International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(4): 2647-2651

Received: 18-05-2020
Accepted: 22-06-2020

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Effect of integrated nutrient management on the growth and nutrient content of chilli (*Capsicum annuum* L.)

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DOI: https://doi.org/10.22271/chemi.2020.v8.i4ae.10040

Abstract
A field experiment was conducted at farmer's field in Sivapuri village, Chidhambaram taluk, Cuddalore district, Tamilnadu with chilli variety K2 as the test crop. The experimental soil was sandy clay loam. The treatments consisted of application of inorganic fertilizers, organic manures and biofertilizers in different combinations. The experiment was laid out in randomized block design and replicated three times. The growth attributes and nutrient content were recorded at 60, 90 and 120 DAT. The results of the experiment revealed that the application of 75% recommended dose of fertilizers + poultry manure @ 5 t ha^{-1} + biofertilizers + 2% $MgSO_4$ (T_{11}) registered the maximum growth attributes (plant height, leaf area index, number of branches $plant^{-1}$, chlorophyll content) and nutrient content (N, P, K, Ca, Mg and S) of chilli.

Keywords: NPK fertilizers, FYM, sheep manure, pressmud, poultry manure, chilli

Introduction
Chilli (*Capsicum annuum* L.) is one of the commercial high value crops. It is called as the universal spice of India. Chillies belong to the family Solanaceae and originates from South America. Chillies are excellent source of vitamins with minerals like molybdenum, magnesium, potassium and copper. It is an essential ingredient of Indian curry. It is predominantly popular for its green pungent fruits, which is used for culinary purpose. It is commercially important for its red colour due to the chemical constituent capsaicin. India is the largest producer, consumer and exporter of chilli, which contributes to 25 per cent of total world's production. In India, the most important chilli growing states are Karnataka, Tamilnadu, Odisha, Maharashtra, Rajasthan and West Bengal. It is cultivated in almost all the states and union territories.

Studies have revealed that continuous use of sub-optimal doses of nutrients in an unbalanced proportion led to severe depletion of nutrient reserves in Indian soils, causing multiple nutrient deficiencies and decline in crop productivity. The use of inorganic fertilizers is to be responsible for over 50 per cent yield increase in crops. It has been widely accepted that organic manure application alone could serve as a holistic approach towards achieving agriculture as it is nature based, environment friendly and ensures the conservation of resources for the future.

Use of organic manures to meet the nutrient requirements of crop would be an inevitable practice in the years to come for sustainable agriculture since organic manures not only improve yield but also maintain the physical, chemical and biological properties of soil. Organic sources for incorporation into the soil are becoming scarce. Essential elements locked up in the organic manures are slowly mineralized and made available to the crops, which helps in increasing the growth and nutrient content besides improving the fertility of the soil. Organic manures like farm yard manure, sheep manure, pressmud and poultry manure considered as a store house of various nutrients which are essential for the plant growth. Use of organic manures alone cannot fulfill the crop nutrients requirement.

Farmyard manure is decomposed mixture of dung and urine of farm animals along with litter and left over material from roughages or fodder fed to the cattle. The droppings of sheep and goats contain higher nutrients than farm yard manure and compost.

The sweeping of sheep or goat sheds are placed in pits for decomposition and it is applied later to the field. Pressmud is a solid residue, obtained from sugarcane juice before crystallization of sugar. Generally, pressmud is used as manure in India. It is a soft, spongy, lightweight, amorphous, dark brown to black coloured material. The poultry manure or chicken manure is the organic waste from poultry composed of mainly faeces and urine of chickens. The excreta of poultry birds ferment very quickly. Poultry manure has been found to decrease the bulk density, increase the water holding capacity, organic matter content, oxygen diffusion rate and aggregate stability of soils.

The integrated supply and use of plant nuteients from chemical fertilizers and organic manures has shown to produce higher growth and nutrient content than when they are applied alone. Hence, the present investigation was carried out to find out the effect of Integrated Nutrient Management on growth and nutrient content of chilli (*Capsicum annuum* L.).

Materials and Methods

A field experiment was conducted at farmer's field Sivapuri village, Chidambaram taluk, Cuddalore district during 2019 to find the effect of integrated nutrient management on growth and nutrient content of chilli variety K2, as the test crop under irrigated condition with eleven treatments replicated thrice in a randomized block design. The experimental soil was sandy clay loam. The treatments were T_1 - 100% recommended dose of fertilizers (control), T_2 - 100% recommended dose of fertilizers + FYM @ 25 t ha^{-1} (farmer's practice), T_3 - 75% recommended dose of fertilizers + sheep manure @ 5 t ha^{-1}, T_4 - 75% recommended dose of fertilizers + sheep manure @ 5 t ha^{-1} + biofertilizers, T_5 - 75% recommended dose of fertilizers + sheep manure @ 5 t ha^{-1} + biofertilizers + 2% $MgSO_4$, T_6 - 75% recommended dose of fertilizers + pressmud @ 10 t ha^{-1}, T_7 - 75% recommended dose of fertilizers + pressmud @ 10 t ha^{-1} + biofertilizers, T_8 - 75% recommended dose of fertilizers + pressmud @ 10 t ha^{-1} + biofertilizers + 2% $MgSO_4$, T_9 - 75% recommended dose of fertilizers + poultry manure @ 5 t ha^{-1}, T_{10} - 75% recommended dose of fertilizers + poultry manure @ 5 t ha^{-1} + biofertilizers), T_{11} - 75% recommended dose of fertilizers + poultry manure @ 5 t ha^{-1} + biofertilizers + 2% $MgSO_4$. Recommended dose of fertilizers were applied uniformly to all plots. The biofertilizers *Azospirillum* and *Phosphobacteria* were applied. The 2% $MgSO_4$ was given as a foliar spray at 30, 60 and 90 DAT. The inorganic fertilizers, organic manures, biofertilizers and foliar spray were applied as per the treatment schedule. Growth attributes and nutrient content were analysed at different stages of chilli production.

Results and Discussion

Growth attributes (Table 1)

Plant height

From the data, it is found that the plant height of chilli at different stages of growth was significantly influenced by the integrated application of inorganic fertilizers, organic manures and biofertilizers in different combinations. Among the different treatments experimented, the application of 75% recommended dose of fertilizers + poultry manure @ 5 t ha^{-1} + biofertilizers + 2% $MgSO_4$ (T_{11}) registered the maximum plant height of 96.62, 107.92, 122.56 cm at 60, 90 and 120 DAT respectively. This was followed by the treatments T_5, T_8, T_{10}, T_4, T_7, T_2, T_9, T_3 and T_6. However, the treatments T_8 and $T_{10;}$ T_7 and $T_{2;}$ T_3 and T_6 were on par with each other. The lowest plant height of 76.24, 83.58 and 93.24 cm at 60, 90 and 120 DAT respectively were recorded in control (T_1). The increased plant height might be attributed to the supply of macro elements through recommended dose of fertilizers. The increased plant height might also be due to the application of poultry manure which contains high N content and was made available to plants through mineralization to stimulate the plant growth and also increased uptake of primary nutrients and fast movements of photosynthates within the plant system (Vimera *et al.*, 2012) [16].

The biofertilizers *viz.*, *Azospirillum* and *Phosphobacteria* included in this treatment might have stimulated the hormones, vitamins and other growth factors which in turn lead to increased plant height. The foliar spray of $MgSO_4$ as water soluble fertilizer might be the another reason for increased plant height in this treatment. Increase in plant height due to foliar application of nutrients was reported by Haleema *et al.* (2018) [4] in chilli. The lowest plant height in control treatment might be due to application of inorganic fertilizers alone and it was less effective than the combined application of organic and inorganic fertilizers.

Leaf area index

The leaf area index was significantly influenced by different integrated nutrient management practices. The data with respect to 60, 90 and 120 DAT, the maximum leaf area index was observed with application of 75% recommended dose of fertilizers + poultry manure @ 5 t ha^{-1} + biofertilizers + 2% $MgSO_4$ (T_{11}) with leaf area index of 1.37, 1.61 and 1.85 respectively. The treatment next in order was application of 75% recommended dose of fertilizers + sheep manure @ 5 t ha^{-1} + biofertilizers + 2% $MgSO_4$ (T_5). This was followed by the treatments T_8, T_{10}, T_4, T_7, T_2, T_9, T_3 and T_6. However, the treatments T_{10} and T_{11}; T_5 and $T_{4;}$ T_7 and T_8 were not significantly different from each other at 30 DAT and the treatments T_8 and T_{10}; T_7 and $T_{2;}$ T_3 and T_6 were comparable to each other at 60, 90 and 120 DAT. The minimum leaf area index of 0.55, 0.64 and 0.76 was recorded in the treatment with application of 100% recommended dose of fertilizer alone (T_1) at different stages of plant growth *viz*., 60, 90 and 120 DAT.

This might be due to availability of dry matter in organic manure namely poultry manure that contains more nutrients and higher light interception which resulted in increased leaf area and higher photosynthetic activity and improved plant growth. These results are in agreement with findings of Islam *et al.* (2018) [6]. The increase in leaf area brought out by the nitrogen supply through N fertilizer, poultry manure and *Azospirillum* might be due to increased supply of nutrients which stimulated cell division, cell expansion and which expanded the individual leave as reported by Taylor *et al.* (1993) [14]. The increase in plant spread was attributed due to inorganic fertilizers and organic manure and biofertilizers application which ascertained to increased nutrients levels such as nitrogen, phosphorus and potassium in plants, and leads to increased plant metabolites that helped to build up the plant tissues. The increase in leaf area might be due to better nutrient uptake, photosynthesis, besides excellent physiological and biochemical activities due to application of *Azosprillum* and *Phosphobacteria*. These results are in conformity with the findings of Malik *et al.* (2011) [8].

Number of branches per plant

The appraisal of data revealed that the application of inorganic fertilizers, organic manures and biofertilizers significantly differed in the number of branches $plant^{-1}$ at 60,

90 and 120 DAT. Among various combinations experimented, The maximum number of branches plant^{-1} of 9.86, 13.09 and 13.52 at 60, 90 and 120 DAT respectively were recorded under the treatment T_{11} (75% recommended dose of fertilizers + poultry manure @ 5 t ha^{-1} + biofertilizers + 2% $MgSO_4$). This treatment was followed by T_5 (9.54, 12.67 and 13.11 at 60, 90 and 120 DAT respectively). The lowest number of branches plant^{-1} was recorded in the treatment T_1 (7.34, 9.73 and 9.88 at 60, 90 and 120 DAT respectively).

The poultry manure applied contains most macro and micronutrients and the recommended dose of NPK provide nutrients to the plant and significant effect on number of branches per plant. This finding is in conformity with the work of Alabi (2006) [1]. The increased number of branches might also be attributed to the foliar application of $MgSO_4$ as water soluble fertilizers at 30, 60 and 90 DAT that could have encouraged more number of auxiliary buds and resulted in more number of productive branches. Similar results of better branching with foliar application of nutrients and NPK inorganic fertilizers were reported by Muthumanickam and Anburani (2017) [9].

Nitrogen supplied through inorganic fertilizer, poultry manure and biofertilizers (*Azospirillum* and *Phosphobacteria*) had a significant effect on number of branches per plant as it activates vegetative growth. These results showed that proper dose of nitrogen and phosphorus were influential for number of branches per plant at final harvesting stage. Similar result was reported by Tumbare and Bhoite (2002) [15]. Moreover, $MgSO_4$ fertilizer applied in the solution form to the plant as foliar spray is more readily available and established more number of branches.

Chlorophyll content

The perusal of data revealed that inorganic fertilizers, organic manures and biofertilizers had significant effect on chlorophyll content of chilli leaves determined at 60, 90 and 120 DAT. At 60, 90 and 120 DAT, the maximum SPAD values of chlorophyll content (58.57, 59.49 and 59.98 respectively) were observed in the treatment with application of 75% RDF + poultry manure @ 5 t ha^{-1} + biofertilizers + 2% $MgSO_4$ (T_{11}) and this was followed by 75% recommended dose of fertilizers + sheep manure @ 5 t ha^{-1} + biofertilizers + 2% $MgSO_4$ (T_5). The treatments next in order were T_8, T_{10}, T_4, T_7, T_2, T_9, T_3, T_6 and T_1. However, the treatments T_8 and $T_{10;}$ T_7 and $T_{2;}$ T_3 and T_6 were not significantly different from each other. The minimum SPAD values of chlorophyll content (46.51, 46.89 and 47.17 at 60, 90 and 120 DAT respectively) was observed in the treatment applied with 100% recommended dose of fertilizers alone (T_1). This might be attributed to the nitrogen present in inorganic nitrogen fertilizer, poultry manure and *Azospirillum* which involved in the formation of chlorophyll and thereby leads to effective photosynthetic rate of chilli plant.

The poultry manure included in this treatment might have supplied the required nitrogen needed for the chilli plant to enhance the chlorophyll content. The nitrogen is a constituent of chlorophyll molecule which is important for preparation of starch in leaves and production of amino acids. These results are in conformity with the findings of Khandaker *et al*. (2017) [7]. The application of *Azospirillum* fixed the atmospheric nitrogen and thereby improved the nitrogen level in both soil and plant. Magnesium supplied by foliar application as 2% $MgSO_4$ in this treatment might have helped to capture the sun's energy for growth and production through photosynthesis. Photosynthesis takes place in green pigments of chlorophyll in chilli plants and magnesium is the central atom of the chlorophyll molecule, with each molecule which might have enhanced the chlorophyll content.

Table 1: Effect of integrated nutrient application on growth attributes of chilli at different stages of growth

Treatment Details	Plant height (cm)			Leaf area index			Number of Branches plant^{-1}			Chlorophyllcontent (SPAD values)		
	60 DAT	90 DAT	120 DAT	60 DAT	90 DAT	120 DAT	60 DAT	90 DAT	120 DAT	60 DAT	90 DAT	120 DAT
T_1 - 100% RDF alone (Control)	76.24	83.58	93.24	0.55	0.64	0.76	7.34	9.73	9.88	46.51	46.89	47.17
T_2 - 100% RDF + farm yard manure @ 25 t ha^{-1} (Farmer's practice)	84.87	93.56	105.75	0.86	1.02	1.15	8.40	11.16	11.43	52.33	52.50	53.32
T_3 - 75% RDF + sheep manure@ 5 t ha^{-1}	79.14	87.07	97.46	0.63	0.77	0.89	7.74	10.26	10.42	48.57	48.97	49.63
T_4 - 75% RDF + sheep manure@ 5 t ha^{-1} + biofertilizers	88.12	97.33	109.71	0.98	1.15	1.32	8.82	11.69	12.01	54.01	54.32	54.89
T_5 - 75% RDF + sheep manure@ 5 t ha^{-1} + biofertilizers + 2% $MgSO_4$	93.82	104.62	118.34	1.24	1.47	1.67	9.54	12.67	13.11	57.08	57.85	58.15
T_6 - 75% RDF + pressmud @ 10 t ha^{-1}	79.06	86.88	97.07	0.62	0.76	0.88	7.67	10.19	10.34	48.44	48.75	49.52
T_7 - 75% RDF + pressmud @ 10 t ha^{-1} + Biofertilizers	84.98	93.83	105.94	0.88	1.04	1.17	8.48	11.25	11.51	52.51	52.55	53.39
T_8 - 75% RDF + pressmud @ 10 t ha^{-1} + biofertilizers + 2% $MgSO_4$	91.11	101.05	114.31	1.12	1.34	1.50	9.21	12.21	12.60	55.65	55.93	59.45
T_9 - 75% RDF + poultry manure @ 5 t ha^{-1}	82.03	90.42	101.65	0.75	0.88	1.02	8.08	10.70	10.93	50.21	50.84	51.46
T_{10}- 75% RDF + poultry manure @ 5 t ha^{-1} + biofertilizers	91.02	100.71	114.29	1.10	1.31	1.47	9.15	12.14	12.51	55.59	55.87	56.40
T_{11}- 75% RDF + poultry manure @ 5 t ha^{-1} + biofertilizers + 2% $MgSO_4$	96.62	107.92	122.56	1.37	1.61	1.85	9.86	13.09	13.52	58.57	59.49	59.98
SE_d	1.236	1.477	1.743	0.015	0.019	0.022	0.123	0.154	0.165	0.670	0.712	0.716
CD (p=0.05)	2.578	3.081	3.636	0.031	0.040	0.046	0.256	0.322	0.345	1.397	1.486	1.493

Nutrient content of plant and chilli fruit

Nitrogen (Table 2):

The perusal of data on nitrogen content by chilli plant at 60, 90, 120 DAT and by fruit revealed that the maximum nitrogen content of 3.66, 2.96, 2.21 and 1.01% were recorded with application of 75% recommended dose of fertilizers + poultry manure @ 5 t ha^{-1} + biofertilizers + 2% $MgSO_4$ (T_{11}) at 60, 90, 120 DAT and by fruit respectively. The treatments next in order were T_5, T_8, T_{10}, T_4, T_7, T_2, T_9, T_3, T_6 at 60, 90, 120 DAT and by fruit. But, The treatment T_8 was comparable to T_{10} and the treatments T_7 and T_2; T_3 and T_6 were on par with each other. At 60, 90, 120 DAT and by fruit, the minimum nitrogen content of 2.71, 2.24, 1.41 and 0.74% respectively was registered in the treatment with application of 100% recommended dose of fertilizers alone (T_1). This might be due the addition of nitrogen through inorganic fertilizer, poultry manure and biofertilizer (*Azospirillum*) which increased the nitrogen content of plant and fruit. Application of inorganic fertilizers alone failed to produce maximum nitrogen content of plant and fruit. The similar findings were reported by Rohit Pawar and Barkule (2017) [11].

Phosphorus (Table 2)

The results showed that the maximum phosphorus content of 0.36, 0.48, 0.44 and 0.33% were registered in the treatment T_{11} (75% recommended dose of fertilizers + poultry manure @ 5 t ha^{-1} + biofertilizers + 2% $MgSO_4$) at 60, 90, 120 DAT and by fruit respectively. The treatment next in line was T_5 recording the phosphorus content of 0.34, 0.46, 0.42 and 0.32% at 60, 90, 120 DAT and by fruit respectively. These treatments were followed by T_8, T_{10}, T_4, T_7, T_2, T_9, T_3, T_6 and T_1. The phosphorus content increased with increase in the content of nitrogen, it means that phosphorus supply depends upon nitrogen availability. Reduction of 25% inorganic fertilizer, 5 tonnes of poultry manure ha^{-1} and *Phosphobacteria* might have caused to produce higher value. The reason behind is that poultry manure might have caused to produce some organic acid for release which may be responsible for the release of phosphorus from insoluble compounds. The similar findings were reported by Roychoudhury *et al.* (1990) [12].

Potassium (Table 2)

From the data, it is found that the integrated nutrient application significantly influenced the potassium content in chilli. With respect to plant at 60, 90, 120 DAT and by fruit, the treatment T_{11} (75% recommended dose of fertilizers + poultry manure @ 5 t ha^{-1} + biofertilizers + 2% $MgSO_4$) registered the highest potassium content of 1.17, 1.52, 2.23 and 1.20% respectively. This treatment was followed by the treatment T_5 (75% RDF + sheep manure @ 5 t ha^{-1} + biofertilizers + 2% $MgSO_4$). The treatments next in order were T_8, T_{10}, T_4, T_7, T_2, T_9, T_3 and T_6. But, the treatments T_8 and $T_{10;}$ T_7 and $T_{2;}$ T_3 and T_6 were not significantly different from each other. The least potassium content was recorded in the treatment T_1 (100% recommended dose of fertilizers alone) registering the potassium content of 0.86, 1.03, 1.41 and 0.71 at 60, 90, 120 DAT and by fruit respectively. This might be due to translocation of photosynthates from source to sink. The increased potassium content in chilli fruit might be due to better mineralization of nutrients from poultry manure, enhanced activity of well developed net work of root and soil aggregate formation. The present findings are in agreement with those reported by Dademal *et al.* (2004) [2] and Singh *et al*. (2004) [13].

Calcium (Table 3)

The investigation of the data revealed that the maximum calcium content on plant and fruit were noticed in the treatment T_{11} (75% recommended dose of fertilizers + poultry manure @ 5 t ha^{-1} + biofertilizers + 2% $MgSO_4$). This treatment was recorded the maximum value of 0.70, 0.73, 0.77 and 0.48% at 60, 90, 120 DAT and by fruit respectively. The treatment T_1 (100% recommended dose of fertilizers alone) registered the minimum calcium content of 0.41, 0.42, 0.48 and 0.21% at 60, 90, 120 DAT and by fruit respectively. This might be due to the presence of some amount of calcium in the soil also along with addition of organic manure namely poultry manure. A part of free available calcium may have been adsorbed in to colloidal sites of humic substances present in poultry manure might be another reason. As result, entry of calcium into fruits of chilli plant. These results are in conformity with findings of Premamali *et al.* (2019) [10].

Magnesium (Table 3)

The data pertaining magnesium content at 60, 90, 120 DAT and fruit, the treatment T_{11} (75% recommended dose of fertilizers + poultry manure @ 5 t ha^{-1} + biofertilizers + 2% $MgSO_4$) registered the highest magnesium content (0.83, 0.97, 0.86 and 0.50% at 60, 90, 120 DAT and by fruit respectively). The treatment T_5 (75% recommended dose of fertilizers + sheep manure @ 5 t ha^{-1} + biofertilizers + 2% $MgSO_4$) was next in order registering the magnesium content of 0.78, 0.92, 0.81 and 0.46% at 60, 90, 120 DAT and fruit respectively. These treatments were followed T_8, T_{10}, T_4, T_7, T_2, T_9, T_3 and T_6. However, the treatments T_7 and $T_{2;}$ T_3 and T_6 were not significantly different from each other. The treatment T_1 (75% recommended dose of fertilizers alone) registered the minimum uptake of magnesium (0.32, 0.47, 0.38 and 0.18% at 60, 90, 120 DAT and by fruit respectively). This might be due to the fact that plants were fertilized with foliar spray of magnesium sulphate and application of organic manure enhanced photosynthetic process which increased the magnesium content of fruit. The sulphur supplied through foliar application and organic manure increased the sulphur content which had synergistic effect with magnesium thereby increased the magnesium content of chilli fruit. These results are in consonance with findings of Harris *et al.* (2018) [5].

Sulphur (Table 3)

Among the different treatment combinations tried, the highest sulphur content of chilli was noticed in the treatment T_8 (75% recommended dose of fertilizers + pressmud @ 10 t ha^{-1} + biofertilizers + 2% $MgSO_4$). This treatment was registered the maximum sulphur content of 0.356, 0.286, 0.268 and 0.084% at 60, 90, 120 DAT and by fruit respectively. The minimum sulphur content of 0.253, 0.167, 0.159 and 0.054% were recorded in the treatment T_1 (100% recommended dose of fertilizers alone) at 60, 90, 120 DAT and by fruit respectively. This might be due to application of sulphur through pressmud and foliar application of magnesium sulphate as 2% had a significant effect on chilli. The organic manure *viz.*, pressmud might have enhanced fruit quality by increasing endogenous content of promoters, plant harmones and decreased inhibitors. The similar findings were reported by Dilmaghani *et al.* (2012) [3].

Table 2: Effect of integrated nutrient application on nitrogen, phosphorus and potassium content of plant and chilli fruit

Treatment Details	Nitrogen content (%)				Phosphorus content (%)				Potassium content (%)			
	60 DAT	90 DAT	120 DAT	Fruit	60 DAT	90 DAT	120 DAT	Fruit	60 DAT	90 DAT	120 DAT	Fruit
T_1 - 100% RDF alone (Control)	2.71	2.24	1.41	0.74	0.21	0.32	0.29	0.20	0.86	1.03	1.41	0.71
T_2 - 100% RDF + farm yard manure @ 25 t ha^{-1} (Farmer's practice)	3.12	2.51	1.70	0.85	0.27	0.39	0.35	0.26	1.00	1.24	1.79	0.91
T_3 - 75% RDF + sheep manure@ 5 t ha^{-1}	2.86	2.33	1.53	0.78	0.23	0.35	0.31	0.22	0.91	1.12	1.53	0.79
T_4 - 75% RDF + sheep manure@ 5 t ha^{-1} + biofertilizers	3.30	2.67	1.88	0.89	0.29	0.42	0.37	0.28	1.06	1.32	1.93	0.98
T_5 - 75% RDF + sheep manure@ 5 t ha^{-1} + biofertilizers + 2% $MgSO_4$	3.58	2.89	2.15	0.97	0.34	0.46	0.42	0.32	1.14	1.47	2.18	1.13
T_6 - 75% RDF + pressmud @ 10 t ha^{-1}	2.82	2.31	1.50	0.77	0.23	0.35	0.31	0.22	0.90	1.10	1.51	0.78
T_7 - 75% RDF + pressmud @ 10 t ha^{-1} + Biofertilizers	3.18	2.55	1.75	0.86	0.27	0.40	0.35	0.26	1.01	1.26	1.81	0.92
T_8 - 75% RDF + pressmud @ 10 t ha^{-1} + biofertilizers + 2% $MgSO_4$	3.47	2.77	2.04	0.94	0.32	0.44	0.39	0.31	1.11	1.41	2.10	1.05
T_9 - 75% RDF + poultry manure @ 5 t ha^{-1}	2.98	2.40	1.61	0.81	0.25	0.37	0.33	0.24	0.95	1.19	1.67	0.85
T_{10}- 75% RDF + poultry manure @ 5 t ha^{-1} + biofertilizers	3.42	2.76	1.99	0.93	0.32	0.44	0.39	0.31	1.10	1.39	2.08	1.04

T_{11}- 75% RDF + poultry manure @ 5 t ha^{-1} + biofertilizers + 2% $MgSO_4$	3.66	2.96	2.21	1.01	0.36	0.48	0.44	0.33	1.17	1.52	2.23	1.20
SE_d	0.042	0.031	0.028	0.013	0.004	0.004	0.006	0.004	0.010	0.017	0.019	0.012
CD (p=0.05)	0.089	0.064	0.058	0.028	0.008	0.013	0.012	0.009	0.022	0.034	0.039	0.024

Table 3: Effect of integrated nutrient application on calcium, magnesium and potassium content of plant and chilli fruit

Treatment Details	Calcium content (%)				Magnesium content (%)				Sulphur content (%)			
	60 DAT	90 DAT	120 DAT	Fruit	60 DAT	90 DAT	120 DAT	Fruit	60 DAT	90 DAT	120 DAT	Fruit
T_1 - 100% RDF alone (Control)	0.41	0.42	0.48	0.21	0.32	0.47	0.38	0.18	0.253	0.167	0.159	0.054
T_2 - 100% RDF + farm yard manure @ 25 t ha^{-1} (Farmer's practice)	0.55	0.54	0.62	0.32	0.53	0.67	0.56	0.30	0.294	0.202	0.201	0.064
T_3 - 75% RDF + sheep manure@ 5 t ha^{-1}	0.45	0.47	0.53	0.25	0.39	0.53	0.45	0.22	0.266	0.179	0.172	0.057
T_4 - 75% RDF + sheep manure@ 5 t ha^{-1} + biofertilizers	0.58	0.60	0.65	0.36	0.61	0.73	0.63	0.34	0.295	0.204	0.203	0.065
T_5 - 75% RDF + sheep manure@ 5 t ha^{-1} + biofertilizers + 2% $MgSO_4$	0.67	0.67	0.74	0.45	0.78	0.92	0.81	0.46	0.331	0.253	0.242	0.077
T_6 - 75% RDF + pressmud @ 10 t ha^{-1}	0.45	0.46	0.52	0.24	0.38	0.52	0.44	0.21	0.278	0.195	0.193	0.061
T_7 - 75% RDF + pressmud @ 10 t ha^{-1} + Biofertilizers	0.56	0.54	0.62	0.33	0.54	0.68	0.56	0.31	0.314	0.242	0.235	0.073
T_8 - 75% RDF + pressmud @ 10 t ha^{-1} + biofertilizers + 2% $MgSO_4$	0.62	0.64	0.71	0.41	0.73	0.85	0.75	0.42	0.356	0.286	0.268	0.084
T_9 - 75% RDF + poultry manure @ 5 t ha^{-1}	0.50	0.51	0.59	0.29	0.47	0.59	0.50	0.26	0.269	0.181	0.175	0.058
T_{10}- 75% RDF + poultry manure @ 5 t ha^{-1} + biofertilizers	0.61	0.63	0.70	0.40	0.66	0.79	0.69	0.38	0.303	0.220	0.219	0.069
T_{11}- 75% RDF + poultry manure @ 5 t ha^{-1} + biofertilizers + 2% $MgSO_4$	0.70	0.73	0.77	0.48	0.83	0.97	0.86	0.50	0.342	0.277	0.254	0.081
SE_d	0.008	0.009	0.010	0.013	0.007	0.008	0.007	0.007	0.002	0.003	0.002	0.001
CD (p=0.05)	0.018	0.019	0.022	0.028	0.015	0.017	0.016	0.015	0.007	0.005	0.004	0.002

Conclusion

This study concludes that the combined application of inorganic fertilizers, organic manures and biofertilizers resulted in higher growth and nutrient content of chilli. The results revealed that application of 75% recommended dose of fertilizers + poultry manure @ 5 t ha^{-1} + biofertilizers (*Azospirillum and Phosphobacteria*) + 2% $MgSO_4$ as a foliar spray improved the growth attributes and nutrient content of chilli compared to other treatments tried.

References

1. Alabi DA. Effects of fertilizer phosphorus and poultry droppings treatments on growth and nutrient components of pepper (*Capsicum annuum* L.). Afr. J Biotechnol. 2006; 5:671-677.
2. Dademal AA, JH Dongale. Effect of manures and fertilizers on growth and yield of okra and nutrient availability in lateritic soil of kokan. J Soils and Crops. 2004; 14(2):262-268.
3. Dilmaghani MR, S Hemmaty, L Naseri. Effects of sulphur application on soil pH and uptake of phosphorus, iron, and zinc in apple trees. J Plant Physiol. & Breeding. 2012; 2(1):1-10.
4. Haleema B, A Rab, SA Hussain. Effect of calcium, boron and zinc foliar application on growth and fruit production of tomato. Sarhad J Agric. 2018; 34(1):19-30.
5. Harris KD, T Vanajah, S Puvanitha. Effect of foliar application of boron and magnesium on growth and yield of green chilli (*Capsicum annum* L.). Foliar application of nutrients. 2018; 12(1):26-33.
6. Islam R, T Sultana, A Haque, I Hossain, N Sabrin, R Islam *et al*. Growth and yield of chilli influenced by nitrogen and phosphorus. J Agric. Vet. Sci. 2018; 11(5):54-68.
7. Khandaker MM, F Rohani, T Dalorima, N Mat. Effects of different organic fertilizers on growth, yield and quality of *Capsicum annuum* L. var. Kulai (Red chilli Kulai). Biosci. Biotechnol. Res. Asia. 2017; 14(1):185-192.
8. Malik AA, MA Chattoo, G Sheemar, R Rashid. Growth, yield and fruit quality of sweet pepper hybrid SH-SP-5 (*Capsicum annuum* L.) as affected by integration of inorganic fertilizers and organic manures (FYM). J Agr. Tech. 2011; 7(4):1037-1048.
9. Muthumanickam K, A Anburani. Effect of combined application of growth parameters of chilli hybrid (*Capsicum annuum* L.). Asian J Hortic. 2017; 12(1):117-120.
10. Premamali, M, KN Kannangara, PI Yapa. Impact of composting on growth, vitamin C, calcium content of *Capsicum chinense*. Sustain. Agric. Res. 2019; 8(3):57-65.
11. Rohit Pawar, Santosh Barkule. Study on effect of integrated nutrient management on growth and yield of cauliflower (*Brassica oleracea* var. botrytis L.). J Appl. Nat. Sci. 2017; 9(1):520-525.
12. Roychoudhury A, R Chatterjee, SK Mitra. Effect of different doses of nitrogen, phosphorus, potassium, magnesium, calcium and iron on growth and development in chilli. Indian Cocoa, Arecanut and Spices J. 1990; 13(3):96-99.
13. Singh TR, S Singh, SK Singh, MP Singh, BK Srivastava. Effect of integrated nutrient management on crop nutrient uptake and yield under okra-per-tomato cropping system in a mollisol. Ind. J Hort. 2004; 61(4):312-314.
14. Taylor G, AJS Mc Donald, I Stadenberg, PH Freer-Smith. Nitrate supply and the biophysics of leaf growth in *Salix viminalis.* J. Exp. Bot. 1993; 44:155-164.
15. Tumbare AD, SU Bhoite. Effect of solid soluble fertilizer applied through fertigation on growth and yield of chilli (*Capsicum annum* L.). Indain J Agric. Sci. 2002; 72(2):109-111.
16. Vimera K, SP Kanaujia, VB Singh, PK Singh. Effect of integrated nutrient management on growth and yield of king chilli under foothill condition of Nagaland. J. Indian Soci. Soil Sci. 2012; 60:45-49.