MILLET CULTIVATION IN FORAGE CROP ROTATION UNDER THE CENTRAL YAKUTIA CONDITIONS

УДК 631.582.(571.56)
DOI:10.24411/2588-0209-2019-10100

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In this article, the results on yield, nutritional value and productivity studies of sowing millet variety “Baganskoye 88” are provided. This study took place in Prilenskoye agrolandscape, located in the second floodplain terrace in the Lena river. Central Yakutia’s climate is considerably harsh. However, by total of heat storages, abundancy of low overcast days, the rapid increase of temperature during spring and in overall high solar radiation activity during the vegetation period, it is safe to argue that this territory is suitable for the successful cultivation of forage crops with relatively short growing period.

One of the promising crops for silage production is millet cultivation. Prospect of cultivating a new millet culture for silage under the permafrost conditions have been launched. According to productivity studies, the yield of dry weight in millet over the years of research was 3,26 t/ha in the control variant, - 4,86t/ha in the $(NPK)_{60}$ variant and 6,10t/ha in the estimated fertilizer dose $(NPK)_{160}$ variant. The yield of exchange energy was 27,42 – 50,94 GJ/ha, feeding units 1,82 – 3,42t/ha, collection of digestible protein – 0,35-0,75t/ha. Nutrition of millet was noted in 1 kg of dry matter 0,56 feed

units, digestible protein 107,17-126,23 g, metabolic energy 8,3-8,4 MJ, gross energy 17,5 -17,6 MJ. The supply of 1 feed unit with digestible protein was 189–227g. The usage of mineral fertilizers improved the quality of the feed crop by 15-20%. The silage from millet contained 1 kg of dry matter - feeding units 0.55; digestible protein 39.9 g; exchange energy -8.21 MJ; gross energy 17.3 MJ and digestible protein in 1 feed unit 72.5 g.

Key words: *sowing millet, seeding norm, mineral fertilizer, green mass, yield, productivity, nutritional value, silage.*

Introduction

One of the major issues in agro-industry are the increase of fodder crops production, its quality and energy saturation improvement. For achieving above mentioned, the main focus relies on cultivation of non-traditional corps with high feeding productivity and adaptivity to particular natural and climatic conditions.

At the current moment, major silage crops produced are oat and its mixture with other varieties. Under these conditions, the inclusion of promising new forage crops in the fodder crop rotation links is one of the effective routes for increasing the productivity within the arable land hectare and in overall improving fodder quality.

Transition of air temperature through 5^0C (vegetative spring) begins in the middle of the May and ends in the middle of September. Ground frosts can rarely occur until the middle of the June and in the end of August. Frost-free period in the middle river Lena cost valley usually lasts for 65-100 days. The middle temperature of the warmest month, July, is 18-19^{0}C; the sum of active temperatures higher than 10^0C in agricultural areas of Central Yakutia is 1400-1600^{0}C [1].

Central Yakutia’s climate is substantially severe, however, judging by the amount of heat storages, the abundancy of low overcast days, rapid increase of temperature during spring and in overall high solar radiation activity during the vegetation period, it is undeniable that this territory is suitable for the successful cultivation of forage crops with relatively short growing period. One of the promising crops for silage production is deemed to be millet.

The sowing millet (*Panicum miliaceum L.*)-is universal crop, biologically it can adapt to local climatic conditions, prefers heat and is classified as short-day plant. Vegetative periods lasts from 60-70 to 100-120 days. It can be characterized with increased durability against drought. The drought tolerance is due to not only low water consumption but with millet ability to effectively utilize late precipitation water and continuance for the assimilation under high temperature. The absence of early precipitation is compensated by entering the anabiosis-like state [3].

Cultivation of light- and heat- preferring crops under Central Yakutia conditions can provide rational utilization of soil and climatic resources. Under the careful consideration of agrotechnical nuances, millet can provide the high yield and quality of green mass for silage production [4].

Materials and methods

Experiments on studying the forage crop rotations (2015-2018) with the usage of regional and prospective annual forage crops in middle-salinity soils with insuffucent mositurizatiion in Prilenskoye agrolandscape [5] took place in irrigation plot “Moyodkh” of agrological company “Nemyugyu” on the second floodplain terrace of river Lena.

Scheme of five-floor forage crop rotation includes local, regional and adapted forage crops: oat, winter rye-winter rye, 2nd term oat- vetch and oat mix- millet-alfalfa+wheatgrass.

The soil of the experimental plot is meadow-chernozemic, slightly saline. Agrochemical characteristics at the initial stage were in following: alkaline reaction pH saline- 7,6-8,4; the humus content - (as of Tyurin) – 3,14% on the upper horizont, the content of mobile forms of nitrogen is 0,34 (via ion selection method); the content of phosphorus mobile forms P_2O_5 - 13.4; potassium content (via Egner-Rome method) is high: K_2O – 22,1 mg / 100 g of soil.

Variances of mineral fertilizers were following: control, estimated dose of $(NPK)_{60}$ kg/ha, and estimated dose- $(NPK)_{160}$ kg/ha. Forage crops sowing took place at the first half of June with SSNP-16 (ССНП -16) seeder machine with millet row-spacing of 30cm, sowing norm of millet variety “Baganskoye 88” was 35kg/ha. Irrigation was

provided via KI-5 (КИ-5) irrigation aggregate with norm 250m^3/ha. Plot area was 25m^2 with three repetitions.

Field experiments and economical, agrological energy values calculations were carried according to recommendations from Research Institute of Forages [6,7]. Fertilizer doses calculations for the planned yield (200c/ha) were carried accordingly to Yudin [8]. Agri-technology of forage crop cultivation methodology was following traditionally characteristic for the one in Republic Sakha (Yakutia) [9]. Biochemical analyses were performed by infrared analyzer SpectraStar 2200 (Unity Scientific, USA). Mathematical analysis of data obtained from experiments was carried in SNEDECOR program following the recommendations by Dospekhov [10].

Results and discussion

Meteorological conditions in 2015 were arid. The precipitation rate throughout vegetative period was 2 times lower than norm (89,9mm against the norm of 159,5mm), hydrothermal coefficient (HTC) from May to August was 0,51. In 2016-2017, the first half of vegetative period was arid, but in contrast precipitation during the second half were higher than norm, assisting to the yield of 7,0-15,0t/ha. Vegetative period in 2018 was advantageous for the growth and development of plants facilitating to production of the yield of 4,0-24,5t/ha.

Sprouting period - mowing ripeness in millet was observed from 64 to 70 days. In mowing ripeness, the height of the plants at the millet "Baganskoye 88" ranged from 52 to 124 cm.

In average, the millet yield throughout years of studies was: control- 13,1; $(NPK)_{60}$ – 19,5; $(NPK)_{160}$ – 24,5 t/ha. The yield supplement with mineral fertilizers application was 6,4-11,5 t/ha of green mass.

Zootechnical data on millet nutritional value per 1kf of dry mass was: feeding unit-0,56, digestible protein 107,17-126,23g, exchange energy 8,33-8,41M, gross energy 17,55-17,65MJ. Security of 1 feeding unit by digestible protein was 189,44-227,29g (Table1). In overall, the application of mineral fertilizers increase quality of forage crops by 15-20%..

Table 1

Millet nutritional values in crop rotation

Fertilizer type	Per 1kg of dry mass				Security of DP/1 feed.unit, g
	Feeding units.	Dig.protein, g	Ex.energy, MJ	Gross energy, MJ	
Control	0,56	107,17	8,41	17,55	189,44
NPK_{60}	0,56	126,23	8,33	17,65	227,29
NPK_{160}	0,56	122,60	8,35	17,63	219,56

Based on studies of millet productivity under crop rotation, it was revealed that output of dry mass of the crop was: control 3,26t/ha, $(NPK)_{60}$ – 4,86 t/ha and $(NPK)_{160}$ – 6,10 t/ha. Output of exchange energy was 27,42; 40,48 and 60,9GJ/ha, feeding units 1,82; 2,72 and 3,42t/ha, digestible protein- 0,35; 0,61 and 0,74t/ha respectively (Table 2).

Table 2

Millet productivity in crop rotation, t/ha.

Fertilizer type	Green mass	Dry mass	Feeding units, t/ha	Digestible protein	Exchange energy, GJ/Ha
Control	13,1	3,26	1,82	0,35	27,42
$(NPK)_{60}$	19,5	4,86	2,72	0,61	40,48
$(NPK)_{160}$	24,5	6,10	3,42	0,75	50,94
HCP_{05}	2,90	0,85-1,47		0,67-1,16	1,92-3,32

1 kg of dry silage from millet contained- 0,55 of feeding units, digestible proteins 39,9g; exchange energy- 8,21MJ; gross energy 17,3MJ and digestible protein in 1 feeding unit 72,5g.

Based on visual analysis, it was revealed that silage was olive color with slightly sour fruity smell. Stems, leaves and panicles structures were completely preserved. Silage water content was 45,2 to 66,6%. Microbiologically, silage contained from 600 to 2000 lactobacterial colonies and no adaptable-pathogenic colonies. No butyric acid was detected in the silage. The proportion of acidic compounds (acetic-butyric-lactic acids) was 38-0-62 with the pH of 5,0.

Nutrient removal per rotation cycle in millet was: by nitrogen 55,5-83,1; by phosphorus- 17,8-26,7; by potassium- 41,4-61,6 kg/ha (Table 3).

Table 3

Nutrient removal (kg/ha) in crop rotation

Fertilizer type	Dry mass, t/ha	Nutrient removal		
		N	P_2O_5	K_2O
Control	3,26	55,5	17,8	41,4
$(NPK)_{60}$	4,86	70,2	22,5	50,3
$(NPK)_{160}$	6,10	83,1	26,7	61,6

Conclusion

Based on our data, it was revealed that the new millet variety “Baganskoye 88” can be included as the new element in the feed crop rotation for the production of green mass for silage, particularly under Central Yakutia conditions.

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