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AGROECOLOGICAL STUDIES OF SOUTHERN FORAGE CROPS IN THE NATURAL CONDITIONS OF THE NOVGOROD REGION

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Abstract:

We studied the possibility of expanding to the north the range of growing paisa, chumiza, mohar, millet, and African millet. High adaptive properties of these crops and their varieties during cultivation in the conditions of the Novgorod region are revealed. When sowing in the third decade of May, the studied crops can be used for green fodder and hay from middle of July to September, in the cold years - during August, for harvesting silage and haylage from middle of August almost until frost. On average for 2015-2018 the maximum plant's height was obtained from the paisley varieties Gulliveria (135 cm) and Stapize (129 cm). A stable yield of green mass in the studied years was established in the varieties paisa (35.4-50.7 t / ha), chumiza (27.8-33.7 t / ha). Mohar Stamoga also obtained a guaranteed high rate of this trait (36.9 t / ha). In years with a lack of heat, the yield of pares decreased by 9.1-24.6 t / ha, of chumiza by 5.8-29.5 t / ha In other crops, productivity decreased by 2 or more times. According to the dry matter content of crude protein, paisa Gotica (20.69%), mohar Athlete (14.57%), chumiza Strela (13.77%) are distinguished. Comply with GOST for the content of raw protein paisa Stapize, mohar Stepnoy Mayak, millet sowing Regent (11.73-12.79%). In terms of energy potentiality (in OE and KE) they correspond to the requirements of the Gotica style, the chumiza Strela. More than 4 tons of dry matter per 1 ha were obtained from all varieties of paisa, mohar Stamoga and Stepnoy Mayak, chumiza Olya, millet African Sogur and millet sowing Zolotaya Orda. At paisa Stapize, the collection of protein per 1 ha is 953.2 kg, and paisa Gotica - 876.8 kg.

Keywords: *introduction, adaptation, green mass, paisa, mohar, chumiza, African millet, sowing millet.*

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1. INTRODUCTION:

In the economy of the Novgorod region, the production and processing of agricultural products is one of the key enterprises. The territory of the region comes to the risky farming zone, therefore, the agricultural industry specializes in the production of meat and dairy products, that is approximatle 67% of the total volume of this direction. In meat products, the needs of the population are fully satisfied, and in milk - by less than 50%.

The expansion of dairy production is provided for by the regional law "On dairy farming." For this, the region's growing industry should expand the area occupied by fodder crops with the aim of ensuring high productivity of the feed hectare and the quality of the resulting feed [1, 2]. New innovative ways of getting feed are needed. There are two main ways of increasing crop yields at minimal cost. The first way is usage of the achievements of domestic crop breeders creating new varieties with desired feed properties [3]. The second way is the introduction of new high-yielding crops into production, which have traditionally other cultivation areas and have high adaptive properties [4-6].

The assortment replacing of traditional crops with new generation varieties makes it possible to use the potential productivity of arable land fully than usual. In the conditions of the non-chernozem belt, the variety of grown crops is quite limited and may not completely solve the problems of the fodder industry. Innovative ways of solving the problem include the use of genetic polymorphism in agrocenoses due to the presence of a significant fund of plant resources [7]. Modern trens in climate change indicate the advisability of paying attention to crops traditionally grown for feeding purposes in the southern regions of the Russian Federation [8, 9]. Their introduction into the Novgorod region allows us to diversify and improve feeding ration of animals, relieve periods of tension in feed conveyors [10-13]. An agroecological investigation of varieties in the conditions of a short growing season and low soil fertility of the Non-chernozem zone is under attention of breeders and workers in the agricultural sector of the region [14, 15].

The purpose of the ongoing agroecological investigations is to identify among crops and their varieties the most adapted for cultivation in the Novgorod region, as well as to evaluate the ability of southern annual forage crops of the bluegrass family to produce stable yields in the created agrophytocenoses and the qualitative characteristics of the resulting feed.

2. MATERIAL AND METHODS

The objects of study were paisa (Echinochloa frumentacea Link), chumiza (Setaria italica L.), mohar (Setaria mocharium Alef), sowing millet (Panicum miliaceum L.), African millet (Pennisetum tuphoideum Rich). The experiment involved cultures and varieties of three regions - Volga, Central and North Caucasus. The Volga region is represented by the Federal State Budget Scientific Institution of RosNIISKH "Rossorgo", the city of Saratov - payza Gotica, millet sowing Zolotaya Orda. From the Central region we studied the paisas of Krasava, Gulliveria, the chumizu Olya and Strela, the millet sowing Regent, the mohar Atlant, the millet African Sogur of selection of the Federal State Institution Federal Scientific Center ZBIKK, Oryol. Federal State Budgetary Institution "North Caucasus FARC" is represented by paisa Stapize, mohar Stamoga and Stepnoy Mayak.

The studies were carried out on the experimental field of the Federal State Budget Scientific Institution Novgorod Research Institute of Agriculture in 2015-2018. The soil of the plot is light loamy, sod-podzolic, its acidity is pH = 5.1-6.6. The mass fraction of mobile potassium compounds (K_2O) is 10.1-22.9 mg/100 g of soil, phosphorus compounds (P_2O_5) - 12.0-73.7 mg/100 g of soil, organic matter - 2.81-3, 57%.

Phenological observations, measurements and counts were made in accordance with the "Methodological recommendations for doing field researches with feed crops of the All-Russian Research Institute of Feed named after V.R. Williams [16]. The predecessor was occupied steam over a layer of perennial leguminous herbs. The area of one plot is 10 m^2, the repetition is fourfold, the placement is systematic.

Sowing was made manually, in an ordinary way, at the beginning of the third decade of May (May 20-22) with the onset of optimal conditions for seed germination. Mineral fertilizers were applied before sowing at a dose of 60 kg ai. NPK per 1 ha. During the growing season, manual weeding and loosening of the soil between rows were made.

During the years of research, the weather conditions of the growing season were different. The growing season of 2015 is characterized by moderate temperatures, a pronounced moisture deficit, the hydrothermal coefficient (SCC) was 0.89, and early frosts were observed on August 25. In 2016, there was an excess of precipitation (SCC 1.73) against a background of moderate temperatures, the frost-free period lasted until October 12. The growing season of 2017 was determined by extreme conditions. In April and the first half of May, cold weather remained frost weather and did not to make field work. The sum of effective temperatures exceeding 10^0C (1908^0C) was 11% less than the long-term average; the onset of phenological phases in plants

took place with a delay of 2-3 weeks. The frost-free period lasted until October 21, the amount of precipitation exceeded the norm by 1.7 times, the SCC amounted to 2.67. In 2018, until mid-May, night frosts were observed with low daytime temperatures, June was cold with frosts in the first decade, July, August and September were warm and sunny. During the growing season, there was a deficit of precipitation (SCC 0.89), the frost-free period lasted until September 25.

3. RESULTS AND DISCUSSION:

During the years of research, when sowing at the beginning of the third decade of May, single seedlings appear 10-14 days before the beginning of June (in 2017 - 3 weeks after sowing), mass shoots within 2-3 weeks. The period of intensive growth and accumulation of biological mass in plants began from the second decade of July. The first to enter the heading phase at the end of July - the beginning of August is the millet African Sogur, mohar Stepnoy Mayak. By mid-August, panicles of chumiza, paisa, millet sowing, and mohar were thrown out. In 2017, the development phases passed with a delay of 3 weeks, so the heading period came at millet sowing and African, mohar Atlant, paisa, chumiza in late August, mohar Stamoga in September.

Vegetation in 2015 for introduced crops ended ahead of schedule: August 25 freezing damaged plants. By this time, seeds have ripened millet African Sogur. Plants in chumiza completed the vegetation in the flowering phase, in mohar seeds were formed. In 2016, by the time the vegetation ended, seeds from the mohar, millet, and African millet ripened. The summer of 2017 was cold and rainy, but the frost-free period lasted until October 21. By the third decade of September, seeds from millet sowing and African ripened, and by the end of the growing season, seeds from paisa, chumiza and mohar Atlant ripened. In 2018, seeds ripened at the mohar Stepnoy Mayak, millet sowing and African, chumiza.

The best period for harvesting of the studied forage crops for green fodder and hay is the period before sweeping and the emergence of inflorescences, the panicles are harvested for silage in the milky-wax ripeness phase of panicles (except for paisa and mohar, which are harvested for silage in the earing phase). The periods of mowing ripeness of the studied crops in the conditions of the Novgorod region on the green mass, hay and silage for years of research are shown in table 1.

Table 1: The length of the period of mowing ripeness in introduced feed crops in the conditions of the Novgorod region

Culture, grade	*2015 year*		*2016 year*		*2017 year*		*2018 year*	
	on green mass and hay	*to silo*	*on green mass and hay*	*to silo*	*on green mass and hay*	*to silo*	*on green mass and hay*	*to silo*
Paisa								
Krasava	20.07-15.08	15.08-25.08	03.07-17.08	17.08-10.09	01.08-20.08	20.08-05.09	15.07-30.07	30.07-15.08
Gulliveria	20.07-15.08	15.08-25.08	01.07-15.08	15.08-01.09	01.08-20.08	20.08-05.09	15.07-10.08	10.08-25.08
Stapize	18.07-18.08	18.08-27.08	01.07-10.08	10.08-25.08	01.08-20.08	20.08-05.09	15.07-05.08	05.08-20.08
Gotica	-	-	-	-	01.08-20.08	20.08-05.09	15.07-05.08	05.08-20.08
Mohar								
Atlant	05.07-31.07	31.07-15.08	01.07-25.07	25.07-10.08	01.08-15.08	15.08-31.08	25.07-10.08	10.08-30.08
Stamoga	01.07-25.07	25.07-10.08	01.07-20.07	20.07-05.08	10.08-05.09	05.09-15.09	20.07-20.08	20.08-10.09
Stepnoy Mayak	-	-	-	-	-	-	20.07-31.07	01.08-15.08
Chumiza								
Olya	05.07-31.07	31.07-25.08	03.07-27.07	27.07-22.08	01.08-20.08	20.08-20.09	20.07-10.08	10.08-10.09
Strela	10.07-10.08	10.08-25.08	05.07-01.08	01.08-22.08	01.08-20.08	20.08-20.09	20.07-10.08	10.08-10.09
African millet								
Sogur	05.07-20.07	20.07-15.09	25.06-10.07	10.07-15.08	01.08-15.08	15.08-20.09	20.07-30.07	30.07-28.08
Sowing millet								
Zolotaya Orda	12.07-25.07	25.07-20.08	10.07-10.08	10.08-10.09	01.08-20.08	20.08-10.09	20.07-31.07	01.08-05.09

Regent	15.07-28.07	29.07-25.08	12.07-15.08	15.08-15.09	01.08-25.08	25.08-30.09	20.07-31.07	01.08-30.08

The length of the period of mowing ripeness depends on the demanding plants to the growing conditions. Less demanding and more precocious are millet African Sogur, varieties of millet sowing. Accordingly, they have shorter maturity dates for harvesting for green fodder and hay (10-20 days), for silage - 15-30 days. Crops with high heat requirements have a longer period for harvesting for green mass: payza, mohar - 15-25 days

When sowing in the third decade of May, the annual studied introduced crops can be used for green fodder and hay from mid-July to the end of August, in cold years - during August, for harvesting silage and haylage - from mid-August almost until frost.

During the years of research, observations were made of the dynamics of plant growth. Table 2 shows the changes in the height and level of productivity of introducers during harvesting for green mass and hay. The lack of heat in the studied crops is the main limiting factor, the lack or excess of moisture has a smaller effect on growth and yield. In the cold year 2017, the height of the plants during the harvesting period for green mass was 56-126 cm. In 2018, this trait had a value of 91-147 cm, and on average over the studied years it was 90-135 cm.

Table 2: Plant height and green mass yield at the time of mowing ripeness on green fodder and hay

Culture, grade	*Plant height, cm*					*Green mass productivity, t / ha*				
	2015	*2016*	*2017*	*2018*	*average*	*2015*	*2016*	*2017*	*2018*	*average*
Paisa										
Krasava	118	108	96	115	109	35.4	38.4	26.3	41.3	35.4
Gulliveria	143	128	126	141	135	53.6	32.3	29.1	35.4	37.6
Stapize	131	121	117	146	129	49.1	61.5	37.5	54.8	50.7
Gotica	-	-	106	147	-	-	-	22.3	32.6	-
Mohar										
Atlant	91	122	56	91	90	40.1	59.4	10.3	10.8	30.2
Stamoga	120	133	92	122	117	38.7	40.1	39.0	29.6	36.9
Stepnoy Mayak	-	-	-	114	-	-	-	-	31.2	-
Chumiza										
Olya	83	80	103	126	98	31.1	29.1	25.3	49.4	33.7
Strela	123	117	85	122	112	41.5	33.2	12.0	24.6	27.8
African millet										
Sogur	114	121	92	104	108	20.6	39.9	14.2	25.8	25.1
Sowing millet										
Zolotaya Orda	128	133	90	115	117	38.7	41.7	18.5	38.0	34.3
Regent	-	-	89	117	-	-	-	23.8	17.1	-
SSD_{05} t / ha						**3.2**	**3.1**	**2.2**	**2.9**	

The maximum plant height was obtained from the paisley varieties Gulliveria (135 cm) and Stapize (129 cm). Stable yield of green mass was observed in varieties of paisa (35.4-50.7 t / ha), chumiza (27.8-33.7 t / ha). In mohar, high rates were obtained in the Stamoga variety (36.9 t / ha). In years with a lack of heat, a decrease in yield of 9.1-24.6 t / ha in varieties of paisa and 5.8-29.5 t / ha in varieties of chumiza was found. In other crops, with heat deficiency, productivity decreased by 2 or more times.

Paisa, chumiza, mohar, sowing and African millet by the end of the growing season in 2015-2016, 2018 had a height in the range of 126-185 cm. 23.5-52.9 t / ha for chumiza, 24.4-56.6 t / ha for sowing millet, 21.8-39.9 t / ha for African millet, 32.2-67.4 t / ha mohar. In 2017, when harvesting for silage, the height of these crops was 84-121 cm, yield at paisa - 22.3-37.5 t / ha, chumiza - 20.5-27.5 t / ha, millet sowing - 17.0 -23.8 t / ha, African millet - 20.4 t / ha, 14.8-39.0 in the mohar. Thus, in the conditions of the non-chernozem zone, the studied southern cultures exhibit a fairly high ecological plasticity, they are able to provide a decent level of green mass productivity even under adverse weather conditions. To increase the efficiency of feed use, one of the determining factors is an objective evaluation of the composition and nutritional value of feeds in order to draw up complete diets in order to obtain high animal productivity. In 2018, a zootechnical analysis of the studied crops and varieties was carried out to determine the content of the main quality indicators (Table 3).

Table 3: The quality of the green mass of introduced crops

Culture, grade	*Green mass productivity, t / ha*	*Mass fraction of dry matter at natural humidity, %*	*Dry matter collection, t / ha*	*Mass fraction in dry matter*		*Content in 1 kg dry matter*	
				crude protein, %	*cellulose, %*	*metabolic energy, MJ*	*feed units*
Paisa							
Krasava	41.7	19.1	7.9	6.81	35.6	8.6	0.60
Gulliveria	35.4	15.6	5.5	5.38	34.0	8.9	0.64
Stapize	54.8	13.6	7.5	12.79	31.6	9.3	0.70
Gotica	32.6	13.0	4.2	20.69	26.9	10.2	0.84
Mohar							
Atlant	10.8	16.2	1.7	14.57	27.8	10.0	0.81
Stamoga	29.6	13.9	4.1	7.63	35.3	8.7	0.61
Stepnoy Mayak	29.6	19.1	5.6	11.73	30.4	9.5	0.74
Chumiza							
Olya	27.8	17.1	4.8	9.59	33.9	8.9	0.64
Strela	22.7	16.7	3.8	13.77	26.9	10.1	0.83
African millet							
Sogur	25.8	17.2	4.4	7.56	30.2	9.6	0.74
Sowing millet							
Zolotaya Orda	38.0	14.7	5.6	10.54	32.7	9.1	0.67
Regent	17.1	14.9	2.5	11.88	28.2	9.9	0.80

The yield of green mass is indicated at the time of sampling for agrochemical analysis. According to the dry matter content of crude protein, paisa Gotica (20.69%), mohar Atlant (14.57%), chumiza Strela (13.77%) are distinguished. Correspond to GOST for the content of raw protein paise Stapize (12.79%), mohar Stepnoy Mayak (11.73%), millet sowing Regent (11.88%). In terms of energy nutrition (in the MA and CE) they correspond to the requirements of the Gotica style, the chumiza Strela. Low nutritional value was noted in paisa Krasava and Gulliveria, chumiza Olya, millet sowing Zolotaya Orda. The remaining varieties have indicators close to GOST. According to the yield of dry matter from 1 ha (more than four tons), the following varieties are distinguished: paisa, mohar Stamoga and Stepnoy Mayak, chumiza Olya, millet African Sogur, millet sowing Zolotaya Orda. A high collection of dry matter per hectare makes it possible to obtain a high collection per hectare even when the raw protein content is below normal. So at paisa Stapize, the collection of protein per 1 ha is 953.2 kg and paisa Gotica 876.8 kg.

4. CONCLUSIONS:

Forage crops from the southern regions exhibit high adaptive qualities in the conditions of the Novgorod region. With a lack of heat, plants form highly productive agrocenoses capable of providing livestock with high-quality nutritious feeds in the second half of summer and early autumn. Paisa, chumiza, and millet sowing varieties exhibit high plasticity, are stable in crop formation both in favorable and in adverse weather conditions, and are able to provide animals with high-quality green mass from mid-July to September. High yield of green mass of introduced crops increases the efficiency of feed production, provides high fees per hectare of the protein component, metabolic energy. The introduction of introducers from the southern regions into the fodder production in the Novgorod region contributes to the expansion of the range of crops grown for the feed conveyor, to strengthening the feed base and the balance of feeding rations in order to effectively manage the production process of agroecosystems.

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