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Research Article

Evaluation of F_1 Hybrids of Bottle Gourd (*Lagenaria siceraria* Mol. Stand) for Yield Attributes

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ABSTRACT

An investigation was carried out to study the performance of 28 hybrids of bottle gourd (Lagenaria siceraria mol. stand) through diallel mating design excluding reciprocals. Observations were recorded on the traits, viz., number of primary branches per vine, days to 50% flowering, node number at which first female flower appears, days to initiation of first female flower, number of fruits per vine, days to first fruit harvest, fruit weight, fruit size, hundred seed weight, flesh thickness, vine length and fruit yield per vine besides quality traits such as moisture content and TSS content in the fruit. Among the 28 hybrids of bottle gourd studied, thecross 'PSPL X Pusa Naveen excelled in yield per vine, followed by the crosses 'DBG-5XPusa Naveen. Thus, first generation hybrids can be well-utilized for exploiting hybrid vigour to achieve improved quality.

Keywords: *Evaluation, Hybrids, Bottle gourd, Generation, Diallel.*

INTRODUCTION

Bottle gourd (*Lagenaria siceraria* Mol. Stand) originated in South Africa, India and is cultivated in the tropical and subtropical regions of the world. It is an important cucurbitaceous vegetable crop of India, constituting a principal ingredient in several Indian dishes. Bottle gourd has received little attention in crop improvement compared to other cucurbitaceous vegetables. In bottle gourd, the major problem is its large-sized fruits (5-6 kg each). This is not overly preferred by the present nuclear families of three to four members. Further, with increase in number of such families recently in India, customers prefer to buy only whole fruits of medium-size bottle gourds, instead of cut pieces. Further, small fruits are easily packed and transported, without any damage. Therefore, developing bottle gourd hybrids with small to medium-sized fruits (500-700 gm) is essential. The present study was undertaken to evaluate F_1 hybrids for yield and quality for this purpose.

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MATERIALS AND METHODS

The investigation was conducted at experimental farm of Rajasthan Agricultural Research Institute, Durgapura, Jaipur during (Zaid, 2016) with 28 F_1 hybrids and their parents obtained through diallel mating design excluding reciprocals. The resulting hybrids of 28 cross combinations were evaluated in a Randomized Block Design with three replications during (Zaid, 2017). The crop was grown on a raised bed of 6.0 meter length and 2.4 m width and 15 cm height having sandy loam soil. Between the two beds 2.4 meter distance was kept for proper intercultural operations as well as crop management. On each bed drip line was stretched parallel to bed. Two seeds were sown directly on both side of the bed at 2.0 cm depth. A random sample of five plants from each of the plot (crosses and parents) from each replication and observations on a total of thirteen morphological traits viz., number of primary branches per vine, node number at which first female flower appears, days to 50% flowering days to initiation of first female flower, number of fruits per vine, days to first fruit harvest, fruit weight, fruit size, vine length, fruit yield per vine and per hectare besides two biochemical characters such as moisture content (%) (Roy, 1973) and TSS content (Chopra & Kanwar, 1976) in the fruit were recorded on each of the five randomly selected plants. Statistical analysis of data was done to estimate *per se* values and degree of significance of various traits (Panse & Sukhatme, 1978).

RESULTS AND DISCUSSION

In Bottle gourd hybrids exhibited significant differences for all the characters under study for growth, yield and quality, thus offering scope for selecting high-yielding hybrids with good quality traits. Results of *per se* performance of hybrids are presented in Tables 1 and 2. The *sca* effect of a hybrid denotes deviation from performance prediction based on *gca* of the parents (Allard, 1960). The *sca* effect seen is due to dominance, epistasis and environmental influence. Under certain favorable conditions, all the non-additive gene functions may be triggered and may result in high *sca* effect and mean value of a responding hybrid. Thus, evaluation of a hybrid for high *per se* and *sca* effect is also an important criterion. Hybrids with high *per se* and *sca* effect were evaluated for selecting the best hybrids. The *gca* and *sca* values of parents and hybrids are presented in Tables 2 and 3, respectively.

Table 1: Mean performance of F_1 hybrids of bottle gourd for growth parameters

Hybrid	Days to initiation of first female flower	Days to 50 % flowering	No. of nodes at which first female flower	Primary branches	Vine length (m)	Days to first fruit harvest	Fruit length (cm)	Fruit girth (cm)	Fruit weight (kg)	Marketable fruits per plant	Total yield (kg)	Total yield (q/ha)
$P_1 \times P_2$	60.33	60.40	10.33	2.20	4.80	70.47	45.57	23.53	1.37	4.63	4.77	550.67
$P_1 \times P_3$	56.37	62.60	11.80	2.33	4.37	69.40	42.53	21.03	0.84	5.43	4.00	496.00
$P_1 \times P_4$	61.00	59.73	10.27	2.40	4.20	67.27	40.60	24.83	1.30	5.87	3.83	513.33
$P_1 \times P_5$	59.17	64.65	10.87	2.70	4.50	65.57	38.53	19.07	0.96	3.27	4.60	367.91
$P_1 \times P_6$	61.37	66.37	10.68	2.47	4.60	66.60	39.63	17.07	1.03	5.50	4.83	414.99
$P_1 \times P_7$	59.50	59.87	11.56	2.00	4.50	68.67	39.73	21.90	1.07	5.93	4.90	460.00
$P_1 \times P_8$	56.27	65.50	10.17	2.47	4.57	69.53	41.87	22.70	0.97	4.27	3.63	367.33
$P_2 \times P_3$	56.57	68.50	12.39	1.83	4.77	71.30	42.20	17.97	1.07	3.77	4.83	430.87
$P_2 \times P_4$	60.34	63.53	10.47	2.43	4.23	70.60	41.97	23.63	1.14	4.70	5.53	494.00
$P_2 \times P_5$	61.60	64.43	11.43	2.87	4.43	72.63	39.44	20.03	0.94	4.83	4.93	386.61
$P_2 \times P_6$	66.37	65.80	12.23	2.47	4.33	68.47	41.33	20.07	1.05	5.37	5.43	476.20
$P_2 \times P_7$	62.47	68.60	11.37	2.77	4.20	69.77	37.29	18.03	0.98	4.57	5.07	415.09
$P_2 \times P_8$	64.34	62.37	11.37	2.27	4.43	71.43	39.37	22.00	1.06	5.50	4.23	375.00
$P_3 \times P_4$	55.20	62.47	10.37	2.57	4.73	65.93	41.53	21.97	1.05	4.97	5.33	464.65
$P_3 \times P_5$	54.23	60.27	12.20	2.73	4.60	64.17	37.57	22.10	1.07	4.50	5.17	413.33
$P_3 \times P_6$	47.83	50.87	8.43	2.90	5.43	54.93	50.57	28.93	1.62	8.57	7.37	657.33
$P_3 \times P_7$	53.27	61.83	11.27	2.47	4.17	66.40	36.40	20.00	1.02	4.47	4.50	383.00
$P_3 \times P_8$	50.50	55.20	7.07	3.17	5.83	59.50	50.30	31.43	1.59	8.47	7.57	685.67
$P_4 \times P_5$	59.97	62.40	10.40	2.30	4.33	69.50	40.43	18.17	0.96	4.33	5.37	407.44
$P_4 \times P_6$	56.43	63.37	10.57	2.93	4.17	72.67	42.53	20.97	1.13	4.50	4.83	457.00
$P_4 \times P_7$	57.33	60.40	11.43	2.70	3.95	73.60	40.63	25.00	1.12	6.37	3.67	338.33
$P_4 \times P_8$	59.37	58.70	9.75	2.60	4.40	67.70	37.47	20.23	0.95	5.47	5.83	460.15
$P_5 \times P_6$	63.70	65.43	9.40	2.97	4.65	65.41	39.73	18.21	1.04	4.57	4.90	423.54
$P_5 \times P_7$	61.53	66.43	10.27	2.47	4.70	69.40	36.33	18.97	0.86	3.57	5.37	385.55
$P_5 \times P_8$	65.47	65.50	10.47	2.40	4.87	70.43	41.20	21.91	0.98	4.70	3.67	301.00
$P_6 \times P_7$	55.23	58.40	11.03	2.63	4.60	62.07	37.28	22.93	1.06	5.37	5.13	454.48

P_6 x P_8	48.40	51.73	7.40	2.73	6.43	59.47	51.67	29.20	1.62	8.43	7.37	679.00
P_7 x P_8	56.50	60.60	11.88	2.67	4.83	69.83	38.37	24.10	1.08	4.57	5.67	509.41
S.Em. ±	0.98	0.71	0.30	0.12	0.16	0.68	0.54	0.55	0.05	0.25	0.29	9.17
CD (5%)	2.77	2.01	0.85	0.35	0.45	1.92	1.52	1.54	0.14	0.72	0.82	25.87
CD (*P=05*)												

Where,

P_1 = Pusa Samaridhi
P_2 = Arka Bahar
P_3 = PSPL
P_4= Pant Lauki-3
P_5 = Narendra Rashmi
P_6 = DBG-5
P_7 = DBG-6
P_8 = Pusa Naveen

Table 2: General combining ability effects of bottle gourd parents

Parents	Days to initiation of first female flower	Days to 50 % flowering	No. of nodes at which first female flower	Primary branches	Vine length (m)	Days to first fruit harvest	Fruit length (cm)	Fruit girth (cm)	Fruit weight (kg)	Marketable fruits per plant	Total yield (kg)
P_1	0.22	0.26	0.11	-0.06*	-0.07	0.34*	-0.05	-0.13	-0.01	-0.1	-0.65**
P_2	3.37**	2.46**	0.62**	-0.2**	-0.07	2.94**	0.15	-1.38**	-0.01	-0.39**	-0.13
P_3	-4.13**	-2.04**	-0.2**	0.11**	0.18**	-2.73**	1.63**	1.32**	0.07**	0.54**	0.42**
P_4	0.31	0.31	0.11	-0.05	-0.32**	2.58**	-0.23	-0.15	-0.01	-0.11	-0.13
P_5	2.58**	2.47**	0.11	-0.02	-0.07	0.27	-1.79**	-2.05**	-0.14**	-1.14**	-0.2**
P_6	-1.43**	-1.67**	-0.52**	0.14**	0.24**	-2.72**	1.68**	0.6**	0.09**	0.72**	0.49**
P_7	0.23	0.29	0.5**	-0.01	-0.25**	0.32*	-2.43**	-0.25	-0.05**	-0.11	-0.13
P_8	-1.15**	-2.08**	-0.72**	0.1**	0.36**	-0.99**	1.03**	2.04**	0.07**	0.59**	0.31**
SE gi	0.23	0.17	0.07	0.03	0.04	0.16	0.13	0.13	0.01	0.06	0.07

*. ** Significant at 5% and 1% level of significance, respectively

Where,

P_1 = Pusa Samaridhi
P_2 = Arka Bahar
P_3 = PSPL
P_4= Pant Lauki-3
P_5 = Narendra Rashmi
P_6 = DBG-5
P_7 = DBG-6
P_8 = Pusa Naveen

Table 3: Specific combining ability effects of hybrids for various characters under study in bottle gourd

Parents	Days to initiation of first female flower	Days to 50 % flowering	No. of nodes at which first female flower	Primary branches	Vine length (m)	Days to first fruit harvest	Fruit length (cm)	Fruit girth (cm)	Fruit weight (kg)	Marketable fruits per plant	Total yield (kg)
P_1 x P_2	-1.8*	-4.53**	-0.85**	-0.04	0.36**	-0.11	4.44**	3.33**	0.31**	-0.03	0.51*
P_1 x P_3	1.74*	2.18**	1.43**	-0.21*	-0.32*	4.5**	-0.08	-1.87**	-0.31**	-0.16	-0.81**
P_1 x P_4	1.92**	-3.04**	-0.41	0.01	0.01	-2.94**	-0.14	3.4**	0.23**	0.92**	-0.43*
P_1 x P_5	-2.17**	-0.28	0.19	0.28**	0.07	-2.34**	-0.65	-0.47	0.02	-0.64**	0.41*
P_1 x P_6	4.04**	5.57**	0.64**	-0.12	-0.15	1.69**	-3.02**	-5.12**	-0.14**	-0.27	-0.05
P_1 x P_7	0.51	-2.89**	0.49*	-0.43**	0.25	0.72	1.19**	0.57	0.04	0.99**	0.64**
P_1 x P_8	-1.34	5.12**	0.32	-0.07	-0.3*	2.89**	-0.14	-0.93*	-0.17**	-1.38**	-1.07**
P_2 x P_3	-1.21	5.88**	1.51**	-0.57**	0.07	3.8**	-0.61	-3.69**	-0.08*	-1.54**	-0.5*
P_2 x P_4	-1.88*	-1.44**	-0.72**	0.19*	0.04	-2.21**	1.02*	3.44**	0.08*	0.04	0.75**
P_2 x P_5	-2.88**	-2.7**	0.25	0.59**	-0.01	2.12**	0.06	1.74**	0	1.21**	0.22
P_2 x P_6	5.89**	2.81**	1.67**	0.02	-0.42**	0.95	-1.53**	-0.88*	-0.12**	-0.12	0.03
P_2 x P_7	0.33	3.64**	-0.21	0.48**	-0.06	-0.78	-1.46**	-2.05**	-0.04	-0.09	0.28
P_2 x P_8	3.58**	-0.22	1.01**	-0.13	-0.44**	2.19**	-2.85**	-0.38	-0.08*	0.14	-0.99**
P_3 x P_4	0.48	2**	-0.01	0.01	0.29*	-1.2*	-0.89*	-0.92*	-0.1*	-0.63**	0
P_3 x P_5	-2.75**	-2.36**	1.83**	0.15	-0.09	-0.67	-3.3**	1.11**	0.05	-0.06	-0.1
P_3 x P_6	-5.15**	-7.62**	-1.31**	0.15	0.43**	-6.91**	6.23**	5.29**	0.36**	2.15**	1.41**
P_3 x P_7	-1.38	1.38**	0.51*	-0.13	-0.34*	1.53**	-3.83**	-2.78**	-0.09*	-1.12**	-0.84**
P_3 x P_8	-2.76**	-2.88**	-2.47**	0.46**	0.71**	-4.06**	6.61**	6.35**	0.36**	2.17**	1.79**
P_4 x P_5	-1.46*	-2.57**	-0.28	-0.13	0.15	-0.64	1.43**	-1.36**	0.03	0.43*	0.65**
P_4 x P_6	-0.99	2.53**	0.51*	0.34**	-0.33*	5.51**	0.06	-1.21**	-0.04	-1.27**	-0.57**
P_4 x P_7	-1.75*	-2.4**	0.36	0.26**	-0.06	3.42**	2.27**	3.68**	0.1*	1.43**	-1.12**
P_4 x P_8	1.67*	-1.73**	-0.09	0.05	-0.22	-1.17*	-4.36**	-3.38**	-0.2**	-0.18	0.61**
P_5 x P_6	4.02**	2.44**	-0.65**	0.34**	-0.1	0.56	-1.18**	-2.06**	-0.01	-0.16	-0.44*
P_5 x P_7	0.19	1.47**	-0.8**	0	0.45**	1.52**	-0.47	-0.45	-0.04	-0.34	0.65**
P_5 x P_8	5.51**	2.91**	0.62**	-0.18*	0	3.86**	0.93*	0.2	-0.04	0.09	-1.49**
P_6 x P_7	-2.11**	-2.42**	0.59**	0	0.03	-2.83**	-2.99**	0.86*	-0.06	-0.4*	-0.27
P_6 x P_8	-7.55**	-6.72**	-1.82**	-0.01	1.25**	-4.12**	7.93**	4.83**	0.37**	1.97**	1.52**
P_7 x P_8	-1.12	0.19	1.64**	0.08	0.14	3.22**	-1.26**	0.59	-0.02	-1.07**	0.44*
SE sij	0.72	0.52	0.22	0.09	0.13	0.5	0.4	0.4	0.04	0.18	0.2

*. ** Significant at 5% and 1% level of significance, respectively

Where,

P_1 = Pusa Samaridhi
P_2 = Arka Bahar
P_3 = PSPL
P_4= Pant Lauki-3
P_5 = Narendra Rashmi
P_6 = DBG-5
P_7 = DBG-6
P_8 = Pusa Naveen

Number of primary branches per vine is an important parameter for obtaining high fruit yield in crops like the bottle gourd. The present study of 28 bottle gourd crosses, the cross 'PSPL X Pusa Naveen (P_3 × P_8) Narendra Rashmi x DBG-5 (P_5 × P_6) and Arka Bahar x Narendra Rashmi (P_2 x P_5) exhibited the high *sca* and mean performance for number of primary branches per vine. The *sca* variances of number of primary branches per vine were greater than those of *gca* suggesting the better role of non-additive genetic factors than that of additive action. Sharma et al. (1993) recorded similar results in bitter gourd in the cross 'Pocha Seed x PSPL'. In these crosses, the parents, Narendra Rashmi, PSPL and Pusa Naveen exhibited good general combing ability for number of primary branches per vine. The predominant role of non-additive gene action for number of primary branches per vine was reported by Sirohi (1993) in bottle gourd. *Per se* and *sca* per formance for node number for first female flower appearance in the 28 crosses was favorable in Narendra Upcar x Suvarna (P_5 x P_8) followed by PSPL x Pusa Naveen (P_3 x P_8) and PSPL x DBG-5(P_3 x P_6). For this character, the *sca* variances were greater than those of *gca* suggesting the role of non-additive gene action. This is in agreement with the findings of Munshi and Sirohi (1994) in bitter gourd. Days taken to first female flower appearance is considered as one of the essential criteria for selecting for earliness in hybrids. Among the 28 bottle gourd crosses studied, the hybrid 'Ambili x Pusa Vishwas (P_1x P_7)' was identified as the best. However, the parents, Narendra Agrim, Kashi Harit and Punjab Samrat had favorable negative *gca* value. Neeraj Sharma et al. (2002) recorded similar results in bottle gourd. Sharma et al. (2002) in bottle gourd and Jha et al. (2009) in bottle gourd recorded the similar results. Fruit number per vine is a preferable trait for screening the hybrids for high yield. In these crosses, as the female parents DBG-5 (P_6) and Pusa Naveen (P_8) had already proved as a good general combiner for this trait. In bottle gourd, Uma Maheshwari and Hari Babu (2005) reported higher fruit number per vine in ten crosses and five parents in a partial diallele analysis wherein the cross 'CM-45 x CM-14' showed highest *per se* performance and *sca* for this trait.

Earliness in terms of days to first fruit harvest is an important criteria to select hybrids for commanding a premium price for fruits in the early markets. The cross combinations for days to first fruit harvest revealed that DBG-5 x Pusa Naveen (P_6 x P_8) followed by PSPL x Pusa Naveen (P_3x P_8) and PSPL x DBG-5 (P_3 x P_6) could be selected as the best performing hybrids as they proved their superiority through *per se*, and *sca* values. Similar trend of earliness was observed in ash gourd hybrids by Mandal et al. (2002). The crosses 'Monsoon Miracle x Holly Green' and 'The largest x Indian Prime' gave significant and negative *sca* for days to first harvest in bitter gourd (Pal et al., 1983).Vine length is an important parameter for obtaining high fruit yield in crops like the bottle gourd. Among the 28 hybrids of bottle gourd studied, the crosses DBG-5 x Pusa Naveen (P_6 x P_8), PSPL x Pusa Naveen (P_3x P_8) and PSPL x DBG-5 (P_3 x P_6) exhibited the high *sca* and mean performance for vine length. Sharma et al. (1993) recorded similar results in bitter gourd in the cross 'Pocha Seed x PSPL'. The *sca* variances of vine length were greater than those of *gca* suggesting the better role of non-additive genetic factors than that of additive action. The predominant role of non- additive gene action for vine length was reported by Sirohi and Ghorui (1993) and Nisha (1999) in bottle gourd.

Fruit weight is a primary trait to be considered in any hybrid development programme, as, it directly contributes towards yield. In this study, of the 28 bottle gourd hybrids studied, highest fruit weight and *sca* effect was registered by Pusa Samridhi X Arka Bahar (P_1 x P_2) followed by PSPL x DBG-5 (P_3 x P_6) and DBG-5 x Pusa Naveen (P_6 x P_8). Higher fruit weight in hybrids was reported by Hegde (2009) in ridge gourd. However, lately, small-to medium-sized bottle gourd fruits of 1-2 kg weight each are preferred. Parent NR (P_5)

is a poor combiner, while the female parents were good combiner for fruit weight. Similar results were recorded by Rao et al. (2000) in ridge gourd. In the case of fruit size, the hybrid *i.e.* PSPL x DBG-5 (P_3 x P_6) was good combiner. The hybrid combinations PSPL x DBG-5 (P_3 x P_6), PSPL x Pusa Naveen (P_3x P_8) and DBG-5 x Pusa Naveen (P_6 x P_8) are proved its superiority in terms of high *per se* and *sca* also. These results were supported by Nisha (1999) in bottle gourd. For any hybrid seed development more seed number per fruit is favorable as it would reduce the cost of seed production. Expression of yield to the fullest potential of the crop is the prime trait to be considered in any hybridization programme. Based on *per se* performance and *sca* of hybrids, the crosses PSPL x Pusa Naveen (P_3x P_8) followed by DBG-5 x Pusa Naveen ($\mathbf{P_6}$ x $\mathbf{P_8}$) and PSPL x DBG-5 ($\mathbf{P_3}$ x $\mathbf{P_6}$) proved to be the best specific combiners for yield which proved their superiority through *per se*, *gca* and *sca* values. Choudhary et al. (2006) also justified similar results that the crosses MS1 x Punjab Sunheri and MS1 x Hara Madhu exhibited the highest *sca* effect and recorded the highest fruit yield per vine in muskmelon.

Evaluation of hybrids for *per se* and *sca* revealed that the cross PSPL x Pusa Naveen (P_3x P_8) was adjudged as the best hybrid, since it recorded the highest mean and *sca* effect for more number of traits of study *viz.*, earliness in terms of early female flowering, fruit number per vine, days to 50% flowering days to first fruit harvest, fruit weight, fruit size, vine length, Moisture content and total yield per vine.

The next best hybrid, DBG-5 x Pusa Naveen ($\mathbf{P_6}$ x $\mathbf{P_8}$) could also be justified as the better combination through less node number for first female flower appearance, fruit number per vine, fruit weight, moisture content and fruit yield per vine.

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