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EFFECT OF ARBUSCULAR MYCORRHIZAL *GLOMUS* SPECIES ON DROUGHT TOLERANCE OF ONION (*ALLIUM CEPA* L.)

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ABSTRACT:
An experiment was conducted to determine the effect of mycorrhizal fungi inoculation on growth of onion grown under well watered and water stressed pot culture conditions. Onion (*Allium cepa* L.) cloves were planted in furrows. The data was collected at an interval of 15 days. Colonization of root with Arbuscular Mycorrhizal (AM) fungi occurred in under water-stressed and well-watered conditions, but the extent of AM fungi root colonization was higher under well-watered than under water stressed conditions. Regarding length of leaves, root, weight of bulb and diameter of onion after 45, 60, 75 and 90 days, data was collected. The AMF-inoculated plants had higher fresh bulb yield and mean bulb weight than uninoculated plants However, inoculation with AM fungi has improved onion bulb yield. The result indicates from AM fungi inoculation benefited more than that of especially under water-stressed conditions.

Key words: AM fungi, inoculation, watered, water stressed, root colonization, onion.

INTRODUCTION:

The onion (*Allium cepa* L.) which belongs to family Liliaceae is one of the important horticultural crops cultivated in India.AM fungi are important in sustainable farming because they improve plant water relations and thus increase the drought resistance of host plants (Allen, E. B., and M. F. Allen. 1986). They improve disease control (Bolandnazar, S.; Aliasgharzad, N.; Neishabury, M.R.; Chaparzadeh, 2007), as well as they increase mineral uptake, which reduces the use of fertilizers. The Arbuscular Mycorrhizal (AM) fungi improve the assimilation of water and nutrition for plants, and enhance resistant ability to drought (Ahonen-Jonnarth, 2000). The capabilities of specific fungus-plant associations to tolerate drought are of great curiosity. Moreover, many mycorrhizal fungi can stand up to drought stress and high temperature (Han et al., 2006). Many mycorrhizae have been shown to enhance plant survival and fitness through mechanisms such as increasing water and nutrient uptake (Pasqualini *etal.*, 2007; Plassard and Dell 2010). Mycorrhizal inoculation with *Glomus aggregatum*, and *Glomusdeserticola* was found to improve onion growth by enhancing the leaf area index, length of leaf, bulb yield, and water use efficiency, under both well-watered and water-deficit conditions (Bolandnazar, S. 2009). Onion as an irrigated crop, but in famine conditions limit of crop productivity, on applying different skills in cropping systems that would enable plants to better resist drought stress. It is helpful to improve crop production under arid

conditions. The Allium species, onion is the most widespread vegetables and show a high nutritional value on human health and beneficial to our cardiovascular system by reducing blood pressure. It is helpful to reduce the severity of cold and flu. Onion is one of the most popular ingredients in cooking. Under drought conditions Arbuscular Mycorrhizal (AM) fungi associated with plant roots enhanced growth of crop as well as productivity by improving the mineral nutritional status. By increasing the surface area of soil explored via fungal hyphae, it can be accomplished (Mushen, 2018). AM fungi also improve soil aggregation and water-holding capacity both by producing external hyphae. Mycorrhizal plants have better capacity to overcome unfavorable conditions of environment and thus produce more benefit. Mycorrhizal fungi can increase absorption of phosphorus by symbiosis with plant roots (Farahani *et al.,* 2008). If tolerance of the plants to drought differs with AM fungi isolate with which plants are associated (Gupta, N. and S. Routaray 2009). The main aim of this study was to grasp effects AM fungi on bulb yield of onion. It has been observed that both sterilized and non-sterilized soil, the inoculation with AMF can cause magnificent increase in root length, leaf and diameter as well as weight of bulb onion.

MATERIAL AND METHODS:

An experiment was conducted during 2013-2014 to determine the effect of arbuscular mycorrhizal fungi inoculation on growth of onion grown under well watered and water stressed pot culture conditions. The data was collected at an interval of 15 days i.e. after 45, 60, 75 and 90 days. The factors were irrigation intervals (2, 4 and 8days), Arbuscular Mycorrhizal Fungi (AMF) species, (*Glomus aggregatum,* and *Glomus deserticola*) and Non-mycorrhizal (NM) as control plants. Onion (*Allium cepa* L.) seeds were disinfected for15 min in 1% sodium hypochlorite and sown in sandy loam Fifteen grams of inoculum (spore, hyphae, AM root fragment and soil) were mixed to one kg of the medium. The control received the same amount of sterilized inoculum. After seedling emergence, their roots were washed, cut into 1cm long pieces and mixed thoroughly. The fragments then were cleared with 10% KOH and stained with 0.05% (w/v) trypan blue in lactoglycerol (Phillips and Hayman, 1970).Percentage of mycorrhizal colonization was determined by gridline intersect method (Furlan and Fortin, 1973). At transplanting (7weeks after sowing) root colonization occurs in seedlings.

RESULTS AND DISCUSSION:

Effect of water stress on length of leaves and root of onion after 45, 60, 75and 90 days. The effect of water stress on growth response of onion was studied with and without AM fungi after 45, 60, 75 and 90 days. The growth parameters like root length, and leaf length was recorded in control and mycorrhizal plants. The water stress was given at 2, 4 and 8 days interval in mycorrhizal plants whereas the control plant was watered with 2 days interval. The length of leaf recorded after 45 days was 28cm in control plants whereas it was 35, 34 and 33cm in mycorrhizal plants watered with 2, 4 and 8 days interval respectively. After 60 days the length of leaf recorded was 36, 35 and 34cm in mycorrhizal plants watered with 2, 4 and 8 days interval respectively whereas it was30 cm in control plants. The length of leaf recorded after 75 days was 29 cm in control plants whereas it was 40,

39 and 38.50cm in mycorrhizal plants watered with2, 4 and 8 days interval respectively. The length of leaf recorded was 32cm in control plant whereas it was recorded 43, 42 and 41cm in mycorrhizal plant watered with 2, 4and 8 days interval respectively after 90 days (Table No.1). The length of root recorded after 45 days was 9 cm in control plant whereas it was 10, 11 and12cm in mycorrhizal plant watered with 2-, 4- and 8-days interval respectively. After 60 days the length of root recorded was 13.00, 13.50 and 14.50 cm in mycorrhizal plant watered with 2-, 4- and 8-days interval respectively whereas it was11 cm in control plant. The length of root recorded after 75 days was13.00cm in control plant whereas it was 14.60, 17.00 and18.50 in mycorrhizal plant watered with 2-, 4- and 8-days interval respectively. The length of root recorded was 15.00cm in control plant whereas it was recorded 16.55, 18.00 and17.80cm in mycorrhizal plant watered with 2-, 4- and 8-days interval respectively after 90 days (Table No.1). The mycorrhizal plant showed better growth after 45, 60, 75 and 90 days as compared to control plant. The results were significant at P≤ 0.05 level. C- Control, E-Experimental watered after 2 days, E4- watered after 4 days, E8- watered after 8 days ± = SE After 45 days the diameter of onion bulb recorded was 11.10 cm in control plant whereas it was 13.20, 12.30 and 11.70 cm in mycorrhizal plant watered with 2, 4and 8 days interval respectively. The diameter of onion bulb after 60 days recorded was 11.80 cm in control plant whereas it was 13.80, 12.90 and 12.40 cm in mycorrhizal plant watered with 2, 4 and 8 days interval respectively. The diameter of onion bulb recorded after 75 days was 14.90, 14.20 and 13.80 cm in mycorrhizal plant watered with 2, 4 and 8 days interval respectively whereas it was 12.20 cm in control plant. After 90 days diameter of onion bulb recorded was 12.40 cm in control plant whereas it was recorded 16.00, 15.30 and 14.70 cm in mycorrhizal plant watered with2, 4 and 8 days interval respectively (Table No.2). 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. The weight of onion bulb recorded after 45 days was 58.50 gm in control plants whereas it was 70.00, 66.00 and 61.00 gm in mycorrhizal plants watered with 2, 4 and 8 days interval respectively. After 60 days the weight of onion bulb recorded was 74.40, 68.30 and 62.50 gm in mycorrhizal plant watered with 2, 4 and 8 days interval respectively whereas it was 60.50 gm in control plant. After 75 days the weight of onion bulb recorded was 64.70 gm in control plant whereas it was 76.50, 71.70 and 66.20 gm in mycorrhizal plant watered with 2, 4 and 8 days interval respectively. Weight of onion bulb recorded was 68.40 gm in control plant whereas it was recorded 89.00, 74.80 and 70.60 gm in mycorrhizal plant watered with 2, 4 and8 days interval respectively after 90 days (Table No.2).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. C- Control, E-Experimental, watered after 2 days, E4- watered after 4 days, E8- watered after 8 days ±=SE

Effect of water stress on number of propagules per 100 gm of soil and percent root colonization of onion after 45, 60,75and 90 days

The number of propagules per 100 gm of rhizosphere soil of onion plants watered with two

days interval was recorded 305, 353, 392 and 503 after 45, 60, 75and 90 days respectively. The percent root colonization reported in these plants was48, 53, 62 and 70 after 45, 60, 75 and 90 days respectively. The number of propagules per 100 gm of soil of onion plants was recorded 241, 296, 348 and 480 after 45, 60, 75 and 90 days respectively in plants watered with four days interval. The percent root colonization reported in plants watered at the interval of 45days was 45,50, 59 and 65 after 45, 60, 75 and 90 days respectively. The plants watered at the interval of eight days showed minimum number of AM propagules and lowest root colonization. It was 206, 257, 309 and 427 after 45, 60, 75 and 90 days respectively. The number of propagules decreased as the water stress was increased. The percent root colonization reported in plants watered at the interval of 8 days was41, 47, 58 and 61 after 45, 60, 75 and 90 days respectively (Table No.3). The results are significant at P≤0.05 level.

NAMP = Number of AM propagules RC = % root colonization C- Control E -Experimental, Watering after 2 days, E4- Watering after every 4 days, E8- Watering after 8 days. ± = SE AMF colonization (Table 3) improved the leaf length, root length,(Table 1) as well as diameter and weight of bulb ratio significantly (Subramanian, K.S., P. Santhanakrishnan and P. Balasubramanian, (2006.). Water stress had significantly reduced bulb yields in un-inoculated plants (Mushen, T.A. and Ali B.Z. 2015). However, inoculation with AM fungi has upgraded onion bulb yield. The length of leaf recorded after 75 days was 31 cm in control plants whereas it was 40, 39 and 38.50 cm in mycorrhizal plants watered with2, 4 and 8 days interval respectively. The length of leaf recorded was 32cm in control plant whereas it was recorded 43, 42 and 41 cm in mycorrhizal plant watered with 2, 4and 8 days interval respectively after 90 days. The length of root recorded was 15.00 cm in control plant whereas it was recorded 16.55, 18.00 and 17.80 cm in mycorrhizal plant watered with 2, 4 and 8 days interval respectively after 90 days (Table No.1).The mycorrhizal plant showed better growth after 45, 60, 75 and 90 days as compared to control plant. After 90 days diameter of onion bulb recorded was12.40cm in control plant whereas it was recorded16.00, 15.30 and 14.70cm in mycorrhizal plant watered with2, 4 and 8 days interval respectively (Table No.2). The mycorrhizal plant showed better growth after 60 and 90 days as compared to control plant. Weight of onion bulb recorded was 68.40gm in control plant whereas it was recorded 89.00, 74.80 and 70.60gm in mycorrhizal plant watered with 2, 4 and8 days interval respectively after 90 days. The plants watered at the interval of eight days showed minimum number of AM propagules and lowest root colonization. It was 206, 257, 309 and 427 after 45, 60, 75 and 90 days respectively. The number of propagules and root colonization arise with decreased as the water stress was increased (Ruiz-Lozano, J. M. and R. Azcon 1996). The symbiotic association between plant-mycorrhiza has seen increased interest and evidenced for direct recycling of nutrients from organic matter to plants by mycorrhizal fungi. The plant mycorrhiza association is mostly studied for many crop plants for enhancement in plant growth and yield due to increased supply of phosphorous to the host plants. There-fore present investigation was undertaken to find out the exact interrelationship

between

AM fungi and yield of onion. Arbuscular mycorrhizal fungi improved onion growth and development in comparison with non-mycorrhizal ones. This improvement resulted from increasing plant height which led to greater leaf area and probably photosynthesis capacity both leading to greater larger bulb. Increasing plant size and yield (Charron et al., 2001a); and enhancing chlorophyll content by AMF colonization. Mycorrhizal onion had greater size of bulb than control plants at first harvest, implying that bulb initiation and bulbing process occurred earlier and produced faster in mycorrhizal plants than non-mycorrhizal ones (Table 1). In control plants, bulbing occurred 10-15 days late. Our results agree with findings of Charron et al.(2001b), who reported that mycorrhizal onion reached to marketable size 2-3 weeks earlier than non-mycorrhizal onion.

CONCLUSION:

The mycorrhizal colonization improves onion seedling endurance and establishment that increased its growth and development which led to producing bigger bulb and greater yield of onion. Hence, it indicates that the presence of arbuscular mycorrhizal association affects the growth and development of onion plant.

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Table1: Effect of water stress on length of leaf and root of onion after 45, 60, 75 and 90 days

No. of days	Parameter	C	E	E4	E8
45 days	Leaf length cm	28.00 ± 1.83	35.00 ± 1.83	34.00 ± 1.83	33.00 ± 1.83
	Root length cm	09.00 ± 1.83	10.00 ± 1.83	11.00 ± 1.83	12.00 ± 1.83
60 days	Leaf length cm	30.00 ± 1.83	36.00 ± 1.83	35.00 ± 1.83	34.00 ± 1.83
	Root length cm	11.00 ± 1.83	13.00 ± 1.83	13.50 ± 1.86	14.50 ± 1.77
75 days	Leaf length cm	31.00 ± 1.83	40.00 ± 1.83	39.00 ± 1.83	38.50 ± 1.75
	Root length cm	13.00 ± 1.83	14.60 ± 1.83	17.00 ± 1.83	18.50 ± 1.75
90 days	Leaf length cm	32.00 ± 1.83	43.00 ± 1.83	42.00 ± 1.83	41.00 ± 1.83
	Root length cm	15.00 ± 1.83	16.55 ± 1.83	18.00 ± 1.83	17.80 ± 1.79

Table2: Effect of water stress on diameter and weight of onion bulb after 45, 60, 75 and 90 days

No. of days	Parameter	C	E	E4	E8
45 days	Diameter of bulb(cm)	11.10 ± 1.96	13.20 ± 1.87	12.30 ± 1.87	11.70 ± 1.77
	Weight of bulb (gm).	58.50 ± 1.97	70.00 ± 1.83	66.00 ± 1.83	61.00 ± 1.83
60 days	Diameter of bulb(cm)	11.80 ± 1.90	13.80 ±1.79	12.90 ± 1.83	12.40 ± 1.94
	Weight of bulb (gm).	60.50 ± 2.01	74.40 ± 1.87	68.30 ± 1.87	62.50 ± 1.94
75 days	Diameter of bulb(cm)	12.20 ± 1.94	14.90 ± 1.83	14.20 ± 1.97	13.80 ± 1.87
	Weight of bulb (gm).	64.70 ± 2.01	76.50 ± 1.94	71.70 ± 1.87	66.20 ± 1.87
90 days	Diameter of bulb(cm)	12.40 ± 2.01	16.00 ± 1.83	15.30 ± 1.97	14.70 ± 1.87
	Weight of bulb (gm).	68.40 ± 2.01	89.00 ± 1.83	74.80 ± 1.87	70.60 ± 1.87

Table No.3: Effect of water stress on percentage root colonization and number of propagules per 100 gm of soil of onion after 45, 60, 75 and 90 days

Treatment	45 days		60 days		75 days		90 days	
	NAMP	RC	NAMP	RC	NAMP	RC	NAMP	RC
C	-	-	-	-	-	-	-	-
E	305 ± 1.83	48 ± 1.83	353 ± 1.83	53 ± 1.83	392 ± 1.71	62 ± 1.83	503 ± 1.83	70 ± 1.83
E4	241 ± 1.83	45 ± 1.83	296 ± 1.83	50 ± 1.83	348 ± 1.15	59 ± 1.83	480 ± 1.83	65 ± 1.15
E8	206 ± 1.83	41 ± 1.83	257 ± 1.83	47 ± 1.83	309 ± 1.83	58 ± 2.94	427 ± 1.83	61 ± 1.83

Values are significant at P≤0.05level.