THE PRODUCTIVITY OF MEADOW-CHESTNUT SOILS OF THE NORTH - WESTERN PRECASPIAN REGION ACCORDING TO THE DYNAMICS OF THE ENVIRONMENTAL FACTORS

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Abstract

The productivity of phytocenoses on the meadow-chestnut soils is theoretically calculated under hydrothermal conditions and practically implanted moisture integral. It is found that high productivity (0.5 t/ha of air-dry weight) of ephemeral synusiae is achieved through the combination of the following environmental factors in April-May; precipitation 80-85 mm, the average temperature is 15-16°C, relative humidity 70-73%, volatility 130-140 mm, coefficient of moisture 0.30, integral hydration period 29.8. In this case, the degree of salinity in soil layer 0-23 cm classified as weak, salinity type is sulfate-chloride. In normal climatic conditions of the year (2013), when precipitation during the vegetation period is distributed relatively evenly, productivity of ephemers and ephemeroids is 2.0 c/ha (centner/hectare) of grasses and thistles – 18.2 c/ha, the coefficient the use of FAR during the vegetation period of 0.30, the share of the ephemeral synusiae in it – 0.16%.

Keywords: evaporation, hydrothermal conditions, integral moisture in the soil, the integral of aridity, meadow -chestnut soil, sulphates, chlorides, degree of salinity, salinity type, productivity of phytocenosis, ephemers, halophytes, species composition of phytocenoses, coefficient the use of FAR.

Introduction

The North - Western Precaspian sea covers the lands of Nogai, Tarumovsky and Kizlyar areas of Dagestan and the part of the lands of the Chechen Republic, Stavropol, Kalmyks total area of more than 1.5 million hectares. This is an important area distant and stationary livestock of Dagestan and neighboring regions, which contains more than 2 million sheep and hundreds of thousands of heads of cattle.

The climate is continental, with hot, dry summers and cold winters. Annual precipitation of 150-320 mm, 1300-1600 mm volatility, the maximum temperature in July and August 40-45^{0}C, its relative humidity in these months of 10-15%. 55 days in a year blow withering (> 15 m/s) southeasterly winds, 110 days - at a rate of more than 5.4 m/s [1]. Soil cover is dominated by light-chestnut soils of varying degrees of salinity, total 534 thousand hectares or 31.7% of the lowland area. The share of the meadow (232.8 thousand hectares), meadow-chestnut (193.0 thousand hectares) and meadow - marsh (80.3 thousand hectares) soil is 32.6%, salt marshes (191.1 thousand hectares) – 12.3% of the total area of semi-desert [3]. This article discusses the issues related to the implementation of the productivity potential only meadow-chestnut soils in the environmental conditions of the Terek-Kuma lowland. A distinctive feature of the lowland soil is light particle size distribution, which combined unfavorable climatic factors, the irrational use of pastures, enhances deflation, degradation of soil - vegetation and desertification area. At the moment there are 319 thousand hectares of open sand areas, which is 20.5% of the area.

The most important factor in desertification of the territory under consideration researchers [9, 10, 12, 13, 18] consider also a significant incidence of secondary processes of soil salinization. Therefore, relevant scientific and production is the study of the dynamics of the content of water-soluble salts in the soil profile, their chemistry in connection with the change of climatic factors on the seasons (spring, summer) and year of studies.

Pasture productivity in the region according to different authors may vary within considerable limits: from 1.6 to 4, c/ha [14] - 5-6 [9] – 7. 2-8.1 [19] and 17.1 c/ha [7]. With yields of 5-7 c/ha of air-dry biomass of coming to the surface of the soil of this area of 50.0 kkal/cm^2, pasture phytocoenosis according to our calculations using only 0.04-0.05% FAR. However, such a yield above-ground mass, in our opinion, it is too low, since the above data may not have been received in protected conditions, and in terms of pasture use phytocenoses, at least for a limited period. It is therefore of considerable interest to establish the species composition of pasture cenoses and potential productivity of meadow-chestnut soils and its implementation in different environmental conditions during the years of research and for different periods of the year.

Material and methods

Object of study is the meadow-chestnut carbonate saline soil Kochubeyskoy biosphere station controller, the Precaspian Institute of Biological Resources, Dagestan Scientific Center, Russian Academy of Sciences (KBS PIBR DSC RAS) in the territory of the Terek-Kuma lowland. The main physical and chemical characteristics of the soil layers in the experimental section (cm) 0-14, 15-20 and 40-60 are as follows: humus content, % - 1.33; 1.25, 0.36; N total,%-0.10, 0.07, 0.06; N hydrolysable mg/kg -52.6, 48.5, 36.0; P_2O_5, mg/kg, 0.84, 0.45, 0.11; K_2O, mg/kg, 33.8, 30.5, 28.9; Density, g/sm^3 – 1.18 1.35, 1.36; solid phase density, g/cm^3 – 2.60, 2.62, 2.62; porosity: general, – 52.2%, 50.3, 48.7; aeration porosity,% – 22.5, 22.2, 20.8; field capacity,% – 23.6, 20.4, 18.7; water permeability, mm/min, 1.26; 1.08; 0.97; EKO mg/ekv.-12.6, 13.3 13.2; pH: 7.1, 7.3, 7.2. Cationic and anionic composition of the soil will be discussed in more details below. Analyses of soil chemical and water-physical characteristics, water extraction were performed according to known methods [2, 4].The sampling soil within each site samples were taken from 4 sites.

Climatic conditions characterized by weather data Kotchubey on the amount of monthly and annual precipitation, monthly and annual average air temperature and humidity. On the basis of these data were calculated evaporation rate and humidity. Evaporation (E_0) calculated by the formula [11]:

$$E_0 = 0.028\,(T + 25)^{2}\,(100-a) \text{ mm/month} \quad (1)$$

where T – air temperature, ^{0}C, and - relative humidity,%.

Dampening factor was determined as the ratio of precipitation (R) to evaporation (E_0).

The calculation of the duration of the vegetative period of plants was carried out on the transition date and the average daily temperature ±5^{0}C.

The studies were conducted in the experimental area, with an area of 100 m^2, enclosed with an iron grid in order to avoid damage phytomass cattle. The plot is divided into 100 permanent plots, with an area of 1 m^2 (1 m x 1 m), polyethylene twine. This breakdown was maintained for the whole period of experimental studies (2011-2013 years). Samples for the determination of the yield of biomass and species composition were taken eight times a year: in the first ten days of each month from April to November include, and soil two times: in the spring during the resumption of the growing season (the second half of April) and late July - early August (the hottest period of the year).

Stocks above and below ground plant matter was considered in [17]. Aboveground mass was determined by cutting method with selected groups of plants in species composition (ephemers and ephemeroids, grass, glasswort) and fractions: live phytomass, rags (dead parts of plants, not deprived of communication with plants), aboveground mortmass (dead remains of plants on the soil surface, deprived of communication with plants). Underground mass was determined after cutting aboveground mass at the same time on the same account sites in the layer 0-60cm method of the monolith. The size of the monoliths 10 x 10 x 10 cm, repetition 4 fold. The list of plants compiled by S.K. Cherepanov [20].

The use of the FAR was determined using the formula [15].

$Y=Rx10^8xK/10^2x4x10^3x10^2$ (2),

To calculate the utilization of FAR formula has the form:

$K=Уx10^2x4x10^3x10^2/Rx10^8$ (3),

Where Y – is biological yield completely dry aboveground mass, kg/ha; R x 10^8 – number of FAR coming on 1 hectare during the growing season of plants, kkal; K – planned utilization of FAR, %; 4 x 10^3 – amount of energy released by burning 1 kg of dry matter biomass, kkal/kg; 10^2 - translation kg in center of product.

The significance of differences between the indicators of hydrothermal conditions, productivity of plant communities were evaluated according to the coefficient of variation (Cv) of salt-forming ions in the soil, standard deviation (s), the average error (m), variance analysis yields of biomass across years and seasons [8].

Results and discussion

Receipt of FAR on the soil surface depends on many factors, primarily on the geographic latitude and hypsometric marks. In the foothills of the territory of Dagestan on 1 cm^2 have of 47.55 (Buynaksk) – 43.91 (Sergokala) kkal, Terek-Sulak of territory – 49.94 (Babaurt) – 51.19 (Kizlyar), Terek-Kuma the territory (Kochubey) – 50.87, in the Coastal lowlands (Derbent) – 56 kkal/ cm^2.

Of the annual amount of FAR entering 1 cm^2 (50.87 kkal or kJ 213.23), in the Terek - Kumskoy semidesert accounts (kkal) for January – 0.59-1.99 in February, March, – 3.82, April – 5.97, 7.27 – May, June – 8.48, July – 7.84, - 6.22 in August, September, - 4.59, - 2.57 in October, November, -1.19, December - 0 , 34 kkal [5].

It is known that the yield of phytomass in ecosystems depends not only on entering the soil surface FAR, but also on the climatic conditions of the year or period, as well as soil conditions. Therefore great interest in the scientific and practical terms, is the study actually sold phytocenoses yield on meadow-chestnut soil moisture under different conditions of the territory, not only in the yearly averages, but also from season to season. Such studies under these conditions and adjacent regions of the Caspian has not previously been conducted.

Judging by the indicators of coefficient of moisture, 2012 year and all long - term value of 0.11 (deviation ± 0.01) on the territory of the Terek-Kuma lowland, and in 2011 year exceeded it by 0.03. So we can assume that years of research, in general, were typical for these conditions.

According to our observations, the most important for achieving high productivity ephemeral of synusiae in the considered conditions are precipitation for April and May. For those months in 2011 year fell 85mm precipitation, 2012 year 25.3 mm, 2013 – 40,0mm, that is, in the first year of studies, the amount of precipitation exceeded two years in 3.4 and 2.1 times (table 1).

Table 1 – Environmental factors and the yield of above-ground phytomass in the meadow-chestnut soils for 2011-2013 years

indicator	2011г.		2012г.		2013г.	
	spring	summer	spring	summer	spring	summer
amount of precipitation, mm			85	64	40	83
Average daily air temperature,^{0}C	13,8	27,4	18,0	25,8	16,4	25,0
Relative humidity, %	73	58	61	62	64	59
Evaporation, mm	135	315	202	275	178	355
coefficient of moisture	0,30	0,11	0,06	0,21	0,10	0,11
Content in the layer 0,23cm (h A+B_1): Cl^-	2,58±0,05 S=0,13,	7,24±0,4 S=0,11,	5,56±0,08 S=0,19,	4,60±0,06 S=0,14,	4,16±0,07 S=0,13,	5,16±0,04 S=0,18,

SO_4^{--}	*Cv* =5,04 1,71±0,05 S=0,11, *Cv* =6,31	*Cv* =1,52 2,92±0,06 S=0,15, *Cv* =5,14	*Cv* =3,92 2,37±0,05 S=0,11, *Cv* =4,64	*Cv* =3,04 2,37±0,02 S=0,04, *Cv* =1,69	*Cv* =5,04 2,46±0,02 S=0,02, *Cv* =2,44	*Cv* =4,33 2,58±0,02 S=0,05, *Cv* =1,98
yield of aboveground mass*, t/ha:	0,55	0,99	0,10	2,11	0,20	1,82
$HCP_{0,5}$	0.17		0.11		0.10	

*in the column "spring" shows the yield of above-ground phytomass and ephemers and ephemeroids, summer - grass and saltworts.

The temperature during these months is also favored the formation of high yields of biomass. Accordingly, the same month it was in 2011 year - 9.2 and 18.4^{0}C, в 2012 year - 15.1 and 20.9^{0}C, в 2013 year – 12.2 and 20.0^{0}C. Between total precipitation for April-May and yield of aboveground phytomass of ephemers and ephemeroids there is a direct correlative relationship that in 2011 year on this soil had a strong (r= 0.78), and in the next two years - the average (r= 0,35) in 2012 and high severity (r= 0,95) in 2013 year.

Integral moisture $\int_a^b \max(W(t) - T(t), 0)dt$ for the same months in 2011. 29.8. In 2012 and 2013 years, the curve of moisture fell below the curve of air temperature, therefore, formed integral aridity $\int_a^b \max(T(t) - W(t), 0)dt$, which amounted, according to years 37.3 and 98.9. Mainly for this reason, the yield of above-ground living biomass ephemers and ephemeroids for 2012 and 2013 years decreased respectively in 5 and 2.5 times.

The species composition of ephemers on the meadow-chestnut soils were very limited, included only *Eremopyrum orientale (L.) Jaub. et Spach. and Bromus squarrosus L.*

Rainfall in the first two decades of June in 2011 year didn't provided a noticeable increase in phytomass on logopolitans soil. By this time, the harvest of ephemers had already been formed and the rainfall of this period could not give the essiantial supplement. And high average daily air temperature during this and the two following months (respectively 24.3; and 27.9 24.9^{0}C) contributed to the heavy loss of soil moisture, precipitation, because the evaporation for the same months amounted to 291; 337 and 293 mm, coefficient of moisture , respectively 0.08; of 0.04 and 0.18. Therefore, the total yield of grass and thistle in the following months, the growing season was higher than ephemers and ephemeroids twice due to the predominance of the species composition of *Artemisia taurica Willd. and Artemisia lercheana*

Web. ex Stechm.,which are more tolerant to high temperatures, efficient use of precipitation for the second half of the summer and form a high yield of biomass [21,22].

Spring months of 2012 year differed significantly aridity: the integral of aridity in April and May was 37.3, volatility increased by 67 mm, coefficient of moisture decreased by 5 times compared with 2011 year (Table 1). These conditions contributed to the rise of water-soluble salts in the upper soil horizons. Cl^- content in the layer 0-23 cm compared with the same period in 2011 year increased by 2.2 times, SO_4^{--} 1.4 times the ratio Cl^-: SO_4^{--} with 0.36, increased to 2.34. This means that the composition of the anion chemistry salinity and chloride - sulfate shifted towards sulfate-chloride. If, in 2011 year salinity of the soil in the same layer is characterized as weak in 2012 year it was as the average [16].

Reverse pattern was observed for the same period in the summer. In the dry season (July-August) 2012 year in the layer 0-23 cm where the main bulk of the roots, Cl^- content decreased by 1.6 times compared to 2011 year, of - for heavy rainfall in these months in 2012 year SO_4^{--} changed insignificantly, the ratio of Cl^- : SO_4^{--} decreased from 2.5 to 1.9. Although the type of salinity in both cases was characterized as sulfate-chloride, the degree of soil salinity in the second half of the summer in 2011 year existing classification [16] refers to a very large, in 2012 year to strong. This degree of salinity meadow- chestnut soil with enough moisture provision contributed to a sharp increase in the yield of forbs and especially saltworts in 2012 year.

Yields of air-dry above-ground biomass of the second half of the summer 2012 year increased compared to 2.3 times 2011 by forbs, primarily, of the Asteraceae family - *Artemisia taurica and Artemisia lercheana.*

Environmental conditions for the functioning of ecosystems in 2013 year occupy an intermediate position between the two preceding years of research. This also applies to climatic conditions, and content of the salt-forming ions in the soil, and the yield of the biomass.

Thus, the formation of biomass and species composition on the meadow-chestnut soils of the North-Western Precaspian region is the result of the combined action of various environmental factors, the main of which are: precipitation, air temperature, relative humidity, evaporation, moisture ratio and the degree of the chemical environment of soil salinity. Dependencies between these factors are expressed by the following equations multiple regression:

for the ephemeral synusiae: $Y = 0.66 + 0.00268X_1-6.5E-5X_2-0.18X_3-0.21X_4 + 0.27X_5$

for grasses and saltworts : $Y = 4.1 + 0.00068X_1-0.000381X_2 + 1.02X_3-0.35X_4-0.2X_5$, where Y is yield of air-dry biomass, c/ha; X_1 precipitation during the vegetation period, mm; X_2 - evaporation, mm; X_3 - coefficient of moisture; X_4 - concentration of Cl^- in the layer of 0-20 cm, mg-Eq./100g soil; X_5 is the ratio of $Cl^-:SO^{4\,--}$ in the layer of 0-20 cm.

In the mean annual data, the duration of the vegetation period of the pasture plant communities in the area Kochubey is 260 days (from 27 March to 15 th November). Over the years of our research, the transition of the specified temperature ± 5°C in 2011 year recorded on 15 of March and November 2, 2012 - March 24, and November 30, 2013 - on March 1 and November 27.

The duration of the vegetation period of grassland ecosystems and the factors driving through communities for the considered conditions are shown in (table 2).

Table 2 –The duration of the period with temperatures above 5^0C and coefficient the use of FAR pasture plant communities in the North-West Precaspian region for 2011-2013 years (admission of FAR on $1cm^2$ for March-June-25,54; July-September 21,22 kkal)

Year	Length of period t^0C air above 5^0C (day)	coefficient the use of FAR	just including	
			ephemers and ephemeroids	grass and saltworts
2011	232	0,029	0,009	0,020
2012	251	0,023	0,007	0,016
2013	274	0,033	0,003	0,030
Average	252	0,028	0,006	0,022

Depending on climatic conditions, the pasture plant communities of meadow-chestnut soils used 0,023- 0.033% FAR. Win ephemera and ephemeroids of this amount was on average 21.4% of years of research, the remaining 78.6% are mixed grasses and halophytes.

Conclusion

In the North-West Precaspian productivity meadow-chestnut soils may reach 5 c/ha of air-dry aboveground mass ephemers and ephemeroids at the confluence of the following environmental factors during April - May precipitation 80-85 mm, the average temperature is 15-16°C, relative humidity 70-73%, evaporation 130-140 mm, coefficient of moisture 0.30, integral hydration period 29.8. Under such climatic conditions, the degree of salinity in soil layer 0-23 cm classified as weak, salinity type is sulfate-chloride. The coefficient the use of FAR is 0,009. Deterioration hydrothermal conditions in the same period (2012 – precipitation 25-26 mm, relative humidity 61%, coefficient of moisture 0.06 average daily air temperature is 18.0°C, isparameter-mm, integral aridity 37,3) leads to an increase in the content of Cl^- in the same soil layer to 5.56 mg-Eq/100g, lower yields of biomass to 1,C/ha and the coefficient the use of FAR to 0.007.The increased rainfall in July-August to 102 mm, even at high daily temperatures (25-26^0C) and evaporation (275 mm), contributes to maintaining the high rate coefficient of moisture (0.21), reducing the concentration of Cl^- in the layer 0-23 cm to 1.40 mg-Eq./100g in the second half of the summer, increasing the yield of grass and saltworts to 21.1 C/ha coefficient the use of FAR reaches of 0.02. In normal climatic conditions of the year (2013), when precipitation during the vegetation period are distributed relatively evenly, yield ephemers and ephemeroids is 2.0 c/ha, herbs thistle – 18.2 c/ha, the coefficient the use of FAR during the growing season reaches 0.033, the share of the ephemeral synusiae in amounts of 0.003.

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