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## The Use Of Sorghum-Sudanese Hybrids In The North Caucasus.

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### ABSTRACT

In 2016-2018 on the base of "North Caucasus FSAC" conducted a study of sterile maternal lines of sorghum and new varieties of Sudanese grass - fertilizer reducing agents, as well as sorghum-Sudanese hybrids obtained on their base, which clarified the economic and biological characteristics and their inheritance in hybrids in comparison with the average parent form indicators. The combination of Zersta 90C x Sputnitsa (Gvardeyets) did not lengthen the sprouting-sprouting season during the growing season compared with the average duration of the parental forms, and during the full ripeness period the grain decreased by 2 days. In variants involving the lines Knyazhna and Zersta 38A, similar indicators increased. Plant height in hybrids is inherited with a high degree of heterosis. The most intensive initial growth of plants on the 30th day of the growing season was found in the variant Zersta 90C x Sputnitsa (71 cm). The heterosis of this trait was 17.5 cm. In the phase of seed ripening, the heterosis indices of this trait compared to the parental forms were 98.5 cm in the hybrid with the Zersta 38A line and 50.5 cm with the Zersta 90C. The true heterosis of increasing the length and width of the leaf in the Zersta 90C x Sputnitsa variant was 11.0 cm and 0.6 cm, respectively. On average, the green leaf mass of the three mowings was obtained from Zersta 38A x Sputnitsa (37.8%) Zersta 90C x Sputnitsa (36.5%), which is 5.1% and 3.8% more than the Navigator standard. The highest yields of green mass and hay were obtained from the Zersta 90C x Sputnitsa variants (61.1 t / ha and 13.2 t / ha), as well as from A-63 x Sputnitsa (58.9 t / ha and 12.7 t / ha). The magnitude of the true heterosis of the yield of green mass obtained from the hybrids and the average data of their parental forms is 21.8 t / ha (55.4%) in Zersta 90C x Sputnitsa, 22.9 t / ha (66.5%) in Zersta 38A x Sputnitsa and 20.8 t / ha (54.6%) in A.63 x Sputnitsa. In the first crop, Gvardeyets hybrid produced 23.4 t / ha of green mass, 28.6 t / ha in the second, and 9.1 t / ha in the third. The protein content in the absolutely dry mass was 10.17%, fiber 29.98%.

**Keywords:** line, variety, sorghum-sudanese hybrid, heterosis, plant height, yield, green mass, hay.

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## INTRODUCTION

The increase in livestock production in the North Caucasus is constrained by arid soil and climatic conditions, especially in the second half of summer. An important source of stabilization of fodder production in these conditions is the expansion of the area of sowing of drought-resistant crops - in particular, sorghum-Sudanese hybrids [1, 2, 3]. In the feed balance of animals they are used for silage, haylage, hay, green fodder, grass meal, pellets, grazing [4, 5, 6]. Factors that increase the drought tolerance of sorghum crops are powerful root systems, large amounts of carbohydrates in cell sap [7]. The stopping cells of the stomatal apparatus for a long time are not paralyzed and restore turgor after a two-week drought. The expansion of crops of sorghum-Sudanese hybrids hinders the incomplete consideration of the biological characteristics and requirements of agricultural technicians by the manufacturers. There is an insufficient number of hybrids adapted to local conditions in production [8, 9, 10]. To address these issues, the breeders of the North Caucasus FSAC obtained a new source material [11, 12], created hybrids with economically valuable traits, guaranteed seed production. Most interspecific sorghum-Sudanese hybrids due to genetic heterogeneity of parental forms have high heterosis in yield of green mass and hay [13, 14, 15, 16]. Many scientists in the study of manifestations of heterosis believe that some hybrids may exceed the parent form by 50-70% or more. In studies of Pal, K., Singh, S.K., [19], Zhukova MP, Volodina AB, Kapustina S.I. [13, 23] determined the magnitude of heterosis with respect to the best parent and their average value. In the latter case, it reached 110-150%.

The peculiarity of plants is their sprouting during the growing season. After cutting, they are able to restore the cut shoots. Therefore, after mowing, they quickly grow and, under favorable conditions, give 2-3 cuttings. They are characterized by high foliage, quality of green mass and hay [17, 18, 19, 20], good palatability and digestibility [21].

Sorghum-Sudanese hybrids have a well-developed root system, penetrating to a depth of more than 2 m. The stem is cylindrical, with stem and, under favorable cultivation conditions, reaches a height of 3 m or more [22, 23, 24]. Plants are characterized by high tillering energy. With a rare standing of plants in the bush can form up to 12-17 shoots [10]. Seeds of sorghum-Sudanese hybrids begin to germinate at a temperature of +8 + 100C, and friendly shoots appear at +12 + 140C. Frost -2-30C completely destroy the seedlings [1, 22]. To soils, plants are undemanding, grow well on chernozem and chestnut soils, and are relatively salt-tolerant. Can be cultivated on the sands, but without fertilizers provide a low yield. Swampy, compacted soils are unsuitable for growing sorghum-Sudanese plants. With high drought tolerance, they respond well to irrigation [25].

**Purpose of research** is to study the heritability and heterosis level of the main quantitative traits, as well as to clarify the yield and quality parameters of green mass, hay, grain in new sorghum-Sudanese hybrids of North Caucasian FSAC breeding obtained on a sterile basis.

## MATERIALS AND METHODS

On the experimental field of the FSUE "North Caucasus FSAC" (Mikhailovsk) in 2016-2018. methods of laboratory and field experiments conducted a study of the passage of the phenological phases of development, the dynamics of the initial growth and post-cutting growth of plants, resistance to lodging, damage by diseases, yield by cutting time, foliarity and quality of the resulting feed of sorghum-Sudanese hybrids. As a standard, the Navigator hybrid was used (in the registry since 2007). In the competition nursery, the combinations created with the participation of the sterile lines Zersta 90C, A-63, Zersta 38A, Knyazhna and the restorer of fertility of a new variety of Sudanese grass Sputnitsa were studied.

The climate of the study zone is moderately continental, the summer is dry and hot, the average annual rainfall is 550 mm, including for May-September - 329 mm. SCC - 0.9-1.1; frost-free period lasts 170-190 days. The soil cover of the experimental field is micellar-carbonate chernozem, medium loamy, low-humus with a humus layer depth of 100-120 cm. The soil supply of mobile elements of mineral nutrition is average. The humus content in the topsoil is 3.2%. Specific weather factors during the growing season are insufficient and extremely uneven distribution of precipitation, high air temperature, frequent and long dry winds, a large number of days with a relative humidity below 30%.

According to the features of the distribution of precipitation and the nature of the temperature regime, 2016 for sorgovykh crops is characterized as moderately warm and humid, in 2017 - arid, in 2018 -

arid. The amount of precipitation in May-September was 385, 305 and 131 mm, respectively (117.93 and 39% of the norm). In all the years of research, the greatest amount of precipitation fell in May (44-163 mm) and July (43-108 mm), which made it possible to obtain friendly shoots and a good yield of green mass from the second crop. In the years studied, the growing season was characterized by increased heat influx. The average daily air temperature for May-September in 2016 was 19.5 ° C, in 2017 - 20.1 ° C, and in 2018 - 21.0 ° C, which is above the norm (18.4 ° C), respectively ; 1.7 and 2.60 ° C. The number of days with a relative humidity below 30% in the years studied was 36, 59 and 77.

Phenological observations, morphological measurements, accounting of the crop and its structure were carried out in accordance with the methods of state variety testing of agricultural crops [26]. The content of protein and fiber in the green mass was determined at the Stavropol State Certified Center for Agrochemical Service by the methods of Kjeldahl and Genneberg-Shtokman. The fruitful results of the experiment were processed according to the method of the field experiment [27]. Tillage and crop care was carried out according to the technology recommended for the Stavropol Territory [2]. The predecessor was a pair of winter wheat, after harvesting which stubble was peeled off, and in the fall plowed plowing was 25-27 cm. Spring soil preparation included early spring cultivation 10-12 cm and preplant 5-6 cm. Accounting area plots 25 m<sup>2</sup>, repeated three times. Yield green mass was calculated at 70% moisture.

### RESULTS AND DISCUSSION

The creation of sterile analogs and analogues of fertility reducing agents is based on the transfer of cytoplasmic male sterility to sterility fixative specimens by the method of saturating crosses with the selection of typical plants for these pollinators, but sterile for pollen. Table 1 presents 4 sterile lines of sorghum, which are used by us when creating new sorghum-Sudanese hybrids and hybrids of sugar sorghum:

- A-63 - a sterile line of sugar sorghum - created by the selection of an elite plant from a variety of sugar sorghum Stavropol 63. The sterilization fixer is derived when testing plants for CMS.
- Zersta 38A was obtained by saturating crosses of the sterile line A-803 with sterility fixer 4338/83, which was created by selecting from the grade of grain sorghum Nadezhda Stavropol.
- Zersta 90C is derived by saturating a sterile grain sorghum line A-803 with sterilizing agent Zersta 90, which is obtained by selecting from a hybrid population from crossing Skorospeloye 89 and Sarvashi.
- Knyazhna (A-3622) was created by saturating the sterility of the Zersta 38A line with sterility fixer 3622/80 by saturating the sterile Zarta 38A line. This fixer is obtained by the method of selection and self-pollination from the variety Nadezhda Stavropol'ya.
- Sputnitsa (paternal form, fertility restorer) - the mid-season variety of Sudanese grass in the State Register of Breeding Achievements of the Russian Federation since 2016. It has an erect shrub, distinguished by high bushiness. The variety is characterized by a high rate of initial growth and post-harvest regrowth aftermath, it does not lodge, is heat and drought resistant, gives steady yields of green mass in various soil and climatic conditions. It has a high combinational ability and a significant level of heterosis.

**Table 1: Economic and biological properties and signs of parental forms (average for 2016-2018)**

Line	Duration of the period, days		Plant height, cm		Leaf, cm		Stalk thickness, cm	Productivity, t / ha	
	seedlings - spouting	seedlings, full ripeness	on the 30th day of the growing season	when seeds mature	length	width		green mass	grains
A-63	58	96	47	121	58	7,2	1,60	24,9	2,98
Zersta 38A	61	92	44	102	64	6,7	1,64	13,5	2,69
Zersta 90C	63	94	50	180	67	6,3	1,64	27,4	3,8
Knyazhna	57	90	42	177	70	6,7	1,35	23,4	3,30
HCP <sub>0,05</sub> , t/ha	-	-	-	-	-	-	-	0,8	0,17
Sudanese grass variety Sputnitsa	53	90	57	253	69	3,3	0,92	51,2	1,89

Table 2 presents 4 new sorghum-Sudanese hybrids bred in North Caucasian FSAC. During the growing season, three mowings were made, the yield of green mass was taken into account manually, from each plot. Dates of cuttings depended on the length of the period of sprouting-sprouting. The duration of the growing season sprouts-sprouting and sprouting-full ripeness in the standard Navigator on average for 2016-2018. amounted to respectively 62 and 97 days. The hybrid Gvardeyets (Zersta 90C x Sputnitsa), these indicators were 4-7 days less and totaled 58 and 90 days. Sterile lines A-63, Zersta 38A and Knyazhna contributed to an increase in the growing season by 4–8 and 6–13 days compared to the Gvardeyets combination. When analyzing the duration of the periods of sprouting-sprouting and sprouting-complete ripeness in hybrids and their parental forms, it was found that the most significant reduction occurred in the Zersta 90C x Sputnitsa combination. Compared with the average length of vegetation periods studied in parental forms (58 and 92 days) of this hybrid, these figures were 58 and 90 days, that is, during the mowing period they did not lengthen, and during the full ripeness period, the grain decreased by 2 days. In the remaining combinations, these signs increased, especially significantly with the participation of the Zersta 38A and Knyazhna lines.

The height of the plant hybrids depends on the genotypes of the original parental forms, is inherited with a high degree of heterosis, and in some cases is enhanced in the resulting combinations [13]. The most intensive initial growth of plants on the 30th day of the growing season occurred in the variant Gvardeyets (71 cm), as well as in the Navigator standard (68 cm). In the other rooms, it varied from 57 to 64 cm. Compared with the average height of plants of parental forms, the heterosis of this trait was 17.5 cm in the Zersta 90C x Sputnitsa hybrid and 13.5 cm in combinations involving the A-63 lines and Zersta 38A. In the first and second cuttings, due to the large initial growth, the plants of the Gvardeyets hybrid (162 and 180 cm) also turned out to be the tallest. In the standard and other investigated options, these figures were 4-21 cm and 3-11 cm below. When seeds mature, the plants of the combinations Zersta 38A x Sputnitsa (276 cm), Gvardeyets (272 cm) and Navigator (265 cm) were the tallest. Heterosis indicators of plant height in comparison with the parental forms were 98.5 cm in the hybrid with the participation of the Zersta 38A line and 50.5 cm in the Gvardeyets.

The number of leaves on a plant is one of the main indicators of the quality of green mass. Juicy, tender leaves are well eaten by animals. According to research Tasoe.Y., Sazuka.T., Yamaduchi.M. et al. [18] heterosis in sorghum does not affect the growth rate, but the rate of photosynthesis increases the area of the leaf. In our experiments, the length and width of the sheet for the Navigator standard were 77 and 5.1 cm. For combinations involving the Zersta 90C and Zersta 38A lines, these values were respectively 79 and 5.4 cm. The true heterosis of increasing the length and width of the sheet is The resulting hybrids compared to the average leaf length and width for parental forms was 11.0 cm and 0.6 cm for Zersta 90C x Sputnitsa, respectively, and 12.5 cm and 0.4 cm for Zersta 38A x Sputnitsa. Number of leaves the studied samples consisted of 9-10 pieces. The maximum stem thickness (1.27 cm) is set to the standard Navigator and the Zersta 38A x Sputnitsa variant.

On average, for three bevels the highest leaf content in green mass was obtained from Zersta 38A x Sputnitsa (37.8%) and from Zersta 90C x Sputnitsa (36.5%). Standard Navigator provided a green leaf content of 32.7%.

When analyzing the amount of foliar green mass, depending on the mowing, higher values of this trait in the studied hybrids were obtained in the third mowing (38.1-45.8%). During the second mowing period, similar indicators were 29.9-34.1%, and at the first cut, 30.2-34.6%. Significant differences in the value of foliage between the first and second mowing is not installed. The hybrid Gvardeyets in terms of the leafiness of the green mass in all 3 terms of mowing had high indicators of this feature and significantly exceeded the similar values of the standard. The green mass was mown during the sweeping period, therefore the leaf content during this period is relatively high compared to the mass of stems and panicles, which increased significantly during the period of milky-waxy or full ripeness of the grain.

**Table 2: Phenological and morphological indicators of sorghum-Sudanese hybrids (average for 2016-2018)**

Hybrid	Duration of the period, days		Plant height, cm				Leaf, cm		Stalk thickness, cm	Leaf content in green mass,%			
	seedlings - spouting	seedlings, full ripeness	on the 30th day of the growing season	I bevel	II bevel	when seeds mature	length	width		I bevel	II bevel	III bevel	average for three bevel
Navigator, St	62	97	68	157	169	265	77	5,1	1,27	30,2	29,9	38,1	32,7
A-63 x Sputnitsa	62	96	64	158	175	263	71	5,5	1,23	34,0	32,6	40,0	35,5
Zersta 38A x Sputnitsa	66	103	64	150	177	276	79	5,4	1,27	33,5	34,1	45,8	37,8
Zersta 90C x Sputnitsa (Gvardeyets)	58	90	71	162	180	272	79	5,4	1,22	34,6	33,8	41,0	36,5
Knyazhna x Sputnitsa	65	101	57	141	168	261	80	5,0	1,21	33,2	33,6	40,4	35,7
HCP <sub>0,05</sub>						9,3							1,6

**Table 3: Productivity and quality of green mass of new sorghum-Sudanese hybrids (average for 2016-2018)**

Hybrid	Productivity, t / ha									The chemical composition of absolutely dry matter,%	
	green mass				dry matter				grain at 13% humidity	protein	cellulose
	I bevel	II bevel	III bevel	total bevels	I bevel	II bevel	III bevel	total bevels			
Navigator, St	19,9	25,4	8,0	53,3	4,3	5,7	1,6	11,6	2,63	9,68	30,34
A.63 x Sputnitsa	22,7	27,5	8,7	58,9	4,8	6,2	1,7	12,7	2,62	10,23	29,83
Zersta 38A x Sputnitsa	20,4	28,2	8,7	57,3	4,3	6,5	1,6	12,4	2,40	9,74	30,06
Zersta 90C x Sputnitsa (Gvardeyets)	23,4	28,6	9,1	61,1	4,9	6,5	1,8	13,2	2,66	10,17	29,98
Knyazhna x Sputnitsa	19,6	28,2	10,1	57,9	4,2	6,3	2,0	12,5	2,43	9,63	30,31
HCP <sub>0,05</sub> , t/ha				2,4				0,65	0,12		

The main criterion for evaluating the studied hybrids is their high yield. Indicators of green mass (53.3 t / ha) and hay (11.6 t / ha) of the Navigator standard on average for three years significantly exceeded all new hybrids presented in table 3. At the same time, the most significant level of green mass and hay was obtained from combinations Zersta 90C x Sputnitsa (61.1 t / ha and 13.2 t / ha) and also A-63 x Sputnitsa (58.9 t / ha and 12.7 t / ha). Comparison of the true heterosis of the yield of green mass obtained from hybrids and averaged data of their parental forms allows us to make a statement about its significant value. The excess of the Zersta 90C x Sputnitsa combination was 21.8 t / ha (55.4%), the Zersta 38A x Sputnitsa - 22.9 t / ha (66.5 t / ha), A.63 x Sputnitsa - 20, 8 t / ha (54.6%), Knyazhna x Sputnitsa - 20.6 t / ha (55.2%). Indicators of true heterosis of ripe grain were positive in hybrids with the participation of lines A.63, Zersta 38A and Zersta 90C and were respectively 0.19 t / ha (7.8%), 0.11 t / ha (4.8%), 0.19 t / ha (7.3%). In the combination of Knyazhna and Sputnitsa, heterosis of ripe grain has not been established in comparison with the average indicators of parental forms.

When comparing the magnitude of the yield, depending on the witness cuts, its dependence on climatic conditions. Temperature and precipitation in 2016-2018 provided three green grass and hay mowing. Despite a significant amount of precipitation in the first half of summer, a higher yield of green mass was obtained with the second crop (25.4-28.6 t / ha). The first cut level (19.6-23.4 t / ha) was lower than the second by 5.2-5.8 t / ha. Indicators of the third mowing were significantly lower and amounted to 8.0-10.1 t / ha. Such fluctuations were not associated with the length of the vegetative period of emergence-sprouting, but was explained by the morphobiological features of the new sorghum-sudank hybrids under study. With the second and third cuttings, when the aftergrowth grew afterwards, the difference in the rates of growth and development of plants was leveled, however, the better development of plants of new hybrids, higher leafiness and bushiness contributed to the fact that they had an advantage in yield of green and dry mass.

According to the analysis of the chemical composition of absolutely dry matter, it follows that the variants A-63 x Sputnitsa and Zersta 90C x Sputnitsa contain the highest amount of crude protein (10.17-10.23%) and the lowest value of fiber (29.83-29.98 %). The standard Navigator similar indicators were worse and amounted to 9.68% and 30.34%.

## CONCLUSION

In the arid conditions of the steppe zone of the Russian Federation, it is advisable to cultivate new sorghum-Sudanese hybrids. On average for 2016-2018 due to a significant amount of precipitation in July, the maximum yield of green mass and hay plants formed in the second crop. Its most significant indicators are obtained from a combination of Zersta 90C x Sputnitsa (Gvardeyets). This hybrid has been submitted for State variety testing since 2018. It belongs to the group of mid-early plants, the first cutting of which can be carried out in the sweeping phase in late June - the first half of July, the second cutting - in the second half of August, the third - in late September - early October.

Among the studied variants, the Gvardeyets hybrid has the most significant initial plant growth on day 30 of the growing season (71 cm), high leaf content in the green mass (36.5%). The presence of dry protein substance is 10.17%. Plants are resistant to drought, lodging, pests and diseases.

Parental forms of the hybrid are distinguished by a high combinational capacity and provide a true heterosis of green mass yield in the amount of 21.8 t / ha (55.4%).

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