Occurrence of Arbuscular Mycorrhizal Fungi in Rhizosphere of *Jatropha curcas* L. in Arid and Semi Arid Regions of India

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Abstract A study was conducted to identify common arbuscular mycorrhizal (AM) fungi present in rhizosphere of *Jatropha curcas* L., an important bio-diesel crop, from different arid and semi arid regions of India viz., Jodhpur (Rajasthan), Hissar (Haryana), Jhansi and Lalitpur (Uttar Pradesh) and Hyderabad (Andhra Pradesh). A total of 20 AM species were recorded, which consisted of two species of *Acaulospora* and 18 species of *Glomus*. The highest frequency of occurrence was recorded for *Glomus intraradix* (100%), followed by *Acaulospora scrobiculata* (83%), *G. etunicatum* (50%) and *Glomus* 1 (50%). Maximum species richness was recorded at Jodhpur, followed by Jhansi, Hissar, Hyderabad and Lalitpur. The results seem to suggest that species richness was more in arid regions as compared to semi arid areas.

Keywords *Acaulospora* · Arid and semi arid regions · Arbuscular mycorrhizal fungi · *Glomus* · *Jatropha curcas*

Inoculations of *Jatropha curcas* L., which is gaining importance as bio-diesel plant, with bio-fertilizers including arbuscular mycorrhizal (AM) fungi have been shown to significantly increase the plant growth and yields under variable conditions. Morphological and biochemical contents of *Jatropha* plants have been reported to increase significantly after combined microbial inoculations with *Azospirillum*, *Azotobacter*, phosphate solubilising bacteria and AM fungi under tropical conditions of Tamil Nadu [1].

Early flowering and fruiting in *J. curcas* has been reported after inoculation of plants with microbial formulations [2].

Above-mentioned information is mostly based on commercial formulations involving unidentified AM species and other bio-fertilizers. Studies on effect of inoculation of purified AM cultures, isolated from diverse conditions, on growth of *J. curcas* could be helpful in realization of full potential of these fungi as bio-fertilizers, as it has been done in many other plant species [3]. To begin with, efforts were made in present study to identify common AM fungi present in rhizosphere of *J. curcas* from different arid and semi arid regions of India viz., Hissar (Haryana), Hyderabad (Andhra Pradesh), Jodhpur (Rajasthan), Jhansi and Lalitpur (Uttar Pradesh). Pantnagar (Uttaranchal) was also included in this study as occurrence of *J. curcas* in lower hills is quite common.

The study was conducted at National Research Centre for Agroforestry, Jhansi (24°11' N latitude and 78°17' E longitudes), Uttar Pradesh, India. A total of 30 samples of rhizosphere soil were collected from above mentioned locations, five from each location during 2007–2008. Trap cultures were set by mixing different soil samples with autoclaved coarse sand in 1:1 ratio (v/v), separately. The mixture was transferred to 15 cm plastic pots, which were seeded with maize and black-gram and were maintained in green house. After 3–4 months, spore/sporocarps were isolated from the substrate taken from the trap cultures according to the method of Gerdemann and Nicolson [4]. AM species were identified by using the keys of Schenck and Perez [5]. Species richness and frequency of occurrence of AM fungi associated with different locations were also calculated [6]. Soil properties and other details of different sampling sites are given in Table 1.

A total of 20 AM species were recorded, which consisted of two species of *Acaulospora* and 18 species of

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Table 1 Soil characteristics and other details of different sampling sites

Location	Soil order	Application of fertilizers	Type of plantation	pH (1:2.5 H ₂ O)	EC (μS/cm)	Organic C (%)	Olsen P (Kg/ha)
Hissar	Entisol	Yes	Pure plantation	8.4	120.0	0.47	12.0
Hyderabad	Vertisol	Yes	Pure plantation	6.6	110.0	0.48	13.5
Jhansi	Vertisol	Yes	Agroforestry	6.5	189.4	0.74	23.4
Jodhpur	Aridisol	Yes	Pure plantation	8.1	200.0	0.15	10.0
Lalitpur	Vertisol	No	Naturally growing plants	7.6	142.0	0.71	8.5
Pantnagar	Mollisols	Yes	Pure plantation	7.1	365.0	0.81	27.9

Table 2 Occurrence of arbuscular mycorrhizal (AM) species in rhizosphere of *Jatropha curcas* at different sampling locations

AM species	AM species recorded at						Frequency of occurrence (%)
	Hissar	Hyderabad	Jhansi	Jodhpur	Lalitpur	Pantnagar	
<i>A. mellea</i>	—	—	—	+	—	—	17
<i>A. scrobiculata</i>	+	—	+	+	+	+	83
<i>Glomus aggregatum</i>	—	—	+	+	—	—	33
<i>G. arboreense</i>	—	—	+	+	—	—	33
<i>G. cerebriforme</i>	+	—	—	—	—	—	17
<i>G. diaphanum</i>	—	—	+	—	—	—	17
<i>G. etunicatum</i>	+	+	+	—	—	—	50
<i>G. hoi</i>	—	+	—	+	—	—	33
<i>G. intraradix</i>	+	+	+	+	+	+	100
<i>G. microaggregatum</i>	+	—	—	+	—	—	33
<i>G. microcarpum</i>	+	—	—	—	—	—	17
<i>G. occultum</i>	—	—	—	—	—	+	17
<i>G. segmentatum</i>	—	—	—	+	—	—	17
<i>G. vesiculiforme</i>	+	—	—	—	—	—	17
<i>Glomus</i> 1	+	—	+	+	—	—	50
<i>Glomus</i> 2	—	—	+	—	—	+	33
<i>Glomus</i> 3	—	—	+	+	—	—	33
<i>Glomus</i> 4	—	—	—	+	—	—	17
<i>Glomus</i> 5	—	—	—	+	—	—	17
<i>Glomus</i> 6	—	—	—	+	—	—	17
Species richness	8	3	9	13	2	4	

+ Present, — Absent

Glomus (Table 2). Frequency of occurrence varied from 17 to 100%. Its maximum value was recorded for *G. intraradix* (100%), followed by *A. scrobiculata* (83%), *G. etunicatum* (50%) and *Glomus* 1 (50%). There are many reports which suggest the presence of rich AM biodiversity in rhizosphere of *J. curcas* from different parts of India. Jamaluddin and Singh [7] reported ten AM species from black cotton and red murumy soils of Jabalpur, Madhya Pradesh. Venkatesh et al. [8] reported the presence of *Glomus*, *Sclerocystis*, *Gigaspora*, *Scutellospora* and *Acaulospora* sp., from three agro-climatic zones of Karnataka. Among the surveyed locations, excellent AM species richness was recorded in aridisol of Jodhpur (pH: 8.1) and entisol of Hissar (pH: 8.4). It seems that AM fungi of the

region have good adaptation to high pH values. Hasan [9] reported similar results from alkaline soils of Faizabad, Uttar Pradesh. A large number of AM species (*Glomus mosseae*, *G. fasciculatum*, *Gigaspora margarita*, *G. gigantea* and *Acaulospora laevis*) were isolated from the farm soil. Among studied vertisols, maximum richness was recorded at Jhansi (pH: 6.5), followed by Hyderabad (pH: 6.6) and Lalitpur (pH: 7.6). The samples from Jhansi were taken from an agroforestry plot (Table 1) and it could be the reason for recorded higher AM biodiversity there. The observations are in accordance with existing reports on stimulatory effects of intercropping on AM activity in tree rhizosphere in agroforestry systems [10]. Relatively lesser number of AM species was recorded in mollisols from

Pantnagar, which can be due to higher level of soil phosphorus (P).

It may be concluded from above observations that *Glomus* and *Acaulospora* were the common genera of AM fungi present in rhizosphere of *J. curcas* in the surveyed regions. Species richness is more in arid regions as compared to semi arid and sub humid areas. Natural soils in aforesaid areas are predominantly low in P content, except Pantnagar and are favorable for growth of AM fungi.

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