VARIABILITY OF THE GRAIN-TO-EAR BINDING FORCE FOR DIFFERENT FORMS OF *TRITICALE*

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A new type of cereal to which the breeders pay more and more attention is *Triticale* — a interspecies crossbriding of wheat and rye. But despite the existence of *Triticale* for about 100 years it has, beside many favourable properties like high crop potential or rich variety of forms, also unfavourable atavistic ones. These properties include first of all the crumblines of the ear torus and, with some breeds, poor threshability. With hexoploidal forms there can occur poor covering of grains with glumes, like in the case of rye [7]. This property causes the tendency to grain shedding.

A considerable progress in the breeding of *Triticale* was achieved by improving the productivity of the plant and the formation of grains, which greatly influenced the crop yielding abilities of *Triticale*. However, information is still sparse about the physical properties of *Triticale*, the knowledge of which can be of great importance for both breeding and production. It is known that the improving of the productivity of cereals can be achieved not only by introducing highly productive, short ear and resistant to illnesses varieties, but also by the limitation to minimum the losses of grain occuring during harvesting. So it seems right to get acquainted with this problem more closely, for a fuller characterization of this type of cereal.

According to Řezniček and co-authors [3, 5] the measure of the grain--to-ear bond is the maximum value of force necessary to overcome the resistance of a grain during removing it from ear along its longest axis. From this it follows that the force necessary to break grain off from the ear torus is not equivalent to the susceptibility to grain shedding, since this property, as yet, is not expressed in absolute values. Nevertheless the grain-to-ear binding force surely determines the resistance of the susceptibility to grain shedding.

MATERIAL AND METHODOLOGY OF INVESTIGATIONS

The investigations of the grain-to-ear binding force were carried out on 22 breeds of *Triticale* derived from crossbreeding of material of Japanese, Hungarian and Swedish origin, and, for comparative purposes, on one variety of winter wheat (Grana) and rye (Pancerne).

Ears for the investigations were taken after establishing full maturity. The measurements of the force were carried out on an electromagnetic micropicker, designed in the Institute of Agrophysics of Polish Academy of Sciences in Lublin [6]. The construction of the apparatus allowed for delicate hold on the grain with precision pliers without impairing its bond with the ear torus and the surounding glumes. The increase of the force was shown by the probe of the apparatus up to the moment of breaking, indicating its maximum value by self-aretation of the control system.

Assuming the variability of the value of force on the length of ear, the measurements were made in its 5 parts (Fig. 1), and from each 3 gra-

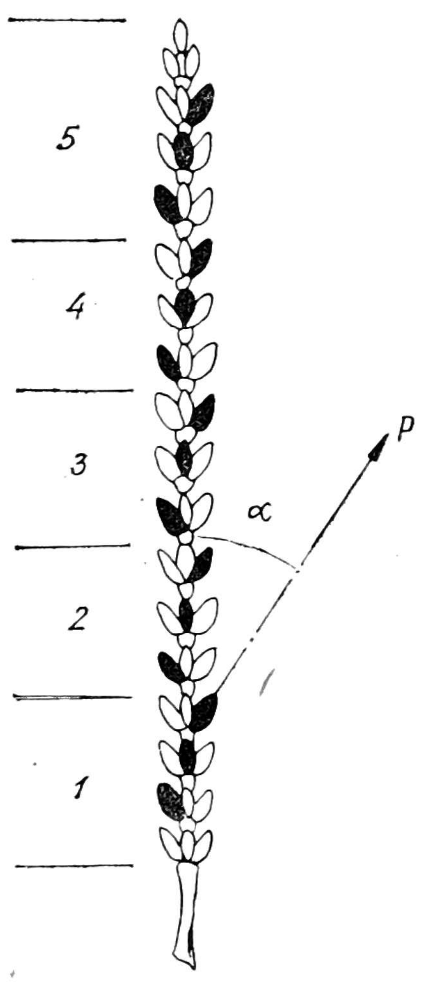

Fig. 1. Diagram of the division of an ear into parts and the direction of the action of force breaking off a chosen grain, 1—5 — parts of ear, P — the maximum value of force (P_x, P_y — constituent forces), α — angle of the action of force P in accordance with the symmetry axis of grain

ins were taken, choosing the middle and side ones from different ears. Every breed of *Triticale* was represented by 30 ears randomly chosen from the experimental fields. In this way 90 single values were obtained for each part of ear, that is 450 for the characterization of one breed.

The application of the direct method of measurement of the grain-to--ear binding force [1, 2, 4] enabled a precise analysis of the property in the investigated breeds of *Triticale* and the comparison with the winter wheat and the rye.

RESULTS OF INVESTIGATIONS

The obtained values of the force were subjected to statistical analysis using the analysis of variance, and in order to grasp the quantitative relations the Tukey's halfranges of credibility were calculate. All the con-

Table 1

Mean values of the grain-to-ear binding force (N) for particular varieties of *Triticale*

Number of variety	Parts of the ear					Mean value
	I	II	III	IV	V	
3	1.19	1.25	1.14	1.11	1.00	1.14
6	1.06	1.14	1.10	1.07	0.93	1.06
11	1.64	1.47	1.47	1.39	1.31	1.46
28	1.31	1.20	1.25	1.11	1.04	1.18
50	1.34	1.37	1.33	1.15	1.01	1.24
61	1.22	1.28	1.19	1.06	1.06	1.16
95	1.50	1.63	1.55	1.46	1.38	1.50
114	1.33	1.29	1.34	1.29	1.19	1.29
122	1.76	1.72	1.63	1.54	1.51	1.63
134	1.43	1.51	1.58	1.34	1.21	1.41
138	1.54	1.69	1.54	1.40	1.27	1.49
158	1.78	1.76	1.69	1.61	1.37	1.64
167	1.50	1.56	1.44	1.33	1.21	1.41
183	1.26	1.20	1.19	1.15	1.06	1.17
187	1.60	1.59	1.38	1.32	1.23	1.60
188	1.40	1.40	1.27	1.20	1.00	1.25
275	1.21	1.33	1.22	1.15	1.10	1.20
323	1.44	1.38	1.45	1.35	1.18	1.36
362	1.53	1.54	1.38	1.32	1.10	1.37
378	1.94	1.87	1.88	1.80	1.54	1.80
415	1.53	1.42	1.41	1.33	1.15	1.37
749	1.44	1.34	1.31	1.21	1.09	1.28
Grana winter wheat	1.03	1.20	1.49	1.05	0.95	1.14
Pancerne rye	0.73	0.92	0 84	0.78	0.69	0.79
Mean value	1.41	1.42	1.38	1.31	1.15	1.33

The smallest significant difference (P = 0.05),
— among the parts of ear — 0.05,
— among the varieties — 0.11,
— in the interaction parts v. varieties' — 0.24.

cluding was done at the significance level $\alpha = 0.05$. Also the variability coefficient of the investigated property was calculated. The results are presented in Tables 1 and 2.

The mean values of the grain-to-ear binding force for *Triticale* in part I (bottom) vary from 1.06 to 1.94 N and are decidedly higher than for wheat (1.03 N) and rye (0.73 N). In part II for the majority of breeds grains are bound the strongest to the ear torus (1.14-1.87 N). The highest value of all the parts occurs also for rye (0.92 N). In part III (middle) grains of wheat are bound the strongest (1.49 N), and for *Triticale* the maximum values are reached here only by three breeds. The limit values form the range from 1.10 to 1.88 N. In part IV of ear the values of the force are within the range from 1.06 to 1.80 N and they are also

Table 2

Values of the indexes of the variability of the grain-to-ear binding force (%) for particular varieties of *Triticale*

Number of variety	Parts of the ear					Mean value
	I	II	III	IV	V	
3	23.25	24.63	24.27	32.21	36.82	29.07
6	22.87	21.03	25.78	27.31	22.15	24.95
11	27.29	35.83	32.95	30.98	33.01	32.88
28	28.49	34.38	33.15	30.16	30.97	32.66
50	37.03	33.39	35.11	35.71	28.85	36.54
61	33.72	36.05	36.24	33.11	31.84	35.29
95	30.79	32.40	35.84	33.42	30.91	33.33
114	30.10	33.02	27.42	30.14	29.79	30.43
122	35.02	37.58	36.18	37.99	26.43	35.63
134	24.32	20.09	23.77	23.84	22.25	24.77
138	30.81	29.08	31.10	34.63	29.85	32.60
158	28.84	25.37	27.27	23.80	26.58	28.08
167	29.61	30.89	31.98	28.06	27.81	31.33
183	34.66	34.36	40.68	36.93	33.14	36.61
187	29.93	29.91	31.25	37.32	36.71	34.40
188	26.00	24.27	26.93	28.60	26.61	29.11
275	22.72	18.57	19.26	20.87	20.03	21.21
323	28.46	36.57	33.19	31.68	37.44	34.16
362	28.14	33.59	29.93	26.60	27.25	31.83
378	31.68	36.19	30.99	31.52	31.03	33.31
415	23.91	24.70	26.68	25.33	27.31	27.20
749	29.32	31.70	30.38	29.64	30.23	31.80
Grana winter wheat	35.65	30.28	22.96	23.98	36.41	33.85
Pancerne rye	42.83	28.54	28.80	33.10	23.18	33.52
Mean value	35.42	34.82	34.61	35.15	34.48	

higher than those for wheat (1.05 N) and rye (0.78 N). Part V (top) of ear is characterized by the weakest bond between grain and ear for *Triticale* (0.93-1.54 N), and wheat (0.95 N), and rye (0.69 N).

The significance of differences among the parts of ear and among the breeds comprises a decided majority of the mean values compared.

An absolute majority of breeds (19 out of 22 taken for the investigations) has grains bound the strongest to the ear torus in parts I and II of the ear, that is in the lowest parts. This creates a somewhat different picture than in the case of wheat, where the highest values occur in the middle part (III). Hence the general mean values for the parts of ear are the highest at the bottom.

Comparing the values characterizing the particular breeds (mean values from five parts of ear) a very great variability of the grain-to-ear binding force was observed, forming a range from 1.06 to 1.80 N. So high differences allow to assume that the investigated breeds can be highly susceptible to the grain shedding or else they can bind grains too strongly causing poor threshability. This is indicated by the values of the variability coefficients, that for the particular breeds form the range from 21.21 to 36.61%. This range becomes much wider (18.57-40.68%) at the analysis of the obtained coefficients for the parts of ear. So high a variability results undoubtedly from the great variability of forms of *Triticale* and the still poor stability of this property in some breeds, which is an unfavourable phenomenon. Among the investigated breeds of *Triticale* there are also such that are characterized by much lower coefficients of variability of the grain-to-ear binding force than wheat and rye. Particular attention is deserved by breeds nr 275 (21.21%), 134 (24.77%), 6 (24.95%), and 415 (27.20%), since they are characterized by low interpart variability.

RECAPITULATION

The great number of the measurements of the grain-to-ear binding force carried out on 22 breeds of *Triticale* allows to state that within this type of cereal there is a statistically proved wide range of variability, both among the particular breeds and among the parts of ear. These facts indicate to high differentiation of the cross-breeding forms of *Triticale*. Although with mechanized harvesting of this type of cereal there can still occur considerable quantitative losses of grain (grain shedding or leaving unthreshed grain in ears) with the lack of knowledge of its mechanical properties, on the other hand we deal with a very valuable breeding material, proper direction of which already on the first stages of selection can lead to obtaining breeds of very favourable parameters. Because early knowledge of the mechanical properties will allow to eliminate the not too favourable properties, both from the breeding and production points of view, thus nearing to perfect this original type of cereal.

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ZMIENNOŚĆ SIŁY ZWIĄZANIA ZIARNA Z KŁOSEM U RÓŻNYCH FORM *TRITICALE*

Streszczenie

Przeprowadzono badania siły wiążącej ziarno z kłosem metodą bezpośrednią na 22 rodach *Triticale*, powstałego z krzyżowania materiału pochodzenia japońskiego, węgierskiego i szwedzkiego. Pomiarami objęto pięć stref kłosa dla określenia rozkładu zmienności siły na całej jego długości.

Stwierdzono, że wartości siły związania ziarna wahają się w szerokich granicach w zależności od rodów i stref kłosa i obejmują przedział od 0,93 N do 1,94 N. Najsilniej osadzone były ziarna w strefach dolnych, najsłabiej zaś w części szczytowej. Dla celów porównawczych przeprowadzono identyczne pomiary na pszenicy ozimej i życie. Duże różnice w wartości siły między poszczególnymi rodami wskazują, że są one w różnym stopniu podatne na osypywanie — od łatwo osypujących się do trudno wymłacalnych.

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ИЗМЕНЧИВОСТЬ СИЛЫ СВЯЗЫВАНИЯ ЗЕРНА С КОЛОСОМ У РАЗЛИЧНЫХ ВИДОВ ТРИТИКАЛЕ

Резюме

Провели исследования силы, связывающей зерно с колосом, непосредственным методом на 22 видах тритикале, возникшего из скрещивания материала японского, венгерского и шведского происхождения. Измерениям подверглись 5 участков колоса для определения распределения изменчивости силы на всей его длине.

Констатировали, что значения силы связывания зерна колеблются в широких пределах в зависимости от видов и участков колоса от 0,93 до 1,94 Н. Сильнее всех держались зерна на нижних участках, слабее всех — в верхушечной части. Для сравнительных целей провели идентичные измерения на озимой пшенице и ржи. Крупные разности между значениями силы отдельных родов показывают, что они в значительной степени подвергаются осыпанию — от легко-осыпающихся до трудновымолачивающихся.

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