

OCCURRENCE OF ARBUSCULAR MYCORRHIZAE IN RHIZOSPHERIC SOILS OF DIFFERENT CROPS AND AGROCLIMATIC ZONES OF HIMACHAL PRADESH, INDIA

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ABSTRACT

Studies on occurrence of arbuscular mycorrhizal fungi in rhizospheric soils of different crops viz., apple, citrus, litchi, pea, cauliflower, cabbage, fenugreek, mustard, turmeric, maize, and potato growing under diverse agroclimatic regions of Himachal Pradesh was made in the present study. The results reveal that arbuscular mycorrhizal fungi are widely present in relatively higher population of *Glomus*, *Scutellospora* and *Acaulospora* under brown alluvial soils. Apple, fenugreek, litchi and maize were found to be the best hosts for root colonization by arbuscular mycorrhizal fungi.

Key words: Arbuscular mycorrhizal fungi, Rhizosphere, Root colonization.

INTRODUCTION

Arbuscular mycorrhizal (AM) fungi penetrate the cortical cells of the roots of vascular plants and are characterized by the formation of unique structures such as arbuscules and vesicles. The plants are benefited by having AM fungi on their roots system through better use of available nutrients especially phosphorus (Covacevich *et al.*, 2006), improved water stress resistance (Michelson and Rosendahl, 1990), better adaption of the plants, protection against soil borne diseases (Vigo *et al.*, 2000; Bharat and Bhardwaj, 2001), soil aggregation (Oehl *et al.*, 2004) and interaction with other beneficial soil microorganisms. There is a great potential for low input agriculture to manage the system in a way that promotes arbuscular mycorrhizal symbiosis (Smith and Read, 1997). Avis *et al.* (2008) studied the effect of AM fungi on the growth and productivity of legumes. They observed that AM fungi have significant effect when compared with non-mycorrhizal plants.

The physical feature and climatic conditions of Himachal Pradesh favour cultivation of different agriculture and horticulture crops. There are four agroclimatic zones (Anonymous, 2009) in the state viz., Shivalik hill

zone (350-650 meters above sea level), Mid hill zone (651-1800 meters above sea level), High hill zone (1801-2,200 meters above sea level) and Cold dry zone (above 2,200 meters above sea level). Earlier study indicates that soil physico-chemical attributes varied significantly among various sites in Himachal Pradesh (Sharma *et al.*, 1998). The contribution of AMF on plants has been widely documented, specially where available soil phosphorus limited plant growth of native plants as well as agricultural crops (Menendez *et al.*, 2001, Covacevich *et al.*, 2006, Smith and Read, 1997 and Guissou, 2009). The studies were, therefore, carried out with an objective to study occurrence of AM fungi in rhizosphere soils of different crops in various agro-ecological zones of the state.

MATERIALS AND METHODS

A survey was conducted in different agroclimatic zones (Zone I, II, III and IV) of Himachal Pradesh i.e., Kangra, Dhaulakuan (Zone I), Nauni, Kullu (Zone II), Mashobra, Shimla (Zone III) and Sharbo and Tabo (Zone IV) to collect rhizosphere soil of citrus, litchi, pea, cauliflower, cabbage, methi (fenugreek), mustard, turmeric, maize, apple and potato for determining the occurrence of arbuscular mycorrhizal fungi.

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The isolation of AM fungal spores was carried out by wet-sieving and decanting method. 25 g of soil was mixed in a convenient volume of water in a large beaker (500 ml) and stirred with a glass rod to make uniform suspension. The suspension was passed through different sieves (500, 300, 250, 125, 105 and 45 MIC mesh sizes). The population of AM fungi was determined under the stereomicroscope. The chlamydospores were picked up with Pasteur pipette and mounted in polyvinyl lactic acid (Omar *et al.*, 1979) for their identification up to species level by referring to the photographic slide collections together with the synoptic key of Hall and Abbott (1983) and also standard keys of Gerdemann and Trappe (1975) and Hall (1984). The AM fungi were classified zone wise, location wise and crop wise based on the data on diameter, wall width etc.

The root colonization in above crops was assessed by collecting roots from their rhizosphere region. The root samples were stained by the method of Phillips and Hayman (1970). The root segments were stained in 0.05 per cent trypan blue in lactophenol, heated gently for 10 minutes and excess of stain removed by clearing in lactophenol. The stained roots were examined under stereomicroscope for the presence of mycelium and arbuscules. The per cent root colonisation was determined following the grid-line intersect method (Giovannethi and Mosse, 1980) which is based on the method of Newman (1966).

RESULTS AND DISCUSSION

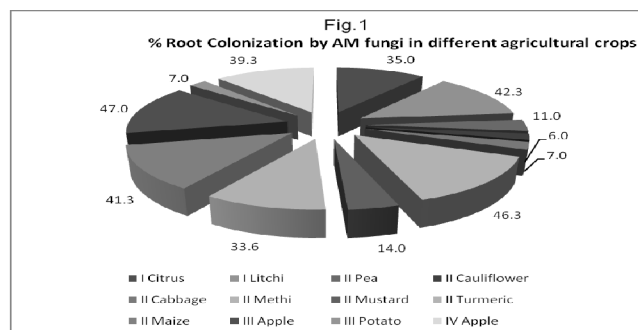
The soil samples were collected from rhizosphere of different agricultural crops in various agro-ecological zones of Himachal Pradesh and were analysed for the relative abundance of AM fungi.

It is evident from the data (Table 1) that the abundance of *Glomus* spp. in rhizosphere soils of apple was maximum in high hills i.e., Mashobra (Shimla) in Zone III followed by Mid-hills at Katrain (Kullu) in Zone II. Similarly, *Acaulospora* and *Scutellospora* population was maximum in rhizosphere soils of apple in high hills. *Gigaspora* population was maximum in very high hills under apple orchards (Sharbo and Tabo) in Zone IV. Among AM fungi, the population of *Glomus* spp. was maximum in alluvial soils of Zone III and II followed by *Scutellospora* and *Acaulospora*. Highest population of AM fungi (85.1%) in rhizosphere soils of apple was in high hills and mid hills which could be attributed to humus alluvial soils. Lowest AM fungal population (19.7%) in very high hills could be due to presence of temperate desert soils which were light and sandy.

The root colonization study revealed maximum root colonization by AM fungi in apple (47%) in Zone III followed by methi (46.3%) in Zone II, litchi (42.3%) in Zone I and maize (41.3%) in Zone II. Cauliflower, cabbage and potato, however, showed minimum per cent root

TABLE 1: Relative abundance of AM fungi in rhizosphere soils of different zones.

Zone (Soil)	Location	Orchard/ Crop	AM Fungal abundance (%)			
			Glomus	Acaulospora	Scutellospora	Gigaspora
I. Low hills (Tarai)	Dhaulakuan Jachh	Citrus Litchi	25.5	12.2	12.4	0.0
II. Mid hills (Alluvial)	Nainatikker Katrain (Kullu) Nauni	Wheat Apple Mustard, Pea, Turmeric, Ginger, Fenugreek and Maize	34.7	10.4	17.4	0.0
III. High hills (Alluvial)	Mashobra	Apple	42.5	15.5	24.6	2.5
IV. Very high hills (Desert)	Sharbo & Tabo	Apple	10.2	2.5	3.5	3.5



colonization to an extent of 6 to 7 per cent, respectively (Fig.1).

AM fungi stabilize soils and improve soil structure in presence of humus as revealed during present investigation in Zone III through binding sand grains and soil aggregate formation thus contributing to soil fertility and quality. The investigation on occurrence of fungi in rhizosphere soils of different plants in various agroclimatic zones revealed that the population of *Glomus*, *Acaulospora* and *Scutellospora* species were highest in high hills which could be due to brown forest alluvial soils. The spore abundance in Zone III could likely to be a good indicator of root colonization and productivity due

to a soil mycorrhizal inoculum potential. The dominance of a given community by a single species was related to contrasting inter-specific differences in development patterns of the AM fungi (Oehl *et al.*, 2004). Species of *Glomus* readily form anastomosis between hyphae and might therefore have high spore density in all zones under different agro-ecological zones of the state. Similar studies were also reported by Voets *et al.* (2006). The present study will be of great significance for the re-establishment of vegetation in degraded semi-arid ecosystems.

CONCLUSION

The results revealed that arbuscular mycorrhizal fungi were widely present and showed relatively higher population of *Glomus* in Zone III of Himachal Pradesh. Apple, fenugreek, litchi and maize were found to be the best hosts for root colonization by arbuscular mycorrhizal fungi. Among AM fungi, the population of *Glomus* spp. was maximum in Zone III and II. The highest root colonization by AM fungi occurred in apple (47%) in Zone III followed by methi (46.3%) in Zone II, litchi (42.3%) in Zone I and maize (41.3%) in Zone II.

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