Int.J.Curr.Microbiol.App.Sci (2017) *6*(3): 1205-1213

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 3 (2017) pp. 1205-1213**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2017.603.140

Exploitation of Promising Hybrids on the Basis of Heterosis and Quality Parameters of Pigeonpea (*Cajanus cajan* (L.) Millsp.)

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K e y w o r d s

Pigeonpea (*Cajanus cajan* (L.) Millsp.) Heterosis.

Article Info

Accepted:
20 February 2017
Available Online:
10 March 2017

A B S T R A C T

The field investigation done at the experimental farm of Department of Agricultural Botany, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra to understand the magnitude of standard heterosis and *dal* quality parameters in newly developed CGMS (Cytoplasmic Genic male Sterility) based hybrids at International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Hyderabad. Total eighteen hybrids along with three checks (Asha, Maruti and ICPH 2671) were planted in randomized block design (RBD) with three replications during Kharif season. The results of the current investigation indicated that out of eighteen hybrids, seven promising hybrids (ICPH 3381, ICPH 2751, ICPH 2673, ICPH 3341, ICPH 3337, ICPH 3933 and ICPH 3359) were identified on the basis of standard heterosis (46.37%, 45.19%, 44.08%, 43.22%, 42.09%, 37.67% and 30.00% respectively) over the higher grain yield performing check Maruti. Significant variation observed for the dal quality parameters among the hybrids except for protein content.

Introduction

Pigeonpea (*Cajanus cajan* (L.) Millsp.) is one of the major pulse crop of the tropics and subtropics endowed with several unique characteristics, it find an important place in the farming system adopted by small holders in large number of developing countries. During the last four decades, the total area under pulses remained stagnant (22 to 24 million ha) with stable production of 12 to 14 million tonnes which yearly lead to shortage of *dal* due to increasing population in India. Due to stagnant production, the net availability of pulses has come down from 60 gm/day/person in 1951 to 31 gm/day/person (Indian Council of Medical Research recommends 65 gm/day/person) in 2008. The per capita availability of protein in the country is one-third of its requirement and if production of major pulses is not increased significantly, the problem of malnutrition in large section of vegetarian population will further aggravate (Saxena and Nadarajan, 2010). Thus, there is an urgent need to increase the production of pulses to meet the increasing demand by adopting the appropriate production technologies.

Exploitation of hybrid vigour is quite possible in cross pollinated crops. However, pigeonpea is a grain legume crop with a moderate level of cross pollination (20-70%), which is mainly added by insect pollinators.

As the first step, hybrids based on genetic male sterility (GMS) were developed in pigeonpea. Considering the limitations in large scale hybrid seed production encountered due to genetic male sterility. Pigeonpea experimental hybrids have been developed by using the CMS-based hybrid technology. The CMS hybrid overcomes the limitations of an earlier generation pigeonpea hybrids. Similarly, it is also essential to improve nutritional qualities of pigeonpea *dal*, so that consumption of quality can fulfill the requirement.

Materials and Methods

The field investigation done at the experimental farm of Department of Agricultural Botany, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra to study the magnitude of standard heterosis and *dal* quality parameters in newly developed CGMS (Cytoplasmic Genic male Sterility) based hybrids at International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Hyderabad. In the current study, 18 hybrids (ICPH-3462, ICPH-3464, ICPH-2740, ICPH-3477, ICPH-3491, ICPH-3461, ICPH-3762, ICPH-2673, ICPH-3341, ICPH- 3472, ICPH-3340, ICPH-3337, ICPH-3359, ICPH-3494, ICPH-3497, ICPH-3933, ICPH-3381, and ICPH-2751) was sown along with check ICPH-2671, Maruti, and Asha in randomized block design (RBD) with three replications. The inter and intra spacing was 75 cm and 30 cm respectively.

The seed material was treated with tetramethylthiuramdisulphide @ 3 g/kg prior to sowing to prevent fungal disease infestations while germination. Recommended package of cultural management practices and plant protection measures were adopted to raise a healthy crop. Data were recorded on five randomly selected plants for yield and its associated parameters. Apart from these quantitative characters, data were recorded on eleven quality parameters in hybrids. The collected data were subjected to statistical analysis to understand the magnitude of standard heterosis along with performance for quality parameters.

Results and Discussion

Analysis of variance for yield and its associated characters indicated that genotypes (treatments) had highly significant differences for the entire yield and its related parameters except plant height (cm) and 100 seed weight (g) (Table 1). The results of the standard heterosis indicated that among eighteen hybrids, ICPH 3381 recorded highly significant positive standard heterosis over the check Maruti for grain yield per plant (46.37 %) along with the higher mean performance (56.94 g). Similarly, the hybrid ICPH 3381 obtained highly significant positive standard heterosis along with highest mean performance for number of primary braches per plant (111.11%, 9.5 resp.), number of secondary branches per plant (43.47%, 16.6 resp.), number of pods per plant (43.47%, 181.55 resp.) and number of seeds per pod (11.11%, 4.50 resp.). The another promising hybrid ICPH 2751 showed highly significant desirable standard heterosis for yield per plant (45.19%) with higher mean performance at 56.48 g as compared to other hybrids. The hybrids recorded significant positive heterosis for other yield associated characters like number of primary braches per plant (133.33%), number of pods per plant (23.96%), number of seeds per pod (14.81%) along with the desirable mean performance at 10.50, 196.70, and 4.65 respectively.

With respect to hybrid ICPH 2673 recorded significantly higher heterosis for grain yield per plant (44.08 %) along with significantly

higher number primary branches per plant (44.44%), number secondary branches per plant (31.00%) and number of pods per plant (6.41%) with the better mean performance at 56.05 g, 6.5, 15.50, and 168.85 respectively. Another promising hybrid ICPH 3341 identified on the basis of higher standard heterosis for grain yield per plant (43.22 %) and associated characters like number of primary branches per plant (63.00%), number of secondary branches per plant (34.78%) and number of pods per plant (6.41%) with good mean performance at 55.71 g, 7.94, 13.50, and 175.90 respectively.

Similarly, ICPH 3337 obtained significantly higher heterosis for grain yield per plant (42.09) and its associated parameters like number of primary branches per plant (37.00%), number of secondary branches per plant (33.34%), and number of pods per plant (8.43%) with good mean performance at 55.27 g, 6.17, 14.50, 172.05 respectively. Likewise, other promising performing hybrid ICPH 3933 recorded significantly higher standard heterosis over the check Maruti for grain yield per plant (37.67%) with higher heterosis for number of primary branches per plant (81.44%), number of secondary branches per plant (40.56%) and number o pods per plant (12.93%) along with mean performance of 53.55 g, 8.17, 16.17, and 179.20 respectively.

Another, promising hybrid ICPH 3359 showed significantly higher heterosis (Table 3) over the check Maruti for grain yield per plant (30.00%) along with number primary branches per plant (17.77%) and number of pods per plant (5.18%). Similarly the hybrid 3359 recorded good higher grain yield (50.57 g), number of primary branches per plant (5.30), and number of seeds per pod (166.90) on mean performance basis (Table 4). Patel *et al.*, (2008), Phad *et al.*, (2009), Sarode *et al*., (2009) higher test weight, number of primary branches, number of secondary branches in pigeonpea hybrid which are yield contributing characters.

Dal quality parameters

The variation due to the treatment effect showed highly significant variation for all the characters except dehulling (%) and protein content (%) (Table 1).

With respect to dehulling (%), the range of dehulling (%) was with 55.75 to 75.06 per cent with an average value of 66.55 per cent. The hybrid ICPH 3762 (75.06 %) with the highest dehulling per cent followed by ICPH 3491 (73.85 %) and the hybrid ICPH 2673 (55.75 %) was with lowest dehulling per cent (Table 5). Ethiwe and Reichert (1986) reported less variation in dehulling characters. In pigeonpea per cent intact seeds were generally more in comparison to cowpea cultivars and mostly it was intermediate. Same has been observed in this study also. However, Weight of 250 CC of seed was ranged from 245.08 to 267.96 g with an average value of 253.22 g among eighteen hybrids, ICPH 3762 obtained maximum weight of 250 CC of seed (267.96 g) and ICPH 3491 showed lowest weight of 250 CC of seed (245.08 g).

Likewise, the range of size of *dal* was 0.255 to 0.345 cm with an average value of 0.301 cm. The hybrid ICPH 3359 was with highest value for size of *dal* (0.345 cm) followed by ICPH 3337 (0.330 cm) and the hybrids ICPH 3491 and ICPH 3497 obtained lowest value for size of *dal* (0.255 cm and 0.255 cm respectively). The medium sized and thick dal is easily cooked than thin dal. Big sized dal has taken the maximum time for cooking. Big sized dal absorbed more water thereby resulting in maximum increase in weight of cooked dal as compared to the small and medium sized dal.

Table.1 Analysis of variance for yield and yield contributing characters in ICRISAT Pigeonpea hybrids

Source of variation	d. f.	Mean sum of squares									
		Fertility (%)	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of primary branches per plant	Number of secondary branches per plant	Number of pods per plant	Number of seeds per pod	100 seed weight (g)	Yield per plant (g)
		1	2	3	4	5	6	7	8	9	10
Replications	1	07.570	05.357	22.881	102.77	0.396	0.172	007.43	0.040	0.228	034.853
Treatments	20	36.117**	34.207**	37.500**	297.10	9.292**	9.325**	347.61**	0.174**	1.235	197.000**
Error	20	10.491	02.907	02.581	165.47	0.0427	0.154	000.91	0.018	0.877	006.871

Note: * and ** indicates significance at 5 and 1 per cent level respectively.

Table.2 Analysis of variance for dal quality parameters in ICRISAT Pigeonpea hybrids

Source of variation	d. f.	Mean sum of squares										
		Dehulling (%)	Weight of 250 CC seed (g)	Size of dal (cm)	Thickness of dal (cm)	Number of dal in 10 g	Volume of 10 g of dal (cc)	Weight of cooked dal (g)	% increase in volume	% increase in weight	Time taken for cooking (m+s)	Protein content (%)
		1	2	3	4	5	6	7	8	9	10	11
Replications	1	00.301	00.728	0.00019	0.000009	001.16	0.023	1.911	001.928	000.095	027.524	0.302
Treatments	20	23.689	44.902**	0.00096**	0.000650**	782.02**	0.866**	3.059**	259.780**	361.460**	180.900**	5.006
Error	20	00.075	01.072	0.00005	0.000069	002.66	0.016	0.209	000.194	000.795	016.624	0.173

Note: * and ** indicates significance at 5 and 1 per cent level respectively.

Table.3 Standard heterosis for various yield and its associated traits over the check Maruti

Sr. No.	Hybrids	No. of primary branches per plant	No. of secondary branches per plant	No. of pods per plant	No. of seeds per pod	100 seed weight (g)	Yield per plant (g)
1	ICPH 3462	-29.66	-02.91	-7.41	1.23	6.27	-22.04
2	ICPH 3464	-09.66	13.60**	-0.92	-4.93	7.95	-0.47
3	ICPH 2740	14.77**	26.08**	1.87**	2.46	0.83	5.50
4	ICPH 3477	-31.88	-02.91	-6.75	-1.23	17.99*	-17.67
5	ICPH 3491	-15.22	08.69*	-5.11	2.46	7.11	-12.89
6	ICPH 3461	-32.44	11.43**	-4.23	0.00	-2.92	-27.64
7	ICPH 3762	-05.88	22.87**	-1.27	-2.46	-2.51	0.87
8	ICPH 2673	44.44**	31.00**	6.41**	-22.22	-8.36	44.08**
9	ICPH 3341	63.00**	34.78**	10.85**	-8.64	-0.41	43.22**
10	ICPH 3472	-07.44	17.39**	-0.48	-6.17	2.51	-0.25
11	ICPH 3340	07.00	23.17**	1.53**	2.46	4.60	4.28
12	ICPH 3337	37.00**	33.34**	8.43**	1.23	-4.18	42.09**
13	ICPH 3359	17.77**	05.78	5.18**	-3.70	0.41	30.00**
14	ICPH 3494	-29.66	26.08**	-5.84	-1.23	14.64	-13.07
15	ICPH 3497	14.77**	34.78**	4.57**	-2.64	-6.22	14.65*
16	ICPH 3933	81.44**	40.56**	12.93**	0.00	-5.85	37.67**
17	ICPH 3381	111.11**	43.47**	14.42**	11.11**	10.87	46.37**
18	ICPH 2751	133.33**	5.78	23.96**	14.81**	0.83	45.19**
	SE ±	0.146	0.278	0.54	0.10	0.66	1.85
	CD at 5%	0.430	0.819	1.60	0.28	1.95	5.46
	CD at 1%	0.588	1.119	2.19	0.38	2.66	7.45

Note: * significant at 5% and ** significant at 1%

Table.4 Mean performance of ICRISAT hybrids for various yield and yield associated parameters

Sr. No.	Genotypes	Number of primary branches per plant	Number of secondary branches per plant	Number of pods per plant	Number of seeds per pod	100 seed weight (g)	Yield per plant (g)
1	ICPH 3462	3.17	11.17	146.9	4.1	12.7	30.32
2	ICPH 3464	4.07	13.07**	157.2	3.85	12.9	38.71
3	ICPH 2740	5.17**	14.50**	161.65**	4.15	12.05	41.04
4	ICPH 3477	3.07	11.17	147.95	4	14.10*	32.02
5	ICPH 3491	3.82	12.50*	150.55	4.15	12.8	33.88
6	ICPH 3461	3.04	12.82**	151.95	4.05	11.6	28.14
7	ICPH 3762	4.24	14.13**	156.65	3.95	11.65	39.24
8	ICPH 2673	6.5**	15.50**	168.85**	3.15	10.95	56.05**
9	ICPH 3341	7.34**	13.50**	175.90**	3.7	11.9	55.71**
10	ICPH 3472	4.17	14.17**	157.9	3.8	12.25	38.8
11	ICPH 3340	4.82	15.34**	161.10**	4.15	12.5	40.56
12	ICPH 3337	6.17**	14.50**	172.05**	4.1	11.45	55.27**
13	ICPH 3359	5.30**	12.17	166.90**	3.9	12	50.57**
14	ICPH 3494	3.17	14.40**	149.4	4	13.7	33.81
15	ICPH 3497	5.17**	15.50**	162.75**	3.95	11.2	44.60*
16	ICPH 3933	8.17**	16.17**	179.20**	4.05	12.65	53.55**
17	ICPH 3381	9.50**	16.50**	181.55**	4.50**	13.25	56.94**
18	ICPH 2751	10.50**	12.17	196.70**	4.65**	11.85	56.48**
19	ICPH 2671(ch)	3.5	13.50**	150.3	3.75	12.15	33.84
20	Maruti (ch)	4.5	11.5	158.67	4.05	11.95	38.89
21	Asha (ch)	3.17	7	148.05	3.85	12.25	32.16
	G. mean	5.17	13.392	162.01	3.99	12.28	42.41
	SE ±	0.146	0.278	0.54	0.1	0.66	1.85
	CD at 5%	0.43	0.819	1.6	0.28	1.95	5.46
	CD at 1%	0.588	1.119	2.19	0.38	2.66	7.45

Note: * significant at 5% and ** significant at 1%

Table.5 Mean performance of ICRISAT hybrids for various dal quality parameters

Sr. No.	Name of hybrid	Dehulling (%)	Weight of 250 CC seed	Size of dal (cm)	Thickness of dal (cm)	Number of dal in 10 g	Volume of 10 g of dal (cc)	Weight of cooked dal (g)	% increase in volume	% increase in weight	Time taken for cooking (m+s)	Protein content(%)
1	ICPH 3462	66.61 (54.69)	253.26	0.27	0.17	264	13.15	30.65	133.07	206.5	60	16.83 (24.21)
2	ICPH 3464	58.70 (50.00)	250.6	0.29	0.19	244	14.15	28.8	100.77	182.5	35.5	18.15 (25.21)
3	ICPH 2740	59.65 (50.55)	254.7	0.3	0.19	249.5	15.25	31.3	107.04	216.5	42.5	18.11 (25.18)
4	ICPH 3477	71.03 (57.43)	250.35	0.32	0.21	229.5	13.35	30.7	127.6	201.5	37.5	17.82 (24.96)
5	ICPH 3491	73.85 (59.24)	245.08	0.25	0.18	242.5	15.35	31.85	104.36	213.5	56	22.11 (28.04)
6	ICPH 3461	65.11 (53.79)	255.96	0.29	0.2	219.5	14.25	28.85	100.06	185.5	42.5	19.795 (26.41)
7	ICPH 3762	75.06 (60.03)	267.96	0.3	0.21	245.5	14.45	29.7	102.59	193.5	49	16.38 (23.86)
8	ICPH 2673	55.75 (48.29)	245.93	0.29	0.21	265.5	14.85	31.25	118.06	217.5	49.5	13.81 (21.80)
9	ICPH 3341	57.81 (49.48)	250.39	0.3	0.22	254	15.05	29.75	93.75	193.5	42.5	19.165 (25.95)
10	ICPH 3472	65.81 (54.21)	252.71	0.3	0.19	280.5	15.55	29.25	84.05	186.5	42.5	20.60 (26.98)
11	ICPH 3340	71.960 (58.01)	251.29	0.31	0.19	241.5	15.25	31.05	102.06	208.5	64	18.58 (25.52)
12	ICPH 3337	69.97 (56.76)	256.36	0.33	0.22	254	15.35	31.95	107.96	220.5	37.5	21.06 (27.31)
13	ICPH 3359	70.64 (57.18)	250.35	0.345	0.215	265	15.5	31.65	103.05	218.5	42.5	21.45 (27.58)
14	ICPH 3494	66.08 (54.37)	251.8	0.295	0.205	269	15.05	32.08	113.41	223.5	65.5	19.125 (25.92)
15	ICPH 3497	68.64 (55.93)	256.95	0.255	0.185	229	14.55	29.75	100.71	193.5	53.5	18.58 (25.52)
16	ICPH 3933	71.03 (57.42)	252.95	0.29	0.225	244.5	14.45	28.75	96	184.5	57.5	20.55 (26.95)
17	ICPH 3381	59.02 (50.19)	258.75	0.305	0.225	249.5	14.75	29.1	95.71	189.5	42.5	16.80 (24.19)
18	ICPH 2751	62.71 (52.36)	250.6	0.315	0.17	281	15.05	30.65	100.91	200.5	52.5	15.44 (23.13)
19	ICPH 2671	66.05 (54.35)	253.76	0.295	0.175	267.5	14.15	30.35	115.9	201	64	19.705 (26.34)
20	Maruti (ch)	71.19 (57.53)	252.71	0.315	0.205	302	14.65	32.35	114.99	218.5	42.5	16.76 (24.16)
21	Asha (ch)	71.01 (57.41)	255.05	0.325	0.215	235.5	15.25	32.5	110.81	210.5	57.5	20.58 (26.97)
	G. mean	66.559 (54.73)	253.22	0.301	0.201	253.98	14.73	30.585	106.33	203.14	49.381	18.638 (25.53)
	SE ±	0.3138 (0.19)	0.73	0.00537	0.0058	1.1547	0.09	0.3238	0.31148	0.6305	2.883	0.3997 (0.29)
	CD at 5%	0.9245 (0.57)	2.16	0.01584	0.01736	3.4011	0.27	0.9539	0.91745	1.8573	8.4918	1.1774 (0.86)
	CD at 1%	1.2624 (0.78)	2.95	0.0216	0.0237	4.645	0.37	1.3028	1.253	2.537	11.598	1.6079 (1.18)

Medium and small sized dal have maximum expansion in volume of cooked dal than big sized dal, increase in volume ranging from 162.2 to 200 per cent reported by Sankaran and Shrinivasan (1963). Similarly, in case if thickness of *dal* ranged with 0.170 – 0.225 cm with an average value of 0.201 cm. Out of eighteen hybrids, four hybrids were with thickness of 0.225 cm and the hybrids ICPH 2751 and ICPH 3462 exhibited lowest value for thickness of *dal* (0.170 cm and 0.170 cm respectively). Variation in dal recovery and size of dal has been reported by Sankaran and Srinivasan (1963) and Ramakrishnalah and Kurien (1985).

With respect to the range of number of *dal* in 10 g (Table 5) was 219.50 to 302.00 with an average value of 253.98. The check Maruti (302.00) followed by hybrid ICPH 3472 recorded highest mean performance for number of *dal* in 10 g (280.50) however, ICPH 3461 with least number of *dal* in 10 g (219.50). Likewise, the range for volume of 10 g *dal* was 13.15 to 15.55 cc with an average value of 14.73 cc. Among eighteen hybrids, ICPH 3472 obtained highest volume of 10 g *dal* (15.55 cc) while ICPH 3462 showed lowest volume of 10 g *dal* (13.15 cc). Similarly, the range for weight of cooked dal was 28.75 to 32.50 g with an average value of 30.58 g. The check Asha showed highest weight of cooked *dal* (32.50 g) followed by check variety Maruti (32.35) and hybrid ICPH 3494 (32.08 g) whereas, ICPH 3933 obtained lowest weight of cooked *dal* (28.75 g). With respect to per cent increase in volume ranged from 84.05 to 133.07 per cent with an average value of 106.33 per cent. Among total eighteen hybrids and checks, the genotype ICPH 3462 recorded highest value for per cent increase in volume (133.07 %) while, the hybrid ICPH 3472 showed minimum value for per cent increase in volume (84.05 %). Per cent increase in weight (Table 5) was ranged from 182.50 to 223.50 per cent with an average value of 203.14 per cent. The genotype ICPH 3494 recorded highest per cent increase in weight (223.50 %) however, the lowest per cent increase in weight observed in the genotype ICPH 3464 (182.50 %). Similarly, time taken for cooking ranged from 35.50 to 65.50 min with an average value of 49.381 min. The hybrid ICPH 3494 required maximum time for cooking (65.50 min) whereas, ICPH 3464 (35.50 min) required less time for cooking. The cooking time variation has been reported by Shrivastava and Shrivastava (2006).

Likewise, the range for protein content was 13.81 to 22.11 per cent with an average value of 18.638 per cent. Among all genotypes, ICPH 3491 recorded highest rate of protein content (22.11 per cent) however, the hybrid ICPH 2673 (13.81 per cent) obtained lowest level of protein content. The results of the present study indicated that the seven promising hybrids viz. ICPH 3381, ICPH 2751, ICPH 2673, ICPH 3341, ICPH 3337, ICPH 3337 and ICPH 3359 need to be multiply on large scale at multi location for the benefit of the farmer.

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How to cite this article:

Priyanka S. Gaikwad, Dipali P. Thakare and Mehtre, S.P. 2017. Exploitation of Promising Hybrids on the Basis of Heterosis and Quality Parameters of Pigeonpea (*Cajanus cajan* (L.) Millsp.). *Int.J.Curr.Microbiol.App.Sci.* 6(3): 1205-1213.
doi: https://doi.org/10.20546/ijcmas.2017.603.140