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Consequence of Arbuscular Mycorrhiza on Enhancement, Growth and Yield of Onion (*Allium cepa* L.)

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ABSTRACT- Arbuscular mycorrhizal fungi play an important role in the uptake of nutrients and water from soil. Onions (*Allium cepa* L.) plants need a lot of fertilizer for their growth and it is sensitive plant to drought. The aim of the current research was to study the beneficial effect of mycorrhizal fungi on the growth, development and yield of onion. Allium species, particular onion, are excellent models for mycorrhizal research because they have a simple rooting system, slow growth, and high response to AMF. The interactions between onion and AMF benefited more intensely. Onion crop is cultivated in two seasons i.e. autumn and winter. Inoculation of *Glomus mosseae* spore in the field showing better result. Parameters like root length, leaf length and number of leaves as well as diameter of bulb, weight bulb etc. per plant was considered. It was observed that non mycorrhizal plant showed decrease in root length, leaf length and number of leaves whereas mycorrhizal plant showed an increase in root length, leaf length and number of leaves. The similar effect was observed regarding productivity of onion. Non mycorrhizal plant showed less in diameter and weight of the bulb, whereas mycorrhizal plant showed better increase in diameter and weight of bulb in both seasons. There is increase in the yield of onion after the inoculation of mycorrhizal spore in the field.

Key-Words: Arbuscular mycorrhizal fungi, Inoculation, Onion, productivity, Interactions

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INTRODUCTION

Arbuscular mycorrhizal fungi (AMF) are associated with roots of approximately 90% the terrestrial plant species. Mycorrhiza is a symbiotic association between soil fungi and fine plant roots. These fungi establish symbioses with roots, contribute to improve mineral and nutrient uptake therefore they referred as phosphorus gathering fungi. The fungus receives carbohydrates and growth factors from the plant, which in turn receives many benefits, including increased nutrient absorption.

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AMF enlarge the soil volume from which nutrients can be taken up, via an extensive mycelium network, enabling host plants to access more resources [1]. The AM fungi can protect the plant against biotic and abiotic (drought) stress, and improve soil aggregation [2,3] AM fungi reported to reduce iron and manganese concentration in soil as well as reduction of root knot nematode. It is observed that when mycorrhiza inoculated to crops, there is an increase in root proliferation and reduction of fertilizer input [4,5]. AMF inoculation increases the uptake of phosphorus and other nutrients which enhanced the growth and yield of crops [6].

Onion (*A. cepa* L.) is an important vegetable crop belonging to family Liliaceae. India is the second largest producer of onion in the world, next to China, accounting for 22.18 percent of the world area and 18.78 percent of the world production. In India, onion is being grown in an area of 0.83 million hectares. It is an annual herb with aromatic

fleshy underground bulb; leaves are linear acicular, hollow, cylindrical and fleshy. Onion has a sparse rooting system without root hairs which makes the crop dependent for water and nutrient acquisition on arbuscular mycorrhizal fungi [7,8].

The Maharashtra, Gujarat, Uttar Pradesh, Karnataka, Haryana, Bihar and Andhra Pradesh are the leading onion growing states of India. Maharashtra state shares 20.13 % of the total production of onion [9]. The common varieties grown in Maharashtra are Agrifound dark red, Agrifound light red, Agrifound red, Baswant 780, N53, Pusa red, Pusa white flat, Pusa white round etc. The experiment was done in the year 2012-13 in both autumn (Kharip) and winter (Rabbi) seasons. The autumn season crop is growing during July to September and it is harvested during October to December. In winter season, the crop is growing in November to January and it will be ready for harvesting during March to May. The onion crop and both seasons were considered for root length, leaf length, number of leaves, diameter of bulb and weight of bulb in the said period.

MATERIAL AND METHOD

In the present study, six localities from Yeola and Niphad taluka of Nashik district, Maharashtra (India) were selected for analyzing soil samples in July-2012 for autumn season and in January-2013 for Rabbi Season. The correlation between AM fungi and onion (*A. cepa* L.) plants was also studied by using control method after referring to relevant literature.

Collection of soil samples

Rhizosphere and non-rhizosphere soil samples were collected from all selected sites (Katarni, Khedala, Manori, Nilkheda, Patoda and Rui.) at an interval of 30 days. Each plot sampled for analysis was measured around 1 acre. These soil samples were collected in autumn and winter seasons for two consecutive years 2012 and 2013. Nearly 250–500 gm of soil was collected from each locality and soil samples were transferred into fine polythene bags, brought to the laboratory and stored in a refrigerator at 5°C until further use.

Collection of root samples

The collection of root samples was done from all the six selected localities. Feeder roots were collected from the rhizosphere zone of the onion plants by obtaining samples from a depth of about 10–15 cms. Root samples were collected at an interval of 30 days throughout the years of study that is 2012 and 2013. All the root samples were collected in sterile polythene bags and the same were brought to the laboratory for processing and used for analysis of root colonization.

Preparation of pure culture

The rhizosphere soil samples of onion plants were collected from selected localities and brought to the laboratory in clean, dry polythene bags. A beaker of 1000 ml capacity containing tap water was taken and the air dried soil sample was mixed to it. The soil water mixture was vigorously stirred using a glass rod. After allowing the heavier soil particles to settle the suspension containing soil, root, and AM fungal hyphae was very slowly allowed to pass through a set of 500, 240, 170,150, 100 and 72 μm sized sieves. The extracts were washed and transferred from the sieves to Whatman filter paper no.1. Using binocular research microscope AM fungal spores, sporocarps and AM fungal aggregates were picked up by means of a needle [10]. In a Petri-plate, seeds of jowar were placed upon a moist filter paper as the same assisted in timely germination of the seed. When roots were about 2-3 cm in length, the isolated spores were surface sterilized using 1% streptomycin solution. The roots of germinated jowar seeds were sterilized using alcohol. Surface sterilized spores (*Glomus mosseae*) were studded on jowar seedling roots. These seedlings of jowar were transferred in pots containing sterilized soil in a green house, after one to two days of inoculation. Pots were watered regularly as per requirement. After

45–50 days, the roots were analyzed for mycorrhizal infection [11]. They were also analyzed for root colonization by Phillips and Hayman [12]. On observing AMF colonization, the supply of water was stopped and shoots were cut off at soil level. These pots with roots were allowed to dry, after which, they were cut using a chopper. Such roots along with rhizosphere soil could be used again for the multiplication of individual species.

RESULTS AND DISCUSSION

Effect of AM fungi on growth response of onion

The effect of AM fungi on growth response of onion was studied during autumn season after 60 and 90 days. The growth parameters like root length, leaf length and number of leaves per plant were recorded in control and mycorrhizal plants. The length of root after 60 days was 3.67cm in control plant whereas it was 5.35 cm in mycorrhizal plant. After 90 days the length of root recorded was 6.24 cm in control plant whereas it was recorded 14.11 cm in mycorrhizal plant. The length of leaf recorded after 60 days was 22.00 cm in control plant whereas it was 25.50 cm in mycorrhizal plant. After 90 days the length of leaf recorded was 28.55 cm in control plant whereas it was recorded 36.00 cm in mycorrhizal plant. The number of leaves recorded after 60 days was 13 in mycorrhizal plant whereas it was 11 in control plant. After 90 days the number of leaves recorded was 12 in control plant whereas it was recorded 15 in mycorrhizal plant. The mycorrhizal plant showed better growth after 60 and 90 days as compared to control plant. The results were significant at P≤0.05 level.

Table 1: Effect of AM fungi on growth response of onion during autumn and winter season

Season	No. of days	Plants	Root length (cm)	Length of leaf (cm)	No. of leaves / plant
Autumn	60 days	Control	03.67±1.15	22.00±2.31	11±1.83
		Mycorrhizal	05.35±1.18	25.50±2.48	13±1.83
	90 days	Control	06.24±1.17	28.55±2.34	12±1.83
		Mycorrhizal	14.11±1.19	36.00±2.31	15±1.83
Winter	60 days	Control	3.60±1.90	21.40±2.99	10±1.83
		Mycorrhizal	7.20±1.90	26.80±3.03	14±1.83
	90 days	Control	7.30±2.01	28.70±3.02	12±1.83
		Mycorrhizal	9.50±2.01	34.60±3.02	16±1.83

The effect of AM fungi on growth response of onion was studied during winter season after 60 and 90 days. The growth parameters like root length, leaf length and number of leaves per plant were recorded in control and mycorrhizal plants. The length of root recorded after 60 days was 3.60 cm in control plant whereas it was 7.20 cm in mycorrhizal plant. The length of root recorded was 7.30 cm in control plant whereas it was recorded 9.50 cm in mycorrhizal plant after 90 days.

The length of leaf recorded after 60 days was 21.40 cm in control plant whereas it was 26.80 cm in mycorrhizal plant. After 90 days the length of leaf recorded 34.60 cm in mycorrhizal plant whereas it was recorded was 28.70 cm in control plant. The number of leaves recorded after 60 days was 10 in control plant whereas it was 14 in mycorrhizal plant. After 90 days the number of leaves recorded was 12 in control and16 in mycorrhizal plant.

The mycorrhizal plant showed better growth after 60 and 90 days as compared to control plant. The results were significant at P≤0.05 level.

It is observed that, in autumn and winter seasons of onion plant, three parameters were studied for 60 and 90 days. At the time interval of 60 days, root length, leaf length and number of leaves increased in mycorrhizal plants whereas it decreased in non mycorrhizal plants [13,14]. The fungal mycelium in soil can absorb nutrients, so that they increase the effectiveness. Colonization on P nutrition are often large and have effect on plant symbiosis on the other nutrients are masked [13]. For the 90 days time interval the root length, leaf length and number of leaves increased in mycorrhizal plants whereas it decreased in non mycorrhizal plants. Significantly increased mycorrhiza formation over that caused by the level of native AM fungi present at the particular site. At the time of harvest, all inoculated onion showed higher values of bulb diameter, fresh weight, shoot dry matter, shoot P content and bulb yield than uninoculate plants [15].

Effect of AM fungi on growth and yield response of onion in autumn and winter seasons

The effect of AM fungi on growth and yield of onion bulb was studied during autumn season after 75 and 105 days. The diameter of onion bulb and weight of onion bulb was recorded in control and mycorrhizal plants. The diameter of onion bulb recorded after 75 days was 20.40 cm in control plant whereas it was 22.00 cm in mycorrhizal plant. After 105 days the diameter of onion bulb recorded was 23.60 cm in control plant whereas it was recorded 26.20 cm in mycorrhizal plant. The weight of onion bulb recorded after 75 days was 78.10 cm in control plant whereas it was 82.70cm in mycorrhizal plant. After 105days the weight of onion bulb recorded was 82.30cm in control plant whereas it was recorded 95.50 cm in mycorrhizal plant. The mycorrhizal plant showed better results than control plant after 75 and 105 days. The results were significant at $p \leq 0.05$ level.

The effect of AM fungi on growth and yield of onion bulb was studied during winter season. The diameter and weight of onion bulb was recorded in mycorrhizal and control plants. The diameter of onion bulb recorded after 75 days was 21.40 cm in control plant whereas it was 24.50 cm in mycorrhizal plant. After 105 days the diameter of onion bulb recorded was 23.10 cm in control plant and 27.90 cm in mycorrhizal plant.

Table 2: Effect of AM fungi on growth and yield of onion during autumn and winter season

Season	No. of days	Plants	Diameter of bulb (cm)	Weight of bulb (gm)
Autumn	75 days	Control	20.40±1.88	78.10±1.83
		Mycorrhizal	22.00±1.83	82.70±2.01
	105 days	Control	23.60±1.92	82.30±1.90
		Mycorrhizal	26.20±2.01	95.50±1.83
Winter	75 days	Control	21.40±1.90	79.20±1.92
		Mycorrhizal	24.50±1.90	86.30±1.88
	105 days	Control	23.10±1.83	82.15±2.63
		Mycorrhizal	27.90±1.86	105±2.58

The weight of onion bulb recorded after75 days was 79.20 cm in control plant whereas it was 86.30 cm in mycorrhizal plant. After 105 days the weight of onion bulb recorded 105.00 cm in mycorrhizal plant whereas it was recorded was 82.15 cm in control plant. The mycorrhizal plant showed better results than control plant after 75 and 105 days. The results were significant at $P \leq 0.05$ level.

Effect of AM fungi on growth and yield of onion plant in autumn

The effect of AM fungi on growth and productivity of onion was studied under field condition. The parameters like diameter of bulb and weight of bulb etc. were observed and studied in control and experimental conditioned onion plants. Data was collected at the interval of 75 days, 105 days, up to four months. Data showed increased in biomass and yield of onion under field condition [16]. According to Goussous and Mohammad [17], inoculation with AM fungi, especially indigenous type is comparable to N, P fertilizer

application in enhancing onion growth and thus could provide a sustainable and environmentally safer option. The various growth biometrics such as plant height, number of leaf sheaths at 30 and 60 days after transplanting in main field was found significantly increased over untreated control plant of onion.

It was concluded that from above experiment that the mycorrhizal plants showed better length of root and leaf as compared to non mycorrhizal plants after 60 and 90 days respectively. The number of leaves per plant was recorded maximum in mycorrhizal plants than non mycorrhizal plants. The results were similar during autumn and winter seasons at all the six selected localities. The effect of AM fungi on growth and productivity of onion was studied under field conditions. The mycorrhizal plants showed more diameter and higher weight of onion bulbs than non mycorrhizal plants after 75 and 105 days. There was similar trend of results during both the seasons.

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