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Effect of integrated nutrient management on yield and quality of sweet pepper

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ABSTRACT

An experiment was carried out at the On Station research field of Agricultural Research Station, On-farm Research Division, Rangpur during 2014-15 and 2015-16 to investigate the effect of integrated nutrient management on the yield and quality of sweet pepper. There were six treatments: T_1 = 100% RD (N115P70K125S20Zn2 kg ha^{-1}), T_2 = 75% RD + 5 tha^{-1} CD, T_3 = 75% RD + 5 tha^{-1} CD Slurry, T_4 = 75% RD + 3 tha^{-1} PM, T_5 = 75% RD + 3 tha^{-1} PM Slurry, T_6 = Native fertility. The tested variety was BARI Misti Morich-1. The experiment was laid out in randomize complete block design with 3 replications. Results revealed that the T_5 (75% RD+ 3 tha^{-1} PM Slurry) produced the highest fruit yield (25.29 & 25.79 tha^{-1}) and the lowest yield (16.34 & 11.27 tha^{-1}) was in control treatment (native fertility). An inclusion of 3 t PM Slurry ha^{-1} with 75% RD can reduce 25% of chemical fertilizer. Integrated use of PM Slurry at the rate of 3 tha^{-1} with 75% RD was found as the best combinations in respect of sweet pepper yield and probable of enriching the soil organic matter.

Key Words: *Sweet pepper, Nutrient management, Yield and Quality*

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I. Introduction

Among the vegetable crop Sweet pepper (*Capsicum annuum* L.) is a popular belong to the solanaceous group. Sweet pepper is also known as Bell pepper or green pepper. In Bangladesh sweet pepper cultivation is found in peri urban areas primarily for the supply of some city markets. Pepper is considered an excellent source of bioactive nutrients. Main antioxidant compounds found in sweet pepper is ascorbic acid (vitamin C), carotenoids and phenolic compounds (Marin et al., 2004). The levels of vitamin C, carotenoids and phenolic compounds in vegetables varied based on several factors, including cultivar, agricultural practice, Physiological maturity and storage duration (Lee and Kader, 2000). The application of organic resources is essential for the balance of soil fertility status and crop productivity in agricultural systems. Imbalance use of chemical fertilizer in vegetable and other crop production is a common practice in Bangladesh. In Bangladesh, most of the cultivated soils have less than 1.5% organic matter (Islam, 2006) while a good agricultural soil should contain at least 2%

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organic matter. In continuous cropping area, organic matter supply to the crop field through different manuring practices is made only to a minimum extent. Under these imbalanced conditions various beneficial soil microorganisms are being adversely affected. Addition of organic manure in soil raise the organic matter content in soil nearby increase the productivity and yields. Crop yields is usually associated with the improvement of soil structure, soil fertility level, soil microbial population activity and moisture-holding capacity of the soil (Arancon et al., 2004) and crop production. Use of organic manures alone, as a substitute to chemical or inorganic fertilizer is not profitable and will not be enough to maintain the high yielding varieties crop productivity. Integrated plant nutrient system most effective fertilizing technique for crop grown due to both organic manures and inorganic fertilizers are used simultaneously to maintain sustainable soil system while increasing crop productivity. From the above point of views the experiment was undertaken to study the effect of organic fertilizers on the yield of sweet pepper and to reduce the use of chemical fertilizer.

II. Materials and Methods

The study was conducted at the research field of Agricultural Research Station, On-farm Research Division, Rangpur during the rabi seasons of 2014-15 and 2015-16. The tested variety was BARI Misti Morich-1. Thirty five days seedlings was transplanted during second week of December. Crop harvesting was done three times started at last week of April and ended in second week of June. The initial soil samples of the experimental field were collected and analyzed following standard methods. Soil chemical properties has been presented in table 01.

Table 01. Analytical data of the experimental soils of Agricultural Research Station, On-farm Research Division, Rangpur

Location	pH	OM	Ca	Mg	K	Total N	P	S	B	Cu	Fe	Mn	Zn
		(%)	meq 100g^{-1}			(%)	µg g^{-1}						
OFRD, Rangpur	5.7	1.24	2.6	1.8	0.17	0.086	76.80	5.43	0.10	2.1	33	4	0.7
Critical level	-	-	2.0	0.5	0.12	0.12	7	10	0.2	0.2	4	1	0.6
Interpretation	Highly acidic	L	H	H	L	VL	VH	VL	VL	H	VH	VH	H

VL=very low, L=Low, M=Medium, VH=Very high, OM=Organic Matter

Experimental layout and Data collection: The experiment was laid out in RCB design with three replications. The unit plot size was 3m ×1m with spacing of 50cm × 50cm. Thirty five days old sweet pepper seedlings were transplanted on 13 December, 2015. All the intercultural operations were done as and when necessary. The crop was harvested four times after the fruit maturity. The field data on important parameters were recorded from 5 randomly selected plants for analysis. The data on plant characteristics were collected on plant height, Number of fruits plant^{-1}, fruit length, fruit diameter, pericarp thickness, individual fruit fresh wt (gm), dry weight (gm) shelf life and yield (tha^{-1}). Data on different yield contributing parameters and yield were recorded and analyzed statistically and adjusted with least significant difference (LSD) at 5% level of significance.

Table 02. Treatment combination for Sweet pepper

Treatments	Treatment combinations
T_1	100% RD (N115P70K125 S20 Zn2) kg ha^{-1}
T_2	75% RD (N88P53K94 S15 Zn1.5) kg ha^{-1} + 5 t ha^{-1} CD
T_3	75% RD (N88P53K94 S15 Zn1.5) kg ha^{-1} + 5 t ha^{-1} CD Slurry
T_4	75% RD (N88P53K94 S15 Zn1.5) kg ha^{-1} + 3 t ha^{-1} PM
T_5	75% RD (N88P53K94 S15 Zn1.5) kg ha^{-1} + 3 t ha^{-1} PM Slurry
T_6	Native Fertility

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III. Results and Discussion

Effect on yield and yield attributing characters of sweet pepper

Plant height: The effect of applied fertilizer on plant height of sweet pepper was significant (Table 3a and 3b). In 2014-15 plant height at maturity varied from 71.15cm to 81.35cm and next year it was ranged 67.47-88.73 cm, where the highest result was observed in 75% RD + 3 t PM slurry ha^{-1} and lowest in native fertility .

Number of fruits plant^{-1} : There was significant difference in average number of fruits per plant. In 2014-15 maximum fruits per plant was found in T_5 (14) and minimum was found in T_6 (9). In 2015-16 maximum fruits bearing was recorded in T_5 (15) and minimum was recorded in native fertility level T_6 (7.0). Application of 75% RD and 3 t PM slurry ha^{-1} might have helped to the slow release of nutrients from organic manures when supplemented with inorganic fertilizers. Furthermore, micro-organisms might have helped in faster decomposition of organic manures thereby increasing the availability of nutrients, especially protein synthesis further it was suggested that increase in fruit weight might have accelerated the mobility of photosynthates from source to the sink which was influenced by the growth hormones released from the organic source (Sivakumar et al., 1999) in sweet pepper.

Fruit length & Diameter: Data presented in table 03a and 03b clearly demonstrated that there were significant differences in fruit quality parameters except for the fruit diameter. Concerning, fruit quality measurements (fruit length and fruit diameter), the obtained results concluded that there were significant increases in sweet pepper fruit parameters with different types of organic manure.

Pericarp thickness: At 90 DAT maximum pericarp thickness was recorded in T_5 (6.64 & 7.11 mm) and minimum pericarp thickness was recorded in T_6 (4.01 & 4.99 mm) respectively 2014-15 and 2015-16. The statistical analysis shows significant variation among pericarp thickness.

Fresh weight of fruit plant^{-1}: At 90 DAT sweet pepper fruits fresh weight (gm) was collected. In both year maximum fresh fruit yield was recorded in T_5 (140.3 g and 79.12 g) and minimum fresh weight was recorded in T_6 (113.8 g and 51.55 g). The statistical analysis shows significant variation among fresh wt. of fruit.

Table 03a. Yield and yield components of sweet pepper as influenced by organic and inorganic fertilizer at OFRD, Rangpur during 2014 -15

Treatment	Plant height (cm)	No. of fruits plant^{-1}	Fruit length(cm)	Fruit diameter(cm)	Pericarp thickness (mm)	Fresh fruit wt. (g)	Dry wt. (g)	Shelf life (days)	Yield (t ha^{-1})
T_1	75.71b	11.00bc	7.57a	5.86b	5.69bc	134.2 a	10.93 ab	6d	21.28c
T_2	75.95b	10.00c	7.39a	5.88b	5.43c	135.1 a	9.97 bc	9c	21.73bc
T_3	77.32b	12.00b	7.58a	5.92ab	6.17ab	135.4 a	8.89 cd	9c	22.43bc
T_4	78.04b	12.00b	7.29a	6.27ab	6.28a	135.5 a	9.31 cd	10b	23.43ab
T_5	81.35a	14.00a	7.77a	6.45a	6.64a	140.3 a	11.51a	12a	25.29a
T_6	71.15c	9.00d	5.79b	5.28c	4.01d	113.8 b	8.6 d	8c	16.34d
CV (%)	2.02	6.82	5.78	5.03	4.66	7.38	7.26	7.16	4.95

Dry weight (g) of fruit: At 90 DAT maximum dry weight was recorded in T_5 (11.51 and 10.1 g) for and minimum dry weight was recorded in T_6 (8.60 and 6.23 g) respectively during 2014-15 and 2015-16. The statistical analysis shows significant variation among dry wt. of fruits.

Shelf life: At 90 DAT maximum shelf life (12) was recorded in T_5 and minimum shelf life (8) was recorded in T_6 i.e native fertility level in both year. The statistical analysis shows significant variation among shelf life of fruits.

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Fresh fruit yield (tha^{-1}): Data regarding the effect of organic fertilizer showed significant variation on the yield of sweet pepper (Table 03a and 03b). In first year the highest yield (25.29 tha^{-1}) was found in T_5 (75% RD + 3 t PM slurry ha^{-1}) treatment followed by T_4 (23.43 tha^{-1}) i.e 75% RD + 3 ton PM ha^{-1} and the lowest in native fertility T_6 (16.34 tha^{-1}). In 2015-16 highest yield was found in T_5 (25.79 tha^{-1}) and lowest was in T_6 (11.27 tha^{-1}). Application of 3 t PM slurry ha^{-1} might increase the physical properties of soil which was again enhanced by the use of 75% RD. As a result growth and yield parameter of sweet pepper was increased in the stated treatment. It is also revealed from the experiment that combined application of chemical and organic fertilizer is effective for the production of sweet pepper.

Pest incidence: Some fruits were infested with fruit borer and at initial stage leaves were infested with leaf caterpillar.

Table 3b. Yield and yield components of sweet pepper as influenced by organic and inorganic fertilizer at OFRD, Rangpur during 2015-16

Treatment	Plant height (cm)	No. of fruits plant^{-1}	Fruit length(cm)	Fruit diameter (cm)	Pericarp thickness (mm)	Fresh fruit wt. (g)	Dry wt. (g)	Shelf life (days)	Yield (t ha^{-1})
T_1	83.67a	13.00ab	7.57a	20.41ab	5.31bc	70.79b	6.75c	7c	20.88c
T_2	84.47a	13.00ab	7.39a	21.63ab	4.78cd	71.99b	6.97c	10c	21.11bc
T_3	87.20a	12.00b	7.58a	21.20ab	6.35ab	73.00b	7.53c	10c	22.78bc
T_4	86.07a	14.00ab	7.29a	22.20ab	6.62ab	74.97b	8.61b	11b	23.81ab
T_5	88.73a	15.00a	7.77a	23.37a	7.11a	79.12a	10.1a	13a	25.79a
T_6	67.47b	7.00c	5.79b	19.78b	4.99d	51.55c	6.23d	9c	11.27d
CV (%)	2.00	6.79	5.69	5.00	4.63	1.36	4.11	7.11	4.89

Effect on fruit antioxidant compounds of sweet pepper

pH: The highest fruit pH was in the T_5 treatment, while the lowest fruit pH was in native fertility; however, no significant difference was found among treatments. This result is the same trend with the findings of Giovanni et al. (2011) and Toor et al. (2006). There has been found correlation among pH of fruit with acidity and acid content and citric acid (Wang and Lin, 2002). Fruits containing less amount of pH (grown in organic fertilizers) indicate presence of more citric acid, which is beneficial for human consumption (Wang and Lin, 2002). Additionally, fruit with low pH is more suitable for ripening while it also improves shelf life (Hernandez- Perez et al., 2005).

TSS: Different types of organic with inorganic manure application significantly increased total soluble solid (Table 04). The level of 3 tha^{-1} PM slurry treatment produced the most total soluble solid (5.40 and 6.43 0Brix) and the least value related to the native fertility (4.00 & 3.99 0Brix).

Table 04: Effect of organic and inorganic fertilizer on fruit antioxidant compounds of sweet pepper in Rangpur

Treatment	pH	TSS (0Brix)	Vit-C mg/100g	Firmness kgf cm^{-2}	pH	TSS (0Brix)	Vit-C mg/100g	Firmness kgf cm^{-2}
	2014-15				2015-16			
T_1	579ab	4.35 bc	50.22 cd	0.32 ab	5.71	4.95bc	81.11	0.32
T_2	5.61ab	4.42 bc	53.37 c	0.30 ab	5.69	5.58ab	85.25	0.31
T_3	5.63ab	4.65 b	62.51 b	0.29 ab	5.68	5.65ab	94.33	0.27
T_4	5.72ab	4.75 b	46.43de	0.31 ab	5.57	5.75ab	108.53	0.33
T_5	5.86 a	5.40 a	78.21 a	0.34 a	5.46	6.43a	111.17	0.36
T_6	5.48 b	4.00 c	44.56 e	0.28 b	5.63	3.99c	57.89	0.29
CV (%)	3.29	5.33	5.04	9.39	6.97	6.17	25.11	10.67

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Compost effect on antioxidant components and fruit quality of sweet pepper reported by Toor et al. (2006) and Santiago et al. (2009) observed that fruits harvested from plants that received compost had significantly higher total soluble solid (TSS) than those harvested from the mineral fertilizer plot. The improvement of fruit quality may be attributed to better growth of plant at different rate of organic fertilizer, which might have favored the production of better quality fruit (Rajbir et al., 2008).

Vit.-C : Table 04 shows the effect of different organic source treatments on vitamin C of fruit. The highest vitamin C content was produced in the T_5 with 78.21 and 111.17 mg 100 g^{-1}, while the least vitamin C was recorded in native fertility with 44.56 & 57.89 mg 100 g^{-1}. Vitamin C content varies based on different factors such as cultivar, plant nutrition, production practice and maturity (Antonio et al., 2007). Similar result was observed by Taiwo et al. (2007) who determined that compost application at different concentrations improved vitamin C of fruit. Organic fertilization has been reported to give a low yield of tomatoes with high ascorbic acid content, whereas mineral or mineral+ organic fertilizer gave a high yield of fruit with lower ascorbic acid content (Dumas et al., 2003). Therefore, our study confirmed previous results that the level of vitamin C in organically grown sweet peppers was consistently higher than that in conventionally grown peppers.

Firmness: The highest value of fruit firmness was obtained at 3 tha^{-1} PM slurry treatment with 0.34 & 0.36 N, while the least fruit firmness was recorded in native fertility with 0.28 & 0.27 N. This is an agreement with Riahi et al. (2009) and Mccollum et al. (2005) where it was revealed that tomato grown with organic manure were generally firm. Tomato fruits cause less damage during carrying and when sliced for consumption less extraction of juice occur due to hard firmness.

Economical profitability: Total gross return (Tk. 2023200/ha) was tohe highest in the treatment T_5 followed by 1874400 Tk./ha and 1794400 Tk./ha respectively in the treatment T_4 and T_3 respectively (Table 05) and lowest was in the T_6 (1307200 Tk. ha^{-1}) during 2014-15. The highest net return over variable cost was Tk. 1750920/ha recorded in T_5 though higher cost was involved. The lowest net return was Tk. 1063320/ha obtained from T_6 (Table 05). In 2015-16 highest gross return and net return was recorded in T_5 (1884000 $Tk.ha^{-1}$ and 1611720 Tk. ha^{-1} respectively) and lowest was in native fertility. So from monetary point of view, the T_5 was the best system under the present study.

Table 05. Cost and return analysis of sweet pepper as influenced by different levels of organic and inorganic fertilizer at on station Rangpur during the Rabi Season, 2014-15 and 2015-2016

Treatments	Gross Return ($Tk.ha^{-1}$)		Total variable cost ($Tk.ha^{-1}$)		Gross margin ($Tk.ha^{-1}$)	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
T_1	1702400	1688800	278750	278750	1423650	1410050
T_2	1738400	1674400	272780	272780	1465620	1401620
T_3	1794400	1732800	274030	274030	1520370	1458770
T_4	1874400	1795200	271530	271530	1602870	1523670
T_5	2023200	1884000	272280	272280	1750920	1611720
T_6	1307200	1368000	243880	243880	1063320	1124120

Farm grate price of Sweet Pepper=Tk.80 kg^{-1}

IV. Conclusion

Based upon the observation, it may be concluded that 3 t ha^{-1} PM slurry along with 75% recommended dose of chemical fertilizer was found best for yield and quality of sweet pepper (cv. BARI Misti Morich-1. Among the 4 organic manures, poultry manure slurry was found best for sweet pepper production followed by poultry manure, cowdung slurry and cowdung.

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