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Investigation on Arbuscular Mycorrhizal colonization on the roots of some members of Fabaceae and selection of suitable hosts for mass multiplication of VAM

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Abstract

Leguminous plants are the very good hosts of both the root symbionts *viz*. vesicular arbuscular mycorrhizal (VAM) fungi as well as rhizobium bacteria and exhibit a very good deal of tri-partite symbiotic relationship. Thus, leguminous plants may well be served as exceptionally good host resource for mass multiplication of AM fungi. Keeping this view in mind, in this present investigation, 30 species of leguminous plants were studied to determine the colonization frequency of VAM fungi in their roots and rhizospheric soil. It was observed that all the 30 plant species were colonized by VAM fungi. Though there appeared a significant variation in root colonization (%). Among all the plants studied, *Arachis hypogea* showed highest percentage of colonization (94%) by VAM and the lowest colonization frequency was recorded in *Desmodium gangeticum* (10%). In legumes, mycorrhizal fungi and nitrogen fixing bacteria are the beneficial components of which contribute to plant growth, provide nutrients (N, P, K & others), inhibit phyto-pathogens and improve drought tolerance. Thus, the legumes with high to very high level of VAM colonization can be used as very efficient biological tool for mass multiplication of AM fungi as well as for restoration of degraded lands.

Keywords: Legumes, roots, vesicles, arbuscules, colonization.

1. Introduction

Mycorrhiza is the symbiotic association between soil born fungi with plant roots. In this association both organisms are benefited. The vesicular arbuscular mycorrhizae are ubiquitous in roots of vascular plants in nature (Harley and Smith 1983, Powel and Bagyaraj 1986; Gabor 1992). Vesicular arbuscular mycorrhizal symbiosis (Walker, Verma and Hock, 1995) is one of the most common and this symbiotic association occurs more than 80% of flowering plant species (Harley, J.L. and Smith, 1983). Fabaceae is one of the most important family of VAM association in dicots. In fabaceae, mycorrhizal fungi and nitrogen fixing bacteria are the two most important beneficial component of soil myco-rhizosphere, which contribute to plant growth and survival by reducing stresses through symbiosis (Sylvia and Williams 1992). The VAM fungi help the plants in uptake of P, N, Zn, K, Cu, S, and Other mineral elements (Powel and Bagyaraj, 1984). The benefit of VAM fungi is due to an increased zone of nutrient depletion by mycorrhizal roots as compared to non-mycorrhizal ones (Owuse, Bennoach and Wild, 1979). VAM association increased the establishment, nodulation, development of phosphate solubilizing bacteria in rhizospheric soil and atmospheric nitrogen fixation capacity in legumes.

In this study, 30 plants of the family Fabaceae were assed to determine colonization status to determine which has significant implications for screening of suitable host in view of mass multiplication of arbuscular mycorrhizal inoculum.

2. Materials and Methods

Site of collection: All the plants of the family Fabaceae were collected from the campus of University and some of the legumes were grown by sowing the seeds in the field of Botany department of the University of Burdwan.

Identification of the plants:

The plants were identified by using published literature and the herbarium of Botany Department, Burdwan University, Burdwan.

Assessment of root colonization:

Root clearing method (Phillips and Haymann 1970) was used to stain the roots. For each plant species fine tertiary roots were collected. Roots were gently washed under the running tap water and cut into 1cm. long segments. The root samples were placed in the test tubes and 10% KOH solution was poured in the test tubes. Then the test tubes were heated for different durations (20, 25, 30, 45 minutes) in a water bath. The root segments were washed with distilled water for several times and acidified with 1 (N) HCl and was stained with 0.05% Trypan blue. The excess stain was removed by washing with lactophenol root segments were temporarily mounted on the slide by using lactophenol and the edges of the cover slips were sealed with DPX and observed under the microscope (Leica DMLB 3000). Percentage of VAM colonization was calculated by using Nicolson simple formula (Gupta and Mukherjee 1999).

Colonization (%) =

$$\frac{\text{No. of root segments colonized with VAM}}{\text{Total no. of root segments observed}} \times 100$$

3. Results

Thirty (30) plant species belonging to the family Fabaceae (sub family- Papilionaceae, Caesalpiniaceae and Mimosaceae) were surveyed. Among these 30 plant species the lowest VAM association was recorded in *Desmodium gangeticum* (10%) followed by *Trigonella foenum-graecum* which exhibited 20% VAM association. On the other hand *Arachis hypogea* showed maximum of VAM association (94%). Furthermore in, *Lathyrus sativus* (92%), *Vigna radiata* (90%), *Cassia alata* (90%), *Tephrosia purpurea* (91%) VAM colonization has been noticed. It was observed that percentage of VAM association vary among the species even of the same genus like, *Desmodium gengeticum* colonization was 10% whereas in *Desmodium trifolium* it was 77% and in *Desmodium microphyllum* it appeared to be 45%. In the genus *Vicia*, there is also variation among the species like, *V.faba* and *V. hirsuta* showed 55% and 63% colonization respectively whereas *V. sativa* posses 75% symbiotic association.

Form the above discussion it is clear that the highest percentage of colonization was observed in *Arachis hypogea* (94%), followed by in *Lathyrus sativus* (92%), *Vigna radiata* (90%), *Pisum sativum* (87%), *Mimosa pudica* showed (85%) and *Cassia oxidentalis* (82%). However, minimum colonization was found in *Desmodium gangeticum* (10%).

Table 1. Vesicular Arbuscular Mycorrhizal colonization in some leguminous plants of West Bengal.

Serial No.	Plant name	Month(season)	Presence of DSE	% of vesicle	% of arbuscule	Hyphal colonization	colonization percentage within roots segment
1.	*Pisum sativum*	Winter	+	90% ±5.24	84%	+	87%
2.	*Dolichos lablab*	Winter	+	70% ±3.80	80%	+	75%
3.	*Cajanus cajan*	Winter	-	80% ±2.18	62%	+	71%
4.	*Lens esculenta*	Winter	-	50% ±1.29	70%	+	60%
5.	*Vigna radiata*	Winter	+	90% ±3.33	90%	+	90%

6.	*Vigna mungo*	Winter	+	39% ±2.25	40%	+	38%
7.	*Cassia sophera*	Autumn	+	68% ±1.78	70%	+	69%
8.	*Cassia alata*	Autumn	+	88% ±2.25	85%	+	90%
9.	*Cassia tora*	Autumn	+	68% ±1.78	65%	+	66%
10.	*Cassia oxidentalis*	Autumn	+	90% ±2.5	88%	+	82%
11.	*Mimosa pudica*	Spring	+	85% ±3.35	58%	+	40%
12.	*Clitoria terneata*	Autumn	-	49%	20%	-	15%
13.	*Vigna Unguiculata*	Winter	+	60% ±4.2	47%	+	80%
14.	*Cicer arietinum*	Winter	-	60% ±1.56	70&	+	62%
15.	*Tephrosia purpurea*	Winter	-	90% ±2.3	85%	+	91%
16.	*Phaseolus vulgaris*	Winter	+	80% ±3.89	75%	+	60%
17.	*Terumnus lebiales*	Winter	-	55% ±3.10	42%	+	40%
18.	*Trigonella foenum-graecum*	Winter	-	20% ±2.38	15%	+	10%
19.	*Desmodium trifolium*	Winter	+	80% ±1.88	75%	+	77%
20.	*Desmodim gangeticm*	Winter	+	10% ±1.01	10%	+	<10%
21.	*Desmodium micrphyllum*	Winter	+	47% ±1.22	56%	+	45%
22.	*Vicia faba*	Winter	+	65% ±1.78	55%	+	55%
23.	*Vicia sativa*	Winter	+	75% ±2.25	78%	+	75%
24.	*Vicia hirsuta*	Winter	+	62% ±1.89	65%	+	63%
25.	*Crotalaria juncea*	Autumn	-	70% ±2.20	72%	+	55%
26.	*Lathyrus sativus*	Winter	+	92% ±3.01	80%	+	92%
27.	*Abrus precatorius*	Spring	-	26% ±1.25	20%	+	22%
28.	*Macrodyloma sp.*	Winter	+	70% ±2.70	68%	+	25%
29.	*Arachis hypgaea*	Summer	+	90% ±4.59	70%	+	94%
30.	*Trifolium repens*	Winter	-	56% ±2.85	47%	+	36%

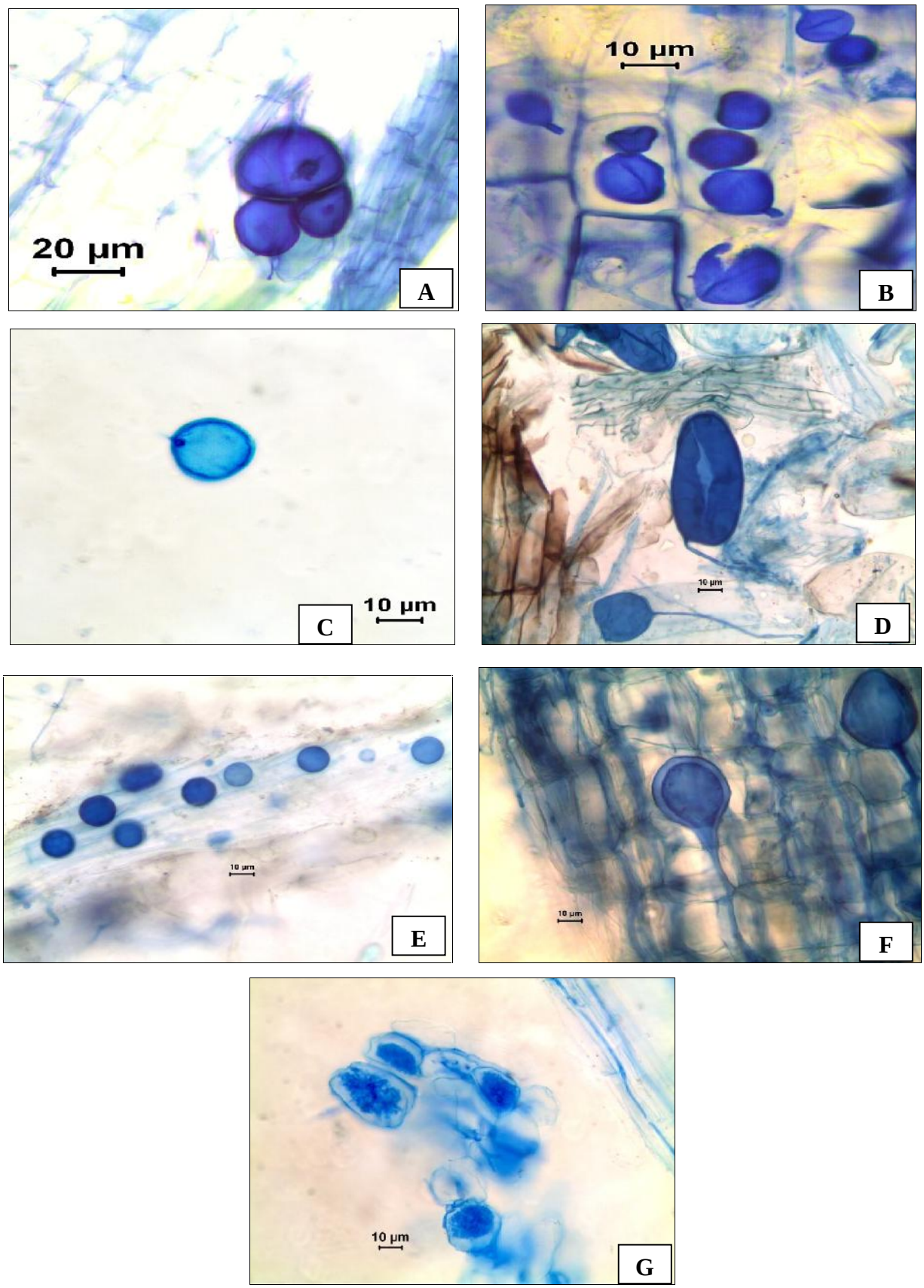

Figure 1. A: Vesicle of *A.hypogea*, B: Spores of *Lathyrus sativus*, C: Single spore of *Desmodium trifolium*, D: Vesicle of *Cassia alata*, E: Spores of *Vigna unguiculats* F: Vesicles of *Mimosa pudica* G: Arbuscules of *Desmodium trifolium*.

4. Discussion

As maximum root infection was found in *Arachis hypogea* (94%), and highest density of spore and hyphae were observed in the plant *Lathyrus sativus*.

In this screening of legumes, there is a significant variation in mycorrhizal colonization among the difference species. In the plants like *Vigna, Vicia, Cassia, Desmodium* all their different species posses different root colonization in *Vigna radiate* was 90% root-infection whereas in *V. mungo* it was 38% and in *Vigna unguiculata* 80%. So it is conclusive that mycorrhizal colonization varies significantly even among the species of the same genus.

As *Arachis hypogea, Lathyrus sativus, Vigna radiata, Pisum sativum* showed high percentage of colonization and as these are plants having marked economic value yielding edible nuts & pulses of commercial use, so results are highly significant suggesting that large scale cultivation of these pulses and groundnut have dual benefit for having pulse as well as mass inoculum production of VAM fungi.

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