RESEARCH ARTICLE

Positive interaction of am fungi with *Capsicum annum* L. (Chilli)

Kelkar Tushar S[1] and Bhalerao Satish A[2]

[1]Environmental Sciences Research Laboratory, Department of Botany,
Wilson College, Mumbai – 400 007, University of Mumbai
[2]S. I. C. E. Society's Degree College of Arts, Science and Commerce,
Jambhul Phata, Chikhloli, Ambernath (W) 421 505, University of Mumbai
*Correspondng author: drsatishbhalerao60@gmail.com

Manuscript details:

Available online on
http://www.ijlsci.in

ISSN: 2320-964X (Online)
ISSN: 2320-7817 (Print)

Editor: Dr. Arvind Chavhan

Cite this article as:
Kelkar Tushar S and Bhalerao Satish A (2016) Positive interaction of am fungi with *Capsicum annum* L. (Chilli), Int. J.of. Life Sciences, Special Issue, A7:7-12.

ABSTRACT

Arbuscular Mycorrhiza is well known symbionts for majority of angiospermic plants. Mycorrhiza is more common than the exception for higher plants. Symbiotic relationship is developed because of requirement of carbon source by the fungus, which is present and can be produced by higher photosynthetic plants. In return, higher plants get enhanced phosphate uptake along with many other minerals like magnesium, iron etc. This symbiotic association proved to be beneficial for both of the symbionts. The benefits of this symbiotic association can be easily checked in host plants which are often a higher plant like angiosperm.

In present investigation *Capsicum annum* L. plant commonly known as chilli was screened and assessed for such benefits shared by mycorrhiza. In present paper biochemical aspects were studied in controlled (non mycorrhizal) and treated (mycorrhizal) plants of chilli. The estimation of total chlorophyll content, total soluble proteins, phosphate phosphorous, Ca and Mg content of leaf was carried out in mycorrhizal chilli plants and is compared with non mycorrhizal plants of chilli. Results from these estimation showed that there is a significant increase in all the studied biochemical parameters in mycorrhizal chilli plants than the non mycorrhizal chilli plants. These results may contribute to the increment in overall yield of chilli plants.

Key words: Arbuscular mycorrhiza, *Capsicum annum* L., total chlorophyll content, total soluble proteins, phosphate phosphorous, Ca and Mg content.

INTRODUCTION

Arbuscular Mycorrhiza is well known symbionts for majority of angiospermic plants. Mycorrhiza is more common than the exception for higher plants. Symbiotic relationship is developed because of requirement of carbon source by the fungus, which is present and can be

produced by higher photosynthetic plants. In return, higher plants get enhanced phosphate uptake along with many other minerals like magnesium, iron etc. This symbiotic association proved to be beneficial for both of the symbionts. The benefits of this symbiotic association can be easily checked in host plants which are often a higher plant like angiosperm.

Capsicum annuum is a perennial herbaceous plant in the family Solanaceae. Although the species name *annuum* means "annual" (from the Latin *annus* - year), the plant is not an annual. The numerous varieties that have been developed are categorized in five major groups: 1) Cerasiforme (cherry peppers); 2) Conoides (cone peppers); 3) Fasciculatum (red cone peppers); 4) Grossum (bell or sweet peppers); and 5) Longum (chili or cayenne peppers). Chillies are used fresh, cooked, or dried in an enormous variety of dishes characteristic of different regional cuisines. They are high in vitamins A and C. Some varieties have been developed to use as ornamentals, often for indoor pots; these often have small, brightly-coloured, persistent fruits. One of the major biochemical active compounds one can obtain from fruits of chilli (*C. annuum* and other *Capsicum* species) is Capsaicin, is an intense skin and eye irritant, and is the ingredient used in pepper sprays sold for self-defense. However, it also has numerous medical uses, including topical pain relief for muscle soreness, shingles, skin irritations, and rheumatism, and as an anti-inflammatory. Recent medical research has also documented antimicrobial and antifungal activity of capsaicin obtained from several *Capsicum* species, and on-going studies are exploring its use in cancer treatment.

There are many references available on the mycorrhization in chilli plant throwing a light of enhancement in yield of chilli plant by use of mycorrhiza [Bhuvaneswari *et al* (2014), Selvakumar and Thamizhiniyan (2011), Gaur *et al* (1998), Vyas and Vyas (2014)]. Kavitha *et al* (2004) studied the use of mycorrhiza in biocontrol of Damping-Off in Chilli. In present paper effect of mix culture of *Glomus* (*Glomus mosseae* and *Glomus fasciculatum*) on *Capsicum annum* L. plant is studied in terms of some of the biochemical parameters. They are Ca and Mg content of leaf, phosphate phosphorous in leaf, protein content of leaf and total chlorophyll content of leaf. Estimation was done in mycorrhizal (controlled) plants of chilli along with non mycorrhizal (controlled) plants of chilli.

MATERIALS AND METHODS

Eighteen cm diameter, bottom holed plastic pots twelve in number were used for the experiment. Out of twelve pots, six were maintained as control and six were used for the treatment with mycorrhiza culture. From nursery suppliers garden soil was obtained in bulk. Sand was collected from Girgaon Chowpatty sea shore and thoroughly washed with plenty of tap water to remove soluble salts. Mixture of soil and sand (volume / volume) in 3: 1 proportion was made in trays. As mycorrhizae are aerobic microorganisms, aeration in pot is essential and that is why sand was added because to support aeration (Potty, 1988).

The above mixture was sterilized at 121^0 C for 1 hour in autoclave at 15 lbs pressure to kill microorganisms and insect present if any. This sterilized mixture was allowed to cool down to normal room temperature and was used as a growth medium for pot experiment. Initially $3/4^{th}$ capacity of each pot was filled up with sterilized soil mixture. 10 g of AM inoculation was added to six pots as experimental or treated pots. The inoculum was distributed evenly in the pot and was covered with a layer of 4 cm of sterilized soil mixture. Fifteen water soaked seeds of *Capsicum annum* L. (Chilly) were sown in each pot, both control and treated and covered with a layer of soil. The pots were watered with watering can having small pores to avoid the disturbance of the soil surface. After intervals of 15 days after sowing (15 DAS), 30 DAS, 45 DAS and 60 DAS, chilli plants were carefully uprooted and all necessary precautions were taken unless and until plant leaves were processed for making aliquots for estimation the biochemical parameters. Various standard biochemical assays wer followed as mentioned. Estimation of Calcium and Magnesium is done by complexometric titration using ethylene diamine tetra acetic acid (EDTA) which is the most reliable method (Jackson, 1973). Phosphate phosphorus in the oven dry leaf material was extracted by the method of wet digestion (Jackson, 1967). Soluble protein contents in the fresh leaf material were analysed by the method of Lowry *et al.,* (1951). The method of Arnon (1949) was used for estimating the chlorophyll content of the leaves. Unpaired t-test is carried out to check the effect of mycorrhizal inoculation of *Capsicum annum* L. plants. All the statistical analysis are carried out with the help of R i386 3.3.3. Ink

RESULTS AND DISCUSSION

Calcium content (mg / g of leaf material)of *Capsicum annum* L. leaf - Table no. 1 depicts that the calcium content of experimental plant of *Capsicum annum* L is significantly high than the control ones throughout the experimental period.

Magnesium content (mg / g of leaf material) of *Capsicum annum* L. leaf - Table no. 2 reflects that similar to that of calcium content, magnesium content of experimental plant leaves were higher than that of control plant leaves.

Phosphate phosphorus content (mg / g of leaf material) of *Capsicum annum* L. leaf - Table no. 3 depicts phosphate phosphorus content in leaves of experimental and control plants of *Capsicum annum* L. It clearly indicates that the mycorrhizal plants of *Capsicum annum* L shows higher phosphate phosphorous than that of non – mycorrhizal plant leaves.

Protein content (mg / g of leaf material) of *Capsicum annum* L. leaf – Protein content in mycorrhizal plants was significantly higher to that of non – mycorrhizal plants. Table no. 4 reflects the same fact.

Total chlorophyll content (mg / g of leaf material) of *Capsicum annum* L. leaf – Table no. 5 depicts the higher amount of total chlorophyll content in experimental leaf of *Capsicum annum* L. than that of control leaves of *Capsicum annum* L.

Table 1: Calcium content of *Capsicum annum* L leaf in experimental and control (mycorrhizal and non – mycorrhizal respectively) plants.

Calcium content (mg / g of leaf material)	15 DAS	30 DAS	45 DAS	60 DAS
Control	1.789	1.892	2.112	2.489
Experimental	1.920	2.325	2.889	3.102
Calculated t	-17.048	-497.14	-566.69	-819.96
Level of significance (p)	0.05	0.05	0.05	0.05

Table 2: Magnesium content of *Capsicum annum* L leaf in experimental and control (mycorrhizal and non – mycorrhizal respectively) plants.

Magnesium content (mg / g of leaf material)	15 DAS	30 DAS	45 DAS	60 DAS
Control	1.121	1.285	1.394	1.676
Experimental	1.749	1.862	1.999	2.212
Calculated t	-284.33	-699.72	-179.98	-384.97
Level of significance (p)	0.05	0.05	0.05	0.05

Table 3: Phosphate phosphorous content of *Capsicum annum* L leaf in experimental and control (mycorrhizal and non – mycorrhizal respectively) plants.

Phosphate phosphorous content (mg / g of leaf material)	15 DAS	30 DAS	45 DAS	60 DAS
Control	0.122	0.149	0.154	0.160
Experimental	0.189	0.252	0.262	0.282
Calculated t	-29.963	-53.547	-43.374	-12.104
Level of significance (p)	0.05	0.05	0.05	0.05

Table 4: Protein content of *Capsicum annum* L leaf in experimental and control (mycorrhizal and non – mycorrhizal respectively) plants.

Protein content (mg / g of leaf material)	15 DAS	30 DAS	45 DAS	60 DAS
Control	1.302	1.384	1.323	1.485
Experimental	2.229	2.321	2.415	2.502
Calculated t	-603.69	-320.4	-484.32	-477.68
Level of significance (p)	0.05	0.05	0.05	0.05

Table 5: Total chlorophyll content of *Capsicum annum* L leaf in experimental and control (mycorrhizal and non – mycorrhizal respectively) plants

Total chlorophyll content (mg / g of leaf material)	15 DAS	30 DAS	45 DAS	60 DAS
Control	20.100	21.290	22.319	22.345
Experimental	30.212	32.485	33.421	33.481
Calculated t	-138.09	-454.33	-3178.5	-2534.4
Level of significance (p)	0.05	0.05	0.05	0.05

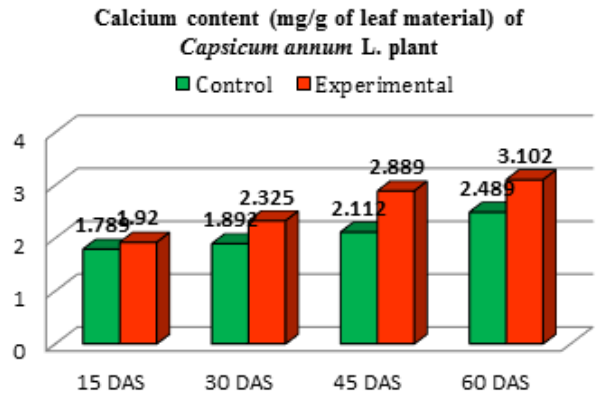

Fig.1: Calcium content of *Capsicum annum* L leaf in experimental and control (mycorrhizal and non – mycorrhizal respectively) plants.

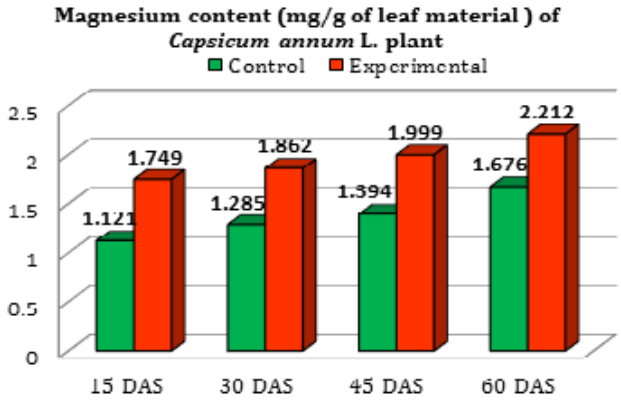

Fig. 2: Magnesium content of *Capsicum annum* L leaf in experimental and control (mycorrhizal and non – mycorrhizal respectively) plants.

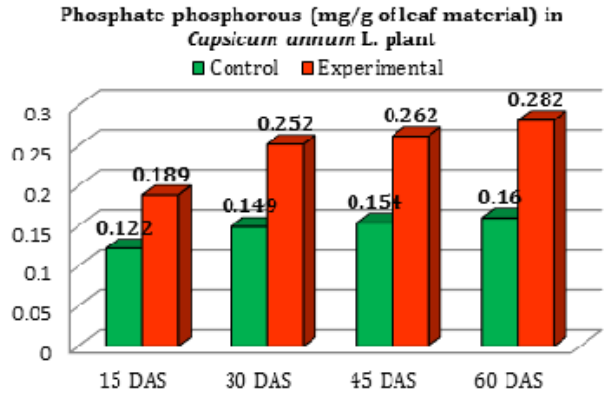

Fig. 3: Phosphate phosphorous content of *Capsicum annum* L leaf in experimental and control(mycorrhizal and non – mycorrhizal respectively) plants

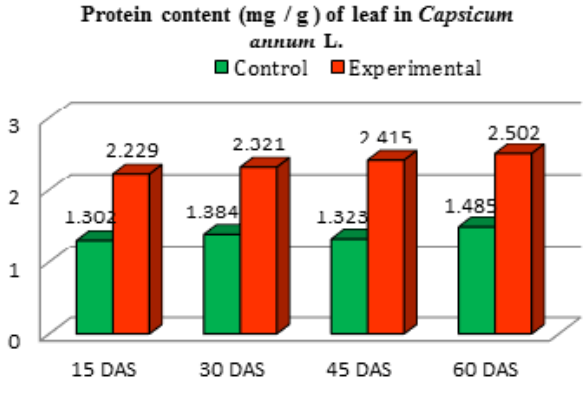

Fig. 4 – Protein content of *Capsicum annum* L leaf in experimental and control (mycorrhizal and non – mycorrhizal respectively) plants

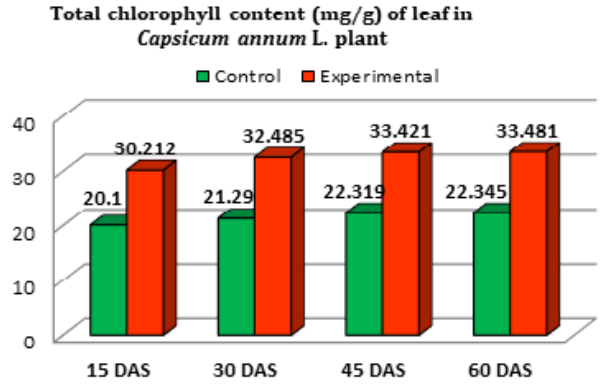

Fig. 5: Total chlorophyll content of *Capsicum annum* L leaf in experimental and control (mycorrhizal and non – mycorrhizal respectively) plants.

It is seen that in the above experiments, enhancement in all the five biochemical parameters studied in mycorrhizal (experimental) plants of *Capsicum annum* L. in comparison with the non mycorrhizal (controlled) plants of *Capsicum annum* L. plants. Similar results have been reported by various researchers in various other plants viz Singh (2004) reported higher concentrations of Ca and Mg in shoots of maize in AM maize plants with comparison to non AM maize. Sitaramamaiah *et al* (1998) observed 55 % increase in Ca and 50 % increment in Mg content in maize plants by *Glomus fasciculatum* inoculation as compared to that of non inoculated maize plants. Mycorrhizal maize leaf shows higher amount of phosphates then the non mycorrhizal ones was shown by McGonigle and Miller (1993). Roy-Bolduc and Hijri (2011) in their review paper throws a light on increase phosphate concentration in mycorrhizal plants with respect to non mycorrhizal ones. Krishna and Lee (1987) reported increased phosphorous uptake and plant growth in pearl millet and sorghum in semi arid tropics. Azcon *et al* (1996) reported increased protein content in Lettuce *Lactuca sativa* plant inoculated with *Glomus fasciculatum* than the non mycorrhizal plant. Fattah and Asrar (2012) reported increased protein content in leaves of mycorrhizal maize plant than the non mycorrhizal plants in saline conditions. Shinde and Thakur (2015) carried out detail experiments on pea plants in water stress condition with mixture of AM fungi species of *Acaulospora denticulata, A. gerdemannii, Glomus macrocarpum, G. maculosum, G. fasciculatum and Scutellospora minuta*. It was observed that protein content of leaf decreases in water stress conditions in non mycorrhizal plants whereas no such decrease was observed by them in mycorrhizal plants of pea in water stress conditions. They concluded that such increased in protein content was because of mycorrhiza, as mycorrhiza is well known stress reducing symbiont. Shinde and Khanna (2014) reported that proteins in mycorrhizal plants are significantly high than that of non mycorrhizal plants of potato. Shinde and khanna (2014), Shinde and Thakur (2015) reported that in mycorrhizal plants of pea and potato, significant increment of chlorophyll content than non mycorrhizal one. Thakur *et al* (2005) reported such increment in total chlorophyll content in leaves of mycorrhizal apple plants in comparison with apple plants which are non mycorrhizal. They predicted that such increase in chlorophyll content is because of increment in Mg content in mycorrhizal plants as Mg is essential for chlorophyll development. Similar kinds of reports are given by Khare *et al* (2008).

REFERENCES

Arnon DI (1949) Copper enzymes in isolated chloroplasts: Polyphenol oxidase in *Beta vulgaris* Plant Physiology 24 (1): 1-15.

Azcon R, Gomez M and Tobar R (1996) Physiological and nutritional response of *Lactuca sativa* L. ti nitrogen sources and mycorrhizal fungi under drought conditions. Biology and fertility of soils 22(1 – 2): 156 – 161

Fattah-Abdel GM and Asrar AA (2012) Arbuscular mycorrhizal fungal application to improve growth and tolerance of wheat (*Triticum aestivum* L.) plants grown in saline soil Acta Physiol Plant 34: 267

Bhuvaneswari G, Reetha S, Sivaranjani R and Ramakrishnan K (2014) Effect of AM fungi and Trichoderma species as stimulations of growth and morphological character of chilli (*Capsicum annuum* .L) International Journal of Current Microbiology and Applied Science3(3): 447-455

Selvakumar G and Thamizhiniyan P (2011) The Effect of the Arbuscular Mycorrhizal (AM) Fungus *Glomus intraradices* on the Growth and Yield of Chilli (*Capsicum annuum L.*) Under Salinity Stress World Applied Sciences Journal 14 (8): 1209-1214

Gaur Atimanav, Alok Adholeya, Krishna G Mukerji (1998) A comparison of AM fungi inoculants using Capsicum and Polianthes in marginal soil amended with organic matter Mycorrhiza Vol. No. 7 (6): 307-312

Jackson ML (1967) Soil and chemical analysis Prentice Hall of India Pvt. Ltd. New Delhi: 38 – 82

Jackson ML (1973) Soil Chemical Analysis, Prentice Hall India Pvt Ltd, New Delhi, India: 498-516.

Sitaramaiah K, Rahul Khanna and Trimurtulu N (1998) Effect of *Glomus fasciculatum* on growth and chemical composition of maize Journal of mycology and plant pathology Vol. 28 (1): 38 – 40

Kavitha K, Meenakumari KS and Sivaprasad P (2004) Arbuscular Mycorrhizal Fungi for Biocontrol of Damping-Off in Chilli Journal of Mycology and Plant Pathology, Vol. 34, No. 2:349 – 353.

Khare V, Singh SK, Singh S and Kheri HK (2008) Effect of AM fungi in improving the growth performance of *Cyamopsis tetragonoloba* under saline soil conditions. Mycorrhiza news 20(2): 17 – 19.

Krishna KR and Lee KK (1987) Management of vesicular arbuscular mycorrhiza in tropical cereals In Mycorrhiza in the next decade NACOM 1987, proceedings of 7th North American conference on Mycorrhizae Florida, USA: 43 – 45.

Lowry OH, Rosebrought S, Farr Al and Randall RJ (1951) Protein measurement with Folin phenol reagent Journal of Biological Chemistry Vol. 193 (1): 265 – 275

Mc Gonigle TP and Miller MH (1993) Mycorrhizal development and phosphorus absorption in maize under conventional and reduced tillage. Plant and Soil 210: 33 – 42.

Roy-Bolduc A and Hijri M (2011) The Use of Mycorrhizae to Enhance Phosphorus Uptake: A Way Out the Phosphorus Crisis. J Biofertil Biopestici 2:104.

Shinde BP and Jaya Thakur (2015) Influence of Arbuscular mycorrhizal fungi on chlorophyll, proteins, proline and total carbohydrates content of the pea plant under water stress condition International Journal of Current Microbiology and Applied Science (2015) 4(1): 809-821

Shinde BP and Manjusha Khanna (2014) Impact of AM fungi on biochemical changes in potato plants International Journal of Current Microbiology and Applied Science Volume 3 (7): 1018-1027

Singh S (2004) Effect of soil moisture on arbuscular mycorrhizal development in plants (Part II) In pulses, vegetables and misclellaneous crops Mycorrhiza News 16 (1): 2- 11

Thakur JS, Sharma YP and Lakhanpal TN (2005) Mycorrhizal Innoculations and Mineral Status of Apple (*Malus domesticus* Borkh.) Journal of Mycology and Plant Pathology, Vol. 35, No. 1:58 –63

Vyas Mohnish and Anil Vyas (2014) Field Response of Capsicum Annuum Dually Inoculated with AM Fungi and PGPR in Western Rajasthan International Journal of Research Studies in Biosciences Vol. 2(3): 21-26.