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Occurrence and characterization of Arbuscular Mycorrhizal Fungi in rainfed paddy fields of Bilaspur, Chhattisgarh

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ABSTRACT

Arbuscular mycorrhizal (AM) fungi are ubiquitous in nature. Occurrence of AM fungi is greatly affected by availability of water. In present study occurrence of AM fungi was investigated in paddy crop under rainfed field located in district Bilaspur, Chhattisgarh. AM colonization, occurrence of AM species, spore density were studied in root and soil samples collected from two rainfed paddy fields of Bilaspur district. The main morphological type of AM colonization was Arum-type in all samples. Difference in shape and size of intraradical vesicles indicated the colonization of multiple species of AM fungi in roots. In most of samples, vesicles were mostly elliptical, globose and spherical shaped which indicates the dominance of Glomus species in the soil. In few samples, rectangular shaped vesicles were also observed. Present study regarding the occurrence of AM fungi in rainfed agro-ecosystem condition in paddy crop will provide basic information on AM diversity which may be utilized for the development of AM inoculants for paddy crop.

Keywords: Arbuscular Mycorrhizal Fungi, AMF, paddy, rainfed

INTRODUCTION

Rice (*Oryza sativa* L.) is an important crop grown under irrigated or rainfed conditions, InChhattisgarh; rice occupies average of 3.6 million ha. with the productivity of the state ranging between 1.2 to 1.6 t/ha depending upon the rainfall. The cropping system of the state is mainly rain dependent. It is well known fact that most of the terrestrial plants (more than 90% of all known species) have association with at least one type of mycorrhizal and out of all, Arbuscular Mycorrhizal fungi (AMF) plays a very important role on enhancing the plant growth and yield due to increased supply of phosphorus to the host plant (Grant *et al.*, 2005).The AMF symbiosis is characterized by highly branched fungal structures, *arbuscules, vesicles and spores*, and form two morphologies, Arum- and Paris-type. The determining factors defining the two different morphologies are not well understood. The use of mycorrhizal biofertilizer helps to improve plant growth and vigor. Therefore, plants with mycorrhizal association will have higher efficiency for nutrients absorption even under extreme agro climatic condition (Purakayastha and Chhonkar, 2001). In spite of importance and wide occurrence of AMF only few reports were on the AMF colonization and its application in paddy crop. Being rice a main crop of Chhattisgarh, it is essential to quantify the AM colonization in this important crop. In view of the importance and needs of AMF associations and also the paucity of work done in the tropical countries particularly rice cultivation, the present study was undertaken to work out the AMF colonization pattern and quantification of AMF colonization under rainfed agricultural system.

MATERIALS AND METHOD

Root samples were collected in triplicate from two villages of Bilaspur district of (Chhattisgarh), namely Beltara and Janji. For collection of root samples plant were uprooted carefully with the help of hoe and care was taken to prevent the main root, secondary roots. Samples were collected in triplicate. Roots were collected with carefully for experiment because these fine roots give better result for assessment of colonization of AM fungi. Freshly collected root samples were rinsed with distill water several times to wash the roots thoroughly. Roots were cut into small pieces of about 1 cm of length for cleaning and staining procedure. Since AMF root colonization consists of intra and intercellular hyphae, vesicles together with finely branched arbuscules within the host cortical tissue. The study of anatomical characteristics of AM fungi requires suitable staining. The Phillips

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and Hayman (1970) procedure for root clearing and staining was followed for its quick results and application for wide range of host plants. Arbuscular mycorrhizal colonization were determined by the slide method. Root segments were selected randomly from the stained samples and observed for the presence or absence of functional structures (mycelium, vesicles and arbuscules) of arbuscular mycorrhizal fungi under microscope. A minimum of 100 root segments were used for this enumeration, and the colonization by arbuscular mycorrhizal fungi was calculated using the following formula:

$$\text{AM Colonization (\%)} = \frac{\text{Total no. of root segment having AM colonization}}{\text{Total number of root segment studied}} \times 100$$

RESULTS AND DISCUSSION

Monocot plants are known for high affinity with AM fungi but in present investigation rice plants showed moderate AM colonization. This was greatly supported by Sun *et al.* (2013) and Zhang *et al.* (2016) who reported a gradual decrease in the number of AMF spores at the seedling stage and then increased at the booting stage to reach a maximum. AM colonization was 29% in the root samples collected from Janji village followed by Beltara village (17%) (Table:1; Fig. 1).The number of vesicle per 100 root segment showed a reverse trend for AM colonization. Number of vesicles was higher in the root samples of Beltara village in comparison to Janji village (Fig. 2). There existed no correlation between % AM colonization and number of vesicle formation in the roots and also plant type (monocot).

Table: 1 Different attributes of AM fungi in paddy under rainfed condition

Study site	No. of Vesicles per 100 root segments	AM Colonization (%)	Type of AM colonization	Structure of AM fungi associated with roots
Janji village	5	29%	Arum type	Extararadical and intararadical mycelium, vesicles, and spores extararadical spores *Glomus mosseae* present.
Beltara village	44	17%	Arum type	Extararadical and intararadical mycelium, vesicles spores and Sporocarp like structure present.

Mycorrhizal nature of rice was reported in lowland and upland rice cultivation (Herdler *et al.*, 2008; Rajshekannan *et al.*, 2009; Subramaniam *et al.*, 2012). Arbuscular mycorrhizal colonization pattern was mostly arum type at both study sites. Arbuscular mycorrhizal structures i.e. Extra radical hyphe, intra radical hyphe, extra radical spore, intra radical spore, intra radical vesicles as well as extra radical vesicles and extra radical mycelium, intra radical mycelium were observed whereas no arbuscules were observed in roots at both sites (Plate 1 & 2).

In root sample of Janji field, AM colonization was higher, and an extensive network of extra radical AM mycelium was observed. The width and length of mycelium varied and intra radical mycelium was observed in the root samples. Although initiation point or penetration point and appressoria were not clearly observed but initiation of vesicle formation was clearly observed throughout the length of the root segments. Intra radical vesicles and intra radical spore were also present in the root sample at Janji village. Spore morphology reveals that these spores were seems to be *Glomus* species, (Fig. 1). An extra radical spore *Glomus mosseae* (= *Funneliformis mossae*; Schüßler and Walker, 2010) observed hyphal network associated with fine feeder roots (Plate 1).

In Beltara root sample showed moderate AM colonization (17%) and relatively higher number of vesicles (44 vesicles per 100 root segments) were noted. Extra-radical mycelium, intra radical mycelium and hyphal coil was also observed. As evident from the results that the number of vesicles was higher and varied in shape and size. In spite of poor colonization, the intra-radical vesicles of various shape and size were observed in roots of *Oryza sativa*. Generally vesicle shapes were spherical, oval, elliptical but rectangular shaped vesicles were also observed in few root samples. The shape of

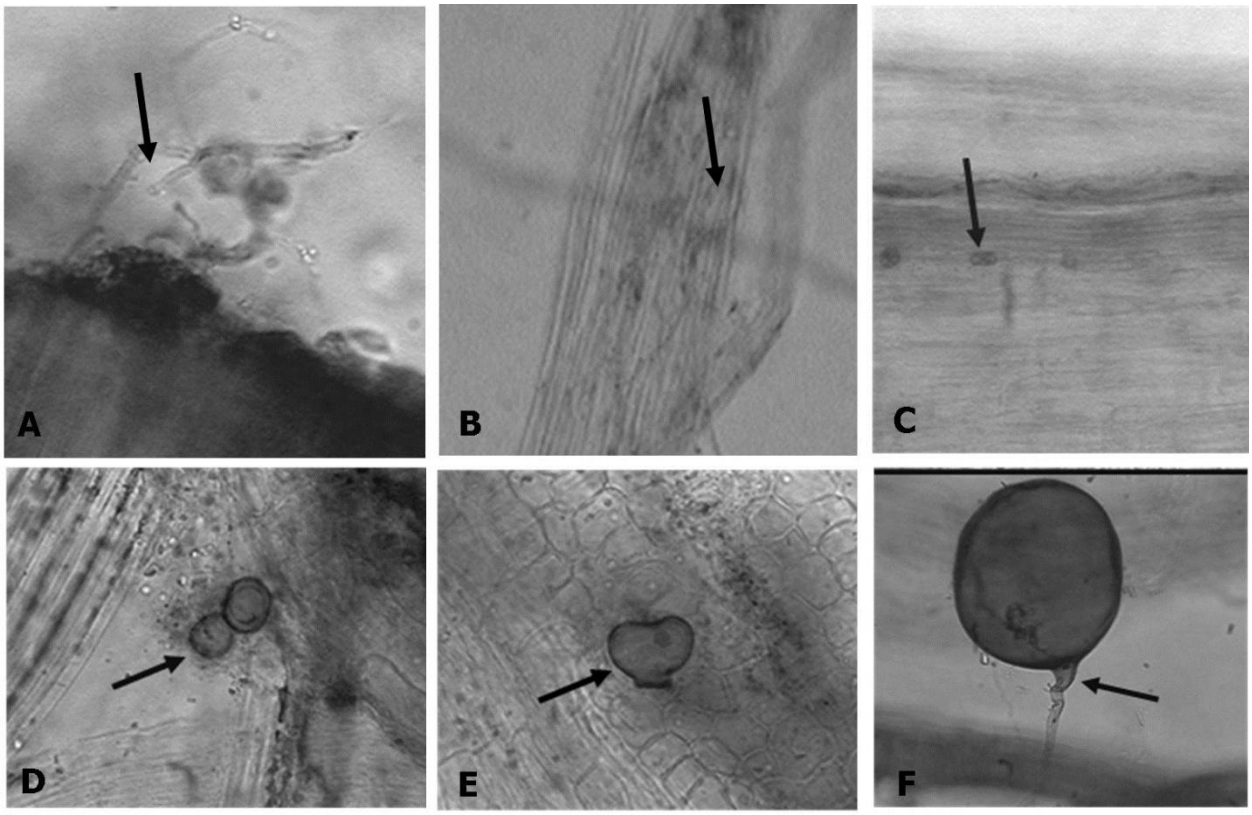

Plate 1: Structure of arbuscular mycorrhizas formed in the roots of rice from Janji village: (A) Extra-radical mycelium, (B) Inra-radical mycelium, (C) Inception of Intra radical vesicles, (D) Intra-radical spore, (E) Intra radical vesicles, (F) extra-radical spore *Glomus mosseae*(= *Funneliformis mossae*)

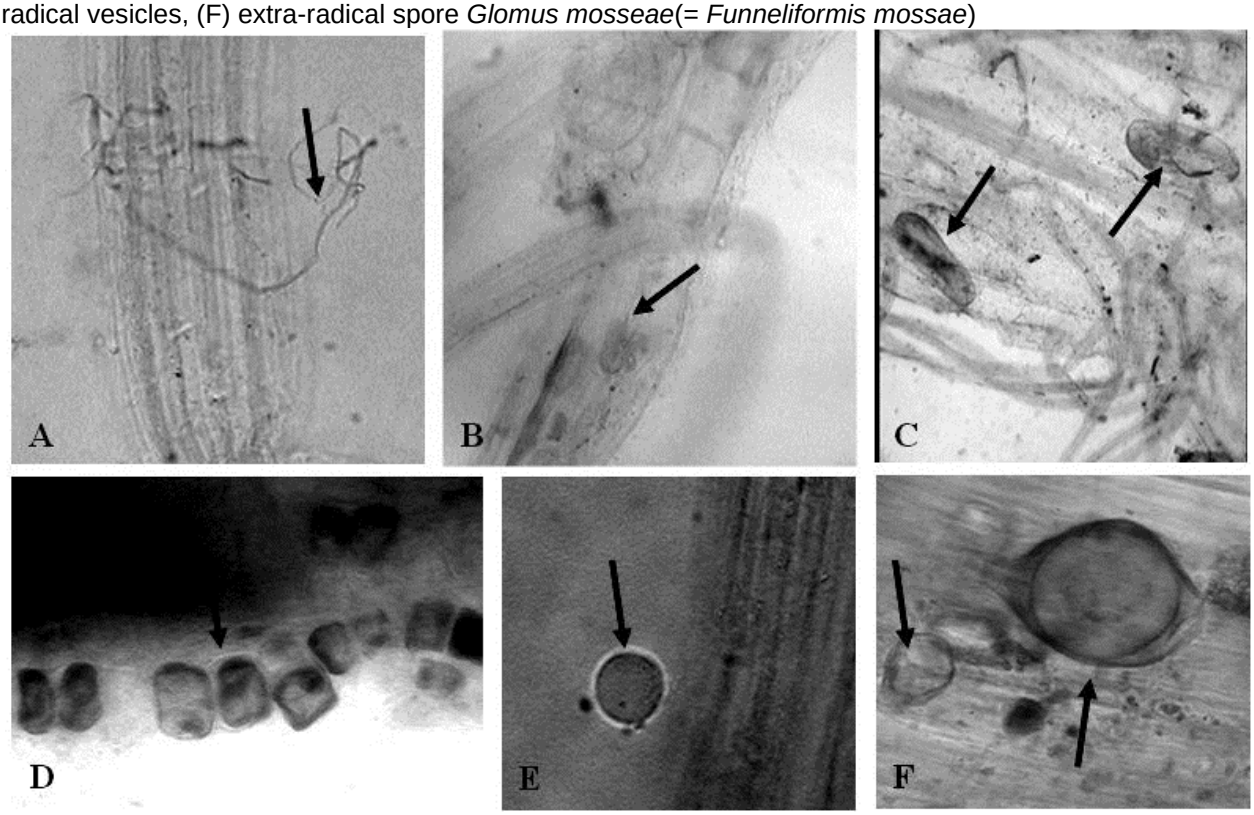

Plate 2: Structure of arbuscular mycorrhizas formed in the root o*f rice* form Beltara village showing (A) extra-radical mycelium, (B) intra-radical mycelium and hyphal coil (C) and (D) showing intra-radical vesicles of various shape and size, (E) extra-radical spore, (F) Intra radical vesicles and spore.

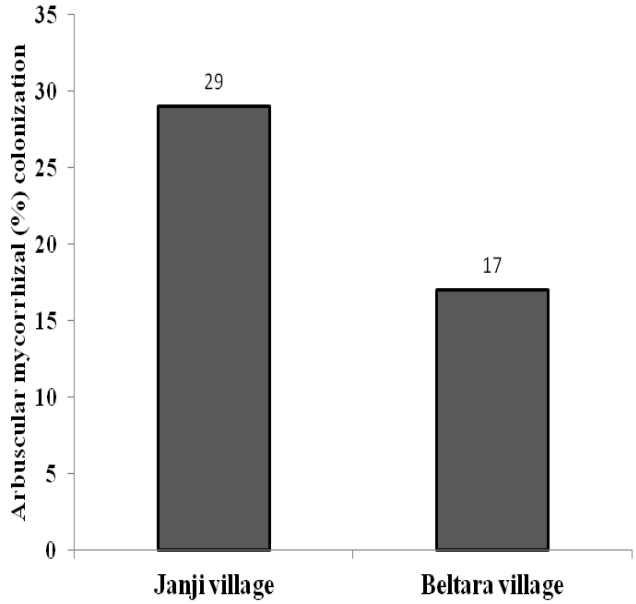

Fig.1: Arbuscular mycorrhizal colonization (%) in roots of paddy.

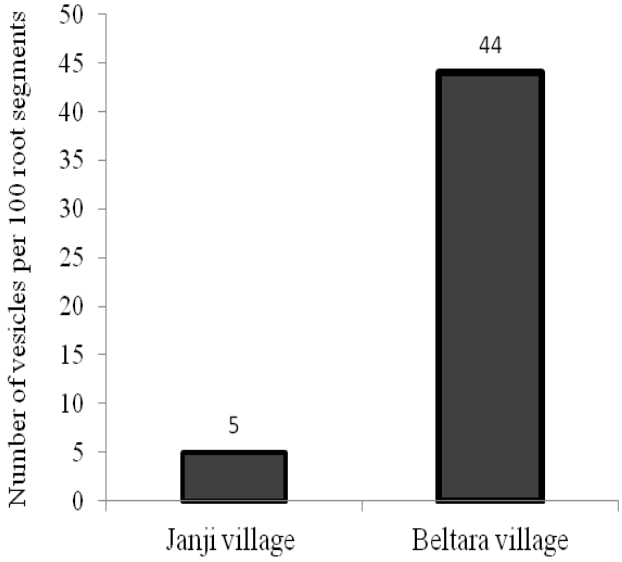

Fig.2: Number of vesicles of arbuscular mycorrhizal colonization in roots of paddy.

vesicle is totally dependent on the type AMF species, so more than one species or many species of AMF may be associated with root at a time. The frequent occurrence of vesicles in the species studied indicates that a large part of the AM fungi belong to the *Glominae*, and diversity in vesicle shape indicates the presence of both *Glomus* (oval to ellipsoid vesicles) and *Acaulospora* (irregularly shaped to rectangular vesicles) species in the soil (Plate 2).

Various types of extra radical spore and intra-radical spore were also observed in roots of Beltara. Intra radical spores were formed in group while extra radical spore other than *Glomus* are rarely formed in group. Arbuscules were not seen in any root sample of both sites. The presence of arbuscules in roots is generally used to associate plants with functional arbuscular mycorrhizae, while the arbuscules were almost absent in the root samples. A mycorrhizal plant was categorized by the presence of arbuscules – generally used to designate plants with functional AM (Munkvold *et al.*, 2004) – or by the presence of hyphae and vesicles in the root samples (Lee *et al.*, 2013).

It may be concluded from the study that AM colonization occur in rice root under rainfed condition, which will help to develop a better understanding towards the development of suitable AMF inoculants for the specific variety of rice in Chhattisgarh.

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REFERENCE

Grant, C., Bittman, S., Montreal, M., Plenchette, C., and Morel, C. (2005) Soil and fertilizer phosphorus: Effects on plant P supply and mycorrhizal development. Canadian Journal of Plant Science **85**: 3-14

Herdler, S., Kreuzer, K., Scheu, S., and Bonkowski, M. (2008) Interactions between arbuscular mycorrhizal fungi (*Glomus intraradices*, Glomeromycota) and amoebae (*Acanthamoeba castellanii*, Protozoa) in the rhizosphere of rice (*Oryza sativa*). Soil Biology and Biochemistry **40**: 660–668.

Lee, E.H., Eo, J.K., Ka, K.H., and Eom, A.H. (2013) Diversity of arbuscular mycorrhizal fungi and their roles in ecosystems. Mycobiology **41**(3): 121–125.

Munkvold L, Kjøller R, Vestberg M, Rosendahl S, and Jakobsen I. (2004) High

functional diversity within species of arbuscular mycorrhizal fungi. New Phytology **164**:357–364.

Phillips J.M. and Hayman D.S. (1970) Improved procedures for clearing roots and staining parasitic and vesicular-arbuscular mycorrhizal fungi for rapid assessment of infection. Trans Brit. Mycol. Soc., **55**: 158–161

Purakayastha, T.J. and Chhonkar, P.K. (2001) Influence of vesicular-arbuscular mycorrhizal fungi (*Glomus etunicatum* L.) on mobilization of zinc in wetland rice (*Oryza sativa* L.) Biology and Fertility of Soils **33**: 323-327.

Rajeshkannan, V., Sumathi, C.S., and Manian, S. (2009) Arbuscular mycorrhizal fungi colonization in upland rice as influenced by agrochemical application Rice science **16**(4): 307–313.

Subramanian, K.S., Gomathy, M., Vijaykumar, S., and Balakrishna (2012) Responses of rice to mycorrhizal inoculation and moisture regimes. In: Proceedings of International Symposium on 100 years of rice science and looking beyond., Vol. II, 639-640.

Sun, X.F., Su, Y.Y., Zhang, Y, Wu, M.Y., Zhang, Z., Pei K.Q., Sun, L. F., Wan, S.Q., and Liang, Y. (2013) Diversity of arbuscular mycorrhizal fungal spore communities and its relations to plants under increased temperature and precipitation in a natural grassland. Chinese Science Bulletin, Vol.58 No.33: 4109–4119.

Zhang T., YangX., Guo R.and GuoJ. (2016)Response of AM fungi spore population to elevated temperature and nitrogen addition and their influence on the plant community composition and productivity. Scientific Reports volume6, 1-12, Article number: 24749.