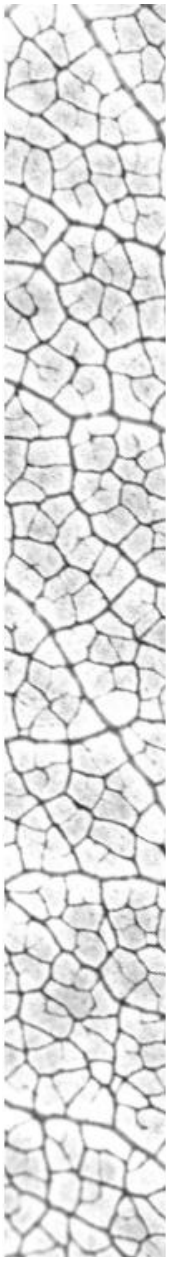

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Improving the fertility of the salted lands of the Western Caspian region by cultivating sorghum crops

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Abstract
The article presents the studies conducted in the Tersko-Sulak sub-province of the Republic of Dagestan aimed at phytomelioration of medium-salted meadow-chestnut soils by cultivating varieties of grain sorghum. The following was revealed. The duration of the growing season of early ripe varieties ranged from 99-101 days, and mid-ripening - 113-115 days. When treated with growth regulators, a decrease in the growing season was noted. Higher values of photosynthetic potential were noted in Khazine 28 and Zernogradskoe 53 varieties. The applied growth regulators contributed to the increase of these indicators. Among the studied early ripe varieties, Khazin 28 provided the highest yield, and among the mid-ripening varieties - Zernogradskoe 53. The same varieties provided the maximum removal of harmful salts from the soil. Against the background of processing by growth regulators, an increase in the yield of grades of grain sorghum was recorded, which, in turn, led to an increase in salt removal.

Keywords: arid zone, tersko-sulaks sub-province, secondary salinization, phytomelioration, grain sorghum, varieties, adaptation, productivity, desalination

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INTRODUCTION

Increasing the yield of all fodder crops is the main problem of modern fodder production. Especially important for increasing the production of grain fodder, under increased aridity of the summer period, is the expansion of high-yielding drought-tolerant crops, which primarily include sorghum.

Sorghum is a unique cereal plant, both in terms of its biological characteristics and economic characteristics. Its main advantages are exceptional drought tolerance, salt tolerance, high productivity, crop stability over the years, good nutritional benefits and universal use. Sorghum grain contains 12-15% protein, 3.4-4.4% fat, 70-80% nitrogen-free extractive substances, 2.4-4.8% fiber. In terms of feed advantages, sorghum grain is equivalent, and even surpasses barley.

Many scientists have dealt with the technology of cultivating grain sorghum in different soil and climatic conditions of the Russian Federation (Alabushev 2016, Danilenko 2013, Zavarzin 1994, Zhuzhukin 2013).

In the lowland zone of the Republic of Dagestan, the development of technology elements for the cultivation of sorghum crops was studied by Abdurakhmanov (1998), Gasanov et al. (Gasanov 2003, Gasanov 2006, Gasanov 2009), Musaev (2004, 2010), Omariev et al. (Omariev 2007).

At the same time, a number of questions concerning the elements of the technology of cultivating sorghum on the irrigated lands of the Tersko-Sulak sub-province of the Republic of Dagestan have not been studied enough, and therefore, studies aimed at selecting promising varieties of grain sorghum treated with different growth regulators in this sub-province of the

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Table 1. Experimental design

No.	Variety - factor A	Growth regulator efficiency - factor B
1	Zersta 97 (standard)	Untreated - control
2		Albit
3		Megamik
4	Khazine 28	Untreated
5		Albit
6		Megamik
7	Zernogradskoe 88	Untreated
8		Albit
9		Megamik
10	Zernogradskoe 53 (standard)	Untreated
11		Albit
12		Megamik
13	Pikador	Untreated
14		Albit
15		Megamik
16	Semiramida	Untreated
17		Albit
18		Megamik

Republic of Dagestan are relevant and in demand in agricultural production.

METHODS

Field experience, placement of replications is systematic, and placement of plots is randomized. The experiment was conducted in quadruplicate, the size of the plots is 500 m^2. Furrow irrigation was carried out by superficial gravity. The studies were conducted on medium saline meadow-chestnut soils. The type of salinization is chloride-sulfate.

RESULTS AND DISCUSSION

The sowing of seeds of grain sorghum in the experiment during the years of research was organized in the first ten days of May because the temperature at the depth of seeding was 10-12°C.

On average, in 2016-2019, harvest ripeness of early ripening control varieties (without growth regulators) occurred 99-101 days after emergence. This period in mid-ripe varieties ranged from 113 to 115 days.

The applied growth regulators helped to reduce the vegetation period of the studied varieties and the hybrid of grain sorghum.

In our studies, on average over the years of research, the height of the plants of the studied varieties of tillering grain sorghum varied from 13 to 16 cm. During the release of sorghum plants into the tube, it increased 2.6-2.9 times.

Indicators of average daily growth in the sprouting-tillering interphase varied in the range of 0.5-0.6 cm per day. The insignificant average daily growth in this period is due to the fact that root crops and a slight linear growth occur in sorghum crops during this period.

After tillering, an increase in the linear growth of sorghum plants was noted. The height of untreated controls varied within 34-41 cm in early ripening varieties, and 37-41 cm in mid-ripening varieties.

When treated with Albit and Megamik, the height of the plants varied, respectively, within 36-43 and 36-42 cm - in early ripening varieties, 39-42 and 40-42 cm - in mid-ripening varieties and the hybrid.

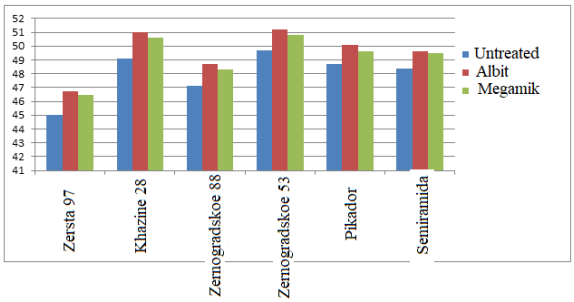

Fig. 1. The leaf surface area of the varieties and hybrid of grain sorghum (average for 2016-2019)

The average daily increase during the tillering - stem elongation differentiated within 1.0-1.4 cm per day.

The maximum growth of early- and mid-ripening varieties and the hybrid of sorghum were observed in the interphase period of stem elongation - paniculation in the range of 2.4-3.1 cm per day in untreated crops, 2.5-3.2 cm per day - treated with Albit, and 2.5-3.3 cm per day - treated with Megamik.

At the end of the growing season, the average daily gain in the interphase period of paniculation - full ripeness decreased to a minimum.

A comparative analysis of the studied varieties and the grain hybrid for this indicator showed no particular difference between them.

The applied growth regulators had a positive effect on the height of plants. The average increase for the studied Albit-treated varieties was 1.8%, and for Megamik-treated varieties - 0.9%.

In the group of early ripening varieties, the largest leaf surface area was formed by Khazine variety - 28–49.1 thousand m^2/ha, which is by 9.1% higher than the standard (Zersta 97), and by 4.2% higher than the data of Zernogradskoe 88 (**Fig. 1**).

The analysis of this indicator among mid-ripening varieties showed that the largest leaf surface area was noted for the standard (Zernogradskoe 53) - 49.7 thousand m^2/ha. The increase in comparison with the Pikador and Semiramida varieties amounted to 2.1-2.7%, respectively.

Indicators of crop photosynthetic potential in early ripening varieties were 2.27, respectively; 2.43 and 2.35 thousand m^2/ha·days, in mid-ripening varieties - 2.82; 2.81 and 2.77 thousand m^2/ha·days.

Higher net photosynthetic productivity and accumulation of dry matter were also observed in Khazine 28 and Zernogradskoe 53, respectively - 3.02-3.04 g/m^2·day and 7.3-8.6 t/ha. Minimum data were recorded for Zersta 97 - 2.76 g/m^2·day, 6.3 t/ha and Semiramida - 2.84 g/m^2·day and 7.8 t/ha (**Fig. 2**).

When treated with Albit, the leaf surface area on average for the studied early- and mid-ripening varieties

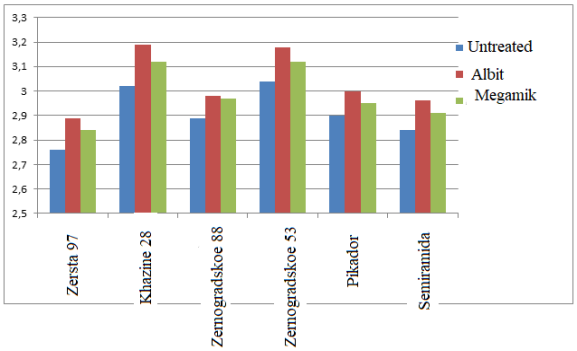

Fig. 2. Net photosynthetic productivity of the varieties and hybrid of grain sorghum (average for 2016-2019)

Table 2. Productivity of varieties of grain sorghum depending on the applied growth regulators, t/ha

Variety	Years				Average for 2016-2019
	2016	2017	2018	2019	
Control (untreated)					
Zersta 97 (standard)	3.50	3.27	3.40	3.45	3.40
Khazine 28	3.97	3.75	3.86	3.90	3.87
Zernogradskoe 88	3.70	3.48	3.58	3.66	3.60
Zernogradskoe 53 (standard)	3.88	3.70	3.80	3.82	3.80
Pikador	3.25	3.15	3.20	3.22	3.20
Semiramida	3.18	3.01	3.09	3.17	3.11
Albit					
Zersta 97 (standard)	3.69	3.43	3.56	3.62	3.57
Khazine 28	4.21	3.92	4.03	4.18	4.08
Zernogradskoe 88	3.91	3.61	3.75	3.89	3.79
Zernogradskoe 53 (standard)	4.11	3.84	3.95	4.00	3.97
Pikador	3.39	3.25	3.33	3.35	3.33
Semiramida	3.29	3.20	3.22	3.26	3.24
Megamik					
Zersta 97 (standard)	3.61	3.39	3.50	3.60	3.52
Khazine 28	4.17	3.88	4.00	4.10	4.04
Zernogradskoe 88	3.82	3.55	3.68	3.79	3.71
Zernogradskoe 53 (standard)	4.06	3.78	3.88	4.00	3.93
Pikador	3.32	3.20	3.28	3.30	3.27
Semiramida	3.23	3.15	3.20	3.23	3.20
НСР $_{05}$, т	0.17	0.15	0.17	0.15	

increased by 3.6-2.9%; indicators of crop photosynthetic potential and dry matter - by 4.5–4.1 and 4.4–4.9%, respectively.

The Megamik-treated plots showed increase by 3.0-2.2, 3.1-2.0 and 4.4-2.4%, respectively.

Among the studied varieties and hybrid of grain sorghum, the control showed the highest productivity among early ripening varieties in Khazine - 28-3.87 t/ha. This is by 13.8% higher than the standard data (Zersta 97), by 7.5% higher than Zernogradskoe 88.

Among mid-ripening varieties, preference should be given to Zernogradskoe 53, which provided a yield of 3.80 t/ha, which is by 18.7% higher than Pikador and by 22.2% higher than the data of Semiramida (**Table 2**).

When treated with Albit, the productivity of early ripening varieties increased by an average of 5.2%, and mid-ripening - by 4.2%. In Megamik-treated variant, the increase was respectively 3.9-3.0%.

The analysis of the yield data of the studied varieties of grain sorghum on treated variants showed that in this case the same pattern is observed as in the case with the untreated variant, that is, higher yields were provided by Khazine 28 and Zernogradskoe 53 - 4.08-4.04 and 3.97-3.93 t/ha, respectively.

The minimum indices among early ripening varieties were provided by Zersta 97 - 3.57-3.52 t/ha, and among mid-early ripening varieties - Semiramida hybrid - 3.24-3.20 t/ha.

Khazine 28 and Zernogradskoe 53 grains, which provided higher grain productivity, were distinguished by higher structural indicators, such as panicle weight, number of grains in panicle, weight of 1000 grains – 83.4-82.2 g, 1522-1620 pcs., 31.3-28.4 g, respectively.

The treated plots showed higher indicators of the studied varieties and hybrid of grain sorghum.

The analysis of data on the removal of salts by the studied varieties of grain sorghum in our studies showed the following. In the untreated plots, among early ripening varieties, the largest salt removal on average for 2016-2018 was provided by Khazine 28 - 0.60 t/ha, Zernogradskoe 88 - 0.48 t/ha was in the second place, and the minimum data was noted for the standard (Zersta 97) - 0.30 t/ha.

Among the mid-ripening varieties, the largest desalination - 0.54 t/ha, was achieved by Zernogradskoe 53. Low and approximately the same values - 0.24 - 0.20 t/ha - were observed in Pikador and Semiramida.

Due to the increase in productivity, significant indicators of salt removal were recorded on variants with growth regulators. Salt removal when treated with Albit was in early ripening varieties 0.43, 0.72, and 0.62 t/ha, respectively, and in mid-ripening varieties - 0.69, 0.6, and 0.34 t/ha, respectively. As in the first case, a significant removal of salts was provided by Khazine 28 and Zernogradskoe 53. Minimum data were noted for Zersta 97 and Semiramida.

The Megamik-treated variant showed the same (although to a lesser extent) picture as in the case with Albit. Khazine 28 and Zernogradskoe 53 provided salt removal equal to 0.69 and 0.67 t/ha, respectively, the second was Zernogradskoe 88 and Pikador - 0.60 and 0.33 t/ha, respectively.

Consequently, the studied varieties of grain sorghum contribute to the desalinization of medium saline meadow-chestnut soils. Khazine 28 and Zernogradskoe 53 provide the greatest phytomeliorative effect.

CONCLUSION

The study revealed that the most feasible grain sorghum for the medium-saline lands of the Tersko-Sulak sub-province of the Republic of Dagestan as cultivating cultures of saline lands are early ripening Hazine 28 and mid-ripening Zernogradskoe 53, against the background of pre-sowing seed treatment with Albit and Megamik.

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