Plant Archives Vol. 26, Supplement 2, 2026 pp. 1579-1583 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.supplement-2.189

EFFECT OF ARBUSCULAR MYCORRHIZAL FUNGI (AMF) AND NPK ON GROWTH, YIELD PARAMETERS OF CHILLI (*Capsicum annuum* L.)

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(Date of Receiving : 20-03-2026; Date of Revision : 26-04-2026; Date of Acceptance : 27-05-2026)

ABSTRACT

A field experiment was conducted during the summer season of 2025 at the Crop Research Center-III, Department of Horticulture, School of Agriculture, ITM University, Gwalior (M.P.) to evaluate the effect of Arbuscular Mycorrhizal Fungi (AMF) and different levels of NPK on growth and yield parameters of chilli. The experiment was laid out in a Randomized Block Design with three replications comprising eight treatments with combinations of AMF (±) and NPK levels (0%, 50%, 75% and 100%). The results revealed that significant differences were observed among treatments for all growth and yield parameters. The maximum plant height, number of branches, leaf area, number of fruits per plant, fruit weight and fruit yield were recorded with the treatment T_7 [AMF (+) + 75% NPK], followed by T_8 [AMF (+) + 100% NPK]. The lowest values were recorded under control (T_1). The study indicated that AMF inoculation significantly enhances nutrient use efficiency and allows reduction of chemical fertilizers up to 25% without yield loss.
***Keywords* :** Chilli, AMF, NPK, Growth, Yield.

Introduction

Chilli (*Capsicum annuum* L.) belongs to the family Solanaceae with chromosome number 2n = 24. It is a predominantly self-pollinated crop, and its centre of origin is Central and South America. The crop was introduced to India by the Portuguese and is now widely cultivated in tropical and subtropical regions under open field, greenhouse, polyhouse, and soilless culture systems. Chilli fruits are rich in essential minerals such as potassium, calcium, magnesium, phosphorus, iron, zinc and copper, along with organic acids like ascorbic acid (vitamin C). The characteristic pungency and flavour are attributed to compounds such as capsaicin and various volatile constituents including aldehydes, esters and terpenoids (Sharma *et al*., 2021; Wahyuni *et al*., 2022).

Chilli is one of the most important vegetable and spice crops in India, cultivated extensively in states like Andhra Pradesh, Telangana, Madhya Pradesh, Karnataka and Maharashtra. India is the largest producer of chilli globally, covering about 8.5 lakh hectares with a production exceeding 30 lakh tonnes (NHB, 2024). Madhya Pradesh is also a major chilli-producing state contributing significantly to national production (Anonymous, 2024).

In recent years, sustainable agricultural practices have gained importance due to declining soil health caused by excessive use of chemical fertilizers. Among these, the use of beneficial soil microorganisms such as *Arbuscular mycorrhizal* fungi (AMF) has emerged as an eco-friendly approach to enhance crop productivity and soil fertility. AMF 1 form symbiotic associations with plant roots and play a vital role in nutrient uptake, particularly phosphorus, nitrogen and micronutrients (Begum *et al*., 2019; Chen *et al*., 2022).

Arbuscular mycorrhizal fungi improve plant growth by extending the root system through a network of hyphae, thereby increasing the absorptive surface area and enhancing water and nutrient uptake. They also improve plant tolerance to abiotic stresses such as drought, salinity and temperature extremes (Smith & Smith, 2020; Zhang *et al*., 2021). Additionally, AMF contribute to improved soil structure, microbial activity and nutrient cycling, making them an important component of sustainable horticulture.

Materials and Methods

The present experiment was conducted during the summer season of 2025 at the Crop Research Center-III, Department of Horticulture, School of Agriculture, ITM University, Gwalior (M.P.), India. The experiment was laid out in a Randomized Block Design with three replications. The treatments consisted of eight combinations of AMF and NPK levels *viz*., T_1: AMF (–), NPK (0%), T_2: AMF (–), NPK (50%), T_3: AMF (–), NPK (75%), T_4: AMF (–), NPK (100%), T_5: AMF (+), NPK (0%), T_6: AMF (+), NPK (50%), T_7: AMF (+), NPK (75%) and T_8: AMF (+), NPK (100%).

Healthy seedlings of chilli *cv*. Kashi Anmol were transplanted in the field at the spacing of 60 cm × 45 cm. The plot size was 3 m². Recommended agronomic practices were followed uniformly for all treatments. Observations were recorded on growth parameters such as plant height (cm), number of branches per plant, leaf area (cm²), chlorophyll content (SPAD value), root length and yield parameters including number of fruits per plant, fruit length (cm), fruit diameter (cm), average fruit weight (g), fruit yield per plant (g) and Fruit yield per hectare (q).

Results and Discussion

Growth parameters

The growth parameters of chilli were significantly influenced by different treatments of AMF and NPK are presented in Table 1 and 2.

A significant effect was observed in plant height at 30 DAT as compared to the control. The plant height range was recorded from 14.67 to 25.80 cm. The maximum (25.80 cm) plant height at 30 DAT was recorded in T_7 [AMF (+), NPK (75%)], followed by T_8 (22.97 cm) and T_4 (20.83 cm). The minimum (14.67 cm) plant height at 30 DAT was recorded in T_1 [AMF (-), NPK (0)]. However, none of the treatments were at par with T_7. The plant height range was recorded from 33.00 to 59.23 cm. The maximum (59.23 cm) plant height at 60 DAT was recorded in T_7 [AMF (+), NPK (75%)], followed by T_8 (53.03 cm) and T_4 (49.33 cm). The minimum (33.00 cm) plant height at 60 DAT was recorded in T_1 [AMF (–), NPK (0)]. However, none of the treatments were at par with T_7. The plant height range was recorded from 45.63 to 81.03 cm. The maximum (81.03 cm) plant height at 90 DAT was recorded in T_7 [AMF (+), NPK (75%)], followed by T_8 (72.20 cm) and T_4 (66.73 cm). The minimum (45.63 cm) plant height at 90 DAT was recorded in T_1 [AMF (–), NPK (0)]. However, none of the treatments were at par with T_7. These results are in conformity with the findings of Gurumurthy *et al*. (2014).

The number of branches per plant ranged from 3.30 to 6.73 at 30 DAT. The maximum (6.73) number of branches at 30 DAT was recorded in T_7 [AMF (+), NPK (75%)], followed by T_8 (6.00) and T_4 (5.37). The minimum (3.30) number of branches at 30 DAT was recorded in T_1 [AMF (–), NPK (0)]. However, none of the treatments were at par with T_7. The number of branches per plant ranged from 5.53 to 10.30 at 60 DAT. The maximum (10.30) number of branches at 60 DAT was recorded in T_7 [AMF (+), NPK (75%)], followed by T_8 (9.30) and T_4 (8.97). The minimum (5.53) number of branches at 60 DAT was recorded in T_1 [AMF (–), NPK (0)]. However, none of the treatments were at par with T_7. The number of branches per plant ranged from 7.30 to 16.83 at 90 DAT. The maximum (16.83) number of branches at 90 DAT was recorded in T_7 [AMF (+), NPK (75%)], followed by T_8 (15.03) and T_4 (13.83). The minimum (7.30) number of branches at 90 DAT was recorded in T_1 [AMF (–), NPK (0)]. However, none of the treatments were at par with T_7. The results are in accordance with the outcomes reported by Bhuvaneswari *et al*. (2014).

The leaf area ranged from 25.77 to 38.26 cm² at 30 DAT. The maximum (38.26 cm²) leaf area at 30 DAT was recorded in T_7 [AMF (+), NPK (75%)], followed by T_8 (35.15 cm²) and T_6 (32.59 cm²). The minimum (25.77 cm²) leaf area at 30 DAT was recorded in T_1 [AMF (–), NPK (0)]. However, none of the treatments were at par with T_7. A significant effect was observed in leaf area at 60 DAT as compared to the control. The leaf area ranged from 31.55 to 43.51 cm² at 60 DAT. The maximum (43.51 cm²) leaf area at 60 DAT was recorded in T_7 [AMF (+), NPK (75%)], followed by T_8 (40.93 cm²) and T_6 (38.52 cm²). The minimum (31.55 cm²) leaf area at 60 DAT was recorded in T_1 [AMF (–), NPK (0)]. However, none of the treatments were at par with T_7. A significant effect was observed in leaf area at 90 DAT as compared to the control. The leaf area ranged from 35.96 to 53.01 cm² at 90 DAT. The maximum (53.01 cm²) leaf area at 90 DAT was recorded in T_7 [AMF (+), NPK (75%)], followed by T_8 (48.60 cm²) and T_6 (45.01 cm²). The minimum (35.96 cm²) leaf area at 90 DAT was recorded in T_1 [AMF (–), NPK (0)]. However, none of the treatments were at par with T_7. These results are in conformity with the findings of Gurumurthy *et al*. (2014).

A significant effect was observed in chlorophyll content at flowering stage as compared to the control. The chlorophyll content ranged from 52.83 to 66.61. The maximum (66.61) chlorophyll content was recorded in T_7 [AMF (+), NPK (75%)], followed by T_8 (65.79) and T_6 (62.19). The minimum (52.83) chlorophyll content was recorded in T_1 [AMF (–), NPK (0)]. However, none of the treatments were at par with T_7. These results are in conformity with the findings of Gurumurthy *et al*. (2014).

A significant effect was observed in root length after last harvest as compared to the control. The root length ranged from 14.85 to 26.45 cm. The maximum (26.45 cm) root length was recorded in T_7 [AMF (+), NPK (75%)], followed by T_8 (24.51 cm) and T_6 (22.13 cm). The minimum (14.85 cm) root length was recorded in T_1 [AMF (–), NPK (0)]. However, none of the treatments were at par with T_7. The results are in accordance with the outcomes reported by Bhuvaneswari *et al*. (2014).

Yield parameters

Significant variation was observed in yield parameters due to different treatments presented in Table 3 and 4. The number of fruits per plant ranged from 55.15 to 135.28. The maximum (135.28) number of fruits per plant was recorded in T_7 [AMF (+), NPK (75%)], followed by T_8 (120.32) and T_4 (110.32). The minimum (55.15) number of fruits per plant was recorded in T_1 [AMF (-), NPK (0)]. However, none of the treatments were at par with T_7. The present findings corroborate the results of Gurumurthy *et al*. (2014) in chilli.

The fruit length ranged from 6.50 to 10.50 cm. The maximum (10.50 cm) fruit length was recorded in T_7 [AMF (+), NPK (75%)], followed by T_8 (9.80 cm) and T_4 (9.20 cm). The minimum (6.50 cm) fruit length was recorded in T_1 [AMF (–), NPK (0)]. However, none of the treatments were at par with T_7. The results were in conformity with the findings of Castillo *et al*. (2013) in Chilean pepper plants.

The fruit diameter ranged from 0.85 to 1.30 cm. The maximum (1.30 cm) fruit diameter was recorded in T_7 [AMF (+), NPK (75%)], followed by T_8 (1.21 cm) and T_4 (1.13 cm). The minimum (0.85 cm) fruit diameter was recorded in T_1 [AMF (–), NPK (0)]. However, none of the treatments were at par with T_7. The results are in accordance with the findings of Banu *et al*. (2013).

The fruit weight ranged from 2.20 to 4.45 g. The maximum (4.45 g) fruit weight was recorded in T_7 [AMF (+), NPK (75%)], followed by T_8 (4.00 g) and T_4 (3.85 g). The minimum (2.20 g) fruit weight was recorded in T_1 [AMF (–), NPK (0)]. However, none of the treatments were at par with T_7. These results are in agreement with the findings of Castillo *et al*. (2013) in chilean pepper plant. The fruit yield per plant ranged from 120.33 to 607.64 g. The maximum (607.64 g) fruit yield per plant was recorded in T_7 [AMF (+), NPK (75%)], followed by T_8 (480.00 g) and T_4 (418.35 g). The minimum (120.33 g) fruit yield per plant was recorded in T_1 [AMF (–), NPK (0)]. However, none of the treatments were at par with T_7. Similar findings are reported in the work of Gurumurthy *et al*. (2014) in chilli plants.

The fruit yield per hectare ranged from 129.33 to 245.32 q/ha. The maximum (245.32 q/ha) fruit yield per hectare was recorded in T_7 [AMF (+), NPK (75%)], followed by T_8 (225.00 q/ha) and T_4 (214.66 q/ha). The minimum (129.33 q/ha) fruit yield per hectare was recorded in T_1 [AMF (–), NPK (0)]. However, none of the treatments were at par with T_7. These results are in accordance with the findings of Singh *et al*. (2021).

Table 1: Effect of arbuscular mycorrhizal fungi and NPK on plant height (cm) and number of branches per plant

Treatment code	Treatment Details	Plant height (cm)			Number of branches per plant		
		30 Days	60 Days	90 Days	30 Days	60 Days	90 Days
T_1	AMF (-), NPK (0)	14.67	33.00	45.63	3.30	5.53	7.30
T_2	AMF (-), NPK (50 %)	17.10	38.60	52.90	3.97	6.83	9.20
T_3	AMF (-), NPK (75 %)	18.95	44.20	60.20	4.70	8.03	11.50
T_4	AMF (-), NPK (100 %)	20.83	49.33	66.73	5.37	8.97	13.83
T_5	AMF (+), NPK (0)	17.57	40.90	55.40	4.13	7.23	10.80

T_6	AMF (+), NPK (50 %)	20.17	47.43	63.90	5.10	8.83	13.30
T_7	AMF (+), NPK (75%)	25.80	59.23	81.03	6.73	10.30	16.83
T_8	AMF (+), NPK (100 %)	22.97	53.03	72.20	6.00	9.30	15.03
SE_m (±)		**0.02**	**0.02**	**0.02**	**0.03**	**0.10**	**0.02**
CD (5%)		**0.05**	**0.05**	**0.05**	**0.08**	**0.30**	**0.05**

Table 2: Effect of arbuscular mycorrhizal fungi and NPK on leaf area (cm²), Chlorophyll content and Root length (cm)

Treatment code	Treatment Details	leaf area (cm²)			Chlorophyll content	Root length (cm)
		30 Days	60 Days	90 Days		
T_1	AMF (-), NPK (0)	25.77	31.55	35.96	52.83	14.85
T_2	AMF (-), NPK (50 %)	27.51	33.69	37.93	55.95	17.11
T_3	AMF (-), NPK (75 %)	29.76	35.35	39.85	59.11	19.24
T_4	AMF (-), NPK (100 %)	31.81	37.41	43.01	61.73	21.49
T_5	AMF (+), NPK (0)	28.62	34.55	40.88	57.64	18.54
T_6	AMF (+), NPK (50 %)	32.59	38.52	45.01	62.19	22.13
T_7	AMF (+), NPK (75%)	38.26	43.51	53.01	66.61	26.45
T_8	AMF (+), NPK (100 %)	35.15	40.93	48.60	65.79	24.51
SE_m (±)		**0.48**	**0.41**	**0.15**	**0.12**	**0.12**
CD (5%)		**1.45**	**1.25**	**0.46**	52.83	14.85

Table 3: Effect of arbuscular mycorrhizal fungi and NPK on number of fruits per plant, Fruit length (cm) and Fruit diameter (cm)

Treatment code	Treatment Details	Number of fruits per plant	Fruit length (cm)	Fruit diameter (cm)
T_1	AMF (-), NPK (0)	55.15	6.50	0.85
T_2	AMF (-), NPK (50 %)	78.33	7.77	0.94
T_3	AMF (-), NPK (75 %)	95.30	8.60	1.05
T_4	AMF (-), NPK (100 %)	110.32	9.20	1.13
T_5	AMF (+), NPK (0)	70.37	7.33	0.91
T_6	AMF (+), NPK (50 %)	98.44	8.87	1.12
T_7	AMF (+), NPK (75%)	135.28	10.50	1.30
T_8	AMF (+), NPK (100 %)	120.32	9.80	1.21
SE_m (±)		**0.60**	**0.08**	**0.01**
CD (5%)		**1.82**	**0.23**	**0.04**

Table 4: Effect of arbuscular mycorrhizal fungi and NPK on fruit weight (g), fruit yield per plant (g) and Fruit yield per hectare (q)

Treatment code	Treatment Details	Fruit weight (g)	Fruit yield per plant (g)	Fruit yield per hectare (q)
T_1	AMF (-), NPK (0)	2.20	120.33	129.33
T_2	AMF (-), NPK (50 %)	2.80	219.30	164.65
T_3	AMF (-), NPK (75 %)	3.32	314.00	194.67
T_4	AMF (-), NPK (100 %)	3.85	418.35	214.66
T_5	AMF (+), NPK (0)	2.53	172.67	150.33
T_6	AMF (+), NPK (50 %)	3.40	345.32	200.67
T_7	AMF (+), NPK (75%)	4.45	607.64	245.32
T_8	AMF (+), NPK (100 %)	4.00	480.00	225.00
SE_m (±)		**0.04**	**4.84**	**1.35**
CD (5%)		**0.13**	**14.69**	**4.10**

Interaction effect

The interaction effect between AMF and NPK was found to be significant. The treatment T_7 [AMF (+) + NPK 75%] performed better than 100% NPK alone, indicating improved fertilizer use efficiency due to AMF inoculation. These findings are supported by Habtemariam *et al*. (2026), who reported that AMF enhances nutrient efficiency and crop productivity under moderate fertilizer application.

Acknowledgement

The authors are thankful to the Department of Horticulture, School of Agriculture, ITM University, Gwalior (M.P.) for providing necessary facilities to conduct the experiment and We would also like to thanks Agri Analize for statistical analysis.

Conflict of Interest

The authors declare no conflict of interest.

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