

## MITOTIC AND MEIOTIC STUDIES IN TWO CULTIVARS OF *CORIANDRUM SATIVUM* L. (APIACEAE)

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**Abstract:** Mitotic and meiotic chromosome studies are performed in two cultivars namely TNP(D)92 and NP(D)95 of *Coriandrum sativum* L. (Apiaceae) with an objective of proper cataloguing of the germplasm under study from the cytogenetical perspectives for better exploration in crop improvement. Karyomorphological details and meiotic chromosome configurations ( $2n=22$ ) are discussed.

**Keywords:** Mitotic, Meiotic, Chromosome, *Coriandrum sativum*

### INTRODUCTION

*Coriandrum sativum* L. belonging to the family Apiaceae is a spice yielding plant of commerce (leaf of the plant species is used as vegetables) with immense therapeutic uses, specifically for diabetic treatments (Msaadaet *al.* 2007, Rajeshwari and Andallu 2011). The species is grown in few states (Andhra Pradesh, Rajasthan, Tamil Nadu) of India and needs to be under sustainable cultivation as it is considered to be a major spice (Pruthi 1988). As several cultivars are grown in different states of India, it is necessary to catalogue the existing germplasms under study for proper exploration. The present article reports on the karyomorphology and meiotic chromosome configurations of two cultivars [TNP(D)92 and NP(D)95] of *C. sativum* with an objective of collecting cytogenetical information for efficient breeding and indexing of the germplasms.

### MATERIAL AND METHOD

#### Germplasm

Seeds of two cultivated varieties namely TNP(D)92 and NP(D)95 of *Coriandrum sativum* obtained from 'Globe Nursery', Kolkata, were used in the present investigation. The varieties were released from ICAR, New Delhi (vide Singh and Singh 1996). NP(D)95 is the local cultivated variety (Nadia district of West Bengal) and also being cultivated in other states of India; while, TNP(D)92 commonly known as Punjab variety is extensively grown in different parts of India.

#### Karyotype analysis

The somatic chromosomes were studied from temporary squash preparations of root tips. Well scattered metaphase plates were obtained by pre-treating the germinating roots with saturated paradichlorobenzene and aesculin mixture for 4h at 16°C followed by overnight fixation (1:3 v/v acetic alcohol). The root tips were hydrolyzed in 1N HCl at 58-60°C for 8-10 mins following gentle warming

over a spirit lamp. The chromosomes staining were made in 2% aceto-orcein solution and after staining the root tips were squashed in 45% acetic acid.

Karyomorphology of metaphase chromosome was analyzed considering the following parameters: (i) mean length of individual chromosome measured in  $\mu\text{m}$ , (ii) relative length of each chromosome represented as per cent length of longest chromosome, (iii) form per cent (F%) for each chromosome length (Hirahara and Tatuno 1967), (iv) total form per cent (TF%) represented as the total length of short arms as per cent of total length of chromosome complement (Huziwara 1962), (v) S per cent representing relative length of the smallest chromosomes divided by relative length of largest chromosome  $\times 100$  and (vi) total haploid chromatin length measured in  $\mu\text{m}$ . Data for karyotype analysis was computed from 4 camera lucida drawings which were drawn at the magnification of  $\times 1500$ . Idiogram was constructed from karyotype analysis.

#### Meiosis

The meiotic observations from control varieties were made from fixed (acetic alcohol 1:3, 6a.m.-7a.m.) floral buds and anther squash preparations were made from those buds in 1% aceto-carmin solution. The differences in meiotic behaviour between the varieties were assessed by  $\chi^2$  test of heterogeneity. Pollen fertility in control varieties was assessed by staining pollen grains in 1% aceto-carmin.

### RESULT AND DISCUSSION

Karyomorphological data are represented in Tables 1 and 2. Karyotype (Fig. 1a-c and 2 a-c) reveals 5 morphological distinct chromosome types (cultivar TNP(D)92:  $4A_{ac}^{sc} + 2B_{ac}^{sc} + 6C_{sac} + 8D_{sm} + 2E_m$ ; NP(D)95:  $10A_{ac} + 2B_{ac}^{sc} + 6C_{sac} + 8D_{sm}^{sc} + 2E_m$ ). The karyotypes show prevalence of acrocentric and sub acrocentric [TNP(D)92: 6 pairs acro and 4 pairs subacro; NP(D)95: 6 pairs acro and 3 pairs subacro] chromosomes in the cultivars. TNP(D)92 possesses 1 pair of submedian chromosome; while, NP(D)95 is

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with a median pair in the complement. Secondary constrictions are noted in three and two pairs in TNP(D)92 and NP(D)95 respectively. Chromosome length in TNP(D)92 ranges from 5.47µm to 3.28 µm and that in NP(D)95 from 5.80 µm to 4.04 µm. F% is variable in the chromosome complement of both the cultivars (TNP(D)92: 14.20 to 37.80; NP(D)95: 9.83 to 43.56). Relative length varies from 100.0% to 59.96% in TNP(D)92 and 100.0% to 69.66% in NP(D)95. TF% [TNP(D)92: 20.27; NP(D)95: 21.50] and S% [TNP(D)92: 41.68; NP(D)95: 35.86] are also determined. TF% suggests that the karyotypes are asymmetric in nature.

Distinct karyotype variations are documented in different cultivars of *C. sativum*. Baijal and Kaul (1973) classify 11 chromosome pairs of *C. sativum* into 7 types possessing 3 pairs of satellites. Hore (1977) described karyotype comprising of 4-6 chromosome types (A to F) in different varieties of coriander according to their length, centromeric position and existence of secondary constrictions. Subramanian (1986) reported 4 types in *C. sativum*; while, Das and Mallick (1989) demonstrated a new karyotype with 7 chromosome types. Pramanik et al. (2017) documents 4 morphologically distinct chromosome types in the species with 1 pair of secondary constriction. In the present investigation, both the cultivars show a gross similarity in morphology but differ in respect to the number of

chromosomes with secondary constrictions, morphology of the chromosome and total haploid chromatin length. Das and Mallick (1989) opined that structural changes of the chromosomes as well as variations of repetitive DNA sequences played significant role in karyotype alterations in different germplasms of coriander.

Meiotic analyses reveal 11II (2n=22) in all meiocytes at diplotene-diakinesis and metaphase I (MI) of TNP(D)92 and NP(D)95. Bivalents (Fig. 3 a – d) configurations (ring and rods) and chiasma per nucleus are random (p>0.05) between the cultivars at diplotene (Table 3). At MI the cultivars form 11II only with equal (11/11) segregation of chromosomes at AI. Pollen grain fertility is found 87.50% in TNP(D)92 and 85.50% in NP(D)95. The chromosome number in the cultivars is in accordance with the earlier reports (Baijal and Kaul 1973, Sengupta 2001, Pramanik et al. 2017). Baijal and Kaul (1973) opined that the chromosome number n=11 in the species is the consequence of chromosome elimination mechanism as was suggested earlier by Darlington (1937). Regular bivalent formation and absence of any structural alteration in the studied cultivars of *C. sativum* possibly indicates homozygosity for different translocation. Such phenomenon may be significant in bringing about cytological variation within the cultivars.

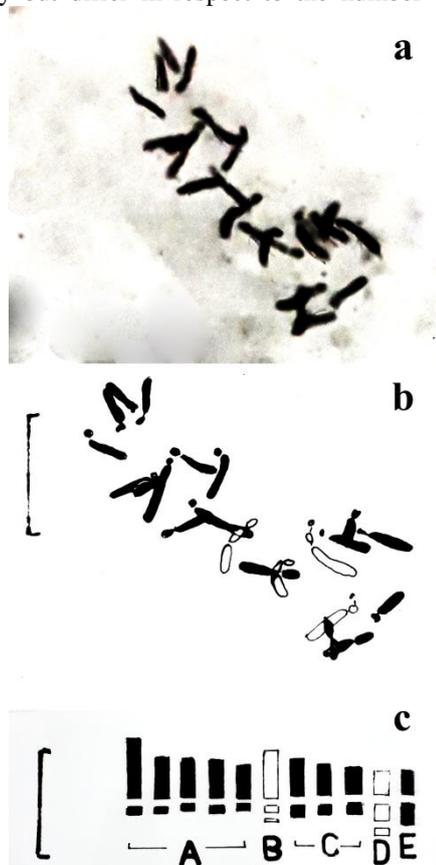


Fig. 1. Somatic chromosome (2n=22) in NP(D)95 of *Coriandrum sativum* L. a) photoplate, b) camera-lucida drawing, c) Idiogram. Bar = 10 µm

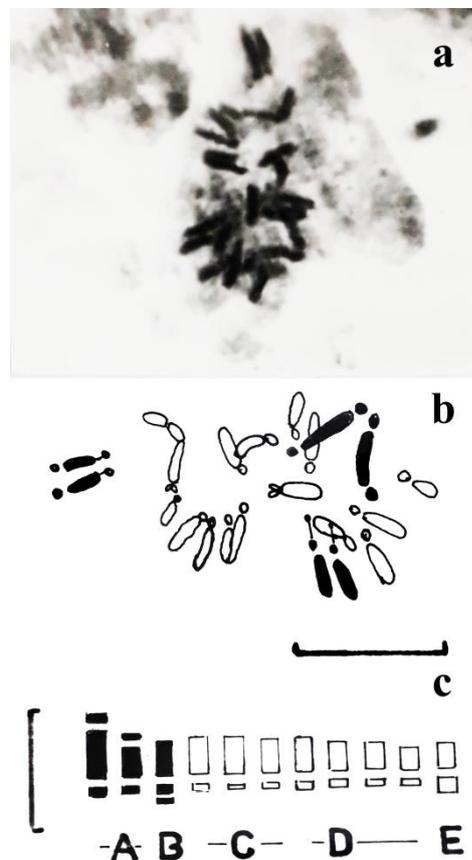
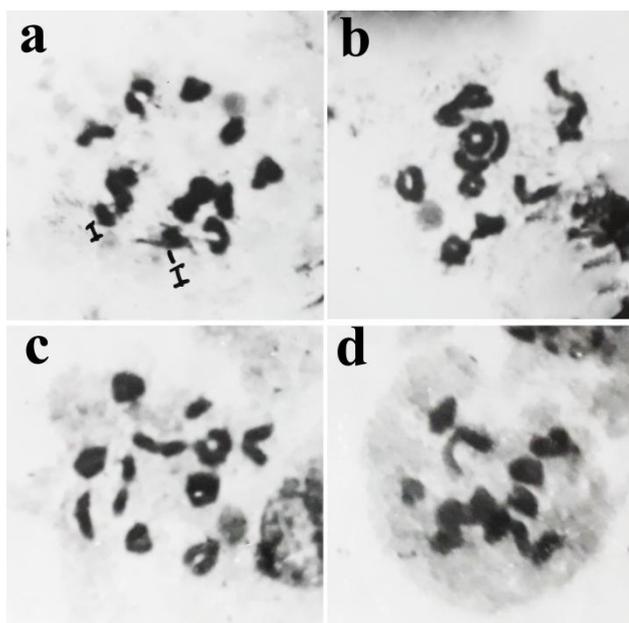


Fig. 2. Somatic chromosome (2n=22) in NP(D)92 of *C. sativum* L. a) photoplate, b) camera-lucida drawing, c) Idiogram. Bar = 10 µm



**Fig. 3.** Meiotic configurations at diplotene showing ring and rod configuration (n=11) of bivalents in cultivars of *C. sativum*

**Table 1.** Karyotypic details of *Coriandrum sativum* var TNP(D)92.

Chromosome types	Somatic chromosome Pair	Chromosome length (µm)				Arm ratio LA/SA	Relative length (%)	F (%)	Nature of primary constriction
		Long arm (LA)	Short arm (SA)	Secondary constriction	Total				
A	A <sub>1</sub> A <sub>1</sub>	3.80	0.86	0.81	5.47	1.00:4.42	100.0	15.72	acrocentric
A	A <sub>2</sub> A <sub>2</sub>	2.33	0.67	0.62	3.62	1.00:3.48	66.18	18.51	acrocentric
B	BB	2.95	0.76	0.38	4.09	1.00:3.88	74.77	18.59	acrocentric
C	C <sub>1</sub> C <sub>1</sub>	3.04	0.67		3.71	1.00:4.54	67.82	18.06	acrocentric
C	C <sub>2</sub> C <sub>2</sub>	3.14	0.52		3.66	1.00:6.04	66.91	14.20	acrocentric
C	C <sub>3</sub> C <sub>3</sub>	2.99	0.62		3.61	1.00:4.82	66.00	17.17	acrocentric
D	D <sub>1</sub> D <sub>1</sub>	2.66	0.76		3.42	1.00:3.50	62.52	22.22	Sub-acrocentric
D	D <sub>2</sub> D <sub>2</sub>	2.33	0.71		3.04	1.00:3.28	55.58	23.36	Sub-acrocentric
D	D <sub>3</sub> D <sub>3</sub>	2.28	0.57		2.85	1.00:4.00	52.10	20.00	Sub-acrocentric
D	D <sub>4</sub> D <sub>4</sub>	1.71	0.57		2.28	1.00:3.00	41.68	25.00	Sub-acrocentric
E	EE	2.04	1.24		3.28	1.00:1.65	59.96	37.80	Sub-metacentric

Total karyotype formula: 4A<sub>ac</sub><sup>sc</sup> + 2B<sub>ac</sub><sup>sc</sup> + 6C<sub>sac</sub> + 8D<sub>sm</sub> + 2E<sub>m</sub>; TF% = 20.27; S% = 41.68

**Table 2.** Karyotypic details of *Coriandrum sativum* var NP(D)95.

Chromosome types	Somatic chromosome Pair	Chromosome length (µm)				Arm ratio LA/SA	Relative length (%)	F (%)	Nature of primary constriction
		Long arm (LA)	Short arm (SA)	Secondary constriction	Total				
A	A <sub>1</sub> A <sub>1</sub>	5.23	0.57		5.80	1.00:9.18	100.0	9.83	acrocentric
A	A <sub>2</sub> A <sub>2</sub>	3.75	0.62		4.37	1.00:6.05	75.34	14.19	acrocentric
A	A <sub>3</sub> A <sub>3</sub>	3.66	0.62		4.28	1.00:5.90	73.79	14.49	acrocentric
A	A <sub>4</sub> A <sub>4</sub>	3.28	0.81		4.09	1.00:4.05	70.52	19.80	acrocentric
A	A <sub>5</sub> A <sub>5</sub>	2.99	0.57		3.56	1.00:5.25	61.38	16.01	acrocentric
B	BB	4.13	0.76	0.38	5.27	1.00:5.43	90.86	14.42	acrocentric
C	C <sub>1</sub> C <sub>1</sub>	3.33	1.19		4.52	1.00:2.80	77.93	26.33	Sub-acrocentric
C	C <sub>2</sub> C <sub>2</sub>	2.85	0.95		3.80	1.00:3.00	65.52	25.00	Sub-acrocentric
C	C <sub>3</sub> C <sub>3</sub>	2.38	0.86		3.24	1.00:2.65	55.86	26.54	Sub-acrocentric
D	DD	2.14	1.47	0.76	4.37	1.00:1.46	75.34	33.64	Sub-median
E	EE	2.28	1.76		4.04	1.00:1.30	69.66	43.56	median

Total karyotype formula: 10A<sub>ac</sub> + 2B<sub>ac</sub><sup>sc</sup> + 6C<sub>sac</sub> + 8D<sub>sm</sub><sup>sc</sup> + 2E<sub>m</sub>; TF% = 21.50; S% = 35.86

**Table 3.** Chromosome configurations at diplotene-diakinesis of two varieties of coriander

Plant types	Total no. of PMC analysed at diplotene	Bivalent configuration/cell				Mean chiasma/nucleus	Chromosome associations(%)		Mean chromosome/cell	
		Ring		Rod			11II	10II+2I	II	I
		Mean	SE	Mean	SE					
NP(D)95	110	2.69	0.1	8.24	0.1	13.6±0.1	93.6	6.4	10.93	0.12
TNP(D)92	126	2.72	0.1	8.20	0.1	13.5±0.1	92.9	7.1	10.92	0.14
X <sup>2</sup> value at 1 df		0.01		0.07		0.09			0.01	0.17
P value of X <sup>2</sup> test of heterogeneity		0.90		<0.80		<0.80			0.90	<0.90

## CONCLUSION

The cytogenetical data obtained from mitotic and meiotic chromosome analyses of two cultivars of *C. sativum* may be helpful for cytological indexing of coriander germplasm. Such indexing of germplasms and their conservation can be significant and may serve as genetic resource for further exploration in crop improvement.

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