



## **YIELD CHARACTERS OF PARENT, INTERVARIETAL AND INTERSPECIES CROSSES OF CAPSICUM ANNUUM AND CAPSICUM FRUTESCENS.**

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### **Abstract**

*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. Fruit length found increased in all hybrids under study over mean of their respective parents. The intervarietal and interspecific crosses of F5 generation showed increases in fresh weight of fruits per plant over mid and higher parental value. However, crosses of F4 generation showed decrease in fresh weight of fruits per plant over higher parental values. It is concluded that the improvement in respect of fruit quality through means of fruit number per plant, fruit length, fresh weight of fruit per plant, Sudried fruit weight per plant (yield) and seed weight per 100 g dry fruits in Capsicum species is achieved by pedigree breeding method.*



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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. 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 an thesis 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 by analysing yield characters. For analysis of yield characters parameters like fruit number per plant, fruit length, fresh weight of fruit per plant, sundried fruit weight per plant (yield) and seed weight per 100 g dry fruits in Capsicum species carried out.

### **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 annum***

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

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

| <b>Parent<br/>Pistillate</b>    | <b>Staminate</b>              | <b>Crosses<br/>Made</b> | <b>Fruit<br/>Set %</b> | <b>Hybrid</b> |
|---------------------------------|-------------------------------|-------------------------|------------------------|---------------|
| C. annum var.<br>Deonur Byadagi | C. frutescens<br>var. Lavangi | 23                      | 00.00                  | -             |
| C. annum                        | C. frutescens                 | 20                      | 00.00                  | -             |

|                  |                  |    |       |   |
|------------------|------------------|----|-------|---|
| var. Jwala       | var. Lavangi     |    |       |   |
| C. annum         | C. frutescens    | 27 | 00.00 | - |
| var. Sankeshwari | var. Lavangi     |    |       |   |
| C. frutescens    | C. annum var.    | 22 | 18.18 | + |
| var. Lavangi     | Deonur Byadagi   |    |       |   |
| C. frutescens    | C. annum         | 25 | 00.00 | - |
| var. Lavangi     | var. Jwala       |    |       |   |
| C. frutescens    | C. annum         | 25 | 00.00 | - |
| var. Lavangi     | var. Sankeshwari |    |       |   |

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 Yield characters of parent, intervarietal and interspecific crosses of Capsicum annum and Capsicum frutescens**

| Hybrid                      | Fruit length |     |     | Fresh weight of fruit per plant |     |     | Sundried fruit weight per plant |     |     | Seed weight per 100 g dry fruits |     |     |
|-----------------------------|--------------|-----|-----|---------------------------------|-----|-----|---------------------------------|-----|-----|----------------------------------|-----|-----|
|                             | A            | B   |     | A                               | B   |     | A                               | B   |     | A                                | B   |     |
|                             |              | b1  | b2  |                                 | b1  | b2  |                                 | b1  | b2  |                                  | b1  | b2  |
| Pant C-1 x Deonur           | 13.          | +10 | -   | 239                             | +8. | +5. | 62.                             | +5. | +4. | 48.                              | +11 | +1. |
| Byadagi (F5)                | 15           | .22 | 9.5 | .98                             | 32  | 49  | 40                              | 79  | 34  | 14                               | .59 | 47  |
|                             |              |     | 5   |                                 |     |     |                                 |     |     |                                  |     |     |
| Deonur x Byadagi            | 19.          | +7. | -   | 236                             | +12 | +2. | 59.                             | +7. | +2. | 41.                              | +5. | +3. |
| Sankeshwari(F5)             | 13           | 05  | 6.4 | .98                             | .11 | 42  | 80                              | 38  | 16  | 64                               | 36  | 55  |
|                             |              |     | 6   |                                 |     |     |                                 |     |     |                                  |     |     |
| Sankeshwari x Deonur        | 18.          | +4. | -   | 232                             | +10 | +2. | 62.                             | +12 | +6. | 46.                              | +17 | +15 |
| Byadagi F5)                 | 69           | 58  | 11. | .60                             | .03 | 25  | 56                              | .33 | 85  | 57                               | .83 | .81 |
|                             |              |     | 83  |                                 |     |     |                                 |     |     |                                  |     |     |
| Pant C-1 x Sankeshwari (F5) | 16.          | +10 | -   | 230                             | +12 | +7. | 61.                             | +9. | +3. | 42.                              | -   | -   |
|                             | 85           | .40 | 20. | .90                             | .37 | 08  | 39                              | 35  | 28  | 64                               | 2.6 | 10. |
|                             |              |     | 50  |                                 |     |     |                                 |     |     |                                  | 9   | 11  |
| Sankeshwari x Pant C-1 (F5) | 17.          | +15 | -   | 265                             | +28 | +22 | 67.                             | +20 | +13 | 42.                              | -   | -   |
|                             | 57           | .13 | 17. | .05                             | .99 | .92 | 53                              | .28 | .61 | 00                               | 3.9 | 11. |
|                             |              |     | 12  |                                 |     |     |                                 |     |     |                                  | 9   | 31  |

|                     |     |     |     |     |     |     |     |     |     |     |     |     |
|---------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Lavangi x           |     |     |     |     |     |     |     |     |     |     |     |     |
| Deonur              | 12. | +21 | -   | 253 | +30 | +11 | 62. | +20 | +6. | 49. | +8. | -   |
| Byadagi (F5)        | 26  | .02 | 15. | .50 | .48 | .44 | 58  | .13 | 91  | 31  | 78  | 5.5 |
|                     |     |     | 68  |     |     |     |     |     |     |     |     | 9   |
| Sankeshwari x       |     |     |     |     |     |     |     |     |     |     |     |     |
| Black short (F4)    | 16. | +24 | -   | 178 | +3. | -   | 46. | +0. | +12 | 46. | -   | -   |
|                     | 81  | .33 | 20. | .66 | 29  | 8.5 | 23  | 47  | .52 | 37  | 0.5 | 12. |
|                     |     |     | 79  |     |     | 2   |     |     |     |     | 5   | 53  |
| Black short x       |     |     |     |     |     |     |     |     |     |     |     |     |
| Deonur              | 11. | +13 | -   | 146 | -   | -   | 36. | -   | -   | 48. | +6. | -   |
| Byadagi F4)         | 60  | .83 | 20. | .25 | 22. | 35. | 05  | 26. | 38. | 90  | 44  | 7.8 |
|                     |     |     | 22  |     | 58  | 70  |     | 20  | 40  |     |     | 2   |
| Capsicum annum      |     |     |     |     |     |     |     |     |     |     |     |     |
| Black short         | 5.8 |     |     | 150 |     |     | 39. |     |     | 53. |     |     |
|                     | 4   |     |     | .38 |     |     | 18  |     |     | 05  |     |     |
| Deonur              | 14. |     |     | 227 |     |     | 58. |     |     | 38. |     |     |
| Byadagi             | 54  |     |     | .41 |     |     | 53  |     |     | 84  |     |     |
| Jwala               | 14. |     |     | 212 |     |     | 61. |     |     | 45. |     |     |
|                     | 57  |     |     | .50 |     |     | 32  |     |     | 17  |     |     |
| Pant C-1            | 9.3 |     |     | 215 |     |     | 59. |     |     | 47. |     |     |
|                     | 3   |     |     | .62 |     |     | 44  |     |     | 44  |     |     |
| Sankeshwari         | 21. |     |     | 195 |     |     | 52. |     |     | 40. |     |     |
|                     | 20  |     |     | .30 |     |     | 85  |     |     | 21  |     |     |
| Capsicum frutescens |     |     |     |     |     |     |     |     |     |     |     |     |
| Lavangi             | 5.7 |     |     | 161 |     |     | 45. |     |     | 52. |     |     |
|                     | 2   |     |     | .70 |     |     | 05  |     |     | 23  |     |     |

A- Mean values per plant

B- Percent increase or decrease of hybrid over b1- Men of two parents b2- Taller/Early/higher 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. annum* 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.

Crosses of F5 generation under study showed higher fresh weight of fruits per plant over mean of respective two parents as well as parent having higher fresh weight of fruits per plant. This vigour in fresh weight of fruit over mean of two parents was observed maximum in Lavangi x Deonur Byadagi (30.48%) and Sankeshwari x Pant C-1 (28.99%). It is followed by increase in Pant C-1 x Sankeshwari (12.37%), Deonur Byadagi x Sankeshwari (12.11%), Sankeshwari x Deonur Byadagi (8.32%), Pant C-1 x Deonur Byadagi (8.32%). Crosses of F4 generation in present study, Sankeshwari x Black short have shown (3.27%) increase in fresh weight of fruits per plant over mean of two parents, however, it showed decrease (8.52%) in fresh weight of fruits per plant over higher parent. In case of Black short x Deonur Byadagi, there was retrogressive phenomenon for fresh weight of fruits per plant, because it showed 22.58 and 35.70 % decrease over mean of both parents and higher parent respectively. Vzo (1984) found highly significant hybrid vigour in intervarietal crosses of *C. annuum* on total fruit weight per plant. In the present study also the intervarietal and interspecific crosses showed increase in fresh weight of fruits per plant.

Sundried fruit weight that is yield per plant was consistently higher in hybrids of F5 generation under investigation than mean of respective two parents and higher parent. The range of increase in yield per plant is 5.79% to 20.28% over mean of both respective parents. The higher percent increase in yield per plant was recorded in hybrid Sankeshwari x



Pant C-1 (20.28%) and Lavangi x Deonur Byadagi (20.13%), it is followed by increase in Sankeshwari x Deonur Byadagi (12.33%), Pant C-1 x Sankeshwari (9.35%), Deonur Byadagi (5.79%) over mean of their respective two parents. Increase in yield per plant over higher parent was observed in Sankeshwari x Pant C-1 (13.61%), Lavangi x Deonur Byadagi (6.91%), Sankeshwari x Deonur Byadagi (6.88%), Pant C-1 x Deonur Byadagi (4.34%), Pant C-1 x Sankeshwari (3.28%) and in Deonur Byadagi x Sankeshwari (2.16%). Hybrids of F4 generation, Sankeshwari x Black short and Black short x Deonur Byadagi, showed decrease in yield per plant over mean of two parents and higher parent. This decrease in yield is much pronounced in later cross i.e. Black short x Deonur Byadagi. Pal (1942) found that F1 hybrids between Pusa strains of *Capsicum annuum*, the two crosses were superior to both the parents while the third was intermediate. Singh et al. (1973) observed that out of 7 chillie crosses, three crosses showed significantly higher yield than the better parent. Pal and Singh (1949) observed that intervarietal hybrid of Brinjal has given 45 to 50% higher yield than the best parent and has uniform attractive fruits. Singh and Roy (1989) found that interspecific hybrid of *Solanum melongene* and *S. surattense* had better yield than the parents. It is also evident from the present studies that the yield of F5 hybrids increased over mid parental value and better parental value in hybrids of intervarietal and interspecific crosses.

Seed weight per 100 g sundried chillie fruit, increased in Pant C-1 x Deonur Byadagi and reciprocal crosses of Deonur Byadagi x Sankeshwari over mean of the seed weight of respective two parents and higher parent. However, in reciprocal crosses of Sankeshwari and Pant C-1 seed weight decreases over mean of both parents and higher parent. In Lavangi x Deonur Byadagi seed weight is intermediate to its parents because it showed 8.78% increase over mean of both parents, but seed weight was not increased over the amount of seed weight of higher parent. There was 0.55% and 12.59% decrease in seed weight per 100 g sundried chillie fruit of Sankeshwari x Black short over mean of the both parents and higher parent respectively. While Black short x Deonur Byadagi showed increased seed weight over mean value of both parents which amounts to 6.44%. However, it has shown decrease in amount of 7.12% over higher parental value. Kumar and Rao (1985) observed marked heterosis of seed per fruit in F1 hybrid of *Capsicum annuum* cultivars G3 x G4. It is clear from present investigation that, out of 6 hybrids of F5 generation, Pant C-1 x Deonur Byadagi, Deonur Byadagi x Sankeshwari and Sankeshwari x Deonur Byadagi showed increase in seed weight. Pant C-1 x Sankeshwari and Sankeshwari x Pant C-1 Showed exclusively decrease in seed content. While Lavangi x Deonur Byadagi had



intermediate seed content over both the parents. In two crosses of F<sub>4</sub> generation, Black short x Deonur Byadagi showed vigour in seed weight over mid parental seed weight, while Sankeshwari x Black short showed retrogression in seed weight over parents.

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

- i) All hybrids of F<sub>5</sub> 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 F<sub>4</sub> generation fruit number per plant was decreased over higher parental values.
- ii) Fruit length found increased in all hybrids under study over mean of their respective parents.
- iii) The intervarietal and interspecific crosses of F<sub>5</sub> generation showed increases in fresh weight of fruits per plant over mid and higher parental value. However, crosses of F<sub>4</sub> generation showed decrease in fresh weight of fruits per plant over higher parental values.
- iv) Sundried fruit weight per plant (yield/plant) of F<sub>5</sub> hybrids increased over mid parental value and better parental value. However, negative effect was observed in hybrids of F<sub>4</sub> generation.
- v) Seed weight per 100 g dry chillies of hybrids showed different effect.

Thus, it is concluded that the improvement in respect of fruit quality-yield in Capsicum species is achieved by pedigree breeding method.

In general, when parental combinations of F<sub>4</sub> and F<sub>5</sub> are assessed, it was observed that crosses of F<sub>5</sub> generations are more fruitful than crosses of F<sub>4</sub> generation. One may attribute this negative heterosis in hybrids F<sub>4</sub> 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 chiasa frequency heterosis can be coupled with each other. Kumar and Rao (1985) also coupled morphological heterosis and chiasma frequency heterosis of intervaietal F<sub>1</sub> 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.

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