

Heat Tolerance and Insect, Diseases Reaction in Eggplant Hybrids during the Summer Season in Bangladesh

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Abstract. A study was evaluated with 20 F₁'s lines/ variety at Olericulture Division, Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute, Gazipur during the summer season of 2017 to develop new high yielding hybrids having tolerance to high temperature and insect [eggplant fruit and shoot borer (EFSB)], disease [bacterial wilt and phomopsis blight]. The concern lines/ variety varied significantly for their response to all characters ($P < 0.05$). The hybrid F₁ 14X216 required minimum 90.33 days to first harvest. Highest marketable fruit number was found by F₁ 14X233 (66.92). Heavier sized fruit was obtained by F₁ 19X5 98.11 g), which was identical with F₁ 5X8 (95.17 g), F₁ 5X203 (95.17 g). The plant height ranges at first and last harvest was 70.00 - 97.88 days and 92.89 - 137.11 days, respectively. The fruit infection by EFSB was 7.40 - 15.40 %, while lowest in F₁ 5X8 (7.40 %), which was identical to F₁ 13X11 (7.45 %). Zero percent bacterial wilt and phomopsis blight diseases incidence was observed in F₁ 1X216, F₁ 1X233, F₁ 14X233, F₁ 19X203, F₁ 19X216 in field level. The yield range of eggplant hybrids was 24.68- 41.49 t/ha. The highest fruit yield was produced from F₁ 14X233 (41.39 t/ha), followed by F₁ 14X216 (35.70 t/ha), F₁ 1X233 (34.08 t/ha), F₁ 19X216 (33.80 t/ha), F₁ 5X233 (33.75 t/ha), F₁ 5X8 (31.54 t/ha), and lowest yield were recorded from F₁ 14X5 (24.68 t/ha). Though the yield was higher in the hybrids F₁ 14X233, F₁ 14X216, F₁ 1X233, F₁ 19X216, F₁ 5X233, F₁ 5X8, but considering attractive fruit shape and fruit colour, earliness, tolerance to high temperature, fruit infection by EFSB, bacterial wilt and phomopsis blight infestation, the hybrids F₁ 1X233, F₁ 5X8, F₁ 13X11, F₁ 14X233, F₁ 14X216, F₁ 19X216, F₁ 19X233, F₁ 21X221B were found best. So these seven hybrids can be selected for advance trial.

Keywords: Heat tolerance, insect and disease reaction, eggplant hybrids, summer season, Bangladesh.

1 Introduction

Eggplant (*Solanum melongena* L.) is the most popular vegetable crop in respect of total acreage (50,415 ha) and production (504,817 ton) in Bangladesh with an average yield of 10.0 tons per hectare (Anon., 2017), which is very low as compared to that in other eggplant producing countries. High yielding variety either hybrid and open pollinated (OP) varieties are important factors for maximizing the yield of eggplant. Increased productivity in the shortest time can be achieved through heterosis breeding (Kakizaki, 1931). Highly varied consumer acceptance demands development of high-yielding F₁ hybrids. Exploitation of hybrid vigor has become a potential tool for improvement in eggplant (Bavage *et al.*, 2005; Dharwad *et al.*, 2011; Prabhu *et al.*, 2005). The estimation of heterosis for yield and its component characters would be useful in determining the best hybrid combination. So, there is a great chance to get higher yield using hybrid exploitation in eggplant. Eggplant has the potential for improvement through heterosis breeding, which can be further utilized for development of desirable recombinants.

Eggplant offers the possibility of improvement through heterosis breeding and continues to be a choice of breeders for exploitation of heterosis due to the hardy nature of the plant, comparatively large size of flowers, and large numbers of seed produced by a single act of pollination. Depending on the varieties used, resistance to *R. solanacearum* is controlled by a single dominant gene (Ajjappalavara *et al.*, 2008; Cao *et al.*, 2009; Gopinath and Zhu *et al.*, 2004) or one recessive gene (Sun *et al.*, 2008) or a dominant polygene (Chaudhary, 2000) or recessive polygene (Feng *et al.*, 2003).

A heterosis study was used to determine heterosis over better parent for 12 characters in 2014. Best five crosses were selected on the basis of their per se (mean) performance: heterosis and the SCA effects. These hybrids could be used commercially due to high yield and low percentage disease for bacterial wilt disease and phomopsis blight. In our country, the yield of eggplant during summer season is low compare to winter season. The main causes of low production are scarcity of summer type heat tolerant good quality eggplant hybrid varieties and also scarcity of bacterial wilt and phomopsis blight disease tolerant good quality eggplant hybrid varieties. So keeping this information, this study was undertaken to study the performance of hybrids regarding yield and having tolerance to high temperature and eggplant fruit and shoot borer and bacterial wilt disease and phomopsis blight.

2 Materials and Methods

The study was conducted at the experimental farm of Olericulture Division, Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute, Gazipur during the summer of 2017. The experimental field was at 23.9917° N Latitude and 90.4124° E Longitudes having an elevation of 8.2 m from sea level. Twenty eggplant hybrid/ varieties viz., F₁ 1X216, F₁ 1X233, F₁ 3X229, F₁ 4X203, F₁ 5X8, F₁ 5X203, F₁ 5X233, F₁ 13X11, F₁ 14X5, F₁ 14X8, F₁ 14X216, F₁ 14X233, F₁ 18X216, F₁ 18X233, F₁ 19X5, F₁ 19X203, F₁ 19X216, F₁ 19X233, F₁ 21X221B, BARI Hybrid Begun-4 were included in the study. The seeds were sown on the seedbed on 15 March 2017. Thirty-two days old seedlings were transplanted in the main field on 16 April, 2017. The experiment was laid out in a RCB design with three replications. The plot size was 7.5 x 0.70 m and 10 plants were accommodated in a plot with a plant spacing of 75 cm apart in single row maintaining a row to row distance of 1 m with 50 cm drain. The land was fertilized with cowdung, N, P, K, S, Zn and B @ 10,000 100, 30, 75, 13, 1.5 and 0.8 kg/ha, respectively. One third of the cow-dung and half of P and full of S, Zn and B were applied during final land preparation. Rest of cow-dung and P and 1/3 of K were applied as basal in pit. Entire amount of N and rest of K were applied in five equal installment starting from 20 days after transplanting. Rest four installments were applied at vegetative, flowering, initial fruiting stage and pick fruiting stage. Concern all operations like- irrigation, weeding, crop protection measures and other intercultural operations were done following standard cultural practices. Data were recorded from five randomly selected plants per entry per replication on - days to 1st harvest, marketable fruit number/ plant, average fruit weight (g), fruit weight/ plant (kg), fruit length (cm), fruit diameter (cm), plant height at 1st harvest (cm), plant height at last harvest (cm), fruit infection by EFSB (%), bacterial wilt infestation (%), little leaf infestation (%), phomopsis blight infestation (%), fruit yield (t/ha), fruit shape and fruit colour. The information on different characters was statistically analyzed.

Table 1. The weather data of Gazipur during summer season, 2017

Month 2017	Temperature			Humidity (%)
	High	Low	Average	
April	36 °C	20 °C	28 °C	72
May	36 °C	21 °C	30 °C	71
June	40 °C	24 °C	30 °C	78
July	36 °C	25 °C	29 °C	81
Aug	34 °C	26 °C	29 °C	82
Sep	35 °C	25 °C	29 °C	81

Table 2. Chemical properties of initial soil of the experimental field of BARI, Gazipur during summer season, 2017

Locations	pH	OM %	Ca	Mg	K	Total	P	S	Zn	B	Fe	Mn	Cu
			meq 100 g ⁻¹			N%							
Gazipur	7.4	0.93	5.47	2.41	0.17	0.054	14.9	17.3	1.64	0.21	33.6	4.3	2.3
Critical level			2.0	0.50	0.12	0.12	7	10	0.6	0.20	4.0	1.0	0.2

3 Results and Discussion

Mean performances of eggplant hybrids are presented in Table 3, 4, 5 and Figure 1. The hybrids varied significantly ($P < 0.05$) for their response to days to 1st harvest, marketable fruit number/ plant, average fruit weight, fruit weight/ plant, fruit length, fruit diameter, plant height at 1st harvest, plant height at last harvest, fruit infection by EFSB, bacterial wilt infestation, fruit yield. In respect of days to first harvest, the earliest line was F₁ 14X216 (90.33 days) followed by F₁ 19X216 (92.60 days), F₁ 4X203 (93.70 days) and hybrid F₁ 1X233 was the most delayed (106.00 days). The range of marketable fruit number was (26.56 – 66.92). The highest marketable fruit number per plant was counted in F₁ 14x 233 (66.92) which followed by F₁ 14X216 (54.10), F₁ 1X233 (47.16), F₁ 19X233 (43.78), F₁ 19X216 (43.12), while lowest fruit number was counted in F₁ 19X5 (26.56). Average fruit weight is an important criterion to select a high yielder line. The heaviest fruit was produced in F₁ 19X5 (98.11 g), which was identical with F₁ 5X8 (95.17 g), F₁ 5X203 (95.17 g), while lightest fruit was in F₁ 14X233 (55.93 g). Fruit weight/ plant was maximum in F₁ 14X233 (3.76 kg) followed by F₁ 14X216 (3.24 kg), F₁ 19X216 (3.07 kg), F₁ 1X233 (3.09 kg), F₁ 5X233 (3.00 kg), F₁ 5X8 (2.87 kg), while minimum was in F₁ 14X5 (2.24 kg). Identical longest fruit was produced by F₁ 1x233 (19.10 cm) and F₁ 19X233 (18.72 cm) followed by F₁ 1x216 (17.20 cm) and F₁ 14X5 produced the shortest fruit (8.57 cm). Maximum diameter fruit was produced by the line F₁ 5X8 (6.75 cm) followed by F₁ 21X221B (5.62 cm), BARI Hybrid Begun 4 (5.42 cm), F₁ 18X216 (5.15 cm) and minimum was by F₁ 14X233 (2.95 cm). The range of plant height at first and last harvest was 70.00 - 97.88 days and 92.89 - 137.11 days, respectively.

Table 3. The yield and yield contributing characters of 20 hybrids/ variety of eggplant

Treatment	Days to 1st harvest	Marketable fruit number/plant	Average fruit weight (g)	Fruit weight/ plant (kg)
F ₁ 1X216	103.45 b	39.60 c-e	69.80 g	2.76 b-e
F ₁ 1X233	106.00 a	47.16 bc	66.20 h	3.09 bc
F ₁ 3X229	96.80 f-h	32.853 e-i	74.33 ef	2.43 de
F ₁ 4X203	93.70 ij	32.18 e-i	72.50 fg	2.32e
F ₁ 5X8	103.07 bc	30.23 f-i	95.17 a	2.87 b-e
F ₁ 5X203	96.60 hi	27.74 g-i	95.17 a	2.60 b-e
F ₁ 5X233	97.40 f-h	38.38 d-f	79.88 d	3.00 b-d
F ₁ 13X11	99.67 d-f	30.90 f-i	83.40 c	2.56 c-e
F ₁ 14X5	104.13 ab	29.45 g-i	76.31 e	2.24 e
F ₁ 14X8	103.45 b	38.00 d-f	71.27 fg	2.70 b-e
F ₁ 14X216	90.33 k	54.10 b	59.97 i	3.24 ab
F ₁ 14X233	101.67 b-d	66.92 a	55.93 j	3.76 a
F ₁ 18X216	99.60 d-g	27.16 hi	88.40 b	2.38 e
F ₁ 18X233	102.73 bc	31.56 e-i	80.52 cd	2.53 c-e
F ₁ 19X5	100.45 c-e	26.56 i	98.11 a	2.60 b-e
F ₁ 19X203	97.73 e-h	35.67 d-h	71.27 fg	2.54 c-e
F ₁ 19X216	92.60 jk	43.12 cd	71.27 fg	3.07 b-d
F ₁ 19X233	96.67 g-i	43.78 cd	63.40 h	2.77 b-e
F ₁ 21X221B	98.33 e-h	31.36 e-i	81.57 cd	2.53 c-e
BARI Hybrid Begun 4	103.11 bc	35.98 d-g	71.93 fg	2.59 c-e
Level of sig.	*	*	*	*
CV (%)	1.82	13.93	2.45	14.41

Table 3. Contd.

Treatment	Fruit length (cm)	Fruit diameter (cm)	Plant height at 1st harvest (cm)	Plant height at last harvest (cm)
F ₁ 1X216	17.20 b	2.65 l	80.00 i	121.89 a-c
F ₁ 1X233	19.10 a	3.59 jk	97.88 a	137.11 a
F ₁ 3X229	11.43 f	3.35 k	83.00 g	127.55 ab
F ₁ 4X203	9.23 hi	5.00 de	76.33 k	110.00 b-d
F ₁ 5X8	13.55 d	6.75 a	91.22 b	118.78 a-c
F ₁ 5X203	8.75 jk	4.65 fg	76.33 k	110.00 b-d
F ₁ 5X233	9.07 ij	4.09 i	87.66 d	118.45 a-c
F ₁ 13X11	8.81 jk	3.69 j	78.00 j	114.11 b-d
F ₁ 14X5	8.57 k	4.74 e-g	78.00 j	117.11 a-c
F ₁ 14X8	15.48 c	3.35 k	80.00 i	117.45 a-c
F ₁ 14X216	13.37 d	3.35 k	81.00 h	117.78 a-c
F ₁ 14X233	10.70 g	2.95 l	70.33 m	102.22 cd
F ₁ 18X216	11.61 f	5.15 cd	89.66 c	92.89 d
F ₁ 18X233	9.53 h	4.86 d-f	85.66 e	119.78 a-c
F ₁ 19X5	12.57 e	4.55 gh	80.00 i	120.11 a-c
F ₁ 19X203	10.70 g	4.98 de	73.33 l	112.00 b-d
F ₁ 19X216	15.27 c	4.32 hi	83.00 g	125.55 ab
F ₁ 19X233	18.72 a	2.85 l	83.00 g	114.45 b-d
F ₁ 21X221B	11.00 g	5.62 b	70.00 m	111.78 b-d
BARI Hybrid Begun 4	9.00ij	5.42 bc	84.00 f	131.22 ab
Level of sig.	*	*	*	*
CV (%)	1.92	4.34	0.58	11.24

Table 4. Fruit infection by EFSB, infestation by bacterial wilt infestation and phomopsis blight of 20 hybrids/ variety of eggplant

Treatment	Fruit infection by EFSB (%)	Bacterial wilt infestation (%)	Phomopsis blight infestation (%)
F ₁ 1X216	9.40 f	0.00 c	0.00 b
F ₁ 1X233	12.40 c	0.00 c	0.00 b
F ₁ 3X229	10.40 e	10.00ab	10.00 a
F ₁ 4X203	11.40 d	3.33 bc	0.00 b
F ₁ 5X8	7.40 h	3.33 bc	0.00 b
F ₁ 5X203	15.40 a	13.33 a	0.00 b
F ₁ 5X233	9.60 f	0.00 c	3.33 ab
F ₁ 13X11	7.45 h	3.33 bc	0.00 b
F ₁ 14X5	9.40 f	3.33 bc	0.00 b
F ₁ 14X8	9.40 f	0.00 c	3.33 ab
F ₁ 14X216	9.40 f	0.00 c	3.33 ab
F ₁ 14X233	8.40 g	0.00 c	0.00 b
F ₁ 18X216	13.40 b	10.00ab	10.00 a
F ₁ 18X233	10.40 e	10.00ab	0.00 b
F ₁ 19X5	8.40 g	3.33 bc	0.00 b
F ₁ 19X203	10.40 e	0.00 c	0.00 b
F ₁ 19X216	8.40 g	0.00 c	0.00 b
F ₁ 19X233	10.40 e	0.00 c	3.33 ab
F ₁ 21X221B	11.40 d	6.66 a-c	0.00 b
BARI Hybrid Begun 4	13.16 b	0.00 c	3.33 ab
Level of sig.	*	*	*
CV (%)	3.92	157.95	122.50

The range of fruit infection by EFSB was 7.40 - 15.40 %, while lowest in F₁5X8 (7.40 %), which was identical to F₁13X11 (7.45 %) and followed by F₁14X233, F₁19X5, F₁19X216 (8.40 %), F₁1X216, F₁14X5, F₁14X8, F₁14X216 (9.40 %) and highest was in F₁5X203 (15.40 %). In case of bacterial wilt (BW) infestation at field level performance, zero percent incidence was observed in F₁1X216, F₁1X233, F₁5X233, F₁14X8, F₁14X216, F₁14X233, F₁19X203, F₁19X216, F₁19X233, BARI Hybrid Begun 4, while maximum was observed in F₁5X203 (13.33 %). Phomopsis blight diseases zero percent incidence were observed in the lines viz., F₁1X216, F₁1X233, F₁4X203, F₁5X8, F₁5X203, F₁13X11, F₁14X5, F₁14X233, F₁18X233, F₁19X5, F₁19X203, F₁19X216, F₁21X221B. Morphological characteristics of the lines are presented in table 4.

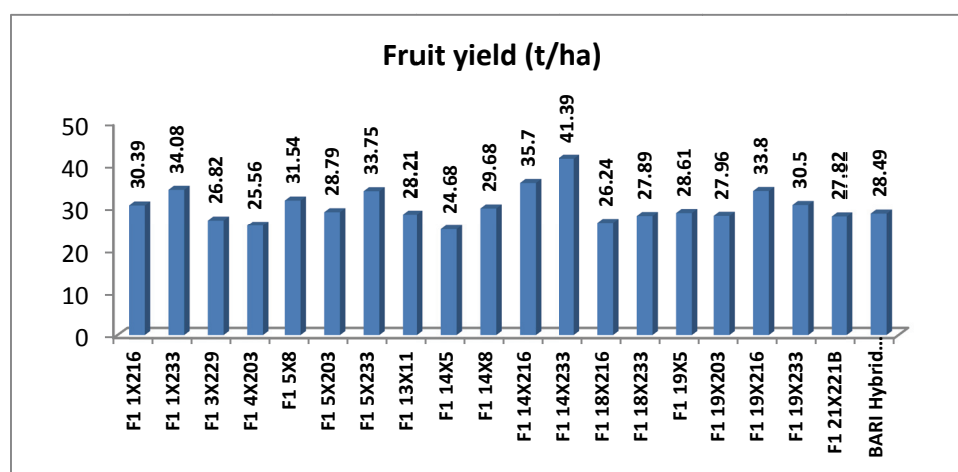


Figure 1. Fruit yield (t/ha) of 20 eggplant hybrids/ variety

Table 5. Fruit shape and colour of 20 eggplant hybrid lines/ variety

Hybrids	Fruit shape	Fruit colour
F ₁ 1X216	Cylindrical	Purple
F ₁ 1X233	Cylindrical	Purple
F ₁ 3X229	Elongate	Light green
F ₁ 4X203	Oblong	Purple
F ₁ 5X8	Elongate	Purple
F ₁ 5X203	Oval	Purple
F ₁ 5X233	Oblong	Purple
F ₁ 13X11	Oval	Light green with white spot at bottom
F ₁ 14X5	Oblong	Purple
F ₁ 14X8	Oblong	Purple
F ₁ 14X216	Elongate	Purple
F ₁ 14X233	Elongate	Purple
F ₁ 18X216	Oblong	Purple
F ₁ 18X233	Oblong	Purple
F ₁ 19X5	Oblong	Purple
F ₁ 19X203	Oval	Purple
F ₁ 19X216	Cylindrical	Purple
F ₁ 19X233	Cylindrical	Purple
F ₁ 21X221B	Oblong	Green with white spot at bottom
BARI Hybrid Begun 4	Oval	Light green

The yield range of eggplant hybrids was 24.68- 41.49t/ha. The highest fruit yield was recorded from the line F₁14X233 (41.39 t/ha), followed by F₁14X216 (35.70 t/ha), F₁1X233 (34.08 t/ha), F₁19X216

(33.80 t/ha), F₁ 5X233 (33.75 t/ha), F₁ 5X8 (31.54 t/ha), and lowest yield were recorded from F₁ 14X5 (24.68 t/ha).

Four types of fruit shape were observed among the lines viz., elongate (4 hybrids), cylindrical (4 hybrids), oval (4 hybrids), oblong (8 hybrids), while in term of fruit colour, all the hybrids were purple in colour except four hybrids viz., F₁ 3X229 and BARI Hybrid Begun 4 (Light green), F₁ 13X11 and F₁ 21X221B (Green with white spot at bottom).

4 Conclusion

Though the yield was higher in the hybrids F₁ 14X233, F₁ 14X216, F₁ 1X233, F₁ 19X216, F₁ 5X233, F₁ 5X8, but considering earliness, tolerance to high temperature, fruit infection by EFSB, bacterial wilt and phomopsis blight infestation, attractive fruit shape and fruit colour, the hybrids F₁ 1X233, F₁ 5X8, F₁ 13X11, F₁ 14X233, F₁ 14X216, F₁ 19X216, F₁ 19X233, F₁ 21X221B were found promising. So these seven hybrids can be selected for advance trial.

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