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Combining ability studies in bottle gourd (*Lagenaria siceraria* (Mol.) Standl.)

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Abstract

Line x Tester study was conducted in bottle gourd during summer and *kharif* 2008 at Zonal Agriculture Research Station, Chhindwara, centre of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur. It is observed that the estimates of specific combining ability variances were higher in magnitude than general combining ability variances for all the characters, indicated that the predominance of non-additive type of gene action. The estimate of general combining ability effects showed that JBG 9 was a good general combiner for all the characters except for days to appearance of first male flower, number of female flowers per plant, fruit setting percent. Estimates of specific combining ability effects revealed that five crossed *viz*., JBG4 x T1 (Pusa Naveen), JBG6 x T1 (Pusa Naveen), JBG9 x T1 (Pusa Naveen), JBG5 x T3 (PSPL) and JBG11 x T3 (PSPL) were the best specific combiners for yield and major yield components.

Keywords : Bottle gourd, combining ability, specific combining ability, general combining ability.

Introduction

Selection of suitable parent for heterosis breeding programme is an important step. The estimation of combining ability analysis by line x tester analysis as proposed by Kempthorne (1957) provides useful information on the nature of inheritance of quantitative characters. This also helps in identifying the superior parents and the combination which are likely to produce high heterotic effects in the desire direction. Studies on combining ability in bottle gourd have been reported by earlier workers (Dubey and Maurya, 2006 and Kumar *et al.,* 2011) but this information has not been utilized fully for commercial hybrid production. The present study was therefore, undertaken to estimate the extent of combining ability of bottle gourd cultivars used as parents and specific combining ability of crosses.

Material and Methods

The experiment was conducted at Research Farm, Zonal Agricultural Research Station, Chhindwara, Jawaharlal Nehru Krishi Vishwa Vidyalaya (M.P.). The experiment was laid out in Randomized Complete Block Design (RCBD) with 63 treatments (45 F_1's + 18 parents) in three replications. The bottle gourd genotypes to be used as line and testers were planted in crossing blocks at two different dates of sowing at an interval of 15 days, so as to get sufficient number of flowers. The fifteen genotypes *viz*. JBG1, JBG2, JBG3, JBG4, JBG5, JBG6, JBG7, JBG8, JBG9, JBG10, JBG11, JBG12, JBG13, JBG14 and JBG15 were treated as female parent (lines) and genotypes Pusa Naveen, Punjab Komal and Pusa Summer Prolific Long were used as male parent (tester). In the crossing programme, each of the lines was crossed to each tester in line X tester fashion, which resulted in 45 F_1 crosses. All F_{1s} with their parents in summer season were evaluated in February and July. The observations were recorded on five randomly selected plants for ten character namely, vine length, primary branches per plant, node to first female flower appeared, sex ratio, fruit setting percentage, days taken to first harvest, average weight of edible fruits (kg/fruit), number of fruits per plant, seed pulp ratio and yield per plant (kg). Data were analysed for the study of combining ability as suggested by Kempthorne (1957).

Result and Discussion

Mean squares due to lines were significant for all the characters except for vine length and average weight of fruit (Table 1). Whereas, testers were significant for all the characters except for vine length, days to first harvest, average weight of fruit and number of fruits per plant, which indicated that the presence of variability in lines

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and testers. The line x tester interaction was highly significant for all the characters except for vine length, sex ratio, fruit setting percentage, average weight of fruit, and number of fruits per plant. These findings are in agreement with the findings reported by Dubey and Maurya (2006) and Kumar *et al*. (2011). The combining ability analysis studies in F_1 population revealed the predominance of non-additive gene action in the expression of all characters. These findings are in agreement with the findings of Dubey and Ram (2005) Parvathi and Reddy (2005), Dubey and Maurya (2006), Maurya *et al*. (2006), Dubey and Maurya (2007).

The estimate of general combining ability effects showed that JBG9 was a good general combiner for all the characters except for fruit setting percent (Table 2). But the fruit yield was negatively significant. Similarly, JBG15 was found to be good combiner for all the characters except for vine length, number of primary branches per plant, average weight of fruit. Parent (Pusa Naveen) also proved good combiner for less branching per plant, early flowering for male and female flower, nodes to first male flower, early first harvest, and yield with positive and non significant. These findings are in agreement with the findings reported by Kumar and Singh (1997) for average weight of fruit, number of fruits per plant, primary branches per plant and yield per plant; Singh *et al*. (1999) for days to early female flowering, early harvest, weight, number of fruits per plant, vine length and yield per vine; Sreevani (2005) for yield and its components, Parvathi and Reddy (2005) for fruits per vine and fruit weight, Dubey and Maurya (2006) for most of the traits, Dubey and Maurya (2007) for most of the characters, Singh and Singh (2009) for yield and number of fruits.

Table 1: Analysis of variance for combining ability of parent and crosses for ten characters in bottle gourd (Pooled)

Source of variation	DF	Vine length	Primary branches /plant	Node to 1st female flower appeared	Sex ratio	Fruit setting %	Days taken to first harvest	Average weight of edible fruits (kg/fruit)	No. of fruits/ plant	Seed pulp ratio	Yield/ plant (kg)
Replication	2	0.000**	4.796**	0.018	13.87**	28.96	11.16*	271735.8	1.594	0.001 *	1.463
Environments	1	0.000**	17.242**	7.868**	44.15**	864.39**	5.079	11146.9	0.015	0.079**	10.86**
Crosses	44	0.000**	10.024**	7.112**	9.34**	270.68**	62.071**	192921.3	4.414**	0.006**	4.47**
Line effect	14	0.000**	22.920**	16.038**	15.00*	514.34**	100.40*	208415.4	6.466	0.012**	6.268
Tester effect	2	0.000**	3.526	3.381	11.07	180.51	53.725	173168.2	6.078	0.000	0.205
Line x Tester effect	28	0.000**	4.040**	2.916**	6.38**	155.30**	43.50**	186585.1	3.268**	0.004**	3.88**
Error	176	0.000**	0.719	0.191	1.257	79.611	2.398	194343.5	0.917	0.000	0.668

* Significant at 5% **Significant at 1%

Table 2: Estimation of general combining ability of parents for ten characters in bottle gourd (Pooled)

Character/ parent	Vine length	Primary branches /plant	Node to 1st female flower appeared	Sex ratio	Fruit setting%	Days taken to first harvest	Average weight of fruits (kg/fruit)	No. of fruits/ plant	Seed pulp ratio	Yield / plant (kg.)
	1	2	6	9	10	11	15	16	18	20
JBG1	-0.107	1.088**	1.575**	-0.026	2.192	-1.408**	-45.339	0.093	0.002	0.003
JBG2	-0.397**	-1.103**	0.502**	-0.689*	0.706	-0.335	-45.271	-0.175	0.035**	-0.381
JBG3	-0.675**	0.472*	-0.330**	0.913**	3.764	1.663**	-57.105	0.360	-0.021**	0.202
JBG4	0.006	-0.418	-0.606**	-0.734*	-8.639**	3.229**	-22.236	-0.816**	0.009	-0.642**
JBG5	-0.158	1.018**	1.207**	-0.844**	-0.079	-1.034*	-82.548	0.366	0.022**	0.023
JBG6	0.300**	1.138**	0.852**	-0.247	-4.628*	-2.593**	-27.467	-0.046	0.008	-0.220
JBG7	-0.062	-0.185	-0.831**	-0.659*	0.495	0.625	7.376	0.250	0.040**	0.382
JBG8	0.055	-0.202	-0.669**	-0.479	-4.695*	-0.849*	-51.980	-0.693**	-0.013*	-0.728**
JBG9	0.584**	-0.799**	0.426**	1.032**	-3.028	1.558**	365.222	-0.526*	-0.026**	-0.628**
JBG10	0.708**	-0.293	1.484**	1.421**	10.021**	1.688**	-57.284	0.289	-0.063**	0.062
JBG11	0.359**	2.446**	-1.030**	-1.123**	-6.310**	-4.796**	-45.118	0.061	-0.003	0.021
JBG12	-0.260*	0.350	-0.777**	-0.322	-0.340	-3.169**	-36.271	0.429	0.024**	0.222
JBG13	-0.301**	-1.805**	0.004	0.585*	-3.475	0.343	23.352	-1.032**	-0.006	-0.537*
JBG14	-0.070	-1.589**	-0.540**	1.791**	8.104**	3.674**	54.107	0.063	-0.004	0.689**
JBG15	0.019	-0.117	-1.266**	-0.620*	5.912*	1.404**	20.561	1.377**	-0.004	1.530**
SE diff.	0.0937	0.1999	0.1030	0.2643	2.1031	0.3650	103.9079	0.2257	0.0052	0.1926
(Pusa Naveen)	-0.024	-0.211*	0.017	0.234	1.103	-0.524**	-34.157	0.139	-0.002	0.028
(Panjab Komal)	0.029	0.182	0.185**	0.169	0.495	0.887**	49.468	0.161	0.000	0.027
(PSPL)	-0.005	0.028	-0.202**	-0.403**	-1.597	-0.364*	-15.311	-0.300**	0.002	-0.055
SE diff.	0.0419	0.0894	0.0461	0.1182	0.9405	0.1632	46.4690	0.1009	0.0023	0.0861

* Significant at 5% **Significant at 1%

Estimates of specific combining ability effects revealed that five crossed *viz*., JBG4 x T1 (Pusa Naveen), JBG6 x T1 (Pusa Naveen), JBG9 x T1 (Pusa Naveen), JBG5 x T3 (PSPL) and JBG11 x T3 (PSPL) were the good specific combiners for yield and major yield components (Table 3). On the other hand, JBG5 x T3 (PSPL) was identified as the good combiner for early flowering, minimum node to first male and female flowers and early first picking. JBG4 x T1 (Pusa Naveen) was found to be good combiner for vigorous branching, more male and female flowers per plant, ultimately increase in fruit setting percent, early first harvest, less seeded and positive value of yield. Similarly, JBG6 x T1 (Pusa Naveen) was identified as a good combiner for number of early male and female flower, early first picking, less seed pulp ratio and more yield. Cross combination of JBG9 x T2 (Punjab Komal) was good combiner for number of fruits per plant. These results are proximate with those of Kumar and Singh (1997), Singh *et al*. (1999) for yield per vine for fruit weight, days to first

Table 3 : Estimates of specific combining ability effect on crosses of bottle gourd (Pooled analysis)

Character/ Crosses	Vine length	Primary branches /plant	Node to 1st female flower appeared	Sex ratio	Fruit setting%	Days taken to first harvest	Average weight of fruits (kg/fruit)	No. of fruits / plant	Seed pulp ratio	Yield / plant (kg)
JBG1 x T1	-0.586 **	-0.317	0.219	-0.803	-6.645	-0.086	17.450	-0.603	-0.016	-0.634
JBG1 x T2	0.454 *	0.566	0.696 **	0.301	2.638	-0.945	-4.072	0.410	-0.013	0.773 *
JBG1 x T3	0.131	-0.249	-0.915 **	0.502	4.008	1.031	-13.378	0.193	0.030 **	-0.139
JBG2 x T1	-0.052	0.252	0.002	-0.696	3.021	-0.414	27.298	0.229	-0.005	0.294
JBG2 x T2	-0.080	0.203	0.147	0.043	0.214	-0.986	-98.243	0.036	0.005	-0.273
JBG2 x T3	0.132	-0.455	-0.148	0.653	-3.234	1.400 *	70.946	-0.265	0.001	-0.020
JBG3 x T1	0.074	-0.564	0.063	0.414	-3.000	3.165 **	-43.361	-0.727	-0.006	-0.933 *
JBG3 x T2	0.058	-0.372	-0.014	0.381	5.621	0.963	47.626	0.791	0.004	1.284 **
JBG3 x T3	-0.132	0.937 *	-0.049	-0.795	-2.622	-4.128 **	-4.265	-0.064	0.002	-0.351
JBG4 x T1	-0.399 *	1.169 **	-0.417 *	0.157	6.986	-1.446 *	53.954	1.664 **	-0.033 **	1.441 **
JBG4 x T2	0.239	-1.016 **	-0.410 *	0.349	-3.633	0.259	-136.479	-1.121 *	0.015	-1.472 **
JBG4 x T3	0.160	-0.153	0.827 **	-0.506	-3.353	1.187	82.524	-0.544	0.018	0.032
JBG5 x T1	0.487 **	0.173	1.474 **	-0.023	-0.971	3.367 **	-6.913	0.405	0.017	-0.041
JBG5 x T2	-0.016	1.027 **	0.061	-0.057	1.880	-1.877 **	-5.086	0.153	0.005	0.404
JBG5 x T3	-0.471 *	-1.201 **	-1.535 **	0.080	-0.909	-1.489 *	12.000	-0.558	-0.022 *	-0.363
JBG6 x T1	0.289	-1.062 **	-0.021	-0.104	1.192	-1.698 *	102.375	0.256	-0.007	0.979 **
JBG6 x T2	-0.146	1.386 **	0.327	-0.137	-1.195	0.713	-171.919	0.084	-0.007	-1.230 **
JBG6x T3	-0.144	-0.324	-0.306	0.242	0.003	0.984	69.544	-0.340	0.014	0.252
JBG7 x T1	0.220	0.155	-0.362	-0.485	0.387	-3.332 **	-21.293	0.609	0.003	0.058
JBG7 x T2	-0.330	0.141	-0.157	-0.289	6.730	2.564 **	5.898	0.574	-0.014	1.045 **
JBG7x T3	0.110	-0.296	0.518 *	0.774	-7.118	0.768	15.395	-1.184 **	0.011	-1.103 **
JBG8 x T1	0.180	0.538	-0.782 **	0.174	-0.611	-1.102	86.692	-0.434	0.019 *	0.197
JBG8 x T2	-0.150	0.059	0.092	-0.682	-3.523	1.532 *	0.509	-0.087	-0.011	0.074
JBG8 x T3	-0.031	-0.597	0.690 **	0.508	4.134	-0.430	-87.201	0.521	-0.008	-0.271
JBG9 x T1	0.234	-0.321	-0.045	1.089 *	0.860	-5.630 **	-293.320	-0.487	0.035 **	-0.108
JBG9 x T2	-0.315	-0.204	-0.280	0.225	-5.446	-0.062	685.569 **	-0.401	0.024 *	-0.348
JBG9 x T3	0.081	0.525	0.325	-1.314 *	4.586	5.692 **	-392.249 *	0.888 *	-0.059 **	0.456
JBG10 x T1	-0.204	-0.748 *	-0.733 **	-0.433	-3.331	0.223	49.264	-0.038	-0.023 *	0.190
JBG10x T2	0.116	-0.161	0.488 *	-0.176	-3.601	-1.098	-105.300	-0.238	0.014	-0.605
JBG10 x T3	0.088	0.908 *	0.245	0.609	6.932	0.875	56.036	0.276	0.008	0.415
JBG11 x T1	-0.402 *	-0.773 *	-0.577 **	1.161 *	4.614	1.000	-64.687	-0.537	-0.041 **	-0.872 *
JBG11 x T2	0.388 *	-0.347	0.059	-0.952	-0.315	-1.381 *	-11.055	0.438	-0.001	0.461
JBG11 x T3	0.014	1.120 **	0.518 *	-0.209	-4.299	0.381	5.627 **	0.099	-0.082 **	0.410
JBG12 x T1	-0.066	0.368	0.256	-0.065	4.377	0.455	6.737 **	0.697	-0.024	0.353
JBG12 x T2	-0.094	-0.851 *	-0.056	0.509	-4.833	-0.780	-2.696 **	-1.003 *	0.001	-0.597
JBG12 x T3	0.160	0.483	-0.201	-0.444	0.456	0.325	-4.040 ***	0.306	0.023	0.245
JBG13 x T1	0.162	0.293	0.429 *	-2.194 **	-5.798	0.541	-0.730 *	0.322	-0.021	0.399
JBG13 x T2	-0.234	-0.778 *	-0.144	-0.130	-2.431	-0.356	1.943 ***	-0.441	0.002	-0.188
JBG13 x T3	0.072	0.485	-0.285	2.324 **	8.229 *	-0.185	-1.213 **	0.119	0.019	-0.211
JBG14 x T1	0.238	0.950 *	-0.507 *	1.966 **	-1.090	0.517	-2.098 ***	-1.167 **	-0.059 *	-1.112 **
JBG14 x T2	-0.026	0.032	-0.442 *	-0.064	2.361	0.388	1.066 **	0.631	-0.009	0.470
JBG14 x T3	-0.212	-0.982 *	0.949 **	-1.902 **	-1.272	-0.906	1.032 **	0.535	0.068 *	0.642
JBG15 x T1	-0.177	-0.115	1.000 **	-0.157	0.008	4.439 ***	-1.023 **	-0.189	-0.018	-0.211
JBG15 x T2	0.135	0.316	-0.367	0.680	5.533	1.067	0.684	0.173	0.035	0.203
JBG15 x T3	0.042	-0.201	-0.633 **	-0.523	-5.541	-5.506 ***	0.340	0.016	-0.018	0.007
SE of F1	0.162	0.346	0.178	0.457	3.642	0.632	0.327	0.390	0.025	0.333

* Significant at 5% **Significant at 1%

female flower, fruit number, vine length and first harvest; Sreevani (2005) for fruit number per vine, fruit weight, yield per vine; Parvathi and Reddy (2005) for node at first female flower appeared, fruit weight, and yield per vine; Dubey and Maurya (2006) for yield per plant; Dubey and Maurya (2007) for yield and days to first harvest; Singh and Singh (2009) for number of fruits and branches per plant; Singh *et al*. (2011) and Shaikh *et al*. (2011) for fruit yield per plant.

Estimates of specific combining ability variances were higher in magnitude than general combining ability variances for all the characters, indicated that the predominance of non-additive type of gene action. Similar results have been reported by Celine and Sirohi (1998), Singh and Singh (2009), Kumar and Singh (1997) for fruit length and fruit diameter both additive and non additive gene action; Singh *et al*. (1999), Sreevani (2005), Sit and Sirohi (2005), Parvathi and Reddy (2005), Dubey and Maurya (2006), Singh et al. (2006), Dubey and Maurya (2007) for fruit weight, branches per plant, vine length, nodes at first female flower appeared.

Over dominance was observed for vine length, number of primary branches per plant, number of nodes to first female flower appeared, sex ratio, fruit setting percentage, days taken to first harvest, number of fruits per plant, seed pulp ratio, and fruit yield per plant Similar results have been reported by Dubey and Ram (2005), Dubey and Maurya (2006), Maurya *et al*. (2006). Whereas, partial dominance was observed for number of nodes to first male flowers appeared. Similar results have been obtained by Dubey and Maurya (2006).

सारांश

लौकी में लाइन x टेस्टर प्रजनन पद्धति का अध्ययन क्षेत्रीय कृषि शोध परिसर छिंदवाड़ा, जवाहर लाल नेहरू कृषि विश्वविद्यालय जबलपुर (म.प्र.) में अध्ययन वर्ष 2008 के ग्रीष्म एवं वर्षाकाल में किया गया। परीक्षण में सामान्य संयोजन समता की तुलना में विशिष्ट संयोजन क्षमता का परिणाम सभी गुणों के लिए अधिक पाया गया। इससे संकेत मिलता है कि अयोज्य जीन की प्रबलता अधिक है। सामान्य संयोजन क्षमता के प्रभाव का आकलन स्पष्ट करता है कि जे.बी.जी.–9 प्रथम नर पुष्पन के दिन, प्रति पौध मादा फूलों की संख्या व फल धारण प्रतिशत को छोड़कर सभी गुणों के लिए एक उत्तम संयोजक है। विशिष्ट संयोजन क्षमता के प्रभाव से पता चला कि पांच संकरण यानी जे.बी.जी.–4 × टी–1 (पूसा नवीन), जे.बी.जी.–6 × टी–1 (पूसा नवीन), जे.बी.जी.–9 × टी–1 (पूसा नवीन), जे.बी.जी.–5 × टी–3 (पूसा समर प्रोलिफिक लांग) एवं जे.बी.जी.–11 × टी–3 (पूसा समर प्रोलिफिक लांग) उपज एवं मुख्य उपज घटक के रूप में सबसे विशिष्ट संयोजक थे।

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