

FLORAL MORPHOLOGY AND FRUIT FORMATION IN EGGPLANT (*Solanum melongena* L.) GENOTYPES

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ABSTRACT

Floral morphology of seven eggplant genotypes including SM 164 and BW 11 (recommended cultivars) were studied during 2000 *yala* and 2000/2001 *maha* seasons. Three floral types namely, long style (LS), stigma projected outside the anther cone, short style (SS), style within the anther cone and true short styles (TS), flowers with rudimentary female organs were identified. During both seasons significant varietal differences in flower number for different flower types were observed. Seasonal difference was also significant. Interactions of variety x flower number, variety x flower types, variety x season were also significant. Significantly higher number of flowers (189) and fruits (90) were produced during *maha* season than flowers (157) and fruits (72) in *yala* season. On an average 66% flowers were long style 10% were short style and 24.3% were true short style. Fruit formation by LS flowers and SS flowers was 74.5% and 6.5%, respectively. TS flowers formed no fruits. Variety SA7MTE2 recorded the highest percentage of LS flowers (73%) while SM 164 produced the lowest percentage (54.4%). On the other hand GAB 11 produced highest percentage of SS (12%) flowers and lowest percent of TS (17.8%). The lowest percentage of SS flowers (4.1%) was recorded in BW 11.

KEY WORDS: Eggplant, Floral Morphology, Flower Types, Long Style, Short Style, True Short Style

INTRODUCTION

This study was initiated as a result of low success rates experienced during a hybridization program initiated to develop F₁ eggplant hybrids. A closer look at the floral morphology of eggplant and subsequent literature survey revealed the existence of the heterostyle character to varying degrees between varieties and in different flowers of the same variety. The hermaphrodite flowers of eggplant can be of three types depending on the length of styles or the position of the stigma *viz.*, 1) Long style with stigma projecting outside the anther cone, 2) short style/medium short style/ pseudo short style with stigma within the anther cone 3) true short style (SS) with flowers having rudimentary female organs (Pal and Singh, 1943). Pal and Singh (1943), Matang (1949), Chada and Saimbhi (1977) and Baksh and Iqbal (1979) reported that variation in the style length is very common in eggplant and even in the same cluster, both long and short-styled flowers may be present. They also reported that position of the stigma in relation to the stamens varies with variety. However, local researchers have paid no attention to the floral characteristics and its relation to fruit formation. Even with the few studies conducted elsewhere there is lack in agreement on different aspects of floral characteristics and fruit formation (Prasad and Prakash, 1968; Som and Maity, 1986). Therefore, it was felt that more information should be

gathered on the floral morphology in relation to fruit set and fruit formation especially under local conditions before embark on a hybridization program to exploit hybrid vigour in eggplant.

MATERIALS AND METHODS

Floral morphology and subsequent fruit formation of seven eggplant varieties including SM 164 and BW 11 as checks were studied during 2000 *yala* and 2000/2001 *maha* seasons at an experimental field of the Horticultural Crop Research and Development Institute (HORDI), Gannoruwa. Three weeks old seedlings were transplanted on ridges fertilized with 140 kg N, 175 kg P₂O₅ and 105 kg of K₂O per hectare at a spacing of 90 x 60 cm. Plot size was 3.6 x 4 m. RCBD with three replications was used.

At 50% flowering three flower types, *viz.*, long style flowers (LS) with stigma projected outside the anther cone, short style flowers (SS) with stigma at the same level or just below the tip of the anther cone and true short styled flowers (TSS) with underdeveloped ovary (Figures 1 and 2), of 10 plants/plot of each variety were tagged. During tagging flower counts were recorded. Tagged flowers were monitored until fruit formation. Number of fruits set by each flower type was recorded. Data were treated statistically using SAS systems.

RESULTS AND DISCUSSION

Some selected climatic data representing the period from transplanting to first harvest for 2000 *yala* and 2000/2001 *maha* are given in Table 1. Higher maximum and minimum temperatures were exhibited during *yala* season compared with *maha* season. A difference of all most 2°C in minimum temperature was observed between the two seasons. The *maha* season had a higher total rainfall (572.2 mm) than the *yala* season (418.4 mm). Mean relative humidity during *yala* season (75.6%) was lower than during *maha* (77.4%) *maha* season.

Table 1. Some climatic parameters observed during the growing seasons

Month	Maximum Temperature (°C)	Minimum Temperature (°C)	Total Rainfall (mm)	No. Rainy days	Relative Humidity (%)
May-June	30.9	23.4	159.1	17	77.5
June-July	29.8	22.4	48.8	8	72.8
July-August	30.5	22.5	210.5	19	76.4
Mean (<i>yala</i>)	30.4	22.8	139.5	15	75.6
Nov-Dec.	29.4	20.5	159.6	16	74.2
Jan. - Feb.	28.2	20.1	181.8	15	77.6
Feb-March	28.7	19.9	230.8	18	80.4
Mean(<i>Maha</i>)	28.8	20.2	190.7	16	77.4

FLORAL MORPHOLOGY OF EGGPLANT

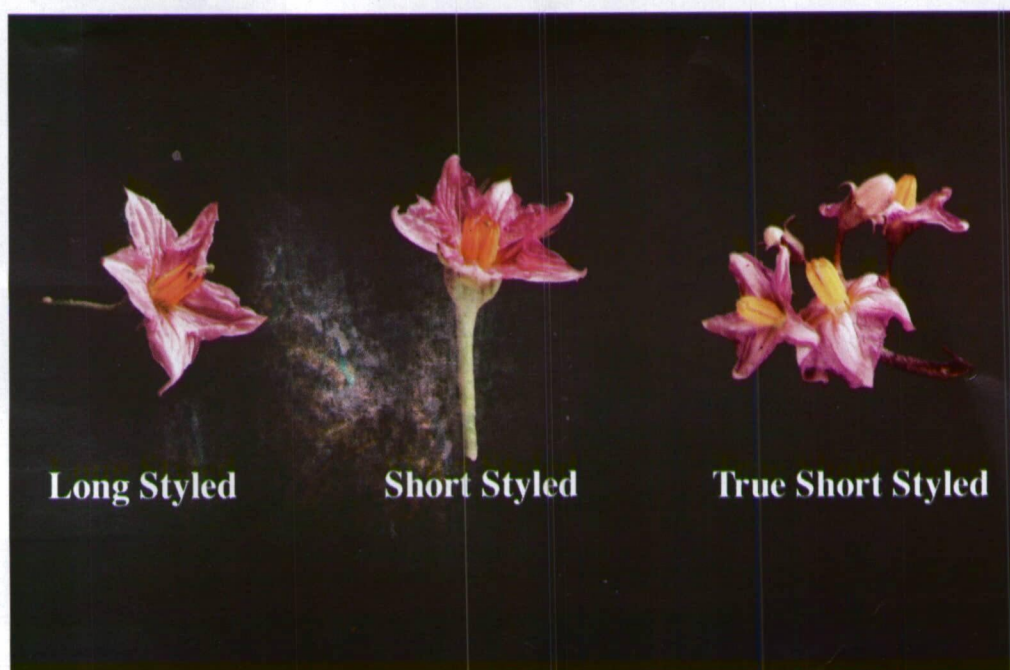


Figure 1. Three flower types of Brinjal



Figure 2. Longitudanal sections of three flower types (sterio microscopic view)

Seasonal differences in number of flowers and number of fruits of seven eggplant varieties are given in Table 2. Analysis of Variance (ANOVA) showed that the seasonal and varietal differences and their interactions were significant for number of flowers and fruits produced during the two seasons. The pronounced climatic differences between seasons and tremendous genetic variation between varieties explain significant differences exhibited by ANOVA. Significant variety x season interaction suggests that the effect of both factors plays a decisive role in determining flower and fruit number. Therefore, data are interpreted to highlight the seasonal and varietal differences observed during experimentation. However, generalization of data was done wherever applicable. Mean fruit formation followed a similar trend as observed for flowers (Table 2). Mean flower production during *yala* season (157) was significantly lower than during the *maha* season (189). Flower number varied significantly between varieties. Flower production of variety SA7MTE2 showed stability over seasons. Mean flower number (285.0) of GAB 11 was significantly higher than the other varieties. Varieties SA7MTE2 and 08890 registered 2nd and 3rd ranks respectively. Recommended varieties SM 164 and BW 11 secured 6th and 7th ranks respectively.

Table 2. Seasonal variations in mean flower number and fruit number of seven eggplant varieties

Variety	Number of Flowers		Number of Fruits		Mean	
	Yala	Maha	Yala	Maha	No. of Flowers	No. of Fruits
08890	151 c	218 b	73 c	113 a	184 c	93 b
08891	132 cd	145 c	79 b	74 e	138 de	77 d
07157	138 c	167 c	74 c	93 c	153 d	84 c
SA7MTE2	213 b	220 b	94 a	113 a	216 b	103 a
GAB 11	265 a	305 a	97 a	106 b	285 a	101 a
SM 164	95 e	156 c	47 d	79 d	126 de	63 e
BW 11	106 de	110 d	42 e	50 f	108 e	46 f
Mean	157	188	72	90	173	81

Means followed by the same letter in each column are not significantly different at $p \geq 0.05$ level by Duncan New Multiple Range Test (DNMRT)

Maha season seemed to produce more flowers and thereby more fruits than the *yala* season. An average of 90 fruits formed during the *maha* season was significantly higher than 72 fruits produced during the *yala* season. Lower flower formation and fruit production during *yala* could be attributed lower rainfall and warmer climate experienced.

Varietal differences in mean fruit number were significant. Varieties SA7MTE2 and GAB 11 showed no significant differences for mean fruit number producing 103 and 101 fruits respectively. As in the case of mean

flower number, for mean fruit number too recommended varieties SM 164 and BW 11 were ranked 6th and 7th respectively. Varietal variation of mean flower number and fruit number indicates the production potential of a genotype. Though, variety GAB 11 produced a higher total number of flowers, it failed to record higher number of fruits particularly in *yala*. In general, all flower buds may have not produced fruits and all fruits may have not lasted until final harvest since the long process of conversion of flower bud to fruit and its subsequent growth would have been affected by a large number of biotic and abiotic stresses. The degree of resistance or tolerance to these stresses expressed by a variety will determine the final fruit count. Therefore, variety SA7MTE2 exhibited a high degree of tolerance to environmental stresses and formed a higher number of fruits at the end (Table 2).

A breakdown of flower number for three flower types during the two seasons is shown in Table 3. Long style flowers were produced in greater proportions than other two flower types during both seasons. Production of TSS flowers was much higher than the production of SS flowers. All varieties produced a low number of SS flowers. During both seasons production of LS flowers by GAB 11 and SA7MTE2 was higher than other varieties. Variety 08890 ranked 3rd for LS flower production while SM 164 and BW 11 produced the lowest numbers. Number of TSS flowers of different varieties showed less variation. Variation in style length is reported (Chada and Saimbhi, 1977; Baksh and Iqbal, 1979; Som and Maity, 1986) to be common in eggplant. Results of the present study too clearly proved the varietal variation in style length of the flowers. It is also reported by the above authors that LS flowers are appreciably more in number than the SS and TSS flowers which is in agreement with the results of the present study. Short style flower production showed less variation over seasons.

Table 3. Seasonal and varietal variation of flower number under different flower types of seven eggplant varieties¹

Variety	Long Style		Short Style		True Short Style	
	Yala	Maha	Yala	Maha	Yala	Maha
08890	105 c	153 c	16 b	23 b	29 d	42 b
08891	88 e	97 e	13 c	16 d	31 cd	32 e
07157	97 d	119 d	11 dc	14 d	31cd	34 de
SA7MTE2	156 a	161 b	18 b	19 c	39 a	39 cb
GAB 11	138 b	213 a	23 a	37 a	35 b	55 a
SM 164	50 g	87 f	12 c	13 d	33.cb	56 a
BW 11	63 e	66 g	8 d	7 e	35 b	37 cd
Mean	100	128	15	18	27	43

¹Means followed by the same letter in each column are not significantly different at $p \geq 0.05$ level by DNMRT

Analysis of variance showed that variety, flower types and seasonal effects on flower number were highly significant. Interactions of variety x season, variety x flower types and season x flower types were significant.

Varietal and seasonal differences for number of different flower types calculated as percentages are given in Table 4. It shows less variation between season and varieties as compared in Table 3. It also revealed that irrespective of variety and season majority of flowers belong to LS and TSS types. Short style flowers were low in number for all varieties during both seasons. Variety SA7MTE2 showed less variation in different flower types across seasons. Mean percentage of flower types for each season yielded almost similar values. Accordingly, 66% flowers will be of LS 10% will be SS and 24% will be TSS flowers.

Table 4. Seasonal differences in percent flower types formed by seven brinjal varieties

Variety	Long Style Flowers (%)		Short Style Flowers (%)		True Short Style Flowers (%)	
	<i>Yala</i>	<i>Maha</i>	<i>Yala</i>	<i>Maha</i>	<i>Yala</i>	<i>Maha</i>
08890	70.0	70.2	10.5	10.6	19.5	19.2
08891	66.5	66.9	9.6	10.8	23.7	24.1
07157	70.0	71.2	7.7	8.2	22.2	20.6
SA7MTE2	73.0	73.4	8.6	8.8	18.4	17.9
GAB 11	70.5	70.4	11.8	12.1	17.7	17.9
SM 164	52.8	55.9	12.9	8.3	34.3	35.8
BW 11	59.5	54.8	7.8	6.4	32.7	33.9
Mean	66.0	66.1	11.3	9.3	24.1	23.9

Based on the variety mean over two seasons in Table 2 and percentages shown in Table 4, ratio of LS: SS: TS flowers was 6: 1:2. According to Pal and Singh (1943) the ratio of three flower types of variety Muktakesi, long-styled, pseudo-short-styled and true short-styled was 2: 1: 3. More LS flowers observed in the present study may be attributed to the tremendous variation found in the definition of the terms used in the available literature (Smith, 1931; Pal and Singh, 1943; Prasad and Prakash, 1968; Som and Maity, 1986) to describe different flower types. Highest percentage of LS flowers was in variety SA7MTE2 while GAB 11 recorded the lowest. GAB 11 produced the highest percentage of SS flowers and TS flowers.

There is a general opinion that the weak femaleness of TSS flowers was associated with growth and nutrients. It has been proved (Pal and Singh, 1943) that the stunted nature of the styles does not depend on growth and nutrition. Since data for *yala* and *maha* of TSS flowers did not show much variation we believe that it is more due to genetic factors rather than environment. This is in agreement with Chada and Saimbhi (1977). Although day length variation between the seasons does not amount to much cloudiness

during *maha* could have an effect on flower number and morphology. It may be pointed out however, that with the changes in the season not only the day length though this does not amount to much, but temperature and rainfall also changes. Since *yala* temperatures are higher than *maha*, the variations in flower number and their morphology may be influenced by the temperature as well as rainfall variations between seasons (Pal and Singh, 1943; Prasad and Prakash, 1968).

Mean number of fruits formed by different flower types are given in Table 5. Total number of fruit formed during *yala* was lower than during the *maha* season. Performance of the varieties SA7MTE 2 and GAB 11 during both seasons was superior over other varieties and they outnumbered them. However, during *maha* season, fruit counts for LS flowers of variety 08890 recorded no significant difference compared with GAB 11. Varietal and seasonal variation for number of fruits formed by SS flowers was less.

Table 5. Mean seasonal difference in fruits formed by two flower types of seven eggplant varieties¹

Variety	Mean number of Fruits formed by long Style Flowers		Mean number of Fruits formed by short Style Flowers	
	<i>Yala</i>	<i>Maha</i>	<i>Yala</i>	<i>Maha</i>
08890	64 d	101 b	9 a	13 a
08891	73 b	69 d	6 b	5 cd
07157	68 c	86 c	6 b	7 bc
SA7MTE2	88 a	106 a	6 b	6 c
GAB 11	91 a	99 b	6 b	7 bc
SM 164	41 e	71 d	5 b	9 b
BW 11	39 e	47 e	3 c	4 d
Mean	66	83	6	7

¹Means followed by the same letter in each column are not significantly different at $p \geq 0.05$ level by DMRT

Data in Table 5 can be described as conversion ability from flowers to fruits. This conversion ability varied considerably depending on the season (66.3 in *yala* and 82.7 in *maha*) and on the variety. Irrespective of the type of flower, climatic conditions during *maha* season seemed favourable for more efficient conversion of flowers to fruits. Varietal effect on the conversion showed that GAB 11 and SA7MTE2 had higher conversion ability than other varieties.

Percentages of fruits calculated for different flower types during both seasons are given in Table 6. True short styled flowers formed no fruits, as the female organs of these flowers were underdeveloped. Contribution of LS flowers to fruit formation was greater in all most all varieties during both seasons. It ranged from 88-93.8% during *yala* season.

Table 6. Seasonal variation in percent fruit formed by different flower types of seven eggplant varieties

Variety	Long Style		Short Style	
	Yala	Maha	Yala	Maha
08890	88.0	88.8	12.0	11.2
08891	92.3	93.2	7.7	6.8
07157	92.3	92.5	7.7	7.5
SA7MTE2	93.9	94.4	6.1	5.6
GAB 11	93.8	93.4	6.2	6.6
SM 164	88.6	89.0	11.4	11.0
BW 11	92.1	92.6	7.5	7.3
Mean	91.6	91.9	8.4	7.9

Maha season may have had a favourable effect on fruit formation by LS flowers. Short styled flowers formed more fruits during the *yala* season (range 6.1-12.0%) than during the *maha* season (range 5.6-11.2%).

CONCLUSIONS

Floral morphology of eggplant plays a vital role in determining the subsequent fruit formation. Proportions of three flower types vary with the variety as well as with the season. The greater number of flowers (66%) was of the LS type. Short style and TSS flowers were 10% and 24% respectively. Contribution of LS flowers to fruit production was much greater than other flower types. The ratio of LS:SS:TSS flowers in eggplant were 7:1:2. Since TSS flowers formed no fruits due to physiological reasons, they function as male flowers and female: male ratio is 4:1. In other words about 20% of flowers serve as male flowers, which shed off with time without affecting the final yield. It is not definitely known whether variation in floral morphology is regulated by genetic means or whether they are dependent solely on the environment. Genetic studies on closely related species of *Solanum* might answer this question. Apart from the flower types discussed edaphic and biotic factors too play a decisive role during the period of fruit set and fruit maturity in the final outcome of fruits harvested. The identification of stigmatic position of eggplant flowers in relation to the anther cone is of significance as far as true-to-type seed production is concerned. since SS flowers have a better chance for natural self-pollination and as a result, to produce true-to-type seeds in contrast to LS flowers morphologically adapted to natural cross-pollination.

ACKNOWLEDGEMENTS

We wish to extend our gratitude to Dr. L.H.P. Gunaratne and Mr. Jayalal Chandrasiri for their assistance during data analysis and Champa and Mahendra for their assistance in conducting the experiment.

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