



Effect of NPK Levels with Biofertilizers on Growth and Yield of Chilli (*Capsicum annum* L.) in Alluvial Soil of Gwalior, Madhya Pradesh

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2022/v34i2231504

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/91546>

Original Research Article

Received 13 July 2022
Accepted 06 September 2022
Published 06 September 2022

ABSTRACT

A field experiment was carried out during *rabi* season in December 2021-May 2022 at the Crop Research Center Department of Soil Science and Agriculture Chemistry, School of Agriculture, ITM University, Gwalior, Madhya Pradesh, to investigate the effect of different levels of N, P and K fertilizers with biofertilizers on growth, dry matter accumulation and yield of Chilli (*Capsicum annum* L.) in Alluvial soil of Gwalior, Madhya Pradesh. The experiment was laid out in randomized complete block design with three replications. The experimental treatments comprised nine NPK with biofertilizers combinations as control, (no nutrient added) 50% RD of NPK, 75% RD of NPK, 100% RD of NPK, 50% RD of NPK with N-fixer, 50% RD of NPK with *Aspergillus niger*, and 50% RD of NPK with N-Fixer & *Aspergillus niger*, 75% RD of NPK with N-fixer, 75% RD of NPK with *Aspergillus niger*, and 75% RD of NPK with N- Fixer & *Aspergillus niger*. Growth and yield significantly influenced by different doses of NPK with biofertilizers. Application of 75% RD of NPK with N- Fixer & *Aspergillus niger* produced the tallest plant height maximum dry matter production at harvest⁻¹, highest green chilli and stover yield of chilli (122.54 q ha⁻¹ and 14.38 qha⁻¹). Based on the results of this study, it can be suggested that the combined use of 75% RD of NPK with N- fixer + *Aspergillus niger* increased plant growth and fruit yield of chilli.

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Keywords: Chilli; growth; NPK; yield.

1. INTRODUCTION

Chilli (*Capsicum annuum* L.), a member of the Solanaceae family, is one of the most significant spices and vegetable cash crops. India is the world's top producer, user, and exporter of dried whole chillies. Salads, chutneys, sauces, and pickles all contain it, and it is a staple of the Indian cuisine in every household. It is prized for its pungency and spicy flavor, as well as the pleasing colour it imparts to cuisine. Capsanthin, a carotenoid pigment, is the primary colorant in chilli, accounting for around 35% of the total pigments. The red pigment collected from chilli fruits is widely utilized in cosmetics, fragrances, dyes, and food coloring. The alkaloid capsaicin is responsible for chilli's pungency. Oleoresins are also employed in the manufacture of a variety of medicinal formulations. Fertilizer usage must be scientific and efficient if agriculture is to be sustained. Chilli requires a lot of plant nutrients, notably nitrogen, phosphorus, and potassium, to ensure optimal plant development and productivity. The following are the nutrient removal rates for chillies with a yield of 10 t/ha: N-56 kg ha⁻¹, P-11 kg ha⁻¹, and K-112 kg ha⁻¹. Chemical fertilizers have played a critical role in supplying nutrients for intensive food production, which has resulted in a considerable rise in output but has negative consequences concerning the quality of fruits and vegetables, the environment, animal and human health. The use of organic manures and biofertilizers in combination with chemical fertilizers on an annual basis has a significant impact on improving chemical fertilizer efficiency along with soil health. [1]. Free-living nitrogen fixing bacteria such as; *Azotobacter chroococcum* and *Azospirillum lipoferum*, has the ability to fix nitrogen and also the ability to release phytohormones similar to gibberellic acid and indole acetic acid, which could stimulate plant growth, photosynthesis and absorption of nutrients [2]. The increase in the yield and essential oil component of plants can be observed by management practices of using organic manures and biofertilizers to improve physical, chemical and biological properties of soils [3].

2. MATERIALS AND METHODS

The experiment was laid out in Randomized Complete Block Design (RBD) having with three replications. An area of 20 m x 7 m was divided into three equal blocks. Each block consists of

10 plots where 10 treatments were allotted randomly. There were 30-unit plots in the experiment. The size of each plot was 2.3 m x 2.3 m, which accommodated plants to plant and row to row at a spacing 0.35 m x 45. The soil was well prepared and converted into loose friable and dried mass by spading. All weeds and stubbles were removed and 5 kg well rotten cow dung was mixed with the soil in the seed bed and the seeds were sown on 12th December, 2021. After sowing, seeds were covered with light soil. The emergence of the seedlings took place within 5 to 6 days after sowing. Weeding, mulching and irrigation were done as and when required in seed bed. After 25 days of seed sowing, they are ready for transplanting. NPK with biofertilizers combinations as control, (no nutrient added) 50% RD of NPK, 75% RD of NPK, 100% RD of NPK, 50% RD of NPK with N-fixer, 50% RD of NPK with *Aspergillus niger*, and 50% RD of NPK with N-Fixer & *Aspergillus niger*, 75% RD of NPK with N-fixer, 75% RD of NPK with *Aspergillus niger*, and 75% RD of NPK with N-Fixer & *Aspergillus niger*. Urea, single super phosphate (SSP), Murate of potash (MOP) and borax were used as source of nitrogen, phosphorus and potassium, respectively. Well decomposed cow dung was also applied and properly incorporated with the soil 15 days before final ploughing for land preparation. The sources of N, P, K were urea, single super phosphate (SSP) and muriate of potash (MoP). Total amount of SSP, MOP and 50% of urea were applied as basal doses during final land preparation. The remaining 50% urea was top dressed at 40 days after transplanting (during flowering and fruit setting stage). Healthy and uniform 25 days old seedlings were uprooted separately from the nursery bed and were transplanted in the experimental plots in 17th January, 2021 maintaining a spacing of 35 cm x 45 cm between the plants and rows respectively. The seedlings were watered after transplanting. After transplanting, different intercultural operations such as irrigation, weeding, plant protection etc. will be done and kept uniform for all the plots. Five plants were selected randomly from each plot for data collection in such a way that the border effect could be avoided for the highest precision. Data on the following parameters were recorded from the sample plants during the course of experiment. The data on plant height at 30 DAS, 60 DAS, at harvest, dry matter production at harvest, green yield of chilli, and stover yield per hectare were recorded.

The recorded data on various parameters were statistically analyzed. The mean for all the treatments was calculated and analysis of variance for all the characters were performed by difference between treatment means were determined at 5% level of significance.

3. RESULTS AND DISCUSSION

3.1 Plant Height

The data pertaining to plant height of chilli was statistically significant with the application of 75% RD of NPK with N- Fixer + *Aspergillus niger* recorded at 30 DAS, 60 DAS and at harvest (Table 1 & Fig. 1). It is observed that at 30 DAS (22.80 cm), 60 DAS (44.53 cm) and at harvest (48.66 cm) with Treatment T₁₀, (75 % NPK from inorganic sources + N- Fixer + *Aspergillus niger*) recorded significantly highest plant height amongst the treatments, which was found at par with T₄, T₅, T₆, T₃, T₈ and T₉.

The plant height at 30,60 and at harvest significantly increase due to the appropriate level of N, P and K fertilizer with N-fixer and *Aspergillus niger* to better availability and solubility of nutrient to enhancing chilli crop growth. The maximum plant height was observed in the combination of both of N, P and K fertilizer with biofertilizers might be due to the quick availability of nutrients especially nitrogen the chief nutrient of protein for the formation of protoplasm which leads to cell division and cell enlargement. Similar results was also found by Sarma et al. [4] and reported that chilli height increased with increase in 8 different combinations of N, P and K, i.e., 0:0:0, 30:15:15,

60:30:30, 90:45:45, 120:60:60, 150:75:75, 180:90:90 and 210:105:105. They observed that the treatment receiving N@ 125 kg ha⁻¹ + FYM@ 10 t ha⁻¹ + *Azospirillum* reported maximum plant height [5]. The significant differences were observed among the treatments in plant height (96.6 cm) [6]. Application of plant nutrients through various sources of organic manures combined within organic fertilizers increased the plant height significantly at 30DAS, but plant height at 60DAT and at harvest did not reach the levels of significance due to several treatments. Such increase in plant height vis-à-vis increasing dose of N through combination of organic and inorganic sources were also reported by Ikeh et al. [7], Shashidhara and Shivamurthy [8], Chavan et al. [9], Pariari and Khan [10], and Rani et al. [11].

3.2 Dry Matter Production at Harvest (g / plants)

The data pertaining to on the yield contributing characters i.e., dry matter production at harvest (g/plants) of chilli was statistically significant were significantly influenced due to application of different levels of N, P and K fertilizers with and without biofertilizers and their combination with Treatment T₁₀, (75 % NPK from inorganic sources + N- Fixer + *Aspergillus niger*) recorded (Table 2 & Fig. 2). It is observed that maximum dry matter production at harvest (17.55g plant) with Treatment T₁₀, (75 % NPK from inorganic sources + N- Fixer + *Aspergillus niger*) recorded significantly dry matter production at harvest (g/plants) amongst the treatments, which was found at par with T₄, T₅, T₆, T₃, T₈ and T₉. Higher dry matter production of chilli crop

Table 1. Effect of different levels of N, P and K fertilizers with and without biofertilizers on height of chilli(cm)

Sl. No.	Treatments	Plant height (cm)		
		30 DAS	60 DAS	At Harvest
1	No nutrient added	12.35	34.17	40.81
2	50% Rd of NPK	13.25	35.55	41.30
3	75% Rd of NPK	18.25	38.35	44.34
4	100% RD of NPK	15.44	35.98	42.33
5	50 %NPK with N-fixer	17.24	36.44	43.17
6	50% RD of NPK + <i>Aspergillus niger</i>	17.76	38.20	43.82
7	50% RD of NPK with N-fixer & <i>Aspergillus niger</i>	21.12	40.23	47.38
8	75% RD of NPK with N-fixer	19.98	38.89	44.83
9	75% RD of NPK with <i>Aspergillus niger</i>	21.00	39.65	45.52
10	75%RD of NPK with N- fixer & <i>Aspergillus niger</i>	22.80	44.43	48.66
C.D. (p= 0.05)		4.008	4.534	4.690
S.Em. ±		1.339	1.514	1.566

Table 2. Effect of different levels of N, P and K fertilizers with and without biofertilizers on dry matter production (g/plants), green and stover yield of chilli

Sl. No.	Treatments	Dry matter production at Harvest (g/plants)	Green yield (q ha ⁻¹)	Stover yield (q ha ⁻¹)
1	No Fertilizers (Absolute Control)	13.77	88.05	8.95
2	50% NPK from Inorganic sources	13.95	99.46	9.35
3	75% NPK from Inorganic sources	14.52	101.95	11.76
4	100%NPK from Inorganic sources	14.88	105.30	10.81
5	50 %NPK from Inorganic sources + N-fixer	15.25	108.48	10.96
6	50 %NPK from inorganic sources + <i>Aspergillus niger</i>	15.48	110.46	11.33
7	50 % NPK from Inorganic sources + N-Fixer + <i>Aspergillus niger</i>	15.94	111.08	12.84
8	75%NPK from Inorganic sources + N-fixer	16.11	112.65	12.03
9	75%NPK from inorganic sources + <i>Aspergillus niger</i>	16.41	114.35	12.26
10	75%NPK from inorganic sources + N- Fixer + <i>Aspergillus niger</i>	17.55	122.54	14.38
C.D. (p= 0.05)		0.884	N/A	2.47
S.Em. ±		0.295	7.826	0.825

might to be balancing use and better utilization of N, P and K fertilizer with biofertilizers. The Range of the yield recorded here was similar with the results obtained by Mujumdar et al. [12], Kasture [13] and Kokare [14].

3.3 Effect on Green Chilli Yield

The application of different sources of N, P and K fertilizers with and without biofertilizers and their combination non-significantly influenced the yield of green chilli. The application of different sources of N, P and K fertilizers with and without biofertilizers and their combination on chilli non-significantly influenced the yield of green chilli as well as stover yield. Highest green yield of chilli (122.54 q ha⁻¹) was recorded in the treatment T₁₀ (75% NPK from inorganic sources + N- Fixer + *Aspergillus niger*) which was found non-significantly higher over rest other treatments except the treatment T₄(105.30q ha⁻¹), T₅(108.48q ha⁻¹), T₆(110.46q ha⁻¹), T₃(101.95 q ha⁻¹), T₈(112.65 q ha⁻¹) and T₉(114.35 q ha⁻¹) which were statistically at par. The lowest yield (88.05 q ha⁻¹) was recorded in control treatment (T₁) No fertilizer (Absolutecontrol) which was least effective. Increase the green chilli weight with increases the N, P and K fertilizers with

biofertilizers in an integrated manner these possible might be due to the higher translocation was possible perhaps due to better sink source capacity as indicated by the higher number of fruits and weight of chilli fruits per plant. The yield qha⁻¹ was recorded in lateritic soils of Konkan is in agreement with Kasture [13] and Kokare [14].

3.4 Effect on Stover Yield of Chilli

Stover yield of chilli was found to be a significant difference. Numerically higher stover yield (14.38 qha⁻¹) was obtained by treatment T₁₀, (75% NPK from inorganic sources + N- Fixer + *Aspergillus niger*), which was significantly higher over the rest of treatment and treatment T₄, T₅, T₆, T₃, T₈ and T₉ was found to be at par. The lowest stover yield (8.95 q ha⁻¹) was recorded in treatment T₁ No fertilizer (Absolute control). The combination of N, P and K fertilizers with biofertilizers increases the growth than development of the plant this may be due to increase the vegetative growth of the plant cell division and symbiotic activity among the all organism which influence play important role in growth of plant and stover yield. The yield q ha⁻¹ was recorded in lateritic soils of Konkan is in agreement with Kasture [13] and Kokare [14].

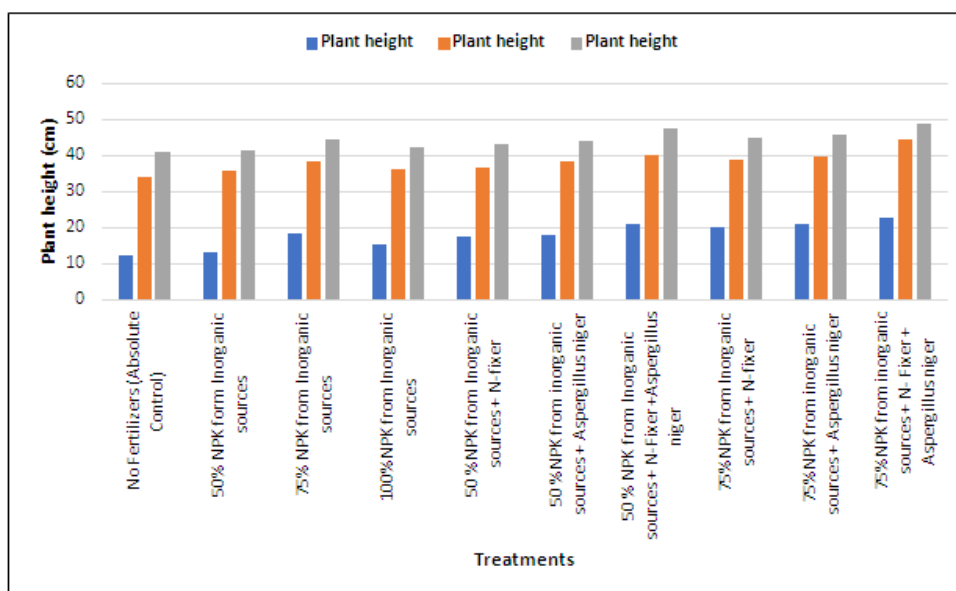


Fig. 1. Effect of different levels of N, P and K fertilizers with and without biofertilizers on height of chilli (cm)

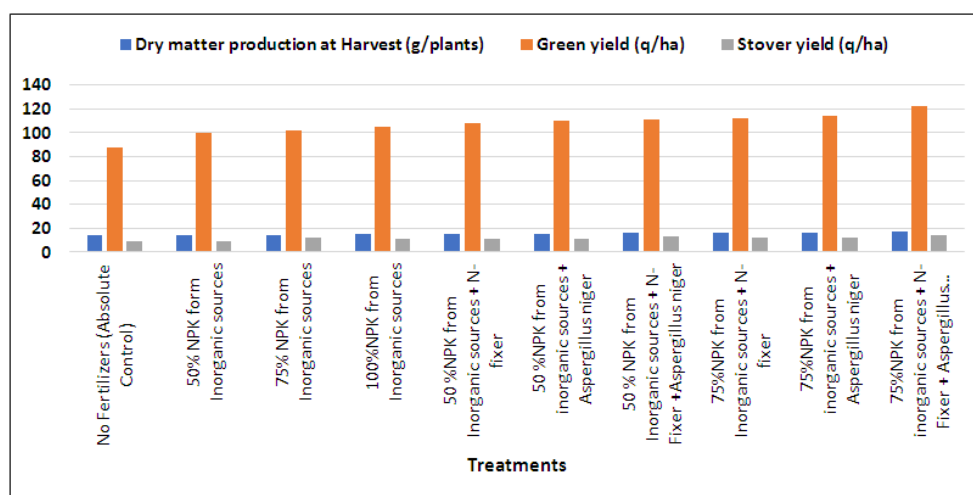


Fig. 2. Effect of different levels of N, P and K fertilizers with and without biofertilizers on dry matter production (g/plants), green and stover yield of chilli

4. CONCLUSION

Considering the above-mentioned results, it may be concluded that, different sources of N, P and K fertilizers with and without biofertilizers varied significantly for growth and yield of chilli. The effect of treatment T₁₀ (75 % NPK from inorganic sources + N- Fixer + *Aspergillus niger*) on chilli growth and yield was statistically highest. It was revealed that application of 75% NPK from inorganic sources + N- Fixer + *Aspergillus niger* produce maximum yield and yield contributing characters of chilli.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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