



GROWTH OF PARENT, INTERVARIETAL AND INTERSPECIES CROSSES OF CAPSICUM ANNUUM AND CAPSICUM FRUTESCENS.

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Abstract

*Success of hybridization is more in intervarietal crosses than interspecific crosses. In interspecific crosses of *Capsicum annum* and *C. frutescens*, *C. annum* was found unsuitable as female parent. In general heterotic effect in plant height was observed in hybrids of *Capsicum*. Hybrids of F5 generation showed significant increase in leaf area over mean of two parents and higher leaf area parent, while decrease in leaf area over higher parental value has been shown by hybrids of F5 generation. Hybrids of F5 generation have shown earlier flowering than mean days for flowering of two parents of each hybrid. However, hybrids of F4 generation showed delay in flowering over mid parental and early parental value. All hybrids of F5 generation under study bear more number of fruits respective and higher parent (except in Lavangi x Deonur Byadagi). Mean value of fruit number per plant was higher in Lavangi x Deonur Byadagi as compared to all other hybrids which may be attributed to a great natural potential of *C. frutescense*, one of the parents for high fruit number. In crosses of F4 generation fruit number per plant was decreased over higher parental values.*



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Introduction :

Since the methods of plant breeding are applied for the improvement of our crop plants, hybridization has played a key role. A survey of methods by which pepper cultivars have been developed reveals that the following methods were used –

- i) Pedigree breeding with selections from superior cultivars.
- ii) Pedigree breeding following hybridization between superior cultivars.
- iii) Transfer of single genes from primitive cultivars or wild forms to leading cultivars by the back cross pedigree method and

iv) Intercrosses between different back cross families with different recurrent parents and with different target genes for divers germplasm to combine several disease resistance and new horticultural traits.

Tewari and Ramanujam (1974) evolved variety Jwala by a cross between NP 46 A X Puri red. They found that Jwala is tolerant to leaf curl disease. Matahi et. al. (1977) crossed NP 46 A and perennial type with small pungent fruits grown in Tarai region of Kumaon hills (free of leaf curl virus). Selections were made upto F7 and Pant C-1 and Pant C-2, two new promising hybrids were released. They also mentioned that Pant C-1 is high yielding type and also more tolerant to leaf curl disease than Pant C-2 and NP 46 A. Khot and Herlekar (1980) developed DH-7-6-6 by crossing puri red and Byadagi varieties. A new strain DH-7-6-6 said to be tolerant to leaf curl disease. Chandra et al. (1987) derived 'Jawahar Mirch 218' from cross Kalipeeth X Pusa Jwala is bright red, pungent chillie. Thus, it is evident from the foregoing account that attempts have been made to improve chillies.

However, in the present investigation, further improvement is tried in following varieties and species by making interspecific and intervarietal crosses. Choice of parents clears the direction of improvement of chillies followed in this study.

Choice of parents :- Following pure lines of species and their varieties of Capsicum were involved in breeding.

Species	Variety	Desirable character/s
C. annum	Black short	Erect fruits and resistance to leaf curl disease.
C. annum	Deonur Byadagi	Deep brown colour after ripening.
C. annum	Jwala	Productivity and pungency.
C. annum	Pant C-1	Erect fruits, leaf curl resistance and adequate pungency.
C. annum	Sankeshwari	Length of fruits.
Capsicum frutescens	Lavangi	highest pungency and perennial habit.

Material And Methods :

Seeds of above mentioned parental varieties were sown in field nursery and seedlings were transplanted after 40 days to field.

Crossing experiments were performed in Capsicum species and their varieties under study.

In Capsicum, the majority of flowers opened in between 5 a.m. to 6 p.m. i.e. the maximum anthesis in chillie takes places between 5 to 6 a.m. (Padda and Singh, 1971). So the flower buds emasculated, labeled one day before anthesis of flower and on the next day pollinated by pollen grains of desirable parents during 6 a.m. (while selecting plants of

parental varieties for breeding, selection was performed in terms of fruit number per plant, fruit length and fruit size (l x b). The F1, F2, F3, F4 and F5 generations are raised and observed. In each generations plants having conspicuous fruit length, fruit size, high yield (fresh weight as well as dry weight) were selected and grown for next generation. No fungicides or pesticides were spread on plants at any stage in generation. Obviously plants showing healthy nature also received preference for selection.

Pedigree breeding following hybridization between superior varieties is followed. Fifty selections and fifty plants of each selection (family) of every cross were made upto F3 generation. In F4 and F5 generation, 25 selections and 25 plants of each selection of each cross were made. The plant to plant distance was 45 cm while rows were 60 cm apart from each other. Fertilizers applied for each raising were as 60 kg of N, 60 kg of P₂O₅ and 50 kg of K₂O per ha as a basal dressing. Besides this, 120 kg of N was applied in 5 splits (15 days after transplantation, during flowering, after first, second and third plucking) followed by a copious irrigation at fortnightly intervals as a top dressing. The trial was terminated after fourth plucking.

Six crosses of F5 generation and two crosses of F4 generation were assessed by analysing growth, yield and quality of fruit. For analysis of growth and yield, parameters like plant height, leaf area, days for flowering (50% bloom), fruit number per plant.

Results And Discussion:

Results of intervarietal crosses of *Capsicum annum* and interspecific crosses between *C. annum* and *C. frutescense* carried out in the present investigation are depicted in Table-I and Table-II respectively. It is clear from both the tables that success of fruit setting is more (80%) in intervarietal crosses than interspecific crosses (16.6%). In successful crosses, none of the fruit was observed without seeds. The hybrid seeds were well filled with high level of fertility. Each hybrid in each generation showed normal fruit set. Smith and Heiser (1951) mentioned that in interspecific crosses of *C. annum* and *C. frutescens*, when *C. annum* was used as female parent, no viable seeds were obtained. In present study also in interspecific crosses no cross was successful to form hybrid fruit when *C. annum* was female parent.

While raising the first filial generation of hybrids, intervarietal hybrids namely, Deonur Byadagi x Jwala; Jwala x Deonur Byadagi; Jwala x Sankeshwari; Black short x Deonur Byadagi and Sankeshwari x Black short seeds were lost because of exceptional heavy rains. Few seeds of crosses Black short x Deonur Byadagi and

Sankeshwari x Black short were obtained and used for raising F1 in next season. Therefore these two crosses were lagging behind by one generation than other hybrids under study.

Table –I Result of the attempted intervarietal crosses of *Capsicum annuum*

Parent Pistillate	Staminate	Crosses Made	Fruit Set %	Hybrid
C. annuum var. Black short	C. annuum var. Deonur Byadagi	30	16.66	+
C. annuum var. Black short	C. annuum var. Pant C-1	25	0	-
C. annuum var. Black short	C. annuum var. Sankeshwari	27	18.50	+
C. annuum var. Denour Byadagi	C. annuum var. Black short	24	25.00	+
C. annuum var. Denour Byadagi	C. annuum var. Jwala	21	14.28	+
C. annuum var. Deonur Byadagi	C. annuum var. Pant C-1	20	00.00	-
C. annuum var. Jwala	C. annuum var. Deonur Byadagi	23	8.69	+
C. annuum var. Jwala	C. annuum var. Sankeshwari	21	14.28	+
C. annuum var. Pant C-1	C. annuum var. Deonur Byadagi	20	10.00	+
C. annuum var. Pant C-1	C. annuum var. Sankeshwari	23	39.13	+
C. annuum var. Sankeshwari	C. annuum var. Black short	28	21.42	+
C. annuum var. Sankeshwari	C. annuum var. Deonur Byadagi	22	36.36	+
C. annuum var. Sankeshwari	C. annuum var. Jwala	28	00.00	-
C. annuum var. Sankeshwari	C. annuum var. Pant C-1	25	12.00	+

**Table –II Result of the attempted interspecific crosses between
C. annuum and *C. frutescens***

Parent Pistillate	Staminate	Crosses Made	Fruit Set %	Hybrid
C. annuum var. Deonur Byadagi	C. frutescens var. Lavangi	23	00.00	-
C. annuum var. Jwala	C. frutescens var. Lavangi	20	00.00	-
C. annuum var. Sankeshwari	C. frutescens var. Lavangi	27	00.00	-
C. frutescens var. Lavangi	C. annuum var. Deonur Byadagi	22	18.18	+
C. frutescens	C. annuum	25	00.00	-

var. Lavangi	var. Jwala			
C. frutescens	C. annum	25	00.00	-
var. Lavangi	var. Sankeshwari			

In first filial generation, hybrids namely, Black short x Pant C-1 Black short x Sankeshwari have shown very poor growth performance as compared to first filial generation of other crosses and obviously those crosses were rejected. Finally there were total eight crosses namely Pant C-1 x Deonur Byadagi; Deonur Byadagi x Sankeshwari; Sankeshwari x Deonur Byadagi; Pant C-1 x Sankeshwari; Sankeshwari x Pant C-1; Lavangi x Deonur Byadagi; Black short x Deonur Byadagi and Sankeshwari x Black short.

Growth and yield assessment of intervarietal and interspecific crosses of Capsicum under study at F4/F5 stage is summarised in Table-III. Table depicts mean values and increase or decrease in plant height, leaf area, days for flowering (50% bloom), number of fruits per plant, fruit length, fresh weight of ripen fruits per plant, sundried fruit weight per plant (yield/plant) and seed weight per 100 g dry chillies of hybrids over mean of respective two parents and higher parent. Mean values of parental varieties are also presented in Table-III.

Table –III Growth parent, intervarietal and interspecific crosses of Capsicum annum and Capsicum frutescens

Hybrid	Plant height			Leaf area cm			Days for flowering 50% bloom			Fruit number per plant		
	A	B	b2	A	B	b2	A	B	b	A	B	b2
		b1			b1			b	1		b1	
Pant C-1 x Deonur Byadagi (F5)	68	+26	+10	19.	+33	+25	53	+	-4	10	+31.	+15
Deonur Byadagi x Sankeshwari (F5)	.9	.20	.21	61	.22	.86		4		9	32	.95
Deonur Byadagi x Sankeshwari (F5)	67	+5.	+2.	19.	+22	+8.	57	+	+	97	+32.	+31
Sankeshwari (F5)	.5	22	58	68	.69	25		4	1		81	.08
Sankeshwari x Deonur Byadagi (F5)	71	+11	+8.	20.	+29	+13	57	+	+	91	+24.	+22
Deonur Byadagi (F5)	.4	.13	60	71	.11	.91		4	1		65	.97
Pant C-1 x Sankeshwari (F5)	65	+23	+5.	21.	+26	+17	53	+	-4	98	+16.	+4.
Sankeshwari (F5)	.8	.32	50	28	.06	.05		1			66	25
Sankeshwari x Pant C-1 (F5)	67	+19	+2.	20.	+22	+14	53	+	-4	10	+25.	+11
Pant C-1 (F5)	.3	.70	40	73	.80	.02		1		5	00	.70
Lavangi x Deonur	62	+8.	+0.	18.	+52	+30	58	+	+	13	+20.	-

Byadagi (F5)	.9	27	68	15	.26	.48		1	4	0	03	10.
												34
Sankeshwari x												
Black short (F4)	67	+11	+2.	21.	+1.	-	60	-7	-	74	+8.8	0
	.5	.69	58	58	01	10.			13		3	
						75						
Black short x												
Deonur	68	+15	+9.	21.	+13	-	63	-8	-	63	-	-
Byadagi F4)	.2	.98	06	53	.07	10.			16		5.97	12.
						95						50
Capsicum annum												
Black short	55			24.			47			62		
	.0			18								
Deonur	62			13.			64			72		
Byadagi	.5			19								
Jwala	44			15.			56			90		
	.8			42								
Pant C-1	46			15.			49			94		
	.7			58								
Sankeshwari	65			18.			58			74		
	.8			18								
Capsicum frutescens												
Lavangi	53			9.9			54			14		
	.8			4						5		

It is evident from table that there is heterosis in plant height of hybrids over parental varieties and taller parents. Percent increase in plant height of Pant C-1 x Deonur Byadagi is higher, which amounts to 26.2% over mean of two parents. It is followed by 23.92, 19.70, 11.69, 11.13, 8.27 and 5.22% increase in plant height of Pant C-1 x Sankeshwari, Sankeshwari x Pant C-1, Black short x Deonur Byadagi, Sankeshwari x Black short, Sankeshwari x Deonur Byadagi, Lavangi x Deonur Byadagi and Deonur Byadagi x Sankeshwari over mean of their two parents respectively. Percent increase in plant height of hybrids over taller parent ranges from 0.68 to 10.21%. The highest vigour in plant height over taller parent is recorded in Pant C-1 x Deonur Byadagi and lowest increase in plant height over taller parent in Lavangi x Deonur Byadagi. Pal (1942) carried out hybridization between Pusa strains of *C. annum* L. and observed that F1 hybrids were intermediate or shorter than either of the parents. Singh et al. (1973) have seen heterosis in chillie crosses for plant height. Vzo (1984) found highly significant hybrid vigour in intervarietal crosses of *C. annum* on plant height at F1, F2, BC1 and BC2. Kumar and Rao (1985) have observed marked heterosis in respect to number of morphological characters such as plant height in the intervarietal F1 hybrid of *C. annum* cultivars G3 x G4. In present study also increase in plant height of hybrids is seen over parental varieties and taller parents. Thus it is clear from present investigation and earlier reports that in general, crosses between individuals from

populations that have been isolated from one another in reproduction for a period of time display greater hybridity than crosses between individuals that share the same gene pool. However, interspecific cross in *C. annuum* and *C. frutescens* is showing the property of reproductive incapability or sterility in F1 or so. In addition the segregating generation usually display weakness associated with genetically controlled physiological disturbances (genetic adaptability) here height of the plant. However, the interspecific hybrids run the gamete from complete fertility to complete sterility. It is also (from meiotic studies of the interspecific cross) difficult to distinguish between genic and chromosomal sterility. Therefore, for the present study, it is safe to conclude that the disharmonies effects of gene recombination and the effects of deficiencies, duplications and other alternations of chromosomal segments operate singly or jointly to produce its weaknesses.

Hybrids of F5 generation namely Pant C-1 x Deonur Byadagi, Deonur Byadagi x Sankeshwari, Sankeshwari x Deonur Byadagi, Pant C-1 x Sankeshwari, Sankeshwari x Pant C-1 and Lavangi x Deonur Byadagi showed vigorous increase in leaf area over mean of two parents and higher leaf area parent in range of 22.69 to 52.20% and 8.25 to 30.48% respectively. Cross Sankeshwari x Black short and Black short x Deonur Byadagi of F4 generation have also shown increase in leaf area over mean of two parents with value of 1.01% and 13.07% respectively, however, both crosses have shown 10.75% and 10.95% decrease leaf area than the parent having higher leaf area. Vzo (1984) observed no any significant hybrid vigour on leaf area at F1, F2, BC1 and BC2 of intervarietal crosses of *Capsicum annuum*. However, Kumar and Rao (1985) noted marked heterosis in respect of leaf length, leaf width and number of other morphological characters in intervarietal F1 hybrid of *C. annuum* cultivars G3 x G44. Our results are also in agreement with observations of Kumar and Rao.

Days required to flowering (50% bloom) in hybrids and increase or decrease in days for flowering in hybrids over parents is shown in Table-III. Hybrid Pant C-1 x Deonur Byadagi required 53 days for blooming. Thus, showing four days advancement over mean of two parents, however, there is lateness of four days for flowering over early parent. The reciprocal crosses of Deonur Byadagi and Sankeshwari require 57 days for flowering. These crosses blossomed four days earlier than mean days required for flowering for both parents. While these two crosses bloomed one day early than early flowering parent i.e. variety Sankeshwari. Another reciprocal cross of Pant C-1 and Sankeshwari flowered at 53 days after transplantation, which is one day advance than mean of two parents and four days later than early parent that is Pant C-1. Hybrid Lavangi x Deonur Byadagi blossomed one

day and four days earlier than mean of two parents and early flowering parent respectively. There is 7 days and 13 days delay in flowering in hybrid Sankeshwari x Black short over mean of two parents and early parent of hybrid respectively. Black short x Deonur Byadagi also require 8 days and 16 days more for flowering than mean of two parents and early parent respectively. In F1 hybrids between Pusa strains of *C. annuum* L., Pal (1942) observed that hybrids tended to be as early or slightly earlier than the early parent with few exceptions. Luckwill (1940) observed that the time of flowering of the interspecific hybrids was intermediate between that their parents in *Lycopersicon*. In present study, hybrids did not showed uniform increase or decrease in days for flowering over parental varieties. Hybrids of F5 generation shown earlier flowering than mean days for flowering of two parents of each hybrid, however, hybrids of F4 generation have shown delay in flowering than mean days required for flowering of two parents as well as early flowering parent.

Hybrids of F5 generation showed increase in number of fruit per plant. All these crosses bear more number of fruits per plant than mean fruit number of two parents and higher parent except Lavangi x Deonur Byadagi, which showed increase in fruit number per plant over mean fruits of two parents, but decrease in number of fruits than higher parent. Sankeshwari x Black short of F4 generation has shown increase (8.82%) in fruit number per plant over mean fruit number of both parents. While total number of fruits in this hybrid was equal to that of higher parent. Hybrid Black short x Deonur Byadagi (F4) showed decrease in fruit number over mid parental and higher parent values. Production of four to eight fruits in clusters has been described in chillie varieties (Deshpande, 1944; Murthy and Murthy, 1962 and Ohta and Chuong, 1975). The clustering habit of fruit bearing is controlled by a single recessive gene now designated as 'fa' for fasciculate (Lippert et al. 1965; Barrios and Mosokau, 1972 and Ohta and Chuong, 1975). Pal (1942) observed in F1 hybrids between Pusa strains of *C. annuum* L. were the poorer than the parents in respect of number of fruits per plant. Singh et al (1973) have seen heterosis in chillie crosses for fruit number per plant. Highly significant hybrid vigour in intervarietal crosses of *C. annuum* on number of fruits per plant was observed by Vzo (1984). In present study generally hybrids have shown increase in fruit number per plant over their parents with one exception of Black short x Deonur Byadagi. Mean values of fruit number per plant was higher in cross Lavangi x Deonur Byadagi as compared to all other hybrids which may be attributed to a great natural potential of *C. frutescens* one of the parents for high fruit number.

Fruit length increased in all hybrids under study over mean of respective two parents. Increase in fruit length varies from 4.58 to 23.33%. over mean of respective two

parents. However, none of the hybrids have shown increase in length of fruit over higher parent. Singh et al (1973) have reported heterosis in chillie crosses for fruit length. Kumar and Rao (1985) studied the intervarietal F1 hybrid of *C. annuum* cultivars G3 x G4 and observed marked heterosis in respect of fruit length. In present investigation, it may be concluded that fruit length in hybrids under study showed intermediate increase to both the respective parents because fruit length over mid parent fruit length and decrease over higher parent value.

From the foregoing account of pedigree breeding in Capsicum, it can be summarised that

- i) Success of hybridization is more in intervarietal crosses than interspecific crosses.
- ii) In interspecific crosses of *Capsicum annuum* and *C. frutescens*, *C. annuum* was found unsuitable as female parent.
- iii) In general heterotic effect in plant height was observed in hybrids of *Capsicum*.
- iv) Hybrids of F5 generation showed significant increase in leaf area over mean of two parents and higher leaf area parent, while decrease in leaf area over higher parental value has been shown by hybrids of F5 generation.
- v) Hybrids of F5 generation have shown earlier flowering than mean days for flowering of two parents of each hybrid. However, hybrids of F4 generation showed delay in flowering over mid parental and early parental value.
- vi) All hybrids of F5 generation under study bear more number of fruits respective and higher parent (except in Lavangi x Deonur Byadagi). Mean value of fruit number per plant was higher in Lavangi x Deonur Byadagi as compared to all other hybrids which may be attributed to a great natural potential of *C. frutescense*, one of the parents for high fruit number. In crosses of F4 generation fruit number per plant was decreased over higher parental values.

Thus, it is concluded that the improvement in respect of growth especially plant height, leaf area, days for flowering 50% blooms, fruit number per plant in *Capsicum* species is achieved by pedigree breeding method.

In general, when parental combinations of F4 and F5 are assessed, it was observed that crosses of F5 generation are more fruitful than crosses of F4 generation one may attribute this negative heterosis in hybrids F4 generation in variety Black short al and race of *Capsicum annuum*.

It has found that hybrid of *Capsicum* species under study are showing heterosis in chiasma frequency. The morphological heterosis and chiasa frequency heterosis

can be coupled with each other. Kumar and Rao (1985) also coupled morphological heterosis and chiasma frequency heterosis of intervarietal F1 hybrids of *Capsicum annuum* together.

Field trials are an essential part of the work of plant breeders who wish to compare the yields of their best lines with leading commercial cultivars. Such trials will provide an unbiased objective evaluation based on probability theory. It is also intended to conduct field trials and regional trials if possible of selections obtained in present investigation for enhancing their chances of commercial acceptance of new cultivars.

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