

# Perennial grasses in the south of Primorsky kray

Nataliya Klochkova<sup>1</sup>, Ol'ga Telichko<sup>2\*</sup>, Oksana Mokhan<sup>1</sup>, Elena Kul'dyaeva<sup>1</sup>, and Polina Bogdan<sup>1</sup>

<sup>1</sup>FSBSI "FSC of Agricultural Biotechnology of the Far East named after A.K. Chaiki", 30, Volozhenina st., Ussuriysk, 692539, Russia

<sup>2</sup>Far Eastern Scientific Research Institute of Plant Protection – branch of FSBSI "FSC of Agricultural Biotechnology of the Far East named after A.K. Chaiki", 42A, Mira st., Kamen-Rybolov, 692684, Russia

**Abstract.** Timothy grass (*Phleum pratense* L.) and cocksfoot (*Dactylis glomerata* L.) are among essential perennial fodder crops in the monsoon conditions of Primorsky kray. The paper presents the results of a study on hybrid specimens of timothy grass and cocksfoot. It was discovered that the herbage productivity of the timothy grass hybrids ranged from 317 (Morshanskaya 69 x Primorskaya mestnaya) to 372 g per plant (Primorskaya mestnaya x Narymskaya). The herbage productivity of the cocksfoot hybrids varied within 333-374 g per plant (Pushkinskaya x Dikorastushchaya and Dikorastushchaya x Aukshtuole, respectively). The following hybrids had the highest seed productivity per plant: Primorskaya mestnaya x Morshanskaya 69 (4.8 g, timothy grass) and Dikorastushchaya x Aukshtuole (3.5 g, cocksfoot). Hybrids Primorskaya mestnaya x Narymskaya and Dikorastushchaya x Aukshtuole stood out for the complex of economically important traits.

## 1 Introduction

Perennial grasses play a key role in the feeding of agricultural animals. A long life expectancy, a high number of possible cuttings, and a high content of nutrients make them cheap and high quality feed both when used for grazing and harvested for hay, silage, and herbage [1-4].

Timothy grass (*Phleum pratense* L.) and cocksfoot (*Dactylis glomerata* L.) are among the most important perennial fodder crops. However, abiotic environmental conditions such as drought and high humidity threaten plant resistance and ability to produce stable forage biomass.

Timothy grass and cocksfoot as fodder crops are wide spread in the south of Primorsky kray [5-6]. They are one of the most valuable components in grass mixes with the legume crops used for the production of green forage, hay, silage, and pasture forage, especially in districts with wet climate. They grow successfully in moderately wet soils and are able to

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\* Corresponding author: [olgatlichcko@yandex.ru](mailto:olgatlichcko@yandex.ru)

endure short-term waterlogging. Moreover, long droughts decrease the herbage yield of these crops [7-9].

The development of perennial grasses depends primarily on ecological factors. For this reason, creating varieties with resistance to abiotic factors of the environment is a key task for fodder production. The duration of the growing period is a significant biological trait of agricultural plants and determines their suitability to be cultivated in a particular region. It is well known that the duration of the growing period depends mainly on climatic conditions (daily mean temperature and the amount of precipitation). High temperatures shorten the period between the stages of flowering and seed maturation while an increase in precipitation prolongs it.

Our research goal was to identify promising breeding specimens of the perennial grasses and evaluate them for economically important traits for further use in the breeding process to create new varieties.

## **2 Materials and methods**

The research was conducted in the fields of the Department of Fodder Production with a breeding crop rotation at FSBSI "FSC of Agricultural Biotechnology of the Far East named after A.K. Chaiki" in 2021-2023.

Hybrid specimens of timothy grass and cocksfoot were used as the research objects.

The breeding nurseries were planted by the single-row method with a row length of 4.5 m and at an inter-row spacing of 0.5 m. Seeds were sown in individual holes (from five to eight seeds in each) [10].

The dates of the following growth stages were recorded in the first year of the experiment: the beginning of germination, most seedlings emerged, the beginning of tillering, most tillers formed, and the end of the growing period. The dates of the following developmental stages were noted in the subsequent years: the beginning of the growing period, the beginning of heading, most heads formed, the beginning of the flowering stage, full flowering, the full maturation of seeds, and the end of the growing period.

## **3 Results and Discussion**

Day length, temperature, and humidity are key factors influencing the duration of the growing period of perennial grasses.

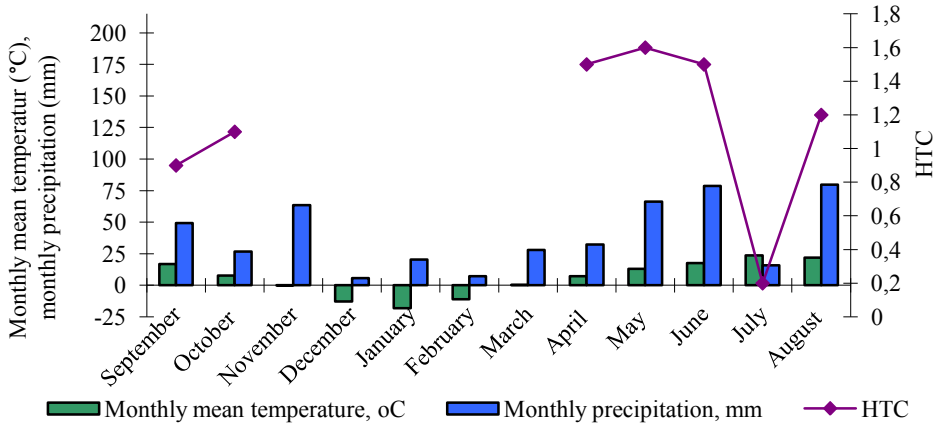
The meteorological conditions during the growing season of 2021-2023 were characterized by significant differences in the distribution of precipitation and the temperature regime. The temperature regime was favorable for the growth and development of the perennial grasses. The sum of active temperatures (above 10 °C) varied within 2400-2863 °C and the total amount of precipitation was 314.0-833.5 mm. The hydrothermal coefficient of Selyaninov (HTC) was 1.1 in 2021, 2.4 in 2022, and 2.9 in 2023.

The period from the emergence of the first seedlings to the beginning of the heading stage was favorable for plant development in 2021. The conditions of 2021 facilitated the normal development and growth of the perennial grasses. The stages of plant growth and flowering were characterized by high temperatures and moderate humidity (Figure 1).

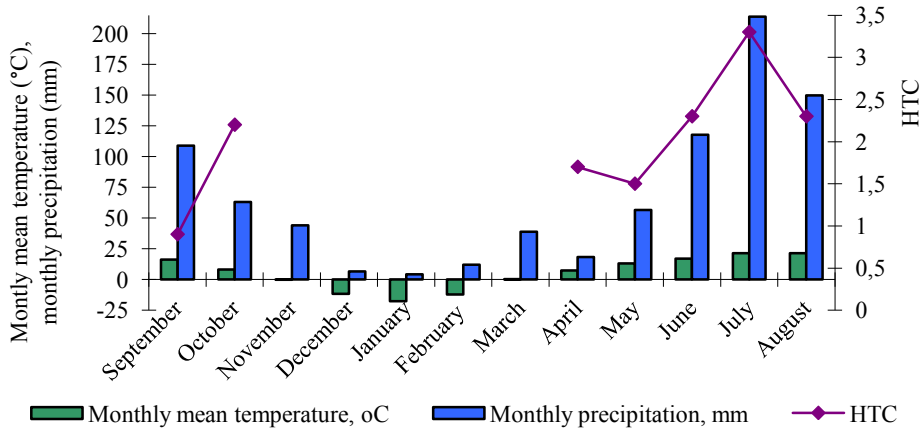
In 2022, the growth of the perennial grasses started by six days earlier than in 2021. The meteorological conditions corresponded to the long-term average. The sum of active temperatures were lower than in 2021. The period between the stages of germination and tillering was characterized by sufficient precipitation and lowered temperatures. Flowering occurred under dry weather conditions, seeds formed when the soil moisture was excessive. The total amount of precipitation reached 160 mm and the sum of active temperatures was

598 °C over the period from the tillering stage to the full maturity of seeds. The total amount of precipitation over the growing period was 657.8 mm exceeding the rainfall of 2021 by two times. The sum of active temperatures was 2728 °C, which was by 182 °C lower than in 2021 (Figure 2).

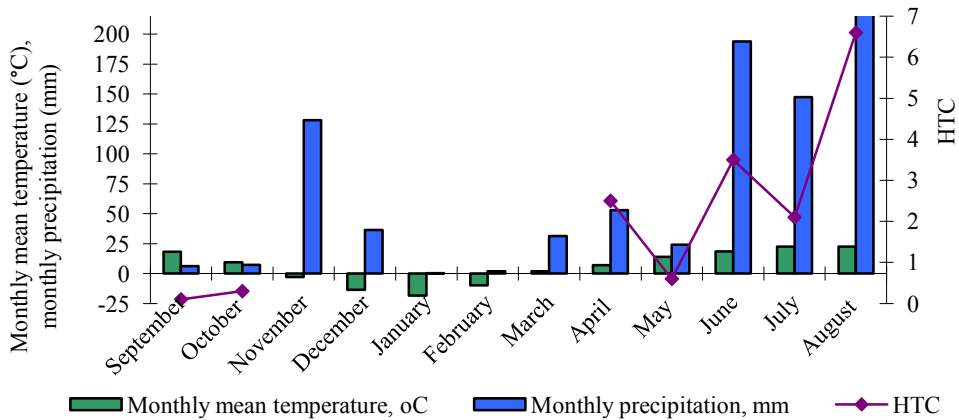
The growth of the perennial grasses started by three-six days later in 2023 than in 2021-2022. The sum of active temperatures was higher than in 2022 but lower than in 2021. Flowering and seed formation occurred at high humidity. The total amount of precipitation was 803 mm and the sum of active temperatures was 639 °C over the period from the beginning of heading to the full maturity of seeds (Figure 3).



**Fig. 1.** Hydrothermal parameters of the meteorological conditions in 2021.



**Fig. 2.** Hydrothermal parameters of the meteorological conditions in 2022.



**Fig. 3.** Hydrothermal parameters of the meteorological conditions in 2023.

The research results showed that the growing period of timothy grass was by 6-32 days shorter in 2023 than in 2021 and 2022.

According to our data, hybrid ♀ Primorskaya mestnaya x ♂ Narymskaya had the highest yield of herbage on average over the three years (Table 1). The herbage yield of the other hybrids (♀ Primorskaya mestnaya x Morshanskaya 69♂, ♀ Morshanskaya 69 x ♂ Primorskaya mestnaya, ♀ Narymskaya x ♂ Primorskaya mestnaya) was by 25-166 g/plant lower compared to the standard. Among the cocksfoot specimens, hybrid ♀ Dikorastushchaya x ♂ Aukshtuole stood out for the productivity of herbage and seeds over 2021-2023 and exceeded the standard by 191 and 0.6 g/plant, respectively.

**Table 1.** Characteristics of the herbage and seed productivity of the perennial grasses.

Varietyr/ hybrid	Productivity of herbage, g/plant			Mean	Seed productivity, g/plant			Mean
	year				year			
	2021	2022	2023		2021	2022	2023	
Timothy								
♀ Narymskaya x ♂ Primorskaya mestnaya	300	340	330	323	1.6	3.9	5.8	3.7
♀ Primorskaya mestnaya x ♂ Morshanskaya 69	270	210	290	257	3.8	4.3	6.3	4.8
♀ Primorskaya mestnaya x ♂ Narymskaya	360	300	456	372	1.2	5.1	3.7	3.3
♀ Morshanskaya 69 x ♂ Primorskaya mestnaya	230	290	431	317	2.5	6.0	3.5	4.0
♀ Primorskaya mestnaya (St)	300	310	415	342	3.4	4.6	4.2	4.0
Cocksfoot								
♀ Dikorastushchaya x ♂ Aukshtuole	180	500	442	374	3.6	3.2	3.7	3.5
♀ Pushkinskaya x ♂ Dikorastushchaya	190	300	510	333	1.2	2.5	2.9	2.2
Morshanskaya 143 (St)	170	180	200	183	2.6	2.1	3.9	2.9

The plantings of timothy grass and cocksfoot are especially valuable for the local fodder production in the second and fourth year of their life when they can produce stable yield under the unfavorable conditions of Primorsky kray. The generative shoot length of cocksfoot hybrid ♀ Dikorastushchaya x ♂ Aukshtuole exceeded the other specimens by 6.6-7.2 cm (Figure 4). Hybrid ♀ Dikorastushchaya x ♂ Aukshtuole formed the highest number of vegetative shoots per plant and exceeded the standard by 27 pcs/plant. However, the standard had a higher number of generative shoots (by 4-6 pcs/plant higher) (Table 2).

♀ Hybrid Narymskaya x ♂ Primorskaya mestnaya was the highest among the studied timothy grass specimens and exceeded the standard by 6.6-11.5 cm. The length of vegeta-

tive shoots varied within 30.1-34.8 cm among the hybrid specimens and did not exceed the standard. Genotypes ♀ Narymskaya x ♂ Primorskaya mestnaya and ♀ Primorskaya mestnaya x ♂ Narymskaya had the highest number of vegetative shoots. All the hybrid specimens had a higher number of generative shoots than the standard.

**Table 2.** Length (cm) of the shoots of the perennial grass hybrids at the stage of ear emergence.

Parameters	Year	Primorskaya mestnaya (St)	♀ Narymskaya x ♂ Primorskaya mestnaya	♀ Primorskaya mestnaya x ♂ Morshanskaya 69	♀ Primorskaya mestnaya x ♂ Narymskaya	♀ Morshanskaya 69 x ♂ Primorskaya mestnaya	♀ Dikorastushchaya x ♂ Aukshtuole	♀ Pushkinskaya x ♂ Dikorastushchaya	Morshanskaya 143 (St)	
		Timothy					Cocksfoot			
Generative shoots, cm	2021	60.5	81.5	66.0	73.5	62.0	71.0	54.0	65.5	
	2022	68.2	75.5	73.3	75.2	68.4	99.4	99.0	80.0	
	2023	98.0	104.0	102.0	101.0	102.0	103.2	99.2	108.3	
Mean		75.5	87.0	80.4	83.2	77.4	91.2	84.0	84.6	
Vegetative shoots, cm	2021	36.5	29.0	31.0	30.0	31.5	40.0	32.5	32.0	
	2022	37.3	35.3	33.0	39.3	42.0	68.0	60.0	31.0	
	2023	31.0	26.0	31.0	30.0	31.0	32.5	26.2	28.6	
Mean		34.9	30.1	31.6	33.1	34.8	46.8	39.5	30.5	
Number of shoots, vegetative / generative, pcs/plant	2021	40/9	62/23	66/6	53/4	38/5	21/11	14/8	22/2	
	2022	86/17	90/14	62/19	88/15	94/21	80/15	63/13	41/12	
	2023	115/23	101/27	98/32	112/34	105/28	115/20	65/18	73/45	
Mean		80/16	84/21	75/19	84/17	79/18	72/15	47/13	45/19	



**Figure 4.** Hybrid specimen ♀ Dikorastushchaya x ♂ Aukshtuole – *Dactylis glomerata* L. (photo by the authors).

## 4 Conclusions

The research showed that the herbage productivity of the studied timothy grass hybrids ranged from 317 (♀ Morshanskaya 69 x ♂ Primorskaya mestnaya) to 372 g/plant (♀ Primorskaya mestnaya x ♂ Narymskaya). The herbage productivity of cocksfoot ranged

from 333 (♀ Pushkinskaya x ♂ Dikorastushchaya) to 374 g/plant (♀ Dikorastushchaya x ♂ Aukshtuole). The following hybrid specimens were characterized by the highest seed productivity per plant: ♀ Primorskaya mestnaya x ♂ Morshanskaya 69 (4.8 g, timothy grass) and ♀ Dikorastushchaya x ♂ Aukshtuole (3.5 g, cocksfoot). Genotypes ♀ Primorskaya mestnaya x ♂ Narymskaya and ♀ Dikorastushchaya x ♂ Aukshtuole had the highest number of vegetative/ generative shoots (84/17 and 72/15 psc/plant, respectively).

The conducted research allowed us to identify hybrid specimens of the perennial grasses with a complex of economically important traits (♀ Primorskaya mestnaya x Narymskaya – timothy grass, ♀ Dikorastushchaya x ♂ Aukshtuole – cocksfoot).

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