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SEASONAL DYNAMICS OF MYORRHIZAE IN SUGARCANECULTIVARS FROM MARATHWADA REGION OF MAHARASHTRA

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ABSTRACT

Present study revealed that the seasonal variations of arbuscular mycorrhial fungi in different cultivars of sugarcane were studied from five different study sites and correlated with physicochemical analyses.Root colonization was found maximum in winter season among studied cultivars.The maximum root colonization was found in Co86032 (70.91%) while minimum in Co8371 (24.53%) of winter season. Per cent root length colonization was maximum in Co8611 (44.86%) followed by C086032 (34.53%) in winter while minimum in Co8371 (7.97%) in monsoon. Hyphal, vesicular and arbuscular types of colonization was observed in all cultivars.The highest spore density was observed in cultivar Co740 (867±2.1) followed by Co7114 (823±5.22) in winter season while minimum in Co8611 (266±4.12) in monsoon. The AM fungal spore species diversitywas observed in Co740 and Co7114 cultivars.*Acaulospora* and *Glomus* genera were found dominant.

Keywords: *Saccharum officinarum*,Cultivars, Seasonal variation AMF root colonization,Spore density and diversity

Sugarcane (*Saccharum officinarum*L.) belongs to family Poaceae of the tribe Andropogoneae. It is a tropical crop, grows most successfully in those areas where the climate is more or less tropical, but it can grow in sub-tropics also.arbuscular mycorrhizal fungal diversity in sugarcane rhizosphere in relation with soil properties has been reported (Datta and Kulkarni, 2012). An *in-vitro* study on sugarcane with respect to VAM fungi was carried (Muniyamma et al., 2000). Soil is the foundation of an agricultural field and mediates processes essential to the functioning of the system, including: biogeochemical cycling of elements such as carbon and other mineral nutrients; provision of habitat for soil organisms; movement, storage, and decontamination of water; and promotion of plant growth (Brady and Weil,2000). Soil organic Matter (SOM) encompasses living microorganisms as well as plant and animal tissues in various stages of decomposition (Craswell and Lefroy,2001).Seasonal dynamics of AM fungi in sugarcane (*Saccharum officinarum* L. Cv. Spf-213) in relation to red rot (*Colletotrichum fulcatum*) disease reported from Punjab, Pakistan has noted (Nasim et al., 2008).It was discussed that the mycorrhizal symbiotic status changes the chemical composition of root exudates andfungi serves as a carbon source to rhizosphere microbial communities and further it introduces the physical modifications in the environments surrounding the plant roots (Barea et al.,2002). The growth and development of the plant root probably plays an important role in improving the productivity of sugarcane and root growth in the soil is influenced by various cultural practices, irrigation and fertilizer application, AMF species and cultivars; however its root distribution is affected by physiochemical and biological factors (Gomathi et

al.,2015; Smith et al., 2005;Marin et al., 2011; Thorburn et al., 2009). Early seedling root growth and development determined the optimum root system throughout the entirely life of plant. This research was conducted to observe if there are any favourites among sugarcane varieties to be colonized by AM fungi species and whether root exudations of different sugarcane varieties have attracting or resistingimpacts with AM fungi.

MATERIALS AND METHODS

Sampe collections

The rhizosphere soil samples and roots of sugarcane five cultivars i.e. Co86032, C07114, Co8371, Co8611 and Co740 were collected from different localitiesof study sites of Maharashtra.The survey was conducted during 2019-20.

Physico-chemical parameters

Available Nitrogen was assessed by alkaline permanganate method by using Kjeldhal tube (Subbiah and Asija, 1956). Available Phosphorus in soil was determined by Olsens method by using spectrophotometer(Olsen et al.,1954;Bray and Kurtz., 1945).Water soluble and exchangeable Potassium was calculated by Ammonium acetate method of Hanway and Heidel using Flame photometer (Hanway and Heidel ,1952). Analysis of nitrogenwas done by acid digestion method (Jackson, 1967).

Soil and Root Sampling

Soil samples and roots were collected from the rhizosphere of sugarane plant. The samples consisting of feeder roots + soil were collected with the help of a soil auger (0-25cm) so as to represent the complex root zone. Root systems of common plant species were excavated taking care to ensure that fine root predominates in the sample and to exclude entangled roots of other species. Sufficient samples were taken to determine, if there is any variation in the constituency and degree of mycorrhizal colonization roots between or within the sampling cultivars. Roots were gently washed and immediately fixed in Formalin Acetic Acid Alcohol (FAA) in the field **(**Kormanik et al., 1980**)**. Rhizospheric soil was collected in polythene bags and after drying stored at 4^0C.

Mycorrhizal study

Numerous techniques were available to recover AMF spores from soil. The most basis of this is wet sieving and decanting, which remove the clay, sand and organic matter fractions while retaining spores and other similar sized soil particles on sieves of various with stainless steel stack of sieves (35, 63, 125,150 212 and 355µm). For the isolation, 100g of soil was weighed and is added to1000 ml of water taken in a conical flask. Then the flask was shaken well in a vortex mixture and allowed to sediment for few seconds and was immediately transferred to a series of sieves. The jar was washed twice with water and added in to sieves series. This sieving was collected in respected jars by washing with water. Then transferred the sieving on to a gridded petriplate and observed it under the binocular microscope 400X (Lawrence & Mayo LM-52-3521). The number of spores were counted and expressed as number of spores/100g of soil sample. These isolated spores were picked up using micropipette and were mounted in Poly Vinyl Lacto Glycerol (PVLG) to make permanent slides.

Root Colonization and Spore Density

Collected fresh roots were washed in tap water and cut into 1 cm pieces in length and cleared with 10% KOH and acidified in 5NHCL and stained with Trypan Blue **(**Phillips and Hayman,1970**)**. Root colonization percentage was measured according to the formula **(**Giovannetti and Mosse , 1980**).**It was recorded the mycorrhizal root length colonization was quantitatively calculated according to (McGonigles et al.,1990**;**Bierman and Linderman,1981**)**. Hundred grams of rhizosphere soil from each sample was analyzed for spore isolation by wet sieving and decanting method **(**Gerdemann and Nicolson, 1963). Identification of AM fungal species was done by using the manual **(**Schenck and Perez,1990**)**.

Statistical Analyses

The output results obtained from the differences between the cultivars and AMF are significant @$p<0.05$ or insignificant. All data were statistically analyzed and the significance of differences was determined by using book (Mungikar,1997).

RESULTS AND DISCUSSION

Study sites

The soil and roots samples of sugarcane five cultivars i.e. Co86032, C07114, Co8371, Co8611 and Co740 were collected from different localities such as Naldurg (17 º49' N, 76 º 15'E),Osmanabad (18º08'N,76º06'E), Nanded (19º09'N,77º27' E), Aurangabad(19º53'N,75º19' E) and Solapur ($17^0$65'N, $75^0$90'E) of study sites of Maharashtra.

Physico-chemical parameters

Plant health is interrelated with soil fitness. Proper management of the soil by conserving and enhancing the soil biota improve crop yields and quality. During investigation, soil studied from four different study sites i.e Naldurg,Osmanabad, Nanded , Aurangabad and Solapur.Types of soil are found medium blackish, black to brownish, black cotton black cotton and medium blackish respectively.It was found alkaline pH EC responsible for movement of cataions and anions from soil to root was sufficient and ranging from 0.18 to 1.02dS/m. Nitrogen was found maximum in Nanded (301.02kg/h) while minimum in Solapur (189.54kg/h), In case of phosphorus, Aurnagabad (67.32kg/h) site found maximum while least in Osmanabad (27.20kg/h).Potassium content was found maximum in Naldurg (616.04kg/h) minimum in Aurangabad (389.23kg/h) (Table 1).

Mycorrhizal Root colonization

Collected root samples from different cultivars, Mycorrhizal root colonization was foundmaximum in winter season. Among studied cultivars, Co86032 (70.91%) was found maximum root colonization followed by Co8611 (62.33%) and Co7114 (61.10%) in winter season. Per cent root length colonization wasfound maximum in Co8611 (44.86%) followed by C086032 (34.53%) in winter while minimum in Co8371 (7.97%) followed by Co 7114 (8.43%) in monsoon. Hyphal, vesicular and arbusular types of colonization was observed in all cultivars (Table 2; Fig.1).

Mycorrhizal Spore density& diversity

Spore density/ 100g soil was observed in all cultivars. The highest spore density was observed in cultivar Co740 (867±2.1) followed by Co7114 (823±5.22) in winter season while minimum in Co8611 (266±4.12) in monsoon.The five AM fungal spore species were observed in Co740 i.e. *Acaulospora gerdemannii, A.scrobiculata Gigaspora sporadecipiens Glomus clarum, Glomus macroaggregatum, Sclerocystis sinuosa followed* by Co7114.*Acaulospora*and*Glomus*genera were found dominant (Table 3;Fig.2).

Table 1: Physico-chemical parameters of rhizosphere soil.

Sr. No	Parameters of soil	Naldurg	Osmanabad	Nanded	Aurangabad	Solapur
1	Soil type	Medium Blackish	Black to brownish	Black cotton	Black cotton	Medium Blackish
2	pH	7.30	7.10	7.12	7.88	6.34
3	EC (dS/m)	0.29	0.12	1.02	0.43	0.83
4	Nitrogen (kg/ha)	207.81	262.01	301.02	202.40	189.54
5	Phosphrous (kg/ha)	50.32	27.20	34.07	67.32	47.12
6	Potassium (kg/ha)	616.04	470.86	423.11	389.23	412.11

Table 2: Status of AMF root colonization of sugarcane (n*).

Sr No.	Cultivars	(%) RC			(%) RLC			Type of Colonization
		Summer	Monsoon	Winter	Summer	Monsoon	Winter	
1.	Co86032	51.49	44.72	70.91	23.90	22.18	34.53	H,V
2.	Co7114	29.53	24.99	61.10	07.83	8.43	19.00	H,A,V
3.	Co8371	24.53	29.62	53.11	07.05	7.97	14.74	H,A,V
4	Co8611	57.00	45.34	62.23	23.07	12.11	44.46	H,A,V
5	Co740	44.41	49.54	50.14	11.00	9.11	15.05	H,A
CD@p=0.05%		17.35	13.44	10.18	10.29	7.39	16.55	

Legends: Values are means of three replication, **Rc**- Root colonization, **Rlc**-Root length colonization, **AMF**- Arbuscular Mycorrhizal Fungi, **H**- hyphal, **V** – Vesicular, **A**-Arbuscular and **n***- Number of root segments.

Table 2: Quantification of AM fungal spores in rhizosphere soil of sugarcane.

Sr. No.	Cultivars	Spore density/100 g soil			AM fungal species
		Summer	Monsoon	Winter	
1	Co86032	494±2.01	538± 2.11	801±2.12	*Acaulospora gerdemannii,Gigasporas* p
2	Co7114	617±3.04	501±3.12	823±5.22	*Gigasporaspora decipiens, Glomus clarumGlomusaggregatum*
3	Co8371	601± 2.23	428±6.11	789±3.23	*Acaulospora* sp, *Glomus macroaggregatum,*
4	Co8611	377±1.01	266±4.12	523±3.21	*Glomus aggregatum*
5	Co740	514±4.21	317±3.23	867±2.1	*Acaulospora gerdemannii, A. Scrobiculata, Gigasporaspora Decipiens, Glomus clarum, Glomus macroaggregatum, Sclerocystissinuos a*

Values are means of three replications, standard error (±).

Fig 1: Seasonal Variations of AMF Root Colonization of *S.officinarum.*

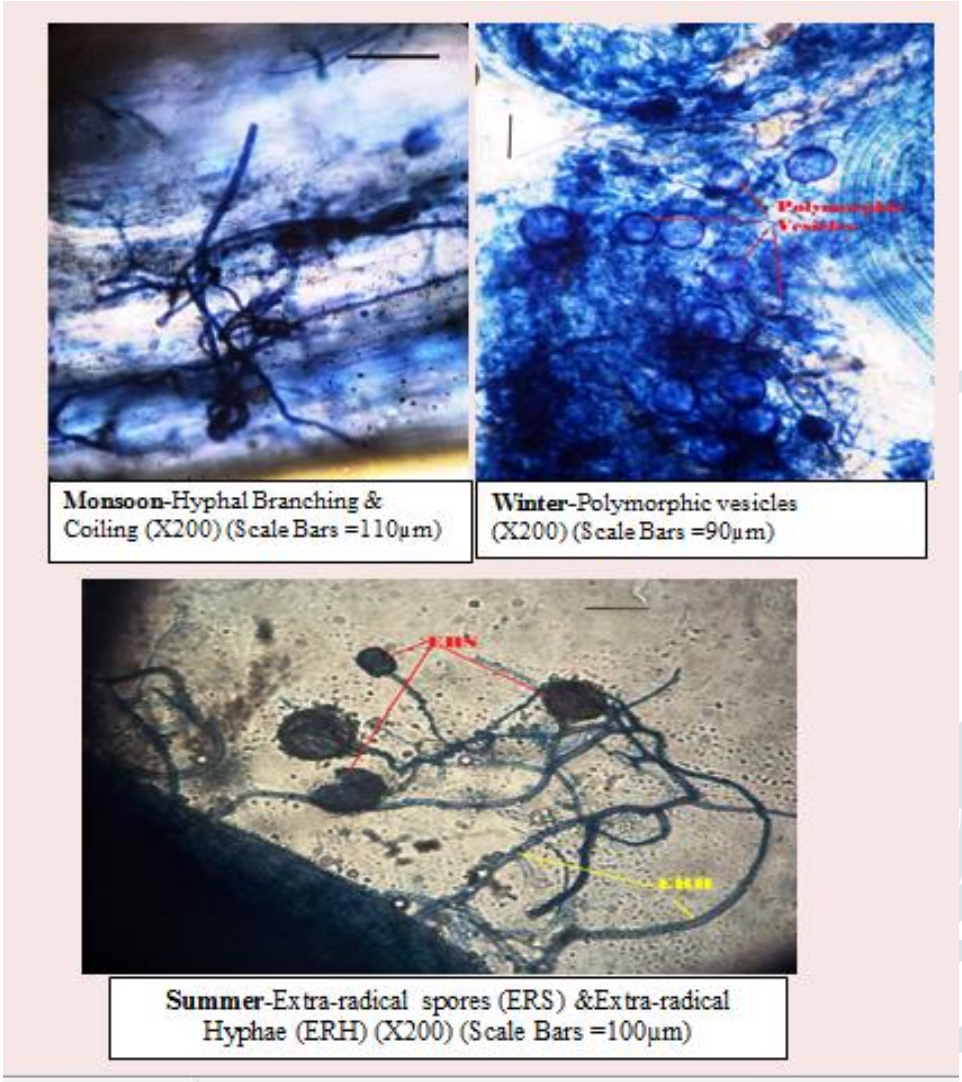
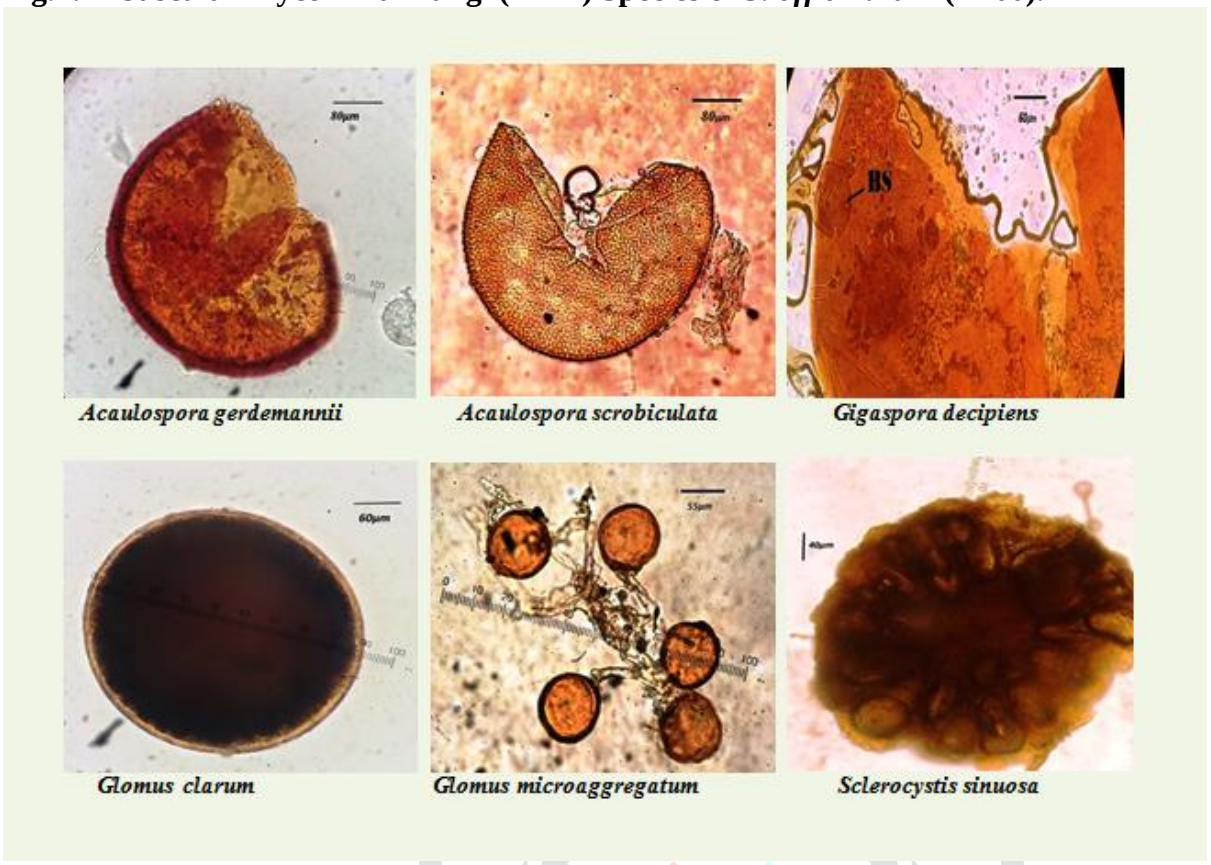


Fig.2:Arbuscular Mycorhizal Fungi (AMF) Species of *S. officinarum* (X400).



The study was in accordance with earlier workers, it was defined soil health as: "the continued capacity of soil to function as a vital living system, by recognizing that it contains the biological elements that are the key to ecosystem function within land use boundaries" (Doran and Zeiss, 2000). It was studied relation between soil characters and occurrence of AMF where greater number of AM fungal propagules were found in neutral to slightly alkaline (pH 7 to 8) soil whereas alkaline soils (pH higher than 8.0) have not favoured mycorrhizal fungi (Sreevani and Reddy 2004).It was reported the varieties CC93-7711 (Pierna Bella) and CC93-7510 (VendeFinca) showed a higher percentage of AMF colonization in response to the inoculation of *Glomus* sp. (Wilches et al.,2019).It was reported the variation in AM spore population, root colonization and number of AM fungal species in different sampling season and reported higher spore population and number of AMF fungal species in the rainy season while minimum in the winter (Suresh and Nelson, 2015). It was observed and analysed four common sugarcane cultivating varieties of CP57-614, CP48-103, CP69-1062, NCO-310 for AMF association and sixteen AMF species observed, among tested cultivars CP48-103 and the least with NCO-310 found most diversity of association AM fungi, in Iran (Rokni and Mohammadi, 2012). It was reported the mycorrhizal colonization of sugarcane roots in current study is within the range observed in other studies, i.e. 10 to 89% in sugarcane under different field and greenhouse conditions (Kelly et al., 2001;.Sivakumar, 2013).Azevedo et al. (2014) also recorded highest number of AMF species i.e.37 in a small area of sugarcane plantations from Brazil.Mycorrhizal association in Sugarcane (*Saccharum officinarum*) grown in four different areas of South India was recorded and observed root colonization percentage range between 34 and 84 and mycorrhizal fungal species i.e. *Glomus aggregatum, G. deserticola, G. fasciculatum* and *Gigaspora margarita* were encountered (Srikumar et al., 2009).

CONCLUSION

Study concluded that theadoption of AMF in sugarcane growing soils and studied cultivars. Habitat of AMF resulted in improving the profitability of the farmers and it is good for millers since it has a direct impact on the quality of sugarcane juice.The present study shows good association of AM fungi in sugarcane plants in the agro-ecosystem. It also emphasizes the fact, that this symbiosis is controlled by various edaphic factors. Higher levels of fungal root colonization is an indication of better fungal root contact which is a prerequisite for increased benefits of AM symbiosis and better adaptation to present soils. Rainy seasons should be preferable (spore

density was higher) for AM fungal inoculation as compared to summer season. The sugarcane plant offers the possibility of using AM fungi as a potential bio- fertilizer for enhancement of crop growth as well as productivity.

Authors' Contribution

Conceptualization of research work and designing of experiments (NRS,UNB); execution of lab and field experiments and data collection (NRS); analysis of data and interpretation (NRS,UNB,MNJ); preparation of manuscript (NRS,UNB,SAB

Competing Interests

The authors declared that they have no conflict of interest.

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