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Response of *Solanum xanthocarpum* Schrad. and Wendl. to Different Indigenous Arbuscular Mycorrhizal Fungi

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A study was conducted under green house nursery condition on the efficacy of seven indigenous arbuscular mycorrhizal (AM) fungi in the improvement of growth, biomass and nutrition in the roots and leaves of *Solanum xanthocarpum* Schrad. and Wendl. Seedlings were raised in polythene bags containing soil inoculated with isolates of seven different indigenous AM fungi, viz. *Acaulospora scrobiculata*, *Archaeospora trappei, Glomus aggregatum, Glomus fasciculatum, Glomus pakistanika, Gigapora margarita and scutellospora persica. S.xanthocarpum* seedlings raised in the presence of AM fungi generally showed an increase in plant growth, biomass and nutritional status over those grown in the absence of AM fungi. The extent of growth, biomass and nutritional status enhanced by AM fungi varied with the species of AM fungi inhabiting the roots and leaves of *S.xanthocarpum* seedlings. Considering the various plant growth parameters and nutritional status in the roots and leaves of *S. xanthocarpum*, it was observed that *Glomus aggregatum* is the best AM symbiont for *S. xanthocarpum* used in this experiment.

Key words: Green house, Arbuscular Mycorrhizal Fungi, plant growth.

The introduction of beneficial organisms into soil is a present crux of applied mycorrhizal research. Utilization of mycorrhizal bioinoculants in the cultivation of medicinal and aromatic plants is of recent interest. Arbuscular mycorrhizal (AM) fungi have been used to enhance the plant growth, nutrients and yield of medicinal crops and to help maintain good soil health and fertility that contributes to a greater extent to a sustainable yield and good quality of the products[14]. The activity has gained momentum in recent years due to higher cost and hazardous effects of heavy doses of chemical fertilizers. With the advent of innovative technologies and the importance being given to sustainable agriculture, AM fugal association is of great economic significance on the growth and nutrition of agricultural and medicinal crops. Thus it is essential to screen for an efficient AM fungus for a particular host in order to harness the maximum benefit from the fungus[1]. Furthermore, since AM fungi cannot be grown on laboratory media, production of a large quantity of the inoculum for inoculation of the soil under field conditions is difficult.

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Nevertheless, Since most of the commercially important medicinal crops are raised under nursery conditions before being transplanted to the main field, the inoculation of soil in the nursery would not only result in the saving of the inoculum needed but also help in better establishment of the transplanted seedlings. These are few published reports on the influence of AM fungi on the growth and nutrition of medicinal plants[8,5,2,15]. *Solanum xanthocarpum* is an important medicinal plant belonging to the family Solanaceae and commonly called as "*Kandan Kattiri*". It has profound use in Ayurveda and folklore medicine. Root is an expectorant forming an ingredient of well known Ayurvedic, Dasamula. It is employed in cough, asthma and pains in chest, being used in the form of decoction. The juice of berries are used in sore-throat. It is a commonly growing perennial herbaceous weed with bright green leaves and zig-zag stem mostly found in the arid region. It is supposed that the plant has Solasodine in its different parts, which is responsible for its medicinal value[11]. Hence, the present investigation was done to screen for an efficient AM fugus for *S. xanthocarpum* and also to study the effects of the association on the growth, biomass and nutritional status in the roots and leaves of *S. xanthocarpum*.

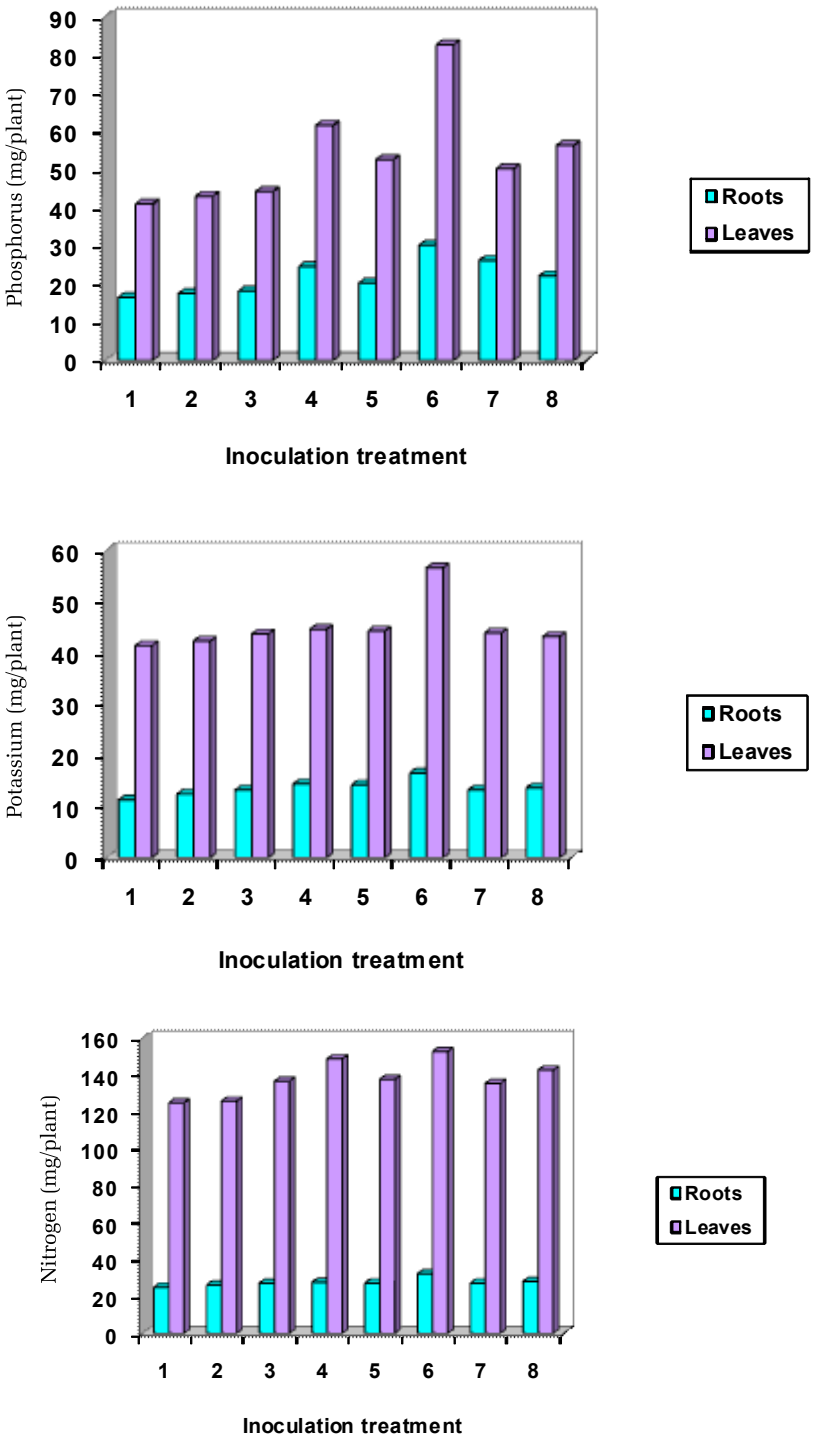
Pot culture Experiment

This investigation was carried out under nursery condition in a green house. The soil used in this study was collected form an uncultivated field at a depth of 0-30 cm and was classified as fine, entisol, isohypertherimic kanhaplustalfs. The soil pH was 7.2 (1:10 soil to water extract ratio), and it contained 2.7 ppm available phosphorus (extractable with NH_4 F + HCL) and an indigenous AM fungal population of 60 spores / 50g of soil. Nursery was raised by sterilizing the seeds of *S. xanthocarpum* with 5% chloramine T solution for 30 min, then washing and sowing in polybags (10x15cm) containing sterilized soil: vermiculite mix (1:1v/v). Ruakura nutrient solution at 50ml per poly bag was applied once in 10 days. After 30 days seedlings were transplanted to PVC pots of size 18x24 cm containing 3kg of stabilized soil: sand (1:1 v/v).

The AM fungal species used in this study (Table1) were isolated from the rhizosphere soil of soda apple cultivated at the herbal garden of Tamil University, Tamilnadu, India. These AM fungal species were isolated by using wet - sieving and decanting technique[6]. The species level identification of different AM fungal species was done following the keys provided by Trappe[18] and Schenck and Perez[17]. These fungi were multiplied using sterilized sand : soil mix (1:1 v/v) as the substrate and onion as the host. After 90 days of growth, shoots of onion was severed and the substrate containing hyphae, spores and root bits was air dried and used as inoculum. The inoculum potential (IP) of each culture was estimated adopting the Most Probable Number (MPN) method as outlined by Porter[13]. The soil in each pot was mixed with this inoculum at different rates so as to maintain as initial IP of 12,500 per pot. Each pot containing the potting mixture, with or without AM inoculum as the treatment may be, was planted with one seedling of *S.xanthocarpum*. One set of plants without inoculation was the control. Each treatment with 5 replication was maintained in a green house and watered regularly so as to maintain the field capacity of the soil. Ruakura plant nutrient solution without phosphate was added to the pots at the rate of 50 ml per pot once in 15 days.

EXPERIMENTAL

Ninety days after transplanting, the plants were harvested for determination of the mycorrhizal status, growth response, biomass and nutritional status. Plant height was measured from soil surface to the growing tip of the plant. Dry biomass was determined after drying the plant sample at 60ºC to a constant weight in a hot air oven. Soil sample (100g) was collected form each pot and subjected to wet sieving and decantation method[6] to estimate the population of spores. The root system was removed and assessed for AM fungal infection by the grid-line intesect method[7] after cleaning the roots with 10% KOH and staining with trypan blue (0.02%) as described by Phillips and Hayman[12]. Shoot and root P, K and N concentrations were determined by employing the vanado molybdate phosphoric yellow colour, flame photometric and microkjeldahl methods respectively[9].Atomic absorption spectrophotometry was employed to estimate zinc, copper and iron content of the plant



1. uninoculated control
2. Arachaeospora trappei
3. Acaulospora scrobiculata
4. Gigaspora margarita
5. Glomus aggregatum
6. Glomus fasciculatum
7. Glomus pakistanika
8. Scutellospora persica

Fig. 1. Macronutrient content in the roots and leaves of *S. xanthocarpum* as influenced by native AM fungi

samples, using respective hollow cathode lamps. The data thus generated was subjected to statistical analysis of completely randomized block design with five replicates and the means were separated by Duncan's Multiple Range Test (DMRT)[10] for significant difference P<0.05).

Screening, growth, biomass and mycorrhizal development

In the field survey, soda apple plants growing in uncultivated p- deficient sandyloam soils were almost same as in cultivated soils. Microscopic examination of their roots revealed extensive colonization by AM fungi with 96.5% level of infection. A large number of inter and intra - matrical vesicles were noticed between 120µm and 140µm in size. The vesicles were globose to subglobose and the subtending hyphae were simple. Based on the morphological characters, the AM fungal isolate was identified as *Glomus* species. Altogether seven AM fungi were isolated form root- zone soils and identified (Table 1). Among them, *Glomus aggregatum and Glomus fasciculatum* were predominant However, *Acaulospora, Archaeospora, Gigaspora and Scutellospora* rarely occurred.

The growth response, biomass, nutritional status and mycorrhizal development of plants raised in sandy loam soils were assessed for the impact of inoculation with different native AM fungi. The responses of the soda apple plants to inoculation with different AM fungi were found to be varied. Mycorrhizal inoculation resulted in a significant

Table 1. Influence of native AM fungi on plant growth response of *S. xanthocarpum* (Mean of five replicates)

Inoculation treatment	Shoot length (cm)	Root length (cm)	Root volume / plant (cm^2)	Plant dry biomass		
				Shoot	Root	Total
Uninoculated control	62.5^c	24.4^d	11.2^d	16.5^d	12.5^c	29.0^e
Acaulospora delegata	78.6^c	33.2^b	13.2^c	20.6^c	18.4^c	39.0^c
Glomus aggregatum	90.6^a	42.4^a	15.1^a	25.5^a	22.4^a	47.9^a
Gigaspora fasciculatum	84.5^b	42.4^a	14.2^b	23.2^b	19.6^b	42.8^b
Glomus feugianum	68.5^d	29.2^c	14.0^b	18.4^d	15.2^c	33.6^c
Gigaspora margarita	83.2^b	32.8^b	13.6^c	21.2^c	18.6^c	39.8^c
Sclerocystis0rubiformis	64.4^d	28.5^c	13.0^c	17.2^d	14.5^d	31.7^c
Scutellospora0heterogama	68.4^d	28.4^c	14.0^b	18.2^d	15.0^d	33.2^d
SEM ±	6.2	2.4	0.8	1.8	1.2	2.4
CD (P = 0.05)	16.4	6.2	2.2	3.2	2.8	4.8

Means in each column followed by the same letter are not significantly different (P < 0.05) from each other according to DMR test.

Table 2. Influence of native AM fungi on Zn, Cu and Fe content in shoot and root of *S.xanthocarpum*

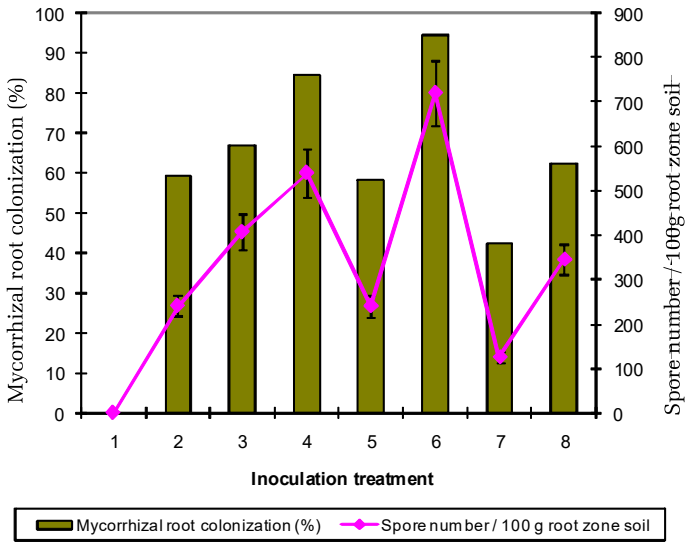
Treatment	Zinc content (µg/Plant)		Copper content (µg/Plant)		Iron content (µg/Plant)	
	Root	Shoot	Root	Shoot	Root	Shoot
Control (without AM fungi	94.5^a	163.8^a	49.5^a	61.8^a	52.8^a	59.5^a
Acaulospora scrobiculata	105.6^b	194.2^b	56.8^b	74.8^b	68.4^b	64.2^b
Archaeospora trappei	106.4^b	198.2^b	58.2^b	76.2^b	66.2^b	68.4^b
Gigaspora margarita	128.4^c	212.4^c	64.2^c	112.3^c	70.4^c	72.8^c
Glomus aggregatum	192.5^d	290.5^d	68.5^d	116.6^d	92.4^d	95.8^d
Glomus fasciculatum	184.6^d	282.4^d	64.8^c	114.2^c	90.5^d	92.2^d
Glomus pakistanika	112.5^b	199.4^b	58.4^b	91.2^b	70.2^c	69.5^b
Scutellospora persica	124.6^c	212.8^c	58.6^b	98.4^b	70.6^c	72.4^c

Means (n=5) in each column followed by the same letter are not significantly different (P<0.05) from each other accord to DMRT

increase in height, biomass and nutrient content of soda apple seedlings. However, there was no positive correlation between plant growth parameters and mycorrhizal colonization. Earlier studies also showed the same trend for medicinal plants subjected to AM inoculation[5,16,2,3] and these studies also indicated the need for selecting efficient native AM fungi for plant species. The present study conducted with an objective of screening for an efficient indigenous AM fungi for *S.xanthocarpum* seedlings has also resulted in varied plant growth responses to different AM fungi. Among the seven different AM fungi tested, the plants inoculated with *Glomus aggregatum* showed maximum plant height, root and shoot biomass which differed significantly from all other treatments (Table 1). More number of spores were encountered in the root zone of inoculated plants compared to uninoculated plants. Maximum number of spores occurred in the root zone soils of soda apple plants inoculated with *Glomus aggregatum* followed by *Glomus fasciculatum*, both being statistically on per with each other (Fig. 1). Lowest number of spores were noticed in the root zone of *Glomus pakistanika* inoculated plants. Mycorrhizal root colonization was also maximum in plants inoculated with *Glomus aggregatum,* followed by plants inoculated with *Glomus fasciculatum* (Fig. 1). These two treatments did not differ significantly from each other. It is well known that enhanced nutritional status of a plant is manifested in its improved growth. Soda apple plants grown in the presence of AM fungi showed a general increase in such growth parameters as plant height and total dry weight as against those grown in soils uninoculated with AM fungi (Table 1).

Nutritional Status

Mycorrhizal inoculation resulted in significant increase in shoot and root N, P, K, Zn, Cu, and Fe, content (Fig. 2 Table – 2). Highest N, P, K, Zn, Cu, and Fe content was recorded in plants inoculated with *Glomus aggregatum* which differed significantly from other treatments (Fig 2 and Table -2). Such a variation in the plant nutrient status in relation to the fungal species for other medicinal plant species is well documented[16,3,15]. The enhancement in growth, biomass and nutritional status is also related to the precent root colonization apart from several soil and environmental factors. AM fungi differ greatly in their symbiotic effectiveness which depends on their preference for particular soils



1. Control (uninoculated)
2. Acaulospora delegate
3. Gigaspora margarita
4. Glomus fasciculatum
5. Glomus feugianum
6. Glomus aggregatum
7. Sclerocystis rubiformis
8. Scutellospora heterogama

Fig. 2. Influence of native AM fungi on percent mycorrhizal root colonization and spore numbers in the root-zone soils of *S.xanthocarpum*

or host plant specificity[14], direct ability to stimulate plant growth, rate of infection, competitive ability, and tolerance to applied chemicals. Giving growth, biomass and nutritional status, *Glomus aggregatum* was found to be the best AM fungus for inoculating *S.xanthocarpum* in the nursery in order to obtain healthy, vigourously growing seedlings that could establish and perform better when planted in sandy loam soils.

S.xanthocarpum seedling show varied responses to different AM fungi, with *Glomus aggregatum* conferring greater benefits compared to all other fungi used in this study. Further consideration of the ability for higher root colonization, spore number, plant height biomass and mineral nutrient content suggested that a clear and specific relationship exists between a particular species of fungus and the plant.

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