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Short Communication

Agroclimatic conditions influencing wheatgrass (*Agropyron pectinatum*, M. Biev.) production in Volgograd region of southern Russia

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The Volgograd region is one of Russia's largest agricultural regions. It has great nature and climate potential, which allows the region not only to meet domestic demands but also influence the Russian food market. Crop production accounts for about 70% of agricultural products (high-quality grain, corn, cereals, oil crops and their seeds, vegetable oil, vegetables, fruit and gourds), and livestock breeding, for 30% (pork, cattle, poultry and sheep). Variation in precipitation and temperature results in inadequate pasture feed in many areas and in some seasons that hinders the further development of animal husbandry, mainly sheep farming (Sivtseva *et al*., 2018; Bulakhtina *et al*., 2021). The main source of creating insurance stocks of feed in the semi-desert zone is grass planting (Manaenkov *et al.,* 2020; Kudryashova *et al.,* 2020). Berseem (*Trifolium alexandrinum* L.) and the hybrid napier (*Pennisetum purpureum x P. americanum*) are the two highly valued forage crops of India (Singh *et al.,* 2012). Sowing of perennial grasses in a semi-desert zone simultaneously solves two important issues: strengthening and expanding the feed base for livestock and tinning eroded lands and restoring their fertility (Grebennikov *et al.,* 2020).

Wheatgrass (*Agropyron pectinatum* (Biev.)) is a perennial loose-leaf cereal with numerous stems 50-70 cm tall, with an inflorescence of ears and a growing season of April-May. It has high plasticity and responsiveness to environmental conditions, and therefore is in great demand. This crop is resistant to extremely stressful conditions of cultivation in arid conditions, has a high potential for the production of various types of bulky feed (Shipilov *et al*., 2018; Buyankin *et al.,* 2019). Of the currently sown perennial grasses, it is difficult to find a crop that would surpass the *Agropyron pectinatum* in drought resistance, winter hardiness and a number of other qualities. In the presence of precipitation, it grows back after mowing and can be used for grazing (Turko *et al*., 2020). The relationship between the nature of agrometeorological phenomena and the vegetation of forage crops makes it possible to correctly assess the impact of agricultural practices and make the necessary adjustments, effectively use the available resource potential and yield.

In order to understand the influence of agrometeorological conditions on the formation of the harvest of wheatgrass (*Agropyron pectinatum)* stands in the semi–desert zone of Volgograd region, this study was carried out during 2014-15 to 2023-24 on experimental production sites having light chestnut loamy and sandy soils of the Scientific Research Center of Agroecology of the Russian Academy of Sciences. The weather conditions of the research period were analyzed according to the data of the Volgograd weather station (48° 48' N latitude, 44° 21' E longitude; altitude 130 m amsl). The amount of precipitation during the growing season (April-May), for the period from harvesting in the previous year to the beginning of the growing season (August-March), for the cold period (November - March). Harvesting of grass for hay was carried out annually at the end of earing - the beginning of flowering (end of May – beginning of June). The yield was determined by mowing grass on plots of 1 m^2 in 5-fold repetition. Statistical processing of the obtained data was carried out by the method of variance, and correlation analysis was carried out using Excel 2019 and STATGRAPHICS+5.0 programs.

Fig. 1 shows the 10 year average data (2014-15 to 2023-24) of precipitation and temperature by month, characterizing the meteorological conditions under which the research took place.

Precipitation, temperature and hay yield of wheatgrass

The distribution of precipitation during the growing

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Table 1: Precipitation (mm), temperature (^{0}C) and hay yield (t ha^{-1}) during growth period of wheatgrass in different years

Year	Precip. (mm) (Nov.-March)	Tillering phase (April - May 10)			Earing and flowering phase (May 11- June 10)			Total hay yield (t ha^{-1})	Precip. (mm) (July-Oct.)	Temp. (°C) (July -Aug.)	Height from otava*, (cm)
		Precip. (mm)	Temp. (°C)	Phytomass (t ha^{-1})	Precip. (mm)	Temp. (°C)	Phytomass (t ha^{-1})				
2014-15	175.2	45.7	12.0	0.62	42.5	21.5	0.94	1.57	61.7	20.0	10
2015-16	273.5	35.7	13.6	0.59	78.7	18.2	1.38	1.98	59.0	18.3	10
2016-17	206.9	57.9	12.5	0.56	37.0	16.5	0.85	1.41	72.9	20.0	12
2017-18	243.9	19.4	13.5	0.52	17.9	20.3	0.80	1.34	53.3	21.0	5
2018-19	122.8	42.8	13.1	0.72	30.1	23.0	1.09	1.81	19.3	18.3	-
2019-20	182.0	19.1	11.0	0.78	73.4	17.7	1.17	1.95	65.9	21.2	10
2020-21	218.9	68.4	13.0	0.72	49.8	21.1	1.07	1.79	17.1	24.7	-
2021-22	319.0	10.7	11.4	0.73	58.4	17.4	1.45	2.18	41.4	19.0	-
2022-23	282.5	36.5	12.1	0.54	22.2	17.8	0.81	1.35	143.4	18.8	23
2023-24	351.7	9.0	15.9	0.47	0.0	19.9	0.78	1.26	-	-	-

*otava -regrowth after mowing; Precip.- Precipitation; Temp- Temperature

season (April-May) was very uneven with a minimum of 9 mm in 2024 (the deviation in moisture supply was -64 mm from the average annual data of the period) and a maximum of 113.7 mm in 2016. The monthly precipitation for the 10-year period during the growing season was 24.9 mm in April (tillering phase), 47.1 mm in May (earing phase and flowering phase). The temperature regime of the growing season is no less important for the growth and development of plants. During the study period (10 years), the average monthly temperature in the tillering phase of wheatgrass (April) was 10.1°C, in the earing and flowering phases (May) was 18.2°C. The average air temperature for April-May 2015-2024 ranged from 12.3°C to 16.1 °C. An analysis of the temperature regime of the growing season separately by year showed a deviation of up to 2.0 °C (2021). Spring regrowth begins with a steady transition of the average daily air temperature through 3-4°C. In years with low precipitation during the cold period (≤ 100 mm), as it was in 2019-20, and consequently, higher temperatures and it begins after a steady transition of the average daily air temperature through 5-6°, and the beginning of tillering is noted at 8-9°. The beginning of spring tillering is greatly influenced by the summer-autumn regrowth in the previous year (Table 1).

The most favorable temperature regime in the tillering phase is created at 10-15º. The duration of the tillering phase is 30-50 days and falls on the period from the third decade of March, April and the first decade of May. Due to the biological characteristics of perennial cereals, the increase in aboveground mass in the first decade of tillering is insignificant and amounts to 2-3 cm. During this period, there is an increase mainly of the root system. Subsequently, the intensity of both linear and weight gain increases from decade to decade.

The formation of the green mass of the wheatgrass occurs mainly during the phases of tillering (20-40%) and earing (40-70% of the total hay harvest). Earing lasts 13-20 days: from the second decade of May. During the earing phase, the formation of the green mass of the wheatgrass mainly ends, and at this time the plants have almost the maximum height (in wet years 80-90 cm, in dry years 50-60 cm) and the highest nutritional value (crude protein 6.8%). By the beginning of the phase, there is a steady transition of the average daily air temperature through 15°, which creates an optimal heat supply in the range of 15-20° (Table 1).

This is not the case with moisture availability, which determines the formation of a green mass during this period. At the same time, the main increase in height occurs, reaching 20 cm in a decade. Cool (15-20 °C) with precipitation during the earing phase contributes to a good harvest of wheatgrass. High temperatures and humidity deficiencies significantly reduce it. During the flowering phase, the wheatgrass is harvested for hay. The cleaning calendar dates fall at the end of the first to the beginning of the second decade of June. The delay in harvesting leads to a deterioration in the quality of hay. After harvesting, with sufficient rainfall, grass regrowth is observed after mowing.

Along with the spring moisture reserves accumulated by the soil during the cold season, precipitation from the post-harvest period of the previous year is of great importance, causing a summer-autumn wave of tillering, which helps to strengthen the bush due to the deposition of spare nutrients in the reserve organs. In the conditions of the semi-desert zone, the average daily air temperatures in the post-harvest period (August, September) are quite high and amount to >20 ° in August and > 15 ° in September, the minimum temperatures reach 13-16 °. A steady downward transition through 10 ° occurs in mid-October. The summer-autumn regrowth of Agropyron (July-October) occurs with precipitation of more than 25 mm per month. In the dry post-harvest period, as it was in 2019, 2021, 2022, when the amount of precipitation from harvesting to October inclusive was <50 mm, there was no summer-autumn tillering. In the absence of tillering after haymaking, the wheatgrass bushed only in spring.

The precipitation of the autumn-winter period determines the amount of moisture reserves by the beginning of the spring growing season. Over the years of research, the largest amount of precipitation (277 mm in November-March) was observed in the winter of 2021-22, which is on par with the average annual (280 mm). The minimum amount of precipitation for the same period (about 103 mm) was recorded in 2018-19. In other winters of 2017-18, 2020-21 and 2023-24, the precipitation of the cold period was about 200 mm (Table 1).

The main factor determining the productivity of the herbage in the semi-desert zone is the degree of atmospheric moisture. The wheatgrass is a perennial crop, in this regard, the interrelationships of the amount of precipitation from on the yield of the herbage were considered. The correlation between precipitation

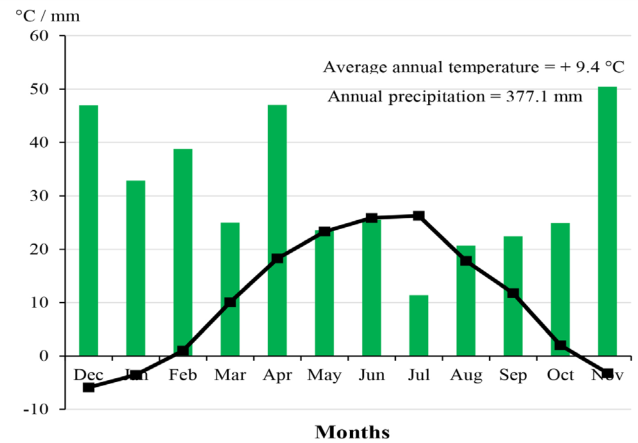

Fig. 1: Monthly precipitation and temperature data Volgograd for 10 years by month.

during cold period (November-March) and hay yield of wheat grass was found to be highly significant (r=0.946). The regression equation has the form: y=0.0052x + 0.7692, where y is a hay harvest in t ha^{-1}; x is the amount of precipitation (mm) during November-March. The average error of the equation is ±0,10 t ha^{-1}. The limits of application of the equation for x are from 100 to 280 mm (Fig. 2).

Thus, it can be revealed the main factors determining the harvest of wheatgrass are the temperature and moisture availability during different periods of the crop. Quantitative associations of the hay harvest with the amount of precipitation during the cold period (November-March) were revealed highly significant correlation and the regression equation developed can be used for estimating the harvest of wheatgrass (*Agropyron pectinatum)* in Volgograd region of southern Russia.

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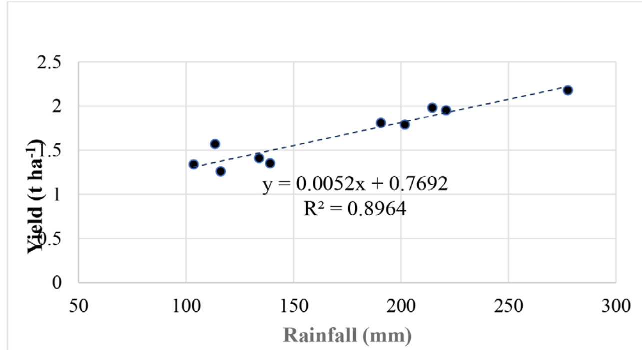

Fig. 2: Dependence of the harvest of wheatgrass hay on the amount of precipitation during the cold period (Nov.-March)

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