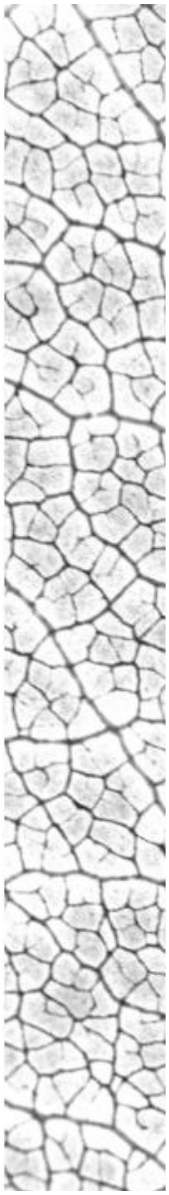

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Preselectional study of *Triticum aestivum* samples from VIR collection by productivity indicators

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Abstract
The preselection study of wheat sample collection included the identification of the research object characteristics in order to identify the best candidates for use in selection practice. The object of the study was 19 samples of soft winter wheat from the collection of the All-Russian Institute of Plant Genetic Resources named after N.I. Vavilov (VIR). The following characteristics were used as the indicators of ear productivity in the analysis of the collection material: the length of the main ear (cm), the number of spikelets in the main ear (pcs.), the number of grains in the main ear (pcs.), the weight of grain from the main ear (g), the weight 1000 grains (g). The height of the plants was one of the basic indicators of the studied material, because a number of samples differed in alleles of short-stemmed genes. According to the results of two years of research, and according to the indicator "the weight of 1000 grains", the cultivar Cologna lunga razza 188 (Italy) stood out and made 71.20 g. According to the indicator "the number of grains per ear", the cultivar Fenotipo 1 (Italy) - 57.3 g., according to the totality of indicators, the cultivar Kaloyan (Bulgaria) was selected with an average weight of 1000 grains over two years of research - 51.77 g., the number of grains per ear - 51.6 pcs. and the mass of grains from an ear - 2.71 g.

Keywords: soft wheat, plant height, ear productivity, 1000 grain weight

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INTRODUCTION

The improvement of cultivated wheat genotype is one of the priority tasks of agriculture. One of the solutions to this issue is the preselection study of samples taken for storage in seed banks. There are about 229 genetic collections in the world, and the total number of wheat samples stored there is estimated at slightly more than 850 thousand. Russia has one of the most significant national collections of wheat in terms of volume and genetic diversity, located at the Federal Research Center of All-Russian Institute of Plant Genetic Resources named after N.I. Vavilov (VIR), along with Japan, China, USA, Italy and India. The VIR collection of wheat genetic resources is a significant source of material for breeding this crop, both in our country and abroad, as well as the main base for applied and fundamental research and it has more than 54 thousand samples (Bespalova, 2015; Vavilov, 1926; Nanjundan, et al. 2020; Fitriatin, & Simarmata, 2016).

The aim of the study was to study the collection of winter bread wheat samples from the VIR collection, differing in weight of 1000 grains and in the alleles of short-stemmed genes in terms of productivity.

The following tasks were set to achieve the goal:

- Distribution of the studied samples according to the "plant height" indicator;
- Evaluation of ear productivity indicators;
- Allocation of promising collection samples for selection.

MATERIALS AND METHODS

The experimental part of the work was carried out in the "Laboratory of Genetics, Selection and Control Seed Analysis", on the basis of the Federal State Budgetary Educational Institution of Higher Education "Kuban State Agrarian University named after I.T. Trubilin" and on the experimental field of the educational farm "Kuban" of KubSAU, Krasnodar (2018-2019).

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Table 1. Studied samples of winter soft wheat from the VIR collection

Item №	VIR catalogue number	Country of origin	Name
1	Control	Russia	Vassa (k)
2	26537	Italy	Cologna lunga razza 188
3	55185	Russia	Olympia
4	57271	Bulgaria	Kaloyan
5	57272	Bulgaria	Requiem
6	57274	Bulgaria	Trajana
7	58801	Russia	Spartanka
8	62505	Bulgaria	KS 58
9	62506	Bulgaria	KS 60
10	62827	France	Miplain
11	63328	France	Rossini
12	63642	France	Dore
13	63885	Czech Republic	Vega
14	63886	Czech Republic	Alana
15	63888	Czech Republic	Samara
16	64019	Czech Republic	Mironovskaja 808
17	64068	Bulgaria	Bononia
18	64534	France	Trend
19	65025	Bulgaria	Enola
20	–	Italy	Fenotipo 1

One-factor laboratory-field experiment was laid in three repetitions with a randomized arrangement of experimental plots during the fall of 2017 on the experimental field of the educational experimental farm "Kuban". The plot size made 1.5 × 0.5 m., manual sowing, ordinary sowing, row spacing - 15 cm, seeding rate - 65-75 grains per running meter. The seeding depth is 4-6 cm. The sowing time is optimal for the central zone of Krasnodar Territory. Fertilizers and plant protection products were not used in the experiment. Sowing and harvesting method is manual.

The object of the study is 19 specimens from the collection of the "Federal Research Center of All-Russian Institute of Plant Genetic Resources named after N.I. Vavilov" (VIR) from 5 countries: Bulgaria, Italy, Czech Republic, France and Russia. We took the Vassa variety as control, from the selection of NGC named after P.P. Lukyanenko (**Table 1**).

During the experiment, they analyzed the following indicators: plant height (cm), the main spike length (cm), the number of spikelets in the main spike (pcs.), the number of grains in the main spike (pcs.), grain weight from the main spike (g), the weight of 1000 grains (g). Evaluation of productivity elements was carried out according to the methods adopted in KubSAU.

V.F. Dorofeev's scale was used for comparative characteristics of the winter soft wheat collection samples in terms of plant height: tall (over 120 cm), medium-sized (106–120 cm), short-stemmed (86–105 cm), semi-dwarf (61–85 cm); dwarf (41–60 cm) and superdwarf samples (less than 41 cm) (Dorofeev et al. 1976).

The computer program Microsoft Excel 2010 was used for statistical processing of the data, using the methods for calculating the standard deviation and analysis of variances. The results were compared using NSR with a 95% confidence interval. The calculation of one-factor analysis of variance was carried out according to the method by B.A. Dospekhov (Til'ba, & Sinegovskaya, 2012).

RESULTS AND DISCUSSION

Tall growth and low strength of the stem are the main reasons for lodging. At that, about 80% of the influence is exerted by the length of the stem (Kameneva, 2019). During the study, significant lodging of soft winter wheat

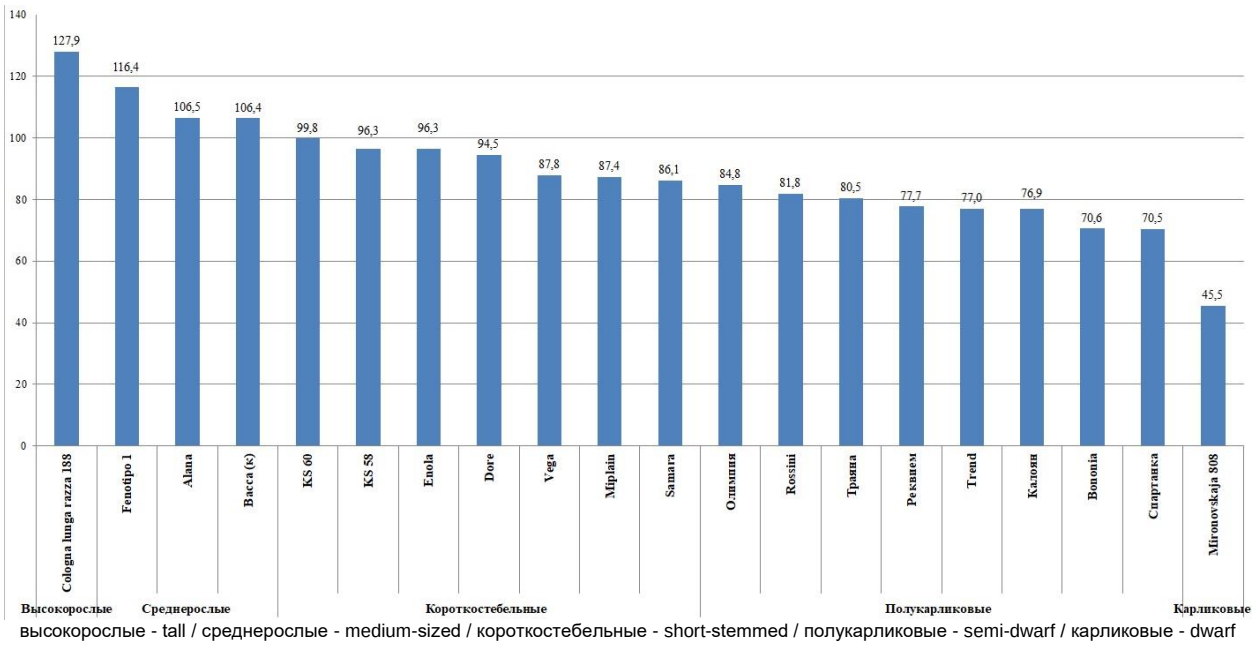
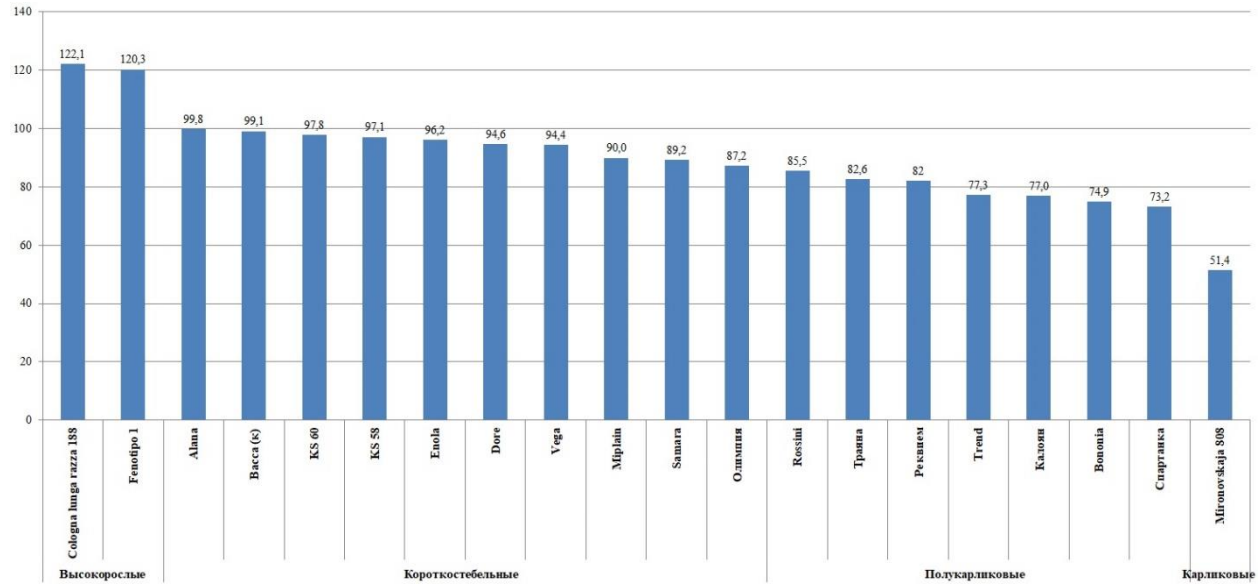


Fig. 1. Plant height of winter soft wheat samples from the VIR collection, 2018



высокорослые - tall / короткостебельные - short-stemmed / полукарликовые - semi-dwarf / карликовые - dwarf

Fig. 2. Plant height of winter soft wheat samples from the VIR collection, 2019

Table 2. Ear length and the number of productive spikelets and grains in an ear of winter soft wheat samples from the VIR collection, 2018-2019

Variety sample	Ear length, cm				The number of productive spikelets per ear, pcs.				Ear density index, units	
	2018		2019		2018		2019		2018	2019
	X*	±σ**	X	±σ	X	±σ	X	±σ		
Bacca (к) Vassa(k)	10,9	0,9	9,8	0,8	23,8	2,2	24,0	2,0	21,8	24,5
Cologna lunga razza 188	10,7	1,6	10,3	1,7	14,7	1,7	15,0	1,9	13,7	14,6
Vega	9,3	0,5	9,1	0,7	19,4	1,1	16,2	1,4	20,9	17,8
Alana	9,9	1,1	9,7	1,0	19,2	1,9	17,0	1,8	19,4	17,5
Olympia	8,7	0,9	8,8	0,8	15,9	2,0	15,5	1,8	18,3	17,6
Requiem	8,8	0,7	8,7	0,6	20,1	3,0	20,6	3,0	22,8	23,7
Trend	8,9	0,8	9,2	0,9	18,9	2,2	17,8	2,4	21,2	19,3
Kaloyan	10,7	0,8	9,6	1,0	19,8	3,2	19,9	3,7	18,5	20,7
Spartanka	9,1	1,0	8,9	1,2	17,4	2,2	15,1	1,9	19,1	17,0
KS 58	7,6	0,6	7,9	0,7	16,8	1,6	14,5	1,1	22,1	18,4
Miplain	8,4	0,6	8,2	0,7	17,1	1,0	14,7	1,5	20,4	17,9
Bononia	8,2	0,9	7,9	1,1	17,3	1,8	15,1	2,1	21,1	19,1
Dore	7,3	0,6	7,9	0,8	15,9	1,2	14,3	1,6	21,8	18,1
Enola	7,7	1,0	7,9	0,9	17,2	1,7	17,4	1,7	22,3	22,0
Trajana	8,7	1,1	9,4	1,0	17,2	2,2	16,6	2,4	19,8	17,7
KS 60	7,2	0,8	8,9	1,1	16,3	1,6	15,8	1,9	22,6	17,8
Mironovskaja 808	9,8	1,0	10,4	0,9	17,3	1,8	17,0	1,9	17,7	16,3
Rossini	7,6	0,9	8,8	1,2	15,5	2,6	16,2	2,4	20,4	18,4
Fenotipo 1	10,6	1,0	10,9	0,7	19,6	1,8	20,5	1,6	18,5	18,8
Samara	7,5	0,8	7,3	0,6	23,8	1,9	16,0	2,0	31,7	21,9
HCP_{05}	1,2		0,8		–		–			

*average values
**standard deviation

plants was not observed. Thus, one of the promising areas of wheat breeding is the search and selection of plants by this trait (Koshkin 2015. Nanjundan, et al. 2020) (**Figure 1**).

In terms of the "plant height" indicator, the studied varieties were distributed into the groups as follows (2018): 5% - tall, 15% - medium-sized, 35% - short-stemmed, 40% - semi-dwarf and 5% - dwarf. The maximum plant height was shown by the cultivar Cologna lunga razza 188 - 127.9 cm, the minimum - by Mironovskaja 808 - 45.5 cm. During the second year of the study, the distribution changed: 10% - tall, 50% - short-stemmed, 35% - semi-dwarf and 5% - dwarf. The maximum plant height was shown by the cultivar Cologna lunga razza 188 - 122.1 cm, the minimum - by Mironovskaja 808 - 51.4 cm.

The traits "spike length" and "the number of productive spikelets in an ear" are the indicators of an ear potential productivity (Kuperman 1973, Savichenko 2018). These traits are characterized by constancy, and their changes in the selection process are a difficult task (Tsatsenko 2014, Neshchadim, 2017) (**Table 2**).

Table 3. Number of grains in an ear, weight of grains per ear and the weight of 1000 grains of winter bread wheat samples from the VIR collection, 2018-2019

Variety sample	The number of weevils in an ear, g				Weight of grains per spike, g				Weight of 1000 grains, g			
	2018		2019		2018		2019		2018		2019	
	X*	±σ**	X	±σ	X	±σ	X	±σ	X	±σ	X	±σ
Bacca (к) Vassa(к)	53,8	8,9	50,3	9,1	3,01	0,44	2,88	0,51	56,91	4,81	55,63	5,02
Cologna lunga razza 188	26,5	4,2	24,5	4,0	1,89	0,34	1,70	0,41	71,20	3,45	69,15	3,62
Vega	45,2	7,8	35,5	6,3	2,06	0,59	1,33	0,30	46,60	7,10	37,24	3,68
Alana	39,9	7,8	38,5	7,0	1,90	0,44	1,51	0,35	47,61	3,91	38,89	3,63
Olympia	39,5	8,5	31,6	7,1	1,78	0,39	1,34	0,34	44,92	2,72	42,01	5,15
Requiem	53,1	12,1	50,3	10,1	1,86	0,48	1,43	0,57	35,11	4,75	34,21	5,14
Trend	48,5	11,4	46,6	10,4	1,87	0,57	1,52	0,44	38,52	3,89	32,57	4,43
Kaloyan	52,4	10,7	50,8	11,6	2,63	0,62	2,78	0,73	50,23	3,35	53,31	3,79
Spartanka	38,1	9,5	40,0	5,6	1,68	0,47	1,37	0,25	44,10	4,74	40,28	3,03
KS 58	35,8	6,7	30,2	5,5	1,96	0,43	1,41	0,26	54,62	3,29	46,87	2,81
Miplain	38,2	5,9	33,2	6,9	1,84	0,40	1,41	0,36	48,33	8,53	41,81	4,78
Bononia	42,1	10,1	33,1	9,9	2,30	0,66	1,56	0,60	54,62	3,97	46,45	4,16
Dore	34,8	5,5	33,5	6,5	1,66	0,29	1,43	0,39	47,02	5,63	42,18	6,32
Enola	40,3	4,0	36,4	7,5	1,74	0,20	1,37	0,30	43,11	2,20	37,64	2,95
Trajana	35,3	7,7	38,8	8,6	1,74	0,43	1,74	0,43	49,42	2,75	44,62	2,96
KS 60	33,4	8,5	40,0	10,2	1,79	0,53	2,06	0,56	53,77	3,25	51,44	4,25
Mironovskaja 808	37,1	10,4	43,1	7,4	1,28	0,39	1,25	0,29	34,46	5,33	28,77	3,96
Rossini	38,8	11,9	42,4	9,7	1,82	0,59	1,48	0,34	46,92	9,97	35,01	7,84
Fenotipo 1	58,3	7,1	56,2	6,8	2,28	0,47	2,35	0,39	46,50	5,30	47,98	4,83
Samara	35,7	6,6	33,6	7,0	1,29	0,32	1,12	0,31	36,10	3,39	34,88	3,25
HCP_{05}	4,4		6,3		0,26		0,19		3,17		4,71	

*average values
**standard deviation

The “spike density index” was used to assess the combination of two characteristics, which is the ratio of the productive spikelet number in an ear to 10 cm of an ear length.

In 2018, 4 variants were distinguished by the ear length: Vassa (control), Kaloyan, Cologna lunga razza 188 and Fenotipo 1 - 10.9, 10.7, 10.7 and 10.6 cm, respectively. However, the cultivar Cologna lunga razza 188 was characterized by high variability of the trait in comparison with the rest of the samples (σ = ± 1.6) and the lowest indicator of "productive spikelet number in an ear" made 14.7 pcs., which characterizes the ear as a long one with a low index ear density - 13.7. Also, the varieties Kaloyan and Fenotipo 1, which stood out by the spike length, had the following numbers of productive spikelets: 19.8 and 19.6 pcs., and spike density index made 18.5 units. Kaloyan and Fenotipo 1 varieties did not outperform the control variety Vassa.

In 2019, the sample Fenotipo 1 stood out according to the indicator "spike length" - 10.9 cm, significantly surpassing the control variety Vassa by 1.1 cm (HCP_{05} = 0.8). However, according to the indicator “the number of productive spikelets in an ear”, it was significantly inferior to the control of 3.5 pcs. and the spike density index of 18.8 units.

Thus, according to the results of two years of research, the specimen Fenotipo 1 was isolated from the collection samples - the average length of an ear is 10.8 cm, the number of productive spikelets in an ear is 20.1 pcs., the density index of an ear is 18.7 units.

One of the key indicators of ear productivity is the "number of grains in an ear" and "1000 grain weight". An inverse correlation is noted between them. Thus, the search for a combination of both features is a priority task (Savichenko 2018). The result of the aggregate of these indicators is the "weight of grains per ear" (Tsatsenko, 2013). (**Table 3**).

In 2018, according to the indicator "the number of grains per ear", the specimen Fenotipo 1 stood out - 58.1 pcs. significantly surpassing the control variety Vassa by 4.5 pcs. (HCP_{05} = 4.4). The smallest value was shown by the cultivar Cologna lunga razza 188 - 26.5 pcs. However, it was characterized by the highest value of the mass of 1000 grains - 71.20 g. In terms of the mass of grains per spike, the control variety Vassa had the highest value - 3.01 g.

In 2019, according to the indicator "the number of grains per ear", the specimen Fenotipo 1 stood out - 56.2 pcs. insignificantly surpassing the control variety Vassa by 4.9 pcs. (HCP_{05} = 6.3). According to the indicator "weight of 1000 grains", the sample Cologna lunga razza 188 showed the highest value - 69.15 g. According to the indicator "weight of an ear", the variety Kaloyan stood out, showing the value of 2.78 g, insignificantly yielding to the control variety Vassa with an ear weight of 2,88 g (HCP_{05} = 0.19).

According to the results of two years of research, the Fenotipo 1 and Kaloyan samples stood out in terms of an ear productivity with over two years of research on the average: the mass of 1000 grains is 47.24 and 51.77 g, the number of grains per ear is 57.3 and 51.6 pcs., the mass of grains from an ear is 2.31 and 2.71 g, respectively. The Cologna lunga razza 188 sample stood out in terms of the "mass of 1000 grains" - 70.18 g.

CONCLUSIONS

According to the data for two years of research, the distribution by height of plants of the studied varieties was the following: 5-10% - tall, 0-15% - medium-sized, 35-50% - short-stemmed, 35-40% - semi-dwarf and 5% - dwarf. According to the productivity parameters of the studied sample ear of winter soft wheat, the samples of Cologna lunga razza 188 (Italy) were distinguished by the weight of 1000 grains - 70.2 g, the sample Fenotipo 1 - by the number of grains in the ear - 57.3 pcs., and the variety Kaloyan by the totality of ear productivity indicators.

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