Tertiary Trisomics in Pea (*Pisum sativum*)

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Tertiary trisomics have been reported in a wide range of plants, such as, corn, barley, tomato and rye etc. and have been also effectively used, among others, in hybrid seed production in a few crops (Khush and Rick 1967, Ramage 1965, and others). Remarkably, only a few preliminary reports on tertiary trisomy in pea are available (Müller 1975, Sutton 1939). The present communication deals with the isolation and cytomorphological characterisation of five tertiary trisomics.

Materials and methods

Seeds of pea (*Pisum sativum*) of different interchange heterozygotes were raised in M_3 generation. Initially these interchanges were induced through 10 KR gamma-irradiation of the F_1 seeds originating from a 9×9 diallel cross involving diverse parents. The off-type plants were marked and subjected to chromosome study at MI and AI. For cytological study, PMCs were collected in acetic-alcohol (1 : 3) and squeezed in a drop of 2% aceto-carmin. Pollen sterility was studied by using 2% iodine-potassium iodide solution.

Results

The frequency of tertiary trisomics, among other aneuploids, was 0.21% (5 plants out of 2492 seeds sown). They were present in populations arising from the crosses $T163 \times 5806-S$ (2, 0.975%), $T163 \times DA$ (2, 0.362%) and $46C \times PI280064$ (1, 0.333%), while remaining crosses derived from a 9×9 diallel set did not yield any tertiary trisomic.

Five tertiary trisomics, distinguishable from their corresponding siblings, were morphologically characterised in the following four groups (Figs. 1-4).

1. L332-2 ($T163 \times 5806-S-2-2-2-2$): This mutant was dwarf with slender stem, small stipule and leaflets. The distance between stipule and first leaflet was highly enlarged. It flowered late by 12 days.
2. i. L284-1 ($T163 \times 5806-S-1-14-5-1$):
ii. L324-3 ($T163 \times DA-2-12-2-3$):

Both the trisomics had succulent stem with round stipule and leaflets.

3. L307-1 ($T163 \times DA-1-5-3-1$): It had succulent stem with highly enlarged internode. Stipule and leaflets were small, round and greenish dark in colour. The distance between stipule and 1st leaflet was enlarged. Flowering was late by 19 days.

4. L350-1 (PI280064 $\times$ 46C-1-1-1-1): This plant was semidwarf and slender stem with small and erect stipule and leaflets.

Chromosome configurations at MI and AI in tertiary trisomics are given in Figs. 5-8 and Table 1. On an average, the tertiary trisomics showed 38.4% cells

Figs. 1-8. 1-4: Leaves of four tertiary trisomics (left) and their corresponding control (right) of pea. 1, L332-2. 2, L284-1. 3, L307-1. 4, L350-1. 5-8: Chromosome configuration in tertiary trisomics of pea. 5, metaphase I, 1V+5II. 6, metaphase I, 1III+6II. 7, metaphase I, 7II+1I. 8, anaphase I, 8: 7 disjunction.

with pentavalent ranging from 32.0 (L284-1 and L350-1) to 48.0 (L324-3) per cent. The modal configuration was $1\text{III}+6\text{II}$ (50.0% cells). At AI, 8-7 distribution was in excess (66.7%) ranging from 53.3 (L307-1) to 80.0 (L284-1) per cent cells. Only 17.8% cells showed laggards.

Tertiary trisomics accounted about 45.0 per cent pollen fertility ranging from 30.4 (L350-1) to 67.0 (L324-3) per cent. Seed fertility was very poor. Seed yield ranged from nil to 4 seeds per plant; two trisomics (L332-2 and L350-1) failed to produce any seed.

Discussion

Trisomics occur in the progeny of interchange heterozygote as a result of 3 : 1 disjunction of the configuration of 4 chromosomes at AI resulting in the formation of $n+1$ gametes (Burnham 1962, Ramage 1960; and others). The $n+1$ gametes having two normal chromosomes plus one extra interchanged chromosome upon fertilization with n pollen produce tertiary trisomic.

Tertiary trisomics showed wide range of variations in morphophysiological traits as compared to diploid sibs, which indicated that each of the four types of tertiary trisomics probably had different extra chromosome.

Although, size and shape of stipules and leaflets were appeared to be characteristic feature, none of the characters was found to be quite effective in distinguishing between the different types of tertiary trisomics.

The frequencies of the different associations at MI, obviously depend upon the length of the chromosomes involved, the duplicated segments and the chiasma frequency. The distinguishing configuration in tertiary trisomic is a pentavalent. Data presented in Table 1 clearly indicated the high frequencies of cells with $1\text{V}+5\text{II}$ (38.4%) and $1\text{III}+6\text{II}$ (50.0%) configurations in tertiary trisomics as also observed in tomato (Khush and Rick 1967). In general, the extra chromosomes with two long arms tended to form pentavalent at higher frequency than the ones with two short arms, while those which one long and one short arm tended to have intermediate frequencies (Khush 1973).

Fertility of tertiary trisomics, as judged in terms of seed production, was very poor even though they displayed pollen fertility ranging from 34.6 to 67.0%. The high or complete sterility of trisomics was ascribed to imbalance between aneuploid and euploid cells, in addition to trisomy and interchange heterozygosity (Das and Srivastava 1969). Thus, the seed sterility in the tertiary trisomy was evidently due to the presence of an extra chromosome. It might be also noted that none of the parental interchanges analysed in this laboratory (Kumar, personal communication) showed such a high seed sterility. Since tertiary trisomics did not produce adequate seeds, further studies on them could not be undertaken.

Summary

Five tertiary trisomics, isolated in the progenies of interchange heterozygotes, were morphologically classified into four groups. They might be named as slender,

Table 1. Meiotic behaviour of certain tertiary trisomics isolated in M_3/F_3 generation of certain interchanges (F_1 seeds of intervarietal crosses irradiated with 10KR gamma-ray)

Particulars/ pedigree	Chromosome configuration at MI (per cell)						Chromosome behaviour at AI (%)		
	IV+5II	1C ₄ +5II+1I	1III+6II	1III+5II+2I	7II+1I	6II+3I	Disjunction		Laggards
							Normal (8-7)	Aberrant	
L332-2	40.0	0.0	44.0	0.0	8.0	8.0	73.3	6.7	20.0
L284-1	32.0	2.0	66.0	0.0	0.0	0.0	80.0	6.6	13.4
L324-3	48.0	0.0	44.0	4.0	4.0	0.0	66.7	26.7	26.6
L307-1	40.0	0.0	44.0	4.0	8.0	4.0	53.3	20.0	26.7
L350-1	32.0	0.0	52.0	4.0	8.0	4.0	60.0	20.0	20.0
Average	38.4	0.4	50.0	2.4	5.6	3.2	66.7	16.0	17.3

succulent, enlarged internode and small-erect stipule, respectively. At MI, characteristic pentavalent configuration was accounted in 38.4% cells; the modal configuration was 1III+6II (50.0%). At AI, 7-8 disjunction was about 66.7%. Pollen fertility ranged from 30.4 to 67.0%, while seed yield was very poor, ranging from 0-4 seeds per plant.

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