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«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ» РҚБ

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ИЗВЕСТИЯ

РОО «НАЦИОНАЛЬНОЙ
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РЕСПУБЛИКИ КАЗАХСТАН»

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NAS RK is pleased to announce that News of NAS RK. Series of geology and technical sciences scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of geology and technical sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы «ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

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ADAPTABILITY OF KOCHIA PROSTRATA (L.) SCHRAD AND CAMPHOROSMA MONSPELIACA AGRICULTURAL ECOSYSTEMS ON SALINE LANDS OF THE NORTHERN CASPIAN DESERT

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Abstract. In the northern part of the Caspian Desert, where we conducted our research, the average precipitation is not more than 170-180 mm, but 92% of the plain space is saline to some extent. Because of the climate's aridity, rainfed farming is not practiced in this area; instead, natural pastures with low production (2–3 c/ha) are intended for cattle grazing and sheep in general. Excavation of irrigated regions beyond two thousand hectares is not feasible due to the extensive salinity of the soils. Dry plant cultivation for feed is out of application. Drought, salinity in the soil, and low pasture productivity are three aspects of the natural environment that influence pasture radicalization and the choice of improved crops. The purpose of the research implies the selection of salt- and drought-tolerant plants from natural pastures for cultivation on saline soils in the Caspian Sea region. As a research method, testing of introductory crops on saline soils with the simultaneous study of their salt tolerance in field conditions is applied. The research resulted in defining the 40–50 cm soil-layer medium saline soils with a 2–3 % toxic ion content to the final root penetration depth of 360–516 cm. as suitable for cultivation of *Kochia prostrata* and *Camphorosma monspeliaca*. At such salinity of soils, *Kochia prostrata* provides 23–25 c/ha of fruiting pro-

duction, while Camphorosma monspeliaca provides 12–16 c/ha of pasture mass, which is respectively 11.5–8.3 and 6–6.3 times higher than the productivity of natural pastures (2–3 c/ha). At radical improvement of pastures, with 7 cm-depth highly saline soils and 200 cm-depth very highly saline soils are suitable to cultivate Camphorosma monspeliaca. Still, 50 cm-depth medium-saline automorphous clayey soils suit Camphorospha monspeliaca and Kochia prostrate sowing.

Keywords: Kochia prostrata, Camphorosma monspeliaca, salinity, halophyte phytocenoses, salt tolerance, fodder production

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СОЛТҮСТІК КАСПИЙ ШӨЛІНІҢ ТҰЗДЫ ЖЕРЛЕРІНДЕГІ KOCHIA PROSTRATA (L.) SCHRAD ЖӘНЕ CAMPHOROSMA MONSPELIACA АУЫЛШАРУАШЫЛЫҚ ЭКОЖҮЙЕЛЕРІНІҢ БЕЙІМДЕЛГІШТІГІ

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Аннотация. Біз зерттеу жүргізген Каспий Шөлінің солтүстік бөлігінде жауын-шашынның орташа мөлшері 170–180 мм-ден аспайды, бірақ жазық кеңістіктің 92 % - ы белгілі бір дәрежеде тұзды. Климаттың құрғақшылығына байланысты бұл ауданда жауын-шашынды егіншілік жүргізілмейді; оның орнына өнімділігі төмен (2–3 ц/га) табиғи жайылымдар мал жаюға және жалпы қой бағуға арналған. Екі мың гектардан асатын суармалы жерлерді қазу топырақтың тұздылығына байланысты мүмкін емес. Жемге арналған өсімдіктерді құрғақ өсіру қолданыстан шыққан. Құрғақшылық, топырақтың тұздылығы және жайылымның төмен өнімділігі-бұл

жайылымдардың радикалдануына және жақсартылған дақылдарды таңдауға әсер ететін табиғи ортаның үш аспектісі. Зерттеудің мақсаты Каспий теңізі аймағындағы тұзды топырақтарда өсіру үшін табиғи жайылымдардан тұзға және құрғақшылыққа төзімді өсімдіктерді таңдауды көздейді. Зерттеу әдісі ретінде егістік жағдайында олардың тұзға төзімділігін бір мезгілде зерттей отырып, тұзды топырақтарда кіріспе дақылдарды сынау қолданылады. Зерттеу нәтижесінде тамырдың енуінің соңғы тереңдігі 360–516 см болатын 2–3 % улы ионы бар 40–50 см топырақ-қабатты орташа тұзды топырақтар *Kochia Prostrata* және *Camphorosma Monspeliaca* өсіруге жарамды деп анықталды. Топырақтың осындай тұздылығында *Kochia prostrata* 23–25 ц/га жеміс өндіруді қамтамасыз етеді, ал *Camphorosma monspeliaca* 12–16 ц/га жайылым массасын қамтамасыз етеді, бұл сәйкесінше 11,5–8,3 және 6–6, 3 есе жоғары, табиғи жайылымдардың өнімділігі (2–3 ц/га). Жайылымдарды түбегейлі жақсарту кезінде *Camphorosma monspeliaca* өсіру үшін тереңдігі 7 см жоғары тұзды топырақтар және тереңдігі 200 см өте жоғары тұзды топырақтар қолайлы. Дегенмен, 50 см тереңдіктегі орташа тұзды, автоморфты сазды топырақтар *Camphorospha monspeliaca* және *Kochia prostrate* егуге жарамды.

Түйін сөздер: Kochia prostrata, Camphorosma monspeliaca, тұздылығы, галофитті фитоценоздары, тұзға төзімділігі, жемшөп өндірісі

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АДАПТИВНОСТЬ СЕЛЬСКОХОЗЯЙСТВЕННЫХ ЭКОСИСТЕМ KOCHIA PROSTRATA (L.) SCHRAD И CAMPHOROSMA MONSPELIACA К ЗАСОЛЕННЫМ ЗЕМЛЯМ ПУСТЫНИ СЕВЕРНОГО КАСПИЯ

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Аннотация. В северной части Прикаспийской пустыни, где мы проводили наши исследования, среднее количество осадков составляет не более 170–180 мм, но 92 % равнин в той или иной степени засолены. Из-за засушливого климата в этом районе не практикуется богарное земледелие; вместо этого естественные пастбища

с низкой продуктивностью (2–3 ц/га) предназначены для выпаса крупного рогатого скота и овец в целом. Выемка грунта на орошаемых территориях площадью более двух тысяч гектаров невозможна из-за сильного засоления почв. Выращивание аридных растений на корм не применяется. Засуха, засоленность почвы и низкая продуктивность пастбищ – вот три аспекта природной среды, которые влияют на рационализацию пастбищ и выбор улучшенных сельскохозяйственных культур. Цель исследования — отбор соле- и засухоустойчивых растений с естественных пастбищ для выращивания на засоленных почвах в регионе Каспийского моря. В качестве метода исследования применено тестирование интродукционных культур на засоленных почвах с одновременным изучением их солеустойчивости в полевых условиях. В результате исследований были определены средне-засоленные почвы слоем 40-50 см с содержанием токсичных ионов 2-3% и конечной глубиной проникновения корней 360–516 см как подходящие для выращивания *Kochia prostrata* и *Camphorosma monspeliaca*. При таком засолении почв *Kochia prostrata* обеспечивает урожайность 23–25 ц/га, а *Camphorosma monspeliaca* – 12–16 ц/га пастбищной массы, что соответственно в 11,5–8,3 и 6–6,3 раза превышает продуктивность естественных пастбищ (2–3 ц/га). При радикальном улучшении пастбищ для выращивания *Camphorosma monspeliaca* подходят сильно засоленные почвы глубиной 7 см и очень сильно засоленные почвы глубиной 200 см. Тем не менее, среднезасоленные автоморфные глинистые почвы глубиной 50 см подходят для посева *Camphorospha monspeliaca* и *Kochia prostrate*.

Ключевые слова: Kochia prostrata, Camphorosma monspeliaca, засоление, галофитные фитоценозы, солеустойчивость, кормопроизводство

Introduction

From an evolutionary perspective, the Caspian lowland's desert-type vegetation is thought to be the original. The Caspian lowland's recent (in geological terms) past influences this phenomenon. The region was totally devoid of marine transgressions in the Caspian Sea about 8000 years ago (Nikolaev, 1953). Since then, the salinity of the soil has determined the growth of halophilic desert plants everywhere and the cultivation of specific plant species.

In modern conditions, the dominant vegetation in the desert zone of the Caspian lowland is annual halophytes, the representatives of typical deserts on saline and near-saline groundwater soils. Evidently, with soil desalinization, halophyte phytocenoses are replaced by semi-shrub communities in striped ecological rows starting from the shore.

Phytocenoses of *Artemisia Monogynae* formations are dominant here, while formations of rod-root formations, *Camphorosmeta Monspeliacae* and *Anabasis Salsa, Anabasis Aphylla* are of subordinate importance. The sub-edifiers of the communities of the above-mentioned formations are such solanaceous semi-shrubs as *Anabasis Aphylla, Salsola Laricina, Kochia Prostrata* (Svetlakova, 1986; Goryaev, 2019; Goryaev and Korablev, 2020).

Among ephemerals, the dominant grasses are *Eremopyrum Triticeum* and in some years *Ceratocarpus Arenarius*.

Of the listed species, the greatest forage value is represented by *Camphorosma Monspeliaca* and *Kochia Prostrata*, which, as a result of frequent stratification and desertification of the climate, either mosaically interspersed (*Camphorosmeta monspeliacae*) or sporadically occur (*Kochia Prostrata*), among other phytocenoses. Soil stepping goes in the direction from marginal solonchaks to salt-washed to middle degree (to the depth of 40–50

cm) stepped meadow soils, i.e., the character of salt removal is presented as follows: The marsh solonchaks, still located in the seaside narrow strip, are replaced by meadow highly saline soils, and they in turn are replaced by steppe meadow-brown or alluvial-brown soils (Akhanov et al., 1979; Vasjukov, 2015).

Long-term researches we conducted show that steppe soils with 40–50 cm-depth salination and toxic ions content below the layer of maximum salinity accumulation horizon, i.e., with the salt concentration characteristic of solonchaks, are suitable for agricultural development of semi-desert lands through rainfed grass sowing (*Agrophyron desertorum, Elymus junceus, Melilotus albus*), Sudan grass (*Sorghum × drummondii*) and winter rye (*Secale cereale*) (Mukhambetov, 1983). But research on determining the suitability of soils for the sowing of *Kochia prostrata* and *Camphorosma monspeliacae* has not been conducted in the desert zone.

The salt tolerance and drought resistance of *Kochia prostrata* are under study in Russia, China, Iran, Mongolia, and South Serbia, while in North America, its aggressiveness and competitiveness in phytocenosis are subjected to scrutiny (Li et al., 2017; Gao et al., 2015; Bademuqiqige et al., 2018; Wang et al., 2019; Acar and KoçKoyun, 2019; Pirasteh-Anosheh et al., 2023; Junjun et al., 2018).

We analyzed genetic polymorphism in *Kochia prostrata*, growing on different soils with contrasting salt content, in eight variants of desert-steppe plant communities to determine the possibility of the development of solonchaks of the Southern Urals in Russia. Significant genetic differentiation between two populations on dark humus saline soils indicates that soil conditions may influence not only the level of diversity but also the genetic structure of populations.

Kochia prostrata is salt-tolerant and well-adapted to some ecosystems dominated by halophytic species. Also, it is highly productive (up to 1.8 t/ha) when grown in soils with salinity levels (conductivity) approaching 20 DS/m and is able to persist at much higher levels of electrical conductivity. It is cultivated under conditions with 100–200 mm of rainfall per year.

In Iran, as reported by, the salt tolerance of *Kochia prostrata* was studied alongside the CL^- and NA^+ ions' effects on its growth, water relations, glycine betaine, free proline, number of stomata, and pasture mass size. Adaptation of halophytes to salinity has been found to be associated with metabolic changes that result in the accumulation of several organic dissolved substances such as sugars, polyols, betaines, and free proline (Flores et al., 1977; Qozham et al., 1981; Briens and Larher, 1982).

The accumulation of proline in cells indicates an increase in the resistance of *Kochia prostrata* to salt stress (Stozey and Wyn-Jones, 1979; Tumlert et al., 2023).

Kochia prostrata was found to be a salt-tolerant species, with optimal growth occurring up to 150 mm/NaCl. Glycine, betaine, proline, and soluble sugars are accumulated in the cytoplasm and its organelles to support photosynthesis. It can be successfully planted to improve low-saline areas of Iran in arid and semi-arid regions.

Since soil salinity is the determining factor in the growth and development of forage crops in this zone, for their development, valuable forage grasses of natural pastures, such as *Kochia prostrata* and *Camphorosma monspeliacae*, were selected.

The purpose of the research is to select salt-solonetz and drought-resistant plants from natural pastures for cultivation on the saline soils of the Caspian region; the objectives of the research are to study:

- salt tolerance of *Kochia prostrata* and *Camphorosma monspeliacae*;
- growth and development, their productivity;
- determination of the suitability of soils for the cultivation of *Kochia prostrata* and *Camphorosma monspeliacae* on rainfed lands.

Materials and methods

The experiments were laid in the subwinter of 2021 by the field method according to B. Dospekhov in fourfold repetition on 30m^2 - sized plots of three types of soils (Dospekhov, 1979). The granulometric composition of soils is medium and heavy loamy, humus content is 0.9-1.2% total nitrogen is 0.15-1.1%, phosphorus is 1.3%, and potassium is 1.75%.

Soils are provided with mobile forms of nitrogen (4.5 mg per 100 g of soil) and phosphorus (1.4 mg per 100 g of soil) to a weak degree, and potassium (38 mg per 100 g of soil) to a high degree. Soils are salinized in medium and strong degree, where the content of toxic ions is respectively (%) 0.6 and 0.9 and the salinity type is chloride-sulfate.

Chemical analysis of water extract and determination of mobile compounds of phosphorus, potassium, and nitrogen were carried out according to the state standard of OST-46-52-76. "*Methods of agrochemical analysis of soils. The determination of the chemical composition of water extracts and the composition of groundwater for saline soil*s". The separation of soils by degree of salinization and the calculation of toxic ions were carried out according to the method of N.I. Bazilevich and E.I. Pankova (Bazilevich and Pankova, 1972; Keller, 1940; Lavrenko, 1974).

The method by B.P. Stroganov was applied to assess crops for salt tolerance and the nature of distribution in the soil environment of the root system of plants (1968), which assumes consideration of tropisms (osmotropism, geotropism, chemotropism, etc.) (Stroganov, 1968).

Results

The study of plants salt tolerance was carried out in two stages: on natural pastures of the Caspian Sea (Table 1) and in crops-introducers (Table 2)

Table 1 - Content of toxic salts under wild fodder plants

Number of sections	Soil and groundwater sampling depth, in cm	Toxic ions, %			plants
		amount	Cl	SO_4	
1	0-5	3.003	0.112	1.910	*Calamagrostis epigeios*
	5-15	1.502	0.035	0.984	*Alhagi pseudalhagi*
	15-25	0.106	0.106	0.509	*Aeluropus littoralis*,
	25-35	1.736	0.035	0.571	*Phragmites australi*s
	35-45	1.005	0.085	0.643	
	45-55	1.096	0.024	0.710	
	55-65	1.159	0.140	0.624	
	groundwater (g/l)	4.134 (65cm depth)			
2	0-5	1.081	0.815	0.350	*Phragmites australis Alhagi pseudalhagi*

2a	0-5	9.764	1.862	4.536	*Alhagi pseudalhagi*
	5-25	0.180	0.105	0.461	
	60-70	0.747	0.087	0.384	
	groundwater (g/l)	5,698 (70cm depth)			
3	0-5	2.776	0.752	1.037	*Aeluropus littoralis*, *Artemisia maritima*
	5-25	3.312	1.260	0.845	
	groundwater (g/l)	400,872 (85 cm depth)			
3a	0-5	1.853	0.441	0.763	*Artemisia maritima* *Atriplex tatarica,* *Aeluropus littoralis*, *Melilotus albus, Glycyrrhiza glabra*
4	0-5	6.997	0.490	4.204	*Puccinellia distans*, *Aeluropus littoralis*
	5-15	3.124	0.182	1.977	
	15-25	1.471	0.070	0.912	
	25-45	1.281	0.087	0.768	
	Groundwater (g/l)	30.4 (86 cm depth)			
5	0-5	9.830	0.812	6.760	*Calamagrostis epigeios*
	5-25	8.029	0.262	1.756	
	25-45	1.684	0.059	1.075	
	45-65	1.085	0.052	0.653	
	Groundwater (g/l)	46,2 (95 cm depth)			
7	0-5	12.728	1.190	7.248	*Phragmites australis*
	5-25	0.918	0.052	0.552	
	25-45	1.016	0.032	0.619	
	45-69	1.109	0.059	0.682	
	69-90	1.225	0.094	0.715	
	Groundwater (g/l)	24.170 (90 cm depth)			

Table 1 shows salinity indices under wild fodder plants. It should be noted that wild forage plants grew in pits dug during the construction of the experimental estuary. The upper 1.0–1.5-mmeter layer of soil was removed to fill the estuary rolls, and seeds of wild plants migrated on the bare soils, which are soil-forming rocks with a salinity of 2–3 % (according to dense residue). Some pits were located 10–20 meters from the Kursai River, so the salts in these pits were washed from bottom to top. Due to the lateral filtration of river water, the capillary rim reached the soil surface.

In nature, even at 2–3 % salinization, as the Table 1 data show, and at redistribution of salts in the process of washing them from bottom to top, fodder plants such as *Melilotus albus, artiplex tartarica, Glycyrrhiza glabra, Artemisia maritima, Puccinellia distans, and Calamagrostis epigeios* grew successfully. And what is worth mentioning is that sprouts of wild forms of *Melilotus albus* and other species of wild flora withstand soil salinity corresponding to secondary saline soils, at which sprouts of all field fodder crops die. The fact that wild crops are grown on very highly saline (2–3 % by dense residue) soil-forming rocks

under their abundant irrigation (at the constant lowest soil water capacity) indicates the possibility of developing such lands under sufficiently high salinity. With an abundant water supply, salts are diluted, and their toxicity decreases.

According to the data from Table 1, the greatest salt tolerance is found in such representatives of meadow perennial grasses as *terrestrial Calamagrostis epigeios, Aeluropus littoralis, Phragmites australis,* and *Puccinellia distans,* and, against expectation, *xerophyte phreatophyte* or *Alhagi pseudalhagi*, which can be referred to as especially salt-tolerant plants withstanding from 6.997 to 12.728 % of toxic ions. The second medium salt-tolerant group includes *Artemisia*, with an in-soil content of toxic ions of 3.312 %, and to the third weakly salt-tolerant group can be attributed *Artiplex tartarica* and *Glycyrrhiza glabra*, whose threshold of toxic ions does not exceed 1.853 %.

To note, in conditions of the meadow regime, where strongly mineralized ground water and brines are located at a depth of 65–95 cm, bright representatives of automorphic soils, such as *Kochia prostrata*, do not grow, despite the hollows being bordered by automorphic solonets, which are natural conditions for *Kochia prostrata and Camphorosma monspeliaca.*

Determination of toxic ions under *Kochia prostrata* and *Camphorosma monspeliaca* growing on automorphous solonetz showed that the latter was more salt tolerant than *Kochia prostrata*, as it withstands strong degree of soil salinization (1.0814 % of toxic ions, 0.815 % of chlorine, 0.350 % of SO_4), while *Kochia* displays an average degree.

Extreme conditions inherent in desert soils cause the most severe trials for plants in general and for their root systems in particular. Therefore, when evaluating crops for salt and drought resistance, it is highly relevant to find out the peculiarities of root distribution in very densely solonized soil and the underlying excessively saline, so-called horizon of maximum salinity accumulation, which contains up to 2–3 % of easily soluble salts.

Sections 7 and 8 present the results of the study on the distribution of roots of *Kochia prostrata* and *Camphorosma monspeliaca* saline from the soil surface up to 40 cm in medium and strong degree, and below saline to very strong degree with 1.8–2.5 % content of toxic ions.

The study on root distribution along the profile of saline lands showed that the root systems of *Kochia prostrata* and *Camphorosma monapeliaca* successfully passed the horizon of maximum salinization (1.8–2.5% toxic ions), reaching a depth of 360 cm (*Camphorosma monspeliaca*) and 526 cm (*Kochia prostrata*), with a salt content of a medium degree above this horizon (40 cm). It should be emphasized that the roots of other plants, such as ephemeral annuals (*Artemisia absinthium*) from natural pastures growing there on saline soils, cannot overcome the horizon of maximum salinity, while annual halophytes cannot overcome saline horizons located at a depth of 10–25 cm.

Taking into account the high salt tolerance of *Kochia prostrata* and *Camphorosma monspeliaca*, the roots of which can penetrate into highly-strong degree salt-content horizons to successfully extract moisture and nutrients for survival in the desert, we carried out introduction studies on *Kochia prostrata* and *Camphorosma monspeliaca* to examine their productivity in moderately saline up to 40 cm and very strongly saline below this horizon residual meadow-brown soils (Table 2).

Table 2 - Yield of crops-introducers on saline soils of the Caspian Sea area

Number of sections	Sampling depth, cm	Salt content in the soil, %		Degree of soil salinity	Crop-introducers	Productivity, c/ha								
		Toxic ions	Cl			Pasture grass			Hay			Fruit forage		
						2nd year, 2022	3rd year, 2023	Average	2nd year, 2022	3rd year, 2023	Average	2nd year, 2022	3rd year, 2023	Average
7	0-7	0.680	0.001	strong	*Camphorosma Monspeliaca*	9.8	14.2	12.0	3.23	4.3	3.8	-	-	-
	7-30	0.360	0.301	Very strong (solonchak)	*Kochia Prostrata*									
	30-200	2.40	0.640	Very strong (solonchak)										
8	0-20	0.323	0.092	moderate	*Camphorosma Monspeliaca*	11.0	19.6	15.3	3.63	5.9	4.8	-	-	-
					Kochia Prostrata	18.4	22.4	20.4	6.0	6.7	6.3	20.2	26.4	23.3
	20-40	0.646	0.196	strong										
	40-100	1.96	0.470	Very strong (solonchak)										
9	0-20	0.117	0.022	moderate	*Camphorosma Monspeliaca*	12.4	21.3	16.8	4.05	7.09	5.6	-	-	-
					Kochia Prostrata	19.6	25.6	22.6	7.5	8.21	15.70	22.2	28.4	25.3
	20-50	0.315	0.10	moderate										
	50-200	2.16	0.482	Very strong (solonchak)										

*Note: in the first year *Kochia Prostrata* and *Camphorosma Monspeliacae* do not provide yielding

As it follows from the data in Table 2, *Camphorosma monspeliaca* provides productivity on soils with medium and strong salinity, and no suppression of *Camphorosma monspeliaca* seedlings is observed at soil salinity (0–7 cm) of a strong degree (section 7), despite the fact that below this layer up to 2.0 meters the content of toxic chlorine varies from 0.308 % to 0.640 %; that is, according to this indicator, the lower horizons are saline to a very high degree, which corresponds to solonchaks.With strong salinization of the 0–7 cm upper layer of solonchak, *Camphorosma monspeliaca* in the second and third years of life provides from 9.8 to 14.2 c/ha of pasture mass, which is 3–3.5 times higher than the productivity of natural pastures (2–3 c/ha).

On soils with a strong salination surface, *Kochia prostrata* does not provide productivity and remains low-growing during the second and third years of life, with a height of not more than 6–8 cm that is not suitable both for haymaking and pasture use. *Kochia prostrata* provides noticeably high productivity of pasture mass, hay, and fruit forage on soils (section 8), salinized from the surface to a medium degree (0–20 cm), a strong degree (20–40 cm), and a very strong degree in the lower horizons (40–200 cm). On saline soils up to 20 cm, it provides productivity in the second and third years of life, yielding 18.4–22.4 c/ha of pasture mass, 6.0–6.7 c/ha of hay mass, and 20.2–26.4 c/ha of fodder mass. The notion of fruit forage, which might be incomprehensible for a wide range of researchers and producers, implies a mixture of small stems, clusters, and fruit of Kochia prostrata, harvested in the phase of full fruit formation in late October and the first half of November, the nutritional value of which is 1.5-2 times higher than its hay and pasture mass (Mukhambetov et al., 2023).

On such background (section 8) and the last third background (section 9) represented by salinization of an average degree of (0–50 cm) and a very strong degree of salinization below this layer (50–200 cm), the productivity of pasture mass and hay of *Camphorosma monspeliaca*, respectively, is 11.0–21.3 and 3.63–7.09 c/ha, much lower than the same indicators in Kochia prostrata, yielding 18.4–25.6 and 6.0–8.21 c/ha, respectively.

Notably, in domestic practice, *Camphorosma monspeliaca* is exploited as a pasture plant rather than hay, which is confirmed by the results of other studies (Arkhipov, 1978; Zlatković et al., 2019; Akzhigitova, 1982; Oksanen et al., 2019).

The data from Table 2 suggest that the highest productivity is ensured when using *Kochia prostrata* for fruit forage, which is the same winter fodder in Kazakhstan as hay.

To summarize, at salinization of the upper layer, clay soils of the Caspian Sea should be employed for cultivating *Camphorosma monspeliaca* for pasture, while medium-degree (20 cm) and strong-degree (20–40 cm) desalinized soils are to be applied for the sowing of *Kochia prostrata* for fodder production and *Camphorosma monspeliaca* for grazing. At the same time, lower soil layers (40–50 cm–200 cm) can be highly saline, which is characteristic of solonchaks.

Conclusions

Natural pastures in the Caspian Sea region are unproductive (2–3 c/ha) and cannot serve as reliable sources of fodder production due to widespread soil salinity and climate aridity.

The lands that suit agricultural development in the Caspian Sea territory are represented by soils that are strongly to moderately saline from the surface (0–50 cm), with very high salinity in the lower horizons (50–200 cm) to a very strong degree, which corresponds to solonchaks.

Strongly saline soils from the surface should be used for grazing with the cultivation

of *Camphorosma monspeliaca*, which provides 6.0-6.3 c/ha times higher productivity than natural pastures, that is, 12–18.8 c/ha on average for 2 years of life compared to 2–3 c/ha.

Medium-saline soils are advisable for pastures to cultivate *Kochia prostrata* and *Camphorosma monspeliaca* with productivity of 15.3–20.4 c/ha on average for 2 years.

Soils medium saline from the surface (0-20 cm and 0-50 cm) provide higher fruit forage production (22.6-25.3) than when it is used for hay (15.7) and pasture (22.6).

With very highly salinated surfaces, meadow and automorphic soils are not subject to agricultural development, as meadow grasses (*Aeluropus, Alkali grass, Reed, Reed grass*) and *Alhagi pseudalhagi*, despite tolerating a very high degree of salinity, do not provide economically justifiable pasture productivity.

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