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Importance of VAM fungi in increasing the yield of oil seeds crops

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Abstract

In the use of synthetic fertilizers is being discourage and they are being replaced by bio fertilizers or microbial inoculants symbiotic and non symbiotic nitrogen fixers vesicular Arbuscular Mycorhizae (VAM) fungi are being exploited to insure better productivity of crops. They are being as microbial inoculants in order to achieve good growth and high yield through an increased uptake of phosphorus.

In view of the facts stated above, the present study is undertaken in order to explore the possibility of developing a package of microbial fertilizer which could insure better productivity of crops without the aid of high input of chemical fertilizers.

Keywords: Biofertilizers, nitrogen fixers, VAM, growth and yield.

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Introduction

Phosphate is one of the most required in optimum amounts for proper growth of plants about 98% of the Indian soils have inadequate supply of available phosphorus (More ever, due to chemical fixation of phosphate fertilizers by soil, their efficiency of utilization is of the order of 10 to 15% only (Gaur 1982). Therefore, the solubilization of fixed soil phosphorus is of practical importance.

Vesicular Arbuscular Mycorrihizal (VAM) fungi form a symbiotic association with the roots of the plants and are capable of scavenging phosphorus from the soil solution into the root system mainly through the exploration of the soil by the external hyphae beyond the plant uptake of Zinc, Copper, Sulphur, Potassium and calcium play an important role in water economy of plants: During last twenty years much attention has been paid to VAM fungi as tool for improving the growth of agricultural crops. The symbiotic system of these fungi has also been exploited to save the costly phosphatic fertilizers (Abbott & Robson, 1982). Though the use of phosphatic fertilizers has increased to such an extant that they are losing their relevance in developing countries, due to their heavy cost and pollution problems. Under the circumstances, availability of a system which can improve the fertilizer efficiency is a great asset to the agriculture in these countries. According to Mosse (1973) 75% of the phosphorus applied to the crops is not utilized by them gets converted to form unavailable to plants. It has been estimated that in soils of high pH a major portion of the fertilizer applied becomes non-usable (fixed) via chemical reactions. VAM fungi have been found to be very effective under such conditions, because of their ability to utilize extremely small quantities of fertilizer. That is the reason why VAM fungi are being regarded as biofertilizers and their use in agriculture is being encouraged. They may play an important role in the tropical agriculture because in the tropics the soils are phosphorus deficient as well as phosphorus fixing (Dobin, 1980). Farmers in the tropics are generally poor and they cannot afford high input technology. Phosphatic fertilizers are expensive due to the high energy cost. Mycorrhizal benefits are greatest and most obvious under low fertilizer input conditions that exist in developing countries. The marginal agricultural lands could be made more productive if VAM fungi having the ability to utilize extremely small quantities of fertilizer are selected and added to the soil.

A number of factors have been shown to govern the response of the host to a VAM inoculants viz., type and density, infection potential, site of placement, spread and competitive abilities etc. According to Hayman (1982) four major factors can determine the success of the inoculation, the crop species involved the size and effectiveness of the indiginous VAM fungal population, the fertility of the soil and cultural practices.

Good establishment in the soil and residual effect of introduced VAM fungi have important implications in the tropics because of intensive cropping pattern. Good residual effects save the expenses of reinoculation and may enhance rapid infection which is important for short duration crops. But the persistence of introduced VAM fungi will depend on its ability to cope with physical and biological stresses.

Materials and Methods

A number of sides were identified in and around Ayodhya and a number of agricultural fields raising diverse crops were marks out of each site. Roots of different crops along with adhering soil were collected from different spots in a field and merged into a composite sample. Roots of five plants were selected at random from each composite sample were collected and stored for recoding population of the spores of VAM fungi.

The washed roots were segmented into pieces of one cm. hundred segments selected randomly were cleared in 10% KOH solution for 24 hours at room temperature (Phillips and Hayman 1970). This removed the cytoplasm and nuclei form them and they became clear with vascular sylinder distinctly visible. The segments were removed from KOH solution and rinsed well in a Petridis at least three times with water. They were then transferred to 3% solution of sodium hypochlorite and kept at room temperature for 10-20 minutes. After that they were rinsed thoroughly in water to remove all the sodium hypochlorite. They were then kept in 1% HCL for 3 to 4 min. The segments were then stained in 0.05% trypan blue and mounted on slides in 50% glycerin. All infected an unifected segments were counted and the percentage root colonization was calculated as follows:

% VAM colonization of root =

$$\frac{\text{Number of Infected segments}}{\text{Total Number of Segments examined}} \times 100$$

Results

Potentaility of VAM fungi to improve performance of linseed and Sesamum under pot condition

Two varieties of linseed (Shubhra and Garima) and two of sesamum (T-4 and T-12) was included in the study. Ten isolates of Glomus sp. (SCS_1, SCS_2, SCS_3, SCS4, SCS_5, SCS_1, SCS_2, SCS_3, SCS_4, SCS_5,) recovered from the agricultural fields at Ayodhya and adjacent regions were evaluated for their efficacy in improving the performance of the crops in terms of their growth and yield. The isolates were first evaluated for their growth to colonize the roots of the crops in sterilized and unsterilized field soil. The crops were raised in earthen pots with soil separately supplemented with different isolets of Glomus sp. The Mycorrhizal intensity in the roots of linseedling and the population of spores in their rhizoshpere were recorded.

In sterilized soil (Lacking indigenous VAM inoculums, the seedling of both the crops showed neither mycorrhization in their roots nor VAM spores in their rhizoshpere [Table 1 & 2]. On the other hand, in the same soil, in the presence of added inoculums of different isolated of Glomus sp. the seedling of both the crops showed mychorrhization in the roots as well as VAM spores in their rhizoshpere irrespective in the rhizoshpere of the seedlings varied with the isolates. A comparison however, shows that out of 10 isolates, the following caused comparatively higher mycorrhization of the roots [Table 03 & 04].

Linseed

Var. SHUBHRA = SCS_2, SCH_2, SCH_5

Var. GARIMA = SCH_3

Sesamum

Var. T-4 = SCS_2, SCH_2, SCH_6

Var. T-12 = SCS_3, SCH_3

Table : 01

Mycorrhizal infection in the roots and spores population in the Rhizoshpere of seedling of linseed Var. *Shubhra* and *Garima* inoculated with different VAM fungi in sterilized soil.

VAM Fungi inoculated	Var: Shubhra		Var: Garima	
	% root bits infected	Spore population 20gm dry soil	%root bits infected	Spore population 20gm dry soil
SCS_1	34	40	20	35
SCS_2	50	65	45	50
SCS_3	48	55	44	39
SCS_4	28	35	30	38
SCH_1	18	32	13	25
SCH_2	51	60	46	42
SCH_3	42	35	83	28
SCH_4	42	38	31	45
SCH_5	85	48	28	45
SCH_6	35	45	30	26
Control	00	00	00	00

Minimum difference required for significance (C.D.) at 5% level:

Var: Shubhra

% Infection= 2.76

Spore Population= 2.84

Var: Shubhra

% Infection= 3.04

Spore Population= 3.55

Table: 02
Mycorrhizal infection in the roots and spores population in the Rhizoshpere of seedling of Sesamum Var. *T-4* and *T-12* inoculated with different VAM fungi in sterilized soil.

VAM Fungi inoculated	Var: T-4		Var: T-12	
	% root bits infected	Spore population 20gm dry soil	%root bits infected	Spore population 20gm dry soil
SCS_1	35	22	50	32
SCS_2	48	25	50	29
SCS_3	45	30	52	55
SCS_4	28	36	42	37
SCH_1	38	40	46	49
SCH_2	51	28	49	61
SCH_3	42	33	39	38
SCH_4	41	31	32	35
SCH_5	38	31	40	61
SCH_6	48	36	38	29
Control	00	00	00	00

Minimum difference required for significance (C.D.) at 5% level :

Var: T-4
% Infection= 1.89
Spore Population= 1.17

Var: T-12
% Infection= 1.94
Spore Population= 1.74

Table: 03
Mycorrhizal infection in the roots and spores population in the Rhizoshpere of seedling of linseed Var. *Shubhra* and *Garima* inoculated with different VAM fungi in unsterilized soil.

VAM Fungi inoculated	Var: Shubhra		Var: Garima	
	% root bits infected	Spore population/ 20gm dry soil	%root bits infected	Spore population/ 20gm dry soil
SCS_1	88	65	77	58
SCS_2	98	82	96	85
SCS_3	98	120	96	106
SCS_4	88	96	65	79
SCH_1	73	98	83	62
SCH_2	95	118	98	76
SCH_3	79	89	93	56
SCH_4	91	78	60	72
SCH_5	80	105	79	68
SCH_6	92	102	83	92
Control	45	59	48	81

Minimum difference required for significance (C.D.) at 5% level :

Var: Shubhra
% Infection= 1.46
Spore Population= 2.27

Var: Shubhra
% Infection= 2.34
Spore Population= 1.76

Table: 04
Mycorrhizal infection in the roots and spores population in the Rhizoshpere of seedling of Sesamum Var. *T-4* and *T-12* inoculated with different VAM fungi in unsterilized soil.

VAM Fungi inoculated	Var: T-4		Var: T-12	
	% root bits infected	Spore population 20gm dry soil	%root bits infected	Spore population 20gm dry soil
SCS_1	62	48	85	125
SCS_2	84	69	86	108
SCS_3	85	115	86	110
SCS_4	74	55	65	98
SCH_1	80	65	31	75
SCH_2	89	82	87	68
SCH_3	56	41	82	46
SCH_4	29	45	51	72
SCH_5	75	66	73	68
SCH_6	80	110	52	59
Control	17	59	35	48

Minimum difference required for significance (C.D.) at 5% level :

Var: T-4

% Infection= 1.87
Spore Population= 1.83

Var: T-12

% Infection= 1.54
Spore Population= 2.37

On the other hand, the following isolates produced higher population of spores in the rhizoshpere –

Linseed

Var. SHUBHRA = SCS_2, SCH_2,
Var. GARIMA = SCS_2, SCH_4, SCH_5

Sesamum

Var. T-4 = SCS_4, SCH_1,, SCH_6
Var. T-12 = SCH_1, SCH_5

In unsterilized soil, having indigenous VAM inoculums, the seedling of both the crops showed a low level of mycorrhization in their roots and spores in their rhizoshpere. In presence of added inoculums of different isolates of ***Glomus sp.*** the seedling of both the crops showed comparatively higher mycorrhization in their roots as well as higher population of VAM spores in their rhizoshpere. However, irrespective of the crops and their varieties, the improvement of mycorrhization in roots and population of VAM spores in the rhizosphere varied with the isolates of ***Glomus sp.*** emoloyed.

The following isolates caused comparatively higher mycorrhization in roots.

Linseed

Var. SHUBHRA	=	SCS_2, SCS_3, SCH_3
Var. GARIMA	=	SCS_2, SCS_3, SCH_2

Sesamum

Var. T-4	=	SCS_2, SCS_3, SCH_2
Var. T-12	=	SCS_2, SCS_3, SCH_2

On the hand, the following isolates produced higher population of spores in the rhizosphere :-

Linseed

Var. SHUBHRA	=	SCS_3, SCH_2, SCH_5, SCH_6
Var. GARIMA	=	SCS_3, SCH_6

Sesamum

Var. T-4	=	SCS_3, SCH_6
Var. T-12	=	SCS_1, SCS_2, SCH_3

A comparision shows that even in the presence of indigenous VAM and other microbes in the soil, three isolates of ***Glomus sp.*** viz. SCS_2, SCS_3 and SCH_2 caused comparatively higher mycorrhization in the roots of the crops. On the basis of a critical study on the morphology of spores, the isolates were identified as follows :-

Isolate SCS_2	=	***G. fasciculatum*** (Thaxter sensu Gerd.) Gerdemann & Troppe
Isolate SCS_3	=	***G. claroideum*** Schenck & Smith
Isolate SCH_4	=	***G. aggregatum*** Schenck & Smith

Discussion and Conclusion

VAM fungi have been shown to differ in the exist to which they benefit the plants and improve their performance.

The ability of VAM fungi to improve the performance of plant does not depend only on their capacity to form mycorrhiza rapidly and extensively but also on their ability to absorb nutrients from soil and to transfer them to host.

The difference in the efficiency of different VAM fungi is related to same kind of "inmate efficiency " and at least four factors govern this efficiency viz, the ability to form extensive and well distributed hyphae in soil, the ability of hyphae to absorb nutrients specially phosphorus from the soil and the logetivity of the transport mechanism along hypae and into the root all these characteristics are involved with the uptake of nutrients and may differ in different VAM fungi.

Improvement in the yield as well as growth of roots and shoots of linseed and sesamum was recorded in the present study may be safely attributed to an increased input of phosphorus and nitrogen in their shoots.

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