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Prevention of Desertification and Land Degradation using Black Saxaul in Arid Conditions

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Abstract: The harsh climate of the arid zone determines several biological features in black saxaul plantations. Therefore, the study of the growth and condition of artificial plantations, depending on the use of physiologically active moisture-absorbing substances and growth biostimulants, is of particular practical importance. In the Moinkum sands of the Zhambyl region (Kazakhstan), observations of the growth and development of the black saxaul in places where physiologically active substances and biostimulants of growth were used were continued at industrial plantings in 2018, 2019, and 2020. The purpose of these studies was to prevent desertification by improving the preservation of forest crops of the black saxaul. The use of various water-retaining compounds (hydrogels), growth stimulants (Epin-Extra), and fertilizers, as well as their combined use, had a positive effect. The use of moisture-absorbing substances and biostimulators of plant growth in the cultivation of black saxaul increased the average diameter and average height of seedlings by an average of 30.1 and 38.6%, respectively. The best effect of the growth stimulators used was shown with hydrogel, Epin-Extra (plant growth biostimulator), and a ready-made mixture of hydrogel, fertilizer, and Epin. The use of moisture-absorbing substances, growth biostimulators, and nitrogen fertilizers affected the second and subsequent years after planting.

Keywords: Black Saxaul, Moisture-Absorbing Substances, Plant Growth Regulators, Forest Culture Fund, Forest Crops

Introduction

One of the fundamental requirements for protective forest stands is their biological and ecological sustainability, as well as their durability (Ortúzar *et al*., 2022). The creation of stable and long-lasting protective forest stands in arid conditions of Kazakhstan remains a difficult issue due to the sharply continental climate (Lopez Fernandez *et al*., 2020), the large complexity of forest-growing properties of soils, low agrotechnics of cultivation, and the lack of measures for their maintenance and protection. Researching on improving agricultural cultivation techniques and identifying optimal techniques and methods of their creation will allow us to give production proposals for creating more stable, durable, and effective protective forest crops, as well as reduce labor, material, and monetary costs of their cultivation (Mukasheva *et al*., 2022).

A review of literature sources shows that the available information on the cultivation of arid crops is regional and is often contradictory, which hinders the process of restoration of saxaul forests. In Central Asia, there is a lot of practical experience in the afforestation of sands and pastures while in the regions of the Northwestern Caspian Sea, the black saxaul crops being created are characterized by high and stable survival and successful growth (Czimczik *et al*., 2004). In Kazakhstan, such works are at the initial stage of development. In the desert areas of the Republic of Kazakhstan, large amounts of work have been carried out on the culture of the black saxaul but the state of forest production still does not meet modern requirements. The effectiveness of crops remains low and there is a lack of consensus on the choice of a method of cultivation. A similar phenomenon is noted in choosing a tillage system and the expediency of agrotechnical care. Therefore, optimization of specific soil-climatic and forest-growing conditions is an important task.

The research aimed to study the effect of various water-retaining substances in combination with growth stimulants and the use of fertilizers to increase the safety of black saxaul forest plantations. The study consists of five sections, namely the introduction, materials and methods, results, discussion, and conclusion.

Materials and Methods

The object of the research was the State Forest Fund of the Koskuduk State Institution for the Protection of Forests and Wildlife of the Department of Natural Resources and Environmental Management of the Zhambyl Region. In 2018, 2019, and 2020 in the Moinkum sands of the Zhambyl region of Kazakhstan (Fig. 1), we made observations on production plantings on the growth and development of black saxaul in places where physiologically active substances and growth biostimulants were used.

Selection of Plots

(a) Six plots (2018 – two plots, 2019 – two plots, and 2020 – two plots) with an area of 1-3 ha on two different types of soils (as two options) were selected from the areas of the forest culture fund 2018-2020 to establish the influence of soils on the conditions for the use of moisture-absorbing substances and biostimulators of growth in the creation of forest crops with seedlings of the black saxaul. Cartographic, soil, and taxation materials of the forestry enterprise for the forest cultural fund were used for the selection. (b) The plots of only mechanized planting by forest planting machines of forest crops of seedlings of the black saxaul were selected, according to the planting scheme established and applied in the forestry.

Establishment of Options for Research and Development

a. A variation in soils – two types of soils
b. Variation of the field experiments – four with one row

According to the following scheme:

1. Two "clean" rows (one row at the edges of the plot)
2. With the use of moisture-absorbing substances (one row)
3. With the use of growth stimulants (one row)
4. With the use of fertilizers (autumn fertilizing)
5. Using a mixture of moisture-absorbing substances growth stimulants and 10% N ml. fertilizers (one row)

The number of seedlings in a row can be 100 pcs. with a length of the test run of 100 m, depending on the accepted scheme of the created forest crops of the black saxaul:

c. The application (dose) of moisture-absorbing substances was carried out from the calculation of 50 g of hydrogel for conditional 10 L of water. The amount of water was determined by the best adhesion of the suspension to the roots
d. The application (doses) of biostimulators of growth was carried out from the calculation of 50 mL substances for conditional 10 L of water
e. The use of fertilizers (autumn top dressing of 10% N ml. For conditional 10 L of water)
f. The use of a mixture of moisture-absorbing substances and growth stimulants was in the same parameters, with the use of fertilizers of 10% N ml. for conditional 10 L of water

Establishment of the Investigated Parameters

Comparison by variants was carried out on 10 pcs. Of seedlings in each row, i.e., with five variants from 160 to 320 pcs. Per plot. The comparison for all five variants was carried out according to the following parameters under study (1, 2, and 3 years of experiments).

Biometric taxation indicators of seedlings (height, diameter at the root neck).

Establishment of % survival rate of seedlings in all variants.

Conducting phenological observations for two seasons (spring/autumn).

For the initial determination of the main average parameters of the planting material, a "blind" sample of two bundles of 10 pcs. Of black saxaul, seedlings were measured.

Establishment of Final Indicators

a. Determination of indicators of the consumption of moisture-absorbing substances for conditional 1,000 pieces of seedlings
b. Determination of the effect of the use of these substances by variants on the % survival and viability of forest crops and by the autumn biometric measurement of the taxation indicators of seedlings of the black saxaul

We adopted Epin-Extra, P (0.025 g/L 24 epibrassinolides), a growth regulator, for conducting experimental studies. It is not phytotoxic and it is not dangerous for bees, useful insects, and fish. Hazard class: D.V. – Class 4 (low-hazard substance). Developed and manufactured by: NNPP "NEST M", Russia, TU2387-002-18769652-06, GOST R51247. Mineral fertilizer/Nitrogen 33%/based on ammonium nitrate with trace elements of grade K, hazard class – III, N – 20-30 g per 10 L of water. The main application was the autumn fertilizing of black saxaul plantings. The ABSORBENT preparation is most suitable for laying experiments with black saxaul. The drug is potassium-based polymer granules and due to this fills the need of plants for potassium. The consumption rates of hydrogel/fraction 2-4 mm/(with an experimental pilot sample for treatment on soaking seedlings) were 50 g per 10 L and 100 g per 20 L, based on the calculation of 1 g per 200 mL of water.

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Fig. 1: Zhambyl Region, Kazakhstan

Table 1: Experiment design

No.	Variants
1	Control
2	Fertilizer (F)
3	Hydrogel (H)
4	Total (H+B+F)
5	Epin-Extra (B)

The effect of the use of moisture-absorbing substances and biostimulators on plant growth in the cultivation of black saxaul was studied according to five variants (Table 1).

Statistical data processing was carried out by determining the significance of differences between samples by the Least Significant Difference (LSD) in Microsoft Excel (Ryazanova *et al*., 2013). The significance level was 0.05.

Results

To relieve stress and achieve a better survival result, we carried out work on the selection of physiologically active moisture-absorbing substances and growth biostimulators. The plant growth stimulator Epin-Extra was selected, hydrogel (Produced in South Korea), and fertilizer – Nitrogen 33%. To achieve the best result, the root system was soaked in solutions:

Epin-Extra: 50 mL of the substance was diluted in 10 L of water and the root system of seedlings was soaked for 12 h. Hydrogel: Consumption rates/fraction 2-4 mm/(with an experimental pilot sample for treatment for soaking seedlings) was 50 g per 10 L, based on the calculation of 1 g per 200 mL of water. Fertilizer: Nitrogen 33% based on ammonium nitrate with trace elements of grade K, hazard class – III, N – 20-30 g per 10 L of water. The main application was the autumn fertilizing of black saxaul plantings.

When planting, the hydrogel consumption rate was 100 g per 20 L. The consumption rates of moisture-absorbing substances, growth biostimulator, and fertilizers did not change since these standards are recommended by manufacturers and an increase or decrease in the rate of drugs can reduce the growth and survival of black saxaul in experimental plots. Experimental data are presented in Tables 2-6.

As can be seen from Table 2, the average biometric indicators of the black saxaul in 2018 in plot no. 1 (seedlings from the Zhambyl region) show that the best height indicators were traced in fertilizers, hydrogel, total (H+B+F), and Epin-Extra, where the height was higher than in the control by 6.54, 3.03, 5.03 and 5.35 cm, respectively. The same patterns were observed in the diameter of the trunk and the diameter of the crown, where the best indicators were seen in saxaul when using fertilizers, as well as when using the mixture and Epin-Extra. The best survival rate was observed when using Epin-Extra, where it was 49.7%, which was 38% higher than in the control. Good survival rates were also seen when using hydrogel and total (H+B+F), which was higher than in the control by 39.6 and 27.3%, respectively.

In plot no. 2 (seedlings from the Kyzylorda region), we see the best height indicators in saxaul with the use of the mixture (H+B+F) and Epin-Extra, where it was slightly higher than in the control by 0.18 and 2.1 cm, respectively. The same patterns could be traced with the diameter of the trunk, where the mixture (H+B+F) and Epin-Extra had it higher by 0.13 and 0.14 cm, respectively. The best survival rate was seen in the hydrogel, where it was higher than in the control by 5.9%.

When conducting an inventory of the same plots in 2019 (Table 3), we saw that the best biometric indicators (plot no. 1) (height, trunk diameter, and crown diameter) were observed in saxaul, in which moisture-absorbing substances and growth biostimulators were used, where on average the height was 10.75 cm higher, the diameter of the root neck was 0.2 cm larger and the crown diameter was 5.3 cm larger.

In plot no. 2, complete drying and loss of black saxaul were observed in the control. When using moisture-absorbing substances and biostimulants of growth, the best indicators were traced in Epin-Extra, hydrogel, and total. Here the height varied from 32.1 cm in total to 39.6 cm in Epin-Extra. The best indicators for the diameter of the stem and crown were also traced in the above preparations.

The lowest values in height and diameter were visible when applying fertilizer.

The survival rate in 2019 averaged 5.5% for the hydrogel, 4.0% for total, 3.5% for Epin-Extra, and 3.0% with the use of fertilizer.

Analyzing the indicators obtained during the autumn inventory of the above-mentioned plots in 2020, we see that the best biometric indicators in height and diameter can be traced in black saxaul forest crops planted with seedlings of local origin (plot no. 1 seedlings from the Zhambyl region). Here, the best average indicators for the height of the saxaul were visible when using a hydrogel, total H+B+F, and Epin-Extra, where it was 63.75, 87.35, and 61.27 cm.

Table 2: Average biometric indicators of the black saxaul in 2018 (planting 2018)

No 1	Treatments 2	h of trunk, cm 3	d of trunk, cm 4	d of crown, cm 5	Survival, % 6
Plot 1 (seedlings from the Zhambyl region)					
1	Control	30.12±2.88	0.38±0.07	19.17±3.40	11.7
2	Fertilizer (F)	36.66±2.72	0.46±0.09	23.33±3.06	25.3
3	Hydrogel (H)	33.15±2.20	0.34±0.07	23.30±3.25	51.3
4	Total (H+B+F)	35.14±2.32	0.51±0.05	27.00±3.56	39.0
5	Epin-Extra (B)	35.50±1.76	0.55±0.03	32.87±2.61	49.7
Plot 2 (seedlings from the Kyzylorda region)					
1	Control	35.60±3.82	0.56±0.10	32.50±3.22	7.7
2	Fertilizer (F)	33.70±3.46	0.55±0.05	28.38±3.60	7.1
3	Hydrogel (H)	33.69±1.10	0.52±0.02	29.04±1.23	13.6
4	Total (H+B+F)	35.78±1.44	0.69±0.05	29.84±1.50	7.0
5	Epin-Extra (B)	37.70±1.25	0.70±0.03	26.57±1.27	5.7

Table 3: Average biometric indicators of the black saxaul in 2019 (planting 2018)

No 1	Treatments 2	h of trunk, cm 3	d of trunk, cm 4	d of crown, cm 5	Survival, % 6
Plot 1 (seedlings from the Zhambyl region)					
1	Control	44.50±11.3	0.96±0.38	28.20±1.90	2.0
2	Fertilizer (F)	51.70±5.44	1.20±0.09	34.30±3.45	4.0
3	Hydrogel (H)	55.53±1.86	1.00±0.06	32.00±1.46	35.5
4	Total (H+B+F)	55.05±4.05	1.16±0.11	32.90±2.34	26.5
5	Epin-Extra (B)	58.70±2.96	1.32±0.08	34.80±1.79	29.5
Plot 2 (seedlings from the Kyzylorda region)					
1	Control	-	-	-	-
2	Fertilizer (F)	26.7±3.21	0.64±0.08	20.5±3.10	3.0
3	Hydrogel (H)	34.1±3.63	1.02±0.18	25.0±2.94	5.5
4	Total (H+B+F)	32.1±2.48	0.82±0.13	23.3±3.07	4.0
5	Epin-Extra (B)	39.6±5.84	1.16±0.15	27.7±5.24	3.5

Table 4: Average biometric indicators of the black saxaul in 2020 (planting 2018)

No 1	Treatments 2	h of trunk, cm 3	d of trunk, cm 4	d of crown, cm 5	Survival, % 6
Plot 1 (seedlings from the Zhambyl region)					
1	Control	50.20±4.89	1.08±0.09	42.50±4.32	2.0
2	Fertilizer (F)	51.25±4.15	0.95±0.07	41.55±3.00	3.9
3	Hydrogel (H)	63.75±13.4	1.52±0.34	54.25±2.98	15.7
4	Total (H+B+F)	87.35±6.21	2.07±0.21	71.70±6.14	17.5
5	Epin-Extra (B)	61.27±4.58	1.17±0.10	55.62±4.41	28.0
Plot 2 (seedlings from the Kyzylorda region)					
1	Control	-	-	-	-
2	Fertilizer (F)	41.00±3.74	1.10±0.09	43.66±2.88	2.5
3	Hydrogel (H)	60.50±5.57	1.35±0.04	51.00±4.12	5.0
4	Total (H+B+F)	65.25±1.38	1.50±0.12	61.75±4.89	2.9
5	Epin-Extra (B)	55.08±3.20	1.17±0.12	55.16±4.69	3.0

Table 5: Average biometric indicators of the black saxaul for 2019-2020 during the autumn inventory (planting 2019)

No	Treatments	h of trunk, cm	d of trunk, cm	d crown, cm	Survival, %
Indicators of 2019					
Plot 1 (seedlings from the Zhambyl region)					
1	Control	56.08±1.41	0.84±0.02	42.30±1.38	78.0
2	Fertilizer (F)	59.02±1.73	0.90±0.04	43.06±1.27	80.0
3	Hydrogel (H)	66.80±1.48	1.08±0.04	51.20±1.37	96.0
4	Total (H+B+F)	62.05±1.71	0.96±0.03	44.50±1.18	88.0
5	Epin-Extra (B)	69.70±1.91	1.03±0.04	50.70±1.84	87.0
Plot 2 (seedlings from the Kyzylorda region)					
1	Control	51.7±2.01	0.88±0.05	39.3±1.39	62.0
2	Fertilizer (F)	56.2±1.95	0.96±0.05	44.1±1.93	64.0
3	Hydrogel (H)	61.4±1.75	1.05±0.05	45.6±1.55	84.0
4	Total (H+B+F)	58.7±1.79	0.96±0.04	43.0±1.53	70.0
5	Epin-Extra (B)	66.2±1.62	1.11±0.04	50.0±1.24	79.0
Indicators of 2020					
Plot 1 (seedlings from the Zhambyl region)					
1	Control	77.75±3.00	1.32±0.11	75.95±4.28	65.0
2	Fertilizer (F)	79.80±3.17	1.42±0.11	78.55±3.27	78.0
3	Hydrogel (H)	94.30±2.00	2.29±0.12	95.10±2.67	94.0
4	Total (H+B+F)	89.50±3.29	1.74±0.09	83.95±3.05	86.0
5	Epin-Extra (B)	81.55±1.79	1.88±0.27	81.20±1.91	84.0
Plot 2 (seedlings from the Kyzylorda region)					
1	Control	80.85±3.90	1.71±0.10	78.30±4.71	54.0
2	Fertilizer (F)	78.95±3.96	1.58±0.18	80.40±4.64	62.0
3	Hydrogel (H)	86.15±2.35	2.05±0.12	78.95±3.88	60.0
4	Total (H+B+F)	81.35±4.18	1.74±0.07	81.60±2.19	68.0
5	Epin-Extra (B)	94.70±3.53	1.91±0.11	91.45±3.90	55.0

Table 6: Average biometric indicators of the black saxaul in autumn 2020 (planting 2020)

No	Treatments	h of trunk, cm	d of trunk, cm	d of crown, cm	Survival, %
Plot 1 (seedlings from the Zhambyl region)					
1	Control	35.60±2.03	0.72±0.05	28.90±1.67	68.0
2	Fertilizer (F)	33.95±3.48	0.75±0.05	30.20±1.86	54.0
3	Hydrogel (H)	46.55±2.82	0.78±0.04	34.65±1.72	80.0
4	Total (H+B+F)	48.85±1.46	0.87±0.04	32.10±1.06	90.0
5	Epin-Extra (B)	37.30±1.73	0.85±0.05	31.15±1.38	76.0
Plot 2 (seedlings from the Kyzylorda region)					
1	Control	37.70±1.59	0.62±0.05	29.80±1.66	58.0
2	Fertilizer (F)	35.15±2.99	0.81±0.04	31.65±2.11	54.0
3	Hydrogel (H)	52.95±2.03	0.66±0.04	28.30±1.50	64.0
4	Total (H+B+F)	40.30±2.45	0.69±0.05	26.15±2.00	75.0
5	Epin-Extra (B)	42.10±1.68	0.65±0.03	28.65±1.74	60.0

This was higher than in the control by 37.15, 13.55, and 11.07 cm, respectively.

The same patterns were observed in the diameter of the stem and the diameter of the crown, where with the use of hydrogel, total H+B+F, and Epin-Extra, these indicators were higher than in the control on the diameter of the stem by 0.17, 0.99 and 0.09 cm and the crown diameter by 11.75, 29.2 and 13.1 cm, accordingly.

In plot no. 2 forest crops of the black saxaul planted with seedlings imported from the Kyzylorda region had lower biometric indicators.

In conclusion, we may say that when planting seedlings of black saxaul forest crops of local origin (zoned seedlings) in 2018 with the use of moisture-absorbing substances and growth biostimulators, the best biometric indicators were traced in experimental plots using hydrogel and Epin-Extra, as well as their mixture.

Table 5 shows that seedlings planted on experimental plots in 2019 showed the following biometric indicators and survival rates.

During the autumn inventory of 2019, it can be seen that the best height indicators were observed in seedlings planted with the use of moisture-absorbing substances and growth biostimulators. The best results were shown by seedlings of local origin, where the height of seedlings was 2.94 cm (fertilizer), 10.72 cm (hydrogel), 5.97 cm (total), and 13.62 cm (Epin-Extra) higher than the control. The same patterns can be traced by the diameter of the root neck, where the best indicators were seen in seedlings that were planted using hydrogel, total, and Epin-Extra. They were larger than the control by 0.24, 0.12, and 0.19 cm, respectively. The crown size was 8.9, 2.2, and 8.4 cm larger, respectively. The best survival rate was seen in black saxaul with the use of hydrogel, where it was 96% and in seedlings with the use of total and Epin-Extra, it was 88 and 87%, respectively. In the control, this indicator is 78%. The autumn inventory of 2020 showed that the two summer forest crops of the black saxaul also had the best height indicators on plot no. 1, where local seedlings were planted. Thus, the best height indicators were visible when using hydrogel, total, and Epin-Extra, where it was higher than in the control by 16.55, 11.75, and 3.8 cm, respectively. The same patterns can be traced by the diameter of the root, where the best indicators were seen in seedlings that were planted using hydrogel, total, and Epin-Extra. They were larger than the control by 0.97, 0.42, and 0.56 cm, respectively. The crown size was larger by 19.5, 8.0, and 5.25 cm, respectively. The best survival rate was seen in black saxaul with the use of hydrogel (94%) and in seedlings with the use of total and Epin-Extra, it was 86 and 84%, respectively. In the control, this indicator was 65%. In 2020, we also conducted experiments with the use of moisture-absorbing substances and growth biostimulators in two plots, where seedlings from a local nursery were planted on the 1st and 2nd plots. The results of the autumn inventory are shown below in Table 6.

As can be seen from Table 6, the best height indicators are seen in black saxaul with the use of hydrogel, total, and Epin-Extra where it was higher than in the control by 10.95, 13.25, and 1.7 cm, respectively. The diameter of the stem was also larger than in the control by 0.03, 0.15, and 0.13 cm, respectively. The same patterns can be traced with the diameter of the crown.

Analyzing the survival rate, we see that the best indicators were traced with the use of total, where it was 90% and in seedlings with the use of hydrogel and Epin-Extra, it was 80 and 76%, respectively. In the control, this indicator was 68%.

Discussion

Natural and Climatic Conditions of the Research Area (Zhambyl Region)

The characteristic features of the climate of the Zhambyl region are significant aridity and continentality (Karatayev *et al*., 2022). This is due to the location of the territory of the region within the Eurasian continent, the remoteness from the oceans, and the peculiarity of atmospheric circulation, which contributes to the frequent formation of clear or low-cloud weather, as well as the southern position, which provides a large influx of solar heat. In addition, a significant area of the region is occupied by deserts (Betpak-Dala and Moyinkum), and only the south-western, southern, and south-eastern outskirts are occupied by mountains (Karatau, Kirghiz, and Shu-Ili). These differences in relief bring a great variety to the climate of the region. The continentality of the climate is manifested in the sharp temperature contrasts of day and night, winter and summer, in the rapid transition from winter to summer. In the southern mountainous part of the region, the features of continentality are softened: Winter is milder here and precipitation is higher. The desert plains of the northern and central regions of the region are especially arid. Summer is very hot here, the average July temperature ranges from 21 to 25°C, and on some days the air temperature reaches 45-48°C (absolute maximum). However, winter in its severity does not correspond to geographical latitude. The coldest month is January, with an average temperature of -8, -12°C in the north of the region and -4, -7°C in the south. Cold Arctic air in winter, penetrating to the south of the region, causes severe frosts reaching -45, -50°C (absolute minimum).

The period with an average daily air temperature above 0°C is quite long. In the north of the region, it is 240-250 days, in the central regions 260-270 days. In general, there is little precipitation in the region, especially in its flat part (140-220 mm per year). An insignificant amount of precipitation (135 mm per year) is observed in the northeast region near the coast of Lake Balkhash. In the foothill areas, precipitation increases to 210-330 mm. 400-500 mm of precipitation falls in the mountains of the Kyrgyz Alatau. According to the seasons of the year, precipitation is distributed extremely unevenly-most of it falls during the winter-spring period. Almost the entire territory of the region is dominated by the east and north-east wind directions and only in the extreme south the winds of the south and south-east directions are more often repeated. Their average speed is 2.5-3.5 m/s. In mountainous areas, there are winds, the formation of which is due to local characteristics (mountain-valley, etc.).

Soil Cover of Zhambyl Region

Due to the heterogeneity of soil formation conditions, the soil cover of the Zhambyl region is characterized by significant diversity (Toktar *et al*., 2016). The mechanical composition of soils depends on the soil-forming rocks, which are also very diverse in the region. The whole variety of soils of the region is distributed in the following zones: High-altitude zone; Mountain-steppe zone with a very arid climate; Desert-steppe zone with a dry hot climate; Desert zone with a dry hot climate. The territory of this region has a diverse soil cover. In the lower reaches of the Shu River, as well as in the depressions of the relief of deserts, takyr soils and takyrs are common. Deserts are characterized by gray-brown soils, loose-sanded and sandy gray soils, and gray foothills. The desert-steppe zone is confined to the low mountains of the middle mountains of the Karatau, Kirghiz, and Kurdai ridges and the Chu-Ili Mountains and the Saz areas of the Kuragata-Chui Valley, and the Talas Assinsky interfluve region in the range from 600 to 1,300 m of absolute altitude. The main types of soils for this zone are light chestnut soils and gray soils. The distribution area of light chestnut soils is semi-desert and desert-steppe regions of the Zhambyl region.

The following horizons are distinguished in their profile: Humus (up to 18 cm thick); transitional (10 to 20 cm thick); carbonate (45 to 85 cm thick); parent rocks. The upper layers of light chestnut soils contain up to 2.5% humus. These soils are upper and alkaline in the lower horizons. It is possible to cultivate crops on such land only if special irrigation measures are regularly carried out. Serozems are a type of soil formed in a sharply continental climate under semi-desert vegetation on loams, loam-like loams, and ancient alluvial deposits. They are characterized by a non-washing and effluent water regime, good water-physical properties, significant fertility (although they contain 13.5% humus in the upper horizon A), alkaline reaction, gray or gray-pale color, carbonate content (horizon B), salinity, annual cyclicity of the soil-forming process. In spring, plant residues accumulate and humify in the upper horizon, and some of the mineral salts move to the lower horizons, in summer humus substances are mineralized, and easily soluble salts rise with capillary moisture to the upper horizon.

They have many varieties, a characteristic feature of this type of soil is a slight accumulation of humus and a relatively high carbonate content of soils in the absence of a pronounced carbonate horizon. These soils were formed under the type-wormwood vegetation with the participation of ephemera.

The Shu River Basin (Chu)

The qualitative composition of the Shu (Chu) river water coming from the territory of Kyrgyzstan has deteriorated over the past 10 years. According to IZV, the waters of this river have moved from the category of "clean" to the category of "moderately polluted". In 2005, there was an excess of the MPC for copper by 4.8 times, BPK5 by 1.7, nitrite nitrogen by 1.6, phenols by 2.0, and petroleum products by 1.2 times. The river is intensively used throughout for household needs and irrigation, which causes significant changes in water quality (data are given from UNEPROAP (2006).

Cultivation of Black Saxaul

In the harsh natural and climatic semi-desert conditions of the Moyinkum sands of the Zhambyl region, the cultivation of black saxaul forest crops, which are soil-strengthening and anti-erosion plantings, is very relevant. The preservation of artificially created saxaul forest plantations, especially in the first years of planting, is a problematic issue, in the future, after good preservation in the first years of life, when the roots of forest plantations reach groundwater (Mortelliti and Lindenmayer, 2015), forest crops develop well and begin to bear fruit. As a result of the research conducted in 2018-2020 and the analysis of the data obtained, the following conclusions can be drawn. The beginning of bud swelling in seedlings of saxaul of black local origin begins earlier than in seedlings brought from the Kyzylorda region. In our opinion, this is because when transporting seedlings over long distances, they receive stress, which further affects the beginning of vegetation and survival (Loebach and Anderson, 2018). The beginning of kidney swelling in the experimental areas refers to the 3rd 10-day period of March (25.03) to the 2nd 10-day period of April (15.04). Full leaf bloom in forest crops planted from local planting material refers to the 2nd 10-day period of April, while crops planted from seedlings brought from the Kyzylorda region, the beginning of full vegetation is extended until the 1st 10-day period of May.

According to the results of observations of the first, second, and third years, it should be noted that the use of various water-retaining compounds (hydrogels), growth stimulants (Epin-Extra), fertilizers, as well as their combined use, gave a positive effect. In arid conditions, where there is an acute lack of moisture, the intensity of saxaul growth in height largely depends on the use of moisture-absorbing substances, growth biostimulators, and nitrogen fertilizers (Rathore *et al*., 2021). When creating forest crops of the black saxaul in the south of Kazakhstan, it is necessary to use zoned standard planting material.

The use of moisture-absorbing substances and biostimulators of plant growth in the cultivation of black saxaul increases the average diameter and average height of seedlings by an average of 30.1 and 38.6%, respectively than in the control. The best effect of the used growth stimulants is shown by a moisture-absorbing substance-hydrogel, Epin-Extra, and a ready-made mixture of hydrogel, fertilizer, and Epin-Extra. The gradual impact of the use of moisture-absorbing substances, growth biostimulants, and nitrogen fertilizers affects the 2nd and subsequent years after planting.

Conclusion

The 2018-2020 studies allow us to draw the following conclusions. In arid conditions, where there is an acute lack of moisture, the intensity of saxaul growth in height largely depends on the use of moisture-absorbing substances, growth biostimulators, and nitrogen fertilizers. When creating forest crops of the black saxaul in the south of Kazakhstan, it is necessary to use zoned standard planting material.

The use of moisture-absorbing substances and growth biostimulators in the cultivation of black saxaul increases the average diameter and average height of seedlings by an average of 30.1 and 38.6%, respectively, compared to the control. The best effect of the used growth stimulants is shown by hydrogel, Epin-Extra, and a ready-made mixture of hydrogel, fertilizer, and Epin-Extra. Thus, we see the prospects of our study in the selection of the most effective types of moisture-absorbing substances, growth biostimulators, and nitrogen fertilizers.

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Ethics

This article is original and contains unpublished material. The corresponding author confirms that all of the other authors have read and approved the manuscript and that no ethical issues are involved.

References

Czimczik, C. I., Mund, M., Schulze, E. D., & Wirth, C. (2004). Effects of reforestation, deforestation, and afforestation on carbon storage in soils. *The Carbon Balance of Forest Biomes*, 319-330.

Karatayev, M., Clarke, M., Salnikov, V., Bekseitova, R., & Nizamova, M. (2022). Monitoring climate change, drought conditions and wheat production in Eurasia: The case study of Kazakhstan. *Heliyon*, 8(1), e08660. https://doi.org/10.1016/j.heliyon.2021.e08660

Loebach, C. A., & Anderson, R. C. (2018). Measuring short distance dispersal of Alliaria petiolata and determining potential long-distance dispersal mechanisms. *Peer J*, 6, e4477. https://doi.org/10.7717/peerj.4477

Lopez Fernandez, M. L., Zhumabayev, D., Marco Garcia, R., Baigarin, K., Lopez Fernandez, M. S., & Baisholanov, S. (2020). Assessment of bioclimatic change in Kazakhstan, end 20th-middle 21st centuries, according to the PRECIS prediction. *Plos One*, 15(10), e0239514. https://doi.org/10.1371/journal.pone.0239514

Mortelliti, A., & Lindenmayer, D. B. (2015). Effects of landscape transformation on bird colonization and extinction patterns in a large-scale, long-term natural experiment. *Conservation Biology*, 29(5), 1314-1326. https://doi.org/10.1111/cobi.12523

Mukasheva, D., Kirshibayev, Y. A., Baiseitova, G., Orazbayev, A., & Admanova, G. (2022). Features Resistance of Sugar Sorgo (*Sorghum Saccharatum* (L.) Pers.) Varieties to Environmental Stress Factors. *OnLine Journal of Biological Sciences*, 22(1), 46-57. doi.org/10.3844/ojbsci.2022.46.57

Ortúzar, M., González López, J. J., & Aranda Ballesteros, E. (2022). Pharmaceutical Pollution in Aquatic Environments: *A Concise Review of Environmental Impacts and Bioremediation Systems*. https://doi.org/10.3389/fmicb.2022.869332

Rathore, V. S., Nathawat, N. S., Bhardwaj, S., Yadav, B. M., Kumar, M., Santra, P., ... & Yadav, O. P. (2021). Optimization of deficit irrigation and nitrogen fertilizer management for peanut production in an arid region. *Scientific Reports*, 11(1), 1-14. https://doi.org/10.1038/s41598-021-82968-w

Ryazanova, L. G., Provorchenko, A. V., & Gorbunov, I. V. (2013). The basics of statistical analysis of research results in horticulture. Kuban State Agrarian University, Krasnodar, Russia. https://kubsau.ru/upload/iblock/c12/c1233a2f893f8abe71bd29a367674972.pdf

Toktar, M., Papa, G. L., Kozybayeva, F. E., & Dazzi, C. (2016). Ecological restoration in contaminated soils of Kokdzhon phosphate mining area (Zhambyl region, Kazakhstan). *Ecological Engineering*, 86, 1-4. https://doi.org/10.1016/j.ecoleng.2015.09.080

UNEPROAP. (2006). Assessment reports on priority environmental problems of Central Asia. Ashgabat. http://www.cawater-info.net/library/eng/icsd2-en.pdf