Studies on heterosis in sponge gourd [*Luffa cylindrica* (Roem.) L.]

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***Abstract*- A study was carried out on heterosis for fruit yield and yield related traits in sponge gourd. Thirty six F_1 hybrids were generated by full diallel (including reciprocals) mating system using six diverse genotypes. These F_1 hybrids along with six parents were evaluated in randomized block design with two replication at Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal during 2023. Observation were recorded on five randomly selected tagged plant from each treatment for yield and yield attributing character *viz.*, vine length, number of primary branches per vine, number of nodes per vine, sex ratio, days to first fruit harvest, fruit length, fruit girth, number of fruits per vine, fruit yield per vine, TSS and crude fibre. Based on standard heterosis, the best cross combination was Pusa Sneha × Kashi Shreya in terms of yield and yield component traits followed by Pusa Sneha × Kashi Rakshita, Kashi Rakshita × Kashi Shreya and Pusa Supriya × Kashi Shreya. Kashi Shreya × Kashi Rakshita was the best performed cross for TSS and crude fibre followed by Phule Prajaktha × Kashi Rakshita and Pusa Sneha × Kashi Shreya.**

***Keywords*- Heterosis, sponge gourd, diallel**

I. INTRODUCTION

Cucurbits are distributed mainly in tropical and subtropical regions of the world. The main cucurbits producing countries are China, Korea, India, Japan, Nepal and Central America. In India, major cucurbits growing states are U.P., Punjab, Bihar, Jharkhand, Gujarat, Rajasthan, Haryana, Karnataka and Delhi. Some of its largely represented genera along with their number of approximately reported species include *Momordica* (bitter gourd), *Cucumis* (cucumber, muskmelon), *Cucurbita* (pumpkin, squash), *Lagenaria* (bottle gourd) and *Luffa* (sponge gourd) [10]. Sponge gourd [*Luffa cylindrica* (L.) Roem.] is an important cucurbitaceous plant i.e. can be grown both as rainy and summer season vegetable which is grown throughout throughout the year except extreme winter [8] . It was originated in subtropical Asian region particularly India [3]. This crop has a long history of cultivation in the tropical countries of Asia and Africa [7]. Luffa commonly called sponge gourd, loofah, vegetable sponge, bath sponge or dish cloth gourd, smooth luffa, climbing okra, and Chinese okra is a member of cucurbitaceous family. The vernacular names of sponge gourd are kali tori, ghia tori, torianemia, nenuwa, chiori, dundul, ghosaligilka, bhol or tarada and ghiraula in different parts of the world. Sponge gourd is quite lower in immersed fats as well as calories [11]. In spite of the availability of wide range of genetic variability in plant and fruit characters and also produce large number of hybrid seed at reasonable cost, very little work has been done to exploit the hybrid vigour in this crop. One of the methods to achieve quantum jump in yield and quality is heterosis breeding. Hence, an attempt was made to study the heterosis in different crosses commercial check or standard parent to develop and identify the suitable best performing hybrids.

II. MATERIALS AND METHODS

The experimental material use for the present investigation comprised of six genetically diverse parents *viz.*, Phule Prajaktha (P_1), Pusa Sneha (P_2), Pusa Chikni (P_3), Kashi Shreya (P_4), Kashi Rakshita (P_5) and Pusa Supriya (P_6) and one standard hybrid check Pusa Shreshta.

These parents were crossed by Full diallel mating design and 30 F_1 hybrids obtained. Thirty crosses along with six parents were raised in randomized block design (RBD) with two replications during 2023 at Department of Horticulture, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal with a spacing 1.5 x 3.0 m was followed.

All the recommended agronomic package of practices was followed to grow a healthy crop. In each replication, five competitive plants were identified randomly for recording data on vine length (m), number of primary branches per vine, number of nodes per vine, node to first staminate flower anthesis, node to first pistillate flower anthesis, days to first staminate flower anthesis, days to first pistillate flower anthesis, sex ratio, days to first fruit harvest, fruit length (cm), fruit girth (cm), fruit weight (g), number of fruits per vine, Total Soluble Solids (°Brix), crude fibre (g) and fruit yield per vine (kg).

Heterosis was calculated as percentage of F_1 performance in the desirable direction over commercial check or standard hybrid hybrid (Pusa Shreshta) was computed for each character using following formula. Estimation of heterosis over standard hybrid Pusa Shreshta as per method of [12].

1) Standard heterosis (Best parent value) $dii = \dfrac{\overline{F_1} - \overline{SH}}{\overline{SH}} \times 100$

Where,

F_1 = mean value of the F_1 hybrid

SH = mean value of the standard hybrid (Pusa Shreshta)

III. RESULTS AND DISCUSSION

The magnitude of heterosis was calculated as per cent increase or decrease of F_1 values over the standard hybrid (SH). The hybrid 'Pusa Shreshta' was used as check or standard hybrid. The negative estimates of heterosis were considered desirable for the traits *viz.*, sex ratio, days to first fruit harvest. However, for rest of the characters studied positive estimates of heterosis was consider desirable.

A perusal of data presented in Table 1 - 2 revealed that maximum standard heterosis for vine length (41.21 per cent) was observed in Pusa Supriya × Pusa Chikni ($P_6 \times P_3$), for number of branches per vine (46.89 per cent) in Kashi Rakshita × Kashi Shreya ($P_5 \times P_4$), for number of nodes per vine (38.53 per cent) in Pusa Sneha × Pusa Supriya ($P_2 \times P_6$), for sex ratio (-55.08 per cent) in Kashi Rakshita × Pusa Sneha ($P_5 \times P_2$), for days to first fruit harvest (-15.90 per cent) in Phule Prajaktha × Pusa Supriya ($P_1 \times P_6$), for fruit length (28.90 per cent) in Pusa Sneha × Kashi Shreya ($P_2 \times P_4$), for fruit girth (36.83 per cent) in Pusa Chikni × Phule Prajaktha ($P_3 \times P_1$), for fruit weight (218.76 per cent) in Pusa Sneha × Kashi Shreya ($P_2 \times P_4$), for number of fruits per vine (77.18 per cent) in Pusa Sneha × Kashi Shreya ($P_2 \times P_4$), for TSS (52.79 per cent) in Kashi Shreya × Kashi Rakshita ($P_4 \times P_5$), for crude fibre (44.12 per cent) in Kashi Shreya× Kashi Rakshita ($P_4 \times P_5$) and for fruit yield per vine (130.64 per cent) in Pusa Sneha × Kashi Shreya ($P_2 \times P_4$).

Among 30 crosses, the top three ranking cross combinations based on standard heterosis for the 16 characters are given in Table 1-2. In cross combinations, Pusa Sneha × Kashi Shreya (130.64 per cent), Pusa Supriya × Pusa Sneha (117.49 per cent) and Pusa Supriya × Kashi Shreya (124.80 per cent) exhibited over standard parent for fruit yield per vine. In evaluating the hybrids based on standard heterosis, the hybrid Pusa Sneha × Kashi Shreya ($P_2 \times P_4$) which manifested high heterotic effects for yield and its important attributes was found to be the best performing hybrid. Also, the other hybrids *viz.*, Pusa Sneha × Kashi Rakshita ($P_2 \times P_5$), Kashi Rakshita × Kashi Shreya ($P_5 \times P_4$), Pusa Supriya × Kashi Shreya ($P_6 \times P_4$), Kashi Shreya × Pusa Sneha ($P_4 \times P_2$), Kashi Shreya× Kashi Rakshita ($P_4 \times P_5$) and Pusa Supriya × Pusa Sneha ($P_6 \times P_2$) were also superior with respect to the significant standard heterosis for yield and its important attributes. Similar results were obtained by [2] for fruit yield per vine and fruit weight in ridge gourd, [9] for fruit length and fruit yield per vine in ridge gourd, [1] for vine length and fruit yield per vine in bottle gourd, [6], [7], [2], [14] and [5] for fruit yield per vine in sponge gourd.

Table 1. Estimation of standard heterosis for various characters in sponge gourd

Crosses	Vine length	Number of primary branches per vine	Number of nodes per vine	Sex ratio	Days to first fruit harvest	Fruit length
Phule Prajaktha × Pusa Sneha	-4.92 **	-5.96	5.27 *	-42.11 **	-6.77 **	22.76 **
Phule Prajaktha × Pusa Chikni	11.50 **	-21.97 **	-4.83 *	-21.29 **	11.06 **	17.83 **
Phule Prajaktha × Kashi Shreya	9.89 **	3.93	-4.56 *	-29.11 **	-11.06 **	21.74 **
Phule Prajaktha × Kashi Rakshita	10.57 **	-16.07 **	-2.12	-32.07 **	12.24 **	17.80 **
Phule Prajaktha × Pusa Supriya	23.19 **	-33.01 **	15.75 **	-0.55	18.69 **	13.31 **
Pusa Sneha × Phule Prajakta	3.58 **	3.06	-1.22	-45.04 **	-4.51 **	6.10 **
Pusa Sneha × Pusa Chikni	8.77 **	-4.70	-4.31	-41.06 **	-2.47 *	25.42 **
Pusa Sneha × Kashi shreya	-2.00	7.54	9.13 **	-40.50 **	-13.00 **	28.90 **
Pusa Sneha × Kashi Rakshita	11.42 **	1.75	1.70	-43.30 **	-10.42 **	18.42 **
Pusa Sneha × Pusa Supriya	41.21 **	-14.64 **	38.53 **	-8.50 **	9.99 **	15.25 **
Pusa Chikni × Phule Prajakta	9.41 **	-21.64 **	0.23	-20.37 **	8.27 **	11.18 **
Pusa Chikni ×Pusa Sneha	-1.86	5.85	1.09	-35.72 **	3.97 **	19.48 **
Pusa Chikni × Kashi Shreya	5.48 **	2.73	-8.86 **	-12.17 **	-11.39 **	15.78 **
Pusa Chikni × Kashi Rakshita	-1.19	-12.08 **	-7.58 **	-26.79 **	-4.40 **	21.77 **
Pusa Chikni × Pusa Supriya	10.85 **	-43.50 **	9.79 **	38.53 **	14.50 **	14.42 **
Kashi Shreya × Phule Prajakta	-1.01	1.53	-5.27 *	-24.96 **	-3.01 **	24.47 **
Kashi Shreya × Pusa Sneha	9.27 **	14.43 **	-5.81 *	-49.15 **	-12.78 **	27.31 **
Kashi Shreya × Pusa Chikni	26.41 **	-0.98	-6.71 **	-21.13 **	0.32	22.69 **
Kashi Shreya × Kashi Rakshita	10.10 **	10.05 *	-12.00 **	-27.67 **	-15.90 **	23.20 **
Kashi Shreya × Pusa Supriya	10.42 **	3.39	4.95 *	20.08 **	5.26 **	25.22 **
Kashi Rakshita × Phule Prajaktha	13.64 **	3.39	-4.04	-27.71 **	2.47 *	19.08 **
Kashi Rakshita × Pusa Sneha	-13.49 **	7.65	5.41 *	-55.08 **	4.40 **	17.65 **
Kashi Rakshita × Pusa Chikni	24.68 **	-4.59	-4.37	-31.82 **	4.73 **	17.87 **
Kashi Rakshita × Kashi shreya	17.98 **	46.89 **	-6.95 **	-32.95 **	-13.32 **	15.14 **
Kashi Rakshita × Pusa Supriya	7.42 **	-23.28 **	16.98 **	7.84 *	14.07 **	19.54 **
Pusa Supriya × Phule Prajaktha	11.11 **	-28.09 **	-11.09 **	0.00	12.89 **	15.41 **
Pusa Supriya × Pusa Sneha	25.54 **	-14.64 **	1.33	-32.93 **	-4.83 **	25.38 **
Pusa Supriya ×Pusa Chikni	26.95 **	-37.27 **	3.19	15.13 **	8.59 **	17.19 **
Pusa Supriya ×Kashi Shreya	19.48 **	30.49 **	4.05	-33.52 **	-2.90 *	27.02 **
Pusa Supriya × Kashi Rakshita	11.66 **	2.62	0.91	10.98 **	9.77 **	22.60 **

***, ** Significant at 5% and 1% level, respectively**

Table 2 Estimation of standard heterosis for various characters in sponge gourd

Crosses	Fruit girth	Fruit weight	Number of fruits per vine	Fruit yield per vine	TSS	Crude fibre
Phule Prajaktha × Pusa Sneha	4.17	42.68 **	44.17 **	47.78 **	-14.34 **	5.88
Phule Prajaktha × Pusa Chikni	26.62 **	3.98 **	15.19 **	-26.72 **	-6.37	-26.47 **
Phule Prajaktha × Kashi Shreya	-1.45	86.30 **	41.00 **	58.14 **	0.60	-5.88
Phule Prajaktha × Kashi Rakshita	31.74 **	32.66**	14.77 **	-27.59 **	25.10 **	20.59 **
Phule Prajaktha × Pusa Supriya	28.18**	52.54 **	10.55 *	-25.41 **	0.20	-1.47
Pusa Sneha × Phule Prajaktha	31.36 **	94.63**	45.04 **	45.95 **	-9.36 *	-11.76
Pusa Sneha × Pusa Chikni	-1.07	79.14 **	27.98 **	38.47 **	-18.33 **	-14.71 *
Pusa Sneha × Kashi shreya	31.24 **	218.76 **	77.18 **	130.64 **	11.55 **	23.53 **
Pusa Sneha × Kashi Rakshita	12.01 *	178.05 **	47.84 **	49.61 **	0.40	23.53 **
Pusa Sneha × Pusa Supriya	4.59	169.24 **	46.04 **	88.77 **	-10.96 **	-11.76
Pusa Chikni × Phule Prajaktha	36.83 **	5.81**	8.98	11.92	-6.37	-20.59 **
Pusa Chikni ×Pusa Sneha	6.46	48.07 **	40.79 **	44.30 **	-18.33 **	-19.12 **
Pusa Chikni × Kashi Shreya	7.99	52.49**	28.34 **	47.26 **	1.79	-13.24 *
Pusa Chikni × Kashi Rakshita	23.71**	16.91 **	5.22	-44.47 **	22.11 **	26.47 **
Pusa Chikni × Pusa Supriya	-1.80	9.23**	-28.58 **	-14.80	-2.19	-29.41 **
Kashi Shreya × Phule Prajaktha	30.13**	147.93 **	31.41 **	27.94 **	-1.79	-2.94
Kashi Shreya × Pusa Sneha	3.63	216.97 **	55.08 **	113.32 **	-15.54 **	5.88
Kashi Shreya × Pusa Chikni	4.78	102.59 **	24.48 **	47.00 **	24.30 **	-8.82
Kashi Shreya × Kashi Rakshita	-1.34	208.22 **	40.70 **	54.13 **	52.79 **	44.12 **
Kashi Shreya × Pusa Supriya	10.78*	189.98 **	50.35 **	81.64 **	5.98	-5.88
Kashi Rakshita × Phule Prajaktha	32.24 **	26.41**	20.86 **	-53.44 **	3.19	-7.35
Kashi Rakshita × Pusa Sneha	14.26**	52.34 **	51.67 **	14.01	-15.74 **	11.76
Kashi Rakshita × Pusa Chikni	23.21 **	42.18**	9.98 *	-69.10 **	4.58	2.94
Kashi Rakshita × Kashi shreya	5.05	95.17 **	42.00 **	48.65 **	-10.16 *	17.65 **
Kashi Rakshita × Pusa Supriya	15.76 **	86.67**	-3.08	-9.40	-7.77	-2.94
Pusa Supriya × Phule Prajaktha	29.10**	89.26 **	30.03 **	-57.79 **	0.80	-26.47 **
Pusa Supriya × Pusa Sneha	34.11 **	191.82 **	43.96 **	117.49 **	-7.77	-26.47 **
Pusa Supriya ×Pusa Chikni	10.82*	63.19**	-26.53 **	-32.11 **	-7.37	-11.76
Pusa Supriya ×Kashi Shreya	30.90 **	171.00 **	45.64 **	124.80 **	-2.79	-20.59 **
Pusa Supriya × Kashi Rakshita	18.59 **	60.78**	-0.81	-50.65 **	15.74 **	19.12 **

***, ** Significant at 5% and 1% level, respectively**

IV CONCLUSION

Based on the present research work, it is evident that heterosis can be exploited in this crop for yield and yield attributing traits. The best performing hybrids *viz.*, Pusa Sneha × Kashi Shreya, Pusa Supriya × Kashi Shreya and Pusa Supriya × Pusa Sneha had high heterotic vigour.

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