.

Discussion

The present survey supports the generally held view that most plants growing under natural conditions possess VA mycorrhizas and that *Endogone* spores are a regular component of soil microflora.

The plants belonging to families, Amaranthaceae, Chenopodiaceae, Palmae, Zygophyllaceae, Nyctaginaceae, were found to be non-mycorrhizal as also observed by Khan (1974). Plants belonging to Vitaceae, Spindaceae, Oxalidaceae, Celastraceae and Acanthaceae, that were examined in the present study were also found non-mycorrhizal. However, members of the family Euphorbiaceae, which were regarded non-mycorrhizal (Gerdemann 1968; Khan 1972, 1974)), were found to have an extensive vesicular-arbuscular mycorrhizal infection. Large number of arbuscules and vesicles were observed in all the plants examined. Their rhiosphere samples showed large population of all the three types of *Endogone* spores in which yellow vacuolate, non-endosporic type was predominant.

Information referring to mycorrhization of the Labiatae is limited. In *Mentha lonfigolia* ectomycorrhizal infection is obvious and extensive whereas the thin rootlets of *Leucas cephalotes* and *Anisonales indica* showed heavy phycomycetous infection with no vesicles.

Although the Compositae is considered to have approximately 20,000 species, less than 100 have been studied from the mycorrhizal stand point. McDogall & Glasgow (1929) established an inventory which have not been enlarged. Out of 5 plants sampled, 2 showed no infection whereas *Conyza ambigua, Filago pyramidata* and *Bidens biternata* showed high percentage of mycorrhizal infection. All of the species have thamniscophagus infection, but with perticular intensity in the roots of inner cortical cells and vesicles were not observed.

Most of the plants which were highly infected, showed very few *Endogone* spores in their rhizosphere. This may be related with the time of sampling since plants were sampled in their early stage of growth . This is further supported by the observation that most of these plants showed arbuscular infection only.

Both ectomycorrhiza and endomycorrhiza were found in the members of Oleaceae and this observation is consistent with previons findings (Khan & Saif, 1973). The failures to recover the spores of the endophyte (Probably *Endogone fasiculata*) from the soil around the roots of these plants is because of their smaller size, always under 100μm in diameter. Khan (1974) also did not observe any *Endogone* spore in the soil around members of Oleaceae *e.g. Fraxinus xanthoxyloides* and *Olea. ferruginea* and also did not observe any mycorrhizal infection in these plants.

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