The Pharma Innovation Journal 2022; 11(2): 1919-1926

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(2): 1919-1926

www.thepharmajournal.com
Received: 07-11-2021
Accepted: 29-01-2022

Chandan HP
Department of Vegetable Science, College of Horticulture SKLTSHU, Rajendranagar, Hyderabad, Telangana, India

Dr. J Cheena
Senior Scientist, Department of Horticulture and Head of Medicinal and Aromatic Plant Research Station, SKLTSHU, Rajendranagar, Hyderabad, Telangana, India

Dr. P Prasanth
Senior Scientist, Department of Horticulture and Head of Floricultural Research Station SKLTSHU, Rajendranagar, Hyderabad, Telangana, India

Dr. D Laxminarayana
Associate Professor, Department of Horticulture, Collage of Horticulture, SKLTSHU, Rajendranagar, Hyderabad, Telangana, India

Dr. B Naveen Kumar
Assistant Professor, College of Horticulture, SKLTSHU, Rajendranagar, Hyderabad, Telangana, India

Corresponding Author:
Chandan HP
Department of Vegetable Science, College of Horticulture SKLTSHU, Rajendranagar, Hyderabad, Telangana, India

Studies on effect of organic and inorganic nutrients on growth and yield of capsicum (*Capsicum annuum* L. var. Grossum)

Chandan HP, Dr. J Cheena, Dr. P Prasanth, Dr. D Laxminarayana and Dr. B Naveen Kumar

Abstract
The present research entitled "Studies on effect of organic and inorganic nutrients on growth and yield of capsicum (*Capsicum annuum* L. var. Grossum)." was carried out at the research block of the Medicinal and Aromatic Plant Research Station, Rajendranagar, during Rabi-2020. The experiment was laid in factorial randomized block design with three replications. Results revealed that organic nutrients [Neem cake (1t/ha), *Azotobacter* (4 kg/ha) + *Azospirillum* (4 kg/ha), *Azotobacter* (4 kg/ha) + PSB (4 kg/ha), *Azospirillum* (4 kg/ha) + PSB (4 kg/ha)], inorganic nutrients (100% RDF, 75% RDF, 50% RDF) and its combinations significantly improved the plant growth and yield parameters. *Azospirillum* + PSB significantly recorded the maximum plant height (77.66 cm), primary branches per plant (3.68), polar diameter of fruit (9.21 cm), equatorial diameter of fruit (7.20 cm), number of fruits per plant (9.93), fruit weight (105.39 g), fruits yield per plant (1.05 kg), fruit yield per plot (21.37 kg) and fruit yield per hectare (35.64 t). *Azospirillum* + PSB treated plant also took least number of days taken to 50 per cent flowering (39.61days) and first picking (60.38 days). Among the different levels of inorganic nutrients, 100% RDF through inorganic nutrients recorded significantly maximum plant height (78.99 cm), primary branches per plant (3.78), polar diameter of fruit (9.41 cm), equatorial diameter of fruit (7.33 cm), number of fruits per plant (10.27), fruit weight (107.56 g), fruit yield per plant (1.10 kg), fruit yield per plot (22. 09 kg), fruit yield per hectare (36.81 t). 100% RDF through inorganic nutrients treated plant also took minimum number of days taken to 50 per cent flowering (39.14 days), days taken to first picking (59.96 days). The interaction between organic nutrients and inorganic nutrients sources had shown significant results. Maximum plant height (79.95 cm), primary branches per plant (3.86), polar diameter of fruit (9.61 cm), equatorial diameter of fruit (7.48 cm), number of fruits per plant (9.93), fruit weight (108.32 g), fruit yield per plant (1.15 kg), fruit yield per plot (23.03 kg), fruit yield per hectare (38.32 t), and least number of days taken to 50 per cent flowering (38.70 days), days taken to first picking (59.26 days) was noticed in *Azospirillum* + PSB in combination with 100% RDF.

Keywords: Capsicum, neem cake, *Azotobacter*, *Azospirillum*, PSB, 100% RDF, 75% RDF, 50% RDF

Introduction
Sweet pepper (*Capsicum annuum* L. var. *Grossum*), a member of Solanaceae family, is a native of Mexico with secondary centre of origin in Guatemala (Bukasov, 1930) [5]. It was introduced in India by the Britishers in 19th century in Shimla hills (Greenleaf, 1986) [8]. It is also rich in minerals like iron, potassium, calcium, magnesium, phosphorus, sodium and selenium (Agarwal *et al*., 2007) [1]. One hundred grams edible portion of bell pepper provides 24 Kcal energy, 1.3 g protein, 4.3 g carbohydrates and 0.3 g fat (Rubio *et al*., 2010) [24].
Application of essential nutrient elements from a single source, be it chemical fertilizer, organic fertilizer or biofertilizer cannot meet the requirement of any crop. Rather, nutrients have to be supplied through organic, inorganic and bio-fertilizer sources in an integrated manner and in balanced amounts, following appropriate management technology which is economically viable, socially acceptable and ecologically friendly (Jaggi *et al*., 2001) [11].
Keeping in view of the above information, the present investigation was planned to evaluate the studies on effect of organic and inorganic nutrients on growth and yield of capsicum (*Capsicum annuum* L. var. *Grossum*).

Materials and Methods
The present experiment was conducted to find out the studies on effect of organic and inorganic nutrients on growth and yield of capsicum at Medicinal and Aromatic Plant

Research Station, Rajendranagar, Hyderabad comes under arid sub-tropical climatic zone with an average rainfall of 800 mm at an altitude of 542.3m above MSL on 17.19^0 N latitude and 78.23^0 E longitudes. It experiences hot dry summer and mild winters. The experiment was laid in factorial randomized block design with three replications.

Treatment details

Factor A: Organics and Bio-fertilizers

A_1 - Neem cake (1t ha^{-1}).
A_2 - *Azotobacter* (4 kg ha^{-1}) + *Azospirillum* (4 kg ha^{-1}).
A_3 - *Azotobacter* (4 kg ha^{-1}) + PSB (4 kg ha^{-1}).
A_4 - Azospirillum (4 kg ha^{-1}) + PSB (4 kg ha^{-1}).

Factor B: Inorganic fertilizers

B_1- 100% RDF.
B_2- 75% RDF.
B_3- 50% RDF.

Treatment combinations

A_1B_1 : Neem cake (1t ha^{-1}) + 100% RDF
A_1B_2 : Neem cake (1t ha^{-1}) + 75% RDF
A_1B_3 : Neem cake (1t ha^{-1}) + 50% RDF
A_2B_1 : *Azotobacter* (4 kg ha^{-1}) + *Azospirillum* (4 kg ha^{-1}) + 100% RDF
A_2B_2 : *Azotobacter* (4 kg ha^{-1}) + *Azospirillum* (4 kg ha^{-1}) + 75% RDF
A_2B_3 : *Azotobacter* (4 kg ha^{-1}) + Azospirillum (4 kg ha^{-1}) + 50% RDF
A_3B_1 : *Azotobacter* (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) + 100% RDF
A_3B_2 : *Azotobacter* (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) + 75% RDF
A_3B_3 : *Azotobacter* (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) + 50% RDF
A_4B_1 : *Azospirillum* (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) + 100% RDF
A_4B_2 : *Azospirillum* (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) + 75% RDF
A_4B_3 : *Azospirillum* (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) + 50% RDF

Where
RDF: Recommended dose of Fertilizers (N:P:K) was applied through inorganic source 100:75:50 Kg h^{-1} respectively.
PSB: Phosphorus solubilizing bacteria.
Note: Farm Yard Manure (5 t ha^{-1}) was applied as basal dose for every treatment.

Main field preparation and sowing

The field was ploughed thoroughly by tractor followed by planking, 15 days prior to actual date of transplanting. Stones, pebbles and residues of previous crop were removed manually. Organic manures like, well decomposed farmyard manure @ 3 kg per plot and neem cake @ 600 g per plot were incorporated in to the respective experimental plots, before transplanting as basal application. Bio fertilizers *Azotobacter*, *Azospirillum* and Phosphorus solubilizing bacteria @ 4 kg ha^{-1} each were mixed with FYM, incubated for 3-4 days and applied to the soil after land preparation prior to transplanting to the respective plots. Similarly, N, P and K @ 100:75:50 kg ha^{-1} was applied. Nitrogen was applied in two splits, the first dose as basal application and another dose at 30 days after transplanting. The entire dose of phosphate and potash were applied at the time of transplanting as basal dose. Moderate irrigation was provided to the plot a day before transplanting the seedlings to keep the plot moist. Thirty days old, good, vigorous and uniform height seedlings were selected and transplanted at a spacing of 60 cm × 45 cm according to treatments in the open field. Other cultural operations including need-based plant protection measures were done regularly.

Observations recorded

Data on the following characters were recorded on five randomly selected labelled plants from the plot in each treatment and in each replication.

Growth parameters

1. Plant height (cm)

Plant height of five randomly selected plants was measured in centimeters from the ground level to the top of the plant at 30, 60, 90 and120 days after transplanting from each plot and mean values were worked out.

2. Number of primary branches per plant

The number of laterals arising from the main stem of five randomly selected plants were counted and average was worked out.

3. Days taken to 50% flowering

It was recorded as number of days taken from date of transplanting to the date when first flower emerged (pre-anthesis stage) in 50% of the plants in a plot per treatment.

4. Days taken to first picking

It was recorded as number of days taken from date of transplanting to the date when at least one marketable fruit was harvested from 50% plant in a plot per treatment.

Yield parameters

1. Polar diameter (cm)

Five fruits from first picking were selected randomly and their length was measured from the tip of the fruit to the point of contact of the fruit with the base with the help of Vernier calliper and recorded in centimeters.

2. Equatorial diameter (cm)

After recording the fruit length, the same fruits were also used for measuring the fruit width at stem end, middle of the fruit and at blossom end.

3. Number of fruits per plant

The total number of fruits harvested from five randomly selected plants in different pickings was summed up and average value per plant was worked out.

4. Fruit weight (g)

The total marketable yield of all the pickings from five randomly taken plants was divided by the number of marketable fruits harvested from these plants and average fruit weight was worked out.

5. Fruit yield per plant (kg)

The total yield of fruits per plant from all harvests under various treatments were recorded and expressed in kilograms.

6. Fruit yield per hectare (t)
The fruit yield per hectare was calculated based on the fruit yield per plant and was expressed in t/ha.

Statistical analysis
The data was analyzed as per ANOVA outlined by Panse and Sukhatme (1985) [22]. Statistical significance was tested by 'F' value at 5 per cent level of significance. The critical differences at 0.05 level was worked out for the effects which were significant.

Results and Discussion
Growth parameters
Plant height (cm)
The maximum (Table 1) plant height (63.45 cm) was recorded with treatment A_4 [*Azospirillum* (4 kg/ha) + PSB (4 kg/ha)] followed by A_3 (62.71 cm). This can be attributed to the increased uptake of nutrients in the plants leading to enhanced chlorophyll content and carbohydrates synthesis and increased activity of hormones produced by *Azospirillum* and PSB. These results are supported by the reports Amirthalingam (1988) [2], Singh *et al*. (2017) [7].
Different levels of inorganic nutrients had significant effect on plant height. The treatment, B_1 (100% RDF) recorded maximum plant height (78.99 cm) followed by B_2 (77.78 cm). The increase in plant height at 100% RDF at different stages might be due to maximum uptake of nutrients resulting in better availability of sufficient quantity of nutrients. These findings are in conformity with Yasuor *et al*. (2013) [30], Dubey *et al*. (2017) [7].
The interaction effect of organic nutrients and inorganic nutrients showed significant variation. Significantly maximum plant height (79.95 cm) was recorded in A_4B_1 [*Azospirillum* (4 kg/ha) + PSB (4 kg/ha) in combination with 100% RDF] which was statistically on par with A_3B_1 (79.39 cm) and A_2B_1 (78.91 cm).

Table 1: Effect of organic and inorganic nutrients sources on plant height (cm) of capsicum at 120 days after transplanting.

Treatments	Inorganic nutrients			
Organic nutrients	**B_1**	**B_2**	**B_3**	**Mean (A)**
A_1	77.71	76.32	69.50	74.51
A_2	78.91	78.08	72.76	76.58
A_3	79.39	78.30	73.25	76.98
A_4	79.95	78.45	74.58	77.66
Mean (B)	78.99	77.78	72.52	
		Factor (A)	Factor (B)	A × B
F test		*	*	*
SE (m) ±		0.244	0.211	0.422
CD at 5%		0.720	0.623	1.246

Number of primary branches per plant
The different levels of inorganic and organic nutrients (Table 2) had significant effect on number of primary branches per plant. The highest number of primary branches per plant (3.68) was observed in A_4 which was statistically on par with A_3 (3.64) and lowest number of primary branches per plant (3.37) was observed in A_1. This might be due to increased availability of nutrients (nitrogen, phosphorus) and by production of growth promoting substances by microbial inoculants.
Plots treated with 100% RDF (B_1) produced highest number of primary branches per plant (3.78) which was followed by B_2 (3.66) and minimum number of primary branches (3.26) per plant was recorded in B_3. This might be due to high levels of N, P and K during early stage, which would have increased the root activity. The transport of cytokinin from the root would have encouraged axillary buds resulting in increased number of branches. Similar results were obtained by Manchanda and Singh (1988) [19], Khan and Chattopadhyay (2009) [13], Kumar *et al*. (2014), Islam *et al*. (2018) [9].

Table 2: Effect of organic and inorganic nutrients sources on number of primary branches per plant of capsicum.

Treatments	Inorganic nutrients			
Organic nutrients	**B_1**	**B_2**	**B_3**	**Mean (A)**
A_1	3.63	3.56	2.93	3.37
A_2	3.80	3.66	3.26	3.57
A_3	3.83	3.70	3.40	3.64
A_4	3.86	3.73	3.46	3.68
Mean (B)	3.78	3.66	3.26	
		Factor (A)	Factor (B)	A × B
F test		*	*	*
SE (m) ±		0.022	0.019	0.039
CD at 5%		0.066	0.057	0.115

Days taken to 50% flowering
The data (Table 3) regarding the number of days taken to 50 per cent flowering as influenced by organic nutrients and inorganic nutrients. There was no significant variation recorded among organic nutrients. However, the minimum number of days taken to 50 per cent flowering (39.61) was recorded with A_4 whereas maximum number of days taken to 50 per cent flowering (40.60) was recorded in A_1. Different levels of inorganic nutrients which had significant effect on number of days taken to 50 per cent flowering. The treatment B_1 resulted in the minimum number of days taken to 50 per cent flowering (39.14) which was statistically on par with B_2 (39.60). However, treatment B_3 was found to be having maximum number of days taken to 50 per cent flowering (41.26). The possible reason for earliness in flowering might be due to accelerated photosynthesis and rapid translocation of photosynthates towards the initiating flower buds resulting in early flowering. Similar views have also been expressed by Kumar *et al*. (2013), Dhiman *et al*. (2018) [6].

Table 3: Effect of organic and inorganic nutrients sources on days taken to 50 percent flowering of capsicum.

Treatments	Inorganic nutrients			
Organic nutrients	**B_1**	**B_2**	**B_3**	**Mean (A)**
A_1	39.81	40.06	41.93	40.60
A_2	39.13	39.66	41.33	40.04
A_3	38.93	39.43	40.93	39.76
A_4	38.70	39.26	40.86	39.61
Mean (B)	39.14	39.60	41.26	
		Factor (A)	Factor (B)	A × B
F test		NS	*	NS
SE (m) ±		0.390	0.337	0.675
CD at 5%		--	0.996	--

Note: A_1 - Neem cake (1 t/ha), B_1 - 100% RDF
A_2 - *Azotobacter* (4 kg/ha) + *Azospirillum* (4 kg/ha) B_2 - 75% RDF
A_3 - *Azotobacter* (4 kg/ha) + PSB (4 kg/ha) B_3 - 50% RDF
A_4 - *Azospirillum* (4 kg/ha) + PSB (4 kg/ha)

Days taken to first picking

The different levels of inorganic nutrients (Table 4) had significant effect on days taken to first picking. The treatment, B_1 resulted in the minimum number of days taken to first picking (59.96) which was statistically on par with B_2 (60.64). Treatment B_3 was found to be having maximum number of days taken to first picking (62.12). The data regarding the number of days taken to first picking was not significantly affected by organic nutrients. However, the minimum number of days taken to first picking (60.38) was recorded in A_4 and maximum number of days (61.13) taken to first picking was recorded in A_1. The application of 100% RDF might have provided balanced nutrition, better growth and development and hence early picking (Shree *et al*., 2018) [26].

Table 4: Effect of organic and inorganic nutrients sources on days taken to first picking of capsicum.

Treatments	Inorganic nutrients			
Organic nutrients	**B_1**	**B_2**	**B_3**	**Mean (A)**
A_1	60.83	61.14	62.93	61.63
A_2	60.06	60.70	62.06	60.94
A_3	59.68	60.48	61.83	60.66
A_4	59.26	60.23	61.66	60.38
Mean (B)	59.96	60.64	62.12	
		Factor (A)	Factor (B)	A × B
F test		NS	*	NS
SE (m) ±		0.405	0.351	0.702
CD at 5%		--	1.036	--

Yield parameters

Polar diameter of fruit (cm)

The different levels of inorganic nutrients and organic nutrients (Table 5) had significant effect on polar diameter of fruit**.** Among organic nutrients, the maximum polar diameter of fruit (9.21 cm) was recorded with A_4 followed by A_3 (9.10 cm) and minimum polar diameter of fruit (8.67 cm) was recorded in A_1. Among the inorganic nutrients, the treatment B_1 (100% RDF) recorded maximum polar diameter of fruit (9.41cm) followed by B_2 (9.12 cm) and However, minimum polar diameter of fruit (8.44 cm) was recorded in B_3. This increase in polar diameter of fruit could be due to the ability of microbial (*Azospirillum* and PSB) inoculation to produce some growth promoting substances which might have led to enhanced cell division and cell elongation, resulting in belter root development, increased uptake of nutrients leads to produce a large size fruit and also due to sufficient quantity of the fertilizers i.e. nitrogen, phosphorus and specially potassium, fulfilled the need of plants to attain more vigor, flowering and fruit development thereby resulting in good quality and large size (length) of fruits. Similar opinions were expressed by Khan and Chattopadhyay (2009) [13], Kiran *et al*. (2010) [14], Dubey *et al*. (2017) [7], Dhiman *et al*. (2018) [6].

Table 5: Effect of organic and inorganic nutrients sources on polar diameter (cm) of capsicum fruit.

Treatments	Inorganic nutrients			
Organic nutrients	**B_1**	**B_2**	**B_3**	**Mean (A)**
A_1	9.05	8.86	8.10	8.67
A_2	9.43	9.10	8.43	8.99
A_3	9.55	9.16	8.58	9.10
A_4	9.61	9.36	8.66	9.21
Mean (B)	9.41	9.12	8.44	
		Factor (A)	Factor (B)	A × B
F test		*	*	*
SE (m) ±		0.017	0.015	0.030
CD at 5%		0.051	0.044	0.087

Note: A_1 - Neem cake (1 t/ha) B_1 - 100% RDF
A_2 - *Azotobacter* (4 kg/ha) + *Azospirillum* (4 kg/ha) B_2 - 75% RDF
A_3 - *Azotobacter* (4 kg/ha) + PSB (4 kg/ha) B_3 - 50% RDF
A_4 - *Azospirillum* (4 kg/ha) + PSB (4 kg/ha)

Equatorial diameter of fruit (cm)

The highest (Table 6) equatorial diameter of fruit (7.20 cm) was recorded with A_4 followed by A_3 (7.11 cm) which was statistically on par with A_2 (7.06 cm). Among the inorganic nutrients, treatment B_1 recorded maximum equatorial diameter of fruit (7.33 cm) followed by B_2 (7.17 cm) and however, lowest equatorial diameter of fruit (6.55 cm) was recorded in B_3. This might be due to the increment in supply of essential nutrients to plant, their availability, mobilization and influx into the plant tissues increased and thus improved fruit size (Shukla *et al*., 2009) [27]. These results are supported by findings of Jadhav *et al*. (2014) [10], Dubey *et al*. (2017) [7], Islam *et al*. (2018) [9], Padhiary and Dubey (2020) [21].

Table 6: Effect of organic and inorganic nutrients sources on equatorial diameter (cm) of capsicum fruit

Treatments	Inorganic nutrients			
Organic nutrients	**B_1**	**B_2**	**B_3**	**Mean (A)**
A_1	7.06	6.86	6.15	6.69
A_2	7.38	7.21	6.60	7.06
A_3	7.40	7.28	6.64	7.11
A_4	7.48	7.31	6.81	7.20
Mean (B)	7.33	7.17	6.55	
		Factor (A)	Factor (B)	A × B
F test		*	*	*
SE (m) ±		0.020	0.017	0.034
CD at 5%		0.059	0.051	0.102

Number of fruits per plant

Significantly (Table 7) (Fig 1) maximum number of fruits per plant (9.93) was in A_4 followed by A_3 (9.79) and minimum number of fruits per plant (9.35) was recorded in A_1. The data on different levels of inorganic nutrients revealed that the treatment B_1 resulted in the maximum number of fruits per plant (10.27) which was followed by B_2 (9.80) and treatment B_3 was found to be having minimum number of fruits per plant (8.96). This result may be due to increase in the number of branches which leads to increase in number of leaves which worked as an efficient photosynthesis structure and produced high amount of carbohydrates in the plant system. More number of branches which borne a more number of flowers, resulting as higher fruits per plant. Similar results were obtained by Kumbar *et al*. (2017) [18], Singh *et al*. (2017) [7], Kasi *et al*. (2018) [12], Shelke *et al*. (2019) [25].

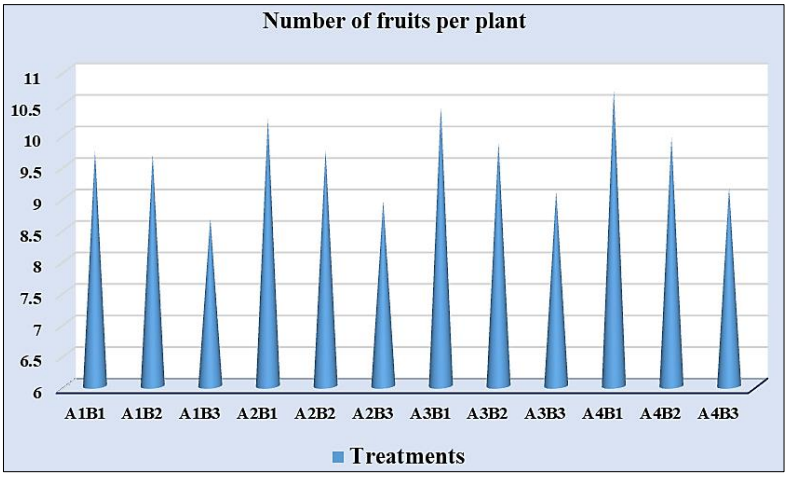


Fig 1: Effect of organic and inorganic nutrients sources on number of fruits per plant of capsicum.

Table 7: Effect of organic and inorganic nutrients sources on number of fruits per plant of capsicum.

Treatments	Inorganic nutrients			
Organic nutrients	**B_1**	**B_2**	**B_3**	**Mean (A)**
A_1	9.73	9.67	8.66	9.35
A_2	10.24	9.74	8.94	9.64
A_3	10.43	9.86	9.09	9.79
A_4	10.69	9.95	9.15	9.93
Mean (B)	10.27	9.80	8.96	
		Factor (A)	Factor (B)	A × B
F test		*	*	*
SE (m) ±		0.041	0.035	0.071
CD at 5%		0.121	0.105	0.209

Note: A_1 - Neem cake (1 t/ha) B_1 - 100% RDF
A_2 - *Azotobacter* (4 kg/ha) + *Azospirillum* (4 kg/ha) B_2 - 75% RDF
A_3 - *Azotobacter* (4 kg/ha) + PSB (4 kg/ha) B_3 - 50% RDF
A_4 - *Azospirillum* (4 kg/ha) + PSB (4 kg/ha)

Fruit weight (g)

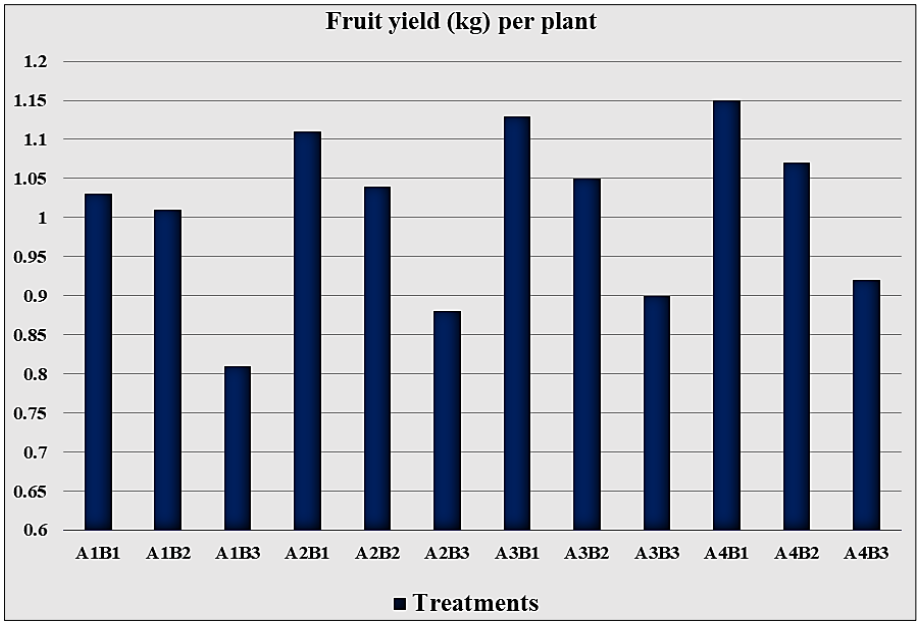
The maximum average (Table 8) fruit weight (105.39 g) was recorded with the application of A_4 which was statistically on par with A_3 (104.85 g) and A_2 (104.36 g). Minimum average fruit weight (101.68 g) was recorded in A_1. The data recorded on different levels of inorganic nutrients showed that significant difference on fruit weight. Maximum average fruit weight (107.56 g) was observed with application of B_1 which was followed by B_2 (106.56 g) and minimum average fruit weight (98.09 g) was recorded in B_3. This might be due to the presence of higher amount of nitrogen, phosphorus and potassium, NPK favoured the metabolic and auxin activities in plant and also due to presence biofertilizers which ultimately increased auxin activities, growth and activity of microbes and phosphates activity which ultimately influenced the fruit weight and yield attributes. These results are in accordance with Kiran *et al*. (2010) [14], Angadi *et al*. (2017) [3], Dhiman *et al*. (2018) [6], Islam *et al*. (2018) [9].

Table 8: Effect of organic and inorganic nutrients sources on fruit weight (g) of capsicum.

Treatments	Inorganic nutrients			
Organic nutrients	**B_1**	**B_2**	**B_3**	**Mean(A)**
A_1	105.93	104.98	94.13	101.68
A_2	107.83	106.78	98.48	104.36
A_3	108.15	106.96	99.43	104.85
A_4	108.32	107.51	100.34	105.39
Mean(B)	107.56	106.56	98.09	
		Factor (A)	Factor (B)	A × B
F test		*	*	*
SE (m) ±		0.318	0.276	0.552
CD at 5%		0.940	0.814	1.628

Fruit yield per plant (kg)

The (Table 9) (Fig 2) treatment A_4 [*Azospirillum* (4 kg/ha) + PSB (4 kg/ha)] produced higher fruits yield per plant (1.05 kg) which was followed by A_3 (1.03 kg) and lowest fruits yield per plant (0.95 kg) was recorded in A_1. Among the different levels of inorganic nutrients which had significant effect on fruit yield per plant. The plots which were treated with B_1 (100% RDF) produced higher fruit yield per plant (1.10 kg) which was followed by B_2 (1.04 kg) and lowest fruits yield per plant (0.88 kg) was recorded in B_3. The maximum fruit yield per plant might be due to better vegetative growth (number of branches, plant height) and highest number of fruits per plant and due to the more carbohydrate production and assimilation in fruit by the effect of nitrogen, phosphorus and potassium reported by Bidari and Hebsur (2011) [4]. These results are supported by findings of Nicola *et al*. (1995) [20], Dubey *et al*. (2017) [7], Kumar *et al*. (2018), Pratheep and Kanchane (2018) [23].



Note: A_1 - Neem cake (1 t/ha), A_2 - *Azotobacter* (4 kg/ha) + *Azospirillum* (4 kg/ha), A_3 - *Azotobacter* (4 kg/ha) + PSB (4 kg/ha) and A_4 - *Azospirillum* (4 kg/ha) + PSB (4 kg/ha), B_1 - 100% RDF, B_2 - 75% RDF and B_3 - 50% RDF.

Fig 2: Effect of organic and inorganic nutrients sources on fruits yield (kg) per plant of capsicum.

Table 9: Effect of organic and inorganic nutrients sources on fruits yield (kg) per plant of capsicum.

Treatments	Inorganic nutrients			
Organic nutrients	**B_1**	**B_2**	**B_3**	**Mean (A)**
A_1	1.03	1.01	0.81	0.95
A_2	1.11	1.04	0.88	1.01

A_3	1.13	1.05	0.90	1.03
A_4	1.15	1.07	0.92	1.05
Mean (B)	1.10	1.04	0.88	
		Factor (A)	Factor (B)	A × B
F test		*	*	*
SE (m) ±		0.006	0.005	0.010
CD at 5%		0.017	0.014	0.029

Note: A_1 - Neem cake (1 t/ha) B_1 - 100% RDF
A_2 - *Azotobacter* (4 kg/ha) + *Azospirillum* (4 kg/ha) B_2 - 75% RDF
A_3 - *Azotobacter* (4 kg/ha) + PSB (4 kg/ha) B_3 - 50% RDF
A_4 - *Azospirillum* (4 kg/ha) + PSB (4 kg/ha)

Fruit yield per ha (t)

The maximum (Table 10) fruit yield per ha (35.64 t) was observed in A_4 which was followed by A_3 (35.04 t) and lowest fruit yield per ha (32.51 t) was observed in A_1. The different levels of inorganic nutrients had significant effect on fruit yield per hectare. Among the inorganic nutrients, maximum fruit yield per hectare (36.81 t) was recorded with application of B_1 which was followed by B_2 (35.01 t) and minimum fruit yield per hectare (31.38 t) was recorded in B_3. The higher yields per hectare were probably due to increased uptake of nutrients in the plants leading to enhanced chlorophyll content and carbohydrate synthesis, higher accumulation of photosynthesis and their distribution to the developing ovules which led to better development of fruit. These results are supported by findings of Tesfaw (2013) [29], Jadhav *et al*. (2014) [10], Kumbar *et al*. (2017) [18], Dhiman *et al*. (2018) [6].

Table 10: Effect of organic and inorganic nutrients sources on fruits yield (t) per hectare of capsicum.

Treatments	**Inorganic nutrients**			
Organic nutrients	**B_1**	**B_2**	**B_3**	**Mean (A)**
A_1	34.36	33.93	29.24	32.51
A_2	37.03	34.76	31.41	34.40
A_3	37.53	35.46	32.13	35.04
A_4	38.32	35.84	32.75	35.64
Mean (B)	36.81	35.01	31.38	
		Factor (A)	Factor (B)	A × B
F test		*	*	*
SE (m) ±		0.162	0.140	0.280
CD at 5%		0.478	0.414	0.828

Note: A_1 - Neem cake (1 t/ha) B_1 - 100% RDF
A_2 - *Azotobacter* (4 kg/ha) + *Azospirillum* (4 kg/ha) B_2 - 75% RDF
A_3 - *Azotobacter* (4 kg/ha) + PSB (4 kg/ha) B_3 - 50% RDF
A_4 - *Azospirillum* (4 kg/ha) + PSB (4 kg/ha)

Conclusion

Finally, to conclude application of *Azospirillum* + PSB in combination with 100% RDF through inorganic nutrients can be recommended as suitable crop nutrient management practice in capsicum to improve plant growth and to get higher yield leads to get better net income and to improve the physico-chemical properties of soil.

Acknowledgements

At the very outset, I submit the commodious and indefinite thanks to COH, Rajendranagar for giving me a platform to conduct research work and also to my advisory committee (Dr. J. Cheena, Dr. P. Prasanth, Dr. D. Laxminarayana and Dr. B. Naveen Kumar) for giving me valuable suggestions throughout my research work. I am always thankful to ICAR for giving me timely scholarship. I am in dearth of words to express my sense of gratitude to my beloved parents (Sri. Prakash and Smt. Vasantha). and my guardians Sri. Puttaveeraiah. S and Smt. Leelavathi. B and my caring brother Chethan. H. P and lovely sisters Deeksha. H. P and Varsha. H. P and my truly inspiring grandfather Sri. Sannaiah and my grandmother Smt. Puttalingamma and my family members Shivaswamy, Sowbhagya, Ashwini, Puneeth, Yashash. without whom i could not have achieved all my success in my life. No scholar can complete the work on his own. So, I owe my gratitude towards my friends, juniors and seniors (Manikanta, Umesh, Chandan, Tirupati, Murugesh, Kancha, Shivanand, Veeresh, Sharanayya, Sahikrishna, Prasanth, Mahesh, Nayan, Amul, Venkatesh, Jyothi, Swetha, Divya).

References

1. Agarwal A, Gupta S, Ahmed Z. Influence of plant density on productivity of bell pepper (*Capsicum annuum* L.) under green house in high altitude cold desert of Ladakh. Acta Horticulturae. 2007;756(1):309-314.
2. Amirthalingam S. Studies on the effect of *Azospirillum*, nitrogen and NAA on growth and yield of chilli (*Capsicum annuum* L.). South Indian Horticulture. 1988;36(4):218.
3. Angadi V, Rai PK, Bara BM. Effect of organic manures and biofertilizers on plant growth, seed yield and seedling characteristics in tomato (*Lycopersicon esculentum* Mill.). Journal of Pharmacognosy and Phytochemistry. 2017;6(3):807-810.
4. Bidari BI, Hebsur NS. Potassium in relation to yield and quality of selected vegetable crops. Karnataka Journal of Agriculture Science. 2011;24(1):55-59.
5. Bukasov SM. The cultivated plants of Mexico, Guatemala and Columbia. Bulletin of Applied Botanical Genetics and Plant Breeding Supplement. 1930;47(4):261-273.

6. Dhiman JS, Raturi HC, Kachwaya DS, Singh SK. Effect of nitrogen and phosphorus on tomato (*Solanum lycopersicum* L.) grown under polyhouse condition. Bull. Env. Pharmacol. Life Sci. 2018;7(1):25-29.
7. Dubey AK, Singh D, Rajput PS, Kumar Y, Verma AK, Chandraker SK. Effect of NPK on plant growth, yield and quality of capsicum (*Capsicum annum* L.) cv. Swarna under shade net condition. Int. J Curr. Microbiol. App. Sci. 2017;6(3):1085-1091.
8. Greenleaf WH. Pepper breeding. In: Breeding Vegetable Crops. AVI, West Port, 1986, 67-134.
9. Islam Rizvi, Md. Sultana, Tania, Haque, Ahsanul, Md. Hossain, *et al*. Growth and yield of chilli influenced by nitrogen and phosphorus. IOSR Journal of Agriculture and Veterinary Science. 2018;11(5):54-68.
10. Jadhav PB, Dekhane SS, Saravaiya SN, Tekale GS, Patil SJ, Patel DJ. Effect of nitrogen fixing *Azotobacter* and *Azospirillum* on growth and yield of chilli (*Capsicum Spp*. L.) cv. Acharya. International Journal of Innovative Research and Studies. 2014;3(5):827-832.
11. Jaggi RC, Mahajan A, Chaudhary AK, Bhagla K. Integrated plant nutrient management (IPNM) in agriculture - the need of the day. Indian Farmers Digest. 2001;2(6):10-12.
12. Kasi MU, Gola AQ, Bhat RA, Zimri MA, Wahocho SA, Durrani ASK, *et al*. Response of various varieties rate of NPK fertilizer on brinjal (*Solanum melongena* L.) Journal of Entomology and Zoology Studies. 2018;6(6):684-688.
13. Khan S, Chattopadhyay N. Effect of inorganic and biofertilizers on chilli. Journal of Crop and Weed. 2009;5(1):191-196.
14. Kiran J, Vyakaranahal BS, Raikar SD, Ravikumar GH, Deshpande VK. Seed yield and quality of brinjal as influenced by crop nutrition. Indian Journal of Agricultural Research. 2010;44(1):1-7.
15. Kumar A, Pal AK, Sandeep KM, Yadav KS, Pal SK. Effect of different doses of NPK and various bio-fertilizers on floral characters and yield attributes in okra. International Journal of Pure and Applied Bioscience. 2018;6(2):352-356.
16. Kumar M, Meena ML, Kumar S, Maji S, Kumar D. Effect of nitrogen, phosphorus and potassium fertilizers on the growth, yield and quality of tomato var. Azad T-6. The Asian Journal of Horticulture. 2013;8(2):616- 619.
17. Kumar S, Rakesh K, Sutanu M, Devendra K, Manoj K. Effect of organic manures and bio-fertilizers on growth, flowering, yield and quality of tomato cv. Pusa Sheetal. Int. J Agric. Sci. 2014;10(1):329-332.
18. Kumbar HA, Chandini R, Hore JK. Effect of Biofertilizers and inorganic fertilizers on growth and yield of chilli (*Capsicum annuum* L.). International Journal of Current Microbiology and Applied Sciences. 2017;6(7):1564-1568.
19. Manchanda AK, Singh B. Effect of plant density and nitrogen on growth and fruit yield of bell pepper. Indian Journal of Agronomy. 1988;33(4):445-447.
20. Nicola S, Basoccu L, Serra G, Tongoni F, Leoni S. Pretransplant nutritional conditioning affects pepper seedling growth and yield. International symposium on new cultivation systems in greenhouse, Cagliari, Italy. Acta-Hort. 1993-95;361:519-526.
21. Padhiary GG, Dubey AK. Effect of Bio-Fertilizers on growth, yield and yield attributing characters of brinjal. International Journal of Current Microbiology and Applied Sciences. 2020;9(3):1643-1647.
22. Panse VG, Sukhatme PV. Statistical methods for agricultural worker, ICAR, Pub Ist impression, 1954.
23. Pratheep S, Kanchana D. Effect of biofertilizers and inorganic fertilizers on growth and yield of chilli (*Capsicum annuum* L.) var. CO-1. International Journal of Current Research in Life Sciences. 2018;7(4):1454-1456.
24. Rubio JS, Garcia SF, Florers P, Navarro JM, Martinez V. Yield and fruit quality of sweet pepper in response to fertilization with Ca^{2+} and K^{+}. Spanish Journal of Agricultural Research. 2010;8(1):170-177.
25. Shelke AA, Wadatkar SB, Beldar RM. Effect of different levels of fertilizer on growth and yield of okra. Int. J Curr. Microbiol. App. Sci. 2019;8(12):1363-1367.
26. Shree S, Regar CL, Ahmad F, Singh VK, Kumari R, Kumari A. Effect of organic and inorganic fertilizers on growth, yield and quality attributes of hybrid bitter gourd (*Momordica charantia* L). International. Journal of Current Microbiology and Applied Sciences. 2018;7(4):2256-2266.
27. Shukla YR, Thakur AK, Arun J. Effect of inorganic and bio-fertilizer on yield and horticultural traits in tomato. Indian Journal of Horticulture. 2009;66(2):285-287.
28. Singh H, Singh AK, Alam S, Singh T, Singh VP, Parihar AKS, *et al*. Effect of various integrated nutrient management models on growth and yield of wheat in partially reclaimed sodic soil. Int. J Curr. Microbiol. App. Sci. 2017;6(3):803-808.
29. Tesfaw AN, Dechassa, Kebede WT. Performance of hot pepper (*Capsicum annuum* L.) varieties as influenced by nitrogen and phosphorus fertilizers at bure, upper watershed of the blue nile in Northwestern Ethiopia. Int. J Agric. Sci. 2013;3(8):599-608.
30. Yasuor H, Ben-Gal A, Yermiyahu U, Beit-Yannai E, Cohen S. Nitrogen management of greenhouse pepper production: agronomic, nutritional, and environmental implications. Hortsci. 2013;48(10):1241-1249.