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Research Article

Effect of AM fungi on medicinally significant plant *Solanum surattense* Burm F.

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Abstract

Solanum surattense is a bright green perennial herb. It used in traditional medicine for treatment of various infections. AM fungi contribute to the phosphorus nutrition of plants by enhancing phosphorus uptake from the soil. The AM fungi association had not only enhanced the growth of medicinal plants but also improve the productivity of medicinal compounds. The present study was carried out to investigate the inoculation of AM fungi as individual, dual and consortium for the growth and nutrients content of *S. surattense*. A significant increased over control in Plant height (62.56 cm), dry weight (7.95 g) of AM fungi. The nutrient content N (36.70 g/plant), P (21.15 g/plant), K (25.82 g/plant), Cu (26.78 ppm plant^{-1}), Fe (140.70 ppm plant^{-1}), Mn (30.54 ppm plant^{-1}), Zn (26.74 ppm plant^{-1}), the percent root colonization (61.90 %) and spore number (65.80/25 g of rhizosphere soil) were recorded.

Keywords: AM fungi, *Solanum surattence*, Consortium and Nutrient content.

Introduction

India has been known to be rich repository of medicinal plants. The history of plants to be utilized as medicine is thousands of years old. It was documented that 80% of the world's population has faith in traditional medicine, particularly plant drugs for the primary health care (Dubey, 2004). Solanaceae is a large plant family containing two thousand and three hundred species, nearly half of which belong to a single genus, *Solanum*. There are herbs, shrubs or small trees under this genus (Sheeba, 2010.) *S. surattense* Burm F. is a perennial herb and is considered as one of the most useful traditional medicine in India. Traditional peoples are using this plant for various disorders such as gonorrhea, urolithiasis, amenorrhoea, also as an ingredient of an Ayurvedic drug Arkadhi a remedy for bronchitis, dengue and fever (Kapoor, 1990). In India, AM fungi are found to be well distributed in both cultivated and non-cultivated soil, of which the genus *Glomus* having large number of species (Mukerji and Kapoor, 1990). The AM fungal association help plants grow better in low fertility soils, compared to non-mycorrhizal plants (Tran and Cavagnaro, 2010). AM fungi have been associated with medicinal plants (Gupta *et al*., 2009). It plays a significant role in the growth and metabolism of the plants (Althaf Hussain and Srinivas, 2013). Cultivation of medicinal plants has a significant commercial importance. Thus, the need for the study of medicinal plants and their growth conditions is gaining a lot of importance. Therefore, the present work has been made to document the inoculation of AM fungi in medicinally significant plant *S. surattense*.

Materials and Methods

The present study was conducted at Department of Microbiology and Biochemistry, Nadar Saraswathi College of Arts and Science, Theni, Tamilnadu. The seeds of *S. surattense* were collected from Veli hills of Kanyakumari District, Tamil Nadu. Seeds were soaked in 5% sodium chloride and sterilized with 0.1% $HgCl_2$

for 1 min followed by thorough washings with sterile distilled water atleast for 7-10 times. The sterile seeds were used for sowing in cement pots of size (45 x 30 x 45 cm) filled with sand and garden soil (1:3).

The efficient strains of AM fungi (*Acaulospora laevis*, *Glomus fasciculatum* and *Glomus macrocarpum*) were previously isolated from soil of *S. surattense* and maintained at Department of Microbiology and Biochemistry, Nadar Saraswathi College of Arts and Science, Theni, Tamilnadu. The AM fungi were applied 3 cm below the soil surface as thin layer @ 5.0 g/pot before propagating. The pots culture experiment was conducted with individual, dual and consortium inoculation of *A. laevis*, *G. fasciculatum* and *G. macrocarpum* with the following treatment in triplicates.

Treatments

T_1 - Control
T_2 - *Acaulospora laevis*
T_3 - *Glomus fasciculatum*
T_4 - *Glomus macrocarpum*
T_5 - *Acaulospora laevis* + *Glomus fasciculatum*
T_6 - *Acaulospora laevis* + *Glomus macrocarpum*
T_7 - *Glomus fasciculatum* + *Glomus macrocarpum*
T_8 - *Acaulospora laevis* + *Glomus fasciculatum* + *Glomus macrocarpum*

Samples were collected from each treatment on 30, 60 and 90 DAS and analyzed for different parameters. The plant height was measured from ground level to apical meristem and expressed in cm. The dry matter content was estimated by drying the plants in Hot air oven at 60°C till a constant weight was obtained and expressed in grams. The N, P, K contents of the plant was estimated by Microkjeldahl, Vandomolybdate and Flame photometer (Piper, 1950; Jackson, 1973 and Daniels *et al.,* 1982) respectively. The micronutrients present in sample were estimated using atomic absorption spectrometry (model-Shimadzu) in Annamalai University according to the methods put forth by Clarson (2002). AM fungal spores per 25 g of rhizosphere soil and AM fungal root colonization percentage were estimated by following the standard methods (Philip and Hayman. 1970; Bagyaraj and Manjunath 1980). The data were statistically analyzed by Randomized Block Design (RBD).

Results and Discussion

Pot culture experiment was carried out to study the effect of AM fungi (*A.laevis,G. fasciculatum* and *G. macrocarpum*) as individual, dual and consortium in *S. surattense*. The effect of AM fungi on growth parameters (plant height and dry matter content) on 30, 60 and 90 Days were presented in (Table - 1).

Among the eight treatments, the maximum plant height was recorded in T_8 (consortium inoculation of AM fungi) as 62.56 cm followed by dual inoculation treatments T_5, T_6 and T_7 (60.73, 60.18 and 58.90 cm). In individual inoculation treatments (T_2, T_3 and T_4) recorded the plant height 57.05, 56.82 and 55.00 respectively, whereas the minimum plant height was observed in control (without inoculation) T_1 as 49.46 cm.

The least dry matter production observed in control (without inoculation of AM fungi) as 3.60 g/plant. In individual inoculation treatments T_2, T_3 and T_4 recorded the dry weight of 6.18, 5.83 and 5.25 g/plant. The next best response observed in dual and consortium treatments viz., T_5, T_6, T_7 and T_8 (7.35, 6.98, 6.76 and 7.95 g/plant). AM fungi have shown enhanced growth and development as compared to control plants. When grown in un-sterilized soil due to low level natural inoculum. These outcomes prove the early reports by Bagyaraj and Manjunath (1980). Results of the experiments confirm various reports studies on the role of AM fungi in enhancing the growth of medicinal plants is also gaining much importance in the recent years (Beena *et al.,* 2001 and Mani, 2006). Several workers have observed the effects of AM fungi on increased plant biomass (Hemalatha and Selvaraj, 2003; Yudhvir, 2004).

In the present study the maximum N, P and K contents was observed in inoculation of T_8 (*A. laevis* + *G. fasciculatum* + *G. macrocarpum*) as 36.70, 21.15, 25.82 g/plant at 30 DAS. The nest best response recorded in dual inoculation T_5 (35.38, 19.67 and 24.45 g/plant) T_6 (34.80, 18.88 and 23.89 g/plant) and T_7 (34.06, 18.20 and 23.06 g/plant) followed by single inoculation T_2 (32.74, 16.70 and 21.68 g/plant), T_3 (32.05, 15.64 and 20.95 g/plant) and T_4 as 30.73, 14.15 and 19.55 g/plant. The minimum was observed in (without inoculation) T_1 26.80, 9.70 and 15.40 g/plant (Table - 2).

Hemalatha *et al*. (2003) and Murugan *et al*. (2003) also observed increased "P" content in medicinal plants. The "P" content was more pronounced in plants inoculated wilh *Glomus fasciculatum* in *Withanio somnifera* and AM fungi are known to improve plant growth mainly through increased uptake of P and other nutrients (Jeffries, 1987). Increase in the N content in AM

Table 1 Effect of AM fungi on the growth parameters in *S. surattense*

T. No	Treatments	Plant height (cm)			Dry weight (g)		
		30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1	Control	7.43	28.76	49.46	0.22	3.30	3.60
T_2	*A. laevis*	12.38	35.75	57.05	0.80	4.72	6.18
T_3	*G. fasciculatum*	11.96	35.02	56.82	0.75	4.53	5.83
T_4	*G. macrocarpum*	10.81	33.45	55.00	0.60	4.25	5.25
T_5	*A. laevis* + *G. fasciculatum*	14.66	38.89	60.73	1.09	5.24	7.35
T_6	*A. laevis* + *G. macrocarpum*	14.06	38.15	60.18	1.03	5.15	6.98
T_7	*G. fasciculatum* + *G. macrocarpum*	13.52	37.32	58.90	0.95	4.98	6.76
T_8	*A. laevis* + *G. fasciculatum* + *G. macrocarpum*	15.80	40.45	62.56	1.22	5.50	7.95
	SEd	0.56	0.77	0.90	0.06	0.12	0.28
	CD (p = 0.05)	1.12	1.54	1.80	0.12	0.24	0.56

Table 2: Effect of AM fungi on the NPK contents in *S. surattence.*

T. No	Treatments	N (g/plant)			P (g/plant)			K (g/plant)		
		30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1	Control	26.80	52.90	95.90	9.70	30.70	65.40	15.40	28.05	57.40
T_2	*A. laevis*	32.74	60.55	104.90	16.70	37.70	73.45	21.68	35.33	65.15
T_3	*G. fasciculatum*	32.05	59.82	103.52	15.64	37.13	72.52	20.95	34.50	64.60
T_4	*G. macrocarpum*	30.73	58.08	101.60	14.15	35.51	70.74	19.55	32.87	62.80
T_5	*A. laevis* + *G. fasciculatum*	35.38	64.05	108.69	19.67	40.90	77.00	24.45	38.58	68.68
T_6	*A. laevis* + *G. macrocarpum*	34.80	63.51	107.52	18.88	40.15	76.56	23.89	37.61	67.55
T_7	*G. fasciculatum* + *G. macrocarpum*	34.06	62.30	106.80	18.20	39.30	75.23	23.06	36.95	66.90
T_8	*A. laevis* + *G. fasciculatum* + *G. macrocarpum*	36.70	65.82	110.58	21.15	42.50	78.76	25.82	40.20	70.44
	SEd	0.65	0.86	0.94	0.73	0.79	0.87	0.68	0.80	0.87
	CD (p = 0.05)	1.30	1.72	1.88	1.46	1.58	1.75	1.36	1.60	1.74

Table 3: Effect of AM fungi on the micronutrient contents (copper, iron, manganese and zinc) in *S. surattense*

T. No	Treatments	Cu (ppm plant^{-1})			Fe (ppm plant^{-1})			Mn (ppm plant^{-1})			Zn (ppm plant^{-1})		
		30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1	Control	7.60	15.52	20.70	89.69	109.70	126.30	13.90	21.90	26.01	9.65	17.01	21.10
T_2	*A. laevis*	10.17	18.47	24.32	95.02	116.18	134.92	16.08	24.20	28.75	12.00	19.80	24.50
T_3	*G. fasciculatum*	9.95	18.31	23.95	94.56	115.52	133.99	15.75	23.98	28.42	11.72	19.48	24.03
T_4	*G. macrocarpum*	9.37	17.60	23.13	93.40	114.06	132.08	15.30	23.45	27.81	11.20	18.85	23.30
T_5	*A. laevis + G. fasciculatum*	11.32	19.88	25.96	97.35	119.10	138.77	17.04	25.25	29.94	13.04	21.05	26.00
T_6	*A. laevis + G. macrocarpum*	10.98	19.30	25.52	96.92	118.64	137.55	16.95	25.03	29.62	12.87	20.74	25.86
T_7	*G. fasciculatum + G. macrocarpum*	10.74	19.17	25.14	96.19	117.64	136.85	16.55	24.72	29.34	12.51	20.43	25.25
T_8	*A. laevis + G. fasciculatum + G. macrocarpum*	11.90	20.58	26.78	98.52	120.58	140.70	17.52	25.78	30.54	13.56	21.68	26.74
	SEd	0.28	0.34	0.40	0.57	0.72	0.95	0.23	0.25	0.29	0.25	0.30	0.36
	CD (p = 0.05)	0.56	0.68	0.80	1.14	1.44	1.90	0.46	0.50	0.58	0.50	0.60	0.72

Table 4: Effect of AM fungi on percent root colonization and spore number of *S. surattense*

T. No	Treatments	Per cent root colonization			Spore number/25 g of rhizosphere soil		
		30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T1	Control	24.01	34.65	51.10	28.50	37.70	52.60
T2	*A. laevis*	29.19	40.30	57.45	35.96	45.48	60.33
T3	*G. fasciculatum*	28.54	39.92	57.02	35.12	44.56	59.86
T4	*G. macrocarpum*	27.40	38.60	55.55	33.45	42.84	58.04
T5	*A. laevis + G. fasciculatum*	31.47	42.96	60.42	37.28	48.92	63.98
T6	*A. laevis + G. macrocarpum*	31.02	42.12	60.15	38.56	48.56	63.45
T7	*G. fasciculatum + G. macrocarpum*	30.33	41.64	58.93	37.62	47.20	62.14
T8	*A. laevis + G. fasciculatum + G. macrocarpum*	32.62	44.30	61.90	40.94	50.64	65.80
	SEd	0.56	0.65	0.73	0.82	0.84	0.90
	CD (p = 0.05)	1.12	1.30	1.46	1.64	1.70	1.80

inoculated plants has been reported by Kessel *et al.* (1985). Potassium has a major role on photosynthesis which has been established with a wide range of higher plants (Hartt and Burr, 1967).

The trace elements namely copper, iron, manganese and zinc analyzed in the *S. surattense* test plants were also found to be influenced by AM fungal inoculation. Among the eight treatments, T_8 recorded the maximum Cu, Fe, Mn and Zn content (26.78, 140.70, 30.54 and 26.74 ppm plant^{-1}) at 90 DAS. . It was followed by T_5 (25.96, 138.77, 29.94 and 26.00 ppm plant^{-1}), T_6 (25.52, 137.55, 29.62 and 25.86 ppm plant^{-1}) and T_7 (25.14, 136.85, 29.34 and 25.25 ppm plant^{-1}), T_2 (24.32, 134.92, 28.75 and 24.50 ppm plant^{-1}), T_3 (23.95, 133.99, 28.42 and 24.03 ppm plant^{-1}), T_4 (23.13, 132.08, 27.81 and 23.30), T_1 (20.70, 126.30, 26.01 and 21.10 ppm plant^{-1}). The nutritional status of *W. chinensis* seedlings, *viz*., phosphorus, potassium, zinc, copper, magnesium and iron content, was also significantly higher in plants raised in soil inoculated with AM fungi as reported by Nisha and Rajeshkumar (2010). Variations in plant nutrient status in relation to the fungal species for other medicinal plant species were well documented (Ndiaye *et al.,* 2009).

The maximum percentage of root colonization and spore number recorded in consortium treatment (T_8) as 61.90% and 65.80/25 g of soil respectively. In dual inoculation treatment the higher per cent root colonization and spore number was observed in T_5 (60.42% and 63.98/25 g of soil), T_6 (60.15% and 63.45/25 g of soil) and T_7 (58.93% and 62.14/25 g of soil) followed by individual inoculation of *A. laevis* T2 (57.45% and 60.33/25 g of soil), *G. fasciculatum* T_3 (57.02% and 59.86/25 g of soil) and *G. macrocarpum* T_4 (55.55% and 58.04/25 g of soil). The minimum per cent root colonization and spore number was observed in (T_1) control 51.10% and 52.60/25 g of soil (Table - 4).

The rate of AM root colonization, vesicles and arbuscles formation in the root and AM fungal spore population in the rhizosphere of all five medicinal plants which showed a wide range of changes with in every month thought the year revealed by Kumar *et al* (2010). Kapoor *et al*. (2004) reported that root colonization percentage in fennel inoculated treatments with two species of mycorrhizal fungi (*G. fasciculatum* and *G. macrocarpum*) was substantially more than non-inoculated treatments. Sreenivasa and Gurumoorthy (1997) reported increased root colonization and spore numbers in the root zone soil of brinjal inoculated with different AM fungi. The predominant VAM spores observed in the soil sample includes *Glomus* and *Gigaspora* species from selected medicinal plants. (Thenmozhi *et al.,* 2011).

Thus, the present study reveals that the consortium inoculation of AM fungi (*A. laevis* + *G. fasciculatum* + *G. macrocarpum*) more effective in *S. surattense* plant. These bioinoculants have also proved to improve the growth and nutrient content of medically important plants. The greater plant biomass will be available to the drug manufacturers for the preparation and formulation of quality and effective drugs from these medicinally important plants for the treatment of various ailments.

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