Cytomorphological Studies in Two Autotriploids of *Capsicum annuum* L.

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Production of polyploids is of immense value in plant breeding since they are considered to be one of the sources of variation and thus helps in evolution. Both induced and naturally occurring triploids were recorded earlier in *Capsicum*. (Pal and Ramanujam 1939, Kormos 1954, Chennaveeraiah and Habit 1973, Nishiyama and Karasawa 1954, Ohta 1962). The present investigation pertains to cytomorphological study of the two autotriploids obtained for the first time in the progeny of intraspecific hybrids of a male sterile line with two varieties of *Capsicum annuum* L.

Materials and methods

Two triploids isolated in the F_1 hybrid progeny of Male sterile $\times$ Cluster (Triploid-1) and Male sterile $\times$ Santaka (Triploid-2) respectively constituted the material of the present investigation. For meiotic studies young flower buds were fixed in 1:3 acetic alcohol mixture. After 24 hours the material was transferred to 70% alcohol and stored in a refrigerator. Acetocarmine squash technique was employed for making meiotic preparations. Pollen fertility was estimated by using 4% iodine-potassium iodide solution. Densely filled and darkly stained, round pollen grains were considered as fertile and lightly stained, shrivelled as sterile.

Observations

a. *Morphology*: Morphometrics of the triploids, sibling hybrids and their parents are given in Table 1. Both the triploids were highly vigorous and taller with good spread than the sibling hybrids and their parents (Figs. 1, 2). However, there was no significant change in leaf and flower size. Fruit and seed number as well as their size were remarkably reduced. Pollen fertility was also highly reduced (Table 1).

b. *Meiosis*: Cytological analysis revealed the triploid chromosome number of $2n=36$ (Fig. 5). The meiotic behaviour of these two, exhibited differences in the frequency of chromosome associations (Table 2), average number of chiasmata, univalents, segregation of chromosomes at anaphase I and pollen fertility. In Triploid-1, the maximum chromosome association was a quadrivalent, while in the second triploid, an association of six chromosomes was observed (Fig. 5). The most frequently encountered association in both was a trivalent (Table 2, Figs. 5, 6), the number of which varied from 3–6 in Triploid-1 and 3–7 in Triploid-2 per cell. Bivalents were observed 6.77 per cell in Triploid-1 and 6.36 in Triploid-2. Univalents were present in both (Figs. 5, 6) 3–13 in Triploid-1 with a mean of 7.93, and 4–11 in Triploid-2 with a mean of 7.86 per cell. Average number of chiasmata per cell was 21.83 and 20.44 respectively.

Anaphase I was highly irregular in the two triploids with a number of lagging chromosomes (2–11) (Table 3). A maximum of 11 chromosomes were found to be lagging which organize into different groups as a consequence of which telophase II was also highly abnormal with the

Table 1. Comparative morphology of the two triploids, their sibling hybrids and parents

Character	Male sterile	Triploid-1	Triploid-2	Sibling hybrids		Cluster	Santaka
				Ms × Cluster	Ms × Santaka		
Plant height (cm.)	92.0	97.67	133.0	61.8	59.6	39.6	61.0
Plant spread (cm.)	122.5	90.0	209.0	108.0	119.0	59.6	113.0
Number of branches	258.0	56.0	155.0	57.0	59.0	29.0	56.0
Leaf length (cm.)	3.46	3.65	6.1	5.34	6.02	4.18	6.2
Leaf breadth (cm.)	1.68	2.09	3.44	2.74	3.04	2.44	3.42
Colour of the leaf	thick green	green	green	green	green	green	green
Flower length (cm.)	1.40	1.30	1.44	1.35	1.35	1.59	1.30
Flower breadth (cm.)	2.10	1.63	2.04	2.00	2.00	2.22	2.00
Anther colour	modified as corolla	bluish green	bluish green	bluish green	bluish green	bluish green	bluish green
Calyx shape	cup	cup	cup	cup	cup	cup	cup
Petal length (cm.)	1.10	0.90	1.10	0.90	1.00	1.20	1.00
Petal breadth (cm.)	0.60	0.48	0.50	0.50	0.50	0.60	0.56
Corolla colour	white	white	white	white	white	white	white
No. of fruits per plant	—	12.0	17.0	66.0	134.0	23.0	99.0
Fruit length (cm.)	—	4.70	5.20	7.46	7.92	5.86	5.62
Fruit girth (cm.)	—	2.22	2.46	3.70	3.82	2.92	3.45
Fruit colour (mature)	—	thick red	red	red	red	red	red
Number of seeds per fruit	—	5.0	6.0	62.0	61.0	27.0	53.0
Fruit disposition	pendent	pendent	pendent	pendent	pendent	erect	terect
Pollen fertility (%)	—	26.13	49.14	96.64	86.36	96.62	96.00

formation of as many as 4–8 nuclei and 1–10 micronuclei in Triploid-1 and 5–10 nuclei and 1–6 micronuclei in Triploid-2 (Figs. 7, 8).

Discussion

The occurrence of triploids in the intervarietal hybrid progeny was hitherto unknown in the genus *Capsicum*. However, in the present investigation, two triploids were recorded for

Figs. 1–4. Plant and fruit photographs of Triploid-1 and-2. 1, Triploid-2. 2, Triploid-1. 3, fruits of diploid hybrid and Triploid-2. 4, fruits of diploid hybrid and Triploid-1.

the first time in the progeny of the hybrids *Ms* × *Cluster* and *Ms* × *Santaka*. A feature of particular interest to note is that both the triploids were obtained in the hybrid progeny where the male sterile is the pistillate parent. Besides these two, three more triploids were screened by Nalini Kumari (1986) in our laboratory in the progeny of varietal crosses with the same

male sterile line. These observations in conjunction with those of Nalini Kumari (1986) are suggestive of the production of viable unreduced gametes in the male sterile line employed.

Table 2. Chromosome associations in the two triploids at diakinesis

Type of association	Triploid-1		Triploid-2	
	Number of cells	Percentage	Number of cells	Percentage
1 IV+4 III+6 II+ 8 I	1	3.33	1	2
1 IV+4 III+5 II+10 I	2	6.67	1	2
6 III+7 II+ 4 I	1	3.33	5	10
6 III+6 II+ 6 I	2	6.67	2	4
6 III+5 II+ 8 I	2	6.67	8	16
5 III+6 II+ 9 I	2	6.67	10	20
4 III+8 II+ 8 I	3	10.00	3	6
4 III+7 II+10 I	3	10.00	6	12
3 III+8 II+11 I	2	6.67	1	2
1 IV+5 III+5 II+ 7 I	1	3.33	—	—
1 IV+5 III+4 II+ 9 I	1	3.33	—	—
1 IV+3 III+7 II+ 9 I	2	6.67	—	—
5 III+9 II+ 3 I	2	6.67	—	—
5 III+8 II+ 5 I	2	6.67	—	—
5 III+7 II+ 7 I	3	10.00	—	—
3 III+7 II+13 I	1	3.33	—	—
1 VI+1 IV+4 III+5 II+ 4 I	—	—	1	2
7 III+4 II+ 7 I	—	—	1	2
5 III+7 II+ 7 I	—	—	7	14
5 III+5 II+11 I	—	—	2	4
4 III+9 II+ 6 I	—	—	2	4

Table 3. Data on anaphase I distribution in the two triploids

Segregation	Triploid-1		Triploid-2	
	Number of cells	Percentage	Number of cells	Percentage
13: 12+11 L	4	6.67	4	5.71
14: 11+11 L	2	3.33	2	2.86
13: 13+10 L	1	1.67	4	5.71
14: 12+10 L	2	3.33	5	7.14
14: 13+ 9 L	5	8.33	7	10.00
14: 14+ 8 L	5	8.33	6	8.57
15: 13+ 8 L	7	11.67	7	10.00
15: 14+ 7 L	10	16.67	8	11.43
16: 13+ 7 L	3	5.00	2	2.86
16: 14+ 6 L	5	8.34	6	8.57
15: 15+ 6 L	3	5.00	2	2.86
16: 15+ 5 L	7	11.67	8	11.43
16: 16+ 4 L	3	5.00	5	7.14
17: 15+ 4 L	2	3.33	2	2.86
17: 16+ 3 L	1	1.67	1	1.43
17: 17+ 2 L	—	—	1	1.43

L=Laggards

Triploids generally arise by crossing tetraploids with diploids or due to fertilization of a haploid egg by two male gametes. They may also originate as an offspring from diploid parents by the union of an unreduced diploid gamete with a normal gamete. In the present case, the

unreduced gamete might have been contributed by the pistillate male sterile parent and its subsequent fusion with a normal male gamete could have resulted in triploidy.

Polyploids generally exhibit enhanced size in different characters such as height, cell size, stomata etc, but here only plant height has been increased while there was reduction in the number of fruits per plant, number of seeds per fruit and pollen fertility. Thus triploidy does not seem to be the optimum level of ploidy in *Capsicum*.

Figs. 5-8. Meiotic stages in Triploid-1 and 2, 5, Triploid-2, diakinesis with 1 VI+1 IV+2 III+10 II, $\times 2400$, 6, Triploid-2, metaphase-I showing stickiness of chromosomes, $\times 2500$, 7, telophase I and II cells with 3 and 5 micronuclei respectively in Triploid-1. $\times 2200$, 8, telophase II showing 5 nuclei and several micronuclei in Triploid-1. $\times 2750$.

Because of the presence of large number of univalents and less number of trivalents encountered, the triploids can be considered as segmental autotriploids. The differences observed in the cytomorphology were due to the absence of uniform genetic background, which is evidenced by the involvement of two different male parents in the origin of the two triploids. The occurrence of higher associations such as hexavalents and quadrivalents is indicative of the

presence of structural alterations. The triploids will serve as a good source of aneuploids which are of immense value in genetic experiments.

Summary

Two autotriploids were isolated in the F_1 hybrid progeny of $Ms \times Cluster$ and $Ms \times Santaka$. Triploids exhibited increased vigour in plant height and spread with no marked change in leaf and flower size. Fruits were few in number and small in size with very poor seed set. Trivalents ranged in number from 3–7 per cell. High frequency of univalents and bivalents along with a few trivalents and occasional presence of hexavalents and quadrivalents indicated that the plants are segmental autotriploids with some structural alterations. The triploids might have originated by the fusion of the unreduced gametes produced in the male sterile line with normal male gametes. The difference observed in the two triploids in cytomorphological features can be ascribed to the absence of uniform genetic background.

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