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# CROSSABILITY AND ENDOSPERM DEVELOPMENT IN RECIPROCAL HYBRIDS OF OCTOPLOID TRITICALE WITH DURUM WHEAT

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## ABSTRACT

Four newly synthesized octoploid triticales were crossed with three durum wheats reciprocally to study the crossability and endosperm development. Crossability was expressed as % seed-set and data on endosperm development were recorded at different days after pollination (DAP). Overall crossability was relatively higher when durum wheat was used as the maternal parent. Development of endosperm was normal in octoploid triticale × durum wheat crosses. However, in reciprocals endosperm degenerated between 16-19 DAP. Pronounced disturbance in embryo : endosperm chromosome ratio and the tetraploid cytoplasmic background of hybrids seem to be the probable causes of the degeneration of endosperm in durum wheat × octoploid triticale hybrids.

**Key Words :** Durum wheat, octoploid triticale, crossability, endosperm development, cytoplasmic effect.

Among various alien species of wheat, rye (*Secale cereale*) is the most important because of its greater tolerance to drought and cold, acid soils, resistance to several diseases of wheat, higher lysine content, higher P- and Cu- uptake efficiency, large number of spikelets and longer grains. However, the addition of complete genome of rye into wheat for synethesizing triticale (*Triticosecale* Wittmack) at different ploidy levels leads to some reproductive disorders in the amphiploids, e.g., meiotic instability, aneuploidy, partial sterility, grain shriveling etc. [1]. Nevertheless, following triticale × Wheat hybridization at different ploidy levels (6x wheat × 6x triticale and 4x wheat × 8x triticale), useful genetic material of rye can be incorporated into wheat through chromosomal substitutions [2], Robertsonian translocations [3, 4] and genetic recombination [4].

Poor crossability and hybrid seed development are the major bottlenecks to the successful transfer of desirable genes from wild and other alien species into wheat (*Triticum spp.*). Before taking up any hybridization programme, it is important to know crossability and relative success in a particular direction. Although 8x triticale

× 4x wheat crosses have been reported to be more successful than their reciprocals, information on endosperm development which ultimately affects their viability is quite limited [5, 6]. It is particularly important to know the stage(s) at which endosperm degenerates so as to plan rescue of the hybrid embryos at an appropriate stage before their abortion. Keeping this in view, the present study was undertaken to know the crossability and endosperm development of the reciprocal crosses of 4 octoploid triticales with three durum wheats (*Triticum durum* Desf.) in addition to generation of breeding material to transfer rye chromatin into wheat.

## MATERIALS AND METHODS

Four newly synthesized octoploid triticales involving some elite lines of 6x wheat with "PSF" rye, viz, C306 (T), CPAN 1905 (T), CPAN 1767 (T) and CPAN 1922 (T) were reciprocally crossed with three durum wheats namely CPAN 6119, CPAN 6124 and CPAN 6127 during winter 1991-92 and 1992-93 at research farm of Himachal Pradesh Krishi Vishva Vidyalaya, Palampur. In each cultivar about 200 florets were emasculated and pollinated at appropriate stage of stigma receptivity. Crossability was expressed as % seed-set out of the total florets pollinated in each cross. The hybrid nature of these crosses was confirmed from expression of some dominant markers such as dark-purple coleoptile and hairy peduncle. The overall seed-set in 8x triticale × 4x wheat crosses was compared with their reciprocals using Fisher's t' test or Cockran and Cox 't' test depending upon homogeneity of variances.

Atleast 20 developing hybrid caryopses from each of the cross depending upon seed-set were excised from the spike on different days after pollination (DAP), and were dissected under stereo-dissection microscope to study the status of endosperm development. Observations on time taken for the start of endosperm degeneration and its completion were also taken in all 4x wheat × 8x triticale crosses. To know the germination and to advance the breeding material, the resultant hybrid seeds of all the crosses were sown in field.

## RESULTS AND DISCUSSION

Crossability and status of endosperm development in reciprocal hybrids of 4x wheat and 8x triticales are presented in Table 1. Mean crossability over two seasons in twelve 4x wheat × 8x triticale crosses ranged from 15.0 to 41.6% with an average of 25.9%, whereas in their reciprocals it ranged from 0 to 3.2%, with an average of 1.1%. The overall crossability between 4x wheats and 8x triticales was higher when the former was used as maternal parent. Contrary to above, Beva [5, 6] had reported 8x triticales × 4x wheat crosses to be more successful than their reciprocals. These

**Table 1. Crossability and endosperm development in reciprocal hybrids of 3 tetraploid wheats with 4 octoploid triticales**

| Cross | Per cent seed set | | | Endosperm development |
|---|---|---|---|---|
| | 1991-92 | 1992-93 | Mean | |
| CPAN 6119 × C 306 (T) | 50.0 | 39.6 | 23.2 | Deg.[$] 13-19 DAP[#] |
| C 306 (T) × CPAN 6119 | 2.5 | 0.5 | 1.1 | Normal |
| CPAN 6119 × CPAN 1905 (T) | 18.9 | 28.1 | 25.0 | Deg. 16-19 DAP |
| CPAN 1905 (T) × CPAN 6119 | 0.0 | 0.0 | 0.0 | - |
| CPAN 6119 × CPAN 1676 (T) | 17.0 | 46.4 | 31.9 | Deg. 16-19 DAP |
| CPAN 1676(T) × CPAN 6119 | 0.0 | 0.0 | 0.0 | - |
| CPAN 6119 × CPAN 1992 (T) | 7.8 | 36.2 | 18.7 | Deg. 13-16 DAP |
| CPAN 1992 (T) × CPAN 6119 | 5.3 | 0.0 | 2.8 | Normal |
| CPAN 6124 × C 306 (T) | 15.6 | 27.1 | 19.6 | Deg. 13-16 DAP |
| C 306(T) × CPAN 6124 | 5.9 | 1.3 | 3.0 | Normal |
| CPAN 6124 × CPAN 1905 (T) | 1.8 | 30.8 | 18.2 | Deg. 13-16 DAP |
| CPAN 1905 (T) × CPAN 6124 | 0.0 | 2.2 | 1.3 | Normal |
| CPAN 6124 × CPAN 1676 (T) | 17.3 | 53.8 | 41.6 | Deg. 13-16 DAP |
| CPAN 1676 (T) × CPAN 6124 | 2.6 | 0.0 | 0.8 | Normal |
| CPAN 6124 × CPAN 1992 (T) | 41.0 | 18.3 | 29.3 | Deg. 16-16 DAP |
| CPAN 1992 (T) × CPAN 6124 | 0.0 | 0.0 | 0.0 | - |
| CPAN 6127 × C 306 (T) | 19.4 | 21.2 | 20.2 | Deg. 16-19 DAP |
| C 306 (T) × CPAN 6127 | 0.0 | 2.8 | 1.3 | Normal |
| CPAN 6127 × CPAN 1905 (T) | 15.1 | 43.1 | 26.3 | Deg. 16-19 DAP |
| CPAN 1905 (T) × CPAN 6127 | 0.0 | 4.4 | 2.2 | Normal |
| CPAN 6127 × CPAN 1676 (T) | 16.6 | 58.1 | 40.0 | Deg. 16-19 DAP |
| CPAN 1676 (T) × CPAN 6127 | 0.0 | 0.0 | 0.0 | - |
| CPAN 6127 × CPAN 1992 (T) | 5.0 | 20.0 | 15.0 | Deg. 13-16 DAP |
| CPAN 1992 (T) × CPAN 6127 | 0.0 | 0.0 | 0.0 | - |
| 4x wheat × 8x triticale | | | | |
| Mean ± SE | 18.8*±3.9 | 35.2*±3.8 | 25.9*±2.4 | Deg. |
| 8x triticale × 4x wheat | | | | |
| Mean ± SE | 1.3±0.6 | 0.9±0.4 | 1.1±0.3 | Normal |

$Degenerates between; #Days after pollination; *Significantly higher than reciprocal at $P \leq 0.05$

**Table 2. Weather parameters for the months of February to May during 1991-92 and 1992-93 seasons at Palampur**

| Month/year | Temperature | | Rainfall (mm) | RH (%) | Sunshine hours |
|---|---|---|---|---|---|
| | Max. | Min. | | | |
| February 92 | 15.0 | 4.8 | 194.8 | 49 | 6.6 |
| -do- 93 | 18.5 | 8.7 | 55.5 | 55 | 6.1 |
| March 92 | 19.1 | 9.4 | 155.0 | 50 | 5.4 |
| - do - 93 | 18.4 | 7.8 | 260.0 | 56 | 6.7 |
| April 92 | 24.9 | 13.8 | 41.4 | 55 | 7.6 |
| - do - 93 | 25.6 | 15.3 | 22.0 | 33 | 8.2 |
| May 92 | 28.1 | 17.1 | 71.0 | 58 | 9.1 |
| - do - 93 | 29.7 | 19.2 | 129.4 | 47 | 9.6 |

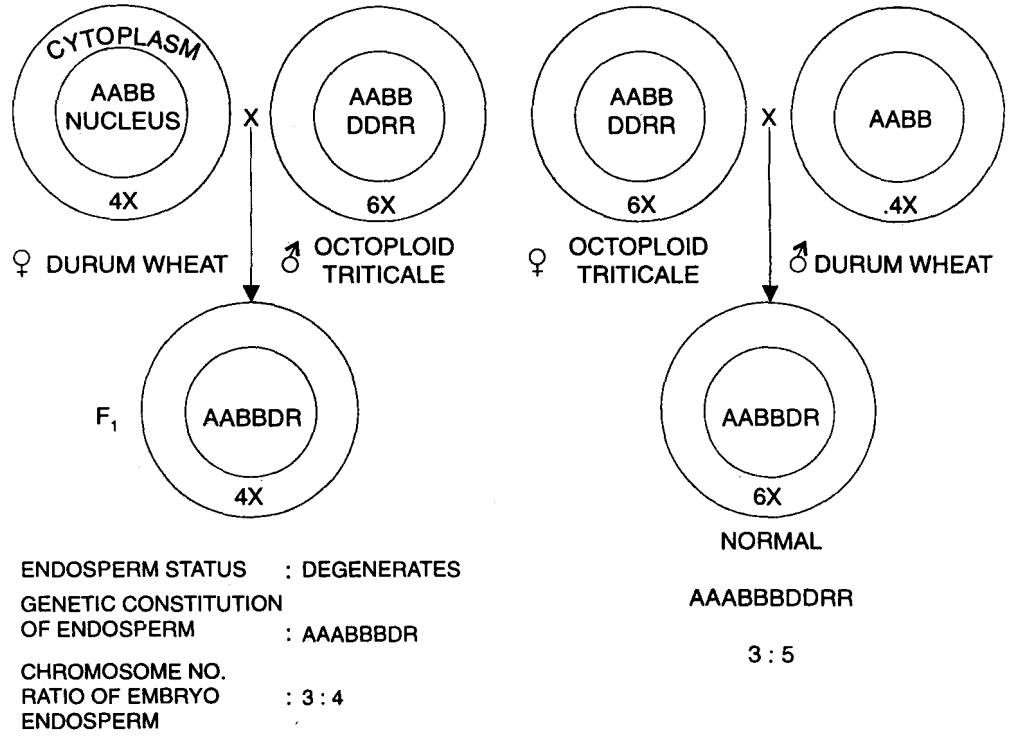


**Fig. 1. Endosperm status, it's genetic constitution and chromosome ratio of emrbyo: endosperm in crosses of durum wheat and octoploid triticales**

contrary results can probably be due to the difference in the triticale parents used in hybridization work as the parents used in the present study were newly synthesized and also had low sterility as compared to earlier studies where parents used were normal and stable. The overall crossability in most of the hybrids was higher in winter 1992-93 as compared to 1991-92 which can be due to effect of environmental factors as has also been reported by Kovtun [7]. During crossing season in February 1993, there was higher temperature and humidity as compared to that in previous season which is more conducive for pollination, restore fertilization and seed-set (Table 2). Additionally, rainfall was high and more frequent during 1991-92 which hampers seed-set and thus crossability.

The development of endosperm in all the 8x triticale × 4x wheat crosses were normal and well-filled hybrid seeds were obtained which germinated well in the field. However, in 4x wheat × 8x triticale hybrids, endosperm development was normal upto 13 DAP and then degenerated between 16-19 DAP in most of the crosses. Some of the hybrid caryopses of these crosses which were left for harvesting at maturity were shrivelled and did not germinate. From the results it can be inferred that 8x triticale × 4x wheat hybrids can produce viable seeds but the embryos of their reciprocals must be rescued *in vitro* before the complete degeneration of endosperm by 16-19 DAP to get hybrid plants. The differences in reciprocal hybrids with respect to endosperm development in the present study can be attributed to disturbed chromosome number ratio of embryo and endosperm from normal (2:3) which arises due to the difference in the ploidy level of parents (8). In this study, the endosperm development was observed to be normal when chromosome numbers in the embryo and endosperm were in the ratio of 3:5 (more close to 2:3) as compared to 3:4 in 4x wheat × 8x triticale hybrids in which endosperm was more shrivelled and embryo aborted more readily (Fig. 1). Besides this, hexaploid cytoplasmic background of hybrids was accompanied by normal endosperm development, whereas in tetraploid cytoplasmic background the endosperm degenerated.

To conclude, the present study indicates the suitability of hybridization of octoploid triticale with durum wheats to transfer the rye chromatin into wheat using former as female parent if embryo rescuing is to be avoided. However, with the facilities of *in vitro* embryo rescuing available, durum wheat should be hybridized as female parent to take the advantage of higher crossability. Degeneration of endosperm in durum wheat × octoploid triticale crosses can be attributed to more pronounced disturbances in embryo : endosperm chromosome ratio and tetraploid cytoplasmic background of hybrid.

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