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Impact of Salinity Stress (NaCL) And AM Fungi on Growth and Yield of Onion (*Allium Cepa* L.)

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ABSTRACT:

In the twenty-first century, agriculture industry faces several critical challenges, including the need to enhance crop immunity, reduce the dependance on chemical fertilizers, synthetic pesticides and herbicides and most importantly, improve overall crop yield and quality. Onion is one of the significant crops which is widely cultivated in Maharashtra. Maharashtra produces around 8.6 million tons of onions annually. Onion is commonly used as an edible vegetable and essential role in everyday cooking. Nowadays it is important to increase quality and quantity of onion is the need of society. The am fungi significantly enhanced the yield and quality and quantity of crop. The aim of present study to understand the impact of salinity and AM fungi on production of Onion for this purpose we use arbuscular mycorrhizal (AM) fungal species such as *Acaulospora spinosa, Glomus fasciculatum, Glomus mosseae, and Gigaspora candida* to increase the productivity of onion to examined how salt affects the growth of onion. The treated plots are compared with untreated plots. The treatments included onion crop with AM fungi with salt (NaCl) and crop without AM fungi with salt, to see how each group responded to salt stress.

The experiment evaluated the effects of mycorrhizal fungi under NaCl-induced salinity on onion plants compared to non-mycorrhizal (non-AM) plants exposed to the same conditions. The findings revealed that non-AM plants exhibited significantly lower yields than those inoculated with AM fungi.

The findings of study show positive effects of treatment on Onion crop showed consistently better growth than non-inoculated plants under all levels of salt stress. Increasing NaCl concentrations reduced leaves, roots, shoot/root length, and biomass, but AM-treated plants maintained significantly higher values. AM fungi notably improved bulb fresh and dry weight compared to plants without AM under the same salt levels. Overall, AM inoculation effectively mitigated the negative impact of salinity on onion plant growth.

The present study was conducted during the period from October 2023 to January 2024. During the winter season, characterized by moderate daytime temperatures, distinctly cooler nights and low humidity.

Keywords: *Allium cepa* L., Salt Stress, AM Fungi, Pesticides, Soil Analysis etc.

INTRODUCTION

The control of salinity in these studies was insufficient to precisely examine the relative salt tolerance of VAM and non-inoculated plants. However, in another study, salinity was precisely controlled and a significant VAM-salinity interaction was found (**J. A. POSS, *et.al*, 1985).** It is most widespread in arid, semi-arid, coastal regions and also irrigated lands because of low precipitation, high evaporation, drainage issues, and irrigation with saline waters. Similarly, the majority of cultivated areas are often threatened by drought stress **(Pritee Singh, and Jai Gopal, 2019).** Salinity is one of the most important abiotic stress factors limiting plant growth and productivity.

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Salinity affects almost every aspect of the physiology and biochemistry of plants and significantly reduces yield **(Carmen BEINSAN *et.al*, 2015).** To develop these procedures, we have to understand the anatomy, morphology, and physiology of yield formation of the crop being studied, particularly when salinity is added as another variable **(Rafika Sta-Baba *et.al*, 2010).** A primary response in plants affected by salt stress shows a decrease in plant water potential to a greater extent, resulting in degradation in water use efficiency, which leads to toxic damage and overall reduction in yield **(B. P. Shinde and Neelima Singh, 2017).** This could mostly occur due to soluble minerals found in irrigation water and the high fertilizer input from agricultural practices **(Ashok Aggarwal *et.al*, 2012).** This is primarily regulated by the supply of nutrients to the root system and increased transport by AMF. The growth of the plant &its biomass suffered a Setback under the salt stress. It may be the non-availability of nutrients and his expenditure of energy to contract the toxic effect of NaCl **(SHINDE S.K *et.al*, 2013).** Salinity in soil or water is of increasing importance to agriculture because it causes a stress condition to crop plants. Salt-affected soil is one of the serious abiotic stresses that cause reduced plant growth, development, and productivity worldwide the salt-affected soils occupy approximately 7% of the global land surface **(J. Beltrano, *et.al*, 2013).** Onion contributes significant nutritional value to the human diet has medicinal properties and is primarily consumed for their unique flavor and also the ability to enhance the flavor of other **foods (M. A. Razzaque *et.al*, 2021).** The purpose of this study was to compare the effects of drought and salt stress on four onion cultivars using both morphological and physiological parameters in the early growth phase and determine the differences between cultivars **(F. HANCI and E. CEBECI,2015).**AM fungi also provide their host plants with protection against environmental abiotic stresses **(Neelakandan. M and Mahesh.V., 2016).** High-salinity conditions adversely affect plant growth and photosynthesis as a result of elevated ethylene levels in roots, ionic imbalance, and hyperosmotic conditions ***(*Ioanna Kakabouki *et.al.*2023).**

MATERIALS AND METHODS

Study Area: The experiment conducted at the PG Research Laboratory, Department of Botany, J.E.S. College, Jalna, Tal. Jalna during the period From October 2023 to January 2024. During the winter season, characterized by moderate daytime temperatures, distinctly cooler nights and low humidity.

Preparation of Pot Experiment: The experiment was established using 2×4 plastic trays, providing a uniform and controlled environment for seedling growth**.** study the effect of various salt concentrations on onion plants 'growth with and without the association of AM fungi. Forty-five days old onion plantlets transplanted in plastic tray filled with soil: sand (2:1v/v) mixture. The tray and soil: sand mixture was sterilized using silver nano hydrogen peroxide two days before transplantation

Data Analysis The onion root, shoot, bulb fresh and dry weights were calculated. The bulb, the fresh weight of the bulb and dry weight was calculated and using a weighing balance and the air-drying method, the fresh and dry weights of the roots were determined. along with the shoot length measured.

RESULTS

Growth parameters like root length, Number of leaves, bulb weight, and shoot length per plant were recorded in control with mycorrhizal plants with NaCl. The onion plant was treated in the winter season with controlled NaCl, and AM Fungi with NaCl treatment ranged from Control to 25 mM, 50 mM, 75 mM, and 100 mM Concentration.

The number of Leaves was substantially higher (13±1) in AM-inoculated plants without salt treatment, considered a control. One more control was kept without the AM inoculation and salt treatment, in which the number of leaves was reduced (12±0.577) compared to AM-inoculated plants. In 25 mM salt treatment, plants showed a significantly reduced number of leaves compared to control plants; however, the AM inoculation improved several leaves (12±2) compared to non-inoculated plants (11±1.528). In 50 mM salt treatment, plants showed a significantly reduced number of leaves compared to control plants; however, the AM inoculation improved several leaves (11±1) compared to non-inoculated plants (10±1). In 75 mM salt treatment, plants showed a significantly reduced number of leaves compared to control plants; however, the AM inoculation improved several leaves (10±1) compared to non-inoculated plants (9±0). In 100 mM salt treatment, plants

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showed a significantly reduced number of leaves compared to control plants; however, the AM inoculation improved several leaves (8±0.577) compared to non-inoculated plants (7±0.577).

The number of roots was substantially higher (87±2) in AM-inoculated plants without salt treatment, considered a control. One more control was kept without the AM inoculation and salt treatment, in which the number of roots was reduced (83±4) compared to AM-inoculated plants. In 25 mM salt treatment, plants showed a significantly reduced number of roots compared to control plants; however, the AM inoculation improved the Number of roots (82±2.517) compared to non-inoculated plants (78±3.215). In 50 mM salt treatment, plants showed a significantly reduced number of roots compared to control plants; however, the AM inoculation improved the Number of roots (71±1.528) compared to non-inoculated plants (68±1). In 75 mM salt treatment, plants showed a significantly reduced number of roots compared to control plants; however, the AM inoculation improved the Number of roots (67±4.583) compared to non-inoculated plants (61±2.082). In 100 mM salt treatment, plants showed a significantly reduced number of roots compared to control plants; however, the AM inoculation improved the Number of roots (63±2) compared to non-inoculated plants (57±4.583).

Shoot length was substantially higher (58±8.888cm) in AM-inoculated plants without salt treatment, considered a control. One more control was kept without the AM inoculation and salt treatment, in which the shoot length was reduced (45.67±15.948cm) compared to AM-inoculated plants. In 25 mM salt treatment, plants showed significantly reduced shoot length compared to control plants; however, the AM inoculation improved shoot length (59.33±2.173 cm) compared to non-inoculated plants (44.03±2.775 cm). In 50 mM salt treatment, plants showed significantly reduced shoot length compared to control plants; however, the AM inoculation improved shoot length (51±4cm) compared to non-inoculated plants (39.67±4.163 cm). In 75 mM salt treatment, plants showed significantly reduced shoot length compared to control plants; however, the AM inoculation improved shoot length (44.67±3.055cm) compared to non-inoculated plants (37.33±9.452 cm). In 100 mM salt treatment, plants showed significantly reduced shoot length compared to control plants; however, the AM inoculation improved shoot length (39.83±1.893cm) compared to non-inoculated plants (36.05±4.093 cm).

Root length was substantially higher (6.2±0.173 cm) in AM-inoculated plants without salt treatment, considered a control. One more control was kept without the AM inoculation and salt treatment, in which the root length was reduced (5.4±0.1cm) compared to AM-inoculated plants. In 25 mM salt treatment, plants showed significantly reduced root length compared to control plants; however, the AM inoculation improved root length (5.53±0.306 cm) compared to non-inoculated plants (4.93±0.153 cm). In 50 mM salt treatment, plants showed significantly reduced root length compared to control plants; however, the AM inoculation improved root length (4.13±0.153cm) compared to non-inoculated plants (4.7±0.2 cm). In 75 mM salt treatment, plants showed significantly reduced root length compared to control plants; however, the AM inoculation improved root length (4.43±0.153cm) compared to non-inoculated plants (3.97±0.153 cm). In 100 mM salt treatment, plants showed significantly reduced root length compared to control plants; however, the AM inoculation improved root length (4±0.1cm) compared to non-inoculated plants

The shoot fresh weight was substantially higher (38.400±1.980) in AM-inoculated plants without salt treatment, considered a control. One more control was kept without the AM inoculation and salt treatment, in which the number of roots was reduced (35.090±2.430) compared to AM-inoculated plants. In 25 mM salt treatment, plants showed a significantly reduced number of roots compared to control plants; however, the AM inoculation improved the Number of roots (33.570±1.884) compared to non-inoculated plants (29.080±1.878). In 50 mM salt treatment, plants showed a significantly reduced number of roots compared to control plants; however, the AM inoculation improved the Number of roots (34.650±2.048) compared to non-inoculated plants (25.390±2.382). In 75 mM salt treatment, plants showed a significantly reduced number of roots compared to control plants; however, the AM inoculation improved the Number of roots (33.270±1.528) compared to non-inoculated plants (26.270±0.901). In 100 mM salt treatment, plants showed a significantly reduced number of roots compared to control plants; however, the AM inoculation improved the Number of roots (24.730±2.190) compared to non-inoculated plants (19.500±1.084).

The shoot dry weight was substantially higher (6.40±0.487) in AM-inoculated plants without salt treatment, considered a control. One more control was kept without the AM inoculation and salt treatment, in which the number of roots was reduced (5.78±0.487) compared to AM-inoculated plants. In 25 mM salt treatment, plants

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showed a significantly reduced number of roots compared to control plants; however, the AM inoculation improved the Number of roots (4.86±0.240) compared to non-inoculated plants (4.21±0.142). In 50 mM salt treatment, plants showed a significantly reduced number of roots compared to control plants; however, the AM inoculation improved the Number of roots (4.97±0.159) compared to non-inoculated plants (3.42±0.398). In 75 mM salt treatment, plants showed a significantly reduced number of roots compared to control plants; however, the AM inoculation improved the Number of roots (2.52±0.157) compared to non-inoculated plants (2.11±0.116). In 100 mM salt treatment, plants showed a significantly reduced number of roots compared to control plants; however, the AM inoculation improved the Number of roots (2.20±0.070) compared to non-inoculated plants (1.54±0.102).

Root fresh weight was substantially higher (1.110±0.113) in AM-inoculated plants without salt treatment, considered a control. One more control was kept without the AM inoculation and salt treatment, in which the Root fresh weight was reduced (0.560±0.070) compared to AM-inoculated plants. In 25 mM salt treatment, plants showed significantly reduced Root fresh weight compared to control plants; however, the AM inoculation improved Root fresh weight (1.090±0.046) compared to non-inoculated plants (0.538±0.026). In 50 mM salt treatment, plants showed significantly reduced Root fresh weight compared to control plants; however, the AM inoculation improved Root fresh weight (0.980±0.025) compared to non-inoculated plants (0.535±0.015). In 75 mM salt treatment, plants showed significantly reduced Root fresh weight compared to control plants; however, the AM inoculation improved Root fresh weight (0.890±0.031) compared to non-inoculated plants (0.467±0.015). In 100 mM salt treatment, plants showed significantly reduced Root fresh weight compared to control plants; however, the AM inoculation improved Root fresh weight (0.820±0.031) compared to non-inoculated plants (0.340±0.020).

Root dry weight was substantially higher (0.467±0.010) in AM-inoculated plants without salt treatment, considered a control. One more control was kept without the AM inoculation and salt treatment, in which the Root dry weight was reduced (0.243±0.004) compared to AM-inoculated plants. In 25 mM salt treatment, plants showed significantly reduced Root dry weight compared to control plants; however, the AM inoculation improved Root dry weight (0.276±0.002) compared to non-inoculated plants (0.223±0.005). In 50 mM salt treatment, plants showed significantly reduced Root dry weight compared to control plants; however, the AM inoculation improved Root dry weight (0.268±0.002) compared to non-inoculated plants (0.209±0.009). In 75 mM salt treatment, plants showed significantly reduced Root dry weight compared to control plants; however, the AM inoculation improved Root dry weight (0.214±0.004) compared to non-inoculated plants (0.187±0.003). In 100 mM salt treatment, plants showed significantly reduced Root dry weight compared to control plants; however, the AM inoculation improved Root dry weight (0.156±0.005) compared to non-inoculated plants (0.139±0.005).

Bulb fresh weight was substantially higher (98.10±1.844) in AM-inoculated plants without salt treatment, considered a control. One more control was kept without the AM inoculation and salt treatment, in which the Bulb fresh weight was reduced (93.08±2.004) compared to AM-inoculated plants. In 25 mM salt treatment, plants showed significantly reduced Bulb fresh weight compared to control plants; however, the AM inoculation improved Bulb fresh weight (88.53±4.428) compared to non-inoculated plants (84.40±1.643). In 50 mM salt treatment, plants showed significantly reduced Bulb fresh weight compared to control plants; however, the AM inoculation improved Bulb fresh weight (79.12±1.768) compared to non-inoculated plants (73.67±0.452). In 75 mM salt treatment, plants showed significantly reduced Bulb fresh weight compared to control plants; however, the AM inoculation improved Bulb fresh weight (61.55±1.261) compared to non-inoculated plants (58.76±1.858). In 100 mM salt treatment, plants showed significantly reduced Bulb fresh weight compared to control plants; however, the AM inoculation improved Bulb fresh weight (58.98±1.544) compared to non-inoculated plants (53.71±1.702).

Bulb Dry weight was substantially higher (91.23±2.627) in AM-inoculated plants without salt treatment, considered a control. One more control was kept without the AM inoculation and salt treatment, in which the Bulb dry weight was reduced (83.20±1.195) compared to AM-inoculated plants. In 25 mM salt treatment, plants showed significantly reduced Bulb dry weight compared to control plants; however, the AM inoculation improved Bulb dry weight (79.33±3.836) compared to non-inoculated plants (75.60±0.422). In 50 mM salt treatment, plants showed significantly reduced Bulb dry weight compared to control plants; however, the AM

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inoculation improved Bulb dry weight (72.84±1.512) compared to non-inoculated plants (59.16±1.035). In 75 mM salt treatment, plants showed significantly reduced Bulb dry weight compared to control plants; however, the AM inoculation improved Bulb dry weight (55.37±1.252) compared to non-inoculated plants (50.39±1.178). In 100 mM salt treatment, plants showed significantly reduced Bulb dry weight compared to control plants; however, the AM inoculation improved Bulb dry weight (45.61±1.139) compared to non-inoculated plants (44.61±2.254).

Table No. 1-Effect of NaCl and AM fungi on the Number of Leaves and Number of Roots of onion crop.

Treatments	**Number of Leaves**	**Number of Roots**
Control (NAM)	12±0.577	83±4
Control (AM)	13±1	87±2
25 mM (NAM)	11±1.528	78±3.215
25 mM (AM)	12±2	82±2.517
50 mM (NAM)	10±1	68±1
50 mM (AM)	11±1	71±1.528
75 mM (NAM)	9±0	61±2.082
75 mM (AM)	10±1	67±4.583
100 mM (NAM)	7±0.577	57±4.583
100 mM (AM)	8±0.577	63±2

Each value is a mean of three replicates, ± standard deviation. Means followed by different letters in one column are significantly different.

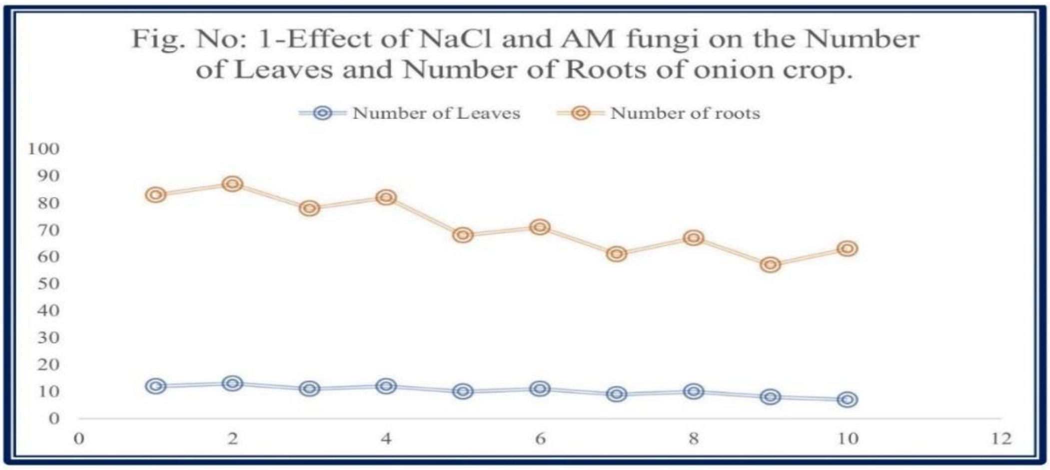

Table No. 2-Effect of NaCl with AM fungi on the Shoot Length and Root Length of onion crops.

Treatments	**Shoot Length (cm)**	**Root Length (cm)**
Control (NAM)	45.67±15.948	5.4±0.1
Control (AM)	58±8.888	6.2±0.173

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25 mM (NAM)	44.03±2.775	4.93±0.153
25 mM (AM)	59.33±2.173	5.53±0.306
50 mM (NAM)	39.67±4.163	4.13±0.153
50 mM (AM)	51±4	4.7±0.2
75 mM (NAM)	37.33±9.452	3.97±0.153
75 mM (AM)	44.67±3.055	4.43±0.153
100 mM (NAM)	36.5±4.093	3.43±0.208
100 mM (AM)	39.83±1.893	4±0.1

Each value is a mean of three replicates, ± standard deviation. Means followed by different letters in one column are significantly different

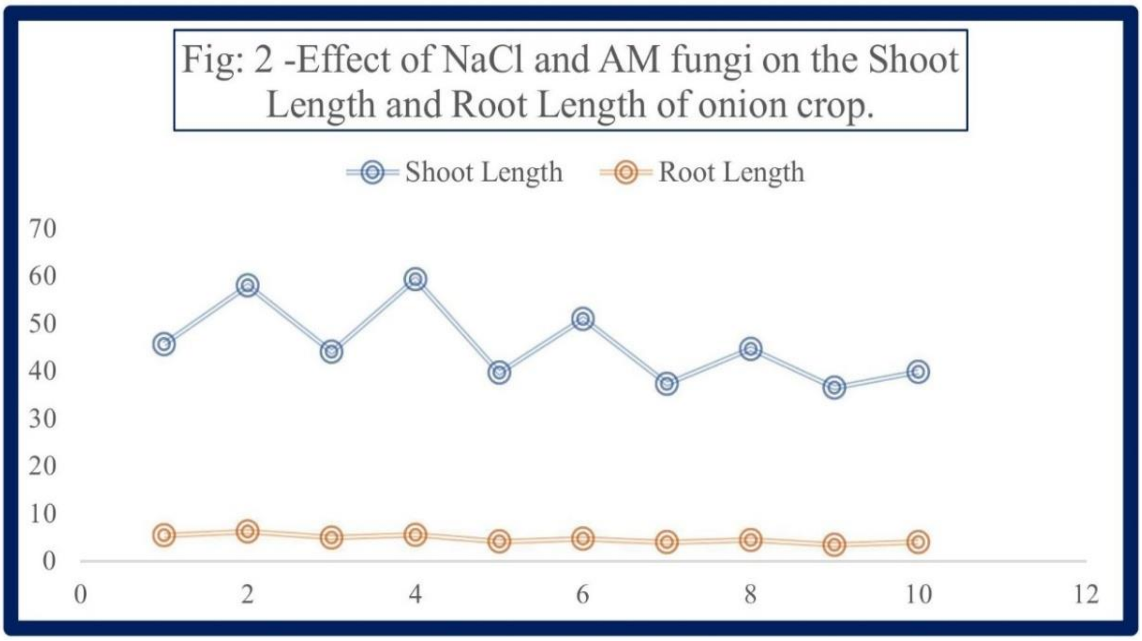

Table No. 3-Effect of NaCl with AM fungi on the Root Fresh Weight and Root Dry Weight of onion crop.

Treatments	**Root Fresh wt. (gm)**	**Root Dry wt. (gm)**
Control (NAM)	0.560±0.070	0.243±0.004
Control (AM)	1.110±0.113	0.467±0.010
25 mM (NAM)	0.538±0.026	0.223±0.005
25 mM (AM)	1.090±0.046	0.276±0.002
50 mM (NAM)	0.535±0.015	0.209±0.009
50 mM (AM)	0.980±0.025	0.268±0.002
75 mM (NAM)	0.467±0.015	0.187±0.003

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75 mM (AM)	0.890±0.031	0.214±0.004
100 mM (NAM)	0.340±0.020	0.139±0.005
100 mM (AM)	0.820±0.031	0.156±0.005

Each value is a mean of three replicates, ± standard deviation. Means followed by different letters in one column are significantly different.

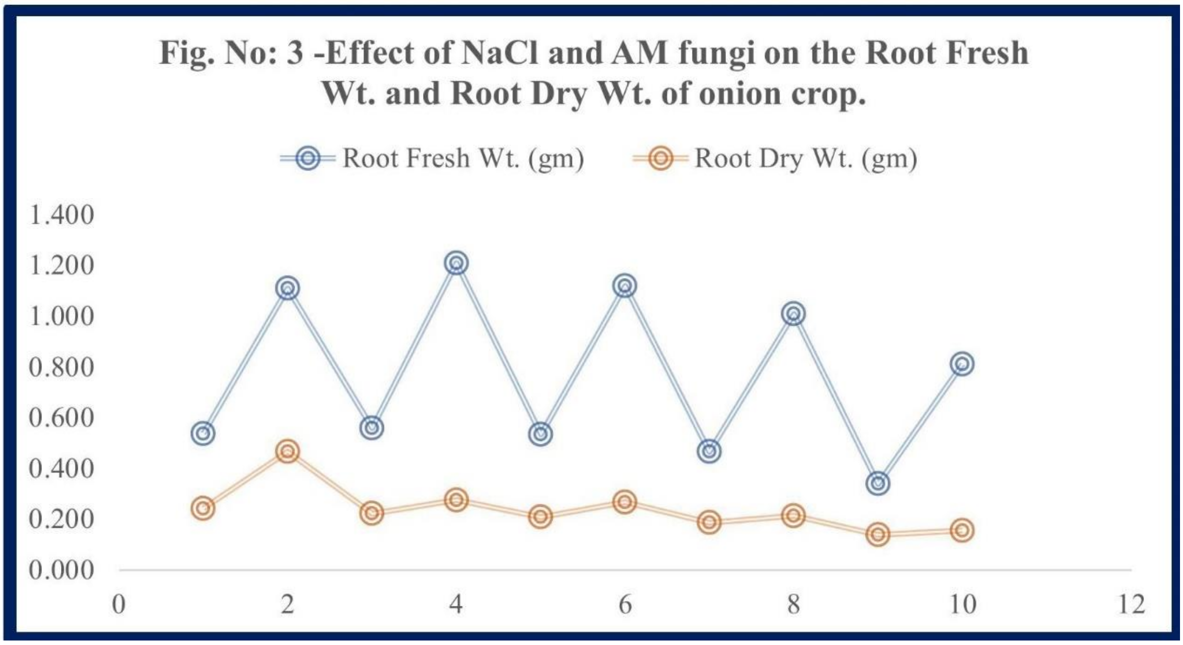

Table No. 4-Effect of NaCl with AM fungi on the Bulb Fresh Weight and Bulb Dry Weight of onion crop.

Treatments	**Bulb Fresh wt. (gm)**	**Bulb Dry wt. (gm)**
Control (NAM)	93.08±2.004	83.20±1.195
Control (AM)	98.10±1.844	91.23±2.627
25 mM (NAM)	84.40±1.643	75.60±0.422
25 mM (AM)	88.53±4.428	79.33±3.836
50 mM (NAM)	73.67±0.452	59.16±1.035
50 mM (AM)	79.12±1.768	72.84±1.512
75 mM (NAM)	58.76±1.858	50.39±1.178
75 mM (AM)	61.55±1.261	55.37±1.252
100 mM (NAM)	53.71±1.702	44.68±2.254
100 mM (AM)	58.98±1.544	45.61±1.139

Each value is a mean of three replicates, ± standard deviation. Means followed by different letters in one column are significantly different.

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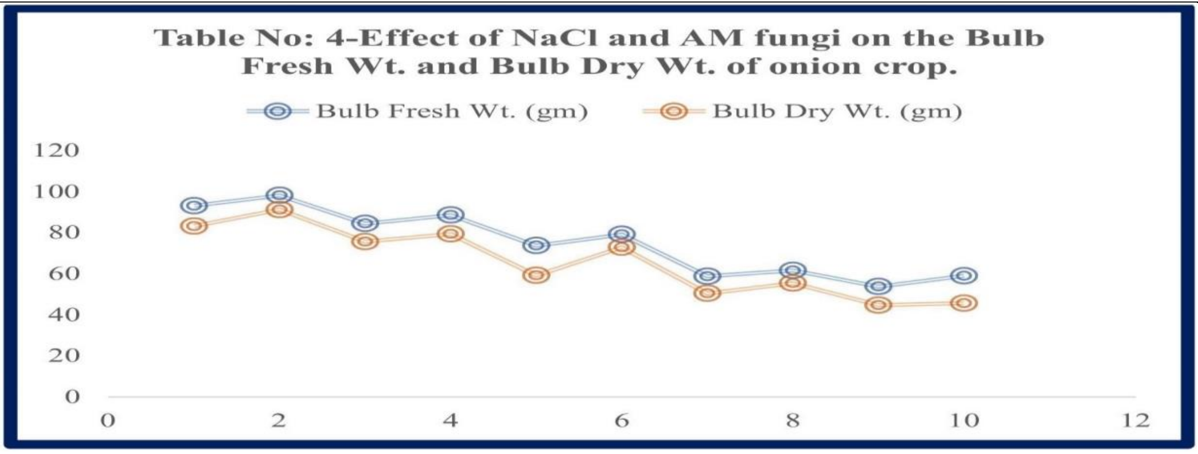
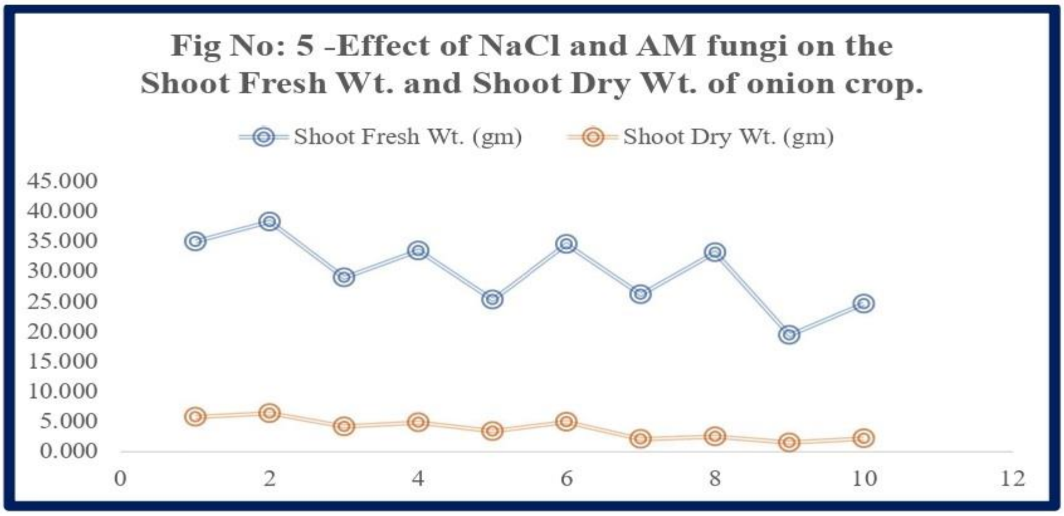


Table No. 5-Effect of NaCl with AM fungi on the Shoot Fresh Weight and Shoot Dry Weight of onion crop.

Treatments	**Shoot Fresh wt. (gm)**	**Soot Dry wt. (gm)**
Control (NAM)	35.090±2.430	5.78±0.487
Control (AM)	38.400±1.980	6.40±0.442
25 mM (NAM)	29.080±1.878	4.21±0.142
25 mM (AM)	33.570±1.884	4.86±0.240
50 mM (NAM)	25.390±2.382	3.42±0.398
50 mM (AM)	34.650±2.048	4.97±0.159
75 mM (NAM)	26.270±0.901	2.11±0.116
75 mM (AM)	33.270±1.528	2.52±0.157
100 mM (NAM)	19.500±1.084	1.54±0.102
100 mM (AM)	24.730±2.190	2.20±0.070

Each value is a mean of three replicates, ± standard deviation. Means followed by different letters in one column are significantly different.



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DISSCUSSION

Onions inoculated with VAM and grown under saline P-deficient conditions showed increased growth and enhanced nutrient concentration and total ion uptake when compared to non-inoculated plants (**J. A. POSS, *et.al*, 1985).** It is assumed that AMF has the potential to reduce the high application rate of fertilizer needed to produce high onion yield **(Abdullahi R. and Sheriff, H. H., 2013).** In our experiments cv.13 plants showed a significant decrease in growth in leaves, roots, and bulbs, but only after 50 mM NaCl, although they surprisingly recovered at 75 mM and 100 mM. The growth limitation effect in onions has been associated with limited water absorption in seedlings **(Alireza Solouki *et.al*, 2023).** The increase in bulb dry weight can be attributed to the increased plant photosynthetic rate achieved by VAM inoculation through increased leaf stomatal conductance as compared to non-inoculated plants resulting in more CO2 uptake **(Z.M. Dar *et.al*, 2018).**

CONCLUSION

The present study shows that AM Fungi significantly improves the growth and yield of onion (*Allium cepa* L.) under treated plots. AM fungi plants showed enhanced root development, greater biomass and improved nutrient uptake compared to non- treated plots. These benefits were more observed under NaCl stress, indicating the ability of AMF to mitigate the adverse effects of salinity. Overall, the study demonstrates that AM application is an effective, eco-friendly approach to improving onion productivity. By enhancing nutrient use efficiency and resilience to salinity, AMF can reduce reliance on chemical fertilizers and support sustainable agricultural practices.

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