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Short communication

Flowering biology in *Solanum* species

Neeraja Puthiamadom* and K.T. Presanna Kumari

College of Horticulture, Kerala Agricultural University, Vellanikkara, Thrissur- 680656, Kerala, India.

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Abstract

The floral diversity prevailing among selected species of *Solanum* was traced in the present study. Comparison of the *S. melongena* varieties Haritha and Surya with the wild variants of *Solanum viz*., *S. viarum, S. incanum,* and *S. gilo* was done based on various floral characters. Among the genotypes evaluated *S. gilo* took more number of days from transplanting till the visual observation stage of flower bud. Flowers of *Solanum* species are positively geotropic, zygomorphic, bisexual, hypogynous and complete. Presence of prickles on calyx was observed to be a unique feature of *S. viarum*. A change in the colour of corolla on the day prior to flower opening was observed in *S. viarum*, *S. incanum* and Surya. The selected genotypes were grouped into various clusters based on different qualitative and quantitative floral characters. The cultivated variety Haritha was closely related with *S. gilo* with respect to qualitative characters. However, Surya resembled *S. incanum* in terms of both qualitative and biometric characters.

Keywords: Clustering, Flowering initiation, Heterostyly

Brinjal (*Solanum melongena* L.) is an important vegetable crop of the tropics and subtropics. It is known by different names *viz*., eggplant, aubergine (French word) in European countries, garden egg, guinea squash and melongena (Sekara et al., 2007). In India, brinjal is grown throughout the year in all parts of the country except in higher altitudes. It occupies an area of 711.3 thousand hectares which accounts for nearly 8.3% of the total area under vegetables, with a productivity of 19.1 metric tonnes per hectare. India is the second largest producer of brinjal with a world production share of 27.2% [as per NHB database 2014].

Brinjal (*Solanum melongena* L.) has potential wild relatives that exhibit resistance to a large number of pests and diseases (Behara and Singh, 2002). It is the need of the hour to tap this diversity prevailing in the *Solanum* species. Acknowledge of the flowering behaviour of allied wild species is important for any further interspecific hybridization programme. It was in this background the present study was taken up with the objective of understanding the flowering behaviour of the selected species of *Solanum*, as well as for clustering them based on floral characters.

Three wild species variants of *Solanum viz*., *S. viarum* (IC241673), *S. gilo*, (IC611554) and *S. incanum* (IC203609) maintained by NBPGR – RS, Vellanikkara as well as two high yielding varieties of brinjal (*S. melongena*), Haritha and Surya formed the material for the study. The selected types were transplanted at two leaf stage into grow bags of 35 x 25 x 20 cm size in a replicated fashion with 5 replications. The recommendations of the Package of Practices by KAU (2011) was followed in the case of manuring.

The floral characters were critically evaluated in three different wild species as well as Haritha and Surya following the descriptor developed by IPGRI

*Author for correspondences: Phone: 91-8086850065, Email: neerajaputhiamadom@gmail.com

(1988). The days taken for the visual observation stage of first flower bud since transplanting into the grow bags as well as days taken for the opening of the flower bud from visual observation stage were recorded. Number of flowers per inflorescence and longevity of flowers were also observed from all the types evaluated. The floral features of the three wild species as well as Haritha and Surya were described after examining the fresh flowers on the first day of blooming. The presence of pseudo or heterostyly in any of the evaluated types were also noted. Observations on various biometric characters of the flowers belonging to different types were also recorded.

Cluster analysis was done considering five qualitative and 11 quantitative characters. 'NTSYS' software was used for cluster analysis based on qualitative characters and 'Minitab 17' for biometric characters.

The results of the study are presented in Tables 1 to 4. The days taken for visual observation stage of first flower bud, days for opening of flower bud from visual observation stage, as well as number of flowers per inflorescence in selected *Solanum* species and varieties are presented in Table 1.

Appearance of visually recognizable flower bud is considered to be an indication of the onset of flowering initiation. Among the wild species which produced flowers, *S. gilo* took the highest number of days for flowering initiation (70.80 days) and *S. viarum,* the lowest (41.20 days). Significant difference was observed among Haritha and Surya in the days taken for flowering (42.80 days and 55.00 days, respectively). However, Haritha was on par with the wild type *S. viarum*. Surya resembled *S. incanum* in days to initiation of flowering. Prasad and Prakash (1968) also reported that flowering initiation occurred in brinjal nearly 40 – 45 days after transplanting.

Even though the different species differed significantly in the days to visual observation stage of flower bud, no significant difference could be observed among the species for the days taken for opening of the flower bud from visual observation

Table 1. Flowering behaviour in different species of *Solanum*

Types	Days to visual observation stage of flower bud	Days to opening of flower bud	Flowers per inflorescence
S. viarum	41.20	10.20	3.60
S. gilo	70.80	10.40	1.80
S. incanum	56.00	10.20	2.20
Haritha	42.80	9.60	2.00
Surya	55.00	10.00	1.40
CD (0.05)	1.97	NS	1.31
CV (%)	2.80	NS	15.46

Table 2. Biometric characters of the flowers of different species of *Solanum*

Types	Length of flower bud (cm)	Circumference of flower bud (cm)	Length of sepal lobe (cm)	length of petal lobe (cm)	Length of filament (cm)	Length of anther (cm)	Length of style (cm)	
							Short	Long
S. viarum	1.38	1.84	1.06	1.50	0.20	0.60	0.30	1.20
S. gilo	0.80	1.32	0.63	0.82	0.20	0.40	0.30	1.20
S. incanum	1.76	2.06	1.33	1.22	0.20	0.60	0.30	1.20
Haritha	1.84	1.99	1.70	1.92	0.20	0.60	0.30	1.20
Surya	1.66	2.25	1.60	1.96	0.20	0.60	0.30	1.20
CD (0.05)	0.34	0.42	0.26	0.42	NS	NS	NS	NS
CV (%)	17.06	16.63	15.70	21.28	—	—	—	—

Table 3. Details of clusters formed based on qualitative floral characters

Cluster No.	Cluster members
I	Haritha, *S. gilo*
II	Surya, *S. incanum*
III	*S. viarum*

Table 4. Details of clusters formed based on biometric floral characters

Cluster No.	Cluster members
I	Haritha, *S. viarum*
II	Surya, *S. incanum*
III	*S. gilo*

stage. Irrespective of species, it took only 9 to 10 days for flower opening from visual observation stage.

S. viarum was significantly different from all the other species in the number of flowers per inflorescence recording a highest value of 3.60. Haritha and Surya did not differ significantly with respect to the number of flowers per inflorescence. Som and Maity (1986) as well as Pradeepa (2002) also observed that in *S. gilo* flowers were borne either solitarily or in clusters of two or more, which conforms with the findings in the study.

The flowers of *Solanum* species were found to be positively geotropic. In all the species evaluated, flowers are pedicellate, zygomorphic, bisexual, hypogynous and complete. Calyx is persistent with five sepals which are united. Depending on the species prickles may or may not be present on the calyx. Corolla is rotate with five petals which are united. However, in *S. gilo* and Surya, petal number showed a variation from 4 to 6. The aestivation is valvate in both calyx and corolla. Androecium consists of five stamens, epipetalous and arranged in the form of a cone around the style. Anthers are basifixed and dehiscing through apical pores. Gynoecium is bicarpellary, syncarpous with axile placentation. The ovary is oblique in position with respect to the floral axis. This feature makes the flower zygomorphic.

In the flowers of *S. viarum*, calyx is green with prickles. The corolla in this species is light violet in colour. The stamens are with yellowish white filaments and yellow anthers. The stigma is glossy green. The flowers of *S. gilo* are characterized by the presence of petals which are white, stamens with yellowish white filaments and yellow anthers as well as glossy green stigma. In this species calyx is non prickly. Grubben and Denton (2004) also reported that *S. gilo* was having white or pale purple petals. *S. incanum* flowers can be distinguished by the green non prickly calyx and pale violet petals. The filaments of stamens are yellowish white and anthers are yellow. The stigma is glossy green.

In Haritha, the flowers are having green non prickly calyx, white petals and stamens with yellowish white filaments and yellow anthers. In the flowers of Surya, also a *S. melongena* type, the calyx is non prickly and purplish green in colour and corolla is bluish violet. Corolla colour remained white throughout the flowering period in *S. gilo* and Haritha. However, on the day prior to flower opening, corolla colour changed from white to light violet, pale violet and bluish violet in *S. viarum*, *S. incanum* and Surya, respectively. McGregor (1976), also observed that colour of the corolla would be purple or pink or white, depending on the variety.

The presence of prickles on the calyx was observed to be a unique feature of *S. viarum.* All the other wild species as well as cultivated varieties Haritha and Surya were observed to be devoid of prickles on the calyx. Irrespective of the species differences, the calyx is persistent. Lawande and Chavan (1998) also observed that flowers were complete with spines present on the calyx of certain species. Unlike in the present study Lawande and Chavan (1998), however, reported that flowers were actinomorphic in *Solanum* species.

Observations on the biometric characters of the flower like length and circumference of flower bud, length of sepal, length of petal, length of filaments

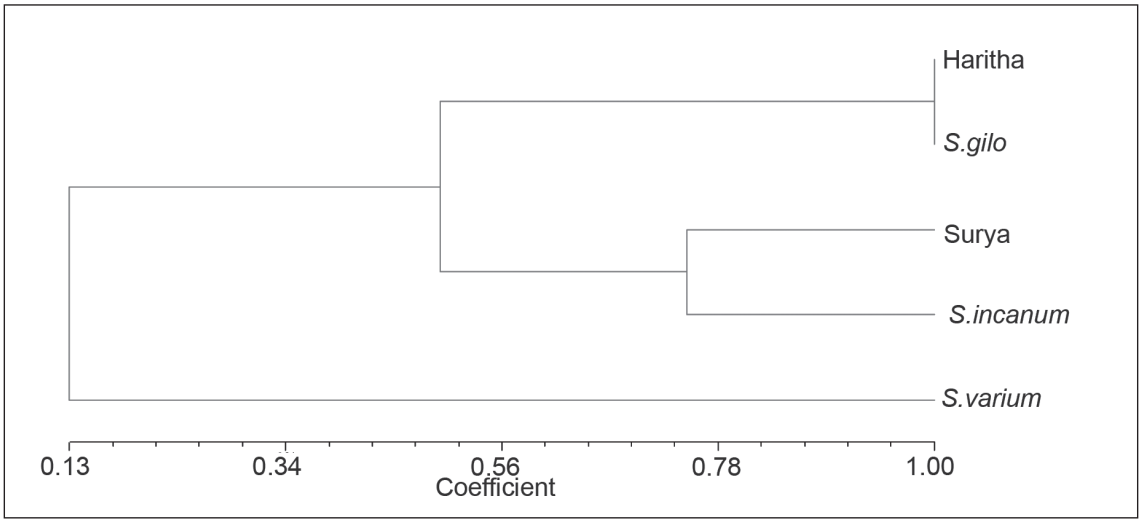

Figure 1. Dendrogram based on qualitative characters

and anthers as well as length of style were also recorded from the different species evaluated (Table 2).

S. gilo was significantly different from all other species evaluated, in the length and circumference of flower bud (0.80 cm and 1.32 cm, respectively). Haritha and Surya were on par with each other and also with the wild species *S. incanum* in the length and circumference of flower bud. The length of the sepal lobe was significantly different in different species evaluated. However, the cultivars under the species *melongena* (Haritha and Surya) were on par with respect to this character (1.70 cm and 1.60 cm, respectively). With regard to the length of the petal lobe also, Haritha (1.92 cm) and Surya (1.96 cm) were on par. The sepals and petals were the shortest in *S. gilo* (0.63 cm and 0.82 cm respectively).The evaluated types did not differ significantly in the length of stamens. The length of style varied from 0.30 cm in short styled flowers to 1.20 cm in long styled flowers.

Irrespective of species, long and short styled flowers were common. Long styled flowers had high frequency of occurrence compared to medium and short styled flowers. However, the frequency of occurrence of medium styled flowers was very rare. Hence, it can be stated that heterostyly is present in all the species. Pal and Singh (1943) also observed three types of flowers in brinjal *viz*., long styled, pseudo short styled and true short styled. True short styled flowers did not set fruits on hand pollination, while long styled and pseudo short styled flowers produced fruits abundantly.

Cluster analysis was done using five qualitative characters observed from the five genotypes belonging to four different species. The resulting dendrogram is depicted in Fig. 1 and the clusters formed are presented in Table 3.

At 70 per cent similarity, three clusters were formed (Table 3). The wild species *S. gilo* fell in the same cluster with Haritha. This may be because of the similarity in the colour of the corolla. The cultivated types Haritha and Surya were falling in different clusters. *S. viarum* bearing prickles on calyx was distinct from the other types.

Dendrogram was also drawn taking into consideration 11 biometric characters (Fig. 2). At 67 per cent similarity, three clusters were obtained (Table 4). Higher affinity was observed between Surya and *S. incanum* with respect to biometric characters. Haritha formed a single cluster with the

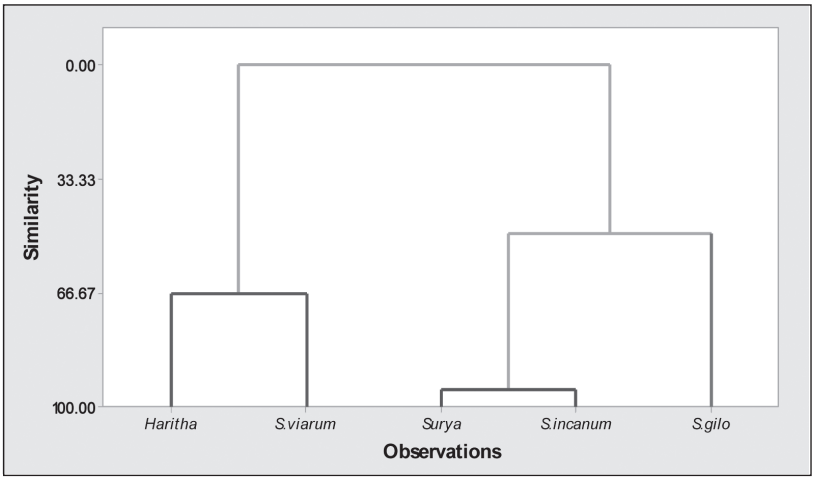

Figure 2. Dendrogram based on quantitative characters

wild species *S. viarum*. *S. gilo* formed a separate cluster. Haritha exhibited 100 per cent similarity with *S. gilo* with respect to qualitative characters. However, Haritha showed more resemblance with *S. viarum* when biometric characters were considered. Surya showed high similarity with *S. incanum* in terms of both qualitative as well as biometric characters.

There is significant genetic diversity among the various *Solanum* species evaluated. Certain wild species exhibited close resemblance with the cultivated types. Knowledge about the flowering behaviour of the wild types as well as the variablility among various species of *Solanum* can be exploited in further crop improvement programmes.

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