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CHARACTERIZATION OF TRANSLOCATION OF RYE STRAINS WITH *DASYPYRUM VILLOSUM* (CRIMEA, UKRAINE)

ABSTRACT

The aim of study was to obtain rye strains of elevated total protein content and 1000–kernel weight with shorter and more rigid stalk comparing to standard cv. Amilo Translocation rye strains created due to distant crossbreeding of cv. Amilo (2n=RR=14) with wild form of *Dasypyrum villosum* (Crimea, Ukraine) (2n=VV=14) using *in vitro* cultures were study objects. F_2 hybrids were three times back–crossed using parental rye pollen and then twice and three times self–pollinated (B_3/F_2 and B_3/F_3), study were sown in a micro–experiment in Laski on a good rye soil complex (ph 6.6) during 1998/1999 (98 strains) and 1999/2000 (123 strains) vegetation seasons. Strains under study were characterized with higher trait differentiation in the first year than the second. They usually headed 4–5 days after standard, although 5 strains among 98 ones studied in the first year and 9 strains among 123 ones in the second headed two days earlier. Comparing to standard, plants height was lower even by 20°cm in both years and their uniformity was usually higher, up to 3.0° and 3.8° respec–tively. Plant's lodging was comparable to cv. Amilo at earlier generation; it increased to 1.8° above standard at the following one. Mean 1000–kernel weight of the standard was 36.8 g and 38.7 g, respec–tively in both years of study; however, it equaled 31.2–47.6 g and 33.8–41.6 g for strains. Only those strains exceeded cv. Amilo referring to protein content (N × 6.25) were selected (0.4–2.6% and 0.1–1.8%, respectively for years of study). Yielding, weight of hectoliter and sedimentation index that were below standard variety should be improved. Generally, better results were obtained in the second year, in which one strain yielded even by 2.8% higher than the standard. Strains selected for further breeding were less infected with black stem rust (up to +1.6°) than a standard rye variety. Selection co–efficient amounted 31% and 21%, respectively in the first and second year of study.

Key words: Dasypyrum villosum, *Haynaldia villosa*, quantitatve traits, *Secale cereale*

INTRODUCTION

A growing interest in creation of hybrids of cultivated plants related with the wild species has been lately observed. These wild species can be a valuable source of genes which by crossbreeding can be transferred into crops and achieve a needed initial material for plant breeding (Słaboński 1969, Frederiksen and Bothmer 1991). *Dasypyrum villosum* (*Haynaldia*

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villosa L.) is a wild, allogamous, Mediterranean *Triticeae* annual plant with 2n=VV=14 chromosomes. Its kernels are characterized by high storage protein content and resistance to some cereal diseases, drought and freezing (Linde–Laursen 1991, Qualset *et al.* 1993, Zhong and Qualset 1993). *Dasypyrum villosum* has been successfully crossbred with various forms of *Triticum* genus (Pace and Delve 1993, Chen *et al.* 1995, 1996). Łapiński obtained first tetraploid hybrids with diploid rye (Łapiński and Gruszecka 1997), and Gruszecka (1997) created *in vitro* cultures of diploid forms that can be directly used as initial material for rye breeding.

The aim of our present study was to obtain rye strains of elevated total protein content and 1000–kernel weight with a shorter and more rigid stalk than a standard parental rye cv. Amilo.

MATERIAL AND METHODS

Translocation rye strains created by distant crossbreeding of Amilo cv. (2n=RR=14) with wild form of *Dasypyrum villosum* (Crimea, Ukraine) (2n=VV=14) using *in vitro* cultures (Gruszecka 1997) were the objects of breeding programme (Fig. 1 and 2). F_2 hybrids were three times back–crossed using parental rye pollen and then twice and three times self–pollinated (B_3/F_2 and B_3/F_3), study were sown in a micro–experiment in Laski on a good rye complex soil (pH 6.6) during 1998/1999 (98 strains) and 1999/2000 (123 strains) vegetation seasons. Fertilization included: N – 86 kg × ha^{-1}, NPK – 254 kg × ha^{-1} with mustard as a forecrop. Micro–experiments were established by means of model method with interpolated standard rye cv. Amilo sown each 5^{th} plot. Each plot was of 0.6 m^2 with 180 kernels sown per plot at 20 × 2.5 cm spacing. Three traits (uniformity of plant height, lodging, infection with black stem rust) were classified according to 9–grade scale, where 9° means the best and 1 – the worst state from agricultural point of view.

In 1998/1999 season, out of 98 strains, 25 were selected and in the next season out of 123, 44 were selected and subjected to further breeding, every next year.

RESULTS AND DISCUSSION

The results of cytological studies and the analysis of qualitative and quantitative traits of hybrid imply that rye genome was enriched in little share of genetic material from the wild form. The genes determining positive traits of *D. villosum* (lowered plant height, elevated content of total protein and mineral ions in kernels) were transferred to rye. Differentiation of morphological and qualitative traits and the effect of gene transfer was evident (Gruszecka and Apolinarska 1996, Gruszecka 1997, Apolinarska and Gruszecka 2001, Gruszecka *et al.* 2001).

In the first experimental year, differentiation of traits was greater than in second one (Table 1 and 2, respectively). Plants usually headed 4 to 5

Fig. 1 Spikes of parental forms, cv. Amilo and *Dasypyrum villosum* (crimea, Ukraine) (from left to right)

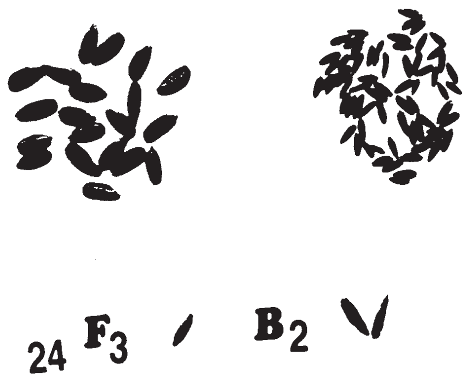

Fig. 2 Kernels of parental forms, cv. Amilo and *Dasypyrum villosum* (crimea, Ukraine), hybrid plants – down

Table 1

Quantitative traits of selected rye strains (1998/1999) – mean values

No	No of plot	Height [cm]		Yield [g]		1000–kernel weight [g]		Hectoliter weight [kg/hl]		Total protein [%]		Sedimentation index [s]	
		x	SD	x	SD	x	SD	x	SD	x	SD	x	SD
1	1	145	–10	410	–270	37.0	0.2	73.6	–1.2	12.6	0.6	206	–48
2	3	150	–5	450	–230	40.4	3.6	72.8	–2.0	13.0	1.0	139	–115
3	4	150	–5	470	–210	38.0	1.2	71.6	–3.2	12.0	0.0	189	–65
4	10	155	0	460	–220	35.8	–1.0	72.8	–2.0	12.7	0.7	161	–93
5	11	150	–5	440	–240	35.6	–1.2	71.2	–3.6	12.6	0.6	164	–90
6	20	160	5	560	–120	39.4	2.6	71.2	–3.6	13.3	1.3	129	–125
7	22	145	–10	600	–80	47.6	10.8	71.2	–3.6	11.5	–0.5	162	–92
8	34	160	5	540	–140	38.4	1.6	72.8	–2.0	12.2	0.2	163	–91
9	37	145	–10	480	–200	36.0	–0.8	70.0	–4.8	13.0	1.0	116	–138
10	38	155	0	410	–270	36.2	–0.6	70.8	–4.0	13.0	1.0	149	–105
11	40	155	0	460	–220	36.4	–0.4	67.2	–7.6	13.6	1.6	131	–123
12	43	155	0	460	–220	38.6	1.8	70.8	–4.0	15.0	3.0	182	–72
13	53	135	–20	300	–380	31.2	–5.6	70.8	–4.0	14.9	2.9	200	–54
14	54	150	–5	480	–200	37.6	0.8	70.4	–4.4	13.3	1.3	241	–13

x – mean value
SD – standard deviation

Table 1

Quantitative traits of selected rye strains (1998/1999) – mean values (continued)

No	No of plot	Height [cm]		Yield [g]		1000–kernel weight [g]		Hectoliter weight [kg/hl]		Total protein [%]		Sedimentation index [s]	
		x	SD	x	SD	x	SD	x	SD	x	SD	x	SD
15	55	145	–10	410	–270	34.6	–2.2	71.2	–3 .6	13.9	1.9	224	–30
16	58	150	–5	620	–60	36.6	–0.2	74.0	–0. 8	13.1	1.1	162	–92
17	59	145	–10	400	–280	38.4	1.6	71.2	–3. 6	15.1	3.1	202	–52
18	61	140	–15	390	–290	36.0	–0.8	69.6	–5. 2	12.7	0.7	197	–57
19	67	155	0	390	–290	38.0	1.2	69.6	–5. 2	14.3	2.3	159	–95
20	72	155	0	540	–140	35.0	–1.8	70.4	–4. 4	13.1	1.1	215	–39
21	75	155	0	500	–180	41.0	4.2	71.6	–3. 2	12.7	0.7	156	–98
22	83	150	–5	400	–280	37.0	0.2	67.6	–7.2	12.5	0.5	145	–109
23	91	160	5	480	–200	38.4	1.6	72.8	–2.0	13.9	1.9	194	–60
24	94	160	5	470	–210	43.6	6.8	75.6	0.8	13.4	1.4	181	–73
25	95	160	5	650	–30	41.0	4.2	72.4	–2.4	14.4	2.4	91	–163
Standard		155		680		36.8		74.8		12.0		254	
V (%)		4.42		17.05		8.43		2.59		7.03		20.80	

x – mean value
SD – standard deviation

Table 2

Quantitative traits of selected rye strains (1999/2000) – mean values

No	No of plot	Height [cm]		Yield [g]		1000–kernel weight [g]		Hectoliter weight [kg/hl]		Total protein [%]		Sedimentation index for standard [s]		Sedimentation index after 24 hrs [s]	
		x	SD	x	SD	x	SD	x	SD	x	SD	x	SD	x	SD
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	808	140	0	570	–200	39.4	0.7	70.8	–3.6	13.3	1.2	218	–32	209	–14
2	812	140	0	720	–50	37.4	–1.3	71.6	–2.8	12.5	0.4	229	–21	232	9
3	813	140	0	590	–180	37.0	–1.7	71.2	–3.2	12.3	0.2	209	–41	205	–18
4	815	140	0	650	–120	39.6	0.9	69.6	–4.8	12.9	0.8	180	–70	193	–30
5	816	135	–5	500	–270	39.6	0.9	69.2	–5.2	12.9	0.8	162	–88	175	–48
6	817	135	–5	620	–150	41.0	2.3	72.0	–2.4	11.3	–0.8	230	–20	213	–10
7	822	135	–5	550	–220	36.6	–2.1	72.4	–2.0	11.4	–0.7	194	–56	185	–38
8	827	135	–5	630	–140	38.0	–0.7	72.8	–1.6	11.8	–0.3	209	–41	216	–7
9	831	135	–5	680	–90	41.6	2.9	72.4	–2.0	11.4	–0.7	207	–43	203	–20
10	833	135	–5	550	–220	37.0	–1.7	72.0	–2.4	11.6	–0.5	194	–56	185	–38
11	838	130	–10	560	–210	39.6	0.9	70.0	–4.4	12.4	0.3	163	–87	173	–50
12	842	130	–10	570	–200	40.2	1.5	70.4	–4.0	12.6	0.5	184	–66	197	–26
13	843	130	–10	540	–230	37.6	–1.1	74.0	–0.4	11.7	–0.4	206	–44	200	–23
14	844	120	–20	510	–260	38.6	–0.1	71.6	–2.8	12.3	0.2	192	–58	212	–11
15	845	135	–5	570	–200	37.0	–1.7	72.0	–2.4	11.5	–0.6	217	–33	189	–34
16	846	140	0	640	–130	41.6	2.9	71.6	–2.8	11.9	–0.2	200	–50	199	–24
17	847	135	–5	560	–210	40.2	1.5	72.0	–2.4	11.8	–0.3	206	–44	226	3
18	848	135	–5	600	–170	38.2	–0.5	71.6	–2.8	12.0	–0.1	204	–46	185	–38
19	855	135	–5	590	–180	36.0	–2.7	70.0	–4.4	12.3	0.2	194	–56	185	–38
20	856	130	–10	570	–200	37.0	–1.7	70.4	–4.0	13.4	1.3	217	–33	193	–30
21	857	130	–10	480	–290	36.6	–2.1	70.4	–4.0	13.4	1.3	194	–56	185	–38
22	858	125	–15	600	–170	37.4	–1.3	72.0	–2.4	13.3	1.2	158	–92	189	–34
23	859	130	–10	490	–280	36.2	–2.5	70.4	–4.0	12.7	0.6	194	–56	185	–38

x – mean value; SD – standard deviation

Table 2

Quantitative traits of selected rye strains (1999/2000) – mean values (continued)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
24	860	130	–10	490	–280	36.6	–2.1	70.8	–3.6	13.3	1.2	194	–56	185	–38
25	863	135	–5	460	–310	37.4	–1.3	70.4	–4.0	11.9	–0.2	194	–56	185	–38
26	865	140	0	640	–130	36.2	–2.5	71.2	–3.2	11.2	–0.9	218	–32	203	–20
27	866	135	–5	540	–230	35.4	–3.3	70.0	–4.4	10.8	–1.3	194	–56	185	–38
28	867	145	5	650	–120	35.8	–2.9	68.8	–5.6	12.0	–0.1	194	–56	185	–38
29	869	140	0	550	–220	37.8	–0.9	70.8	–3.6	11.2	–0.9	202	–48	210	–13
30	870	140	0	640	–130	38.6	–0.1	70.8	–3.6	11.6	–0.5	198	–52	211	–12
31	874	135	–5	620	–150	35.0	–3.7	71.2	–3.2	10.8	–1.3	194	–56	185	–38
32	879	140	0	620	–150	34.2	–4.5	71.2	–3.2	10.3	–1.8	194	–56	185	–38
33	882	135	–5	540	–230	34.0	–4.7	69.2	–5.2	10.8	–1.3	194	–56	185	–38
34	899	145	5	760	–10	41.0	2.3	72.0	–2.4	12.3	0.2	175	–75	156	–67
35	901	145	5	740	–30	40.0	1.3	72.0	–2.4	12.3	0.2	220	–30	214	–9
36	907	145	5	770	0	37.0	–1.7	72.4	–2.0	11.2	–0.9	226	–24	185	–38
37	909	145	5	520	–250	39.4	0.7	70.4	–4.0	13.1	1.0	175	–75	188	–35
38	910	140	0	620	–150	37.6	–1.1	69.6	–4.8	13.0	0.9	194	–56	185	–38
39	913	140	0	660	–110	41.2	2.5	67.2	–7.2	12.7	0.6	175	–75	152	–71
40	917	135	–5	520	–250	39.2	0.5	69.2	–5.2	13.6	1.5	156	–94	143	–80
41	918	140	0	460	–310	33.8	–4.9	68.0	–6.4	14.0	1.9	218	–32	196	–27
42	919	135	–5	650	–120	36.8	–1.9	72.4	–2.0	12.6	0.5	160	–90	154	–69
43	921	130	–10	520	–250	35.8	–2.9	70.8	–3.6	13.4	1.3	194	–56	185	–38
44	922	140	0	550	–220	39.4	0.7	72.0	–2.4	13.0	0.9	120	–130	113	–110
Standard		140		770		38.7		74.4		12.1		250		223	
V (%)		4.03		12.96		5.41		1.88		7.26		11.34		11.48	

x – mean value; SD – standard deviation

days later than standard variety, although 5 out of 98 studied in the first and 9 out of 123 strains studied in the second year headed up to 2 days earlier. As compared to the standard, plant height was lower even by 20 cm in both years and their uniformity was usually higher up to 3.0° and 3.8°, respectively. According to Gruszecka (1997), hybrid plants (2n=14) in F_2 and B_1 showed lower heading, and had moss–covered neck and leaf edges, brittle rachilla and short owns characteristic for *D. villosum*. Hy–brids had less number of shoots than parental forms and their structure was similar to rye. Lodging of analyzed strains was at the level of cv. Amilo at earlier generation (B_3/F_2), and it increased up to 1.8° above standard in the later one (B_3/F_3).

The mean 1000–kernel weight of the standard was 36.8 g and 38.7 g in both succeeding years and 31.2–47.6 g and 33.8–41.6 g for the selected strains (Table 1 and 2), i.e. it was similar to rye in F_2 and B_1 hybrids and significantly higher than of *D. villosum* (Gruszecka 1997).

Only those strains, which exceeded protein content (N × 6.25) of cv. Amilo were selected (0.4–2.6% and 0.1–1.8%) for further breeding. As shown previously (Gruszecka 1997) the mean total protein content in the 'Amilo' × *Dayspyrum villosum* hybrid (Crimes, USSR) amounted 13.09% and was higher than of rye by 12.10% and lower than of *D. villosum* by 19.98%.

Yielding, weight of hectoliter and sedimentation index that were be–low standard variety could be improved. Generally, better results were obtained in the second year, in which one strain yielded even by 2.8% higher than the standard. Spikelet fertility in B_1 was intermediate: higher than for rye and lower than for *D. villosum*. Selection can im–prove this trait (Gruszecka 1997). There is an evidence of very low fer–tility or even the lack of kernels in hybrids of *D. villosum* with the species from *Aegilops*, *Triticum* and *Secale cereale* (Wu and Liu 1988, Frederiksen and Bothmer 1991).

Strains selected for further breeding were less infected with black stem rust (up to +1.6°) than a standard rye variety. Selection coefficient amounted 31% and 21 respectively in the first and second year of study.

CONCLUSIONS

1. Translocation rye strains with *Dasypyrum villosum* characterized great differentiation of traits, especially in the first experimental year.
2. Plant height of hybrid was lower even by 19 cm and 7 cm in the suc–ceeding experimental years respectively.
3. Total protein content in some strain kernels (N × 6.25) was higher than in cv. Amilo: 0.4–2.6% and 0.1–1.8%, respectively in succeed–ing years.
4. Yielding, hectoliter weight and sedimentation index of hybrids should be improved.

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