

Original Research Article

<https://doi.org/10.20546/ijcmas.2017.610.442>

## Efficacy of *Entrophospora sp.* (VA Mycorrhiza) on Salt Tolerance and Vegetative Growth of *Chrysanthemum* var. Marigold [*Dendranthema grandiflora* Tzvelev.]

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### ABSTRACT

The present investigation was aimed at determining the effects of vesicular arbuscular mycorrhiza (VAM) on vegetative growth of chrysanthemum var. Marigold plants grown under salinity condition. *Entrophospora sp.* (VAM) inoculated plants of forty-five days old seedlings (DAS) were transplanted into pots (one seedling per pot) until the flowering. After (75 days) transplanting, seedlings of chrysanthemum var. Marigold were treated with 1.15 (control) 2, 4 and 6 dS/m saline irrigation water and observations showed that whole plant height, number of leaves and branches, N-S and E-W plant spread, leaf area, number of primary and secondary roots, shoot and root length, fresh and dry weight decreased with increasing dose of salinity. Among these treatments, VA mycorrhiza treated plants enhanced vegetative parameters when compared to control plants. VA mycorrhiza promotes salinity tolerance by employing various mechanisms, such as enhancing nutrient acquisition, producing plant growth hormones, improving rhizospheric and soil condition, altering the physiological and biochemical properties of the host. The overall results suggest that mycorrhizal colonization improves host plant mineral concentration and vegetative growth and development of chrysanthemum var. Marigold plants under salinity stress.

#### Keywords

Salt tolerance,  
Vegetative growth,  
Marigold.

#### Article Info

Accepted:  
29 September 2017  
Available Online:  
10 October 2017

### Introduction

*Chrysanthemum* (*Dendranthema grandiflora* Tzvelev.) is one of the most interesting and oldest flower crops. *Chrysanthemum* belongs to the family Asteraceae with diploid chromosome number ( $2n = 36$ ). It is a leading commercial crop grown for cut, loose flowers and pot plant. (Bhattacharjee, 2006). *Chrysanthemum* includes more than 200 species of annuals and herbaceous perennials and is native to northern hemisphere, chiefly Europe and Asia. *Chrysanthemums* are widely spread in temperate, tropical and subtropical

regions of the globe. All these make the *Chrysanthemum* flower suitable for various purposes like bedding plant, vase decorations, garland making and for garden display.

Salinity is one of the major problems which farmers are facing and needs an immediate attention to solve this problem. FAO estimated that globally the total salt affected area 12,781 million ha in which saline soils was 397 million ha and that of sodic soils 434 million ha (Arora *et al.*, 2017). In

India total salt affected area is 6.74 m ha affected with salinity problems Anon. (2015).

Salinity is an abiotic stress that results in negative effects on plant survival and considered as the most important abiotic factor limiting plant growth and yield by inducing severe physiological dysfunctions and causing widespread direct and indirect harmful effects. High salinity causes both hyper osmotic and ionic stress causing plant death (Yeo, 1998). Reduction in assimilates partitioning to roots and imbalance in overall concentrations of the ions due to ion toxic effect on physiological processes (Kokasal, *et al.*, 2016) Presence of excess salts, particularly sodium, chlorine and free calcium is detrimental for the growth, physiology and nutrient uptake of *Chrysanthemums* (Lee *et al.*, 2008).

One of the natural and technological ways which has been among the most studied subjects for the last decades to reduce the salinity damages in horticultural and agricultural crops is the inoculation with Vesicular Arbuscular Mycorrhiza (VAM) fungus. Plants inoculated with VAM maintain relatively higher water content compared to uninoculated plants (Colla *et al.*, 2008; Sheng *et al.*, 2008). This is facilitated by the improved hydraulic conductivity of the root at low water potential (Kapoor *et al.*, 2008). The improved root conductance is associated with a longer root and an altered root system morphology induced by VAM (Dehne, 1982, Kothari *et al.*, 1990). Improves chlorophyll and carotenoid content (Basak *et al.*, 2011) thus maintains osmotic adjustment. Application of AM fungi increases antioxidant enzymatic activity and auxine concentration in plants. Application of VAM Fungi helps in accumulations of phosphorous, potassium, calcium, magnesium and potassium to nitrogen ratio and all the above mechanisms help to mitigate the negative

effect of salinity (Abeer *et al.*, 2015). Keeping in view of the above points, the present study the vegetative growth and salinity tolerance of *Chrysanthemum* var. marigold when inoculated with VAM (*Entrophospora* sp.) was conducted.

## Materials and Methods

The experiment was conducted using two factorial complete randomized design with VA Mycorrhiza (*Entrophospora* sp.) and non mycorrhiza combined with four concentration of NaCl (1.15 (control), 2, 4 and 6 dS/m). These eight treatments were replicated 3 time (each row contain 8 pot plants) to give a total of 192 pots. The data in all the experiments was statistically analysed by the method of analysis of variance as per Panse and Sukhatme (1989). Plants were grown under shade house condition. At the Kittur Rani Channamma College of Horticulture, Arabhavi. University of Horticultural Sciences, Bagalkot, Karnataka, India.

*Entrophodpora* sp. (VA Mycorrhiza) inoculum was mixed with coco peat in the ratio of 1: 3 and 80 g of this mixture was used to fill 100 g capacity polybags. VAM mixture filled and a hole was made. *Chrysanthemum* var. Marigold cuttings were placed in the hole such that maximum root surface was in contact with the mixture. Later some amount of VAM mixture was covered and polybags were irrigated with water. They were allowed to establishing for one and half months later, they were transplanted to bigger pots with capacity of 10 kg soil. Salt treatments were imposed two and half month after transplanting.

*Chrysanthemum* var. Marigold plants, moderately salt tolerant crop. *Chrysanthemum* multiplication was done by using shoot tip cuttings from mother plants. Cuttings were prepared as basal 10-12 cm long cuttings,

planted in coco peat with and without *Entrophospora* sp. inoculums. One and half month old uniform rooted cuttings were transplanted to pots. After 75 days of transplanting, each treatment of mycorrhizal and non mycorrhizal plants was irrigated with an equal (1000 ml) volume of the corresponding NaCl at weekly intervals. Leaching was prevented by keeping the soil below the field capacity at all times. Alternatively Groundnut cake and Neem cake extracts (100 ml) were used as additional supply of nutrients for plants growth at fortnight interval. Plants were harvested 6 month after transplanting.

Morphological data were recorded on the marked plants from which plant height (soil line to plant tip), number of leaves per plant, number of branches per plant (including primary and secondary branchess), plant spread (North to South and East to West) measurements were recorded monthly intervals. Leaf area, shoot length (after detaching of root part), root length (after detachment of shoot part), number of roots (primary and secondary roots) were recorded during harvesting of crop.

## Results and Discussion

Mycorrhiza inoculated plants growth and biomass was more than the uninoculated plants before imposition salt (at 75 days). NaCl stress significantly reduced plant growth and biomass of both mycorrhizal and nonmycorrhizal *Chrysanthemum* var. Marigold plants compared with control treatment and the rate of reduction increased with increasing NaCl concentration in the soil. However, the reduction in most growth criteria was more distinct in non-mycorrhizal *Chrysanthemum* var. Marigold plants (Table 1A and 1B). In general, VAM plants had significantly higher Plant height, No. of leaves, No. of branches, Leaf area (cm<sup>2</sup>),

Number of primary roots, Number of secondary roots, shoot and root length than those of non-mycorrhizal plants at all salt levels. Interactions between salinity and mycorrhizal colonization were significant for all character, except root length.

Salinity is one of the major constraints limiting crop productivity worldwide (Heyward and Bernstein, 1990). Soil salinity decreases crop yield by increasing the osmotic stress, nutrient deficiency and affecting various physiological and biochemical mechanism associated with plant growth and development (Colla *et al.*, 2008; Sheng *et al.*, 2008; Kokasal, *et al.*, 2016;; Abeer *et al.*, 2015). It appears from present study that salinity stress significantly reduced growth responses of mycorrhizal and non mycorrhizal *Chrysanthemum* var. Marigold compared with the control treatment plants. However, VAM inoculation improves growth and biomass of *Chrysanthemum* var. Marigold grown in either salt stressed or control soils compared to non mycorrhizal plants. The rate of growth of mycorrhizal colonization also decreased with increased salinity level these results are In accordance with the earlier reports on the plant species (Belew *et al.*, 2010). Plants in saline conditions has been related partially to mycorrhizal mediated enhancement of host plant P nutrition (Belew *et al.*, 2010; Asrar *et al.*, 2014) interestingly mycorrhizal *Chrysanthemum* var. Marigold plants absorbed more available nutrients from (NPK) soil than non mycorrhizal plants in a salt stress treatment. It is evident from the study that plant tolerance to salt stress was improved greatly by *Entrophospora* sp. (VA Mycorrhizal colonization). We suggested that better growth and biomass in inoculated *Chrysanthemum* var. Marigold plants is an indication of enhanced salt tolerance to salt stress.

**Table.1A** Effect of *Entrophospora* sp. and salinity on growth parameters of *Chrysanthemum* var. Marigold

Treatments	Plant height		Number of leaves		Number of branches	
	Days after planting					
	75	210	75	210	75	210
<b>VAM effect</b>						
M <sub>0</sub>	18.05	48.05	21.78	154.48	2.29	9.67
M <sub>1</sub>	19.85	51.80	29.92	172.85	3.58	12.25
S. Em±	0.32	0.44	1.05	1.07	0.16	0.14
CD at 5%	0.95	1.31	3.14	3.21	0.47	0.42
<b>Salt effect</b>						
S <sub>0</sub>	19.65	54.55	24.60	176.93	2.82	12.03
S <sub>1</sub>	19.22	53.73	27.17	183.57	3.20	12.33
S <sub>2</sub>	18.70	50.10	26.37	161.23	2.89	10.90
S <sub>3</sub>	18.23	41.32	25.27	132.93	2.83	8.57
S. Em±	0.45	0.62	1.48	1.51	0.22	0.20
CD at 5%	NS	1.85	NS	4.54	NS	0.59
<b>Interaction effect</b>						
M <sub>0</sub> S <sub>0</sub>	18.64	53.13	21.27	171.80	2.11	10.80
M <sub>0</sub> S <sub>1</sub>	18.77	49.90	23.80	179.47	2.47	11.27
M <sub>0</sub> S <sub>2</sub>	17.79	49.30	21.53	158.47	2.25	10.13
M <sub>0</sub> S <sub>3</sub>	17.00	39.87	20.53	108.20	2.33	6.47
M <sub>1</sub> S <sub>0</sub>	20.67	55.97	27.93	182.07	3.53	13.27
M <sub>1</sub> S <sub>1</sub>	19.67	57.57	30.53	187.67	3.93	13.40
M <sub>1</sub> S <sub>2</sub>	19.61	50.90	31.20	164.00	3.53	11.67
M <sub>1</sub> S <sub>3</sub>	19.45	42.77	30.00	157.67	3.33	10.67
S. Em±	0.63	0.87	2.09	2.14	0.31	0.28
CD at 5%	NS	2.62	NS	6.41	NS	0.84

NS: Non significant

M<sub>0</sub>- Without *Entrophospora* sp. (VA Mycorrhiza) M<sub>1</sub>- With *Entrophospora* sp. (VA Mycorrhiza) S<sub>0</sub> - Normal water (1.15 dS/m) S<sub>1</sub>- 2 dS/m S<sub>2</sub>- 4 dS/m S<sub>3</sub>- 6 dS/m

**Table.1B** Effect of *Entrophospora* sp. and salinity on growth parameters of *Chrysanthemum* var. Marigold

Treatments	Leaf area (cm <sup>2</sup> )	Shoot Length (cm)	Root Length (cm)	Number of primary roots	Number of secondary roots
<b>VAM effect</b>					
M <sub>0</sub>	1948.92	52.36	30.88	57.58	190.50
M <sub>1</sub>	2635.18	56.96	34.88	80.33	265.50
S. Em±	25.28	0.73	0.68	2.01	5.49
CD at 5%	75.80	2.19	2.04	6.04	16.45
<b>Salt levels</b>					
S <sub>0</sub>	2757.37	61.33	38.25	89.50	283.50
S <sub>1</sub>	2467.49	58.75	35.33	75.33	260.83
S <sub>2</sub>	2152.50	52.17	32.17	64.50	212.17
S <sub>3</sub>	1790.83	46.38	25.75	46.50	155.50
S. Em±	35.76	1.03	0.96	2.85	7.76
CD at 5%	107.20	3.10	2.89	8.54	23.26
<b>Interaction effect</b>					
M <sub>0</sub> S <sub>0</sub>	2541.04	56.50	33.83	71.67	228.67
M <sub>0</sub> S <sub>1</sub>	2057.66	56.00	33.50	64.67	220.67
M <sub>0</sub> S <sub>2</sub>	1747.33	51.67	31.50	59.33	191.67
M <sub>0</sub> S <sub>3</sub>	1449.67	45.27	24.67	34.67	121.00
M <sub>1</sub> S <sub>0</sub>	2973.70	66.17	42.67	107.33	338.33
M <sub>1</sub> S <sub>1</sub>	2877.33	61.50	37.17	86.00	301.00
M <sub>1</sub> S <sub>2</sub>	2557.67	52.67	32.83	69.67	232.67
M <sub>1</sub> S <sub>3</sub>	2132.00	47.50	26.83	58.33	190.00
S. Em±	50.57	1.46	1.36	4.03	10.97
CD at 5%	151.61	4.38	ns	12.07	32.90

Ns: Non significant

M<sub>0</sub>- Without *Entrophospora* sp. (VA Mycorrhiza) M<sub>1</sub>- With *Entrophospora* sp. (VA Mycorrhiza) S<sub>0</sub>- Normal water (1.15 dS/m) S<sub>1</sub>- 2 dS/m S<sub>2</sub>- 4 dS/m S<sub>3</sub>- 6 dS/m

Use of *Entrophospora* sp. VA mycorrhizal fungus enhances growth and biomass of *Chrysanthemum* var. Marigold. Through enhancing nutritional status, water uptake and toxic ions exclusion like Na<sup>+</sup> and Cl<sup>-</sup>. All vegetative growth of plants was found to be significant at control salinity and 2 dS/m salinity level but reduction in plants growth were observed at 4 dS/m salinity level so *Chrysanthemum* var. Marigold is a moderate salt tolerant crop.

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#### How to cite this article:

Irappa Kumbar, Chaya P. Patil, Mukund Shiragur, Balaji S. Kulkarni and Shirol, A.M. 2017. Efficacy of *Entrophospora* sp. (VA Mycorrhiza) on Salt Tolerance and Vegetative Growth of *Chrysanthemum* var. Marigold [*Dendranthema grandiflora* Tzvelev.]. *Int.J.Curr.Microbiol.App.Sci*. 6(10): 4763-4768. doi: <https://doi.org/10.20546/ijcmas.2017.610.442>