

Performance of tomato varieties grafted with eggplant under rain shelter condition

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ABSTRACT

An experiment was conducted at the experimental field of Bangladesh Agricultural Research Institute (BARI), Gazipur during 2nd June 2013 to 1st September 2013 to develop a new grafting technique and rootstock EG03 and to increase tomato production during hot humid season in the country. Two variety of tomato viz. BARI hybrid tomato-4 (V₁) and BARI hybrid tomato-8 (V₂) were grafted with EG203 (R) along with control (non grafted) (R₀) in S=Rain Shelter and S₀ = Open condition (control). Results revealed that tomato yield improved when grafted with EG203 under rain shelter. Both BARI hybrid tomato-8 (32.29 t/ha⁻¹) and BARI hybrid tomato-4 (30.93 t ha⁻¹) grafted on EG203 obtained higher yield and earliness compared to other treatments under rain-shelter condition. But lower results were obtained when BARI hybrid tomato-8 (6.8 t/ha-1) and BARI hybrid tomato-4 (5.36 t/ha) grown under open field condition without grafting. There was significant difference in percent bacterial wilt among the combination. The highest bacterial wilt was recorded in combination of non-grafted BARI hybrid tomato-4 + Open condition (46.00%). These result revealed in open field condition non-grafted plant was more susceptible than grafted plant grown under shelter. In case of both varieties grafting and rain-shelter combination showed better performance than other treatment combinations.

INTRODUCTION

Tomato (*Solanum lycopersicum Mili.*) belongs to the family Solanaceae and is normally a self-pollinated annual crop. Tomato is a universally known vegetable and is one of the widest grown vegetable in the world and leads all other vegetables in total volume of production. Concerning food value, it is very rich because of higher contents precursors of vitamin A, vitamin B and C including calcium, iron and other minerals (Bose and Som, 1986). Lycopene in tomato is a powerful antioxidant and reduces the risk of prostate cancer (Hossain et al., 1999). In Bangladesh with a considerable total production of 1, 90,213 tons produced in an area of 23,827.53 hectares (BBS, 2011) in winter season. The average tomato yield in Bangladesh during winter

was 22.5 ton ha⁻¹ (BBS, 2013). But in summer season the production of tomato is lower than winter season. Because in this season production of tomato in the lowlands has always been a futile attempt because of the influence of unfavorable growing conditions specifically high rainfall, flooding, occurrence of bacterial wilt and high temperature and lack of suitable production technology (Zaman et al., 2006). The main problem of summer tomato production is bacterial wilt, fusarium wilt, and nematode. Soil-borne pathogens and pests such as Verticillium, Fusarium and Meloidogyne spp. may cause yield losses of up to 78% in production areas infested with Verticillium wilt (Bletsos et al., 2003). To control these type of problem Asian Vegetable Research and Development Centre, introduce a new eggplant varieties'EG203 rootstock for

grafting and invent a new grafting technique named rubber tube grafting of their high levels of resistance to bacterial wilt and *Fusarium* wilt, and root-knot nematode and flooding and to avoid the problem of complication, time consumption, high expense and lower success rate in traditional method. In this type of grafting success rate of plant is higher (85-95%) than traditional method (Thuran 2011). This technology is meant to increase tomato production during hot-wet months and at the same time increase farm productivity through the planting of a high-value crop. Among them BARI hybrid tomato 4 & 8 perform well then other variety, for this purpose we select BARI hybrid tomato 4 & 8 as scion variety for this experiment. Under the socio-economic condition of Bangladesh, rubber tube grafting of tomato and eggplant on resistant *Solanum* may be effective technique for the places where wilt, nematode, and excess rainfall problems are acute. It may also very much effective for the early production of tomato. Considering this fact the present investigation was undertaken to evaluate the performance of tomato varieties grafted with eggplant under open field and rain shelter condition.

MATERIALS AND METHODS

The experiment was carried out at the experimental Field of Bangladesh Agricultural Research Institute (BARI), Gazipur during 2nd June 2013 to 1st September. The experiment was conducted following Split plot design with scion × Rootstock as main plot factor and rain shelter as sub plot factor with 4 replications of eight treatments where plot size was 4.8m × 2.3m and Spacing was 0.6m × 0.4m. There were 48 plants per plot. BARI hybrid tomato-4 (V₁) and BARI hybrid tomato-8 (V₂) were used as scion, R= EG203 (grafted) and R₀ = Control (Non-graft) were used as rootstock in Factor A and S=Rain Shelter S₀=Open condition in case of Factor B in this experiment. Seeds of rootstock (EG203) were sown directly in small plastic cup. Tomato seeds for scion were sown in plastic tray, 7 days after sowing of rootstock seeds. At stage of 2-3 leaves of seedling and their stem diameter were 1.6–1.8 mm at the point of excision grafting was done. . The rootstock and tomato scion were cut above the cotyledons or first true leaf at 70 - 80° angle. To

graft the cut angles of the tube scion and rootstock a latex tube of an inner diameter 2.0 mm was cut into 10 mm length & at an angle of 70 – 80°. Grafted seedling transplanted after hardening. Data of days to first flowering, 50% flowering, plant height, primary braches per plant, flowers per cluster, fruits per cluster, flower clusters per plant, fruit set (%), Soil plant analysis development value (SPAD): fruit weight (g), yield per plant (g), yield (t/ha), % bacterial wilt infestation. The value of fruit set (%) was calculated by the following formula:

$$\text{Fruit set \%} = \frac{\text{Total number of fruits of 1st five cluster of selected plants}}{\text{Total number of flowers of 1st five cluster of selected plants}} \times 100$$

SPAD value at Vegetative stage, at flowering stage and at fruiting stage were taken and at the time of taking data 3 types of leaves (older leaf, middle leaf, and tender leaf) were used at every stage. Data of yield was collected during harvest and disease infestation was collected at regular basis.

Data were evaluated by analysis of variance, and means were compared by the method of Duncan, using a significance level of 5 % (GOMEZ and GOMEZ 1984).

RESULTS AND DISCUSSION

Interaction effect of grafting and rain shelter condition on growth and performance of tomato varieties grafted with eggplant were observed.

Effect on plant height

The plant height due to interaction effect between grafting and shelter was found significant (Table 1). It was also observed that plant height was gradually increased up to final harvesting. The highest plant height (120.35 cm) was recorded in non-grafted BARI hybrid tomato-8 when cultivated under rain shelter. While it was at par with non-grafted BARI hybrid tomato-4 under rain shelter (Table. 1), these results indicated higher growth performance by non-grafted plant when grown under rain shelter was due to un-interrupted growth condition in rain shelter. The temperature under the rain shelter was also congenial for growth.

Table 1
Interaction effect of grafting and rain shelter on plant height at different stage of plant growth.

Treatment Combination	Plant height @			
	1 st flowering (cm)	50% flowering (cm)	1 st harvest (cm)	Final harvest (cm)
T ₁ (Grafted BARI hybrid tomato-4 + Rain Shelter)	43.20	48.97 c	96.15 c	101.20 c
T ₂ (Grafted BARI hybrid tomato-4 + Open condition)	39.70	43.88 d	82.52 ef	86.98d e
T ₃ (Non-grafted BARI hybrid tomato-4 + Rain Shelter)	50.78	58.82 a	113.58 a	118.02 a
T ₄ (Non-grafted BARI hybrid tomato-4 + Open condition)	45.92	51.30 b	78.45 f	82.53 e
T ₅ (Grafted BARI hybrid tomato-8 + Rain Shelter)	42.35	48.92 c	102.27 b	106.78 b
T ₆ (Grafted BARI hybrid tomato-8 + Open condition)	38.65	43.27 d	87.95 d	92.25 d
T ₇ (Non-grafted BARI hybrid tomato-8 + Rain Shelter)	50.15	59.12 a	115.75 a	120.35 a
T ₈ (Non-grafted BARI hybrid tomato-8 + Open condition)	43.50	47.88 c	85.82 de	90.69 d
Level of significance	NS	*	**	**
% CV	4.13	3.31	4.38	4.23

Table 2
Interaction effect of grafting and rain shelter on days to first flowering, days to 50% flowering of tomato.

Treatment Combination	Days to first flowering	Days to 50% flowering
Grafting × Rain shelter		
T ₁ (Grafted BARI hybrid tomato-4 + Rain shelter)	22.75	26.26 bc
T ₂ (Grafted BARI hybrid tomato-4 + Open condition)	23.75	28.50 a
T ₃ (Non-grafted BARI hybrid tomato-4 + Rain shelter)	21.25	25.00 d
T ₄ (Non-grafted BARI hybrid tomato-4 + Open condition)	22.00	26.25 bc
T ₅ (Grafted BARI hybrid tomato-8 + Rain shelter)	22.50	27.00 b
T ₆ (Grafted BARI hybrid tomato-8 + Open condition)	23.25	28.25 a
T ₇ (Non-grafted BARI hybrid tomato-8 + Rain shelter)	21.76	25.75 cd
T ₈ (Non-grafted BARI hybrid tomato-8 + Open condition)	21.75	26.00 c
Level of significance	NS	**
%CV	2.81	1.71

Effect on days to 1st and 50% flowering

The data pertaining to the 1st flowering was not significant but days to 50% flowering showed significant variation among the treatments (Table 2). The earliest days to 50% flowering was observed in T₃ (25.00 days) treatment combination where non-grafted BARI hybrid tomato-4 was grown under rain shelter condition, which was statistically similar with combination under rain shelter T₇ (25.75days). On the other hand days to

50% flowering were late in combination T₂ (28.50 days), when BARI hybrid tomato-4 grafted plant was grown in open condition and at par with T₆ (28.25) when BARI hybrid tomato-8 grafted grown in open condition. This result also indicated that grafted plant took the maximum time for 50% flowering when grown in open field condition. High temperature may delay the flowering. Khah (2011) found that the non-grafted eggplant plants had earlier flowering than grafted plants, which support our findings.

Table 4

Interaction effect of grafting and rain shelter on flowers per cluster, fruits per cluster, fruit clusters per plant of tomato.

Treatment Combination	Flowers per cluster	Fruits per cluster	Fruit clusters per plant
Grafting × Rain shelter			
T ₁ (Grafted BARI hybrid tomato-4 + Rain shelter)	6.20	4.56 a	11.00 d
T ₂ (Grafted BARI hybrid tomato-4 + Open condition)	5.12	2.52 c	7.60 f
T ₃ (Non-grafted BARI hybrid tomato-4 + Rain shelter)	6.05	4.10 b	12.45 b
T ₄ (Non-grafted BARI hybrid tomato-4 + Open condition)	5.22	2.12 d	8.02 e
T ₅ (Grafted BARI hybrid tomato-8 + Rain shelter)	6.58	4.12 b	11.82 c
T ₆ (Grafted BARI hybrid tomato-8 + Open condition)	5.75	2.12 d	7.90 f
T ₇ (Non-grafted BARI hybrid tomato-8 + Rain shelter)	6.45	4.02 b	13.86 a
T ₈ (Non-grafted BARI hybrid tomato-8 + Open condition)	5.22	2.02 d	8.55 e
Level of significance	NS	*	**
%CV	7.56	7.26	3.53

Table 5

Interaction effect of grafting and rain shelter on (%) fruit set in tomato.

Treatment Combination	fruit set %
Grafting × Rain shelter	
T ₁ (Grafted BARI hybrid tomato-4 + Rain shelter)	73.45 a
T ₂ (Grafted BARI hybrid tomato-4 + Open condition)	49.08 d
T ₃ (Non-grafted BARI hybrid tomato-4 + Rain shelter)	68.02 b
T ₄ (Non-grafted BARI hybrid tomato-4 + Open condition)	40.85 e
T ₅ (Grafted BARI hybrid tomato-8 + Rain shelter)	70.39 a
T ₆ (Grafted BARI hybrid tomato-8 + Open condition)	46.96 d
T ₇ (Non-grafted BARI hybrid tomato-8 + Rain shelter)	63.95 bc
T ₈ (Non-grafted BARI hybrid tomato-8 + Open condition)	36.71 f
Level of significance	**
%CV	6.88

Effect on flowers per cluster and fruit per cluster

It this field experiment Flower per was not statistically significant but Fruits per cluster varied significantly among the combinations (Table 4). Combination T₁ (4.56) gave maximum number of

fruit per cluster and combination T₈ (2.02) gave minimum number of fruits per cluster. These results also clearly indicated the higher performance in case of fruit production per cluster in grafted plants when grown under rain shelter. Similar result was also found by Khah (2011).

Effect of fruit clusters per plant

Clusters per plant varied significantly among the combinations (Table 4). The highest clusters per plant were recorded from both the variety of non-grafted under rain shelter, T₁ (13.86) followed by T₃ (12.45) and combination T₂ (7.60) produced the lowest number of cluster per plant. However non-grafted tomato plants showed better performance when grown under rain shelter.

Effect on fruit set (%)

In respect of percent fruit set significant variation was observed among the combinations (Table 5). Maximum fruit set percentage was recorded in combination T₁ (73.45%) and minimum was in combination T₈ (38.71%). This results showed higher fruit set (%) in grafted plant compare to non-grafted one when grown under rain shelter. Khah (2011) found that the grafted eggplant plants had earlier flowering than un-grafted, which lead

to higher proportion of fruit setting percentage and bigger production during the primary period, under either greenhouse or open field conditions.

Effect on SPAD value

SPAD value was significantly varied among the combinations at vegetative stage, flowering stage and fruiting stage (Table. 6). In case of vegetative stage SPAD value was higher in rain shelter in respective of variety. This might be due to regular and luxuries plant growth under rain shelter. Almost similar results were obtained in flowering stage. Maximum SPAD value at fruiting stage was obtained grafted and rain shelter treatment T₅ (50.47) closely followed by T₁ (49.38) and the minimum from open field condition T₄ (43.35). From the above discussion we observed that in every graft × shelter treatment combinations showed better result than non-graft × non-shelter treatment combinations.

Table 6

Interaction effect of grafting and rain shelter on SPAD value in tomato.

Treatment Combination	SPAD value @		
	Vegetative Stage	Flowering stage	Fruiting Stage
T ₁ (Grafted BARI hybrid tomato-4 + Rain shelter)	44.42 a	58.32 a	49.38 b
T ₂ (Grafted BARI hybrid tomato-4 + Open condition)	41.95 b	55.10 d	46.98 c
T ₃ (Non-grafted BARI hybrid tomato-4 + Rain shelter)	44.72 a	56.02 bcd	45.58 d
T ₄ (Non-grafted BARI hybrid tomato-4 + Open condition)	41.40 bc	52.17 f	43.35 f
T ₅ (Grafted BARI hybrid tomato-8 + Rain shelter)	44.98 a	57.80 ab	50.47 a
T ₆ (Grafted BARI hybrid tomato-8 + Open condition)	40.75 c	55.27 d	44.65 e
T ₇ (Non-grafted BARI hybrid tomato-8 + Rain shelter)	44.68 a	56.80 cbc	47.22 c
T ₈ (Non-grafted BARI hybrid tomato-8 + Open condition)	40.56 c	54.72 e	45.50 d
Level of significance	**	**	**
%CV	1.07	1.63	1.10

Effect on individual fruit weight

In respect of fruit weight, significant variation was observed among the combinations (Table. 7). Maximum fruit weight was recorded in combination T₅ (54.82 g) which was statistically similar with combination T₁ (50.67 g), and minimum was recorded in combination T₄ (28.32 g). It may be mentioned that BARI hybrid tomato-

8 perform better irrespective of grafting, non-grafting rain shelter and open field condition. Again non-grafted plant of BARI hybrid tomato 4& 8 perform better under rain shelter than open field condition. Khah et al. (2006), who reported that grafted tomato plants produced bigger fruits than non-grafted ones under rain shelter condition.

Table 7
Interaction effect of grafting and rain shelter on fruit weight (g), fruit yield/plant in tomato.

Treatment Combination	Individual fruit weight(g)	Fruit yield/plant
Grafting × Rain shelter		
T ₁ (Grafted BARI hybrid tomato-4 + Rain shelter)	50.67 a	1165.8 d
T ₂ (Grafted BARI hybrid tomato-4 +Open condition)	31.00 e	421.0 e
T ₃ (Non-grafted BARI hybrid tomato-4 + Rain shelter)	45.82 c	1325.9 b
T ₄ (Non-grafted BARI hybrid tomato-4 + Open condition)	28.32 f	368.2 f
T ₅ (Grafted BARI hybrid tomato-8 + Rain shelter)	54.82 a	1258.9 c
T ₆ (Grafted BARI hybrid tomato-8 + Open condition)	35.36 d	458.9 e
T ₇ (Non-grafted BARI hybrid tomato-8 + Rain shelter)	50.10 b	1417.9 a
T ₈ (Non-grafted BARI hybrid tomato-8 + Open condition)	30.32 e	382.1 f
Level of significance	**	**
%CV	5.45	2.64

Effect on fruit yield per plant

Significant variation observed among the combinations in case of fruit yield per plant (Table. 7). Maximum yield was recorded in combination T₇ (1417.9 g) and minimum was In T₄ (368.2 g). This result clearly indicated that the maximum and minimum values were obtained non grafted plants. This might be due to cultivar and temperature differences. Rouphael *et al.* (2010) reported that the fruit yield per plant was higher in non-grafted tomato plant which grown under rain shelter than in grafted plants which grown under rain shelter

Effect on fruit yield per hectare

Fruit yield per hectare exhibited significant difference among the combinations (Figure. 1). Grafted tomato varieties displayed higher yield compare to non-grafted under rain shelter. The highest fruit yield per hectare was observed in combination G₃S₁ (32.29 t ha⁻¹). The lowest yield was observed in combination G₂S₀ (5.36 t ha⁻¹). These results proved that grafted plan produced the maximum yield per hectare compare to non-grafted and when those grown under rain shelter. Aganon et al. (2004) also found 340 % higher yield in grafted plants under rain shelter compare to non-grafted open field condition.

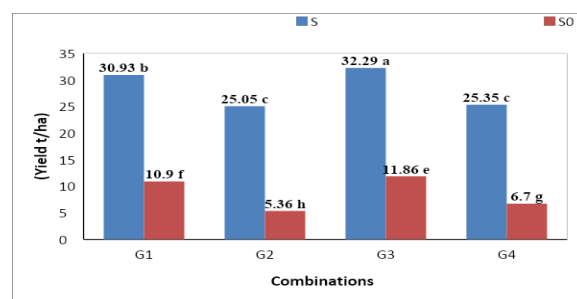


Figure 1

Yield (t ha⁻¹) as affected by grafting and rain shelter. G₁= EG203 × BARI hybrid tomato-4, G₂= BARI hybrid tomato-4 (control), S= Rain shelter, G₃= EG203 × BARI hybrid tomato-8, G₄= BARI hybrid tomato-8 (control), S₀= Open field. Interaction (Graft × Rain shelter) effect on Bacterial wilt (%)

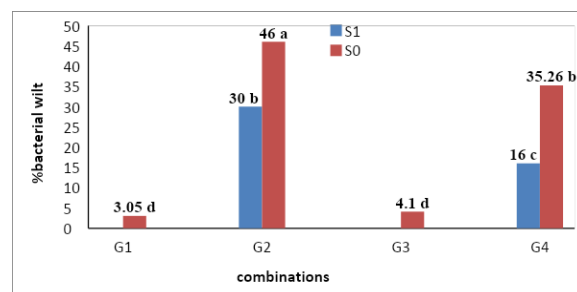


Figure 2

Level of bacterial (%) wilt as affected by grafting and rain shelter in tomato.

There was significant difference in percent bacterial wilt among the combination (Figure 2). The highest bacterial wilt percentage was recorded in combination T₄ (46.00%) which was followed by combination T₈ (35.26%). These result raveled by non-grafted plant in open field condition was more susceptible than grafted plant grown under shelter. These result also proved that EG203 rootstock was resistant to bacterial wilt. The world vegetable center- AVRDC (2004) reported that tomato grafting was shown to improve resistance against flooding and bacterial wilt gave a high plant survival rate (90-95 %) and increased the marketable fruit yield.

CONCLUSION

The BARI hybrid tomato 8 showed better performances when grafted on EG 203 compared BARI hybrid tomato 4 and grafted tomato plant perform better under rain shelter than open field condition, in respect of bacterial wilt percentage, individual fruit weight, fruit yield per plant and fruit yield per hectare.

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