Annals of Plant and Soil Research 23(3): 346-350 (2021)
https://doi.org/10.47815/apsr.2021.10082

Assessment of genetic variability, heritability and genetic advance of biparental progenies in okra [*Abelmoschus esculentus* (L.) Moench]

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Received: April, 2021: Revised accepted: June, 2021

ABSTRACT

In the present investigation, the four cross combinations of Punjab Padmini X Panruti local, Dharmapuri local X Panruti local, Punjab Padmini X Parbanikranthi and Dharmapuri local X Parbanikranthi and three bhendi populations, BIP, F2, and F3, were developed in 2019, and these populations were evaluated in 2020 to determine the extent of genetic variability, heritability, and genetic advance for twelve bhendicharacters. Significant variances in BIP compared to the population of F2 and F3 in most characters have been noted that showed high mean and wider variations in PCV and GCV in fruit length, number of fruits per plant and plant yield. High heritability of BIPS was revealed by Punjab Padmini x Parbanikranthi for the traits viz., days to 50 per cent flowering, number of fruits per plant, fruit length, fruit girth and fruit yield per plant which revealed the importance of additive gene action for these traits. This is indicative of both additive and non-additive gene action (dominance and epistasis). Hence, selection could not be practiced in the immediate segregating generations. These two characters also showed unfavourable association with fruit yield per plant in BIPs which indicated that all the unfavourable linkages were not broken down through intermating in the early segregating generation. Thus, selection should be postponed to later generations after intermating in one or two subsequent to obtain potential recombinants.

Keywords: Additive and dominance variance, epistasis, gene action, biparental progenies, genetic variability

INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench], is a mucilaginous content vegetable crop, and it contains 90% water, 2% protein and 7% carbohydrate and negligible in fat.Bhendi fruit has 88 per cent moisture, 41 kcal, protein 2.2 gm, carotene 58 mg, Fat 0.2 g, thiamine 0.07 mg, fibre 1.2 g, niacin 0.6 mg, carbohydrates 7.7 g, riboflavin 0.10 mg, calcium 0.09 g, magnesium 43 mg, phosphorous 0.08 g, ascorbic acid 16 mg, iron 1.5 mg, Sulphur 54 mg and potassium 332 mg per 100 g of fruit. (Montagnac *et al.* 2009). Okra is an annual shrub that is cultivated mostly within tropical and subtropical regions across the globe and represents a popular garden crop, as well as a farm crop (Meena *et al.* 2019**).** India is one of the highest producers of okra in the world, occupying an area of 526 m ha with a production of 6460 million tones and productivity of 15.0 metric tonnes/ha (Anonymous, 2019-2020a). In Tamil Nadu total area under vegetable crops is 374.46 thousand hectares with production of about 183.17 million tonnes and okra crop occupies area 19, 529 thousand hectares with production 1,75,237 tonnes and productivity of 8.97 tonnes/ ha (Anonymous 2020b). As, this crop has been used in all factors of human life starting from food to industry the demand for this crop is increasing substantially. (Khatik*et al.* 2013**)** This growing demand could be met up only through genetic manipulations which could favourably be done by increasing the productivity as there is only little scope for increasing the area under production. Selection of suitable breeding methodologies which involves suitable mating design for breaking down of undesirable linkages in the early segregating generations is a must (Xu *et al.* 2017). Many breeding methodologies suited the need and production of biparental progenies in the early segregating generation is one such approach which is most effective in breaking the undesirable linkages and in obtaining desirable recombinants. (Kumar *et al.* 2020) In view of the above facts, the current study aimed to compare the output of biparental progenies with the F2 generation of single and double cross populations of Bhendi.

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MATERIALS AND METHODS

The current study was conducted between January 2019 and December 2020 at the Department of Genetics and Plant Breeding, Annamalai University Chidambaram, using three biparental progenies, F2 and F3 populations of okra to determine the type and degree of genetic variability for vegetative and yield parameters. The four cross combinations are Punjab Padmini/ Panruti local, Dharmapuri local/ Panruti local, Punjab Padmini/ Parbanikranthi and Dharmapuri local/ Parbanikranthi. From each of the four cross combinations, 200 F2 plants were raised in non-replicated trail during January 2019 to April 2020 with a spacing of 60 cm between rows and 45 cm between plants. The F2 population was raised and the seeds were harvested to build up F3 generation. At the same time, enough F2 seeds were also retained for raising the F2 population during the next season for comparing F2, F3 and BIPS progenies. BIPs were obtained by intermating the randomly selected F2's as females and males. Recommended agronomic practices and need based plant protection measures were carried out. Four F2 plants selected randomly were designated as males. BIPs were developed by crossing each of these males to four plants selected as females. For the development of BIPs, the plants used as males and females were chosen at random, and no seed parent was used in more than one mating. The rest of the F2 plants after used in making BIPs were selfed by covering the flower with butter paper cover a day previous to anthesis. Selfed F2 plants (F3 seeds) were also harvested separately.

The F2 (200 plants) population was raised in non-replicated trail. The parents (20 plants), F3 (90 plants) seeds and intermated F2 (288 plants) were raised during June 2020 – September 2020 in randomized block design with three replications and the chosen spacing was 60 cm between rows and 45 cm between plants. Observations like Days to 50 per cent flowering, Plant height, Internode length, Number of fruits per plant, Fruit girth, Fruit length and Fruit yield per plant were taken up. (Burton and Devane's 1953) methods were used to calculate the phenotypic and genotypic coefficient of variance. (Oroka*et al.*2016) and (Kumar *et al.*2019) methods were used to calculate heritability and genetic advance as a percentage of the mean.

RESULTS AND DISCUSSION

Through biparental mating, two or more partially balanced genotypes are brought through intermating which makes the change of reassembling maximum number of potentially functional genes and leads to the isolation of suitable, stable and widely adopted genotypes.((Moose and Mumm, 2008). The Analysis of variance of BIPS indicated that there was significant difference among the ovule and pollen parent for almost all the traits in all the crosses studied.

Mean performance

The per se performance revealed that the BIPs of cross 3 recorded superior performance. The BIPs of Punjab Padmini/ Parbanikranthi recorded high mean performance for the traits viz., internode length, number of fruits per plant, fruit length, fruit girth and fruit yield per plant (Table 2). The superiority of BIPs over F3's was also noticed in all the crosses. General shift in the value of ranges for characters by following biparental approaches was also reported by Manickavelu *et al.* (2006) in rice. Hence, BIPs developed in all the four crosses could be used as base population for developing high yielding early maturity cultivars as they had combined superior performance for fruit yield per plant and earliness (Table 1). These finding were similar to the reported mean and range values by Maurya *et al.* (2019) for these traits in bhendi. The study of the components of variance of BIPs in all crosses showed that additive genetic variance was predominant which indicated that selection in the early intermingling generations could result in the development of potential progenies.

Table: 1 Range and mean performance of Parents, F2's, F3's and BIPs for fruit yield per plant (g)

Parents	Generation	Cross 1	Cross 2	Cross 3	Cross 4	General Mean
P1	Range	230-298	300-445	232-300	297-410	321.06
	Mean	250.00	386.20**	275.85	372.22*	
P2	Range	210-280	200-310	219-319	190-300	257.39
	Mean	245.50	254.00	275.00**	255.06*	
F2	Range	210-633	100-584	305-505	120-532	424.42
	Mean	426.40*	439.26**	422.00	410.05	
F3	Range	210-287	194-610	300-525	190-600	413.04
	Mean	415.01*	410.08	422.10**	405.00	
BIPS	Range	212-620	102-620	230-640	120-600	428.41
	Mean	438.18*	420.35	440.09**	415.05	

**Significant at 5 per cent level; ** Significant at 1 per cent level*

Variability parameters

Variability estimates helps us to choose potential crosses as it indicated the extent of recombination for effective selection. Effectiveness of the biparental approach was to create more variations than selfing. The usefulness of intermating, to create variability is largely dependent on aspects like genetic architecture and the nature of linkages among the genes controlling specific traits (Mcclosky and Tansksley 2013).

Table 2: Range and mean performance of Parents, F2's, F3's and BIPs for no. of fruits per plant (g)

Parents	Generation	Cross 1	Cross 2	Cross 3	Cross 4	General Mean
P1	Range	22-29	11-17	23-30	11-14	14.86
	Mean	15.15*	14.40	15.90**	14.00	
P2	Range	14-19	12-19	11-17	13-20	17.45
	Mean	21.00**	15.51	17.20*	16.10	
F2	Range	6-31	6-28	6-38	6-25	20.61
	Mean	19.25	22.10**	20.05	21.05*	
F3	Range	10-30	23-51	8-32	21-50	21.69
	Mean	24.10**	20.22	23.00*	19.45	
BIPS	Range	7-24	6-27	10-29	4-24	22.45
	Mean	21.83	23.00*	24.78**	20.19	

**Significant at 5 per cent level; ** Significant at 1 per cent level*

For fruit yield per plant, the variability studies revealed a high PCV and a moderate GCV in BIPs Punjab Padmini/Parbanikranthi (Table 3).

Table 3: Variability parameters in F2's, F3's and BIPs for fruit yield per plant in Bhendi

Crosses	Population	PCV (per cent)	GCV (per cent)	Heritability (per cent)	Genetic Advance	Genetic Advance as per cent of mean
Cross 1	F2	21.90	15.84	65.81	127.19	30.14
	F3	19.95	14.95	55.50	94.55	22.18
	BIPs	22.00	16.91	76.02	131.58	30.10
Cross 2	F2	18.95	14.55	58.72	99.11	22.42
	F3	23.00	18.93	68.50	129.88	32.00
	BIPs	18.00	15.10	73.01	114.95	29.50
Cross 3	F2	16.88	15.15	81.25	132.59	28.16
	F3	15.31	12.93	70.10	97.18	22.56
	BIPs	21.38	17.90	88.38	148.52	32.81
Cross 4	F2	18.72	14.81	58.12	100.15	24.12
	F3	23.18	19.13	68.25	130.15	31.77
	BIPs	19.14	16.11	14.05	115.00	29.22

PCV and GCV
Below 10 per cent – low;
10 – 20 per cent – moderate;
Above 20 per cent – High;

Heritability
Below 10 per cent – Low;
30 – 60 per cent – Moderate;
Above 60 per cent – High;

Genetic Advance as per cent of mean
Below 10 per cent – low
10 – 20 per cent – Moderate
Above 60 per cent – High

All the other traits recorded low to moderate PCV and GCV. Similar results were obtained by Oyetunde and Ariyo(2014) and for days to first flowering in 70 genotypes of bhendi. However, for almost all of the characters studied, BIPs recorded higher PCV and GCV values than F3s.

Table 4 Variability parameters in F2's, F3's and BIPs for number of fruits per plant in Bhendi

Crosses	Population	PCV (per cent)	GCV (per cent)	Heritability (per cent)	Genetic Advance	Genetic Advance as per cent of mean
	F2	36.53	26.75	67.84	6.86	48.92
Cross 1	F3	30.17	25.72	67.85	6.59	3.89
	BIPs	31.85	28.15	78.80	6.40	51.84
	F2	32.38	26.73	63.99	5.46	44.73
Cross 2	F3	25.57	19.52	65.61	5.69	33.00
	BIPs	31.00	23.14	78.30	6.59	49.98
	F2	31.42	22.65	51.10	5.65	33.70
Cross 3	F3	27.08	18.65	46.19	3.59	25.50
	BIPs	28.97	25.52	78.43	6.98	53.58
	F2	32.15	25.18	62.16	5.32	40.31
Cross 4	F3	26.19	18.36	44.59	4.49	24.53
	BIPs	27.94	23.36	78.0	6.69	49.18

This variability in BIPs might be attributed due to breakage of linkage group obtained through intermating of the early segregating generations. For the traits of days to 50% flowering, number of fruits per plant, fruit length, fruit girth, and fruit yield per plant, high heritability and high genetic advance as a percentage of mean were observed in BIPs of Punjab Padmini/ Parbanikranthi, indicating the importance of additive gene action for these traits (Table 4). High heritability estimates in case of BIPs compared to selfed series were also reported by Parameshwarappa *et al.* (2009) in safflower and Raju *et al.* (2010) in Bhendi. The presence of lower to medium PCV and GCV, as well as high heritability and genetic advance as per cent of mean for these traits, suggested that both additive and non-additive gene action was present (dominance and epistasis). In general, BIPs showed its superiority over F3's. This may be presumed as due to the breakage of unfavourable linkages (Linkage in repulsion phase) and reunion of unfavourable genes in coupling phage. The association analysis also indicated that the characters such as plant height and number of fruits per plant showed positive significant association with fruit yield per plant in all the three crosses.

Thus, it may be concluded that intermating in F2 segregants increased the mean performance in BIPs than F3's. Analysis of variance also indicated the predominance of additive variance. Despite the fact that heritability and genetic advance are high, PCV and GCV are low to moderate for the majority of traits in Punjab Padmini/ Parbanikranthi. This meant that both additive and non-additive gene activity existed. As a consequence, acquiring possible genotypes would require one or two generations of intermating in the subsequent generation, followed by selection.

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