**Original Research Article**

# Effect of integrated nutrient management on fruit quality, soil nutrient status and economics of capsicum under low cost polyhouse condition

ABSTRACT

The field experiment was conducted during 2010-11 at the Experimental Farm of School of Agricultural Sciences and Rural Development, Medziphema, Nagaland to study the effect of different sources of manuring on growth, yield and quality of capsicum cv. California Wonder under low cost polyhouse condition. The experiment was laid out in a randomized block design with three replications. Application of different levels of fertilizers, organic manures and biofertilizers either alone or in combination significantly increased the quality of capsicum as compared to control. The maximum TSS (9.55 $^{o}$Brix) and vitamin C (126.31 mg $100^{-1}$g) were recorded with the combined application of 50% NPK + 50% FYM + biofertilizers. There was a significant build up of organic carbon in the soil after harvest of the crop with 50% NPK + 50% FYM + biofertilizers. It also recorded highest net return of Rs. 7,93,858.00 /ha and the cost: benefit ratio 1:8. These results indicated that the optimum production and quality of capsicum with higher monetary returns can be obtained with integrated application of 50% NPK + 50% FYM + biofertilizers. This integrated nutrient management saved about 50% of chemical fertilizers without any reduction in yield and quality parameters of capsicum.

**Keywords**: Capsicum, biofertlizers, quality, economics, polyhouse.



## Introduction

Capsicum (*Capsicum annum* L.) is highly priced vegetable rich in minerals and vitamins. It is grown extensively in the cooler regions of the country (2). It is grown as winter crop in plains and as summer crop in higher altitudes during March-April. Cultivation of capsicum in Nagaland started only recently. Demand for capsicum in Nagaland is very high and present production is not sufficient to meet the market demand. Among various factors of capsicum production, nutrient management is very essential for higher production and improved soil fertility. The use of chemical fertilizers increasing vegetable production has been widely recognized but its long run impact on soil health, ecology and other natural resources are detrimental living organisms including beneficial soil microorganism and human health. The cost of chemical fertilizers is also increasing day by day. Therefore, there is a need to reduce dependency on chemical fertilizers for sustainable production in modern day agriculture. IT is possible through integrated nutrient management (INM). There are several sources of plant nutrients like organic manures, biofertilizers etc. which apart from supplying nutrients also improve overall soil health (3). Use of organic manures in INM help in mitigating multiple nutrient deficiencies. Application of organic manures to acidic soil reduces the soluble and exchangeable Aluminum temporarily by forming complex and creates better environment for growth and development in addition to improvement in physical, chemical and biological properties of soil (4). Biofertilizers are also promising components of nutrient supply system. Biofertilizers are environment friendly, and in combination with inorganic fertilizers integrated nutrient management strategy play significant role in plant nutrition. The role of biofertilizers is perceived as growth regulators besides biological nitrogen fixation collectively leading to much higher response on various growth and yield attributing characters (13). The agro-climatic condition prevailing in the low hills of Nagaland have been found to be highly favorable for capsicum cultivation. But no information is available about integrated nutrient management in capsicum in north eastern region including acidic soils of Nagaland in particular. Keeping all the points in view of present investigation was carried out to study the effect of integrated nutrient management on the quality of capsicum under low cost polyhouse condition.

## MATERIALS AND METHODS

A field experiment was conducted during October 2010 to March 2011 at the Experimental Farm of SASRD, Medziphema, Nagaland. The experimental site is located at the an altitude of 304.8 m above mean sea level. The soil of the experimental was sandy loam (pH 4.9), high in organic carbon (1.85 %) with available N,P, and K is 296.43, 19.73 and 248.76 kg $ha^{-1}$, respectively. The experiment was laid out in a randomized block design with three replications. The experimental plants measured 2.4 m x 2.4 m and a spacing was maintained at 60 cm x 45 cm was followed for the raising the capsicum. Thirty days old healthy seedlings with uniform vigour and height were transplanted on 2$^{nd}$ November, 2010. The N, P and K were given in the form urea, single super phosphate and muriate of potash, respectively. Full dose of P and K and half dose of N were applied at the time of transplanting and remaining half dose of N was given in two equal splits 30 and 60 days after transplanting. Organic manures *viz.,* FYM, pig manure and vermicompost were incorporated as per treatment in respective plots 20 days before to transplanting. Biofertilizers (*Azospirillum* and *Phosphorus solubilizing bacteria*) were inoculated to seedling prior to transplanting by dipping the seedlings biofertilizers solution @ 2 kg $ha^{-1}$. Observations on TSS and vitamin C were recorded at harvest. Total soluble solid was determined using hand refractometer and results were expressed in degree brix. Vitamin C content was determined by 2, 6-dichlorophenol indophenol visual titration method (1) and expressed in mg 100 $^{-1}$g.

Soil samples were collected before transplanting and after harvest of crop treatment wise from experimental plot to a depth of 15 cm with the help of screw auger. The collected soil samples were reduced into 500 g and then dried under shade, ground and sieved through 2 mm sieve size. Soil samples were analysed for pH, organic carbon, available nitrogen, phosphorus and potassium by digital pH meter, Walkley and Black Rapid titration method, alkaline potassium permanganate method, Olsen's method, flame photometer method, respectively (7). The statistical analysis of the-was carried out as per standard procedure given by (10).

Economics of the treatments was calculated as per the prevailing market price cost of cultivation, inputs and output. Gross income was calculated by multiplying yield with whole sale rate of capsicum (Rs. 30,000 ton$^{-1}$). Net income was estimated by deducting the total cost of cultivation from gross income of the particular treatment. Cost:benefit ratio was worked out by dividing gross return from total cost of cultivation.

**Results and Discussion**

**Yield and Quality characters:**

Capsicum gave the highest yield of 23.25 tonne/ha with the application of 50 % NPK + 50% Poultry manure. These findings are in earlier reports with the findings of (2, 4 and 13), reported that maximum fruit yield with 50% NPK + 50% FYM + biofertilizers in brinjal, tomato and king chilli, respectively. Quality of capsicum was evaluated by Total soluble solid (TSS) and vitamin C. The maximum values of TSS (9.55 º Brix) and vitamin C (126.31 mg 100$^{-1}$g) were recorded with 50 % NPK + 50 % FYM + biofertilizers ($T_9$) Table 1. The comparative higher level of both TSS and vitamin C with INM may be due to action of specific soil nutrients which were made more readily available for plant absorption. Integration of mineral fertilizers and organic manure with or without biofertilizers integrating may activate specific enzymes for the synthesis of these compounds. The maximum ascorbic acid content (14.69 mg 100$^{-1}$g) with application of NPK + FYM + *Azospirillum* + *Phosphotica* in brinjal has also been observed (8). These findings are in earlier reports with (4, 11 and 13), sowing maximum content of TSS in tomato and vitamin C in king chilli with 50% NPK + 50% FYM + biofertilizers.

**Soil Fertility Change**

Available N,P and K, organic carbon and pH in soil after harvest were significantly influenced by application of N,P and K fertilizers, organic manures and biofertilizers alone or in combination over control (Table-2). Maximum available nitrogen (326.64 kg $ha^{-1}$) was recorded with 100% N, P and K ($T_2$) which may be attributed to poor soil physical structure, lack of organic manures and microbial activities, thus resulting in poor utilization of nitrogen by plants. Similar results have also been reported earlier (13) that application of 100% NPK fertilizers alone recorded maximum available nitrogen in soil after harvest. The maximum available P (15.48 kg $ha^{-1}$) and K (253.04 kg $ha^{-1}$) were recorded with 50 % NPK + 50 % FYM + biofertilizers ($T_9$). FYM application might have reduced the solubility of aluminum and Iron and improved the CEC of the soil which inturn increased the retention of K in exchangeable form by mass action effect. The net increase in organic carbon was higher with organic manures in combination with biofertilizers and fertilizers over 100% NPK alone. Application of 50% NPK + 50 % FYM + biofertilizers ($T_9$) recorded significantly higher soil organic carbon (2.19 %) and soil pH (5.25) over other treatments. This might be due to increased microbial activities in the root zone which decomposed organic manures and also transformed unavailable form of mineral nutrients into available forms in soil thereby substantiated crop requirements and improved organic carbon level and stabilized soil pH. It has been reported that (5) incorporation of biofertilizers and FYM with inorganic fertilizers significantly improved the organic carbon content and available N, P and K status in the soil in tomato. Similar results were also reported in capsicum (9) radish (12) and in king chlli (13).

## Economics of treatments

The integration of 50% NPK + 50 % FYM + biofertilizers ($T_9$) recorded the highest net return of Rs. 7,93,858 along with cost: benefit ratio 8.16 followed by Rs. 7,27,738 in 50 % NPK + 50 % pig manure + biofertilizers ($T_{11}$). This might be due to lower cost of input and higher yield. All the INM treatments recorded higher returns as compared to control. Earlier researchers too have recorded higher profit with 50% NPK + 50% FYM + biofertilizers in tomato (4), radish (12) and king chilli (13).

## Conclusion

It is concluded that the optimum production and quality of capsicum with higher monetary returns can be obtained with integrated application of 50% NPK + 50% FYM + biofertilizers. This integrated nutrient management saved about 50% of chemical fertilizers without any reduction in yield and quality parameters of capsicum.

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**Table 1:- Effect of INM treatments on quality of capsicum cv. California wonder under low cost of polyhouse condition.**

| Treatments | Fruit yield (t $ha^{-1}$) | Vitamin C (mg $100^{-1}$g) | TSS ($^{o}$Brix) |
|---|---|---|---|
| $T_1$ | 7.89 | 86.04 | 7.10 |
| $T_2$ | 22.48 | 97.21 | 7.60 |
| $T_3$ | 10.88 | 95.18 | 7.43 |
| $T_4$ | 9.44 | 92.73 | 7.39 |
| $T_5$ | 13.44 | 108.15 | 7.73 |
| $T_6$ | 18.41 | 114.20 | 7.91 |
| $T_7$ | 16.63 | 111.04 | 7.81 |
| $T_8$ | 19.33 | 117.00 | 8.06 |
| $T_9$ | 29.70 | 126.31 | 9.55 |
| $T_{10}$ | 24.74 | 120.88 | 8.43 |
| $T_{11}$ | 29.00 | 123.23 | 8.77 |
| SEm ± | 1.09 | 0.24 | 0.03 |
| CD at 5% | 3.43 | 0.81 | 0.09 |

**Table 2:- Effect of INM treatments on the nutrient status of the soil after harvest of capsicum cv. California wonder under low cost polyhouse condition**

| Treatments | Available N ($kg\ ha^{-1}$) | Available P ($kg\ ha^{-1}$) | Available K ($kg\ ha^{-1}$) | Organic carbon (%) | Soil pH |
|---|---|---|---|---|---|
| $T_1$ | 251.56 | 8.69 | 179.21 | 1.76 | 4.98 |
| $T_2$ | 326.64 | 11.49 | 209.27 | 1.83 | 5.11 |
| $T_3$ | 261.18 | 10.39 | 192.38 | 1.98 | 5.08 |
| $T_4$ | 266.78 | 11.28 | 198.42 | 1.84 | 5.09 |
| $T_5$ | 276.38 | 9.89 | 186.63 | 1.81 | 5.07 |
| $T_6$ | 277.13 | 10.32 | 218.75 | 1.78 | 5.14 |
| $T_7$ | 274.25 | 11.86 | 224.19 | 1.76 | 5.12 |
| $T_8$ | 286.56 | 12.82 | 226.46 | 1.51 | 5.17 |
| $T_9$ | *291.65* | 15.48 | 253.04 | 2.19 | 5.25 |
| $T_{10}$ | 289.43 | 14.75 | 232.24 | 2.03 | 5.19 |
| $T_{11}$ | 281.39 | 14.61 | 228.32 | 2.01 | 5.15 |
| SE (m)± | 1.19 | 0.08 | 4.63 | 0.07 | 0.03 |
| CD 5% | 4.10 | 0.31 | 15.91 | 0.23 | 0.12 |

**Table 3:- Effect of INM treatments on the economics of capsicum cv. California wonder under low cost polyhouse condition.**

| Treatments | Fixed cost (Rs $ha^{-1}$) | Treatment cost (Rs $ha^{-1}$) | Total cost (Rs $ha^{-1}$) | Fruit yield (t $ha^{-1}$) | Gross income (Rs $ha^{-1}$) | Net income (Rs $ha^{-1}$) | Cost benefit ratio |
|---|---|---|---|---|---|---|---|
| $T_1$ | 88500 | - | 88500 | 7.89 | 236700 | 148200 | 1.67 |
| $T_2$ | 88500 | 7424 | 95924 | 22.48 | 674430 | 578506 | 6.03 |
| $T_3$ | 88500 | 10000 | 98500 | 10.88 | 326640 | 228140 | 2.32 |
| $T_4$ | 88500 | 9000 | 97500 | 9.44 | 283320 | 185820 | 1.90 |
| $T_5$ | 88500 | 100000 | 188500 | 13.44 | 403320 | 214820 | 1.14 |
| $T_6$ | 88500 | 8712 | 97212 | 18.41 | 552210 | 454998 | 4.68 |
| $T_7$ | 88500 | 8212 | 96712 | 16.63 | 498900 | 402188 | 4.16 |
| $T_8$ | 88500 | 53712 | 142212 | 19.33 | 579990 | 437778 | 3.08 |
| $T_9$ | 88500 | 8762 | 97262 | 29.70 | 891120 | 793858 | 8.16 |
| $T_{10}$ | 88500 | 8262 | 96762 | 24.74 | 742230 | 645468 | 6.67 |
| $T_{11}$ | 88500 | 53762 | 142262 | 29.00 | 870000 | 727738 | 5.11 |