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Effect of Secondary Nutrients and Biofertilizers on Growth, Yield and Quality of Chilli (*Capsicum annuum* L.)

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ABSTRACT

An experiment was conducted at the Department of Vegetable Science, College of Horticulture, Mudigere during the year 2022-23. The experiment was laid out in Randomized Complete Block Design (RCBD) with eleven treatments and three replications to evaluate growth, yield and quality parameters of chilli. Among the treatments, treatment (T_{11}) which received 75 % RDNPK + $CaNO_3$ @ 0.5 % +$MgSO_4$ @ 0.4 %+ *Azospirillum* + PSB + KSB significantly recorded maximum plant height (84.02 cm), number of leaves per plant (288.58), plant spread (N-S) 61.58 cm, plant spread (E-W) 57.66 cm, number of primary branches per plant (9.37), number of secondary branches per plant (22.54), total number of branches per plant (31.91), leaf area per plant (8085.43 m^2), fresh weight (251.08 g), dry weight(185.20 g), dry matter(175.82 g), Absolute growth rate(1.673 g/plant/day), crop growth rate(6.29 g/m^2/day), net assimilation rate(0.0817 g/dm^2/day), relative growth(0.0309 g/day), quality parameters like highest total chlorophyll content (2.24 mg/g), ascorbic acid content (154.69 mg/100 g) recorded in T_{11}. Significantly recorded maximum fruit length (11.53 cm), fruit diameter (1.82 cm), fruit pericarp thickness (2.49 mm), number of fruits per plant (234.98), average fruit weight (6.42 g), fruit yield per plant (796.1 g), Fruit yield per plot (19.91 kg), Fruit yield (29.50 t/ha) showed the better growth and quality parameters under 75 % RDNPK + $CaNO_3$ @ 0.5 % +$MgSO_4$ @ 0.4 %+ *Azospirillum* + PSB + KSB.

Keywords: Chilli, Secondary Nutrients, Biofertilizers.

INTRODUCTION

Chilli (*Capsicum annuum L.)* is an important vegetable and spice crop which is commercially cultivated in tropical and sub-tropical regions. It requires a combination of warm and humid weather. A temperature range of 20 - 30 ºC is optimum for chilli. The growth and yield of vegetable crops are mainly depending on the quality and quantity of fertilizers used. Secondary nutrients are required by the plant in smaller quantities than macronutrients. Although plants only require relatively small amounts of secondary nutrients but are essential for plant growth. If they are deficient, critical plant functions can be limited resulting in plant abnormalities, reduced growth and yield potential. They helps in absorption and translocation of other nutrients and activates number of plant growth regulating enzymes which are needed for cell wall formation and normal cell division.

Azospirillum can also alter the forms of plant nutrients such as nitrogen and phosphorus to make them more available to plants. *Azospirillum* also make antioxidants that protect the plant roots from stress due to drought and flooding. Plant growth can also be promoted indirectly by *Azospirillum* reducing plant disease (Tikhonova *et al*, 2019). The use of PSB as inoculants increases P uptake by plants. Simple inoculation of seeds with PSB gives crop yield responses equivalent to 30 kg P_2O_5 per ha or 50 per cent of the need for phosphatic fertilizers. Alternatively, PSB can be applied through fertigation or in hydroponic operations (Park *et al,* 2011). Potassium (K) is considered as an essential nutrient and a major constituent within all living cells. Naturally, soils contain K in larger amounts than any other nutrients however, most of the K is unavailable for plant uptake.

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The application of chemical fertilizers has a considerably negative impact on environmental sustainability (Han *et al,* 2006). The present study was conducted to assess the effect of secondary nutrients and biofertilizers on growth, yield and quality of chilli.

MATERIAL AND METHODS

To study the effect of secondary nutrients and biofertilizers on growth, yield and quality of chilli (*Capsicum annuum* L.) under hill zone of Karnataka. The field experiment was conducted at College of Horticulture, Mudigere during *Summer* season 2022-2023. The experiment was laid out in a Randomized Complete Block Design (RCBD) with eleven treatments and three replications. The seedlings were sown in ridge and furrow method at a distance of 60 cm between row to row and 45 cm between plants. All the recommended cultural operations were followed and observations were recorded in five randomly selected plants per replication of all the treatments.

The treatment details as follows

T_1- RDF

T_2 -RDF + $CaNO_3$@ 0.5 %

T_3 -RDF + $MgSO_4$@ 0.4 %

T_4 -RDF + $CaNO_3$ @ 0.5 % + $MgSO_4$ @ 0.4 %

T_5 -RDPK + 75 % N + $CaNO_3$@ 0.5 % + *Azospirillum*

T_6 -RDPK + 75 % N + $MgSO_4$ @ 0.4 % + *Azospirillum*

T_7 -RDNK + 75 % P + $CaNO_3$ @ 0.5 % + PSB

T_8 -RDNK + 75 % P + $MgSO_4$ @ 0.4 % + PSB

T_9 -RDNP +75 % K + $CaNO_3$ @ 0.5 % + KSB

T_{10}- RDNP + 75 % K + $MgSO_4$ @ 0.4 % + KSB

T_{11} -75% RDNPK + $CaNO_3$@ 0.5 % + $MgSO_4$ @ 0.4 % +*Azospirillum* + PSB + KSB

Well decomposed FYM @ 25 t/ha was applied at the time of land preparation. The recommended dose 150:75:75 kg NPK per ha was applied in the form of urea, single super phosphate and muriate of potash, respectively. One week after transplanting drenching of biofertilizers was done and two weeks after transplanting secondary nutrients were sprayed as first spray, second spray was done at 15 days after the first spray and at the same time observations on growth, yield and quality parameters were recorded.

Leaf area was recorded by taking five leaves evenly from the bottom, middle and top portion of the plant using leaf area meter (LICOR portable leaf area meter). The fresh weight, dry weight, dry matter content of fruits were recorded at 60, 90 and 120 days interval and the growth analysis parameters like AGR, CGR, NAR and RGR at 60-90 and 90-120 DAT were worked, fruit quality parameters like fruit length, diameter, pericarp thickness and quality parameters like chlorophyll and ascorbic acid content were recorded and yield parameters like fruit yield per plant, fruit yield per plot and yield per hectare were worked out.

$$\text{AGR (g/plant/day)} = \frac{W_2 - W_1}{t_2 - t_1}$$

Where,

W_1 – Total dry weight of the plant (g) at time t_1

W_2 – Total dry weight of the plant (g) at time t_2

$t_2 - t_1$-Time intervals in days

$$\text{CGR (g/m}^2\text{/day)} = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{1}{A}$$

Where,

W_1 – Total dry weight of the plant (g) at time t_1

W_2 – Total dry weight of the plant (g) at time t_2

$t_2 - t_1$-Time intervals in days

A – Land area in m^2

$$\text{NAR (dm}^2\text{/day)} = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{\text{Loge } L_2 - \text{Loge } L_1}{L_2 - L_1}$$

Where,

L_1 and W_1 - Leaf area in cm^2 and dry weight of the plant (g), respectively at time t_1

L_2 and W_2 - Leaf area in cm^2 and dry weight of the plant (g), respectively at time t_2

Loge – Logarithm to the base e.

$t_2 - t_1$-Time intervals in days

$$\text{RGR (g/g/day)} = \frac{\text{Loge } W_2 - \text{Loge } W_1}{t_2 - t_1}$$

Where,

W_1 – Total dry weight of the plant (g) at time t_1

W_2 – Total dry weight of the plant (g) at time t_2

$t_2 - t_1$-Time intervals in days

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Table 1. Effect of Secondary nutrients and biofertilizers on Growth, Yield and Quality of chilli.

Treatment	Plant Height (cm)	No. of leaves	Plant spread (N-S)	Pt spread (E-W)	Primary branches	Secondary branches	Total no of branches	Leaf area (cm^2)	Fresh weight (g)	Dry weight (g)	Dry matter (g)	Absolute growth rate (g/ plant/ d)	Crop growth rate (g/m^2/day)
T_1	65.94	225.09	44.74	43.00	6.82	12.24	19.06	6445.93	213.30	156.78	147.57	1.421	5.26
T_2	68.92	227.60	44.97	43.40	7.31	12.68	19.90	6598.51	216.70	160.63	151.31	1.483	5.49
T_3	69.66	232.43	46.33	44.18	7.50	16.87	24.37	6761.78	219.54	163.85	154.52	1.502	5.56
T_4	70.35	238.64	49.60	45.40	7.76	15.37	23.13	6925.26	223.60	166.43	157.99	1.537	5.69
T_5	72.53	240.92	50.95	46.08	7.87	15.67	23.65	7089.14	226.68	168.98	159.63	1.539	5.70
T_6	79.40	242.44	53.35	45.86	7.93	14.27	22.20	7252.70	230.58	170.37	161.01	1.541	5.72
T_7	74.16	253.58	53.09	46.36	8.16	14.98	23.14	7416.15	234.96	172.23	162.95	1.555	5.76
T_8	75.92	273.78	52.72	47.05	8.43	13.75	22.18	7592.14	238.88	176.00	166.63	1.578	5.84
T_9	78.45	277.55	53.55	49.77	8.51	15.78	24.18	7756.30	241.85	178.38	169.86	1.606	5.95
T_{10}	81.06	280.05	58.12	52.36	8.68	17.12	25.80	7921.26	245.81	181.17	171.79	1.627	6.02
T_{11}	84.02	288.58	61.58	57.66	9.37	22.54	31.91	8085.43	251.08	185.20	175.82	1.673	6.29
S. Em±	0.68	2.58	0.41	0.44	0.07	0.18	1.48	55.51	1.66	1.67	0.67	0.01	0.03
CD@ (5%)	1.99	7.57	1.19	1.27	0.56	0.63	2.76	163.28	4.85	4.00	3.74	0.03	0.24

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RESULTS AND DISCUSSION

It was found that 75 % RDNPK + $CaNO_3$ @ 0.5 % +$MgSO_4$ @ 0.4 %+ *Azospirillum* + PSB + KSB showed significant increase in plant height (84.02 cm), Number of leaves per plant (288.58), plant spread (N-S) 61.58 cm, plant spread (E-W) 57.66 cm, number of primary branches per plant (9.37), number of secondary branches per plant (22.54), total number of branches per plant (31.91), leaf area per plant (8085.43 m^2), fresh weight(251.08 g), dry weight(185.20 g), dry matter (175.82 g), absolute growth rate(1.673 g/plant/day), crop growth rate(6.29 g/m^2/day), net assimilation rate(0.0817 g/dm^2/day), relative growth(0.0309 g/g/day). The increased growth parameters might be due to the presence of macro, secondary nutrients like calcium which is responsible for physiological processes like cell division and cell elongation in a coincident enlargement of protoplast through water uptake and the microbial bioinoculants might have helped in effective utilization of macro nutrients. Biofertilizers like, PSB and KSB helps in converting the unavailable form of P and K respectively into available form in soil condition. Hence better nutrient uptake by the plants which in turn stimulates the vegetative growth and yield attributing traits. Bharathiraj *et al* (2012) observed similar results in tomato crop sprayed with combination of *Azospirillum lipoferum, Bacillus megaterium, Frateuria aurantia* with inorganic fertilizers to increase the yield both qualitatively and quantitatively . These results were in conformity with the results of Gollagi *et al* (2009), Hao and Papadopoulous (2003) in tomato and Yogaraju *et al* (2017) in chilli

Significantly recorded maximum fruit length (11.53 cm), fruit diameter (1.82 cm), fruit pericarp thickness (2.49 mm), number of fruits per plant (234.98), average fruit weight (6.42 g), fruit yield per plant (796.1 g), Fruit yield per plot (19.91 kg), Fruit yield (29.50 t/ha) which might be due to regulating semi permeability of cell walls, thus mobilizing more water content into fruit and increasing the size of fruits. this might have enabled to accumulate more carbohydrate into the storage organs which might have led to the increased fruit weight and nutrient use efficiency throughout the cropping period which might have enhanced the translocation of photosynthates from source to sink and the major macronutrient such as nitrogen resulted beneficial effects of microflora might have played a role in producing more number of flowers and that helps for production of more number of fruits, which resulted in increased number of fruits per plant and lead to a maximum number of harvest and more number of fruits per square meter and ultimately increases fruits yield. Similar results were reported by Kiran *et al* (2010) in brinjal.

Increase in chlorophyll content (2.24 mg/g), ascorbic acid content (154.69 mg/100 g). This might be due to enhanced availability of major nutrients, secondary nutrients are involved in biochemical and physiological plant processes, including protein synthesis and chlorophyll formation. As magnesium is constituent of chlorophyll, protein and protoplasm resulting in greater photosynthetic activity. Cytokinin produced by microbial inoculants might have greater sink to attract nutrients like Mg, Fe and K. The indirect role of iron is enhancing the functioning of plant system ultimately increased the chlorophyll content in the leaves. These results were in line with the earlier

Table 2. Effect of Secondary nutrients and biofertilizers on Growth, Yield and Quality of chilli.

Treatment	NAR ($g/cm^2/day$)	RGR (g/day)	Fruit length (cm)	Fruit diameter (cm)	Pericarp thickness (mm)	Number of fruits/ plant	Average fruit weight (g)	Fruit yield/ plant (g)	Fruit yield/ plot (kg)	Fruit yield / ha (tons)	Total chlorophyll	Ascorbic acid content (mg/100 g)
T_1	0.0656	0.0234	7.50	1.36	1.89	166.12	3.40	572.0	14.31	21.20	1.26	119.18
T_2	0.0682	0.0246	8.24	1.41	2.02	172.19	3.54	596.0	14.91	22.10	1.65	121.74
T_3	0.0693	0.0257	8.45	1.43	2.05	178.62	3.63	608.0	15.18	22.50	1.74	122.62
T_4	0.0734	0.0260	8.89	1.46	2.18	186.63	4.24	626.0	15.66	23.20	1.85	123.15
T_5	0.0746	0.0264	8.96	1.59	2.21	195.48	4.64	659.1	16.47	24.40	1.87	124.85
T_6	0.0754	0.0266	9.08	1.64	2.19	201.69	4.89	669.5	16.74	24.80	1.94	126.05
T_7	0.0766	0.0268	9.35	1.49	2.09	208.93	5.16	678.4	16.94	25.10	1.97	128.09
T_8	0.0778	0.0272	9.71	1.54	2.22	215.99	5.34	684.8	17.14	25.40	1.96	132.43
T_9	0.0789	0.0278	9.90	1.68	2.17	221.12	5.56	706.8	17.68	26.20	2.04	137.17
T_{10}	0.0800	0.0292	10.61	1.76	2.32	227.94	5.86	712.8	17.82	26.40	2.06	141.18
T_{11}	0.0817	0.0309	11.53	1.82	2.49	234.98	6.42	796.1	19.91	29.50	2.24	154.69
S. Em±	0.0004	0.0005	0.08	0.02	0.05	2.09	0.09	8.82	0.18	0.35	0.02	0.87
CD @ (5%)	0.0013	0.0015	0.22	0.04	0.14	6.00	0.26	25.37	0.51	1.00	0.07	2.52

findings of Alaboz *et al* (2017) in chilli and Bharathiraja *et al* (2012) in tomato and the findings of Yogaraju *et al* (2017) who reported that integrated use of microbial consortia and secondary nutrients had increased fruit quality parameters like chlorophyll content in chilli by the application of *Azospirillum* + PSB + VAM + KSB + 75% RDF + $MgSO_4$ + Micronutrient mixture.

CONCLUSION

The study concluded that treatment T_{11} consisting of 75% RDNPK + CaNO3@ 0.5 % + MgSO4 @ 0.4 % +Azospirillum + PSB + KSB was found to be the most suitable for adoption by the farmers.

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