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ОЦЕНКА НОВЫХ ГИБРИДОВ КУКУРУЗЫ В УСЛОВИЯХ ПРЕДГОРНОЙ ЗОНЫ КАБАРДИНО-БАЛКАРИИ

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Представлены результаты создания гибридов кукурузы с урожайностью не ниже 8–11 т/га, обладающих хорошей влагоотдачей в период созревания, с достаточно хорошей полегаемостью и устойчивостью к биотическим и абиотическим факторам среды. Научно-практическая работа выполнена в 2020, 2021 гг. на опытном поле лаборатории селекции и семеноводства раннеспелой кукурузы в предгорной зоне Кабардино-Балкарской Республики. Проведена оценка гибридных комбинаций различных групп спелости: раннеспелые с индексом скороспелости ФАО 170–220 и среднеспелые – ФАО 220–300. Закладку опытов в контрольным питомнике и изучение экспериментальных гибридных комбинаций по основным хозяйственным значениям проводили согласно общепринятым методическим рекомендациям. Гибриды изучены по основным хозяйственно ценным признакам: уборочная влажность зерна, выход зерна, урожайность зерна при 14%-й влажности. В группе спелости ФАО 170–220 по уборочной влажности отмечено 8 гибридов, по выходу зерна – 6, по урожаю зерна – 7 комбинаций. В варианте ФАО 220–300 выделены по уборочной влажности 5 гибридных комбинаций, по выходу зерна – 7, по урожаю зерна – 3 гибридные комбинации. Данная работа по оценке гибридов кукурузы в контрольном питомнике проведена в соответствии с планом научно-исследовательской работы. Все выделенные в научно-практической работе гибриды превышали достоверно (по оцененным показателям) стандартные значения в своих группах спелости.

Ключевые слова: кукуруза, гибриды, группа спелости, уборочная влажность, урожай зерна, контрольный питомник, результаты испытаний

EVALUATION OF NEW CORN HYBRIDS IN THE CONDITIONS OF THE FOOTHILL ZONE OF KABARDINO-BALKARIA

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The results of creating corn hybrids with yields no lower than 8-11 t/ha, with good water-yielding capacity during ripening, with good enough lodging and resistance to biotic and abiotic environmental factors are presented. Scientific and practical work was carried out in 2020, 2021 in the experimental field of the Laboratory of Breeding and Seed Production of Early-Maturing Corn in the Foothill Zone of the Kabardino-Balkarian Republic. Evaluation of hybrid combinations of different ripeness groups: early-ripening with an index of early maturity FAO 170-220 and medium-ripening - FAO 220-300 was conducted. Planting experiments in the control nursery and the study of experimental hybrid combinations on the main economic values were carried out according to generally accepted methodological recommendations. The hybrids were studied for the main economically valuable traits: harvest grain moisture, grain yield, grain yield at 14% moisture. In the ripeness group FAO 170-220 by harvesting moisture 8 hybrids were noted, by grain yield - 6, by grain yield - 7 combinations. In the variant FAO 220-300, 5 hybrid combinations were selected for harvesting moisture content, 7 hybrid combinations for grain output, 3 hybrid combinations for grain yield. This work on the evaluation of corn hybrids in the control nursery was carried out in accordance with the plan of research work. All hybrids selected in the scientific and practical work exceeded reliably (according to the evaluated indicators) the standard values in their ripeness groups.

Keywords: corn, hybrids, ripeness group, harvesting humidity, grain yield, control nursery, test results

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Conflict of interest
The authors declare no conflict of interest.

INTRODUCTION

Ensuring the growth of grain production, including corn, and the creation on this basis of a balanced fodder base is one of the main priorities of food security of the Russian Federation [1]. Corn is an important grain and fodder crop. It is widely spread because of its high potential yielding capacity. Gross yield of this crop reaches 800 million tons, which makes 34% of total world production. In Russia corn production is about 5 million tons, and there is a tendency of its growth. In almost all corn-growing countries corn is grown for grain, which is used for food, fodder and technical purposes. For the food industry corn grain is a raw material for the production of cereals, flour, oil, starch, alcohol (ethanol), and syrup [2, 3].

Due to its properties corn in Russia is used as a grain and fodder crop, which is mainly used to feed livestock and poultry. Green mass of corn is used for making silage and grain is added to mixed fodder as an obligatory component. Corn grain has high fodder value - 1 kg contains 1.34 fodder units (f.u.), while barley grain - 1.2 f.u., oats - 1 f.u. It contains 65-70% nitrogen-free extractive substances, 9-12% protein, 4-5% fat, 2% sugar, and very little fiber [4]. According to scientists, corn is of great importance in the economy and increasing food security [5].

Expansion of corn crops is an obvious need, it should be given special attention as a crop that gives high yields and allows you to quickly solve the issues of complete supply of livestock nutritious and concentrated fodder, and industry - raw materials for processing [6]. The need to increase grain production is the reason for growing corn outside the traditional cultivation zones, in the areas with less favorable conditions - lack or excess of light, heat, water and other factors. In the Russian Federation corn is cultivated in very contrasting climatic zones. In recent years, a wide range of new high-yielding corn hybrids, the potential yields of which are much higher than the standards, have been grown in production [7]. The most important factor in the intensification of corn grain production is the creation of highly productive hybrids adapted to local soil and climatic conditions [8].

In Kabardino-Balkaria the main priority in crop production is seed production and commercial production of corn, since agroclimatic conditions in the republic are the most optimal in comparison with other regions and the regions of the Russian Federation that produce corn. Cereal crop yields have been showing an upward trend since 2005. Therefore, the creation of a solid base of corn seed breeding requires the study of the breeding material in terms of yield and resistance to extreme environmental factors, the chemical composition of grain and green mass[1]. Because of the increasing competition in the grain market, properly organized breeding and seed breeding research are important areas that determine the further generation of promising varieties and hybrids of agricultural crops [9].

The Kabardino-Balkarian Republic has a well-defined vertical zonality. On a small territory in one climatic zone there are three sharply different agricultural zones: mountain, foothill and steppe (flatland). Corn is cultivated in all zones, but for each zone it is necessary to select

[1]Khatefov E.B. Seed productivity of tetraploid maize and ways to increase it in the conditions of Kabardino-Balkaria: Doctor of Biology thesis: 06.01.05. SPb, 2012, 45 p.

specifically those or other hybrids of different ripeness groups, depending on the purposes for which corn is produced (grain, silage, seeds) [1].

The purpose of the work is to evaluate corn hybrids of different ripeness groups in the control nursery by economically useful traits for further use in the breeding and seed production program of the Institute of Agriculture - Branch of the Federal Scientific Center "Kabardino-Balkarian Scientific Center of the Russian Academy of Sciences" (IA KBSC RAS).

MATERIAL AND METHODS

Scientific and practical work was carried out in 2020, 2021 on the experimental field of the Laboratory of Breeding and Seed Production of Early-Maturing Corn of the Institute of Agriculture - branch of the Kabardino-Balkarian Scientific Center of the Russian Academy of Sciences (IA KBSC RAS) at the Scientific and Production Site No. 1 (piedmont zone).

The soil of the experimental plot is common chernozem. Soil form - carbonate soil. Soil variant - heavy loamy. Agrochemical characteristics of the soil of the experimental plot (according to Chirikov): pH - 7.2; P_2O_5 mobile - 9.8 mg/100 g soil; K_2O exchangeable -7.2 mg/100 g soil; humus (according to Tyurin) - 4.4%. The arable horizon contains 3.9-4.2% humus, 18-27 mg of nitrogen, 27-34 mg of labile phosphorus, and 230-250 mg of exchangeable potassium [10]. Agrometeorological conditions for the years of study are presented in Table 1 (data of the Kabardino-Balkarian Central Hydrometeorological Service).

Weather conditions were generally favorable for good growth and development of the crop.

The material and technical part of the experiment consisted of the following elements: corn seeds of own selection, except for standard values, hand planters, journal of phenological observations, polyethylene bags, scales, moisture meter.

The control nursery included 72 hybrid combinations (FAO 170-220 and 220- 300), (FAO 170-220, standard Mashuk 171, and FAO 220-300, standard Krasnodar 291 AMV). The precursor in the 2020, 2021 trials was winter wheat. Nitro-ammonium phosphate in the amount of 150 kg/ha with inter-row cultivation was applied annually to the experimental plot, and top dressing with ammonium nitrate at the rate of 150 kg/ha was carried out. In the phase of 3-6 leaves the plot was treated with postemergence herbicide Elumis, MD at a rate of 2 l/ha.

Monitoring of corn plants development was carried out throughout the study period, and harvest grain moisture, yield, and grain yield were determined when converted to 14% moisture. Establishment of the experiments and the study of experimental hybrid combinations on the main economic values were carried out according to the methodical recommendations [2-4]. Plots were double-row, in double repetition, the area of one plot was 7.84 m^2, the placement was randomized. Sowing and harvesting of the crop during the years of study were carried out manually. Harvesting was carried out with determination of harvesting moisture content by a Wille 68 moisture meter with 3-fold measurement of each number.

RESULTS AND DISCUSSION

The results of hybrids evaluation in the control nursery by the main economically valuable traits for 2020, 2021 are presented in Table 2.

The data obtained indicate that in the FAO 170-220 group the following hybrids are distinguished by harvesting moisture Malvina C × 1/99-1-1 5014-1-2, Malvina C × 1/99-1-1 5014-1-4, Malvina C × 92c 5428-2-3-3-1, Malvina C × 92c 5195-3-3- 2-1-1, Malvina C × 92c 5195-3-3-2-2-1, Malvina C × 1/99-4-1-1, Milena M × 1/66- 1-4-1, Milena M × 92c 5261-2-1-1-3. On average, the values were in the range

[2]Filev D.S., Tsikov V.S., Zolotov V.I., Logachev N.I., Telyatnikov N.Y., Ponomarenko A.K. Methodological recommendations for field experiments with corn. Dnepropetrovsk: All-Russian Research Institute of Corn, 1980. 54 p.

[3]Methodology of State Variety Testing of Agricultural Crops. 1989. Issue. 2. Moscow, 197 p.

[4]Dospekhov B.A. Methodology of field experience (with the basics of statistical processing of research findings). Moscow: Agropromizdat, 1985. 351 p.

Табл. 1. Метеоданные вегетационных периодов в предгорной зоне Кабардино-Балкарской Республики за 2020, 2021 гг.

Table 1. Meteorological data of vegetation periods in the foothill zone of the Kabardino-Balkarian Republic, for 2020, 2021

Month	Indicator						
	Air temperature, °C			Amount of precipitation		Air humidity, %	
	Average	Maximum	Minimum	Absolute index, mm	% of the norm	Average	Minimum
2020							
April	10,2	16,2	3,2	37,7	61,0	57	36
May	16,1	22,3	11,1	114,1	124,7	68	51
June	21,9	28,8	15,4	71,4	73,0	60	41
July	25,0	31,9	19,5	20,0	33,4	55	33
August	22,1	28,8	15,6	86,3	94,3	54	33
September	19,2	25,9	13,1	20,2	37,1	64	43
2021							
April	11,6	17,8	7,1	35,1	55,1	69	50
May	18,1	24,8	11,8	83,8	98,6	61	42
June	22,3	26,3	15,6	127,1	144,8	69	55
July	24,1	30,8	17,6	112,4	103,4	58	40
August	24,6	34,6	16,2	34,2	34,5	54	33
September	15,3	31,2	5,8	103,5	125,6	79	22

of 14,4–17,2%. In terms of grain yield, the best are Malvina C × 1/99-1-1 5014-1-2, Malvina × 1/99-1-1 5014-1-4, Malvina C × 1/99-4-1-1, Milena M × 1/66-1-4-1, Milena M × 92c 5261-2-1-1-3, Malvina C × КБ 630-2-3-3-2-2-2-4-2-9-1-4, Malvina C × 92c 5195-3-3-2-1-3, this indicator was 82,1–84,3%. In terms of grain yield (at 14% moisture content) – Malvina C × 1/99-1-1 5014-1-2, Malvina C × 1/99-1- 1 5014-1-4, Malvina C × 92c 5428-2-3-3-1, Malvina C × 92c 5195-3-3-2-2-1, Milena M × 1/66-1-4-1, Malvina C × КВ 630-2-3- 3-2-2-2-4-2-9-1-4, Malvina C × 92c 5195-3- 3-2-1-3, hybrid combinations exceeded the standard variant by 0.17-0.60 t/ha. In the variant FAO 220-300 such hybrids can be distinguished by harvesting moisture, as RG 1 C × 92c 5280-2-2-2-2-3, RG 4 M × 92c 5253-1-1-1-3, Madonna M × 92c 5520-1-1-1- 1, OL 3104 M × 6207-1, OL 273 M × 92c 6195- 5-1-1-1 (the values for this attribute were as follows 16,1–18,1%); in terms of grain yield – RG 1 C × 92c 5280-2-2-2-2-3, (В 52м × GK 26 zm) × 633MB, RG 4 M × 92c 5253-1-1-1-3, Madonna M × 92c 5195-3-3-2-2-1, Madonna M × 92c 5520-1-1-1-1, OL 3104 M × 6207- 1, OL 273 M × 92c 6195-5-1-1-1 (at the level of 81,2–84,3%); by grain yield – RG 1 C92c 5280-2-2-2-2-3, (B 52m × GK 26 zm) × 633MB, OL 3104 M × 6207-1, Kr. 704 UM × 633MB (the selected hybrids outperformed the standard value by 0,24–0,62 t/ha).

CONCLUSION

Analysis of corn hybrids in the control nursery is important because it allows us to identify the most valuable hybrids according to the main economically valuable indicators.

In the course of research on evaluation of corn hybrids for economically useful characteristics 6 hybrids were identified in the group FAO 170-220 and 4 hybrids in the group FAO 220-300, which exceeded the standard values on all main indicators of productivity. The selected early- ripening and medium-early corn hybrids are of great breeding interest, therefore, they will be transferred for ecological variety testing to scientific institutions belonging to the Corn Coordinating Council.

Табл. 2. Результаты испытания выделившихся гибридов кукурузы в контрольном питомнике за 2020, 2021 гг. в НПУ № 1 (предгорная зона)
Table 2. Results of testing of isolated corn hybrids in a control nursery for 2020, 2021 in NPU No. 1 (foothill zone)

Item No.	Hybrid	Grain yield at 14% moisture, t/ha			Harvest moisture of grain (average), %			Grain output (average), %		
		2020	2021	Average	2020	2021	Average	2020	2021	Average
	FAO 170–220									
1	Mashuk 171 (standard)	5,47	5,58	5,53	16,8	18,0	17,4	79,9	80,3	80,1
2	Malvina C × 1/99-1-1 5014-1-2	5,96	5,98	5,7	17,0	17,4	17,2	82,8	83,3	83,1
3	Malvina C × 1/99-1-1 5014-1-4	5,95	6,3	6,13	17,4	15,2	16,3	81,6	82,6	82,1
4	Malvina C × 92c 5428-2-3-3-1	6,07	5,98	6,01	14,2	14,8	14,5	82,3	80,1	81,2
5	Malvina C × 92c 5195-3-3-2-1-1	5,8	5,53	5,51	14,9	15,7	15,3	80,2	80,0	80,1
6	Malvina C × 92c 5195-3-3-2-2-1	5,81	5,87	5,84	15,6	14,8	15,2	80,1	79,3	79,7
7	Malvina C × 1/99-4-1-1	5,37	5,45	5,41	15,0	14,4	14.7	83,6	85,0	84.3
8	Milena M × 1/66-1-4-1	5,85	5,81	5,83	17,3	15,1	16,2	82,6	82,2	82,4
9	Milena M × 92c 5261-2-1-1-3	5,32	5,28	5,26	15,9	16,7	16,3	82,9	83,4	83,2
10	Malvina C × K 630-2-3-3-2-2-2-4-2-9-1-4Б 630-2-3-3-2-2-2-4-2-9-1-4	5,90	5,98	5,94	18,0	17,4	17,7	81,6	81,8	81,7
11	Malvina C × 92c 5195-3-3-2-1-3	6,01	6,04	6,02	16,9	18,7	17,8	82,7	81,5	82,1
	LSD_{05}	0,31	0,41							
	FAO 220–300									
12	Krasnodarsky 291 (standard)	7,06	7,88	7,47	18,7	19,5	19,1	80,1	18,3	79,2
13	RG 1 C × 92c 5280-2-2-2-2-3	7,51	8,48	8,0	17,2	17,0	17,1	83,9	84,7	84,3
14	(B 52м × Г 26) K 26 зм) × 633MB	7,72	8,45	8,09	20,3	17,7	19,0	84,1	83,1	83,6
15	RG 4 M × 92c 5253-1-1-1-3	7,35	7,41	7,38	15,8	16,4	16,1	81,5	80,9	81,2
16	Madonna M × 92c 5195-3-3-2-2-1	6,41	6,50	6,46	19,0	19,8	19,4	83,5	84,9	84,2
17	Madonna M × 92c 5520-1-1-1-1	6,61	6,73	6,67	18,1	17,7	17,9	84,3	83,9	84,1
18	OL 3104 M × 6207-1	7,78	7,77	7,78	18,7	16,8	17,8	83,0	84,0	83,5
19	OL 273 M × 92c 6195-5-1-1-1	6,78	7,36	7,07	17,8	18,3	18,1	81,2	81,8	81,5
20	Кр. 704 УМ × 633MB	7,69	7,73	7,71	20,1	20,5	20,3	79,0	79,2	79,1
	LSD_{05}	0,42	0,54							

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