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THE SOURCE MATERIAL FOR LODGING RESISTANCE OF DURUM SPRING WHEAT UNDER THE FOREST-STEPPE OF UKRAINE

The results of studying lodging resistance for 110 collection samples of spring durum wheat of different ecological and geographical origin during 2012-2013 are given. It has been revealed that plant lodging resistance often was not connected with their height, but depended on breaking strength of straw and the thickness of stem for middle height, stunted and dwarf samples. Collection samples which are recommended as source material in breeding process have been selected.

Keywords: spring durum wheat, collection samples, lodging resistance

Introduction. Overcoming the negative effects of plant lodging by creating stunted varieties with the strong straw in the middle of the last century became the basis for the intensification of wheat production. Providing breeders by source material of various eco-geographical and genealogical origin which combines the stunting with other valuable characters will assist to further successful solution of the lodging problem [1].

Analysis of recent researches and publications. Scientists in their researches have found a relationship between lodging and some anatomical and morphological components of plant. Resistance to lodging is ascertained to be determined primarily with the straw height, length of two lower and uppermost internodes, and straw thickness and strength. Wheat plant height and characteristics of morphological and anatomical structure of stem have a great influence on development and formation in agrocenoses a complex set of agronomic traits [2].

The strength of the second straw internode plays an important role in resistance of wheat varieties to lodging and is an important agronomic trait determined with anatomical and morphological structure of stem. A thickness of the second straw internode has a great value in breaking stem under unfavourable environmental conditions [3, 4]. It is the thickness of the second internode of straw that defines stem lodging. The research in this area facilitates the search and selection of genotypes with strong and resistant to lodging stem on the early stages of breeding, therefore we have been investigating just these parameters.

The task of the researches is studying durum spring wheat collection samples of our country and from abroad with high productivity and resistance to lodging in order to involve them in breeding programs as a source material.

Material and methods. The researches were carried out during 2012-2013 at the V.M. Remeslo Myronivka Institute of Wheat at laboratory of spring wheat breeding. As material for the study there were 110 collection samples of domestic and foreign breeding. The samples were sown in optimal terms with cassette sowing machine SCS-6-10 on research fields of breeding crop rotation. Sown plot area was 1 m². Variety Kharkivs'ka 27 was used as standard of durum spring wheat. The standard was sown out every 25 numbers. The crop was harvested in phase of full ripeness; all plants were reaped in sheaves and threshed on threshing machine.

Lodging resistance was evaluated according to method of state strain testing of agricultural crops [5], breaking strength of straw was determined according to technique of S.I. Kuznetsova [6, 7]. Statistical indices and their errors were calculated according to B.A. Dospiekhov [8].

Results and discussion. Results of the study of collection samples of durum spring wheat for 2012-2013 show that resistance of plants to lodging depends on breaking strength of straw

which ranged from 439 g in Yantar Luhanshchyny (RUS) to 717 g in Leukurum 10 - 28 (UKR) and thickness of stem, better of them are presented in Table 1.

Table 1

Breaking strength of straw and the thickness of the second lower internodes in middle height collection samples of spring durum wheat (MIW, 2012-2013)

Variety name, variety standard	Origin	Breaking strength of straw, g	Thickness of the second lower internode, mm	Length of uppermost internode, cm	Plant height, cm	Resistance to lodging, score	Yield per plot, g/m ²
Kharkivska 27 - St	UKR	436±0.1	2.3±0.1	45.0±0.2	76.4±0.1	7	209
Leukurum 10-28	UKR	717±0.3	2.7±0.2	37.3±0.1	85.8±0.2	9	317
Kustanayskaya 28	KAZ	526±0.1	2.6±0.2	46.6±0.2	86.6±0.2	7	290
Yantar Luhanshchyny	UKR	439±0.1	2.5±0.2	44.9±0.2	82.4±0.2	7	277
Nukly	KAZ	621±0.2	2.9±0.2	51.9±0.3	92.1±0.2	7	269
Leukurum 10-07	UKR	599±0.2	2.6±0.2	39.5±0.1	81.9±0.2	8	268
Diana	UKR	560±0.1	2.5±0.2	43.3±0.2	88.0±0.2	8	261
Kustanayskaya 30	KAZ	521±0.1	2.1±0.1	39.9±0.1	87.6±0.2	8	253
Bezenchukskiy yantar	RUS	526±0.1	2.1±0.1	46.3±0.2	85.1±0.2	8	243
Boshak	KAZ	563±0.1	2.7±0.2	48.8±0.2	95.9±0.2	8	243
Chado	UKR	671±0.2	2.7±0.2	52.7±0.3	80.0±0.2	7	237
111 MUSK 7	MEX	593±0.2	2.5±0.2	35.4±0.1	81.2±0.2	8	235
Zolotko	UKR	591±0.2	3.1±0.3	42.6±0.2	83.6±0.2	8	222
Aldarynka	UKR	707±0.3	3.1±0.3	51.3±0.3	91.6±0.2	7	209
X	-	611±0.2	2.2±0.2	45.8±0.2	85.7±0.2	6.7	240.3
Min	-	439±0.1	1.8±0.2	33.5±0.1	80.0±0.1	5.0	187.9
Max	-	717±0.3	3.1±0.3	52.7±0.3	95.9±0.3	9.0	317.0

The strength and the thickness of stem were determined at the second from bottom internode of spring durum wheat plants. The results of studying the collection samples showed that plant resistance to lodging not always was connected with height. To ascertain the nature of resistance of the samples differing in height, we have been determined breaking strength of straw using the dynamometric device.

Data obtained suggest that the resistance of plants to lodging depends on the breaking strength of straw which correlated ($r = 0.52 \pm 0.08$) with stem thickness. 16 average height samples, namely Leukurum 10-28 (UKR), Leukurum 10-07 (UKR), Diana (UKR), Kustanayskaya 30 (KAZ), Bezenchukskiy yantar (RUS), Boshak (KAZ), 111 MUSK 7 (MEX), Zolotko (UKR), Kustanayskaya 28 (KAZ) etc. had high resistance to lodging and strong straw. Thickness of straw of the samples mentioned above was 2.7 mm, 2.6 mm, 2.5 mm, 2.1 mm, 2.1 mm, 2.7 mm, 2.5 mm, 3.1 mm, 2.6 mm, respectively.

11 samples had average resistance to lodging and breaking strength of straw, namely: Novodonskaya (RUS) - 465 g, Hordeiforme 17-41 - 470 g, Nakat (UKR) - 485 g, 182 Bezenchukskaya (RUS) - 570 g, Kardikans 12 (RUS) - 420 g, etc. with thickness of straw: 1.8 mm, 2.0 mm, 2.0 mm, 2.1 mm, 2.1 mm, respectively.

The breaking strength of straw and the thickness of the second lower internode in the years of research in stunted and dwarf collection samples of spring durum wheat is presented in Table 2.

Table 2

Breaking strength of straw and the thickness of the second lower internodes of stunted and dwarf collection samples of spring durum wheat (MIW, 2012-2013)

Variety name, variety standard	Origin	Breaking strength of straw, g	Thickness of the second lower internode, mm	Length of uppermost internode, cm	Plant height, cm	Resistance to lodging, score	Yield per plot, g/m ²
Kharkivska 27 - St	UKR	436±0.1	2.3±0.1	45.0±0.2	76.4±0.2	7	209
Stunted							
Nashchadok	UKR	557±0.1	2.3±0.1	41.8±0.1	74.1±0.1	9	263
Luganska 7	UKR	570±0.1	2.4±0.1	43.2±0.2	68.1±0.1	7	253
Omskaya stepnaya	RUS	660±0.2	2.7±0.1	45.7±0.2	79.0±0.2	7	237
Tverdaya 187	MAR	630±0.2	2.8±0.2	42.9±0.1	79.4±0.2	9	231
Bezenchukskaya stepnaya	RUS	670±0.2	2.7±0.2	49.8±0.2	76.0±0.1	7	225
Hordeiforme 10-17	UKR	653±0.2	2.6±0.2	36.4±0.1	64.5±0.1	8	225
Kharkivska 19	UKR	702±0.3	3.0±0.3	37.4±0.1	66.4±0.1	7	224
Altyn-shygys	KAZ	610±0.1	2.8±0.2	48.1±0.2	79.0±0.2	7	241
X	-	589±0.1	2.4±0.1	41.3±0.1	71.3±0.1	6.8	234.3
Min	-	470±0.1	2.0±0.1	33.8±0.1	60.1±0.1	6.0	183.5
Max	-	702±0.3	3.0±0.3	49.8±0.2	79.4±0.2	9.0	263.0
Dwarfs							
28 THIDSN-2-84 HAI-OUI	MEX	651±0.2	2.7±0.1	25.8±0.1	50.6±0.1	7	344
...138 PODICEPS 9	MEX	613±0.2	2.5±0.1	29.3±0.2	51.7±0.1	9	316
...30 GHAZ 1	MEX	551±0.1	2.4±0.1	27.1±0.2	52.3±0.1	8	279
27 THIDYN 95-96-8 ROMARINO 1	MEX	563±0.1	2.5±0.2	29.9±0.2	55.8±0.2	9	273
143 KIRKI 9	MEX	612±0.2	2.3±0.1	27.8±0.2	55.1±0.2	8	246
28 THIDYN-89 CALELO 2	MEX	521±0.1	2.0±0.1	28.6±0.2	52.4±0.1	9	244
...103 KABA-CAYLAK 2	MEX	566±0.1	2.6±0.2	29.1±0.2	58.3±0.2	9	233
X	-	576.7±0.1	2.3±0.1	27.5±0.2	50.9±0.1	7.9	237.7
Min	-	516.9±0.1	1.8±0.1	23.8±0.1	44.0±0.1	7.0	201.3
Max	-	651.0±0.2	2.7±0.2	29.9±0.2	58.3±0.1	9.0	344.0

The results of studies indicate that resistance of stunted collection samples to lodging depends on breaking strength of straw which directly correlates ($r = 0.51 \pm 0.08$) with thickness of stem. High resistance against lodging and breaking strength of straw was observed in 15 samples, namely Nashchadok - 557 g, Lugans'ka 7 (UKR) - 570 g, Omskaya stepnaya (RUS) - 660 g, Tvierdaya 187 (MAR) - 630 g, Bezenchukskaya stepnaya (RUS) - 670 g, Hordeiforme 10-17 - 653

g, Kharkivs'ka 19 (UKR) - 702 g, Altyn-shygys (KAZ) - 610 g, and others. Thickness of straw of these samples was 2.3 mm, 2.4 mm, 2.7 mm, 2.8 mm, 2.7 mm, 2.6 mm, 3.0 mm, 2.8 mm.

High resistance to lodging and strong straw was observed in 46 dwarfs, namely 138 PODICEPS 9 (MEX), Neodur (FRA), 27 THIDYN 95-96-8 ROMARINO 1 (MEX), Olda (FRA), 28, THIDYN-89 CALELO 2 (MEX), Multidur (FRA), 103 KABA-CAYLAK 2 (MEX), Belladur (AUT), 28 THIDSN-2-83 HAAHKA-1 (MEX) etc. with thickness of straw being 2.5 mm, 2.2 mm, 2.5 mm, 2.4 mm, 2.0 mm, 2.4 mm, 2.6 mm, 2.5 mm and 2.7 mm. Correlation connection was moderate ($r = 0.45 \pm 0.08$) between breaking strength of straw and thickness of stem.

Analysis of collection samples of spring durum wheat during the growing season 2012-2013 based on morphological indices allowed to establish that resistance to lodging is higher in that cases when the length of two lower internodes as well as relation of plant height to diameter of the 2nd lower internode are less (Table 3). The relation of height to diameter of the second internodes ranged from 20,0 in the sample 116 PAGILA 9 (MEX) to 40,5 in Bezenchukskiy yantar (RUS). The most of the collection samples exceeded the variety-standard – Kharkivska 27 for this index.

Table 3

Morphological indices of resistance to lodging in middle height collection samples of spring durum wheat (MIW, 2012-2013)

Variety name, variety standard	Origin	Plant height, cm	Resistance to lodging, score	Length of lower internode, cm		Height relation to diameter of the 2 nd internode
				the first	the second	
Kharkivska 27 - St	UKR	76.4±0.1	7	45.0±0.2	12.2±0.1	33.2±0.1
Leukurum 10-28	UKR	85.8±0.2	9	37.3±0.1	22.7±0.3	31.8±0.1
Kustanayskaya 28	KAZ	86.6±0.2	7	51.8±0.3	14.8±0.1	37.3±0.2
Yantar Luhanshchyny	RUS	82.4±0.2	7	44.9±0.2	16.4±0.2	32.9±0.1
Nukly	KAZ	92.1±0.3	7	51.9±0.3	17.5±0.2	31.7±0.1
Leukurum 10-07	UKR	88.9±0.2	8	39.5±0.1	13.2±0.1	27.6±0.1
Diana	UKR	88.0±0.2	8	43.3±0.2	16.8±0.2	31.2±0.1
Kustanayskaya 30	KAZ	87.6±0.2	8	39.9±0.1	17.6±0.2	37.0±0.2
Bezenchukskiy yantar	RUS	85.1±0.2	8	46.3±0.2	14.4±0.1	40.5±0.3
Boshak	KAZ	95.9±0.3	8	48.8±0.2	18.7±0.2	35.5±0.2
Chado	UKR	80.0±0.2	7	52.7±0.3	11.7±0.1	29.7±0.1
111 MUSK 7	MEX	81.2±0.2	8	45.5±0.2	18.8±0.2	34.4±0.1
Zolotko	UKR	83.6±0.2	8	42.6±0.2	17.7±0.2	26.9±0.1
Aldarynka	UKR	91.6±0.3	7	51.3±0.3	16.3±0.2	29.5±0.1
X	-	85.7±0.2	6.7	45.8±0.2	17.3±0.2	29.8±0.1
Min	-	80.0±0.1	5.0	28.1±0.1	9.4±0.1	20.0±0.1
Max	-	95.9±0.3	9.0	52.7±0.3	22.7±0.3	40.5±0.3

Morphological indices of resistance to lodging in stunted and dwarf collection samples of spring durum wheat are showed in Table 4. Length of the first lower internode has ranged from 25.6 cm in the stunted sample Kharkivska 41 (UKR) to 50.0 cm - Spadshchyna (UKR), in dwarf from 17.5 cm - Olda (FRA) to 32.1 cm - 28 THIDSN-2-5-8 ADAMAR 7 (MEX). For 11 stunted samples the first lower internodes were the shortest (25.6-37.6 cm), the length of the second lower internodes ranged from 6.6 to 18.1 cm, in dwarfs – from 6.8 to 11.2 cm.

The relation of height to diameter of the second internode ranged from 20.6 in stunted sample Kuchumivka (UKR) to 41.8 in Omskaya stepnaya (RUS), in dwarfs from 18.3 - Olda (FRA) to 29.6 - 28 THIDSN- 2-5-8 ADAMAR 7 (MEX). The most of the collection samples yielded variety-standard for this index.

Table 4

Morphological indices of resistance to lodging in stunted and dwarf collection samples of durum spring wheat (MIW, 2012-2013)

Variety name, variety standard	Origin	Plant height, cm	Resistance to lodging, score	Length of lower internode, cm		Height relation to diameter of the 2 nd internode
				the first	the second	
Kharkivska 27 - St	UKR	76.4±0.1	7	45.0±0.2	12.2±0.1	33.2±0.1
Stunted						
Nashchadok	UKR	74.1±0.1	9	41.8±0.1	13.0±0.1	32.2±0.1
Luganska 7	UKR	68.1±0.1	7	42.3±0.1	10.0±0.1	30.9±0.1
Omskaya stepnaya	RUS	79.0±0.2	7	45.7±0.2	17.1±0.2	41.8±0.2
Tverdaya 187	MAR	79.4±0.2	9	42.9±0.1	17.3±0.2	28.4±0.1
Bezenchukskaya stepnaya	RUS	76.0±0.1	7	49.8±0.2	14.3±0.1	30.9±0.1
Hordeiforme 10-17	UKR	64.5±0.1	8	36.4±0.1	11.0±0.1	24.8±0.1
Kharkivska 19	UKR	66.4±0.1	7	37.4±0.1	11.2±0.1	22.1±0.1
Altyn-shygys	KAZ	79.0±0.2	7	48.1±0.2	18.1±0.2	31.8±0.1
X	-	71.3±0.1	6.8	38.9±0.1	13.8±0.1	29.8±0.1
Min	-	60.1±0.1	6.0	26.6±0.1	6.6±0.1	20.6±0.1
Max	-	79.4±0.2	9.0	50.0±0.2	18.1±0.2	41.8±0.2
Dwarfs						
28 THIDSN-2-84 HAI-OUI	MEX	50.6±0.1	7	25.8±0.2	10.4±0.2	25.3±0.2
...138 PODICEPS 9	MEX	51.7±0.1	9	29.3±0.2	8.9±0.1	27.2±0.2
...30 GHAZ 1	MEX	52.3±0.1	8	27.1±0.2	11.2±0.2	22.7±0.1
27 THIDYN 95-96-8 ROMARINO 1	MEX	55.8±0.2	9	29.4±0.2	9.8±0.1	22.3±0.1
143 KIRKI 9	MEX	55.1±0.2	8	27.8±0.2	9.9±0.1	23.9±0.1
28 THIDYN-89 CALELO 2	MEX	52.4±0.1	9	28.6±0.2	9.6±0.1	26.2±0.2
...103 KABA-CAYLAK 2	MEX	58.3±0.2	9	29.1±0.2	11.1±0.2	23.2±0.1
X	-	50.9±0.1	7.9	26.4±0.2	9.9±0.1	23.7±0.1
Min	-	44.0±0.1	7.0	17.5±0.1	6.8±0.1	18.3±0.1
Max	-	58.3±0.1	9.0	32.1±0.2	11.2±0.2	29.6±0.2

Conclusions. The results of the studying durum spring wheat samples resistance to lodging showed that the resistance of plants depended not only on the height, but also on the breaking strength of straw which correlates with the thickness of the stem in middle height ($r = 0.52 \pm 0.08$), stunted ($r = 0.51 \pm 0.08$) and dwarf ($r = 0.45 \pm 0.08$) samples. Analyse of morphological parameters allowed to establish that resistance to lodging is higher in cases when the length of the two lower internodes as well as plant height in relation to diameter of the second lower internodes were less.. Sources of lodging resistance being recommended to involve in crosses in Forest-steppe of Ukraine for creating new inital material: Leukurum 10-28, Zolotko, Lugans'ka 7, Diana (UKR), Kustanayskaya 30, Boshak , Altyn-shygys (KAZ), Omskaya stepnaya, Bezenchukskaya stepnaya (RUS), Neodur, Olda, Multidur (FRA), Belladur (AUT), 28 THIDSN- 2-83 HAAHKA- 1 (MEX) and others have been identified.

References

1. Селекція, насінництво та сортознавство пшениці [Текст] : научное издание / В.В. Шелепов, М. М. Гаврилюк, М. П. Чебаков та ін. ; під ред. : В. В. Шелепова ; Укр. акад. аграр. наук, Миронівський ін.-т пшениці ім. В.М.Ремесла УААН. – Миронівка : [б. и.], 2007. – 408 с.
2. Волков В.А. Реакция сортов озимой пшеницы в условиях полива на нормы высева и удобрения / В.А. Волков // Сб. тр. молодых ученых КНИИСХ. – 1974. – Вып. 4. – С. 91-96.
3. Разумовский А.Г. Морфологический метод определения устойчивости пшеницы к прикорневому полеганию / А.Г. Разумовский // Труды Краснодарского НИИ сельского хозяйства. – 1965. – Т. 3. – С. 117-122.
4. Тетерятченко К.Г. Сортотипная специфичность адаптационных систем мягкой озимой и яровой пшеницы, определяющих устойчивость к полеганию, продуктивность и засухоустойчивость / К.Г. Тетерятченко, К. Гбордзи // Селекция и урожай полевых культур : сборник научных трудов. – Харьков : [б. и.], 1984. – Т. 310. – С. 7-14.
5. Методы селекции и оценки устойчивости пшеницы и ячменя к болезням в странах-членах СЭВ / [Бабаянц Л., Мештерхази А., Вехтер Ф. и др.]. – Прага: [б. и.], 1988. – 322 с.
6. Кузнецова С.И. Исходный материал для селекции ржи на устойчивость к полеганию / С.И. Кузнецова // Научн.-техн. бюл. ВНИИ растениеводства им. Вавилова. – Л., 1968. – С. 38-43.
7. Кобылянский В.Д. Исходный материал ржи для селекции на устойчивость к полеганию / В.Д. Кобылянский, С.И. Кузнецова // Селекция и семеноводство. – 1970. – № 4. – С. 16-19.
8. Доспехов Б.А. Методика полевого опыта / Б.А. Доспехов – М.: Агропромиздат, 1985. – 351 с.

Анотація

Хоменко С.О., Федоренко М.В.

Вихідний матеріал за стійкістю проти вилягання пшениці твердої ярої для умов Лісостепу України

Наведені результати вивчення стійкості проти вилягання 110 колекційних зразків пшениці твердої ярої різного еколого-географічного походження протягом 2012-2013 рр. Виявлено, що стійкість рослин проти вилягання не завжди мала зв'язок з висотою, а залежала від міцності соломини на злам та товщини стебла у середньорослих, низькорослих та карликових зразків. Виділені колекційні зразки, які рекомендовані як вихідний матеріал у селекційному процесі.

Ключові слова: пшениця тверда яра, колекційні зразки, стійкість проти вилягання

Аннотация

Хоменко С.О., Федоренко М.В.

Исходный материал по устойчивости к полеганию пшеницы твердой яровой для условий Лесостепи Украины

Приведены результаты изучения устойчивости к полеганию 110 коллекционных образцов пшеницы твердой ярой разного эколого-географического происхождения в течение 2012-2013 гг. Установлено, что устойчивость растений не всегда имела связь с высотой, а зависела от прочности соломини на излом и толщины стебля у среднерослых, низкорослых и карликовых образцов. Выделены высокопродуктивные образцы, которые рекомендуются как исходный материал в селекционном процессе.

Ключевые слова: пшеница твердая яровая, коллекционные образцы, устойчивость к полеганию