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Genetics and Selection

Towards the Study of the Problem of Inheritance of Length of Tooth of Spikelet Keel in Crosses of Durum Wheat (*T. durum* Desf.) and Dika Wheat (*T. carthlicum* Nevski)

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ABSTRACT. The present work shows that the length of tooth of wheat ear spikelet keel belongs to the group of quantitative-morphological traits, which varies according to years and sowing seasons, but this variation is rather slight and does not affect steadiness of the trait. Due to this the trait can be assessed as a stable characteristic of species, variety or sort and can be used as approbation sign in seed farming. Inheritance of the trait in plants of first generation obtained via crossing short- and long-toothed forms is of intermediate character, though it is inclined towards the short toothed parent. In the second generation segregation is too complicated, segregated forms phenotypically resemble short-toothed and long-toothed parental forms. Among them more short-toothed and more long-toothed forms can be found as well. Inheritance of tooth length has been found to be dependent on several unifrom couples of factors. Short tooth of spiklet keel is found to be a dominant trait. © *2009 Bull. Georg. Natl. Acad. Sci.*

Key words: *spikelet, keel, tooth, awn.*

Introduction. Species belonging to the genus Triticum, except Dika wheat (*Triticum carthlicum* Nevski), are characterized by a peculiar appendix of spikelet keel - the so-called tooth (dent), whose length varies within the range of 0.3-5 mm. In some species, for example *T. dicoccum* Schrnk., tooth length is less than 0.1 mm. Because of small size of this structure this sign was out of interest of researchers and the nature of its inheritance has not been studied so far.

After Dika wheat was discovered (*T. carthlicum* Nev.) it became clear that the length of tooth of spikelet keel in this species reaches several centimeters and it is nearly equal in length to floret awn, making together with it two awns and presence of two awns is a specific trait of Dika wheat.

First scientific investigation on inheritance of length of tooth of the spikelet keel belongs to Acad. N. I Vavilov [1] (together with O. V. Yakushkina), who discovered and described this species. Further an important investigation in this direction was published by T. K Lepin [2]. After more than 80 years from the publication of the mentioned investigations the present work deals with the character of inheritance of the length of tooth of the spikelet keel (awn) in Dika wheat. This is significant not only from the theoretical-genetic viwepoint but also for establishing a new type of segregation.

Initial material and method. Of three main varieties of Dika wheat the long awned variety *var. fuliginosum* Zhuk. ears of black color and short awned durum wheat of (*T. durum* Desf.) *var. coerulescens* Bayle were selected. Research was carried out at the experimantal-training farm of the Georgian State Agrarian University, in particular on the experimental plot of the former Department of Genetics, Selection and Seed Farming.

Pure lines separated from the chosen varieties were used in crossing experiments. Variety *coerulescens* of

durum wheat was used as a maternal parent and as pollinator the variety *fuliginosum* with the longest awn among Dika wheat varieties was applied. Besides this reciprocal crossing was carried out. 200-200 flowers were emasculated (sterilized) for both direct and reciprocal crosses and pollinated. Crossing was performed by means of the free limited method [3]).

Hybrid grains, obtained as a result of reciprocal crossing (F_0) were divided into two parts. One of them was sown in autumn and the second in spring. Every year of the experiment autumn sowing was performed on 25th of October and spring sowing on 20th of March. In both seasons the plot size was 5x25 cm. Parental forms were sown next to the hybrids.

With the aim of getting F_2 generation, all grains of 5-5 well-developed plants of F_1 generation got from seeds sown in both seasons were sown according to seasons, on separate plots.

In order to get F_3 generation 40-40 plants were chosen from F_2 sown in both seasons. Of them 5-5 best developed plants were chosen and all grains were planted as families. To get F_4 from each family of F_3 25-25 the most well-developed plants were analyzed and all grains from each separate plant obtained in such a way were planted on separate plots according to seasons.

Length of 5-5 teeth of spikelet keel from the middle part of the main ear of plants of F_1, F_2, F_3, F_4 generations and of the parent forms was measured by plotting paper and average length of tooth of all five spikelet keels was assessed as the value of tooth length of examined plants in mm.

Results and discussion. Study of tooth length of spikelet keel in 25 well developed main ears of each form participating in crosses has shown that this quantitative trait varies within years and also according to sowing seasons, but the frequency of variation does not form long variation series. This series is too short and varies by 5-6 differing plants. Fluctuation of length of spikelet keel tooth in parental forms (lim) and the mean arithmetic error (M±m) is presented in Table 1.

As a result of study of length of tooth of the spikelet keel of the main ear for five years in pure lines of parental forms it has been established that this quantitative trait slightly varies in different years and according to the sowing season, but variation frequency and level are so low that it does not affect the stability of the trait. Due to this, the length of tooth of spikelet keel can be assessed as a stable trait characteristic of varieties of this species and used in seed farming as an approbation characteristic.

Variation series of tooth length of ear spikelet keel has been found longer in Dika wheat as compared with durum (hard) wheat.

Study of reciprocal combinations has shown that direct and reverse combinations do not differ from each other in tooth length. That's why in this work we present only data of the study of combinations obtained as a result of direct crossing (Durum wheat X Dika wheat) (Table 2).

Study of F_1 plants obtained from plants sown in spring and autumn has shown that inheritance of length of tooth of the main ear spikelet keel is of intermediate

Table 1

Length of tooth of keel of the main ear spikelet of parental pure lines

Year and time of sowing	*T. durum* var. coerulescens		*T. carthlicum* var. fuliginosum	
	lim	M±m	lim	M±m
1990, October, 25…	1.6-2.7	2.1±0.3	48.4-58.5	50.4±1.24
1991, March 20…	1.4-2.2	1.81±0.21	45.5-52.4	47.1±0.62
1991, October, 25…	1.5-2.6	2.0±0.23	50.2-75.5	60.2±0.49
1992, March 20…	1.3-2.1	1.5±0.23	42.6-50.5	46.8±0.52
1992, October, 25…	1.6-2.7	2.0±0.2	45.5-61.5	52.5±0.51
1993, March 20…	1.3-2.1	1.6±0.3	49.2-73.5	50.1±0.49
1993, October, 25…	1.5-2.7	2.1±0.23	47.4-54.2	51.5±0.22
1994, March 20…	1.4-2.1	1.86±0.2	46.5-60.4	50.4±0.35
1994, October, 25…	1.5-2.6	2.0±0.3	50.4-77.4	61.4±0.46
1995, March 20…	1.4-2.2	1.8±0.2	46.5-58.2	48.2±0.48
Average of five years				
Autumn sowing:	1.54-2.66	2.04±0.25	51.2-65.4	57.2±0.36
Spring sowing:	1.36-2.14	1.71±0.25	46.2-56.8	48.4±0.52

Table 2

Number of plants of parental forms and F2-F4 hybrid plants according to length (mm)

Length of spikelet keel tooth / Parental forms and hybrids by generations	Number of analyzed plants according to length of tooth of the spikelet keel																													
	1.1	1.2	1.4	1.6	1.9	2.1	2.3	2.5	2.7	3.1	3.5	3.9	4.3	4.8	5.1	8.5	10.3	12.5	16.3	24.5	32.5	37.5	42.5	49.4	54.5	59.5	62.5	69.5	77.5	M±m
♀ x)spring sown,	-	-	4	10	5	12	14	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.9±
♂ xx) autumn sown	-	-	2	8	4	10	12	2	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.1±0.2
♀ x) spring sown,	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	5	9	11	7	6	4	3	63.3±0.43
♂ xx) autumn sown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	6	2	7	10	8	9	8	7	60.1±0.49
♀ x) spring sown,	-	-	-	-	2	1	1	3	2	1	2	2	1	2	1	2	3	3	1	1	3	-	1	2	4	3	4	5	3	32.7±2.39
♂ xx) autumn sown	1	1	1	1	2	3	-	-	4	2	1	1	1	1	2	1	1	-	2	2	4	3	2	1	1	1	2	4	2	39.3±2.42
♀ x) spring sown,	-	-	5	10	7	11	13	9	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.25±0.2
♂ xx) autumn sown	1	1	6	12	6	12	9	10	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.1±0.3
♀ x) spring sown,	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	2	1	1	7	4	10	12	8	55±0.41
♂ xx) autumn sown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	4	8	6	11	7	10	14	11	62.4±0.41
♀ x) spring sown,	-	-	4	7	4	6	3	4	8	19	12	4	9	6	4	6	3	5	7	8	4	11	4	5	9	12	14	16	-	35.4±2.44
♂ xx) autumn sown	6	9	5	9	6	7	5	5	9	8	10	3	6	3	5	8	6	7	5	8	6	12	5	7	11	13	12	17	15	39.3±2.36
♀ x) spring sown,	-	-	-	6	11	10	14	16	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.15±0.3
♂ xx) autumn sown	1	1	3	8	9	12	13	17	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.9±0.2
♀ x) spring sown,	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	7	3	2	8	6	11	13	10	57.5±0.56
♂ xx) autumn sown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	4	8	2	4	11	-	14	10	16	55.0±0.43
♀ x) spring sown,	-	-	-	-	-	6	8	2	1	-	-	3	10	-	12	16	-	-	9	4	6	7	3	8	10	14	16	17	-	35.8±2.51
♂ xx) autumn sown	-	-	4	8	6	5	9	4	2	3	2	5	12	14	-	10	5	4	10	2	5	-	-	9	-	16	13	14	20	39.4±2.34
x)♀ Durum wheat																														
xx)♂ Wheat Dika																														

x-spring sown, xx-autumn sown

character, though according to manifestation of this character all plants are inclined to short-toothed Durum (hard) wheat.

Investigation of F_2, F_3 and F_4 plants obtained as a result of spring and autumn sowong has shown that segregation according to tooth length of the main ear spikelet glume is of compex character and great variety of forms are received, which create long variation series according to generations. In this respect a longer variation series is characteristic of plants obtained as a result of autumn sowing. In plants obtained from seeds sown in autumn more individuals differ from both initial forms in the direction of both decrease of this trait and its increase.

Our data on length of spikelet keel tooth coincide with data by Vavilov [1] and Lepin [2] in that tooth length is intermediate in plants of F_1 generation and this quantitative trait is conditioned by several genes. But Vavilov's conclusion [1] that short toothedness of hard wheat is suppressed in F_1 generation is not confirmed either by our, or by Lepin's [2] data.

A great bulk of numerical data were got for F_2, F_3, and F_4 generations and it was impossible to present all of them in the form of Tables. That's why here we give variation series from a single plant in each generation with parallel indication of variation series of parental plants (Table 2). Of the obtained results it is noteworthy that segregation in 80 plants of F_2 generation does not correspond to the ratio of Mendel's segregation. This indicates that length of tooth of the ear spikelet keel is dependent on several pairs of simple (single-valued) factors and that short length of tooth is a dominant trait. It becomes clear that single-valued factors hamper longitudinal growth of tooth and development of awn.

Short-toothed plants revealed in hybrid population phenotypically are similar to short-toothed parental plants, but at the edge of the tooth characteristic black coloration of the male parental form Dika *var. fuliginosum* is evident. This points to the heterogeneity of the population and as a result of heterogeneity such biotypes undergo segregation and in every generation long variation series are obtained.

Conclusion. As a result of a study of tooth length of main ear spikelet keel in interspecific hybrids obtained by crossing hard wheat *var. coerulescens* with dika wheat *var. fuliginosum* it has been established that:

1. Length of tooth of spikelet keel slightly varies within years and according to the season of sowing, but variation rate is so insignificant from a practical viewpoint that it does not affect the stability of the trait. Thus length of tooth of the main ear spikelet keel can be assessed as characteristic trait of a species, variety and a sort and may be used as a probation trait in seed farming.

2. Inheritance of length of spikelet glume in the first generation is of intermediate character, though according to this trait, these plants are more inclined to the short-toothed parental form.

3. In the second generation complex segregation is the case – numerous forms, intermediate between parental forms, are segregated; also few extreme forms are obtained, which phenotypically resemble both hard wheat and Dika wheat. Segregation in 80 plants of the total number of plants does not correspond to the ratio of Mendel's segregation, pointing to the fact that several pairs of single-valued factors are responsible for the length of spikelet keel tooth and short length of tooth reprsents a dominant trait.

4. New type of segregation can be established according to manifestation of length of tooth of the main ear spikelet keel.

გენეტიკა და სელექცია

მაგარი ხორბლის (*T. durum* Desf) და ხორბალ დიკას (*T. carthlicum* Nevski) შეჯვარებით მიღებულ ჰიბრიდებში თავთუნის კილის კბილაკის სიგრძის მემკვიდრეობის შესწავლის საკითხისათვის

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ნაშრომში ნაჩვენებია, რომ ხორბლის თავთუნის კილის კბილაკის სიგრძე მიეკუთვნება ოდენობრივ-მორფოლოგიური ნიშნების ჯგუფს, ცვალებადობს წლებისა და თესვის სეზონების მიხედვით, მაგრამ ეს ცვალებადობა იმდენად უმნიშვნელოა, რომ არ ცვლის ნიშნის სიმყარეს, რის გამოც ეს ნიშანი შეიძლება მიჩნეულ იქნეს სახეობის, სახესხვაობის და ჯიშის დამახასიათებელ მყარ ნიშნად და გამოყენებული უნდა იქნეს მეთესლეობაში სააპრობაციო ნიშნად. მოკლე- და გრძელკბილაკიან ფორმათა შეჯვარებით მიღებული პირველი თაობის მცენარეებში ამ ნიშნის მემკვიდრეობა შუალედური ხასიათისაა, თუმცა უფრო მეტადაა გადახრილი მოკლეკბილაკიანი მშობლის მიმართულებით. მეორე თაობაში დათიშვა მეტად რთულია, გამოთიშული ფორმები ფენოტიპურად ემსგავსებიან მოკლეკბილაკიან და გრძელკბილაკიან მშობლიურ ფორმებს, მათ შორისაა აგრეთვე უფრო მეტად მოკლე და გრძელკბილაკიანი ფორმებიც. დადგინდა, რომ კბილაკის სიგრძის მემკვიდრეობა დამოკიდებულია ერთგვაროვან რამდენიმე წყვილ ფაქტორზე. მოკლეკბილაკიანობა დომინანტური ნიშანია.

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