Meiosis in Allotetraploid of *Vigna mungo* × *V. umbellata* Cross¹

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In the genus *Vigna* subgenus *Ceratotropis* induced allopolyploids were studied in crosses of *V. radiata* with *V. mungo*, *V. trilobata* and *V. umbellata*; in *V. mungo* × *V. glabrescens* (synonym: tetraploid *Phaseolus* species) cross, in *V. aconitifolia* × *V. trilobata* cross and in *V. glabrescens* × *V. umbellata* cross (Dana 1966a, b, c, 1968, Biswas and Dana 1976a, b, Chowdhury and Chowdhury 1974). Complete seed sterility was reported in the F₁ of *V. mungo* × *V. umbellata* species cross (Biswas and Dana 1975). The present communication reports the fertility restoration and meiosis in the allotetraploid of *V. mungo* × *V. umbellata* cross.

Materials and methods

The allotetraploids of *V. mungo* (var. T. 9) × *V. umbellata* (var. EC 18183) induced by Biswas and Dana (1975) were used in the present study. The technique of pollen fertility determination and meiotic preparations used were same as reported by Dana (1966a).

Observations

The allotetraploid plants resembled the male parent *V. umbellata* in hypogeal nature of germination, spreading and semiperennial growth habit and slightly lomented surface of mature pods. In colours of petiole, pod and seed coat they were distinct from the parents. In rest of the characters studied they were similar to the female parent. The allotetraploid plants were vigorous than the parents in many vegetative characters (Table 1). The pod and seed characters of the allotetraploid were reported by Biswas and Dana (1975).

The pollen fertility of the allotetraploids was slightly lower (81.2%) than the parents (97.2% to 98.5%) but they had bigger pollen grains (54.5 μ diameter against 39.8 to 43.2 μ in the parents). The number of seeds per pod in the allotetraploid was very low though the number of ovules per ovary was intermediate between the parents (Table 1).

Meiosis was fairly regular in the allotetraploid plants (2n=44). Pairing of all the 44 chromosomes were observed in majority of the cells at diakinesis (79.2% out of a total of 94) and MI (89.9% out of a total of 48) stages. Complete (22) bivalent formation was noted in 70.6% and 78.5% cells respectively at diakinesis and MI stages (Fig. 1). One quadrivalent was observed in 8.6% cells at diakinesis and 11.4% cells at MI (Fig. 2). Univalents (range 2 to 6) were observed in 22.4% and 12.4% cells respectively at diakinesis at MI stages (Fig. 3). The average chromosome association per cell at diakinesis and at MI stages were respectively 0.08 (range 0–1) IV+21.53 (19–22) II+0.60 (0–6) I and 0.11 (range 0–1) IV+21.62 (18–22) II+0.30 (0–4) I.

Out of 74 cells analysed at AI-TI 59.5% cells showed normal (22/22) separation (Fig. 4).

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Unequal separation was noted in 10.8% cells. Laggards (1 to 5) were noted in 29.8% cells (Fig. 5). At AII-TII, out of a total of 30 cells analysed, 66.6% cells showed normal separation. Laggards (1 to 3) were noted in 33.3% cells. Multipolar spindles were also noted in a few cells (Fig. 6).

Discussion

The F_1 hybrid of *V. mungo* $\times$ *V. umbellata* cross was completely seed sterile and had very low (0.66%) pollen fertility (Biswas and Dana 1975). The average chromosome association per cell in the F_1 was reported as 0.05 IV (range 0-1)+4.24 II (0-7)+13.32 I (8-20). Sterility in this hybrid was ascribed to highly irregular meiosis. In the presently studied allotetraploid,

Table 1. Quantitative characters of allotetraploid and parents

Character	<i>V. mungo</i> Female parent	<i>V. umbellata</i> Male parent	Allotetraploid
Primary leaf			
Length	4.64* $\pm$ 0.06	4.85 $\pm$ 0.15	5.40 $\pm$ 0.04
Breadth	1.81 $\pm$ 0.02	1.48 $\pm$ 0.04	1.38 $\pm$ 0.01
Trifoliate leaf (Fifth)			
Petiole length	8.52 $\pm$ 0.14	8.36 $\pm$ 0.23	9.05 $\pm$ 0.24
Stipule			
Length	1.00 $\pm$ 0.02	0.90 $\pm$ 0.01	1.18 $\pm$ 0.02
Breadth	0.40 $\pm$ 0.01	0.31 $\pm$ 0.01	0.39 $\pm$ 0.01
Terminal leaflet			
Length	7.63 $\pm$ 0.03	5.66 $\pm$ 0.06	7.48 $\pm$ 0.10
Breadth	5.02 $\pm$ 0.04	4.41 $\pm$ 0.04	4.63 $\pm$ 0.10
Lateral leaflet			
Length	6.56 $\pm$ 0.07	5.42 $\pm$ 0.12	6.87 $\pm$ 0.09
Breadth	4.43 $\pm$ 0.03	4.09 $\pm$ 0.09	4.17 $\pm$ 0.11
Ovule/ovary	6.40 $\pm$ 0.02	8.25 $\pm$ 0.02	7.40 $\pm$ 0.02
Pod length	4.18 $\pm$ 0.03	7.07 $\pm$ 0.13	3.78 $\pm$ 0.07
Seed			
Length	0.43 $\pm$ 0.01	0.56 $\pm$ 0.01	0.46 $\pm$ 0.01
Breadth	0.32 $\pm$ 0.01	0.28 $\pm$ 0.01	0.31 $\pm$ 0.02
Number/pod	6.60 $\pm$ 0.01	8.10 $\pm$ 0.03	2.80 $\pm$ 0.02
Diameter of stained pollen (μ)	43.20 $\pm$ 0.16	39.85 $\pm$ 0.12	54.50 $\pm$ 0.17

* in cm

pollen fertility has increased to 81.2% and the plants have become seed fertile. During meiosis, complete bivalent (22) formation was observed in majority (70.6% to 78.5%) of the cells. Fertility improvement of the allotetraploid over the F_1 hybrid is evidently due to regularity in bivalent formation. The quadrivalent frequency per cell in the allotetraploid was very low (0.08 to 0.11) as compared to that of the autotetraploids of *V. mungo* (var. T. 9) where 1.83 quadrivalents per cell were noted by Sen and Chheda (1958). The lower quadrivalent frequency indicates the occurrence of preferential pairing which in turn suggests the presence of structural differentiation in parental chromosomes. Segregational nature of hybrid sterility and preferential pairing in the allopolyploid has also been reported in all the partially or completely sterile species crosses of *Vigna* subgenus *Ceratotropis* (Dana 1966a, b, c, 1968, Biswas and Dana 1976 a, b, Chowdhury and Chowdhury 1974). It has been concluded that fertility improvement in the present allotetraploid is due to more regular meiosis than in the F_1 hybrid.

Summary

Allotetraploids of *Vigna mungo* × *V. umbellata* species cross had 81.2% pollen fertility and produced many viable seeds. The average chromosome association per cell at diakinesis and at MI in them were respectively $0.08 \text{ IV} + 21.53 \text{ II} + 0.60 \text{ I}$ and $0.11 \text{ IV} + 21.62 \text{ II} + 0.30 \text{ I}$. Fertility improvement in this allotetraploid was due to more regular meiosis. Preferential pairing in the allotetraploid was evident from the low frequency of quadrivalent formation.

Figs. 1-6. Photomicrographs of meiosis in allotetraploid of *V. mungo* × *V. umbellata* cross. 1, 22II in MI ($\times 1200$, ($\leftarrow$) overlapping bivalents). 2, 11V ($\leftarrow$) + 19II + 2I ($\leftarrow$) in MI ($\times 1200$). 3, 20II + 4I ($\leftarrow$) in MI ($\times 1200$). 4, 22-22 separation in AI ($\times 1800$). 5, a laggard in TI ($\times 900$). 6, Multipolar spindle in AII ($\times 900$).

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