Original Research Article

Study the effect of integrated nutrient management on the quality of capsicum (*Capsicum annum* L.) under low cost polyhouse condition.~~Effect of different sources of nutrient on quality, soil nutrient status and economics of capsicum 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, 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. The experiment was laid out in a randomized block design with three replications. The treatments consisted of T_1 - Control, T_2- 100% NPK (100:60:60 kg ha^{-1}), T_3 - FYM @ 20 t ha^{-1}, T_4 - Pig manure @ 15 t ha^{-1}, T_5 - Vermicompost @ 10 t ha^{-1}, T_6 - 50% NPK + 50% FYM, T_7 - 50% NPK + 50% Pig manure, T_8 - 50% NPK + 50% Vermicompost, T_9 - 50% NPK + 50% FYM + Biofertilizers, T_{10} - 50% NPK + 50% Pig manure + Biofertilizers, T_{11} - 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 ^{o}Brix) and vitamin C (126.31 mg 100^{-1}g) were recorded with the conjoint application of 50% NPK + 50% FYM + Biofertilizers. There is a significant ~~build up~~build-up of organic carbon in the soil after harvest of the crop with 50% NPK + 50% FYM + Biofertilizers. The same treatment also produced the highest net return of Rs. 7, 93,858.00 along with cost benefit ratio 1:8.16. These results suggested that the optimum production of capsicum can be obtained with integrated application of 50% NPK + 50% FYM + Biofertilizers. These results also saved about 50% of chemical fertilizers without any compromise on yield and quality parameters of capsicum.

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

Comment [M1]: It is necessary to arrange all the contents according to the instructions of the journal and to observe the arrangement of the contents.

Comment [M2]: It is better to use words that are not in the title.

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 country. In plains, it is grown as winter crop and in higher altitudes, grown as summer crop during March-April (2011). Cultivation of capsicum in Nagaland has been started recently. Demand of capsicum in Nagaland is very high and present production is not sufficient to meet the demand of market. Among various factors of capsicum production, nutrient management is very essential for maintaining higher production and soil fertility. The increasing use of chemical fertilizers to increase vegetable production has been widely recognized but its long run impact on soil health, ecology and other natural resources are detrimental which affect living organisms including beneficial soil microorganism and human being. The cost of chemical fertilizers is also increasing day by day. Therefore, to reduce dependency on chemical fertilizers in align with sustainable production are vital issues in modern agriculture which is only possible through integrated nutrient management. Besides fertilizers, there are several sources of plant nutrients like organic manures, biofertilizers which apart from manuring also improve overall soil productivity (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 temporarily by forming complex and provides better environment for growth and development in addition to improvement in physical, chemical and biological properties of soil (4). Biofertilizers have also emerged promising components of nutrient supply system. Application of biofertilizers which is environment friendly and low cost input, with organic and 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 capsicum in north eastern region including acidic soils of Nagaland in particular. View of the above, the present investigation was conducted 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 located at the altitude of 304.8 m above mean sea level with geographical location at 20º 45' 43" N latitude and 93º 53' 04" E longitudes. The soil of the experimental site is sandy loam having soil pH 4.9, organic carbon 1.85 % and available NPK 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. Plot size measured 2.4 m x 2.4 m and spacing was maintained at 60 x 45 cm. Thirty days old healthy seedlings with uniform vigour and height were transplanted on 2 nd November, 2010. The treatments consisted of T_1 - Control, T_2 - 100% NPK (100:60:60 kg ha^{-1}), T_3 - FYM @ 20 t ha^{-1}, T_4 - Pig manure @ 15 t ha^{-1}, T_5 - Vermicompost @ 10 t ha^{-1}, T_6 - 50% NPK + 50% FYM, T_7 - 50% NPK + 50% Pig manure, T_8 - 50% NPK + 50% Vermicompost, T_9 - 50% NPK + 50% FYM + Biofertilizers, T_{10} - 50% NPK + 50% Pig manure + Biofertilizers, T_{11} - 50% NPK + 50% Vermicompost + Biofertilizers. N, P and K were given through Urea, SSP and MOP 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 *ie*. 30 and 60 days after transplanting. Manures viz., FYM, pig manure and vermicompost were incorporated as per treatment in respective plot 20 days before to transplanting. Biofertilizers (*Azospirillum* and *Phosphotica*) were inoculated to seedling prior to transplanting as seedling dip methods @ 2 kg ha^{-1}. Observations on TSS and vitamin C were recorded at harvesting. Total soluble solid was determined using hand refractometer and results expressed in ºbrix. 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 and after harvest of crop from different locations of the 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 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 pH meter, Walkley and Black Rapid titration method, Alkaline potassium permanganate method, Olsen's method, Flame photometer method, respectively (7). The statistical analysis was carried out as per procedure given by (10).

Economics of the treatments were also calculated as per prevailing market price of input 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 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 return from total cost of cultivation.

Results and Discussion

Quality characters:

Quality of capsicm is usually evaluated by TSS and vitamin C. It is evident from table-1 that 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). The comparative higher level of both TSS and vitamin C and upon treatments with integration may be due to action of specific soil nutrients which may be made more readily available into soil for plant absorption as a result of mineral fertilizers + lone organic manure or with biofertilizers integrating effect which in turn may activate specific enzymes for the synthesis of these compounds. (8) recorded maximum ascorbic acid content (14.69 mg 100^{-1}g) with application of NPK + FYM + *Azospirillum* + *Phosphotica* in brinjal. These findings are in agreement with (4 and 13), they recorded maximum TSS and vitamin C 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 NPK, organic carbon and pH in soil after harvest were significantly influenced by application of NPK 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 (T_2) which might be due to poor soil physical structure, lack of organic manures and microbial activities, thus resulting in poor utilization of nitrogen by plants. Similar result was reported by (13) who reported that application of 100% NPK fertilizers alone was recorded maximum available nitrogen in soil after harvest. On the other hand, maximum available P_2O_5 (15.48 kg ha^{-1}) and K_2O (253.04 kg ha^{-1}) were recorded with 50 % NPK + 50 % FYM + biofertilizers (T_9). FYM application which might be reduced solubility of Al and Fe and improved the CEC of the soil and thus 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 (T_9) recorded significantly higher soil organic carbon (2.19 %) and soil pH (5.25) over other treatments. This may be due to increased microbial activities in the root zone which decomposed organic manures and also fixed 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 incorporation of biofertilizers and FYM with inorganic fertilizers significantly improved the organic carbon content and available N, P_2O_5 and K_2O status of the soil in tomato. Similar results were also reported by (12) and (13) in radish and king chilli, respectively.

Economics of treatments

It is evident from table-3 that the integration of 50% NPK + 50 % FYM + biofertilizers (T_9) was found to be the most profitable treatment in capsicum exhibiting highest net return of Rs. 7,93,858 along with cost benefit ratio 1:8.16 followed by Rs. 7,27,738 in the treatment 50 % NPK + 50 % Pig manure + biofertilizers (T_{11}). This might be due to lower cost of input and higher yield. Almost all the treatment exhibited better return in comparison to control. These findings are in accordance with (4, 12 and 13), they recorded the maximum profit in the treatment 50% NPK + 50% FYM + biofertilizers in tomato, radish and king chilli, respectively.

Comment [M3]: There is a need for more references and more analysis of the results in this section.
The conclusion section should also be added.

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Table 1: Effect of different sources of manuring 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-} Vermicompost 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 % Vermicompost	8.06	117.00
T_9 -50% NPK + 50% FYM + Biofertilizers	9.55	126.31
T_{10} -50% NPK + 50% Pigmanure + Biofertilizers	8.43	120.88
T_{11}-50% NPK + 50 % Vermicompost + Biofertilizers	8.77	123.23
S.E(m)±	0.03	0.24
CD at 5%	0.09	0.81

Table 2: Effect of different sources of manuring 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_2O_5 (kg ha^{-1})	Available K_2O (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
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 different sources of manurieng on quality of capsicum of capsicum cv. California wonder under low cost of polyhouse condition on the economics of the treatments

Treatments	Fixed cost (Rs ha^{-1})	Treatments 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	1:1.67
T_{2}- 100% NPK (100:60:60 kg ha^{-1})	88500	7424	95924	22.48	674430	578506	1:6.03
T_{3}- Farm Yard Manure 20 t ha^{-1}	88500	10000	98500	10.88	326640	228140	1:2.32
T_{4}- Pig manure 15 t ha^{-1}	88500	9000	97500	9.44	283320	185820	1:1.90
T_5 -Vermicompost 10 t ha^{-1}	88500	100000	188500	13.44	403320	214820	1:1.14
T_6 -50% NPK + 50% FYM	88500	8712	97212	18.41	552210	454998	1:4.68
T_7-50% NPK + 50% Pigmanure	88500	8212	96712	16.63	498900	402188	1:4.16
T_8 -50% NPK + 50 % Vermicompost	88500	53712	142212	19.33	579990	437778	1:3.08
T_9 -50% NPK + 50% FYM + Biofertilizers	88500	8762	97262	29.70	891120	793858	1:8.16
T_{10} -50% NPK + 50% Pigmanure + Biofertilizers	88500	8262	96762	24.74	742230	645468	1:6.67
T_{11}-50% NPK + 50 % Vermicompost + Biofertilizers	88500	53762	142262	29.00	870000	727738	1:5.11