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Fertilizer Requirements for Grafted Tomato

[1]M.F. Hossain, [2]U.K. Majumder, [3]M.A.S. Mondol, [4]M.Z. Haque and [5]M.M. Haque
[1]Department of Agronomy, [2]Department of Statistics,
[3]Department of Agricultural Extension and [5]Department of Crop Botany,
Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200, Bangladesh
[4] Department of Crop Botany, Patuakhali Science and Technology University, Patuakhali, Bangladesh

Abstract: A pot experiment was conducted during November 2000 to March 2001 to find out the optimum fertilizer requirement of grafted tomato. Four levels of N, 4 levels of P, 4 levels of K, 2 levels of S and 1 kg sodium molybdate and 10 t ha^{-1} organic manure were applied in equal distribution to all these by using a selected set of 12 treatments. The highest tomato yield of 1459 g $plant^{-1}$ was obtained with the application of 200 kg N, 120 kg P_2O_5, 80 kg K_2O, 20 kg S ha^{-1}, which was statistically similar with $N_{150}P_{120}K_{80}S_{20}$, $N_{150}P_{40}K_{80}S_{20}$, $N_{100}P_{120}K_{80}S_{10}$, $N_{150}P_{120}K_0S_{20}$, $N_{150}P_{80}K_{80}S_{20}$ and $N_{150}P_{120}K_{120}S_{20}$ treatments. Yield increased 694% over control. On economic point of view $N_{150}P_{40}K_{80}S_{20}$ treatment was the most suitable fertilizer dose for grafted tomato because it gave 605% higher yield over control.

Key words: Grafting tomato, fertilizer, yield and economics

Introduction

Tomato (*Lycopersicon esculentum* Mill.) is one of the most important and nutritious vegetables in Bangladesh. Tomato is highly susceptible to various soil-borne diseases such as wilting and root knot etc. The wild non-tuberous *Solanum* species are highly resistant to wilt and root knot diseases and available almost everywhere in Bangladesh. Ali *et al.* (1994) established a technology to save the tomato plants from soil-borne diseases through grafting of tomato seedlings on wild *Solanum*. Now a days urban people like to cultivate tomato either on house roof or in the garden. Soil-borne diseases are also common in pot culture where grafting technology of tomato may be used potentially. But no report is so far available on the fertilizer requirement of the grafted plants. Subbiah and Sundararajan (1986) reported that the highest tomato yield increment by 74.5% over control was obtained with N:P_2O_5 at 100:150 kg ha^{-1}. Nasreen and Islam (1990) showed that N and P increased tomato yield more effectively than the other nutrients needed. Potassium, sulphur, zinc and molybdenum had hardly any effect. Han and Misra (1976) found that nitrogen application at higher rates improved plant growth, fruit yield and quality. It is likely that wild rootstock of grafted tomato may have changed nutrient requirement and absorbing capacity compared to a normal tomato plant. Therefore, it is imperative that optimum dose of various nutrients in the form of fertilizers for grafted tomato should be worked out. This experiment was therefore, undertaken to determine the optimum fertilizer dose for grafted tomato.

Materials and Methods

A pot experiment was carried out at the Farm of HMD Science and Technology University, Dinajpur, during November, 2000 to March, 2001 to find out the optimum dose of fertilizers for grafted tomato. An indeterminate type tomato variety "Ratan" was grafted on a wild eggplant, *Solanum torvum* (rootstock). There were 12 treatments in the experiment comprising of four levels of N (0, 100, 150 and 200 kg ha^{-1}), four levels of P_2O_5 (0, 40, 80 and 120 kg ha^{-1}), four levels of K_2O (0, 40, 80 and 120 kg ha^{-1}), two levels of S (0 and 20 kg ha^{-1}) and organic manure at 2:3 (cowdung:soil) ratio and M_0 @ 1 kg ha^{-1} was commonly used for all treatments. N, P, K, S, organic manures and M_0 were applied as urea, triple super phosphate, muriate of potash, gypsum, cowdung (cd) and sodium molybdate, respectively. The experiment was laid out in single factor randomized complete block design (RCBD) over locations with four replications. Tomato pots were placed in two locations namely, on house roof and on the bare garden soil. Each replication consisted of 13 pots and individual pot was 90x30 cm^2 in size accommodating 1 plant each. Each pot was filled with a mixture of 10 kg soil and cowdung at the ratio of 3:3, i.e. 6 kg soil and 4 kg cowdung/pot. Full amount of TSP, gypsum and sodium molybdate were added to each pot soil during seedling transplantation. Three weeks after grafting healthy and uniform seedlings were transplanted in the pot on November 21, 2000. Fruits were harvested at 2 days interval at ripening stage. Data on number of trusses/plant, number of flowers/truss, number of flowers $plant^{-1}$, number of fruits/truss, fruit setting rate, number

of fruits/plant, weight of individual fruit and yield/plant were recorded. Total nitrogen content of the plant samples was determined by kjeldahl method (Bremner *et al.*, 1965). Total Phosphorus and potassium contents of plant samples were estimated by perchloric acid digestion assay method (Yomakawa, 1992). The analysis of variance for various characters was done following the principle of F- test and mean separation was done following Duncan's multiple range test (DMRT) (Gomez and Gomez, 1984). Economic evaluation of different fertilizer combinations were performed through partial budgeting and dominance analysis followed by marginal analysis of the cost undominated treatments as suggested by Perrin *et al.* (1979).

Results and Discussion

Number of truss per plant: The number of truss per plant significantly differed among the treatments. Treatment T_7 gave the highest number, which was statistically similar to all other treatments except T_1, T_2 and T_{10}. The lowest number was found in control (T_1) which was statistically similar to treatments T_2, T_3, T_6, T_9, T_{10} and T_{13} (Table 1). In absence of N, P and K the production of truss was considerably lower. Number of truss/plant was 233% higher in T_7 than control (T_1). Anand and Muthukrishnan (1974) reported that N, P and K application enhanced and increased the production of flower truss in tomato plant.

Number of flowers per truss: The result reveals that there was significant difference among the treatments in respect of number of flowers per truss (Table 1). Treatment T_{10} produced the highest number, which was statistically identical with all other treatments except T_2 which produced the lowest number of flowers per plant. It was consistent with the result of Shil (1996). Between treatments T_4 and T_{13} (with same fertilizer combination), T_4 gave the higher number of flowers per truss (Table 1). Individually N or P or K application did not significant effect the number of flower/truss.

Number of flowers per plant: Statistically significant differences among different fertilizer treatments were observed in this parameter. The highest number of flowers per plant was noted in T_7, which was statistically identical with all other treatments except T_1 and T_2 and the lowest in T_1, the later was statistically identical with T_2, T_3, T_9 and T_{13} (Table 1). Production of flowers was 48% higher in T_7 compared to control. Between treatment (grafted) and T_{13} (non-grafted) (with same fertilizer combinations), T_4 gave higher number of flowers/plant (Table 1). Data also indicated that phosphatic fertilizer had no visible effect on flower production in grafted tomato. Similar observation were also made by Uexkull (1979) and Anand and Muthukrishnan (1974).

Number of fruits per truss: The number of fruits harvested per truss was statistically significant for all the treatments (Table 1). Maximum fruits were harvested from

Table 1: Effect of different fertilizers on flowering and fruiting characteristics of grafted tomato

Treatments	No. of trusses/ plant	No. of flowers/ truss	No. of flowers/ plant	No. of fruits/ truss	Fruit setting rate (%)	No. of fruits/ plant	Wt. of individual fruit (g)	Yield/ plant (g)
T_1:control	3.0d	5.3ab	15.3c	2.9bc	56.0ab	8.5cd	22.6b	185.2d
T_2:N_0+BDO	3.6cd	4.9b	18.6bc	2.0c	43.1b	7.1d	23.0b	146.9d
T_3:N_{100}+BDO	5.8b-d	6.8ab	37.5a-c	4.9a	72.6a	27.3ab	43.9a	1194.0a-c
T_4:N_{150}+BDO	8.5ab	6.6ab	50.8a	4.0ab	63.2ab	31.3ab	44.9a	1356.0ab
T_5:N_{200}+BDO	8.9ab	5.5ab	48.3a	3.9ab	71.2a	34.0ab	44.1a	1459.0a
T_6:P_0+BDO	7.0a-d	6.1ab	42.5ab	3.1bc	51.6ab	19.8bc	46.3a	934.3bc
T_7:P_{40}+BDO	10.0a	6.0ab	59.9a	3.4abc	59.0ab	33.9a	42.8a	1306.0ab
T_8:P_{80}+BDO	8.8ab	5.4ab	47.6a	3.4abc	64.1ab	28.8ab	40.8a	1097.0a-c
T_9:K_0+BDO	5.8a-d	6.9ab	35.3a-c	4.8a	71.6a	25.0ab	47.2a	1131.0a-c
T_{10}:K_{40}+BDO	5.5b-d	8.0ab	45.3a	4.1ab	59.0ab	23.1ab	42.2a	632.1bc
T_{11}:K_{120}+BDO	9.4ab	5.4ab	47.1a	2.9bc	50.1ab	25.1ab	43.3a	1044.0a-c
T_{12}:S_0+BDO	7.4abc	5.8ab	44.3a	2.5bc	50.0ab	18.0b-d	42.7a	774.2c
T_{13}:N_{150}+BDO*	6.9a-d	5.5ab	37.4a-c	3.8ab	68.5a	24.1ab	49.0a	1141.0a-c

Treatment means having common letters are non significantly different from each other at 5% level. BDO= Blanket dose of others. BD= $N_{150}P_{120}K_{80}S_{20}$, i.e., 150, 120, 80 and 20 kg ha^{-1} N, P_2O_5, K_2O and S, respectively. * It is used for non-grafted tomato.

Table 2: Nitrogen, Phosphorus and Potassium concentration in grafted tomato plants at final harvest

Treatments	Nitrogen (% dry wt.)	Phosphorus (% dry wt.)	Potassium (% dry wt.)
T_1:control	0.900b	0.085f	1.39c
T_2:N_0+BDO	0.930b	0.120de	2.25b
T_3:N_{100}+BDO	1.508ab	0.120de	2.74ab
T_4:N_{150}+BDO	1.715ab	0.135b-d	2.74ab
T_5:N_{200}+BDO	2.205a	0.118de	2.53b
T_6:P_0+BDO	2.215a	0.080f	2.93ab
T_7:P_{40}+BDO	1.730ab	0.100ef	2.88ab
T_8:P_{80}+BDO	1.600ab	0.110e	2.95ab
T_9:K_0+BDO	1.630ab	0.143bc	1.61c
T_{10}:K_{40}+BDO	1.755ab	0.108e	1.88c
T_{11}:K_{120}+BDO	1.920a	0.150b	3.11a
T_{12}:S_0+BDO	1.697ab	0.138b-d	3.06ab
T_{13}:N_{150}+BDO*	1.915a	0.193a	3.003ab

Treatment means having common letters are non significantly different from each other at 5% level

Table 3: Partial budget and dominance analysis for different fertilizer treatments used for grafted tomato

Treatment	Gross returns (Tk. ha^{-1})	Cost of fertilizer (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	Remarks
T_1:control	227600	0	27600	CUD
T_2:N_0+BDO	21752	4155	17597	CD
T_3:N_{100}+BDO	175040	5240	169800	CD
T_4:N_{150}+BDO	201240	5785	196355	CUD
T_5:N_{200}+BDO	216160	6330	209830	CUD
T_6:P_0+BDO	137880	3035	134845	CUD
T_7:P_{40}+BDO	193440	3948	189492	CUD
T_8:P_{80}+BDO	162600	4872	157728	CD
T_9:K_0+BDO	167520	4713	162807	CD
T_{10}:K_{40}+BDO	137080	5249	131831	CD
T_{11}:K_{120}+BDO	154680	6321	148359	CD
T_{12}:S_0+BDO	114680	5452	109228	CD
T_{13}:N_{150}+BDO*	168960	5785	163175	CD

CUD= Cost undominated, CD= Cost dominated, BDO= Blanket dose of others, BD= $N_{150}P_{120}K_{80}S_{20}$, i.e., 150, 120, 80 and 20 kg ha^{-1} N, P_2O_5, K_2O and S, respectively. Rate used= Tomato Tk. 4.0/kg, Urea= Tk. 5.0/kg, TSP= Tk. 11.0/kg, MP= Tk. 8.0/kg, Gypsum= Tk. 3.0/kg. * It is used for non-grafted tomato

the treatment T_3 which was statistically similar to treatments T_4, T_5, T_7, T_8, T_9, T_{10} and T_{13}. The lowest numbers was observed in T_2, which produced 59% lower number of fruits than that of T_3 (Table 1). Between treatments T_4 (grafted) and T_{13} (non-grafted) (with same fertilizer combinations), T_4 gave higher of fruits/truss (Table 1). Data revealed that nitrogen application did not affect the fruit number/truss while P or K increased the fruit numbers/truss.

Rate of fruit setting: Results revealed that the rate of fruit setting was statistically significant difference among the treatments (Table 1). Treatment T_3 gave the highest fruit setting rate, which was statistically identical to all other treatments except T_2, which showed the lowest fruit setting rate. Between treatments T_4 (grafted) and T_{13} (non-grafted) (with same fertilizer combinations), T_{13} gave higher fruit setting rate (Table 1).

Number of fruits per plant: Present study showed that the number of fruits per plant differed significantly due to combined application of N, P, K and S fertilizers as shown in Table 1. Number of fruits per plant varied from 7.125 to 34.00 with the maximum in T_5 and the minimum in T_2 treatment, indicating an increase by 377%. Between treatments T_4 (grafted) and T_{13} (non-grafted) (with same fertilizer combinations), T_4 gave the highest number of fruits/plant (Table 1).

Weight of individual fruit: There was significant difference among the various fertilizer treatments in respect of individual fruit weight. Maximum fruit weight was found in T_{13} i.e. non-grafted tomato, which was statistically identical to all other treatments except T_1 and T_2 treatments and the minimum in control (Table 1). Between treatments T_4 (grafted) and T_{13} (non-grafted) (with same fertilizer combinations), T_{13} produced the heavier fruits (Table 1).

Fruit yield per plant: There were significant differences among the different fertilizer treatments in respect of fruit yield/plant (Table 1). The highest yield of 1459 g was recorded in T_5. This was statistically identical with all other treatments except T_1, T_2, T_6, T_{10} and T_{12}. The lowest yield of 146.9 g was recorded in T_2 and was 893% lower than T_5. Between treatments T_4 (grafted) and T_{13} (non-grafted) (with same fertilizer combinations), fruit yield per plant was higher in T_4 (Table 1). Fruit yield per plant of grafted tomato was significantly increased with application of sulphur. The probable cause is the lower synthesis of nitrate in absence of sulphur. Marcchner (1986) reported that under sulphur deficiency, inhibition of protein synthesis is corrected with an accumulation of soluble organic nitrogen and nitrate.

Nutrient content in plant sample: N, P and K concentrations in grafted tomato plants at final harvest is presented in Table 2. Nitrogen content varied from 0.900

Table 4: Marginal analysis of cost undominated fertilizer treatments tested on grafted tomato

Cost undominated treatments	Gross margin (Tk. ha^{-1})	Variable cost (Tk. ha^{-1})	Marginal gross margin (Tk. ha^{-1})	Marginal variable (Tk. ha^{-1})	Marginal rate of return (MRR) (%)
T_5	216160	6330	14920	545	2737
T_4	201240	5785	7800	1837	424
T_7	193440	3948	55560	913	6085
T_6	137880	3035	110280	3035	3633
T_1	27600	-	-	-	-

to 2.215% and the highest concentration was found in T_6 whereas the lowest was in control (T_1). Phosphorus concentration varied from 0.08 to 0.193%. The highest P concentration was found in T_{13} (non-grafted), which was statistically different from all other treatments and the lowest was in T_6 treatment. Shil (1996) reported that $N_0P_{120}K_{80}S_{20}$ gave the highest amount of phosphorus. Potassium content of the grafted tomato plant varied from 3.11% in treatment T_{11} to 1.39% in control treatment. Treatment T_{11} was statistically identical with all other treatments except T_1, T_2, T_5, T_9 and T_{10}.

Economic evaluation: The partial budget analysis of fertilizer use indicates that the gross return increased with the increase of fertilizer rates (Table 3). Maximum gross margins of Tk. 2,16,160/= per ha was achieved in treatment T_5. Dominance analysis shows that the treatments T_2, T_7, T_8, T_9, T_{10}, T_{11}, T_{12} and T_{13} were dominated by cost factor. Marginal analysis of the cost undominated treatments is presented in Table 4. The maximum marginal rate of return of 6085% was obtained in treatment T_7. Hence application of 150 kg N, 40 kg P_2O_5, 80 kg K_2O, 20 kg S ha^{-1} appeared to be the most suitable fertilizer dose for grafted tomato in the present agro-ecological conditions from economic point of view.

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