The Andhra Agric. J 61(1):179-185, 2014

Field Screening of Brinjal (*Solanum melongena* L.) Germplasm for Desirable Traits by the Use of Augumented Design

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ABSTRACT

Eighty Four Brinjal accessions were grown in augmented randomized complete block design to screen for superior cultivars with desirable traits. The desirable traits were plant height(cm), number of branches per plant, Days to 50% flowering, number of flowers per cluster, relative style length, Days to first fruit set, fruit set percentage, days to harvest, number of fruits per plant, fruit length (cm), weight of fruit (g), seed weight (g), fruit yield per plant (g) and yield (tha^{-1}). Four standard varieties were used, namely Bhagyamati, Gulabi, Shyamala and Arka Kesav. Accessions that were superior to the standard types in more than one trait were EC 386589, IC 112741, IC 112818, IC 427008 and IC 345747. These accessions could be selected and put into crossing blocks to combine the traits into one genotype. The present results show that augmented design is an efficient method in the identification of superior brinjal genotypes with desirable traits.

Key words : Augmented design, Brinjal, Germplasm, Morphological characters, Yield

Egg plant (*Solanum melongena L),* also known as aubergine or brinjal is an important vegetable in central, southern and south-east Asia and in a number of African countries (Kalloo, 1988). In India brinjal is cultivated in an area of 5.8 lakh hectares with an annual production of 100.7 lakh tonnes (National Horticulture Board, 2009-10) and in Andhra Pradesh 26.6 lakh hectares is under its cultivation with an annual production of 53.13 lakh tonnes (Andhra Pradesh Horticulture, 2009-10).Selection for desirable traits is necessary to enhance brinjal breeding in India. The initial stages of breeding programmes include field-testing of large numbers of accessions. The tests are laborious, time consuming and need to be repeated to minimize effects of uncontrolled environmental factors. With limited resources, the breeder needs to increase efficiency at an early testing in order to reduce the number of genotypes for uniform trials. Federer (1961) proposed the augmented design as a solution to overcome the problem of having large number of genotypes for field-testing. These design allow elimination of soil differences as common causes of error in comparison of entries, and can successfully be employed in genetic studies and breeding programmes for crop improvement, being more cost effective than fully replicated trials (Spehar,1994). These designs are derived from expanded randomized complete blocks in which standard varieties are present in all blocks. The empty spaces of the expanded blocks are filled with the varieties for which information about the performance is needed. The statistical analysis on the standard varieties identifies the varying soil attributes as measured by the blocks, and allows one to correct for these and make a valid comparison.

The objective of the experiment was to adopt the augmented randomized complete block design to screen brinjal germplasm and select superior genotypes with desirable traits to facilitate their use in breeding programmes. Any germplasm collection is of little value in crop improvement until it is evaluated and characterized. Brinjal germplasm evaluation was attempted by several research workers and identified promising accessions for utilization in hybridization programme for selecting desirable segregants/ cross combinations (Thirumurugan *et al.,* 1999; Mohanty and Prusti, 2002; Sherly and Shanthi, 2007 and Vandana Yadav, 2008).

MATERIAL AND METHODS

Eighty Four brinjal accessions were collected from NBPGR Regional Station, Hyderabad (A.P) and planted in an augmented randomized complete block design (Federer, 1956). The experimental design consists of 8 randomized blocks in which each of four standard brinjal genotypes and ten entries were planted, the standard genotypes serving as check. These standard genotypes, namely Bhagyamati, Gulabi, Shyamala and Arka Kesav represented wide range of agronomic characters and were chosen because they were the standard checks commonly used by the vegetable growers for commercial cultivation.

The trial was carried out during Kharif 2010-11 season at Horticultural Research Station, Venkataramannagudem, Andhra Pradesh. The four standard genotypes were grown in each block, but each entry to be evaluated was planted only once in one row of 15 m length. The plants were transplanted in the main field at a distance of 75 cm and 75 cm respectively. The positions of the four standard genotypes and the ten entries in each block were fully randomized and planted in rows. All accessions were evaluated under good management conditions to evaluate their full potential.

The observations were made on five randomly selected plants from each accession for plant height(cm), number of branches per plant, Days to 50% flowering, number of flowers per cluster, relative style length, Days to first fruit set, fruit set percentage, days to harvest, number of fruits per plant, fruit length (cm), weight of fruit (g), seed weight (g), fruit yield per plant (g) and yield (tha^{-1}). The accessions were compared with standard checks for their performance.

RESULTS AND DISCUSSION

The analysis of variance for the fourteen quantitative traits revealed significant treatment differences among 84 accessions for all the characters except for plant characters and relative fruit calyx length indicating wide variation among the accessions and the results are presented in Table 1.

Considerable genetic variation was noticed for the plant height among the brinjal accessions. The plant height ranged from 68.13 cm (IC354564) to 132.52 cm (IC089890). The mean plant height was 100.51cm and thirty six accessions were found to possess greater plant height exceeding the mean plant height among accessions. Out of 80 accessions, 39 accessions recorded relatively greater plant height over the general mean of the check varieties (100.17 cm).

Among 80 brinjal accessions, the highest number of branches was recorded in IC421194 (20.15) whereas the lowest was recorded in IC345740 (10.60). Forty accessions produced relatively higher number of branches compared to the general mean of the accessions (14.64). The mean number of branches of the check varieties was 12.80 and seventy one accessions were found to possess higher number of branches exceeding the mean number of branches of the check varieties.

The number of days taken to 50 per cent flowering ranged from 40.13 to 74.88. The accession EC384565 took minimum number of days (40.13) to 50 per cent flowering, while maximum number of days were taken by the accession IC354135 (74.88). Thirty seven accessions have recorded more number of days compared to the general mean of the accessions (53.7). The mean number of days required by the check varieties to attain 50 per cent flowering was 55.12 and thirty three accessions were found to take more number of days for flowering over mean of the check varieties.

The number of flowers per cluster among the accessions ranged between 0.65 (EC354135) and 5.21 (EC386589). The mean number of flowers per cluster was found to be 2.24 and thirty three accessions exceeded the general mean value. Out of 80 accessions, 10 accessions produced relatively higher number of flowers per cluster compared to the general mean of the check varieties (3.04).

Among the 80 brinjal accessions, the highest relative style length was recorded in EC386589 (0.35 cm) whereas the lowest was observed in IC397299 (0.12 cm). Thirty eight accessions displayed relatively more style length compared to the general mean of the accessions (0.21 cm). The mean style length of the check varieties was 0.212 cm and thirty nine accessions were found to possess more style length over the mean of the check varieties.

The number of days to first fruit set ranged from 46.19 to 141.94 days. Among the accessions the accession IC545919 was the earliest to set fruit (46.19 days) while IC374892 recorded maximum number of days (141.94) to set the first fruit. Thirty three accessions were recorded relatively more number of days compared to the general mean of the accessions (66.32). The mean number of days taken to produce first fruit set by the check varieties was 62.69 and forty three accessions were found to take less number of days than the mean of the check varieties.

The genetic variation for per cent fruit set among the accessions ranged between 1.38 (IC354135) and 75.3 (IC345747). The mean per cent fruit set was 26.95 and thirty accessions exceeded the general mean value. Out of 80 accessions, 12 accessions recorded relatively higher fruit set compared to the general mean of the check varieties (41.47).

The number of days to take first harvest in different accessions ranged from 52.31 to 149.56. The accession IC305131 took minimum number of days (52.31) to produce first fruit while maximum number of days was recorded by IC374892 (149.56). Thirty four accessions recorded relatively more number of days compared to the general mean of the accessions (72.41). The mean number of days taken to produce first fruit by the check varieties was 67.56 and forty one accessions took less number of days than the mean number of days taken by the check varieties.

There was considerable genetic variation among the brinjal accessions for number of fruits per plant, as evident from the observed range of variation between 0.67 (IC354135) to 63.50 (IC345747). The mean number of fruits per plant was found to be 13.54 and twenty nine accessions exceeded the general mean value. The mean number of fruits per plant among the check varieties was 20.22 and twelve accessions were observed to produce higher number of fruits per plant over the general mean of the check varieties.

Among the brinjal accessions, the longest fruits (15.02 cm) were produced by EC316280 while the shortest fruits by IC112322 (2.37 cm). Comparatively, longer fruits were produced by thirty three accessions which exceeded the over all mean fruit length of the accessions (7.36 cm). The mean fruit length of the check varieties was 10.09 cm and twelve accessions were found to possess more fruit length exceeding the mean of the check varieties.

The weight of the fruit was characterized with variability among the accessions, wherein, IC099676 recorded the maximum weight of the fruit (156.84 g) while IC272927 registered the minimum (4.15 g). Thirty two accessions were recorded relatively more fruit weight than the general mean weight of the accessions (52.52 g). Out of 80 accessions, sixty five accessions displayed relatively higher fruit weight compared to the general mean of the check varieties (40.83 g).

There was considerable genetic variation among the brinjal accessions for yield per plant and yield per hectare, as it is evident from the observed range of variation between 11.33 g and 0.28 tha^{-1} (IC272927) to 1382.19 g and 30.81tha^{-1} (EC386589). The mean yield per plant was found to be 633.33 g and 14.18 tha^{-1} and twenty eight accessions exceeded the general mean value of the accessions. The mean yield per plant among the check varieties was 806.0 g and twenty four accessions recorded higher yields per plant exceeding the general mean of the check varieties and eighteen accessions recorded relatively higher yield compared to the general mean of the check varieties (20.18 tha^{-1}).

The accession IC090026 has recorded the maximum hundred seed weight (663.0 mg) while IC397299 registered the minimum seed weight (158.6 mg). Out of 80 accessions, forty four accessions recorded greater seed weight than the mean seed weight of accessions (348.32 mg). The mean seed weight of the check varieties was 309.9 mg and about fifty seven accessions were found to possess more seed weight exceeding the general mean of the check varieties.

The accession EC 386589 recorded the highest fruit yield per plant followed by IC 112741, IC 112818, IC 427008 and IC 345747. The increased fruit yield in the accession EC 386589 was due to more number of flowers per cluster, more number of fruits per cluster/plant and relative style length recorded by it. The accession IC 112741 also recorded fairly high fruit yield through highest 100-seed weight. While, the accessions IC 112818 and IC 427008 showed higher fruit yield

Table 1. Preliminary evaluation of brinjal accessions for fruit yield and its components.

S. No.	Accession	Plant Height (cm)	Number of Branches/ Plant	Days to 50% Flowering	Flowers/ Cluster	Relative Style Length (cm)	Days to First Fruit Set	Fruit Set (%)	Days to harvest	Fruits/ Plant	Fruit Length (cm)	Weight of Fruit (g)	100 Seeds Wt. (mg)	Yield Per Plant (g)	Yield t/ha
1	EC386589	117.25	15.80	47.13	5.21	0.35	56.94	69.23	62.56	40.09	7.49	35.36	265.70	1382.19	30.81
2	IC249358	118.92	11.10	49.13	3.26	0.32	63.94	39.57	70.56	19.29	6.59	57.07	352.20	1133.79	25.29
3	IC089949-B	115.59	14.50	57.13	4.01	0.18	68.94	28.90	74.56	14.09	5.79	45.40	387.20	673.59	15.06
4	IC112738	127.32	12.50	66.13	2.66	0.19	76.94	19.88	82.56	9.69	4.89	76.50	300.00	811.49	18.13
5	IC354528	114.92	11.10	71.13	3.31	0.25	85.94	21.31	91.56	10.39	7.19	41.03	351.70	464.19	10.41
6	IC112750	87.32	12.50	69.13	2.01	0.22	84.94	12.91	91.56	6.29	4.29	38.31	307.50	285.49	6.44
7	IC090915	101.99	13.80	51.13	2.51	0.22	63.94	13.73	70.56	6.69	8.99	40.13	295.80	313.79	7.07
8	IC298633	119.25	14.80	71.13	2.06	0.22	85.94	9.62	91.56	4.69	8.99	86.74	409.50	498.89	11.18
9	IC112909	116.32	12.10	70.13	1.56	0.13	84.94	4.09	91.56	1.99	7.29	94.64	383.80	288.29	6.50
10	IC374892	130.72	13.50	66.13	2.46	0.22	141.94	5.32	149.56	2.59	7.49	75.48	302.40	281.19	6.34
11	IC312984	90.39	15.00	55.88	2.40	0.15	68.19	24.09	73.31	11.74	6.79	71.25	356.90	853.79	18.75
12	IC397299	78.65	13.00	54.88	0.85	0.12	66.19	5.01	73.31	2.44	9.49	34.20	158.60	86.49	1.70
13	IC112997	82.02	13.00	45.88	2.30	0.25	55.19	16.91	61.31	8.24	10.89	50.32	229.60	421.49	9.15
14	IC112741	114.72	14.30	62.88	2.45	0.23	74.19	65.51	81.31	31.94	11.69	42.15	429.80	1315.69	29.02
15	IC345740	97.02	10.60	60.88	2.50	0.30	73.19	19.78	81.31	9.64	9.39	51.87	234.90	504.89	11.00
16	IC354651	95.42	14.60	61.88	2.45	0.17	74.19	39.06	81.31	19.04	7.69	42.50	363.00	793.99	17.42
17	IC467271	105.32	18.60	57.88	2.35	0.17	75.19	33.52	81.31	16.34	6.79	53.69	402.80	875.39	19.23
18	IC090905	95.42	14.00	58.88	1.80	0.25	76.19	28.60	81.31	13.94	14.09	70.05	380.50	987.79	21.73
19	IC336472	96.12	18.00	45.88	1.55	0.20	55.19	31.67	61.31	15.44	7.89	35.43	409.90	532.29	11.61
20	IC112993	100.32	13.00	69.88	3.50	0.26	75.19	23.47	81.31	11.44	6.59	46.13	370.80	527.89	11.51
21	IC089989	83.14	13.85	48.13	2.36	0.20	56.19	15.97	62.56	7.79	6.02	33.02	344.50	292.37	6.60
22	EC316280	76.54	15.55	71.13	1.91	0.25	84.19	39.14	91.56	19.09	15.02	50.60	327.80	987.87	22.06
23	IC545937	100.41	16.55	69.13	0.81	0.27	83.19	19.25	91.56	9.39	5.62	68.75	411.50	700.37	15.67
24	IC279555	81.54	15.55	71.13	0.96	0.23	84.19	13.30	91.56	6.49	4.72	42.62	254.80	321.17	7.25
25	IC281092	96.44	14.25	54.13	2.06	0.23	62.19	24.17	70.56	11.79	6.02	43.12	379.80	539.97	12.11
26	IC545844	106.64	16.85	68.13	3.51	0.31	75.19	27.86	82.56	13.59	9.62	42.16	384.00	603.17	13.51
27	IC397557	94.87	13.55	55.13	1.71	0.21	67.19	6.33	74.56	3.09	4.82	43.69	267.50	186.27	4.25
28	IC350885	69.94	11.55	42.13	1.41	0.25	49.19	10.22	57.56	4.99	7.52	53.63	344.20	321.67	7.26

Table 1 Cont.....

S. No.	Accession	Plant Height (cm)	Number of Branches/ Plant	Days to 50% Flowering	Flowers/ Cluster	Relative Style Length (cm)	Days to First Fruit Set	Fruit Set (%)	Days to harvest	Fruits/ Plant	Fruit Length (cm)	Weight of Fruit (g)	100 Seeds Wt. (mg)	Yield Per Plant (g)	Yield t/ha
29	EC384565	81.51	16.25	40.13	2.16	0.25	47.19	38.94	53.56	18.99	6.12	51.15	366.00	994.37	22.21
30	IC332508	119.74	15.25	44.13	2.96	0.26	54.19	68.06	62.56	33.19	11.72	34.21	411.90	1120.97	25.02
31	IC304072	90.45	15.07	61.88	1.85	0.18	68.19	14.91	73.31	7.27	3.57	45.32	336.20	288.17	6.44
32	IC099676	117.08	13.37	46.88	0.80	0.17	56.19	7.73	61.31	3.77	3.47	156.84	308.30	383.77	8.56
33	IC336793	120.55	14.37	70.88	4.20	0.26	122.19	17.17	130.31	8.37	3.27	44.54	288.70	334.17	7.46
34	IC112726	93.92	14.07	43.88	1.20	0.25	55.19	15.94	61.31	7.77	2.37	52.67	399.00	358.17	7.99
35	IC112322	92.35	13.37	71.88	2.85	0.15	83.19	4.66	90.31	2.27	2.37	60.39	360.00	63.47	1.44
36	IC374912	100.45	15.67	42.88	2.10	0.21	50.19	29.47	56.31	14.37	3.87	64.47	350.10	878.07	19.55
37	EC385380	112.15	17.07	43.88	2.50	0.29	53.19	38.29	61.31	18.67	11.27	61.01	351.30	1108.07	24.66
38	IC354612	113.75	13.37	59.88	1.65	0.22	75.19	19.63	81.31	9.57	5.47	66.90	497.30	573.87	12.79
39	IC398820	102.22	13.37	60.88	2.95	0.23	72.19	22.91	81.31	11.17	10.47	48.41	306.20	505.17	11.26
40	IC344646	93.85	13.67	47.88	2.05	0.26	51.19	18.40	56.31	8.97	5.37	42.56	292.40	350.27	7.82
41	IC354517	100.71	16.55	58.13	2.18	0.21	77.94	50.67	82.56	24.70	5.47	40.12	217.40	976.64	21.72
42	IC090026	94.11	15.15	43.13	2.58	0.26	56.94	43.90	62.56	21.40	9.37	60.07	663.00	1241.24	27.60
43	IC281112	87.38	16.15	63.13	3.23	0.21	77.94	52.92	82.56	25.80	11.87	36.13	242.80	926.34	20.60
44	IC112818	89.11	13.85	41.13	2.23	0.22	57.94	63.79	62.56	31.10	9.47	41.90	334.50	1300.84	28.92
45	IC090785	94.01	15.15	44.13	3.38	0.24	53.94	37.74	57.56	18.40	8.67	47.83	265.30	845.24	18.80
46	EC329327	130.71	14.85	42.13	1.53	0.19	48.94	25.23	53.56	12.30	5.57	54.59	350.40	614.64	13.67
47	IC545948	92.41	14.85	67.13	2.03	0.22	120.94	27.70	131.56	13.50	7.57	46.11	370.50	579.44	12.89
48	IC218975	90.81	15.55	42.13	1.78	0.21	49.94	41.03	53.56	20.00	5.47	52.73	245.00	1016.44	22.60
49	IC345747	80.81	13.85	43.13	2.88	0.31	56.94	75.30	62.56	63.50	13.57	18.45	404.60	1267.04	28.17
50	IC261899	80.81	14.55	43.13	1.48	0.22	48.94	21.13	53.56	10.30	3.47	48.66	388.70	446.54	9.94
51	IC090987	84.81	15.12	65.88	1.60	0.25	121.19	17.58	130.81	8.57	5.09	41.99	427.20	388.57	8.61
52	IC427007	96.51	12.82	42.88	2.15	0.28	47.19	20.45	52.81	9.97	8.09	49.44	460.00	530.37	11.76
53	IC272927	104.08	14.42	43.88	1.25	0.20	48.19	6.50	52.81	3.17	4.49	4.15	318.50	11.33	0.28
54	IC111387	79.81	16.42	70.88	1.55	0.22	83.19	28.45	90.81	13.87	5.49	43.13	303.50	611.37	13.56
55	IC354135	103.11	13.82	74.88	0.65	0.21	134.19	1.38	148.81	0.67	4.89	84.28	462.90	187.87	4.15
56	IC074239	94.94	11.42	55.88	1.90	0.18	62.19	20.66	69.81	10.07	4.89	47.41	348.00	509.67	11.30
57	IC104083	107.71	13.12	43.88	1.70	0.16	46.19	32.55	52.81	15.87	11.59	58.00	331.10	952.27	21.13
58	IC280957	118.51	15.42	46.88	2.45	0.22	50.19	20.86	56.81	10.17	7.99	52.75	347.60	578.97	12.84

Table 1 Cont.....

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59	IC374867	129.88	15.12	46.88	0.85	0.21	56.19	7.94	61.81	3.87	5.09	98.58	395.10	524.47	11.63
60	IC545919	129.71	13.42	43.88	1.75	0.21	46.19	17.37	52.81	8.47	7.99	89.90	376.60	874.27	19.40
61	IC427017	81.43	14.87	45.13	2.19	0.16	51.44	12.34	56.31	6.02	5.82	97.14	383.80	446.42	9.89
62	IC305048	94.83	15.17	54.13	2.24	0.17	68.44	41.88	73.31	20.42	10.92	45.18	355.10	914.72	20.30
63	IC354564	68.13	13.57	44.13	2.44	0.15	56.44	22.60	61.31	11.02	10.22	47.99	304.00	480.42	10.64
64	IC089912	96.43	14.57	43.13	1.79	0.21	55.44	18.50	61.31	9.02	9.02	64.09	326.00	497.02	11.01
65	DBT/098	74.83	15.57	44.13	1.34	0.17	55.44	18.70	61.31	9.12	6.32	52.04	345.10	414.52	9.18
66	IC112350	86.73	13.87	52.13	2.24	0.22	58.44	31.01	61.31	15.12	6.72	37.59	358.50	552.22	12.24
67	IC354597	73.33	16.17	42.13	2.89	0.18	46.44	19.93	52.31	9.72	6.32	52.64	379.50	451.82	10.01
68	IC354563	78.33	14.17	47.13	1.84	0.15	58.44	20.34	61.31	9.92	7.12	55.25	301.70	486.82	10.79
69	IC261772	104.76	15.87	56.13	1.19	0.15	69.44	18.09	73.31	8.82	6.72	73.12	391.10	552.02	12.23
70	IC305131	99.76	16.87	44.13	1.14	0.15	49.44	23.42	52.31	11.42	7.22	44.50	401.30	464.72	10.30
71	IC467274	125.62	15.45	44.88	2.90	0.19	47.94	16.63	53.56	8.11	9.97	57.42	283.90	465.15	10.36
72	IC413648	107.42	14.85	45.88	2.95	0.20	49.94	54.77	53.56	26.71	4.57	23.03	325.30	607.95	13.53
73	IC421194	110.52	20.15	49.88	2.85	0.16	51.94	11.50	57.56	5.61	7.77	41.58	350.30	231.65	5.17
74	IC090938	130.52	18.45	48.88	1.75	0.16	58.94	19.50	62.56	9.51	5.97	51.63	361.00	488.45	10.87
75	IC281104	103.85	17.15	56.88	2.20	0.18	66.94	37.96	74.56	18.51	6.87	39.28	308.00	721.55	16.05
76	IC090942	105.85	18.45	44.88	4.05	0.19	49.94	25.65	53.56	12.51	8.17	46.45	412.30	577.75	12.86
77	IC112747	112.19	19.65	57.88	1.80	0.17	63.94	11.50	70.56	5.61	4.77	39.77	339.00	221.05	4.93
78	IC089890	132.52	15.45	44.88	1.70	0.21	49.94	19.91	53.56	9.71	5.77	60.75	367.10	592.25	13.18
79	IC427008	113.85	11.15	45.88	1.50	0.18	55.94	43.49	62.56	21.21	6.57	60.57	417.30	1283.05	28.53
80	EC316226	98.52	16.85	47.88	2.55	0.22	52.94	52.52	57.56	25.61	6.37	47.93	382.40	1221.35	27.16
81	Bhagyamati	107.58	12.97	55.50	3.46	0.20	63.00	53.29	67.50	25.98	7.09	41.55	285.10	1068.50	26.81
82	Gulabi	104.59	12.54	57.50	3.10	0.24	64.13	49.57	69.00	24.17	10.59	38.97	277.60	936.35	23.41
83	Shyamala	92.00	11.93	49.00	1.86	0.17	59.00	24.05	64.00	11.73	5.32	47.52	351.50	551.86	13.80
84	Arkakesav	96.51	13.75	58.50	3.74	0.24	64.63	38.96	69.75	19.00	17.36	35.29	325.30	667.45	16.69
85	**Mean**	**100.51**	**14.64**	**53.70**	**2.24**	**0.21**	**66.32**	**26.95**	**72.41**	**13.54**	**7.36**	**52.52**	**348.32**	**633.33**	**14.18**
86	Std. Error	1.73	0.21	1.11	0.09	0.00	2.14	1.80	2.26	1.05	0.31	2.19	7.46	35.56	0.80

due to more number of fruits per plant. Similarly, accession IC 345747 recorded promising yield potential as it had relatively more number of longer fruits per plant and higher fruit set percentage. Thus these accessions *viz.,* EC 386589, IC 112741, IC 112818, IC 427008 and IC 345747 appeared to be promising donors for fruit yield and other economic traits. Similar findings were reported by Rajagopal *et al.* (1978), Prakash and Madalageri (1989), Nandi (1994) and Yadav (1996).

Since, brinjal is an often cross pollinated crop and possesses enormous natural variability for quantitative and qualitative traits. The available variability needs to be exploited in the form of development of high yielding hybrids and open pollinated varieties.

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(Received on 31.07.2012 and revised on 21.12.2012)