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The Semishrubs Fodder Productivity Of North-Western Circum-Caspian Region Natural Pastures.

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ABSTRACT

In the article analyzed the results of ecological and biological studies of various fodder semishrubs Krascheninnikovia ceratoides (L.) Gueldenst., Bassia_prostrata (L.) A.J. Scott., Camphorosma lessingii Litv., Artemisia lerchiana Web., A. pauciflora Web., A. diffusa Krasch. in conditions of semi-arid zone of North-Western Circum-Caspian region. Biological features, valuable economic properties, and also nutritional value of four main types fodder semishrubs are defined.

Keywords: Krascheninnikovia ceratoides (L.) Gueldenst., Bassia_prostrata (L.) A.J. Scott., Artemisia lerchiana Web., A. pauciflora Web., A. diffusa Krasch., fodder productivity, natural pastures, agrophytocenoses.

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INTRODUCTION

It should be noted that the arid zone of the Lower Volga Region of Russia (about 31.1 million hectares of arid territory) can be divided into a number of ecological and economic areas: the steppe zone occupies the smallest territory, (17.0%), the largest area is occupied by the dry steppe zone 45.0%, semi-desert and desert zones occupied approximately the same area – respectively 20.5% and 18.1%. A significant part of the agricultural lands of the North-Western Circum-Caspian Region is occupied by 14.2 million hectares of arid region are natural fodder acreage. For many years natural fodder lands was not used very efficiently and there was no evidence-based management (overgrazing, undue cultivation of the virgin lands, anthropogenic loading in the extraction of oil and gas) which in General contributed to a serious decline, and in some places the loss of productive land for food (1, 2, 8, 9).

The study of ecological and biological features of fodder semishrubs, which are increasingly used in technology to restore the productivity of disturbed pastures, is of particular relevance (2, 3-8). The main objective of our research was to study the biometric parameters of the studied plants; comparison in different variants of the experience in the possibility of obtaining a crop and the quality of the products of the studied agrophytocenoses (9, 10, 11, 12).

METHODS

The investigations object are the natural agricultural land of the North-Western Circum-Caspian Region which semishrubs-grasses vegetation grows and some disturbed land. The subject of research is observations and selection of the most viable ones, giving stable yields of fodder, which will later be used for technology of productivity restoration of deserted and degraded lands.

The experiments were carried out in 2011-2017 on the territory of the Base Station of the All-Russian Fodder Research Institute in the Yashkul district of the Republic of Kalmykia. Weather and climatic conditions during our studies were marked by a deficiency of moisture in the atmosphere and soil, and the region itself belongs to the zone with a sharply continental climate. A characteristic feature of the summer season – high heat and dry air temperature, reaching up to +45°C. Little snow Winters, as a rule. The annual precipitation does not exceed 280 mm on average (Fig. 1).

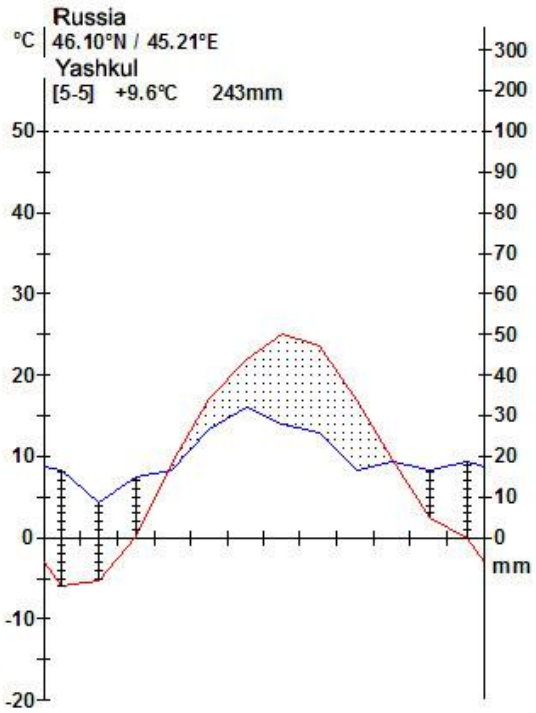

Fig 1: Klimadiagramm of research area (Kalmyk Base Station, Yashkul weather station)

Soil conditions in the experiments area. The physico-chemical and morphological properties characterize soils in the area of research as brown semi-desert, especially loamy varieties. It should be noted that the most characteristic difference is a slight humus and characteristic brownish color of humus horizons. The upper contains of humus (0.00...0.10 m) soil layer – 1.63%, in the root zone (0.10...0.40 m) layer – 0.62...0.94%. The ammonia nitrogen is contained in the fertile horizon of 35 mg/kg, nitrate nitrogen – 8.2 mg / kg, it should be noted that in the horizon of 0.20...0.40 m of nitrate nitrogen contains about 20.9 mg / kg of soil. The exchange potassium is contained in the upper horizon – 430...740 mg/kg. On the movable phosphorus arable horizon (0.00...0.10 m) there is sufficient presence – 32.5 mg / kg, in the horizon of 0.10...0.30 m – small, and 0.30...0.50 m – non-standard 14...15 mg/kg soil.

The scheme of experience included planting different types of fodder semishrubs with an optimum seeding rate of fodder plants determine the density of their standing, and yield of fodder mass, on the basis of experimental data obtained from the study of the All-Russian Fodder Research Institute, and taking into account the production practices to improve pastures:

1. Krascheninnikovia ceratoides – 6 kg / ha. 2. Bassia prostrata (sodic ecotype) – 4 kg/ha, Bassia prostrata (sandy ecotype) – 4 kg/ha, Bassia prostrata (stony ecotype) – 4 kg/ha. 3. Camphorosma lessingii-4,5 kg / ha. 4. Artemisia pauciflora -0.6 kg/ha, A. lerchiana – 0.6 kg/ha, A. diffusa – 0.6 kg/ha. The held plowing in autumn at a depth of 0.20...0.22 m then double harrowing. The area of plots – 40 m^2, the location is systematic, repeat – three times. The sowing was carried out in the optimal time – in early winter (December). The seeds are buried to a depth of – 6...12 mm.

The results of the research: the Study of fodder shrubs Krascheninnikovia ceratoides (L.) Gueldenst., Bassia prostrata (L.) A.J. Scott., Camphorosma lessingii Litv., Artemisia lerchiana Web., A. pauciflora Web. are environmentally friendly crops adapted to the sharply continental climate of the North-Western Circum-Caspian Region, which is subject to high changes in winter and summer temperatures. Depending on the phase of development, the ratios of semishrubs to temperature changes change significantly. Biological features of each semishrub affect the timing and duration of the stages of organogenesis, but at the same time in different regions that differ in climatic and soil conditions, much depends on the seasonal weather. For the specific determination of the dates of the main phenological phases of growth and development of semishrubs, it is necessary to conduct observations. In our experiments, the observation of the phenology of these crops, it was observed that when the pre-winter sowing (November) Krascheninnikovia ceratoides begins to grow in the middle of the month of April, in some growing seasons by the end of the month or at the beginning of the month of April may.

The period of budding took place from mid-July, flowering phase was observed in the first decade of September. The fruits began to form by the end of August and in early September. Observations showed mass fruiting-in the second decade of October. In the second and subsequent years, the difference in the onset of phases in Krascheninnikovia ceratoides, depending on the area of origin, differed by 6-12 days, but with the development of faster than in the plants of the initial year of vegetation. In the initial year of the growing season brought fruit and gave a small crop of seeds, only 19% of individuals. The periods between the phases depending on the climatic conditions in the years of our observations also depended on the area of plant origin varied by 5 years...10 days. The average vegetation period depending on the age of the individuals was 209...220 days.

Growth dynamics. Krascheninnikovia ceratoides grew quite intensively in the first year of his life. The fastest growth was in the third decade of July. Our samples collected in different ecological and geographical areas showed significant differences in growth rates. Thus, the fastest growth of Krascheninnikovia ceratoides was observed in plants from the Astrakhan region (Limansky district), the average for 7 years – 0.62 m, and in the 7^{th} year of vegetation reached 0.84 m (table. 1). The rapid growth from the first to the seventh year of vegetation shows the differences in plants growing in different soil and climatic zones.

Almost all samples of Krascheninnikovia ceratoides showed less intensive growth rates during the first 3 years of life. Then the growth rates of samples increased. During the first 3 years, the increase in shoots of Krascheninnikovia ceratoides 8 samples was observed on average 0.40 m, and during the next 4 years – 0.64 m, i.e. the increase in samples increased 1.5 times. This indicates that Krascheninnikovia ceratoides in culture is a very rapidly growing semishrub.

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Growth and development of root systems. During the excavations the most typical samples of the Krascheninnikovia ceratoides population were selected to observe the growth and development of root systems. The ratio of plant height and depth of penetration of the root system was 1:3. In the fourth year of life, the root system of Krascheninnikovia ceratoides reached a depth of 2.31 m (Fig. 2). Due to the well-developed root system of semishrubs, the sufficient demand of plants for moisture was provided. The root system of semishrubs by the end of the first year of vegetation reached a depth of 0.95...1.05 m, and by the age of 4 years – penetrated on...2,30 2,40 m.

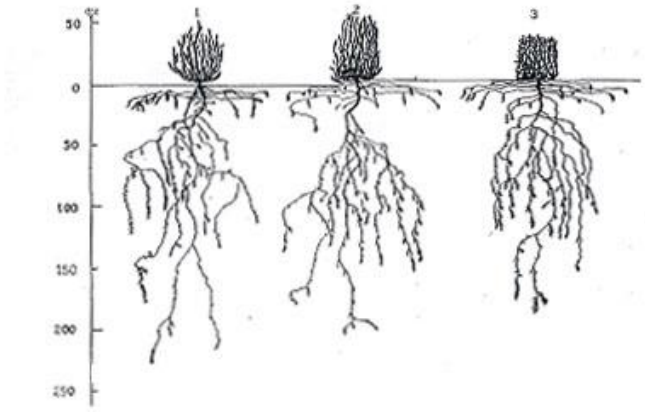

Fig 2: Root system of fodder semishrubs: 1 – Krascheninnikovia ceratoides; 2 – Bassia prostrata; 3 – Camphorosma lessingii

It should be noted, the roots of Krascheninnikovia ceratoides by the fourth year of life consisted of three tiers: the first upper tier was in the arable layer (0.15...0.25 m), consuming moisture precipitation; the second tier – in the layer 0.35...0.45 m; the third tier in the layer of 0.80...1.20 m – in the lower loam (sometimes sandy loam) compacted layer, where there was an abundance of long, thin roots with suction roots.

During the period of our research it was noted that the tested individuals of plants of arid semishrubs in the anomalously weather-climatic zone of the North-Western Circum-Caspian Region were noted quite positively by many necessary biological and production indicators (table. 1).

Table 1: The Biological and production indicators of arid semishrubs, on average for 2011...2017

Indicators	Units	Krascheninnikovia ceratoides	Bassia prostrata	Camphorosma lessingii	Artemisia lerchiana
Field germination of seeds	%	36…42	46…52	40…45	50…58
Survival rate	%	82…91	84…94	69…95	87…92
The growth of individuals	м	0.51…0.62	0.44…0.51	0.30…0.33	0.31…0.50
Density	тыс. особей./га	9.2…15.1	15.1…19.7	15.1…18.2	28.1…35.2
Penetration of the root system	м	2.32…2.42	2.16…2.21	1.91…2.10	1.12…1.31
Vegetation period	сутки	209…213	207…214	213…224	226…235
Content in the fodder: Crude protein	%	9.8	12.1…14.4	13.4	10.9…12.1
Crude fat	%	11.1…12.1	1.20…3.16	5.81	6.3…9.2
Crude fiber	%	35.1…36.7	26.9…31.8	32.7	24.7…28.7
Nutritional value of 1 kg of dry mass	Food unit	0.65…0.68	0.62…0.72	0.62	0.75…0.87
	MJ	8.7…9.1	8.5…9.3	8.5	9.5…10.3

Productivity of 1 ha	Centner of dry mass	14.3	14.7	12.8	3.3
	Food unit	971	992	791	282
	Metabolizable energy, GJ	13.1	13.1	11.2	3.3

Krascheninnikovia ceratoides (L.) Gueldenst. compared to other studied arid plants showed the lowest germination of seeds 36...42%, plant survival averaged 82...91%, linear growth was 0.51...0.62 m, the average density of grass 9.2...15.1 thousand plants per 1 hectare, roots penetrate to a depth of 2,32...2.42 m, fodder nutrition indicators 0.65...0.68 fodder unit or 8.7...9.1 MJ of metabolizable energy per 1 kg dry matter (hereafter DM) and relatively high productivity (970 fodder unit, or 13.0 GJ metabolizable energy per 1 hectare). Krascheninnikovia ceratoides in comparison with other semishrubs is precocious, which leads to a high presence of crude fat in the feed (11...12% of DM) in spite of adequate availability of seeds. That promotes the use of this species as better greasing feed for animals. The high content of crude fiber, compared with other semishrubs, is caused by the presence of a large number of generative shoots from Krascheninnikovia ceratoides.

Bassia prostrata (L.) A.J. Scott. showed field germination of seeds at the level 46...52%, plant survival rate 84...94%, it should be noted the rapid growth rate (height at 0.44...0.51 m), the density of grass was 15.1…19.7 thousand plants / ha, the depth of root penetration reached up to 2.16…2.21 m, average nutritional value (0.62...0.72 fodder units per 1 kg DM) and energy saturation (8.5...9.3 MJ of metabolizable energy in 1 kg DM), high productivity was noted (992 fodder units, or 13.1 GJ of metabolizable energy per 1 hectare). Analysis of fodders showed a high content of crude protein 12.2...14.5%.

Camphorosma lessingii Litv. there was a slight field germination of seeds (40...45%), varying degrees of plant survival (69...95%), a weak rate of increase in plant mass (height reached 0.30...0.33 m), grass stand density index (15.1...18.2 thousand individuals per hectare), roots reach a depth up to 1.90 m in the 4th year, the relative nutritional value of fodder is quite low (0.61 fodder units, or 8.6 MJ of metabolizable energy 1 kg DM) and there is an average productivity (791 fodder units, or 11.1 GJ of metabolizable energy per 1 ha). The content of the amount of DM in Camphorosma lessingii is 13.4%.

Artemisia lerchiana Web. in comparison with other arid semishrubs, the highest field germination of seeds was observed (50...58%) and grass density (28.1...35,2 thousand plants / ha), significant growth rate (plant height 0,31...0.50 m), high survival rates of samples (87...92%), relatively shallow roots penetrating (up to 1.12...1.31 m), fodder nutritious (0.81 fodder units per 1 kg DM) and energy saturation significant (10.0 MJ in 1 kg DM), but relatively low yield (282 fodder units, or 3.4 GJ of metabolizable energy). At saturation, nutrients of Artemisia lerchiana is a little different from the other fodder crops pasture, autumn and winter while keeping sheep on the grassland is the main fodder in the diet.

Our long-term experiments have shown that fodder semishrubs have a fairly significant difference in the timing of plant vegetation. This difference can be used in the creation of perennial sown pastures with different terms of use. In spring and summer, you must use the following semishrubs: Krascheninnikovia ceratoides, Bassia prostrata, Camphorosma lessingii and in the autumn and winter – Artemisia spp. Due to this, it is possible to establish a green fodder conveyor for livestock in the following periods of the year: the first period is spring-summer, the second period is autumn-winter. Our studies found that the semishrubs roots are very deep, allowing the plant to extract the productive moisture reserves of the B, C horizons. The consruction of agrophytocenoses with the relative density of plants allows to reduce the negative impact of wind erosion and the load from overgrazing. This will also allow pasture plants to tolerate significant periods of drying up of the upper soil layers more easily. Our studies have found some differences in the studied samples in fiber, crude fat and protein content. The above distinctions allow the use of fodder semishrubs in the grazing system of the conveyor. Thus, this technology makes it possible to contain animals with the types of nutrition and metabolizable energy.

Observations showed that the formation of the studied pasture agrophytocenoses was economically feasible. So the costs incurred to obtain 100 fodder units falls from 1.5 to 2.0 times than the price of fodder grain in the South of Russia. The developed seeded pastures with the use of fodder semishrubs are characterized by high productivity for a long period of time (10 or more seasons), and the varieties of these

plants allow to organize seed production for the implementation of large-scale phytomelioration of the arid pastures of the North-Western Circum-Caspian Region.

The construction of improved pastures technology with the technology of sowing Krascheninnikovia ceratoides, Bassia prostrata, Camphorosma lessingii, and combined with sowing of Artemisia lerchiana, A. pauciflora on degraded fodder and grazing lands is 1630...1790 rubles / ha, upon receipt of 610...1180 fodder units / ha and justify the cost of the second season of vegetation after sowing; cost 100 fodder units (195...215 RUB.) decreased in 1.6...1.9 times than the price of grain.

CONCLUSION

for increase the productivity of degraded pastures in the arid zone of the North-Western Circum-Caspian Region, a high degree of need for the use of technology of semishrubs: Krascheninnikovia ceratoides, Bassia prostrata, Camphorosma lessingii, Artemisia lerchiana, A. pauciflora. These plants are characterized by many positive and necessary characteristics. A quick development of plant density in crops, early and stable long vegetation. These characteristics contribute to the harvest during the spring-summer and autumn-winter periods. Plants of semishrubs relatively painlessly withstand the anomalous-dry period due to the well-developed and deeply penetrating into the soil root system; there is a significant productivity and nutritional value of the feed.

Krascheninnikovia ceratoides showed the lowest field germination of seeds (36...42%), plant survival averaged (82...91%), linear growth was (0.51...0.62 m), the indicator of the number of plants per unit area – the average (9.2...15.1 thousand plants per 1 hectare) roots penetrate to a depth up to 2,32...2.42 m, energy saturation of fodder (0.65...0.68 fodder units or 8.7...9.1 MJ of metabolizable energy per 1 kg DM (hereafter DM) and relatively high productivity (970 fodder unit, or 13.0 GJ of metabolizable energy per 1 hectare). This plant contains a very large amount of crude fat in its fodder products (11...12% of DM), this contributes to the early ripening of fruits, unlike other semishrubs.

Bassia prostrata showed seed germination at the level 46...52%, plant survival rate (84...94%), it should be noted the rapid growth rate (height at 0.44...0,51 m), the density of grass was 15.1...19.7 thousand plants / ha), the depth of root penetration reached up to 2,16…2,21 m, average nutritional value (0.62...0.72 fodder units per 1 kg DM) and energy saturation (8.5...9.3 MJ of metabolizable energy in 1 kg DM), high productivity was noted (992 food units, or 13.1 GJ of metabolizable energy per 1 hectare).

Camphorosma lessingii showed a slight field germination of seeds (40...45%), varying degrees of plant survival (69...95%), a weak rate of increase in plant mass (height reached 0.30...0.33 m), grass stand density index (15.1...18.2 thousand individuals per hectare), the roots of the plant reach significant depths (up to 1.90 m by the fourth year of life), the individual has a relatively low nutritional value of feed (0.61 fodder units, or 8.6 MJ of metabolizable energy in 1 kg DM) and quite average productivity (791 fodder units, or 11.1 GJ of metabolizable energy per 1 ha). The plant of this semishrub contains 13.4% crude protein.

Artemisia lerchiana is characterized by very high germination of seeds (50...58%) and grass density (28.1...35,2 thousand plants / ha), significant growth rate (plant height 0,31...0.50 m), high survival rates of samples (87...92%), relatively shallow penetrating roots (up to 1.12...1.31 m), in terms of nutritional value of feed contained (0.81 fodder units in 1 kg DM) and significant energy saturation (10.0 MJ per 1 kg DM), but relatively low productivity (282 feed. u, or 3.4 GJ of metabolizable energy).

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