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Effect of R/D substitutions and/or modified rye chromosomes on kernel characters in triticales

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Abstract

The effect of rye chromosome substitution and modification were studied on various kernel characters in sixty six hexaploid triticales. Triticales with a 2R/2D substitution and/or a modified rye chromosome(s) exhibited 'medium' to 'very low' degree of kernel shrivelling as observed through increased grain weight and volume of water displaced by 100-grains. Triticales with a 2R/2D substitution coupled with a modified rye chromosomes like 4R, 6R or 7R, the seed shrivelling is very low. 2R/2D substitution and modification in the rye chromosomes also had a favourable effect on seed setting. Triticales with full complement of rye chromosomes showed 'medium' to 'high' kernel shrivelling and low seed set.

Key words : Triticale, R/D substitution, modification, kernel characters

Introduction

Secondary hexaploid triticales, resulted from crosses between primary hexaploid triticale x bread wheat, were shown to possess a variety of R/D chromosomes substitutions and modified rye chromosomes. These substitutions and modifications in triticales were shown to affect plant morphology. Reduction of heterochromatin from rye chromosomes due to deletion seem to determine to a large extent the meiotic stability and agronomic characters in triticale. The present communication reports the relationship between the rye chromosome composition (either substitution or modification) on various kernel characters in a number of hexaploid triticales.

Materials and methods

A total of 66 hexaploid triticales were earlier analysed by Giemsa C-banding technique coupled with meiotic analysis in hybrids between triticale × ditelos [1] for their rye chromosome composition. The following grain characters in triticales were recorded following the classifications of Darvey [2], Kaltsikes *et al.* [3] and Bennet [4]. (i) Average seed set - low (below 50%), medium (50-65%), high (above 65%) (ii) 100-grain weight(g) (iii) Volume (ml) of water displaced by 100-grains (after ensuring there was no air bubbles formation) (iv) Kernel shrivelling - very low, low, medium, and high and (v) Test weight (kg/ha).

Results and discussion

The status (rye chromosome composition) and the data recorded on various kernel characters in 66 hexaploid triticales are presented in Table 1. Based on the degree of kernel shrivelling, the triticales were grouped as 'high' shrivelled (14 triticales), 'medium' shrivelled (20), 'low' shrivelled (19), and 'very low' shrivelled (15). Triticales with 'high' kernel shrivelling showed lower values for 100-grain weight, volume of water displaced by 100-grains and test weight. Triticales with 'very low' kernel shrivelling showed higher values of the above parameters. The seed set ranged from 42.68 (Local) to 82.74 (Torrs).

Presence of R/D substitutions and/or modification in rye chromosomes in triticales affect yield and other morphological characters [5, 6]. In the present study, triticales with full complement of rye chromosomes (complete tirticales or triticales with no substitutions) exhibited high kernel shrivelling. Accordingly these triticales also exhibited lower values for 100- grain weight, volume of water displaced by 100-grains and test weight. Complete triticales are expected to contain large amount of heterochromatin compared to triticales with substitutions or modified rye chromosomes. Late replicating segments of heterochromatin present on rye chromosomes cause aberrant nuclei and bridges in coenocytic endosperm, leading to shrivelling in mature grain [4. 7]. Therefore, as expected, the triticales either with a 2R/2D substitution or a modified rye chromosome exhibited medium to very low degree of kernel shrivelling showing medium to higher values for other kernel characters like grain weight and test weight. Favourable effect of 2R/2D substitution on kernel shrivelling was noticed earlier in some spring triticales [4, 8, 9]. In the present study, triticales with a 2R/2D substitution either solo or along with a modified 4R, 6R, 7R also exhibited

Table 1. Status of rye chromosomes and various kernel characters in different hexaploid triticales

Sl. No.	Triticale variety	Rye chromosome status**	Grain shrivelling	100-grain weight	Volume of water displaced by 100-grains	Test weight	Seed set (%)
1	2	3	4	5	6	7	8
1	Adsadik	2D present	Very low	4.00 a	4.40 a	73.00 ab	81.02 a
2	*Bolero	Full	High	2.58 b	2.74 b	50.80 d	49.70 hij
3	*Dargo	Full	High	2.62 b	2.78 b	51.88 d	49.50 hij
4	DT 33	Full	High	2.54 b	2.68 b	50.68 d	48.74 hij
5	DT 35	Full	High	2.54 b	2.66 b	50.74 d	49.46 hij
6	DT 38	Full	High	2.56 b	2.70 b	50.82 d	49.60 hij
7	DT 42	4R modified	Medium	3.10 ab	3.20 ab	66.48 c	52.94 gh
8	DT 43	4R modified	Medium	3.12 ab	3.22 ab	66.56 c	54.62 g
9	DT 51	4R, 6R modified	Low	3.42 ab	3.68 ab	66.68 c	59.52 f
10	DT 52	4R, 6R modified	Low	3.44 ab	3.70 ab	66.74 c	47.62 j
11	DT 54	4R, 6R modified	Low	3.48 ab	3.74 ab	66.86 c	46.18 j
12	DT 55	4R, 6R modified	Low	3.48 ab	3.72 ab	66.92 c	48.40 ij
13	DT 56	4R, 6R modified	Low	3.52 ab	3.76 ab	67.36 c	48.52 ij
14	DT 57	4r, 6R modified	Low	3.64 ab	3.84 ab	67.72 c	47.34 j
15	DT 58	4R, 6R modified	Low	3.70 ab	3.92 a	68.46 c	49.00 hij
16	DT 59	4R, 6R modified	Low	3.78 ab	3.98 a	69.02 bc	48.64 hij
17	DTS 977	2D present, 4R, 6R modified	Very low	3.96 a	4.32 a	72.90 ab	80.68 a
18	DTS 1006	2D present, 4R, 6R modified	Very low	3.98 a	4.36 a	72.94 ab	80.74 a
19	Foton	2D present, 4R, 6R modified	Very low	4.12 a	4.44 a	73.44 a	82.66 a
20	Fundules	2D present 4R modified	Low	3.60 ab	3.88 ab	67.66 c	74.02 bc
21	*Grado	Full	Medium	2.92 ab	2.98 ab	66.12 c	49.10- hij
22	HPT 2	Full	High	2.56 b	2.68 b	50.88 d	50.00 hij
23	HPT 5	Full	High	2.58 b	2.70 b	50.94 d	42.68 j
24	HPT 10	2D present	Medium	3.06 ab	3.08 ab	66.04 c	63.20 e
25	HPT 11	2D present 4R modified	Medium	3.08 ab	3.08 ab	66.42 c	73.08 bcd
26	JNIT 42	Full	High	2.58 b	2.68 b	50.92 d	49.68 hij
27	JNIT 159	Full	Medium	3.00 ab	3.02 ab	66.28 c	49.44 hij
28	JNIT 204	2D present	Medium	3.04 ab	3.06 ab	66.36 c	70.68 b-e
29	JNIT 205	2D present	Medium	3.08 ab	3.18 ab	66.44 c	70.22 cde
30	JNIT 206	2D present	Medium	3.18 ab	3.30 ab	66.68 c	69.84 cde
31	JNIT 207	2D present	Low	3.38 ab	3.60 ab	67.02 c	70.16 cde
32	JNIT 209	2D present, 4R modified	Medium	3.26 ab	3.40 ab	66.92 c	72.68 bcd
33	JNIT 210	2D present, 4R modified	Medium	3.28 ab	3.40 ab	66.98 c	72.72 bcd
34	JNIT 211	2D present, 4R modified	Medium	3.28 ab	3.46 ab	66.96 c	72.68 bcd
35	JNIT 212	2D present, 4R modified	Medium	3.30 ab	3.44 ab	67.02 c	72.89 bcd
36	JNIT 213	2D present, 7R modified	Medium	3.28 ab	3.44 ab	67.00 c	72.90 bcd
37	JNIT 214	2D present, 7R modified	Medium	3.46 ab	67.04 c	72.88 bcd	
38	JNIT 215	2D present, 7R modified	Low	3.46 ab	3.72 ab	67.20 c	73.90 bc
39	*Largo	2D present	Low	3.58 ab	3.74 ab	67.96 c	71.38 b-e
40	*lasko	Full	Medium	3.20 ab	3.34 ab	66.76 c	52.24 ghi
41	Local	Full	High	2.62 b	2.72 b	51.48 d	46.68 j
42	Mex F8	2D present, 4R modified	Low	3.52 ab	3.78 ab	67.20 c	72.40 b-e

Table 1. (Contd.)

Sl. No.	Triticale variety	Rye chromosome status**	Grain shrivelling	100-grain weight	Volume of water displaced by 100-grains	Test weight	Seed set (%)
1	2	3	4	5	6	7	8
43	Ningadin	2D present, 4R, 6R modified	Very low	4.08 a	4.40 a	73.18 ab	812.48 a
44	Okla F5	2D present 4R modified	Low	3.54 ab	3.82 ab	67.26 c	73.28 bcd
45	Plovidin	2D present	Low	3.48 ab	3.80 ab	67.28 c	71.06 b-e
46	*Salvo	Full	Medium	3.18 ab	3.36 ab	66.70 c	50.00 hij
47	6TB 227	2D present, 6R modified	Low	3.46 ab	3.78 ab	67.16 c	74.20 bc
48	TL 2595	Full	High	2.54 b	2.60 b	51.00 d	49.76 hij
49	TL 2706	5R modified	High	2.56 b	2.68 b	51.00 d	48.44 ij
50	TL 2709	3R modified	High	2.58 b	2.70 b	51.04 d	48.68 hij
51	TL 2734	2D present, 4R modified	Medium	3.24 ab	3.38 ab	66.88 c	73.26 bcd
53	TL 2758	2D present, 4R, 6R modified	Very low	3.96 a	4.02 a	72.86 ab	80.00 a
54	TL 2768	2D present ,7R modified	Low	3.44 ab	3.70 ab	67.14 c	72.76 bcd
55	TL 2774	2D present, 4R, 6R modified	Very low	3.96 a	4.30 a	72.88 ab	80.08 a
56	TL 2786	2D present 4R, 6R modified	Very low	3.98 a	4.34 a	72.92 ab	80.10 a
57	TL 2790	2D present, 4R, 6R modified	Very low	3.98 a	4.36 a	72.90 ab	80.28 a
58	RL 2796	2D present, 6R, 7R modified	Very low	3.98 a	4.38 a	72.92 ab	81.14 a
59	TL 2799	2D present, 6R, 7R modified	Very low	4.00 a	4.38 a	72.94 ab	81.22 a
60	TL 2800	2D present, 6R, 7R modified	Very low	4.02 a	4.40 a	72.92 ab	81.40 a
61	TL 2801	2D present, 6R, 7R modified	Very low	4.04 a	4.40 a	72.96 ab	81.38 a
62	Torrs	2D present	Very low	4.10 a	4.44 a	73.26 ab	82.74 a
63	T-340	4R,6R modified	Low	3.38 ab	3.62 ab	66.22 c	74.68 b
64	UPT 74	2D present	Medium	2.80 b	2.86 b	65.90 c	69.40 de
65	Warren	2D present, 6R, 7R modified	Very low	3.98 a	4.36 a	72.96 ab	82.08 a
66	Weldeala	2D pesent, 7R modified	Low	3.48 ab	3.80 ab	66.90c	73.26 bcd

* = Winter triticales; ** = 2D present (2R replaced by 2D chromosome); Full = All 14 rye chromosomes are present; 4R/5R/6R/7R modified = Heterochromatin from these rye chromosomes were reduced or deleted. In each column, means followed by a common letter are not significantly different at 5% level by DMRT

low to very low degree of kernel shrivelling. High degree of kernel shrivelling with lower values for other kernel characters were noticed when 3R or 5R was modified.

Complete triticales had low seed set (below 50%), while in the triticales with a single 2R/2D substitution the seed set was high. Favourable effect of modified rye chromosomes on seed set was also evident from the fact that triticales with a modified 4R, 6R or 7R, the seed set was high. The seed set was considerably high when 2R/2D substitution was present along with a modified rye chromosome. High seed set in triticales with 2R/2D substitution was attributed to presence of fertility genes on 2D [10]. Hulgenhof and Schlegel [11] observed that in advanced lines of hexaploid triticales, homozygous deletion of telomeric heterochromatin from one or more of rye chromosomes were associated with improvement in meiotic stability compared to that found in normal/heterozygous for heterochromatin deletion. Improved meiotic stability may reduce the aneuploidy formation and increase the seed set. Triticale lines selected for kernel plumpness, seed fertility and earliness were shown to contain reduced amounts of rye telomeric heterochromatin [12].

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