



**FRUIT ANALYSIS AND DISEASE RESISTANCE ANALYSIS OF INTERVARIETAL  
AND INTERSPECIES CROSSES OF CAPSICUM ANNUM AND CAPSICUM  
FRUTESCENS OVER PARENTS.**

**Sharad S. Phulari, Ph.D.**

*Principal, D.G.Tatkare Mahavidyalay, Mangaon –Raigad 402104*

**Abstract**

*In interspecies crosses of Capsicum annum and C. frutescens, C. annum was found unsuitable as female parent. Success of hybridization is more in intervarietal crosses than interspecies crosses. Capsicum and vitamin C (Ascorbic acid) constituents of chillie increased over mid parent value in hybrids of Capsicum species under study. No consistency in capsaicin content was found in hybrids and their parents. In general, hybrids showed more resistance to leaf curl than the parental varieties, except in Black short x Deonur Byadagi of F4 generation. It is observed that the improvement in respect of fruit quality and disease resistance potentiality to leaf curl in Capsicum species is achieved by pedigree breeding method.*



Scholarly Research Journal's is licensed Based on a work at [www.srjis.com](http://www.srjis.com)

**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 diverse 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. annuum	Black short	Erect fruits and resistance to leaf curl disease.
C. annuum	Deonur Byadagi	Deep brown colour after ripening.
C. annuum	Jwala	Productivity and pungency.
C. annuum	Pant C-1	Erect fruits, leaf curl resistance and adequate pungency.
C. annuum	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 P<sub>2</sub>O<sub>5</sub> and 50 kg of K<sub>2</sub>O 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 for quality of fruit. The sundried red fruits were analysed for Capsicum content, Vitamin C and capsaicin.

For estimating coloring matter (capsicum), A.O.A.C. (1980) method was dopted. Capsaicin estimated by multiband thin layer chromatography method by Pankar and Magar (1977). Ascorbic acid determination by titrimetric method of Alberg (1958).

Inoculum of leaf curl disease of chillie plants, extracted in distilled water was spread over plants of parental varieties and six crosses of F5 generation and two crosses of F4 generation, to test the resistance of crosses to leaf curl disease over parental varieties. Inoculum was spread when the plants were 15 days old after transplantation. The observations were made from 30 days after transplantation upto final harvest of the plants. Assessment was made comparing immunity of crosses over parental varieties to the leaf curl disease.

**Result And Discussion:**

Results of intervarietal crosses of *Capsicum annuum* and interspecific crosses between *C. annuum* 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. annuum* and *C. frutescens*, when *C. annuum* 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. annuum* 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***

<b>Parent Pistillate</b>	<b>Staminate</b>	<b>Crosses Made</b>	<b>Fruit Set %</b>	<b>Hybrid</b>
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. Deonur Byadagi	C. annuum var. Black short	24	25.00	+
C. annuum var. Deonur 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. annum var. Pant C-1	C. annum var. 23 Sankeshwari	39.13	+
C. annum var. Sankeshwari	C. annum var. Black 28 short	21.42	+
C. annum var. Sankeshwari	C. annum var. 22 Deonur Byadagi	36.36	+
C. annum var. Sankeshwari	C. annum 28 var. Jwala	00.00	-
C. annum var. Sankeshwari	C. annum var. Pant 25 C-1	12.00	+

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

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

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.

**Table –IV Fruit analysis of interspecific and inter varietal crosses of Capsicum annum  
and C. frutescens over parents**

Hybrid	1 Colouring Matter (Capsicum)			2 Capsaicin			3 Vitamin C		
	A	B		A	B		A	B	
		b1	b2		b1	b2		b1	b2
Pant C-1 x Deonur	98.1	+28.2	+7.74	0.18	-	-	56.6	+11.3	+8.7

Byadagi (F5)	3	1		7	14.22	25.20	1	6	1
Deonur Byadagi x Sankeshwari (F5)	85.1	+12.7	-6.56	0.11	-	-	55.3	+14.4	+6.2
Sankeshwari	0	7		2	38.12	40.10	3	1	4
Deonur Byadagi (F5)	82.6	+9.46	-9.31	0.10	-	-	58.3	+20.3	+11.
Pant C-1 x Sankeshwari (F5)	0			0	44.75	46.75	0	4	75
Sankeshwari (F5)	63.4	+4.58	+3.25	0.32	+53.3	+30.0	51.4	+9.07	+3.6
Sankeshwari x Pant C-1 (F5)	0			5	0	0	0		0
Lavangi x Deonur Byadagi (F5)	68.2	+12.5	+11.0	0.30	+41.5	+20.0	53.5	+13.5	+7.8
Sankeshwari x Black short (F4)	0	0	7	0	0	0	0	3	6
Black short x Deonur Byadagi (F5)	86.8	+17.5	+4.69	0.37	+47.4	+17.4	55.3	+14.9	+6.1
Black short x Deonur Byadagi (F4)	0	3		0	1	6	3	6	8
Parent Capsicum annum	62.1	+16.6	+3.75	0.12	-	-	45.0	+6.73	+0.8
Black short	0	6		5	37.50	44.44	0		0
Deonur Byadagi	70.2	+1.90	-	0.13	-	-	50.8	+5.04	-
Jwala	0		22.92	7	33.49	39.11	0		2.45
Pant C-1									
Sankeshwari									
Capsicum frutescens									
Lavangi	46.62			0.225			39.68		
	91.08			0.187			52.08		
	68.00			0.287			50.84		
	61.40			0.250			49.60		
	59.85			0.175			44.64		
	56.63			0.315			43.40		

1- Capsicum values expressed in ASTA (American Spice Trade Association) colour units.

2- Capsicum values expressed in g per 100 g sundried red fruits.

3- Ascorbic acid expressed in mg/100 g sundried red fruits.

A- Mean values (per plant)

B- Percent increase of decrease of hybrid over.

b1- Mean of two parent

b2- Higher parent.

**Table –V Effect of spraying of inoculum of leaf curl diseased plants to chillie (extracted in distilled water) over parental varieties of Capsicum and their hybrids.**

Species / Variety	Disease incidence %
Capsicum annum	
Black Short	55
Deonur Byadagi	90
Jwala	66
Pant C-1	50
Sankeshwari	96
Capsicum frutescens	
Lavangi	60

---

Hybrids	
Pant C-1 x Denour Byadagi (F5)	22
Denour Byadagi x Sankeshwari (F5)	20
Sankeshwari x Deonur Byadagi (F5)	32
Pant C-1 X Sankeshwari (F5)	18
Sankeshwari x Pant C-1 (F5)	Nil
Lavangi x Deonur Byadagi (F5)	Nil
Sankeshwari x Black short (F4)	Nil
Black short x Denour Byadagi (F4)	72

---

Effect of spraying of inoculum of leaf curl disease of chillie on parental varieties and hybrids of Capsicum id depicted in Table-V.

Results of fruit analysis of interspecific and intervarietal crosses of Capsicum annum and C. frutescens with parental values is recorded in Table V-IV. Colouring matter (Capsicum), Capsicum and Ascorbic acid content are the important constituents of fruit quality in chillie.

It is clear from the table that there was 1.90 to 28.71% increase in Capsicum in hybrids under study over mean capsicum content of their respective parents. Out of 8 crosses Pant C-1 x Deonur Byadagi, Sankeshwari x Black short showed increase in capsicum in fruits over higher parent. While Deonur Byadagi x Sankeshwari, Sankeshwari d Denour Byadagi, Lavangi x Deonur Byadagi and black short x Deonur Byadadi showed decrease in capsicum content in fruits over higher parent fruit value.

Ripe fruit colour yellow 'y' is recessive to red 'y+' (webber, 1911; Shaw and Khan, 1928; and Munir, 1954; and Gafur et al. , 1970). Various colour shades from red to ivory indicated the action of 3 gene pairs 'y' and 'y+', C1 and C1+ and C2 and C2+ (kormos and Kormos, 1960). Red and yellow mature fruit colour us controlled by two complementary genes (Y and C), having new class of solmon red (Yc) and (yC) as recombinants (Ohta and Chuong, 1975). It is evident from present study that capsicum content increased more in hybrids in which variety Deonur Byadagi is one of contributory parent.

The pungent principle, Capsaicin (Table-VI) decreased in pant C-1 x Deonur Byadagi and both reciprocal crosses of Deonur Byadagi and Sankeshwari over mean pungency of two parents and higher pungent parent. However, reciprocal cross of Sankeshwari and Pant C-1 and cross of Lavangi x Deonur Byadagi showed increase in Capsaicin content over mean of two parents and higher pungent. The highest increase in Capsaicin content was 47.41% and 17.46% in fruits of Lavangi x Deonur Byadagi over mid parental and higher parental value respectively.



While crosses of F4 generation namely Sankeshwari x Black short and Black short x Deonur Byadagi showed decrease on Capsaicin content by 37.5% and 33.49% over mean Capsaicin of two parents and 44.44% and 39.11% decrease over higher pungent parent respectively. Inheritance of Capsaicin content is observed to be controlled by single dominant gene (Deshpande, 1933; Greenleaf, 1952; Heiser and Smith, 1953; Sharma and Saini, 1980). It is then evident from present study that capsaicin content in F5 reciprocal crosses of parent C-1 x Sankeshwari and Lavangi x Deonur Byadagi is higher and this may be due to contributions of parents namely Pant C-1 and Lavangi.

Ascorbic acid (Vitamin C) content (Table -IV) increased in F5 hybrid fruits under investigation over mean ascorbic acid content of respective parents and higher parents except that in the F4 hybrid, Black short x deonur Byadagi. The range of increase in ascorbic acid was 5.04% to 20.34% over mean of both parents, while ascorbic acid content in fruits of hybrids increased in range of 0.80% to 11.75% over higher parents. The hybrid Black short x Deonur Byadagi contains 5.04% more ascorbic acid over mean of both parent, but it was 2.45% less than higher parent. Inheritance of ascorbic acid content in fruit showed partial dominance (Thakur and Brar, 1975). Thus, it is apparent from the present studies that parent variety of Capsicum annum namely Deonur Byadagi is playing important role in inheritance of ascorbic acid content characteristics.

From this fruit content analysis of hybrids, it can be seen that there was 1.90 to 28.71% increase in Capsicum, the range of increase in ascorbic acid was 5.04 to 20.34 and hybrids Sankeshwari x Pant C-1, Pant C-1, pant C-1 x Sankeshwari and Lavangi x Deonur Byadagi showed increase in capsaicin content over mean of two parents and higher parent. Therefore, it may be concluded that there is increase in colouring matter, ascorbic acid and upto certain extent increase in capsaicin. It is evident that from view point of improvement of capsicum and ascorbic acid content of fruits, one can lean on Capsicum annum variety Deonur Byadagi as one of the parent. While to improve the capsaicin content in fruits, Capsicum annum variety Pant C-11 and C. frutescens variety Lavangi can be used as one of the parents. However, C. frutescens variety Lavangi having its own limitation factors i.e. low yield.

It is clear from the table that parental varieties showed 50 to 90% disease incidence. Varieties of C. annum namely Pant C-1, Black short, Jwala and that of C. frutescens variety Lavangi showed more resistance to leaf curl than varieties Deonur Byadagi



and Sankeshwari of *C. annum*. While intervarietal and interspecific hybrids under study showed 0 to 72% disease incidence. Hybrids namely Sankeshwari x Pant C-1, Lavangi x Deonur Byadagi of F5 generation and Sankeshwari x Black short of F4 showed more tolerance to leaf curl disease. Moderate tolerance to leaf curl disease is observed in Pant C-1 x Deonur Byadagi, Deonur Byadagi x Sankeshwari, Sankeshwari x Deonur Byadagi and Pant C-1 x Sankeshwari hybrids of F5 generation. It was ranging from 18 to 32%. Heavy disease incidence was shown by hybrid Black short x Deonur Byadagi of F4 generation which was 72%. Mosaic and leaf curl are caused by a large number of viruses. Holmes (1934) recorded an instance of a dominant gene L, conferring resistance to tobacco mosaic virus (TMV). The resistance to chilli variety Puri red to mosaic appears to be due to a single gene (Rajanujam et al., 1965). In present study, hybrids showed more resistance to leaf curl than the parental varieties. Tewari and Ramanujam (1974), Mathai et al. (1977) and Khot and Herlekar (1980) also found that hybrids are tolerant to leaf curl in chillies.

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 annum* and *C. frutescens*, *C. annum* was found unsuitable as female parent.
- iii) *Capsicum* and vitamin C (Ascorbic acid) constituents of chilli increased over mid parent value in hybrids of *Capsicum* species under study. No consistency in capsaicin content was found in hybrids and their parents.
- iv) In general, hybrids showed more resistance to leaf curl than the parental varieties, except in Black short x Deonur Byadagi of F4 generation.

Thus, it is concluded that the improvement in respect of growth, fruit quality and disease resistance potentiality to leaf curl 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 generations are more fruitful than crosses of F4 generation. One may attribute this negative heterosis in hybrids F4 generation to variety Black short a land race of *Capsicum annum*.

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

### **Bibliography:**

- Alberg, B. (1958).** *Ascorbic acid in Encyclopedia of plant physiology*, 6:478-494. ed. Burstrom, K. Springer-Verloge, Berlin.
- Association of Official Analytical Chemists (1980).** Washington, D.C. 13<sup>th</sup> Ed. Pp. 497.
- Chandra, S.A.; Singh, K., Nair, P.K.R., Usha, B. (1987)** 'Jawahar Mirch 218' as new bright red, pungent chillie. *Indian Horticulture*, 31(4):7-8.
- Deshpande, R.B. (1933).** *Studies in Indian chillies. III. Inheritance of some characters in Capsicum annum.* *Indian J. Agric. Sci.*, 3:219-300.
- Gafur, M.; Hassan, E. and Smith, P.G.(1970).** *The inheritance of mature fruit colour in Capsicum pubescens.* *Hort. Sci.* 5: 174.
- Greenleaf, W.H. (1952).** *Inheritance of pungency and of the deciduous character in pepper.* *Proc. Assoc. South Agric. Workers.* , 49: 110-111.
- Heiser, C.B. and Smith, P.G. (1953).** *The cultivated Capsicum peppers.* *Econ. Bot.* , 7:214-226.
- Holmes, F.O.(1934).** *Inheritance of ability to localize tobacco mosaic virus.* *Phyto-pathology*, 24:984-1002
- Khot, A.B. and Herlekar, V.D. (1980).** *Performance of new chillie variety DH-7-6-6 for Belgaum Region.* *Carr. Res.*, 30-32.
- Kumar, O. Aniel and RajaRao, K.G. (1985).** *Heterosis in the intervarietal hybrid of chillies (Capsicum annum L.).* *Indian J. Bot.* 8(1):88-92.
- Mathai, P.J.; Dubey, G.S.; Peter, K.V.; Sakloni, V.D. and Singh, N.P. (1977).** *Pant C-1 and Pant C-2 two new promising selections fo chilli.* *South Indian Hort.* , 25:123-125.
- Ohta, Y. and Chuog, P.V. (1975).** *Hereditary changes in Capsicum annum I. Induced by ordinary grafting* *Euphytica*, 24:355-365.
- Padda, D.S. and Singh, J. (1971).** *Studies on some important aspects of floral biology in chillies.* *Indian J. Agric. Res.* 5(3) : 217-218.
- Pankar, D.S. and Magar, N.G. (1977).** *New method for the determination of Capsaicin by using multiband thin layer chromatography.* *J. Chromatography*, 144:149-152.

- Ramanujam, S.; Joshi, B.C. and Rao, P.N.(1965).** *Inheritance studies in chillies. Indian J. Genet., 25:360-366.*
- Sharma, P.P. and Saini, S.S. (1980).** *Inheritance of capsaicin content in Capsicum annuum. Proc. All India Workshop on chillies held at Hyderabad on 22<sup>nd</sup> March, 1980 issued by Spice Export Promotion Council, Ernakulum, 85-93.*
- Shaw, F.J.F. and Khan, A.R. (1928).** *Studies in Indian chillies. I –The types of Capsicum. Indian Dep. Agri. Mem. Bot. Ser., 16:59-82.*
- Smith, P.G. and Heiser, C.B. Jr. (1951).** *Taxonomic and genetic studies on the cultivated peppers Capsicum annuum and C. frutescens. Amer. J. Bot. 38:362-368.*
- Tewari, V.P. and Ramanujam, S. (1974).** *Grow Jwala – a disease resistant high yielding chillie. Indian Fmg. 24(1):20.*
- Thakur, M.R. and Brar, M.S. (1975).** *Inheritance of ascorbic acid content in chillies. SABRAO, J. 7:225-229.*
- Webber, H.J.(1911).** *Preliminary notes on pepper hybrids. Ann. Rep. Amer. Breed. Assoc. , 7:188-199.*