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Effect of lime and organic manures on yield and quality of tomato and capsicum grown under protected condition in the mid-hills of Meghalaya

Veerendra Kumar Verma, Bibhash Chandra Verma and Anjani Kumar Jha

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Abstract

Among the vegetable crops, tomato and capsicum are the major crops grown under protected cultivation. Due to high rainfall, the soil of north eastern region of India is acidic in nature and deficient in essential nutrients such as calcium and magnesium by leaching and phosphorous by fixation. Therefore, productivity and quality of the produce is very poor. The mild weather of the north eastern region provides a better option for year-round production of these crops under protected conditions to get the good market price with higher yield and superior quality. With this background, a field experiment was conducted for consecutive two years (2011-2013) to study the effect of lime and organic manures with fertilizers on growth, yield and quality attributes in tomato and capsicum grown under low cost polyhouse with the objective to develop the suitable integrated nutrient management package for tomato - capsicum cropping sequence under protected condition. The highest yield and good quality fruits of tomato (72.6 t/ha) and capsicum (45.80 t/ha) was recorded with the application of NPK (60:60:60 kg/ha) + vermicompost (5 t/ha) + lime (2.5 q/ha) in tomato and 60:60:60 (kg/ha) NPK + vermicompost (5 t/ha) in capsicum. However, from economic analysis of cropping sequence, the highest net income (₹ 13, 91,871 / ha), and BC ratio (2.7) was recorded from the treatment comprises of NPK (60:60:60 kg/ha) + vermicompost (5t/ha) + lime followed by NPK (60:60:60 kg/ha) + pig manure (10t/ha) + lime. Hence, application of lime and vermicompost with fertilizers could be a suitable INM practices to get the maximum output in terms of yield and quality.

Key words: Tomato, capsicum, protected cultivation, organic manure, lime, yield and quality

Introduction

Tomato and capsicum are the leading high value and widely grown vegetable crops under protected condition. These crops have been playing a vital role in nutritional and livelihood security across the world. In north eastern parts of India, they are mostly grown as a single crop during spring summer hence, the availability of produce in the remaining period is scarce and the consumers totally depends on the produce coming from the mainland as a result paying high price. The mild weather of the region, especially mid-hills provide a better option for year-round/off season production of these crops under protected conditions to meet the demand of the market. There will be several factors which govern the yield and quality of tomato and capsicum, among them soil fertility is one of the major factors and plays an important role to determine the yield and quality of tomatoes (Murmu et al. 2013) and capsicum (Appireddy et al. 2008). The yield and quality of the produce in this region are poor due to low soil fertility, which is the result of leaching and fixation of the nutrients as well limited application of manures and fertilizers. Farmers of this region generally depend on the organic inputs (locally available) as they are resource poor and they do not apply or apply very rarely/less chemical fertilizers. However different works suggested that Organic manures alone will not meet the nutritional needs of crops during the crop growth period because they contain a comparatively less quantity of nutrients compared to inorganic fertilizers and need more time for the mineralization of those nutrients, which also depend on several biotic and abiotic factors, hence there is a need to integrate the two forms in order to achieve better nutrient supply and crop yields. Further, use of chemical fertilizer alone also increase the crop yield but adversely affect the sustainability of the ecosystem subsequently. The excessive/ inappropriate use of chemical fertilizers leads to environmental pollution hence, inclusion of organic manures with inorganic sources of nutrient is very essential to provide the nutrients to crop as well as to maintain the environment and ecosystem. It is found that integrated nutrient management had a significant positive effect on yield and quality of the produce

ICAR Research Complex for NEH Region, Umroi Road, Umiam-793103, Meghalaya
Corresponding author, Email: verma.veerendra@gmail.com

(Appireddy et al. 2008, Singh et al. 2010 and Singh et al. 2015). The soil of this region is acidic in nature having low pH which reduces the availability of nutrients particularly P, Ca etc. It was reported that application of lime improves the availability of these nutrients (Tadeusz 2011). Improvement in the availability of nutrients leads to better yield (Asiegbu and Uzo 1983) and quality (shelf life) of fruit and minimizes the incidence of blossom end rot (Taylor and Lucascio 2004) and bacterial wilt (Yamazaki et al. 2000) also. However, the positive impact of lime as well as INM is well documented in the literature, however there is very little information on the effect of liming and integrated nutrient management in the production system of tomato and capsicum under protected condition is available so far for the north eastern region of India. This information will be very helpful for the boosting the production of tomato and capsicum in the off season to improve the income of the north eastern farmer. Therefore, the present investigation was undertaken to study the effect of lime and different sources of organic manures, in an integrated approach, on the yield and quality attributes of tomato and capsicum cropping system under low-cost polyhouse.

Materials and Methods

The experiment was conducted under protected structure (low cost polyhouse) for consecutive two years (2011-12 and 2012-13) at the Horticulture Experimental Farm, ICAR Research Complex for NEH Region, Umiam Meghalaya using indeterminate tomato (cv. Megha Tomato-3) and capsicum (cv. California Wonder) grown in sequence. The experimental site is located at the 960m above mean sea level (MSL) and average day/night temperature under the polyhouse ranged 22-27^{0}C/15-20^{0}C and relative humidity 47-68%. The experimental soil was sandy loam in texture with acidic reaction (pH: 5.4). The bulk density, soil organic carbon, available N, P, K, Ca and Mg were 1.46g/cc, 2.19%, 187kg/ha, 20.19kg/ha, 300kg/ha, 2.37 meq/100g and 0.66 meq/100g, respectively.

Tomato was grown during July - January followed by capsicum (February - June) under the low cost polyhouse/protected structure fabricated by using of bamboo frames for support, UV films (200µ thickness) as rain shelter and surrounding is covered by insect proof nets (40 mesh). The 30 days old seedlings of tomato and capsicum were transplanted in double row system at 60 x 45cm and 50 x 30cm spacing, respectively. The seedlings were irrigated immediately after transplanting and further as per the requirements during the entire crop period. The plants were trained into two stem system. The experiment was laid down in three replications having eleven treatment combinations of different sources of organic manure and ½ of recommended dose of chemical fertilizer nitrogen. Full dosage of P and K was applied uniformly to all the treatments. The lime was applied only once before planting of tomato and other treatment combinations and applied plots were same for both the crops. T_1: Recommended dose of fertilizer (RDF) i.e., nitrogen (N), phosphorous (P) and potassium (K) @ 120: 60: 60 kg/ha, respectively, T_2: T_1 + lime (2.5q/ha), T_3: ½ of N + lime, T_4: ½ of N + poultry manure (5t/ha), T_5: T_4 + lime, T_6: ½ of N + pig manure (10t/ha), T_7: T_6 + lime, T_8: ½ of N + FYM (10 t/ha), T_9: T_8+ lime, T_{10}: ½ of N + vermicompost (5 t/ha), T_{11} : T_{10} + lime. Chemical fertilizers i.e., NPK were applied as urea, single super phosphate and muriate of potash for all the treatments. Full dosage of organic manures and lime was applied in pits 15 days before planting. Half dose of nitrogen and full dose of phosphorous and potassium were applied in pits before planting and the remaining half dose of nitrogen was applied in two split doses at 30 and 60 days after planting. The standard plant protection/ management measures were practiced throughout the crop period.

The observations for yield related attributes were taken from the six randomly selected plants in each replication. However, quality traits in tomato such as pericarp thickness (mm), fruit firmness (kg/cm^2), lycopene content (mg/100g), ascorbic acid (mg/100g), and total soluble solid (^{0}Brix), titrable acidity (%) were determined from the fully ripen fruits. In capsicum, the quality parameters were taken from fully mature fruits. All the measured attributes were determined by using the standards procedure. Vitamin-C and lycopene content was determined by the procedure suggested by Ranganna (1985). The observed data were analyzed using Statistical Tool for Agricultural Research (STAR) software and treatment means were separated for the significance by the Duncan Multiple Range Test (DMRT) at $P<0.05$ level of significance. For economic analysis, budgeting techniques and cost concepts (establishment of polyhouse cost, fixed cost, variable cost and total cost) and economic efficiency measure benefit – cost ratio was estimated. The establishment cost of low cost polyhouse was estimated as Rs. 16.0 lakh per hectare. The cost for polyhouse in each crop (^{1} 2.0 lakh per crop) was calculated based on the equated monthly installments (EMI) paid by the farmers at 9.25 percent interest rate. The interest on working capital was at 7 percent. The price of the produce was considered as the selling price of the farmers in whole sale market at Bara Bazaar in Shillong, Meghalaya.

Results and Discussion

In present investigation, the treatment combinations have shown statistically significant differences ($p < 0.05$) for the yield and quality attributes in tomato and capsicum grown under the protected condition (Table 1 and 2).

Effect on yield and quality attributes of tomato: In tomato except pericarp thickness all the observed traits have shown the statistically significant and positive response to the application of lime and organic manures (Table 1). For yield attributing traits the significant improvement was observed from treatment (T_2) comprised of fertilizers with lime over only fertilizers (T_1). Among the treatments the highest longitudinal diameter (4.6cm), equatorial diameter (4.9cm), fruit weight (78.9g), pericarp thickness (0.7cm), fruit firmness (1.9kg/cm^2), yield per plant (2.47kg) and plant height (163.7cm) was recorded from the treatment T_{11} - NPK (60:60:60 kg/ha) + vermicompost (5 t/ha) + lime followed by T_9 - NPK (60:60:60 kg/ha) + FYM (10 t/ha) + lime. Similarly, the estimated fruit yield per hectare calculated from the total yield per treatment was significantly higher viz. 75.24 and 70.0 t/ha during the year 2011-12 and 2012-13, respectively from treatment T_{11}. Further, from pooled analysis, the highest yield (72.6 t/ha) was also recorded from T_{11} followed by T_9 (67.1 t/ha), T_7 (65.4 t/ha) and both were statistically at par with T_{11} (Table 3). The higher growth and yield in tomato were also observed by the combination of organic and inorganic fertilizers by Singh *et al.* 2015 under protected condition.

The improvement in growth and yield attributes in the treatments comprises of organic manures, fertilizers and lime may be due to increase in the fertility status (soil available nutrients) and soil physical environment. Manure when decomposed increases both macro and micro nutrients as well as enhances the physical chemical and biological properties of the soil; this led to its higher vegetative growth and yield (Saidu et al. 2011). Singh et al. (2011) reported the positive effect of vermicompost on growth and yield attributes of French

Table 1. Effect of INM on yield attributes of tomato grown under protected condition

Treatments	Plant height (cm)	Longitudinal diameter (cm)	Equatorial diameter (cm)	Average fruit weight (g)	Pericarp thickness (cm)	Fruit firmness (kg/cm^2)	Yield per plant (kg)	Yield (t/ha)	
								2011-12	2012-13
T_1: RDF	142.0^{cd}	4.3^{ab}	3.6^{d}	44.8^{e}	0.6	1.3^{cd}	1.43^{cd}	43.56^{f}	42.0^{d}
T_2: T_1+lime	147.0^{bc}	4.6^{a}	4.4^{abc}	69.4^{abc}	0.7	1.4b^{cd}	1.69^{c}	51.48^{e}	42.12^{d}
T_3: 1/2 N + lime	124.7^{e}	3.2^{d}	4.4^{abc}	54.9^{cde}	0.6	1.3^{bcd}	1.17^{d}	35.64^{f}	26.25^{e}
T_4: 1/2 N+POM	140.0^{d}	3.4^{cd}	3.9^{bcd}	52.1^{de}	0.6	1.2^{d}	1.69^{bc}	51.48^{de}	43.75^{d}
T_5: T_4 + lime	151.0^{b}	4.4^{ab}	4.5^{abc}	73.1^{ab}	0.6	1.3^{cd}	2.08^{ab}	63.36^{cd}	59.50^{bc}
T_6: 1/2 N+PIM	135.7^{d}	3.5^{cd}	3.7^{cd}	60.1^{bcd}	0.6	1.7^{abc}	2.08^{ab}	63.36^{cd}	54.25^{c}
T_7: T_6 + lime	163.7^{a}	4.3^{ab}	4.2^{abcd}	63.6^{bcd}	0.7	1.8^{ab}	2.34^{a}	71.28^{ab}	59.50^{bc}
T_8: 1/2 N+FYM	142.0^{cd}	3.9^{bc}	4.6^{ab}	66.3^{abcd}	0.5	1.2^{d}	2.08^{ab}	63.36^{cd}	57.75^{bc}
T_9: T_8 + lime	149.7^{b}	4.3^{ab}	4.8^{a}	66.3^{abcd}	0.6	1.5^{abcd}	2.34^{a}	71.28^{ab}	63.00^{b}
T_{10}: 1/2 N+VC	138.0^{d}	3.6^{cd}	4.4^{abcd}	73.9^{ab}	0.5	1.6^{abcd}	2.08^{ab}	63.36^{cd}	57.75^{bc}
T_{11}: T_{10} + lime	163.7^{a}	4.6^{a}	4.9a	78.9^{a}	0.6	1.9^{a}	2.47^{a}	75.24^{a}	70.00^{a}
CV (%)	10.52	5.36	5.82	7.75	17.29	10.46	6.10	5.80	7.90
LSD (*P* <0.05)	6.53	0.36	0.73	14.61	NS	0.45	0.27	5.50	4.80

*Means with the same letter are not significantly different at P<0.05 (POM= Poultry manure; PIM=Pig manure and VC=Vermicompost)

Table 2. Effect of INM on yield attributes of capsicum grown under protected condition

Treatments	Plant height (cm)	Fruit weight (g)	No of fruits/plant	Longitudinal diameter (cm)	Equatorial diameter (cm)	Pericarp thickness (cm)	Yield per plant (kg)	Yield (t/ha)	
								2011-12	2012-13
T_1: RDF	42.1d	66.2bc	9.67abcd	6.48ab	5.16ab	0.463	0.47e	27.66e	30.0f
T_2: T_1+lime	52.5abc	74.1ab	11.00abc	6.07ab	5.37ab	0.433	0.60bcd	35.45cde	40.0b
T_3: 1/2 NPK + lime	42.3d	50.2d	8.00d	6.45ab	5.24ab	0.470	0.54cde	30.94de	33.74cde
T_4: 1/2 NPK+POM	48.2bcd	72.1ab	8.67cd	4.50d	4.49b	0.477	0.53de	32.25de	32.56e
T_5: T_4 + lime	52.3abc	75.7a	11.67ab	6.02abc	5.60ab	0.490	0.70ab	40.86ab	41.0b
T_6: 1/2 NPK+PIM	45.2bcd	58.2cd	9.33bcd	4.75cd	4.55b	0.470	0.53de	32.65de	31.58ef
T_7: T_6 + lime	53.6ab	76.7a	12.33a	5.47bc	5.46ab	0.430	0.59cd	46.18a	33.49cde
T_8: 1/2 NPK+FYM	44.0cd	71.7ab	9.33bcd	5.71abc	5.01ab	0.387	0.54cde	30.84de	33.19de
T_9: T_8 + lime	50.1abcd	75.7a	9.67abcd	6.44ab	5.35ab	0.427	0.63bc	37.90bcd	35.50c
T_{10}: 1/2 NPK+VC	49.7abcd	73.3ab	9.33bcd	5.05bcd	4.80ab	0.517	0.55cde	33.66cde	35.36cd
T_{11}: T_{10} + lime	57.3a	78.3a	12.33a	6.98a	5.80a	0.503	0.76a	44.10ab	47.50a
CV (%)	6.29	4.37	9.21	8.62	8.10	21.34	5.77	10.17	2.85
LSD (*P* <0.05)	9.05	9.04	2.75	1.46	1.21	NS	0.90	8.08	2.27

*Means with the same letter are not significantly different at P<0.05(POM= Poultry manure; PIM=Pig manure and VC=Vermicompost) bean. Further, application of lime enhances soil pH and increases the availability of nutrients particularly Ca and P. Calcium is important for the cell division and cell wall development. It is reported that accumulation of photosynthates is positively related to application of calcium and their availability (Oyewole et al. 1992). Significant effect of lime and organic manure has also been reported by Asiegbu et al. (1983); Mojeremane et al. (2016) in tomato.

The treatments have also shown significant effect on quality traits of the tomato. Among the treatments, the highest vitamin - C (18.3 mg) was recorded from T_5 - 60:60:60 kg/ha (NPK) + poultry manure (5 t/ha) + lime followed by T_{11} (17.8 mg/100g) and T_3 (17.3 mg/100g) and they were statistically at par. However, the highest lycopene content was recorded from T_{11} followed by T_{10} (Fig.1). Similarly, the highest TSS (6.7) and lowest acidity (0.4) was recorded from the treatment T_5- 60:60:60 kg (NPK) + poultry manure (5 t/ha) + lime followed by T_{11}, T_{10}, T_9, T_7 and they were statistically at par (Fig. 2). The increases in quality traits like, vitamin-C and TSS was also observed by Singh *et al.*, (2015) with the application of 50% fertilizers + 10 t/ha FYM + 5 t/ha poultry manure. The increases in the quality parameters may be due increase in the availability and

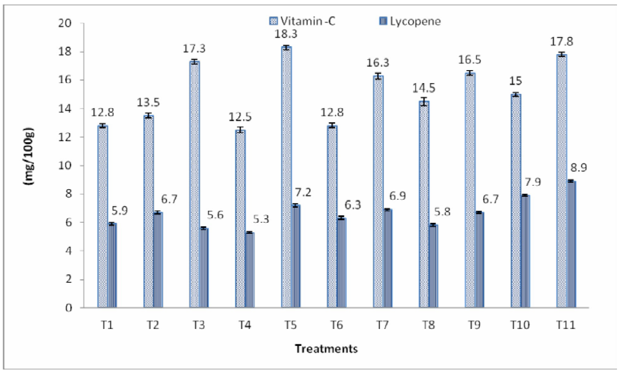

Fig. 1 Effect of integrated nutrient management on vitamin-c and lycopene content in tomato fruits

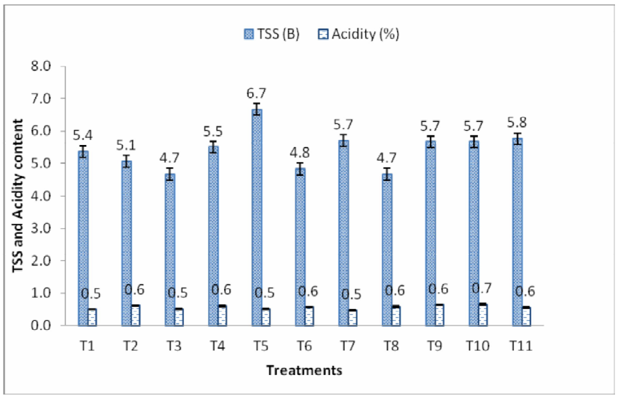

Fig. 2 Effect of integrated nutrient management on TSS and acidity of tomato fruits

uptake of the essential nutrient to the plants by the application of organic manure and lime. The positive correlation has been observed between Ca and Mg to vitamin - C under acidic soil (Abanto-Rodriguez et al. 2016). The higher TSS and vitamin- C was also observed by the application of Ca in strawberry (Khayyat et al. 2007). The superior quality of the tomato in treatment comprises of vermicompost and lime may be due positive effect of organic manure addition and increases in the availability of nutrients such as Ca, Mg and P due to lime application. Improvement in TSS of tomato by the application of vermicompost was also reported by Singh et al. (2013). Kazemi (2014) observed the increases in TSS, vitamin C and lycopene content in tomato by the application of Ca and humic acid.

Effect on yield and quality attributes of capsicum: Like tomato, capsicum has also shown significantly positive response to the application of lime and organic manures (Table 2). Significant improvement was observed for yield attributing traits from the treatment (T_2) comprised of fertilizers (T_1) with lime over fertilizers alone.

Among the treatments the highest longitudinal diameter (6.98 cm), equatorial diameter (5.80 cm), fruit weight (78.3 g), number of fruits/plant (12.33), yield per plant (0.76 kg) and plant height (57.3 cm) was recorded from the treatment T_{11}- 60:60:60 kg/ha (NPK) + vermicompost (5 t/ha) + lime followed by T_5- 60:60:60 kg/ha (NPK) + poultry manure (5 t/ha) + lime. Further, the estimated yield per hectare calculated from the total yield per treatment was significantly higher in T_7 (46.18 t/ha) during 2011-12 and 47.5 t/ha in T_{11} during 2012-13. Moreover, from pooled analysis, the highest yield (45.80 t/ha) was recorded from T_{11} followed by T_5 (40.93 t/ha), T_7 (39.84 t/ha) and both were statistically at par (Table 3). The finding is in closed conformity with those of Singh *et al.*, (2016) in capsicum. The higher growth and yield attributing traits observed on organic manure application and lime may be due to microbial decomposition of organic manures which simultaneous release of growth promoting organic acids which might have favoured the availability of essential nutrients in soil and their uptake (Naidu et al. 2009). The significant effect of vermicompost on growth and yield of capsicum was also observed by Adhikari et al. (2016). Euras (2009) reported that the vermicompost is proving to be highly nutritive organic fertilizer and more powerful growth promoter over the conventional/ rural composts. The application of vermicompost to soils increased their microbial biomass and dehydrogenase or soil enzymes activity (Arancon et al. 2003). This increase in microbial bio mass and soil

Table 3. Economic analysis of treatments in tomato-capsicum cropping sequence under low-cost polyhouse

Treatments	Tomato					Capsicum					Cropping Sequence			
	Yield (t/ha)	Cost of production	Gross Return	Net Income	B:C ratio	Yield (t/ha)	Cost of production	Gross Return	Net Income	B:C ratio	Cost of production	Gross Return	Net Income	B:C ratio
T_1: RDF	42.8^e	377202.7	641700.0	264497.3	1.7	32.4^e	367572.7	810125.0	442552.3	2.2	744775.4	1451825.0	707049.6	1.9
T_2: T1+Lime	46.8^e	377604.0	702000.0	324396.1	1.9	37.7^{bc}	367572.7	943125.0	575552.3	2.6	745176.7	1645125.0	899948.4	2.2
T_3: 1/2 N+Lime	30.9^d	372328.9	464175.0	91846.2	1.2	32.3^c	362698.9	808500.0	445801.2	2.2	735027.7	1272675.0	537647.3	1.7
T_4: 1/2 N+POM	47.6^c	399078.9	714225.0	315146.2	1.8	28.8^d	389448.9	720750.0	331301.2	1.9	788527.7	1434975.0	646447.3	1.8
T5: T_4+ Lime	61.4^b	399480.1	921450.0	521969.9	2.3	40.9^b	389448.9	1023250.0	633801.2	2.6	788929.0	1944700.0	1155771.1	2.5
T_6: 1/2 N+PIM	58.8^b	383028.9	882075.0	499046.2	2.3	32.1^c	373398.9	802875.0	429476.2	2.2	756427.7	1684950.0	928522.3	2.2
T_7: T_6 + Lime	65.4^{ab}	383430.1	980850.0	597419.9	2.6	39.8^b	373398.9	995875.0	622476.2	2.7	756829.0	1976725.0	1219896.1	2.6
T_8: 1/2 N+FYM	60.6^b	383028.9	908325.0	525296.2	2.4	32.0^c	373398.9	800375.0	426976.2	2.1	756427.7	1708700.0	952272.3	2.3
T_9: T_8+Lime	67.1^{ab}	383430.1	1007100.0	623669.9	2.6	36.7^{bc}	373398.9	917500.0	544101.2	2.5	756829.0	1924600.0	1167771.1	2.5
T_{10}: 1/2N+VC	60.6^b	425828.9	908325.0	482496.2	2.1	34.5^{bc}	416198.9	862750.0	446551.2	2.1	842027.7	1771075.0	929047.3	2.1
T_{11}: T_{10} + Lime	72.6^a	426230.1	1089300.0	663069.9	2.6	45.8^a	416198.9	1145000.0	728801.2	2.8	842429.0	2234300.0	1391871.1	2.7

*Means with the same letter are not significantly different at $p < 0.05$(POM= Poultry manure; PIM=Pig manure and VC=Vermicompost)

enzymes activity helps in increasing the availability of nutrients to the crop and boost up their growth and development.

Vitamin-C is one of the most important quality parameters in capsicum and treatments have shown statistically significant and positive effect on vitamin-C content. Among the treatments, the highest vitamin-c (98.9 mg/ 100g) was recorded from T_9 - 60:60:60 kg /ha (NPK) + FYM (10 t/ha) + lime) followed by T_{11} (86.88 mg/100g), T_7 (85.7 mg/100g) and T_5 (81.25 mg/100g) and all were statistically at par (Fig. 3). Significant effect of INM on vitamin - C content was also observed in capsicum by Singh *et al.*, (2016). The higher vitamin - C was observed in treatment having combination of organic manure and lime with 50% N may be due increases in the availability of nutrients to the plant and reduction in the degradation (Conway and Sams 1983) of vitamin-C by providing essential nutrients and reduces the soil related stress.

Economic analysis: The results of economic analysis from the yield (pooled) of the tomato, treatments have shown variation in net income and benefit: cost ratio (Table 3). All the factors of production were estimated based on payment basis including manpower. Although, yield (72.6 t/ha) and net income (₹ 6, 63,069.9 /ha) was highest from the treatment T_{11}-NPK (60:60:60 kg/ ha) + vermicompost (5 t/ha) + lime). But the BC ratio (2.6) was similar for the three treatments T_{11}, T_9 and T_7 having different sources of organic manure with the integration of lime in fertilization. Thus, lime having key role in the nutrient management of the crop in the acidic soil. Likewise, in capsicum, the highest yield (45.8t/ ha), net income (₹ 7, 28,801.0 /ha), and benefit: cost ratio (2.8) was also recorded from treatment T_{11} followed by T_5 and T_7 which were treated by lime in previous crop (Table 3). This also indicated the positive effect of lime on the capsicum yield with different sources of organic manure. From over all cropping system analysis, the highest net income (₹ 13, 91,871.1 /ha), and BC ratio (2.7) was recorded from the treatment

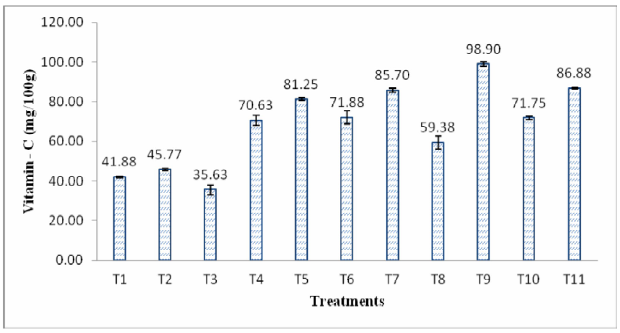

Fig. 3 Effect of integrated nutrient management on vitamin-C content in capsicum

T_{11}- NPK (60:60:60 kg/ha) + vermicompost (5t/ha) + lime followed by T_5- NPK (60:60:60 kg/ha) + pig manure (10t/ha) + lime.

From the above results, the present investigation has shown the positive effect of lime on yield and quality of capsicum. The farmers can get higher income by the integration of liming with the recommended dosage of fertilizers and available sources of organic manure. However, among the organic manure vermicompost found to be superior for growth, yield and quality attributes.

सारांश

सब्जी की फसलों में, टमाटर और शिमला मिर्च संरक्षित खेती के तहत उगाई जाने वाली प्रमुख फसलें हैं। उच्च वर्षा के कारण, इस क्षेत्र की मिट्टी में अम्लीय है और आवश्यक पोषक तत्वों जैसे–कैल्शियम और मैग्नीशियम में कमी लीचिंग और फास्फोरस का स्थिरीकरण के कारण उपलब्धता कम होती है। इसलिए, उत्पाद की उत्पादकता और गुणवत्ता बहुत खराब है। उत्तर पूर्वी क्षेत्र का मृदुल मौसम, उच्च उपज और बेहतर गुणवत्ता के साथ अच्छे बाजार मूल्य प्राप्त करने के लिए संरक्षित परिस्थितियों में इन फसलों के वर्ष पर्यन्त/गैर–मौसमी उत्पादन के लिए एक बेहतर विकल्प प्रदान करता है। इस पृष्ठभूमि के साथ लगातार दो वर्षों (2011–13) के लिए एक प्रक्षेत्र परीक्षपण किया गया ताकि संरक्षित स्थिति में टमाटर और शिमला मिर्च में वृद्धि, उपज और गुणवत्ता वाले गुणों के साथ चूना और जैविक खादों के प्रभाव का अध्ययन एवं टमाटर–शिमला मिर्च की फसल क्रम के लिए उपयुक्त एकीकृत पोषक तत्व प्रबंधन का एक युक्त विकास योजना बनाया जा सके। टमाटर (72.6 टन/हेक्टेयर) एवं शिमला मिर्च (45.80 टन/हेक्टेयर) की सबसे अधिक पैदावार और अच्छी गुणवत्ता वाले फल नत्रजनःफास्फोरसः पोटाश + वर्मीकम्पोस्ट (5.0 टन/हेक्टेयर) में प्रयोग से क्रमशः पाया गया। हालांकि फसल प्रणाली के आर्थिक विश्लेषण से उच्चतम शुद्ध आय (रू. 13,91,871 प्रति हेक्टेयर) और लाभ : लागत का अनुपात (2.7) नत्रजनःफास्फोरसःपोटाश (60:60:60 किग्रा./हेक्टेयर) + सुअर की खाद (10.0 टन/हेक्टेयर) + चूना के प्रयोग में पाया गया। अतः उर्वरकों के साथ चूना और वर्मीकम्पोस्ट का उपयोग उपज और गुणवत्ता उपज और गुणवत्ता के संदर्भ में अधिकतम उत्पादन प्राप्त करने के लिए एकीकृत पोषक तत्व प्रबंधन का उपयुक्त योजना प्रयोग में लायी जा सकती है।

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