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Studies on heterosis in brinjal for yield and yield components

RI Khobragade, PK Nagre and VN Nandeshwar

Abstract
The present investigation entitled "Genetic analysis of F_1 hybrids in brinjal" was undertaken during *kharif* and summer season of 2014-15 at Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola with the objective to estimate the heterosis for yield and its component traits. Eleven geographical and genetically diverced parents of various economic traits (four lines and seven testers) were crossed in line x tester mating design to obtain 28 F_1s. These crosses, parents and check were grown in *kharif* and summer season of 2014-15 in randomized block design with three replications. The *per se* performance for yield characters, among the eleven parents Bhatai Local, Wadsa Local, Aruna, Ruchira, Chandur Local and White Brinjal have found superior in performance, while among the twenty eight crosses, Wadsa Local x Ruchira, Wadsa Local x Chandur Local, Wadsa Local x DBSR-52, Aruna x Ruchira, Aruna x Chandur Local, Aruna x DBSR-52, Bahtai Local x Ruchira and Bhatai Local x Chandur Local have found superior in performance. On the basis of magnitude of standard heterosis, the crosses Wadsa Local x Ruchira, Wadsa Local x Chandur Local, Wadsa Local x DBSR-52, Aruna x Ruchira, Aruna x Chandur Local, Aruna x DBSR-52, Bahtai Local x Ruchira and Bhatai Local x Chandur Local have found superior performance over other crosses in study.

Keywords: Brinjal, heterosis, crosses, parents, yields, per se performance

Introduction
Brinjal (*Solanum melongena* L.), one of the most important vegetable crops, belongs to family Solanaceae. In India, it is known by *baigan* (HindI), *Vangi* (Marathi), *Badanekai* (Kannada), *Katharikai* (Tamil), Vankai (Telagu) *etc.* Internationally, it is referred as Eggplant (England) or Aubergine (France). India is regarded as the primary centre of origin/diversity of brinjal (Bhaduri, 1951 and Vavilov, 1931) [4, 16] and shows secondary diversity in South East Asia. The chromosome number of many species of solanaceae under non tuberous group is fairly stable as 2x = 2n = 24. There are 38 Asian species, which includes 22 Indian species. There is a group of 5 related ones, namely *S. melongena* L., *S. incum* L., *S. xanthocarpum*, *S. indicum* L. and *S. maccani* (Choudhary, 1976) [7]. There are three main botanical varieties under the species melongen. The common brinjal type which is large, round or egg-shaped fruited forms belongs to group under var. *esculentum.* The long, slender types are included under var. *serpentinum* and the dwarf brinjal plants are put under var. *depressum.*
India is the second largest producer of brinjal in the world only after China followed by Iran, Egypt, Indonesia, Japan, Spain, Italy, Bangladesh & Pakistan where it is being grown extensively. Brinjal is cultivated in India, over an area of 0.67 million ha, sharing 6.5 % to the total vegetable area, with an average annual production of 12.40 million tones, sharing 7.08 % production with 18.53 MT/ha productivity compared to 26.5 MT/ha of world. (Anon, 2017) [2]. In Maharashtra, it is grown on an area of 0.22 lakh ha with annual production of 4.33 lakh tonnes having productivity 19.78 MT/ha. Nagpur, Satara, Solapur, Parbhani, Pune Sangali, Bhandara, Amrawati, Wardha Chandrapur, Latur, Nashik, Dhuley, Beed and Aurangabad districts contribute more area and production to the state pool. In genetic improvement, selection of suitable parents is important for development of better hybrids. The *per se* performance of parental lines provides clues, however, reliable information on magnitude of heterosis, combining ability of parents for yield and its component characters and gene action involved in the inheritance in different characters are more helpful in selecting appropriate parents and desirable cross combinations for commercial exploitation of hybrid vigour.
Different mating designs have been used by different workers as an aid in the choice of parents and to understand their genetic worth. Line x Tester analysis was suggested by Kempthrone (1957) [8] to elucidate the nature of gene action and combing ability of parents for different characters. Line x Tester analysis is a useful technique for screening large numbers of lines for identifying the best combiners.

Considering the importance of heterosis and combing ability studies in improvement of brinjal crop, the present investigation "Genetic analysis of F_1 hybrids in brinjal" was carried out with the objectives to estimate heterosis for yield and its component traits. In brinjal, wide range of variability is available in fruit colour, shape and size, which have created region-wise wide range of different consumers preference and thus it offers great potential for exploitation of hybrid vigour. Being an often cross pollination and large flower size, it produces large number of seeds per fruit. Therefore the technology of hybrid seed production and seed cost of F_1 seeds, is comparatively cheaper to other vegetable crops. Thus heterosis breeding will always have great scope in brinjal improvement for early maturity, higher yield and better quality which are the major advantages of brinjal.

Materials and Methods

The present investigation entitled "Genetic analysis of F_1 hybrids in brinjal" was undertaken during *kharif* and summer season of 2014-15 at Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola with the objective to estimate the heterosis for yield and its component traits, For this purpose, eleven geographical and genetically diverced parents of various economic traits (four lines and seven testers) were crossed in line x tester mating design to obtain 28 F_1s. These crosses, parents and check were grown in *kharif* and summer season of 2014-15 in randomized block design with three replications. The brinjal seedlings transplanted at spacing of 75X60cm. The experimental material for this study comprised of eleven inbred parental genotypes which were collected from University Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, All India Co-ordinated Research Project on Vegetable crops and Mahatma Phule Krishi Vidyapeeth, Rahuri based on their diversity for various traits and popular local cultivars from Bhandara, Wadsa (Gadchiroli) and Akola district. From these eleven genotypes, four were used as lines and seven as testers and twenty eight crosses were evolved in a line x tester design. The list of parents, and check along with sources are given in Table 1.

The data was recorded on five selected plants and was recorded for nineteen characters *viz.*, plant height, number of branches per plant, plant spread, days to first flowering, days to 50% flowering, number of flowers per branch, number of fruits per branch, number of fruits per plant, fruit set, fruit length, fruit diameter, fruit weight, yield per plant, yield per plot, yield per hectare, number of seeds per fruit, infestation of shoot and fruit borer, bacterial wilt disease incidence and leaf chlorophyll content.

Table 1: List of parents, crosses and check

Sr. No.	Parents	Code	Source
Lines			
1	Aruna	P1	Dr. PDKV, Akola
2	Bhandara Local (Green round)	P2	Local collection of Bhandara District
3	Wadsa local (White Long)	P3	Local collection of Wadsa, Dist. Gadchiroli
4	Bhatai local (Dark Purple Round)	P4	Local collection of Bhandara District
Testers			
1	Manjari Gota	P5	MPKV, Rahuri
2	Chandur Local	P6	Local collection from Chanduri area of Akola district
3	Ruchira	P7	MPKV, Rahuri
4	Krishna Kathi	P8	MPKV, Rahuri
5	White Round	P9	Local collection of Bhandara District
6	DBSR-52	P10	MPKV, Rahuri
7	Brinjal White	P11	MPKV, Rahuri
Check			
1	Phule Arjun		MPKV, Rahuri

Results and Discussion

Per se performance of parents and crosses

The *per se* performance revealed that, the parent ((Table 2) Bhatai Local executed better *per se* performance for maximum number of fruits per plant, yield per plant, yield per plot and yield per hectare. Whereas the parent Aruna was the next best which exhibited superior per se performance for characters *viz*., number of fruits per branch and number of fruits per plant. The cv. Ruchira was responsible for exhibiting better *per se* performance for fruit diameter, yield per plant, yield per plot, yield per hectare, while White Brinjal for number of fruits per branch, while Wadsa Local fruit length, yield per plant, yield per plot and yield per hectare and Chandur Local number of fruits per plant and fruit set.

Among the crosses, (Table 2) the cross combination Aruna x Ruchira, Bhatai Local x Ruchira and Aruna x Chandur Local expressed better *per se* performance for number of fruits per branch, number of fruits per plant, fruit set, fruit diameter, yield per plant, yield per plot, yield per hectare, while the cross Wadsa Local x Ruchira expressed for number of fruits per plant, fruit set, fruit length, fruit diameter, fruit weight, yield per plant, yield per plot, and yield per hectare. The crosses Bhatai Local x DBSR-52 and Aruna x DBSR-52 commonly expressed better per se performance for number of fruits per branch, number of fruits per plant, fruit set, fruit length, fruit weight, yield per plant, yield per plot, yield per hectare. The crosses Wadsa Local x Chandur Local and Wadsa Local x DBSR-52 also expressed better per se performance for maximum number of characters following to these top ranking crosses. The superior performance of the hybrids in brinjal have been recorded by the Venkataramani (1946) [17], Odland and Noll (1948) [10], Capinpin and Alviar (1949) [6], Sidhu and Chadha (1985) [13] and Ponnuswami (1994) [12].

Heterosis for yield and yields traits

In the present investigation, the wide range of heterosis over standard check was recorded for all characters under study (Table 3). Phule Arjun developed by Mahatma Phule Krishi Vidyapeeth, Rahuri was used as a standard check as it is commercially popular F_1 hybrid grown in Maharashtra. Among the 28 crosses, the cross Wadsa Local x Ruchira exhibited highest standard heterosis (47.13%) followed by Wadsa Local x Chandur (40.55 %), Wadsa Local x DBSR-52

(39.52 %), Bhatai Local x DBSR-52 (34.63 %), Aruna x DBSR-52 (22.88%), Bhatai Local x Ruchira (39.52%), Aruna x Chandur Local (23.78%) and Aruna x Ruchira (23.78%) for yield per plant along with most of the characters. In almost all the heterotic hybrids, heterosis was observed matching with their *per se* performance. Similar results regarding extent of average heterosis, heterobeltosis and standard heterosis were reported by Singh and Nandpuri (1974) [14], Patil (1998) [11], Anuroopa (2000) [3], Bulgundi (2000) [5], Singh and Mourya (2005) [15], Ajjappalavara (2006) [1] and Makani (2013) [9] for fruit diameter, number of fruits per plant, fruit weight and yield per plant.

Table 2: Per se performance of parents and crosses for yield traits in brinjal

Sr. No.	Parents and crosses	Number of fruits per branch	Number of fruits/ plant	Fruit set (%)	Fruit length	Fruit dia. (cm)	Fruit weight (g)	Yield per plant (kg)	Yield per plot (kg)	Yield (q/ha)
	Female parents									
1	Aruna	4.71	24.61	37.13	5.21	3.94	57.11	1.40	27.92	311.03
2	Bhandara Local	2.51	15.84	30.13	5.62	5.50	81.18	1.26	25.51	283.40
3	Wadsa Local	3.18	21.60	33.08	13.76	3.17	68.25	1.46	29.26	325.14
4	Bhatai Local	3.88	26.14	41.89	4.90	4.35	62.52	1.62	32.43	360.10
	Mean	3.57	22.05	35.56	7.37	4.24	67.27	1.44	28.78	319.92
	Male Parents									
5	Manjari Gota	3.13	19.78	33.14	5.23	4.13	63.06	1.26	25.23	280.29
6	Chandur Local	3.28	23.29	34.88	4.87	4.27	64.02	1.38	27.48	306.81
7	Ruchira	2.83	19.94	32.46	5.18	5.16	71.90	1.44	28.79	319.84
8	Krishna Kathi	2.03	12.33	24.18	6.87	5.97	115.45	1.32	26.44	290.70
9	White Round	2.45	14.42	26.38	5.48	5.15	77.02	1.12	22.44	249.37
10	DBSR-52	3.95	17.03	30.04	6.41	4.09	68.51	1.17	23.48	260.92
11	White Brinjal	4.62	21.85	33.88	7.12	4.09	66.64	1.46	29.14	323.81
	Mean	3.18	18.38	30.71	5.88	4.69	75.23	1.31	26.14	290.25
	Parental Mean	3.34	19.91	32.73	6.42	4.53	72.33	1.36	27.24	302.61
	Crosses									
12	Aruna x Manjari Gota	3.88	25.58	39.13	6.23	4.81	71.38	1.85	36.89	409.92
	x Chandur Local	3.80	27.85	40.05	6.61	5.40	77.92	2.19	43.56	485.90
	x Ruchira	3.71	27.45	40.42	6.28	5.51	79.20	2.22	44.11	489.36
	x Krishna Kathi	1.87	13.88	23.73	6.86	5.73	101.09	1.59	31.83	353.35
	x White Round	3.12	18.85	29.70	7.09	5.08	79.24	1.48	29.60	328.14
	x DBSR-52	5.23	27.51	39.59	7.00	4.14	84.14	2.21	44.48	490.79
	x White Brinjal	4.01	23.53	35.47	6.83	4.62	65.59	1.55	31.08	345.36
19	Bhandara Local x Manjari Gota	3.25	22.23	38.71	6.41	5.77	87.92	1.98	39.53	440.36
	x Chandur Local	2.96	17.20	35.75	6.00	5.53	82.87	1.77	44.20	422.10
	x Ruchira	2.73	20.89	31.23	7.43	7.00	88.38	2.13	40.46	468.89
	x Krishna Kathi	2.30	15.50	30.02	6.60	6.08	94.27	1.44	28.87	320.71
	x White Round	2.18	14.16	28.12	6.99	5.74	90.25	1.41	25.72	285.81
	x DBSR-52	3.40	21.07	36.34	7.39	5.00	96.96	2.05	41.00	455.70
	x White Brinjal	3.36	20.04	35.60	6.39	4.77	76.83	1.52	30.48	336.03
26	Wadsa Local x Manjari Gota	3.33	22.59	35.01	10.75	4.10	81.55	1.86	37.24	413.92
	x Chandur Local	2.84	23.24	37.04	13.47	5.05	107.12	2.52	50.49	561.13
	x Ruchira	3.11	25.48	36.70	12.94	5.41	103.76	2.64	52.90	587.23
	x Krishna Kathi	1.97	14.43	23.30	10.71	5.40	110.53	1.66	33.12	368.03
	x White Round	2.77	18.46	31.46	11.48	4.63	84.25	1.56	31.15	346.10
	x DBSR-52	3.44	22.09	33.08	13.95	4.79	110.18	2.46	48.96	545.90
	x White Brinjal	3.48	24.27	35.71	12.19	4.15	85.43	2.32	46.39	459.90
33	Bhatai Local x Manjari Gota	4.60	29.58	43.76	5.79	4.91	76.16	2.16	43.14	479.41
	x Chandur Local	4.09	29.45	43.53	5.50	4.78	73.53	2.11	42.20	469.09
	x Ruchira	3.54	29.23	41.24	6.11	5.64	85.94	2.51	50.03	556.64
	x Krishna Kathi	2.18	15.21	30.90	6.58	5.72	99.47	1.64	32.86	365.09
	x White Round	2.87	18.89	32.73	6.33	5.01	76.35	1.58	31.57	350.81
	x DBSR-52	4.29	27.46	39.99	6.94	5.15	88.20	2.42	48.35	537.49
	x White Brinjal	4.10	25.56	35.68	6.69	4.68	72.36	1.85	36.85	411.25
	Mean	3.30	22.20	35.14	7.98	5.16	86.32	1.95	39.18	431.59
	F1 Check									
40	Phule Arjun	3.11	20.80	35.12	7.21	4.85	86.13	1.80	35.93	399.18
	General Mean	3.30	21.48	34.41	7.53	4.98	82.82	1.78	35.78	394.87
	SE(M)±	0.18	1.13	1.26	0.29	0.18	3.60	0.09	1.68	18.86
	CD 5%	0.51	3.14	3.51	0.81	0.52	10.04	0.25	4.68	52.61
	CD 1%	0.67	4.14	4.62	1.06	0.68	13.25	0.33	6.17	69.39

Table 3: Per cent heterosis for yield and yield traits in brinjal over Standard check

Sr. No.	Crosses	Number of fruits per branch	Number of fruits/ plant	Fruit set (%)	Fruit length	Fruit dia. (cm)	Fruit weight (g)	Yield per plant (kg)	Yield per plot (kg)	Yield (q/ha)
1	Aruna x ManjariGota	25.07 **	22.99 **	11.40 *	-13.59 *	-0.69	-17.12 *	2.88	2.69	2.69
2	x Chandur Local	22.49 **	33.91 **	14.02 **	-8.3	11.35	-9.54	22.18 **	21.24 **	21.73 **
3	x Ruchira	19.48 **	31.96 **	15.08 **	-12.97	13.62 *	-8.04	23.78 **	22.77 **	22.59 **
4	x Krishna Kathi	-39.72 **	-33.29 **	-32.45 **	-4.85	18.16 **	17.37 *	-11.41	-11.41	-11.48
5	x White Round	0.54	-9.37	-15.43 **	-1.73	4.88	-8	-17.80 **	-17.61 **	-17.80 **
6	x DBSR-52	68.28 **	32.24 **	12.71 *	-2.91	-14.65 *	-2.31	22.88 **	23.81 **	22.95 **
7	x White Brinjal	29.04 **	13.13 *	0.97	-5.34	-4.61	-23.85 **	-13.48 *	-13.48 *	-13.48 *
8	Bhandara Local x ManjariGota	4.72	6.89	10.2	-11.07	19.09 **	2.08	10.3	10.02	10.32
9	x Chandur Local	-4.67	-17.32 **	1.77	-16.78 *	14.03 *	-3.79	-1.61	23.03 **	5.74
10	x Ruchira	-12.02	0.42	-11.10 *	2.98	44.36 **	2.61	18.50 **	12.63 *	17.47 **
11	x Krishna Kathi	-26.03 **	-25.47 **	-14.52 **	-8.46	25.52 **	9.45	-19.63 **	-19.63 **	-19.66 **
12	x White Round	-29.95 **	-31.94 **	-19.93 **	-3.14	18.36 **	4.79	-21.48 **	-28.40 **	-28.40 **
13	x DBSR-52	9.5	1.28	3.45	2.5	3.2	12.57	14.13 *	14.13 *	14.16 *
14	x White Brinjal	8.32	-3.65	1.35	-11.44	-1.65	-10.8	-15.24 *	-15.15 *	-15.82 *
15	Wadsa Local x ManjariGota	7.3	8.6	-0.32	49.04 **	-15.37 *	-5.32	3.68	3.65	3.69
16	x Chandur Local	-8.53	11.71 *	5.44	86.73 **	4.13	24.37 **	40.55 **	40.55 **	40.57 **
17	x Ruchira	0.16	22.50 **	4.48	79.45 **	11.59	20.47 **	47.13 **	47.24 **	47.11 **
18	x Krishna Kathi	-36.45 **	-30.63 **	-33.66 **	48.53 **	11.31	28.33 **	-7.8	-7.8	-7.8
19	x White Round	-10.74	-11.27	-10.42 *	59.16 **	-4.5	-2.18	-13.30 *	-13.30 *	-13.30 *
20	x DBSR-52	10.74	6.22	-5.82	93.39 **	-1.13	27.92 **	36.77 **	36.29 **	36.76 **
21	x White Brinjal	11.92	16.68 **	1.67	69.05 **	-14.34 *	-0.81	29.13 **	29.13 **	15.21 *
22	Bhatai Local x ManjariGota	48.26 **	42.20 **	24.59 **	-19.78 **	1.24	-11.58	20.08 **	20.08 **	20.10 **
23	x Chandur Local	31.67 **	41.57 **	23.94 **	-23.71 **	-1.41	-14.63 *	17.48 **	17.46 **	17.51 **
24	x Ruchira	14.01	40.51 **	17.41 **	-15.32 *	16.40 **	-0.22	39.52 **	39.25 **	39.45 **
25	x Krishna Kathi	-29.68 **	-26.90 **	-12.02 *	-8.74	18.02 **	15.49 *	-8.54	-8.54	-8.54
26	x White Round	-7.51	-9.18	-6.81	-12.23	3.4	-11.35	-11.96	-12.12	-12.12 *
27	x DBSR-52	38.22 **	32.01 **	13.86 **	-3.74	6.29	2.41	34.63 **	34.59 **	34.65 **
28	x White Brinjal	32.10 **	22.89 **	1.59	-7.28	-3.37	-15.98 *	3.08	2.56	3.03
	SE(m)±	0.23	1.22	1.85	0.48	0.30	5.84	0.12	2.25	24.27
	CD 5%	0.45	2.41	3.66	0.95	0.60	11.59	0.23	4.45	48.11
	CD 1%	0.60	3.19	4.84	1.26	0.79	15.33	0.30	5.89	63.64

*, ** = significant at 5% and 1% respectively

Conclusions

On the basis of magnitude of standard heterosis, the crosses Wadsa Local x Ruchira, Wadsa Local x Chandur Local, Wadsa Local x DBSR-52, Aruna x Ruchira, Aruna x Chandur Local, Aruna x DBSR-52, Bahtai Local x Ruchira and Bhatai Local x Chandur Local have found superior performance over other crosses in study for yield and yield components traits.

References

1. Ajjappalavara PS. Genetic studies and management of bacterial wilt in brinjal (*Solanum melongena* L.). Ph. D. Thesis, Uni. Agric. Sci., Dharwad (India), 2006.
2. Anonymous Area and production of vegetable crops in India. Indian Horticulture Database, National Horticulture Board, 2017.
3. Anuroopa M. Development of F_1 hybrids with resistance to bacterial wilt in green long brinjal (*Solanum melongena* L.). M. Sc. (Agri.) Thesis, Uni. Agric. Sci., Bangalore (India), 2000.
4. Bhaduri PN Inter-relationship of non-tuberiferous species of *Solanum* with some consideration on the origin of brinjal (*S. melongena* L.). The Indian Journal of Genetics and Plant Breeding, 1951; 11:75-82.
5. Bulgundi SS. Heterosis and combining ability in brinjal (*Solanum melongena* L.). M. Sc. (Agri.) Thesis, Uni. Agric. Sci., Dharwad (India), 2000.
6. Capinpin JM, Alviar MA Heterosis in eggplant. Philippines Agril. Forestry. 1949; 33:126-141.
7. Choudhary B Evolution of Crop Plants, Ed.N.W. Simmonds, Longman Inc. London, 1976.
8. Kempthrone O. An Introduction to Genetic Statistics, John Wiley and Sons, Inc., New York, 1957, 208-223.
9. Makani AY, Patel AL Bhatt MM and Patel PC. Heterosis for yield and its contributing attributes in brinjal (*Solanum melongena* L.) The Bio Scan. An Int J. Life Sci. 2013; 8(4):1369-1371.
10. Odland ML, Noll CJ. Hybrid vigour and combining ability in eggplant. Proceedings of the American Society for Horticulture Science, 1948; 51:417-422.
11. Patil RV. Heterosis, combining ability and disease reaction studies in brinjal. Ph. D. Thesis, Uni. Agric. Sci., Dharwad (India), 1998.
12. Ponnuswami V, Irulappan I, Thamburaj S. Heterosis in eggplant (*Solanum melongena* L.). South Indian Horticulture, 1994; 42:50-52.
13. Sidhu AS, Chadha ML. Heterosis and per se performance studies in brinjal. Indian Journal of Horticulture, 1985; 42:107-111.
14. Singh H, Nandpuri KS Genetic variability and correlation studies in eggplant (*Solanum melongena* L.). J Res. PAU, 1974; 11:150-157.
15. Singh R, Maurya AN. Hybrid vigour in eggplant (*Solanum melongena* L.). Progr. Hortic. 2005; 37(1):100-105
16. Vavilov NI. The role of Central Asia in the origin of cultivated plants. Bulletin of Applied Botany-Genetics and Plant Breeding, 1931; 26(3):3-44.
17. Venkataramani KS. Breeding brinjals (*Solanum melongena*) in Madras. Hybrid vigour in brinjal. Proceedings of Academic Sci. Sec. 1946; 23:262-273.