

Effects of N P K S and cow dung on growth and yield of tomato

A. R. M. Solaiman ^{1)*} and M. G. Rabbani ¹⁾

Abstract

A field experiment was carried out at the Bangabandhu Sheikh Mujibur Rahman Agricultural University farm to assess the effects of inorganic and organic fertilizers on vegetative, flowering and fruiting characteristics as well as yield attributes and yield of Ratan variety of tomato. The plots were treated with three levels each of N (62, 100 and 200 kg/ha), P (11.7, 17.5 and 35 kg/ha), K (26.7, 40 and 80 kg/ha), S (5, 7.5 and 15 kg/ha) and cow-dung (5, 10 and 15 t/ha). There were three replications for each treatment. The highest plant height and dry weight of shoot, the maximum number of clusters of flowers and fruits/plant as well as the greatest fruit size and fruit yield/plant, fruit yield/ha were obtained from the application of the recommended dose of nutrients viz. 200 kg N + 35 kg P + 80 kg K + 15 kg S/ha, but similar results were obtained from the treatment receiving 5t cow dung/ha along with half of the recommended doses of nutrients (100 kg N+ 17.5 kg P + 40 kg K + 7.5 kg S/ha). The effect of 10t cow dung per ha, along with one third of the recommended dose of nutrients, was also comparable to the effect of employing the recommended dose of nutrients. It was further observed, from an economic standpoint, that the combination of 5t cow dung/ha along with half of the recommended doses of nutrients appeared to be a viable treatment which would offer the maximum benefit concerning cost ratio (4.38) for tomato production in the shallow red- brown terrace soil (AEZ-28) of Bangladesh.

Keywords: NPKS, Cow dung, Growth, Yield, Tomato

Introduction

Tomato (*Lycopersicon esculentum* Mill) is a nutritious and popular vegetable produced in Bangladesh. It is produced all over the country and cultivated during the cool season. At present, tomatoes rank third, next to potatoes and sweet potatoes, in terms of global vegetable production (FAO, 2002). It is widely grown not only in Bangladesh but also in other parts of the world. The crop can adapt to different climatic conditions ranging from the tropics to within a few degrees of the Arctic Circle. It is now being cultivated successfully in tropical, subtropical and temperate climates. At present the leading tomato producing countries in the world are China, United States of America, India, Egypt, Turkey, Iran, Italy, Mexico, Brazil and Indonesia (FAO, 2002). The tomato is one of the major vegetables produced

1) Department of Soil Science, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur 1706, Bangladesh

*Corresponding author

E-mail: arm_solaiman@yahoo.com

Fax: 880-2-9252873

in Bangladesh. It occupies an area of 14,607 ha of land and its annual production is 99,690 tons (BBS, 2003). However, the average tomato yield in Bangladesh is quite low (6.82 t/ha) compared to other countries of South and Southeast Asia; such as India (17.00 t/ha), Pakistan (9.67 t/ha), Sri Lanka (7.57 t/ha), Philippines (8.77 t/ha) and Thailand (23.79 t/ha) as well as being low compared to the average yield grown in Asia (24.30 t/ha) and world (26.74 t/ha) (FAO, 2003).

Nutritive fertilizer may be applied in two varieties viz. organic and inorganic. The majority of our Bengali tomato growers do not produce good quality fruit at a high yield because of their lack of knowledge regarding improved production technology, including use of proper organic and inorganic fertilizers. Conversely, low and declining organic matter in the soils of Bangladesh, due to reduced recycling of organic byproducts, is affecting soil fertility and productivity (Saheed, 1992). A crop production system having high yield targets cannot be sustainable unless nutrient inputs to soil are at least balanced against nutrient removal by crops (Bhuiyan *et al.*, 1991). Proper soil fertility management, therefore, is of prime importance in an endeavor to increase crop productivity. Available data indicate that the fertility of most of the soil used for agriculture in Bangladesh has deteriorated over the years (Ali *et al.*, 1997) which is responsible for stagnating and in some cases, even declining crop yields (Anonymous, 1996). The use of chemical fertilizers as a supplemental source of nutrients has been increasing steadily in Bangladesh, but they are usually not applied in balanced proportions by most of our farmers (Anonymous, 1997). A very important factor to consider in improving crop productivity is soil organic matter. Available reports indicate that most soil in Bangladesh has a low organic matter content, usually less than 2% (Anonymous, 1989). Moreover, the organic matter content of Bengali soils is declining with time due to inadequate attention being afforded to improvement and maintenance (Karim *et al.*, 1994). Cow dung is a good source of different plant nutrients particularly NPKS, and judicious application of cow dung along with inorganic nutrients might be helpful to obtain a good economic return as well as provided favorable conditions for subsequent crops. So, the present study was undertaken to improve tomato yields through the integration of organic and inorganic fertilizers.

Materials and Methods

A field experiment was conducted at Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) Farm, Gazipur, Bangladesh, during the *Rabi* (winter) season. The soil was shallow red-brown rerrace soil (AEZ-28) and was classified as Inceptisols having pH 6.4, bulk density 1.32 g/cc, organic carbon 1.146 %, C: N ratio 10.42, available P 25.58 µg/g soil, exchangeable K 0.36 meq/100g soil, available S 44.32 µg/g soil, Ca 7.45 meq/100g soil, Mg 2.21 meq/100g soil, total Zn 3.25 µg/g soil and CEC 11.91 cmol /kg. The experiment was arranged in a randomized complete block design with five treatments replicated three times. Plot size was 2.4 m × 2.4m. Ratan tomatoes were used as the test crop. Twenty five day old seedlings raised in a seedbed were transplanted to the experimental field at a spacing of 60cm × 40cm. The five treatments consisting of T₁-control, T₂ (recommended dose) - 200kg N + 35kg P +80kg K + 15kg S/ha, T₃ - 5t cowdung (CD)/ha + ½ of T₂, T₄ - 10t CD/ha + ⅓ of T₂ and T₅ -15t CD/ha. N, P, K and S were applied in the form of urea, TSP, MP and Zypsum, respectively. The control plot received no manure or fertilizer. Cow dung, TSP, MP and Zypsum were applied during final land

preparation. Urea was applied in 3 splits; the first dose of urea was applied at final land preparation, the second dose at 21 days after transplanting and the third dose at 35 days after transplanting. Intercultural operations were done as and when necessary. Data on plant height, dry weight of shoot, number of clusters per plant, number of flowers per plant, number of fruits per plant, fruit setting rate (%), fruit size (length \times breath) and fruit yield per plant were recorded from ten randomly selected plants from each plot. Total yield per ha was calculated from the yield recorded in each plot. Fruit setting rate (%) was calculated as

$$\text{FSR (\%)} = \frac{\text{Total number of fruits per plant}}{\text{Total number of flowers per plant}} \times 100$$

The benefit cost ratio was calculated as

$$\text{BCR} = \frac{\text{Gross return (Tk/ha)}}{\text{Total variable cost (Tk/ha)}}$$

The cost of labour, land preparation, transplanting and fertilizers were considered as the total variable cost of the experiment, and fruit yield/ha was considered as experimental produce. The collected data were analyzed statistically. Means were separated using DMRT.

Results and Discussion

Plant height

The plant height of tomato, which is an important parameter affecting the growth, significantly varied due to different treatments (Table1). The plant height ranged from 56.73 cm recorded in the control, to 72.02 cm recorded in the treatment T₂ receiving full dosage (recommended dose) of NPKS at 50% flowering stage. Treatment T₃ receiving 5t CD/ha plus half of the recommended dose of inorganic fertilizer, recorded statistically similar plant height. Rahman *et al.* (1996) reported that cow dung in

Table1. Effects of N P K S and cowdung on plant height and dry weight of shoot of tomato

Treatment	Plant height (cm)		Dry weight of shoot (g/plant)
	50% flowering stage	Final harvesting stage	
T ₁ . Control	56.73 d	61.75 d	83.80 c
T ₂ . N ₂₀₀ + P ₃₅ + K ₈₀ + S ₁₅	72.02 a	75.03 a	111.70 a
T ₃ . CD ₅ + 1/2 of T ₂	68.02 ab	72.00 ab	103.80 a
T ₄ . CD ₁₀ + 1/3 of T ₂	65.02 bc	69.22 b	100.30 ab
T ₅ . CD ₁₅	62.45 c	65.12 c	95.70 ab
CV (%)	3.45	2.25	8.68

Cowdung (CD) and NPKS were applied in terms of t/ha and kg/ha, respectively

Means followed by common letter (s) in a column are not significantly different at 5% level by DMRT

combination with other fertilizers played an important role with respect to vegetative growth of tomato. Cowdung at the rate of 5t/ha along with half the recommended dose, and 10t/ha with one third of recommendation dose, were statistically similar in terms of plant height. Application of cow dung alone at a higher rate showed a decreasing effect on plant height. All the treatments recorded higher plant height over the control. At the final harvesting stage a similar trend was observed. At this stage the plant height ranged from 61.75 cm recorded in the control, to 75.03cm recorded in the treatment T₂.

Dry weight of shoot

The dry weight of tomato plant shoots varied significantly due to different treatments. The dry weight of shoots ranged from 83.80 g/plant recorded in the control, to 111.70 g/plant recorded in treatment T₂, which received the full dose of NPKS at the final harvesting stage (Table 1). The treatments T₂, T₃, T₄ and T₅ showed statistically similar shoot weight but their effects were higher than the control. This finding agrees with the results of Masson *et al.* (1999). They found that nitrogenous fertilization with supplementary lighting increased tomato shoot dry weight, leaf area, root dry weight and root: shoot ratio.

Number of clusters per plant

The number of clusters per plant ranged from 13.55 recorded in the control, to 23.48 recorded in treatment T₂, which received the full dose of NPKS (Table 2). Treatment T₃ receiving 5t CD/ha plus half the recommended dose of inorganic nutrients (T₂) recorded a statistically similar number of clusters per plant as that of treatment T₂. The effect of T₄, which received 10t CD/ha plus one third the recommended dose of nutrients, was statistically similar to the effect of T₃. All the treatments recorded a higher number of clusters per plant than the control.

Number of flowers per plant

The number of flowers per plant ranged from 29.15 recorded in the control, to 44.13 recorded in treatment T₂, which received the full dose of NPKS (Table 2). Treatment T₃ receiving 5t CD/ha plus half the recommended dose of inorganic nutrients (T₂) recorded statistically similar results to that of T₄, which received 10t CD/ha plus one third of T₂. The number of flowers per plant recorded with cow dung

Table2. Effects of N P K S and cowdung on yield attributes and yield of tomato

Treatment	No. of cluster/ plant	No. of flower/ plant	No. of fruits/ plant	Fruit setting rate (%)	Fruit size		Fruit yield/ Plant(g)	Fruit yield (t/ha)	Yield increase over control (%)
					Length (cm)	Breath (cm)			
T ₁ . Control	13.55 d	29.15 c	18.35 c	62.95	4.30 b	4.50 b	788.25 b	28.40 c	–
T ₂ . N ₂₀₀ + P ₃₅ + K ₈₀ + S ₁₅	23.48 a	44.13 a	33.32 a	75.50	4.72 a	4.75 a	1159.00 a	44.11 a	55.32
T ₃ . CD ₅ + ½ of T ₂	21.10 ab	43.47 a	33.30 a	76.60	4.69 a	4.73 a	1114.00 a	43.81 a	54.26
T ₄ . CD ₁₀ + ⅓ of T ₂	20.57 b	40.25 a	31.75 a	78.88	4.68 a	4.73 a	1037.00 a	42.72 ab	50.42
T ₅ . CD ₁₅	16.60 c	31.58 bc	23.85 b	75.52	4.61 a	4.67 a	944.30 ab	36.30 b	27.82
CV (%)	7.19	7.31	10.49	–	3.15	1.78	16.78	10.69	–

Cowdung (CD) and NPKS were applied in terms of t/ha and kg/ha, respectively

Means followed by common letter (s) in a column are not significantly different at 5% level by DMRT

alone being applied at the rate of 15t per ha was inferior to treatments T₂ and T₃.

Number of fruit per plant

The number of fruit per plant ranged from 18.35 recorded in the control, to 33.32 recorded in treatment T₂, which received the full dose of NPKS (Table 2). The effects of treatments T₂ receiving full dose of inorganic nutrients, T₃ receiving 5t CD/ha plus half the recommended dose of inorganic nutrients and T₄, which received 10t CD/ha plus one third the recommended dose of nutrients, were all statistically similar in terms of number of fruit per plant. The effects of treatments T₂, T₃ and T₄ were followed by T₅, which received 15t CD/ha alone. All the treatments recorded a higher number of fruit per plant than the control.

Fruit setting rate (%)

The rate of fruit setting varied due to the different treatments (Table 2). The fruit setting rate ranged from 62.95 recorded in the control, to 78.88 recorded in treatment T₄, which received 10t CD/ha plus one third the recommended dose of inorganic nutrients (T₂). Different rates of cow dung application along with NPKS affected the rate of fruit setting. Increasing the rate of cow dung and decreasing NPKS increased the fruit setting rate, but cow dung alone applied at a higher rate (15t/ha) decreased the fruit setting rate. Varis and George (1985) reported that urea levels had no effect on fruit setting.

Fruit length

The longest fruit length of 4.72 cm was recorded from the application of the recommended dose of inorganic nutrients (200kg N + 35kg P +80kg K + 15kg S/ha). Conversely, the shortest fruit length of 4.30 cm was recorded in the control (Table 2). The effects of treatments T₂, T₃, T₄ and T₅ in terms of fruit length were all statistically similar. All the treatments recorded higher fruit length than the control. Islam *et al.* (1997) reported that the length of individual fruit was increased with the increasing of nitrogen levels. Nassar (1986) also observed similar findings.

Fruit breath

The maximum fruit breath of 4.75cm was recorded in treatment T₂ (200kg N + 35kg P +80kg K + 15kg S/ha) and the minimum fruit breath of 4.50cm was recorded in the control (Table 2). Treatments T₂, T₃, T₄ and T₅ recorded similar fruit breath but their effects were superior than the control. Nassar (1986) and Islam *et al.* (1997) posited similar opinions. They stated that the breadth of individual fruit increased with the increasing of nitrogen levels.

Fruit yield per plant

The weight of total fruit yield per plant ranged from 788.25g recorded in the control, to 1159.00g recorded in treatment T₂, which received the full dose of NPKS (Table 2). Treatment T₂ receiving the recommended dose of inorganic nutrients recorded statistically similar fruit yield /plant as that of treatments T₃, T₄ and T₅. Anwar *et al.*, (2001) found that cowdung along with fertilizer produced an optimum fruit yield of tomatoes grown in the grey terrace soil of Bangladesh. All the treatments except T₅ recorded significantly higher fruit yield per plant compared to the control.

Fruit yield per ha

The fruit yield/ha was significantly influenced by treatment type. The fruit yield ranged from 28.40 t/ha recorded in the control, to 44.11 t/ha recorded in treatment T₂, which received the full dose of NPKS (Table 2). Treatment T₂, and T₃ receiving 5t CD/ha plus half the recommended dose of inorganic nutrients and T₄ receiving 10t CD /ha plus one third the recommended dose of inorganic nutrients, recorded statistically similar fruit yield. Treatment T₅, which received 15t CD/ha alone produced statistically similar fruit yield as that of T₄. All the treatments recorded higher fruit yield than the control. This finding is supported by Rahman *et al.* (1996 and 1998) who reported that cow dung in combination with other fertilizers, plays an important role with respect to tomato fruit yield. Aditya (1993) reported that the highest tomato yield (60t/ha) was obtained by the application of 375kg N/ha, 225kg P/ha and 225kg K/ha along with cow dung at 10 t/ha. Nabi and Nandy (2001) observed in a fertilizer trial on summer tomatoes (BARI tomato-4) that 250 kg N, 150 kg P and 150kg K per hectare along with 10 t/ha of cow dung produced the highest yield (21.44 t/ha). Treatments T₂, T₃ and T₄ recorded a 55.32%, 54.26% and 50.42% increase in fruit yield over the control, respectively.

Economic performance

The highest gross return (Taka 2,64,600 /ha) was obtained from the treatment T₂, which received full doses of NPKS, followed by treatment T₃ (Taka 2,62,800 /ha), which received 5t CD/ha plus half the recommended dose of inorganic nutrients, and T₄ (Taka 2,56,200 /ha) receiving 10t CD/ha plus one third of the recommended dose of inorganic nutrients. Cow dung alone, at the rate of 15 t/ha, recorded moderate gross return. All the treatments recorded higher gross return over the control. A similar trend was observed in the case of net return. The highest total variable cost was recorded in the treatment receiving 15t CD/ha alone, which was closely related to other treatments except than that of control. The benefit cost ratio (BCR) was higher in treatment T₃ (4.38), which was closely followed by treatments T₂

Table3. Economic performance of tomato as affected by N P K S and cowdung

Treatment	Yield (t/ha)	Gross return (Tk/ha)	Total variable cost (Tk/ha)	Net return (Tk/ha)	Benefit cost ratio
1	2	3	4	5=(3-4)	6=(3/4)
T ₁ . Control	28.4	170400	53026	117374	3.21
T ₂ . N ₂₀₀ + P ₃₅ + K ₈₀ + S ₁₅	44.1	264600	60566	204034	4.36
T ₃ . CD ₅ + ½ of T ₂	43.8	262800	59926	202874	4.38
T ₄ . CD ₁₀ + ⅓ of T ₂	42.7	256200	61379	194821	4.17
T ₅ . CD ₁₅	36.3	217800	61786	156014	3.52

Cowdung (CD) and NPKS were applied in terms of t/ha and kg/ha, respectively

Means followed by common letter (s) in a column are not significantly different at 5% level by DMRT

Fertilizer cost: Urea	Tk 7.00/kg
TSP	Tk 15.00/kg
MP	Tk 10.00/kg
Gypsum	Tk 8.00/kg
Cowdung	Tk 0.50/kg
Tomato Price:	Tk 6.00/kg

(4.36) and T_4 (4.17).

Conclusion

The above results suggested that cow dung, at the rate of 5t/ha, in combination with half the recommended dose of inorganic nutrients appeared to be the best combination of fertilizer and natural nutrients which provided maximum benefit to the cultivator.

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