

Realization of the bioresource potential of the middle late hybrid of corn Beshtau in the steppe zone of the Chechen republic

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Abstract. The article presents the results of studying the bioresource potential of the medium-late hybrid of corn Beshtau at the All-Russian Research Institute of corn on dry land and at the Chechen Research Institute of Agriculture on irrigation. In the steppe zone of the republic, against the background of the use of irrigation, the application of mineral fertilizers at a dose of N90P120K60 in combination with pre-sowing seed treatment with the agrochemical Bioplant Flora (1.0 l / t) and foliar top dressing with a tank fertilizer mixture Kristalon (3 kg / ha) + Brexil Zn (0, 15 kg / ha) + urea (7 kg / ha) showed high efficiency in realizing the potential of the Beshtau hybrid. Due to irrigation and the use of these fertilizers, it turned out to be possible to increase the grain yield of the Beshtau corn hybrid to 12 t / ha. The application of mineral fertilizers to the soil at a dose of N90P120K60 in combination with foliar feeding of plants with the agrochemical Bioplant Flora at a dose of 1.0 l / ha in 5 leaves and 2.0 l / ha in 8 leaves increased the starch content in the grain from 62.63 to 72.08%, protein - from 10.65 to 12.28%.

1 Introduction

Corn is a high-yielding grain and forage crop. Due to accumulation of a large amount of organic matter within the growing season, plants show a high need for water and mineral nutrients. Lack of water leads to significant losses in grain yield [1].

The most common and effective way to meet the needs of corn plants for nutrients and to increase productivity is application of mineral fertilizers to the soil [2-6]. In addition to traditional fertilizers, plant nutrition with various agrochemicals is now of great importance in the nutrition system. The modern agrochemicals market is represented by a variety of organic, organomineral and mineral fertilizers containing not only basic nutrients (nitrogen, phosphorus, potassium), but also a complex of microelements, organic acids,

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phytohormones. According to many researchers, use of such fertilizers can significantly increase the yield of green mass and corn grain [7-9]. Mineral fertilizers and agrochemicals for foliar dressing also significantly improve the quality of corn grain [10-12].

2 Materials and Methods

Scientific research was carried out at the All-Russian Research Institute of Corn in 2012-2014 and the Chechen Research Institute of Agriculture in 2015-2017. We studied the potential yield of a mid-late hybrid of Beshtau corn bred by All-Russian Research Institute of Corn in different soil and climatic conditions.

The experimental field of the All-Russian Research Institute of Corn is located in the zone of sufficient moisture in the Stavropol Territory. Soil – ordinary calcareous heavy loamy chernozem. The average long-term rainfall for the growing season of corn is 343.6 mm, including: 79.4 in May; June — 87.1; July — 70.4; August — 58.7; September — 48 mm.

The experimental field of the Chechen Research Institute of Agriculture is located in the steppe zone of the Chechen Republic. The soil is meadow-chernozem, calcareous, weakly humified, weakly washed away. The average long-term rainfall for the growing season of corn here is 355 mm, including: 82 in May; June — 95; July — 74; August — 62; September — 42 mm.

The climatic conditions of the steppe zone of the Chechen Republic, in comparison with the zone of sufficient moisture in the Stavropol Territory, are characterized by uneven moisture in the middle of summer, long periods of dryness without precipitation.

Beshtau is a medium-late simple hybrid of corn for universal use, both for grain and for silage. The plants are tall, well leafy, with a strong stem, and are distinguished by their permanent flowering capacity. The hybrid is included in the State Register of Breeding Achievements approved for use in the Russian Federation since 2012.

The commercial grain of the hybrid is tooth-like. The grain contains 69.85 % starch, 8.17 % protein, 3.95 % fat, 2.28 % sugar, 1.12 % fiber, 0.77 % ash. The value of the grain of the Beshtau corn hybrid lies in the increased starch content and its suitability for production of starch and alcohol.

The objective of the study was to identify the reaction of the medium-late hybrid Beshtau under irrigation to mineral fertilizers, the effect on seed material and crops with agrochemicals in order to implement its genetic potential in the Chechen Republic.

3 Results and Discussion

In an experiment conducted in the zone of sufficient moisture in the Stavropol Territory to test corn hybrids of the All-Russian Research Institute of Corn, the Beshtau hybrid showed the highest yield of green mass and grain [13]. In addition, this hybrid was highly responsive to nitrogen fertilization (Table 1).

On average, over 3 years of testing from nitrogen fertilization at a dose of N60, the plant height increased by 11 cm, the yield of green mass – by 6.0 t/ha (12.8 %), grain – by 0.75 t/ha (7.0 %).

In the steppe zone of the Chechen Republic, the factor limiting the yield of corn is moisture availability [14]. As it is known, corn consumes a large amount of water within the growing season. In the experiment carried out at the Chechen Research Institute of Agriculture, the total water consumption of the mid-season hybrid Krasnodar 385 MB on average for 2010-2012 on dry land it was equal to 3,207 m³/ha, and on irrigation it reached 5,790 m³/ha [14].

Table 1. Plant height and yield of the Beshtau corn hybrid without fertilizers in the experiments of the All-Russian Research Institute of Corn

Indicator	2012	2013	2014	On average
No fertilizers				
Plant height, cm	266	250	245	254
Productivity of green mass, t/ha	51.6	40.7	48.7	47.0
Grain yield, t/ha	12.02	11.35	8.76	10.71
N60				
Plant height, cm	275	256	263	265
Productivity of green mass, t/ha	56.8	48.7	53.5	53.0
Grain yield, t/ha	12.45	12.09	9.83	11.46

Without irrigation in this area, corn grain yields are very low. So, on average for 2010-2012, without irrigation and use of fertilizers, the grain yield of domestic corn hybrids Krasnodar 382 MB and Krasnodar 385 MB varied within 2.3-2.8 t/ha (Table 2).

Irrigation of 500-800 m³/ha with an irrigation rate of 2,050-2,800 m³/ha to maintain soil moisture at the level of 70-80 % HB, even without use of fertilizers increased the yield of hybrids on average for 3 years by 1.9-2.0 times.

Importance of irrigation was especially great in the extremely dry 2011, when 1.7-2.8 t/ha of grain were obtained without irrigation on a fertilized background. By artificially improving the moisture supply of corn, the grain yield of the Krasnodar 382 MB hybrid increased 3.8 times, and the Krasnodar 385 MB – 6 times.

In the steppe zone of the Chechen Republic, irrigation combined with an efficient fertilization system is the most important reserve for increasing corn yields.

In conditions of irrigation, the importance of the nutrition system increases, which shall be considered as a priority element of the corn cultivation technology. The use of macro- and micronutrient fertilizers, as well as other agrochemicals, in turn, is a condition for the effective use of irrigation.

In order to use the bioresource potential of the high-yielding corn hybrid Beshtau, the Chechen Research Institute of Agriculture studied the effect on the yield and grain quality of different options for using mineral fertilizers and agrochemicals for pre-sowing seed treatment and foliar top dressing of plants during the growing season.

The decisive importance provided use of a complete mineral fertilizer in a dose of N90P120K60, due to which the yield of the Beshtau hybrid in 2015 increased by 1.2 t/ha (14.1 %), in 2016 — by 1.6 t/ha (18.8 %), in 2017 — by 2.8 t/ha (36.8 %). On average, in addition to the control, 1.9 t/ha (24.1 %) were obtained.

Two foliar top dressing with Bioplant flora fertilizer against the background of mineral root nutrition gave an additional 1.6 t/ha over 3 years, which was 15.8 % compared to the N90P120K60 option.

Table 2. Productivity of corn hybrids depending on irrigation and fertilization.

Irrigation	2010		2011		2012		On average	
	1	2	1	2	1	2	1	2
Hybrid Krasnodar 382 MB								
No irrigation	4.6	5.7	1.9	2.8	2.1	2.9	2.8	3.8
With irrigation	8.7	13.0	6.9	10.5	9.0	12.8	8.2	12.1
Hybrid Krasnodar 385 MB								
No irrigation	4.6	5.8	1.3	1.7	1.0	2.4	2.3	3.3
With irrigation	9.1	13.4	6.7	10.2	9.4	13.6	8.4	12.4
HCP _{0.05}	0.14		0.19		0.21		-	

Note: in column 1 – no fertilizers; 2 – N90P120K60.

Also, foliar top dressing of plants with a tank mixture of Kristalon (3 kg/ha) + Brexil Zn (0.15 kg/ha) + Carbamide (7 kg/ha) fertilizers was effective. On average, over the years of studies in relation to the background, an increase in yield was obtained equal to 1.3 t/ha (12.9 %).

Table 3. The effect of fertilizers on the grain yield of the Beshtau hybrid corn under irrigation (t/ha)

Experience options	2015	2016	2017	Average	Increase	
					t/ha	%
Fertilizer-free (control)	8.5	8.5	7.6	8.2	-	-
N90P120K60 (Background)	9.7	10.1	10.4	10.1	1.9	2.1
Background + top dressing Bioplant flora (1.0 l/ha in 5 leaves + 2.0 l/ha in 8 leaves)	10.8	12.6	11.7	11.7	3.3	40.1
Background + top dressing (Kristalon 3.0 kg/ha + Brexil Zn 0.15 kg/ha + urea 7 kg/ha)	11.2	11.2	11.7	11.4	2.5	28.0
Background + top dressing (Kristalon 3.0 kg/ha + Brexil Zn 0.15 kg/ha + urea 7 kg/ha) + seed treatment Bioplant Flora (1.0 l/ha)	11.7	12.3	12.4	12.1	3.9	47.4
HCP _{0.05} , (t/ha)	0.13	0.18	0.18	0.85	-	-

The same option of use of fertilizers in combination with pre-sowing seed treatment with Bioplant Flora fertilizer gave the maximum increase in the grain yield of the Beshtau hybrid. Compared to the control without fertilizers, the yield increase was 3.9 t/ha (47.4 %). Compared to application of mineral fertilizers to the soil, due to seed treatment and plant top dressing grain yield increased on average by 2.0 t/ha (by 19.8 %).

The effect on the yield of the hybrid was significant both for introduction of mineral fertilizers into the soil before sowing and use of fertilizers for seed treatment and plant top dressing during the growing season.

The offered options for the fertilization system influenced not only the grain yield, but also its quality. The lowest starch content in grain (62.63 %) was found in the control option of the experiment without fertilizers. Application of mineral fertilizers to the soil at a dose of N90P120K60 increased the starch content by 10.39 %. However, at the same time, compared with the control, the protein content in the grain decreased by 2.35 %. The most optimal option of the experiment, providing a simultaneous increase in both starch and protein, turned out to be a combination of mineral fertilizer with treatment of plants with the agrochemical Bioplant Flora at a dose of 1.0 l/ha in 5 leaves and 2.0l/ha in 8 leaves.

Table 4. Chemical composition of corn hybrids (on average for 2015-2016)

Index, %	Experiment option				
	1	2	3	4	5
Starch	62.63	73.02	72.08	65.91	67.6
Protein	10.65	8.30	12.28	5.06	8.95
Fat	5.59	5.45	5.46	5.80	5.67
Ash	1.27	1.23	1.32	1.3	1.31
N	1.70	1.33	1.96	1.63	1.43
P ₂ O ₅	0.31	0.31	0.32	0.33	0.36
K ₂ O	1.96	1.45	1.41	1.99	3.34

Note: 1 – Without fertilizers (control); 2 – N₉₀ P₁₂₀K₆₀ – Background; 3 – Background + top dressing Bioplant Flora; 4 – Background + top dressing (Crystalon + Brexil + urea); 5 – Background + top dressing (Crystalon + Brexil + carbamide) + seed treatment Bioplant Flora.

4 Conclusions

1. Against the background of irrigation, application of mineral fertilizers at a dose of N90P120K60 in combination with pre-sowing seed treatment with the agrochemical Bioplant Flora (1.0 l/t) and foliar top dressing with a tank fertilizer mixture Kristalon (3 kg/ha) + Brexil Zn (0.15 kg/ha) + urea (7 kg/ha) showed the high efficiency in implementing the potential of the medium-late hybrid Beshtau. Due to irrigation and use of these fertilizers, the yield of the hybrid turned out to be possible to increase the yield of corn grain up to 12 t/ha.

2. Application of mineral fertilizers to the soil at a dose of N90P120K60 in combination with foliar top dressing of plants with the agrochemical Bioplant Flora at a dose of 1.0 l/ha in 5 leaves and 2.0 l/ha in 8 leaves increased the starch content in the grain from 62.63 to 72.08 %, protein – from 10.65 to 12.28 %.

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