

Original Research Article

Effect of ~~different sources of nutrients~~ integrated nutrient management (INM) on fruit yield, quality, soil nutrient status and economics of capsicum production ~~cv. California wonder~~ under low cost of polyhouse condition

ABSTRACT

The field experiment was conducted during 2010–2011 at the Experimental Farm of School of Agricultural Sciences and Rural Development (SASRD), Medziphema Campus, Nagaland University, 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. There were 11 treatments comprising different sources of nutrients and their combinations. The experiment was laid out in a randomized block design with three replications. The treatments consisted of T₁ – Control, T₂ – 100% NPK (100:60:60 kg ha⁻¹), T₃ – FYM @ 20 t ha⁻¹, T₄ – Pig manure @ 15 t ha⁻¹, T₅ – Vermicompost @ 10 t ha⁻¹, T₆ – 50% NPK + 50% FYM, T₇ – 50% NPK + 50% Pig manure, T₈ – 50% NPK + 50% Vermicompost, T₉ – 50% NPK + 50% FYM + Biofertilizers, T₁₀ – 50% NPK + 50% Pig manure + Biofertilizers, T₁₁ – 50% NPK + 50% Vermicompost + Biofertilizers. Results revealed that 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°Brix) and vitamin C (126.31 mg 100⁻¹g) were recorded with the conjoint combined application of 50% NPK + 50% FYM + Biofertilizers. There ~~is was~~ a significant build up of organic carbon in the soil after harvest of the crop with 50% NPK + 50% FYM + Biofertilizers. ~~The same treatment also produced~~ It also recorded the highest net return of Rs. 7,93,858/ha.00 along with a cost benefit ratio of 1:8.16. ~~These~~ The results ~~suggested~~ 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. ~~These~~ This integrated nutrient management results also saved about 50% of chemical fertilizers without any ~~compromise on~~ reduction in yield and quality parameters of capsicum.

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Keywords: Capsicum, chemical fertilizer, organic manures, biofertilizers, quality, and economics.

Introduction

Capsicum (*Capsicum annum* L.) belongs to family solanaceae is highly priced vegetable rich in minerals and vitamins. It is grown extensively in the cooler regions of the country. In plains, it is grown as winter crop in plains and as summer crop in higher altitudes, grown as summer crop during March-April (2011). Cultivation of capsicum in Nagaland has been started only recently. Demand of for capsicum in Nagaland is very high and present production is not sufficient to meet the market demand of market. Among various factors of capsicum production, nutrient management is very essential for maintaining higher production and improved soil fertility. The increasing use of chemical fertilizers to increase in increasing vegetable production has been widely recognized but its long run impact on soil health, ecology and other natural resources are detrimental which affect to living organisms including beneficial soil microorganism and human being health. The cost of chemical fertilizers is also increasing day by day. Therefore, there is a need to reduce dependency on chemical fertilizers in align with for sustainable production are vital issues in modern day agriculture, which it is only possible through integrated nutrient management (INM). Besides fertilizers, there are several sources of plant nutrients like organic manures, biofertilizers etc. which apart from manuring supplying nutrients also improve overall soil productivity 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 Al aluminum temporarily by forming complex and provides creates better environment for

growth and development in addition to improvement in physical, chemical and biological properties of soil (4). Biofertilizers ~~have are~~ also ~~emerged~~ promising components of nutrient supply system. ~~Application of b~~ Biofertilizers ~~which is~~ are environment friendly, ~~and low cost input, with organic~~ and ~~in combination with~~ inorganic fertilizers ~~as part of an~~ integrated nutrient management strategy ~~and~~ 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 favourable for capsicum cultivation. But no information is available about ~~the~~ integrated nutrient management ~~of in~~ capsicum in north eastern region including acidic soils of Nagaland in particular. ~~Keeping all these points in~~ ~~view, of the above, the present~~ this investigation was ~~conducted~~ ~~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, ~~campus, Nagaland University,~~ Nagaland. ~~The field is~~ experimental site was located at 20° 45' 43" N latitude and 93° 53' 04" E longitudes at ~~the an~~ altitude of 304.8 m above mean sea level, ~~with geographical location at 20° 45' 43" N latitude and 93° 53' 04" E longitudes.~~ The soil of the experimental site ~~is was~~ sandy loam, ~~acidic in reaction having soil pH (pH~~ 4.9), ~~high in~~ organic carbon (1.85-%) ~~and with~~ available N, P ~~and~~ K ~~of is~~ 296.43, 19.73 and 248.76 kg ha⁻¹, respectively. ~~The treatments consisted of – control (T₁), 100% NPK (100:60:60 kg ha⁻¹) (T₂), FYM @ 20 t ha⁻¹ (T₃), pig manure @ 15 t ha⁻¹ (T₄), vermicompost @ 10 t ha⁻¹ (T₅), 50% NPK + 50% FYM (T₆), 50% NPK + 50% pig manure (T₇), 50% NPK + 50% vermicompost (T₈), 50% NPK + 50%~~

FYM + biofertilizers (T₉), 50% NPK + 50% pig manure + biofertilizers (T₁₀) and 50% NPK + 50% vermicompost + biofertilizers (T₁₁). The experiment was laid out in a randomized block design with three replications. The experimental plants Plot size measured 2.4 m x 2.4 m and a spacing was maintained at of 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 2nd November, 2010. The treatments consisted of T₁ Control, T₂ 100% NPK (100:60:60 kg ha⁻¹), T₃ FYM @ 20 t ha⁻¹, T₄ Pig manure @ 15 t ha⁻¹, T₅ Vermicompost @ 10 t ha⁻¹, T₆ 50% NPK + 50% FYM, T₇ 50% NPK + 50% Pig manure, T₈ 50% NPK + 50% Vermicompost, T₉ 50% NPK + 50% FYM + Biofertilizers, T₁₀ 50% NPK + 50% Pig manure + Biofertilizers, T₁₁ 50% NPK + 50% Vermicompost + Biofertilizers. N, P and K were given through in the form of Ureaurea, SSP single super phosphate and MOP murriate 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 doses splits ie at 30 and 60 days after transplanting. Organic Mmanures viz., FYM, pig manure and vermicompost were incorporated as per treatment in respective plots 20 days before to transplanting. Biofertilizers (*Azospirillum* and *Phosphotica*) were inoculated to seedling prior to transplanting as by dipping the seedlings dip methods biofertilizer solution @ 2 kg ha⁻¹. Observations on TSS and vitamin C were recorded at harvesting. 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 100⁻¹g.

Soil samples were collected before transplanting and after harvest of crop from different locations of the treatment-wise from experimental plot to a depth of 15 cm with the help of screw type auger. The collected soil samples were mixed and reduced into 500 g and

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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 ~~which were determined by Digital-digital~~ pH meter, Walkley and Black Rapid titration method, ~~Alkaline alkaline~~ potassium permanganate method, Olsen's method, ~~Flame-flame~~ photometer method, respectively (7). The statistical analysis ~~of the~~ -was carried out as per ~~standard~~ procedure ~~given by~~ (10).

Economics of the treatments ~~were was also~~ calculated as per ~~the~~ prevailing market price of ~~cost of cultivation,~~ inputs and output. ~~Treatment wise economics was carried out by calculating the cost of cultivation based on prevailing rate of input and outputs.~~ Gross income was calculated by ~~multiplying~~ yield ~~multiplied~~ with whole sale rate of capsicum (Rs. 30,000 ton⁻¹). Net income was estimated by deducting the total cost of cultivation (~~fixed cost + treatment cost~~) from gross income of the particular treatment. Cost-benefit ratio was worked out by dividing ~~net-gross~~ return from total cost of cultivation.

Results and Discussion

Quality characters:

Quality of capsicum ~~is was usually~~ evaluated by ~~total soluble solids (TSS)~~ and vitamin C. ~~It is evident from table 1 that~~The maximum values of TSS (9.55° Brix) and vitamin C (126.31 mg 100⁻¹g) were recorded with 50 % NPK + 50 % FYM + biofertilizers (T₉) (Table 1). The comparative higher level of both TSS and vitamin C ~~and upon treatments~~ with ~~INM~~integration may be due to action of specific soil nutrients which

~~may be were~~ made more readily available ~~into soil~~ for plant absorption, ~~as a result of~~ Integration of mineral fertilizers ~~alone and~~ organic manure with or without biofertilizers ~~integrating effect which in turn~~ may activate specific enzymes for the synthesis of these compounds. ~~(8) recorded.~~ The maximum ascorbic acid content (14.69 mg 100⁻¹g) with application of NPK + FYM + *Azospirillum* + *Phosphotica* in brinjal has also been observed (8). These findings are in agreement with the earlier reports (4 and 13), ~~they showing recorded~~ maximum content of TSS in tomato and vitamin C in king chilli ~~content~~ with 50% NPK + 50% FYM + biofertilizers, in tomato and king chilli, respectively.

Soil Fertility Change

~~Sustainability of a cropping system is being evaluated on the basis of crop yield as well as nutrient status of the soil after harvest of the crop.~~ 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 ~~treatment~~ 100% NPK (T₂), ~~which This might may~~ be ~~due 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 ~~was~~ reported by earlier (13) ~~who reported that~~ indicating that application of 100% NPK fertilizers alone ~~was~~ recorded maximum available nitrogen in soil after harvest. ~~On the other hand,~~ The maximum available P₂O₅-P (15.48 kg ha⁻¹) and K₂O-K (253.04 kg ha⁻¹) were recorded with 50 % NPK + 50 % FYM + biofertilizers (T₉). FYM application ~~which might be might have~~ reduced the solubility of Al-aluminum and Fe-iron and improved the CEC of the soil ~~and thus~~ which inturn increased the retention of K in exchangeable form by a mass action effect. ~~Organic carbon of soil acts as a sink and source~~

~~of nutrients for microbial population, which regulates the availability of different nutrients through microbial transformation.~~ The net increase in organic carbon was ~~much~~ higher with organic manures in combination with biofertilizers and fertilizers over 100% NPK alone. Application of 50% NPK + 50 % FYM + biofertilizers (T₉) recorded significantly higher soil organic carbon (2.19 %) and soil pH (5.25) over other treatments. This ~~may~~ ~~might~~ be due to increased microbial activities in the root zone which decomposed organic manures and also ~~fixed~~ ~~transformed~~ unavailable form of mineral nutrients into available forms in soil thereby substantiated crop requirements and improved organic carbon level and stabilized soil pH. ~~(5) reported that~~ ~~It has been reported that~~ (5) incorporation of biofertilizers and FYM with inorganic fertilizers significantly improved the organic carbon content and available N, ~~P₂O₅~~ ~~P~~ and ~~K₂O~~ ~~K~~ status ~~of in~~ the soil in tomato. Similar results were also reported ~~by (12) and (13)~~ in radish (12) and king chilli (13), ~~respectively.~~

Economics of treatments

~~It is evident from table 3 that~~ ~~the~~ integration of 50% NPK + 50 % FYM + biofertilizers (T₉) ~~was found to be the most profitable treatment in capsicum exhibiting~~ recorded the highest net return of Rs. 7,93,858 along with cost-benefit ratio ~~4~~:8.16 followed by Rs. 7,27,738 in ~~the treatment~~ 50 % NPK + 50 % ~~Pig-pig~~ manure + biofertilizers (T₁₁). This might be due to lower cost of input and higher yield. ~~All the INM treatments most all the treatment exhibited~~ recorded better-higher returns in as comparison compared to control. ~~These findings are in accordance with (4, 12 and 13), they~~ Earlier researchers too have recorded the ~~maximum~~ higher profit in the treatment with 50% NPK + 50% FYM + biofertilizers in tomato (4), radish (12) and king chilli (13), ~~respectively.~~

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UNDER PEER REVIEW

Table 1:— Effect of different sources of manuring INM treatments on quality of capsicum of capsicum cv. California wonder under low cost of polyhouse condition

Treatments	TSS (⁰ Brix)	Vitamin C (mg 100 ⁻¹ g)
T ₁ -Control	7.10	86.04
T ₂ 100% NPK (100:60:60 kg ha ⁻¹)	7.60	97.21
T ₃ FYM 20 t ha ⁻¹	7.43	95.18
T ₄ Pig manure 15 t ha ⁻¹	7.39	92.73
T ₅ Vermicom post 10 t ha ⁻¹	7.73	108.15
T ₆ 50% NPK + 50% FYM	7.91	114.20
T ₇ 50% NPK + 50% Pigmanure	7.81	111.04
T ₈ 50% NPK + 50% Vermicom post	8.06	117.00

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T ₉ -50% NPK + 50% FYM + Biofertilize rs	9.55	126.31
T ₁₀ -50% NPK + 50% Pigmanure + Biofertilize rs	8.43	120.88
T ₁₁ -50% NPK + 50 % Vermicom post + Biofertilize rs	8.77	123.23
S-E(m)± ±	0.03	0.24
CD at 5%	0.09	0.81

UNDER PEER REVIEW

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

Treatments	Available N (kg ha ⁻¹)	Available P ₂ O ₅ P (kg ha ⁻¹)	Available K ₂ O K (kg ha ⁻¹)	Organic carbon (%)	Soil pH
T ₁ Control	251.56	8.69	179.21	1.76	4.98
T ₂ 100% NPK (100:60:60 Kg ha ⁻¹)	326.64	11.49	209.27	1.83	5.11
T ₃ FYM 20 t ha ⁻¹	261.18	10.39	192.38	1.98	5.08
T ₄ Pig manure 15 t ha ⁻¹	266.78	11.28	198.42	1.84	5.09
T ₅ Vermicompost 10 t ha ⁻¹	276.38	9.89	186.63	1.81	5.07
T ₆ 50% NPK + 50% FYM	277.13	10.32	218.75	1.78	5.14
T ₇ 50% NPK + 50% Pigmanure	274.25	11.86	224.19	1.76	5.12
T ₈ 50% NPK + 50 % Vermicompost	286.56	12.82	226.46	1.51	5.17
T ₉ 50% NPK + 50% FYM + Biofertilizers	291.65	15.48	253.04	2.19	5.25
T ₁₀ 50% NPK + 50% Pigmanure + Biofertilizers	289.43	14.75	232.24	2.03	5.19
T ₁₁ 50% NPK + 50 % Vermicompost + Biofertilizers	281.39	14.61	228.32	2.01	5.15
SEm ±SE (m)±	1.19	0.08	4.63	0.07	0.03
CD at 5%	4.10	0.31	15.91	0.23	0.12

Table 3. Effect of different sources of manure and INM treatments on the economics of on quality of capsicum cv. California wonder under low cost of polyhouse condition on the economics of the treatments

Treatments	Fixed cost (Rs. ha ⁻¹)	Treatments 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 -Control	88500	-	88500	7.89	236700	148200	±1.67
T ₂ -100% NPK (100:60:60 kg ha ⁻¹)	88500	7424	95924	22.48	674430	578506	±6.03
T ₃ -Farm Yard Manure 20 t ha ⁻¹	88500	10000	98500	10.88	326640	228140	±2.32
T ₄ -Pig manure 15 t ha ⁻¹	88500	9000	97500	9.44	283320	185820	±1.90
T ₅ -Vermicompost 10 t ha ⁻¹	88500	100000	188500	13.44	403320	214820	±1.14
T ₆ -50% NPK + 50% FYM	88500	8712	97212	18.41	552210	454998	±4.68
T ₇ -50% NPK + 50% Pigmanure	88500	8212	96712	16.63	498900	402188	±4.16
T ₈ -50% NPK + 50% Vermicompost	88500	53712	142212	19.33	579990	437778	±3.08
T ₉ -50% NPK + 50% FYM + Biofertilizers	88500	8762	97262	29.70	891120	793858	±8.16
T ₁₀ -50% NPK + 50% Pigmanure + Biofertilizers	88500	8262	96762	24.74	742230	645468	±6.67
T ₁₁ -50% NPK + 50% Vermicompost + Biofertilizers	88500	53762	142262	29.00	870000	727738	±5.11

<u>SEm ±</u>							
<u>CD at 5%</u>							

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