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ТҮЙІН

Бұл ғылыми мақала қазақстандық селекцияның жоңышқа сорттарының құрғақ заттарындағы каротин құрамының генетикалық өзгергіштігін зерттеуге арналған. Medicago sativa сүт пен ет тұтыну арқылы малға да, адамға да дәрумендік қоректік заттарды қамтамасыз етуде шешуші рөл атқарады. Оның осы аспектідегі маңыздылығы оның аймақтағы мал азықтық өсімдік ретіндегі маңыздылығын көрсетеді.

Эксперимент барысында қазақстандық селекцияның жоңышқа сорттарының құрғақ заттарындағы каротин құрамының генетикалық өзгергіштігін бағалау жүргізілді. Каротин инфрақызыл спектроскопия әдісімен анықталады. Зерттеулер Қазақстан Республикасы Ақмола облысының қырлы-тегіс аймағының солтүстік бөлігінде орналасқан "Көкшетау тәжірибелік-өндірістік шаруашылығы" ЖШС (Шағалалы ауылы) тәжірибелік алаңдарында жүргізілді. Конкурстық сорт сынауда жоңышқаның 10 сортүлгілері зерттелді. Каротин мөлшері жоңышқа сортүлгілерінде 20,86-дан 23,03 мг/кг-ға дейін ауытқыды.

Зерттеу нәтижелері жоңышқаның әртүрлі сорт үлгілері арасындағы каротин құрамының генетикалық вариацияларын анықтауға мүмкіндік береді. Бұл мал азығы құндылығы жақсартылған және әртүрлі өсу жағдайларына төзімділігі бар жаңа сорттарды жасау үшін өте маңызды. Каротин мөлшеріне әсер ететін генетикалық ерекшеліктерді анықтау жоңышқаның тиімді селекция және генетикалық ресурстарын басқаруға ықпал етеді. Нәтижелер каротин мөлшері туралы генетикалық негіз туралы түсінігімізді кеңейтіп қана қоймай, сонымен қатар ауыл шаруашылығы және тамақ өнеркәсібінің қажеттіліктерін қанағаттандыра алатын төзімді сорттарды жасауды қолдайды.

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COMPARATIVE ASSESSMENT OF ANNUAL SPARSELY DISTRIBUTED FORAGE CROPS BY PRODUCTIVITY IN THE CONDITIONS OF THE STEPPE ZONE OF NORTHERN KAZAKHSTAN

ANNOTATION

The article presents the results of a comparative assessment of non-traditional annual fodder crops in terms of productivity in the steppe zone of Northern Kazakhstan. The object of research are varieties and hybrids of sorghum-Sudanese hybrid, corn, paisa and African millet. The purpose of the research is to conduct a comparative assessment of forage crops by productivity in the conditions of the steppe zone of Northern Kazakhstan. The relevance of the research topic lies in the selection and introduction of new, more productive and drought-resistant forage crops for the steppe zone of Northern Kazakhstan. The objectives of the research include to study the peculiarities of the cultivation of forage crops in the steppe zone of Northern Kazakhstan; to conduct a comparative assessment of the yield of forage crops; to determine the most promising for cultivation in the steppe zone of Northern Kazakhstan forage crops. The scientific significance of the work lies in obtaining new data on the comparative yield of various forage crops in the conditions of the steppe zone of Northern Kazakhstan. Contribution of the work: the obtained data on the comparative yield of various forage crops in the conditions of the steppe zone of Northern Kazakhstan will improve the efficiency of agricultural production. The practical significance and value of the work lies in the development of recommendations on the selection of the most promising forage crops for cultivation in the steppe zone of Northern Kazakhstan, as well as for the introduction of adaptive technologies into agricultural production. The following research methods are used in the work: B.A. Dospekhov's experimental case methodology, D.D. vegetation accounting method. Brown, N.M. Bakaev's method of determining soil moisture; laboratory analyses; mathematical processing of yield data. According to the results of the research, it was found that the sorghum-Sudank hybrid formed the highest yield: 209.1 c/ha of green mass and 32.6 c/ha of dry matter. Corn and sorghum-sudank hybrid showed a balanced feed content of crude protein and crude fiber. Payza and African millet have a lower, but reasonably high yield than corn and sorghum-a Sudanese hybrid.

***Key words**: sorghum-sudanese hybrid, payza and African millet, yield, green mass, dry matter.*

Introduction. In a conditions of limited water resources around the world and in Central Asia region [1, p.22], together with adverse weather conditions of Northern Kazakhstan, traditional agricultural methods seeking new adaptive water-saving technologies that can increase the efficiency of agricultural production.

Adaptive water-saving agriculture directed on improving the resistance of production due to unfavourable weather conditions and a decrease in water usage [2, p.37]. This shows, that agricultural methods must be chosen based on the specific characteristics of the region, including precipitation levels, soil types, terrain features, and more.

The advancement of livestock farming, as an essential component of agriculture, and the boost in its efficiency are closely linked to the establishment of a resilient feed source and the enhancement of feed quality [3, p.25; 4, p.57]. The production of superior feed is a critical element in increasing livestock yields.

Foreign researchers indicates that [5, p.341; 6, p.258; 7, p.94; 8, p.1033; 9, p.852], enhancing the variety of forage crops is considered one of the effective ways to address the feed deficit issue. This plan helps to upgrade the resilience of the feed base to adverse environmental factors, ensures more balanced animal nutrition, and enhances livestock productivity. This is because different types of forage crops have different biological characteristics, including resistance to adverse weather conditions, yield, nutritional value, and others.

Traditional forage crops such as maize [10, p.37; 11, p.78; 12, p.84; 13, p.85; 15, p.20], sudan grass [14, p.58; 16, p.15], and alfalfa have several cons, including their amount of water and cultivation requirements.

Expanding the forage base through non-traditional crops helps address the challenge of providing animals with inexpensive and high-protein feed, thereby increasing their productivity.

Incorporating non-traditional crops into animal diets boosts the production of available high-protein feeds, leading to increased livestock productivity [17, p.21; 18, p.151].

In the field forage production system of Northern Kazakhstan, there is a lack of cold-resistant, drought-tolerant annual forage crops with short growing seasons. Among these uncommon non-traditional forage crops, the cultivation technologies of which are still insufficiently studied, are sorghum-sudangrass hybrids, Echinochloa frumentacea and african millet.

Materials and methods of the research. Research on the development of basic cultivation practices for forage crops was conducted in the steppe zone of Northern Kazakhstan at "Novorybinsky and K" LLP during the years of 2015-2016. The soil of the experimental field consisted of ordinary chernozem of a carbonate heavy loamy texture. The predecessor crop was a perennial grass layer (winter wheat). Different forage crops were compared by yield production during the experiment, with maize being used as the control. The sowing was done on May 25 th. The experimental setup and mathematical processing of yield data were conducted using the methodology of experimental agriculture by B.A. Dospekhov [18]. Yield recording was performed using a continuous method on all plots of the experiment. The plot area for recording was 42 m2, with a fourfold repetition, and the placement of repetitions was sequential.

The following varieties were sown: maize – Turgayskaya 5/87, sorghum-sudangrass hybrid - Solaris, african millet - Sogur, pearl millet - Krasava. During the winter, the height and density of the snow cover were determined (Picture 1).

а) densitometer б) measuring stick

Picture 1 – Defining the thickness and hight of snow covering with help of densitometer and measuring stick

The following data of the experiment was received: snow density - 0.23 g/cm³, snow coverage height - 35.6 cm. Soil samples were collected at the experimental site at 35 points according to the method of N.M. Bakaev [19] for the content of nutrients and humus. Based on the conducted analyses in the soil-agrochemical laboratory, the following data on the content of humus, macronutrients and micronutrients in the soil were obtained (Table 1).

Table 1 – Agrochemical characteristics of soil in experimental zone (average of 2 years)

№	Soil horizone	Agrochemical parameters				
		Humus, %	Phosphorus, мг/кг	Potassium, мг/кг	Nitrogen, мг/кг	pH
1	2	3	4	5	6	7
1	0-20	3,14	3,82	660	34,7	7,54
2	0-20	2,71	2,89	546	34,7	7,58
3	20-40	1,87	2,02	469	30,2	7,62

1	2	3	4	5	6	7
4	20-40	1,87	2,40	389	37,0	7,61
5	0-20	2,68	8,66	630	34,7	7,65
6	20-40	1,74	1,99	318	38,1	7,60
7	20-40	2,71	2,67	307	31,4	7,57
8	20-40	1,70	1,58	273	32,5	7,57
9	0-20	2,26	7,22	475	35,8	7,61
10	0-20	2,21	7,94	468	35,8	7,63
11	Control treat 1	1,8	0,79	318	354	7,58
12	Control treat 2	1,93	1,93	351	35,1	7,60
13	A/m	11,35	214,75	2361	32,5	6,88
14	A/m	11,72	198,8	2450	30,2	6,70

According to the Table 1, the humus content in the 0-20 cm layer is at a low level, starting from 2.68% to 3.19%, while in the 20-40 cm horizon, it is at critical level, ranging from 1.74% to 1.87%. Regarding the content of available phosphorus in the soil, the experimental plot shows extremely low levels (less than 10 mg/kg), with values from 2.89 to 8.66 mg/kg in 0-20 cm layer. The potassium exchange capacity in soil ranges from high (401-600 mg/kg) to very high (over 600 mg/kg), indicating a sufficiency of element. The content of readily hydrolysable nitrogen in the soil is low, and the soil solution reaction in the salt extract is weakly alkaline. Thus, the soils of the experimental plot have low sulfur and zinc content, average copper content, and high manganese and cobalt content. They also exhibit very low levels of available phosphorus, low humus and readily hydrolyzable nitrogen content, and high potassium content. Regarding micronutrients, the soil is deficient in sulphur and zinc. During the pre-sowing period, affecting optimal seed swelling and germination factor is a soil density. Its determination in the plowed layer was conducted at three points across the experimental plot (Table 2).

Table 2 – Dense of control area during the pre-sowing period (average of 2 years)

Horizon	Soil humidity (W), %	Completely dry soil mass (M), г	The volume of samples, (V) $см^2$	Bulk density mass, (d) $г/см^2$
1	2	3	4	5
Sample 1				
0-10	19,1	251,7	237,5	1,1
10-20	21,2	267,1	237,5	1,1
20-30	15,7	299,2	237,5	1,3
Average - 1,1				
Sample 2				

1	2	3	4	5
0-10	15,5	229,4	237,5	1,0
10-20	22,3	238,6	237,5	1,0
1	2	3	4	5
20-30	46,9	231,1	237,5	1,0
Average - 1,0				
Sample 3				
0-10	23,9	221,7	237,5	0,9
10-20	20,1	289,3	237,5	1,2
20-30	27,3	256,4	237,5	1,1
Average – 1,1				
Average of control area- 1,1				

It is seen from Table 2, that the mass of completely dry soil is minimal in the 0-10 cm layer, ranging from 221.7 to 251.7 g, and in the 10-30 cm layer, it varies from 238.6 to 299.2 g. Soil humidity in the soil layer of 0-30 cm varied between 15.5 and 46.9%. In terms of compaction, specifically the bulk density, the soil of the experimental plot is loose, averaging 1.1 g/cm³ from 3 samples across the plot.

Meteorological conditions during the study period allowed for the examination of the patterns of crop formation under the influence of various climatic factors, some of which were extreme. However, the hydrothermal conditions, as shown in Tables 3 and 4, were generally typical for the climatic characteristics of the steppe zone and slightly deviated from the multi-year averages.

In terms of precipitation, the study period was close to the multi-year average in terms of the amount of rainfall (Table 3).

Table 3 – Precipitation measurements during the whole experiment

Months	Precipitation amount, мм		Errors from average of multiple years
	Average in 2 years	Average for multiple years	
January	18,5	19	- 0,5
February	6,9	14	-7,1
March	16,6	18	-1,4
April	34,1	20	+ 14,1
May	53,3	31	+ 22,3
June	28,7	41	- 12,3
July	30,7	52	-21,3
August	10,7	41	-30,3
September	31,8	17,5	+14,3
May-August	123,4	165,0	-41,6

However, compared to the distribution of precipitation throughout the year, the exact studied year significantly differed from the norm. The amount of precipitation during the cold period was considerably higher than the multi-year average with total of 123.4 mm from May to August compared to 165 mm according to the multi-year average.

Uneven or error values also emerged concerning temperature parameters (Table 4).

Table 4 – Temperature measurement during the whole experiment

Month	Air temperature, ^{0}C		Errors from average of multiple years
	Average in 2 years	Average for multiple years	
January	- 25,4	- 15,3	- 10,1
February	- 17,6	- 11,3	- 6,3
March	- 6,6	- 10,7	+ 4,1
April	3,9	1,5	+ 1,4
May	12,0	12,5	- 0,5
June	21,5	18,1	+3,4
July	21,6	20,4	+1,6
August	18,7	17,9	+0,8
September	+8,8	+10,2	+1,4

The temperature medium during the winter period was significantly warmer than usual, except for January, which was colder than average. Summer period had an extremely uneven precipitation. From May to August, 123.4 mm of precipitation was recorded, which is 41.6 mm less than the multi-year average. The highest amount of precipitation occurred in May, with 53.3 mm. There was also an excess above the multi-year average in April - 14.4 mm, and in September - 14.3 mm. In the other months of the summer period, precipitation was below the multi-year average. In terms of temperature conditions, the summer turned out to be slightly warmer than usual. July and June were particularly hot, with the average monthly temperature being 3.4 and 1.6 degrees higher than the multi-year average, respectively. Overall, the weather conditions during the analysed period were close to the climatic conditions of the region.

Results and discussion of the research. During the pre-sowing period the germination and purity of seeds of annual forage crops were analysed in laboratory conditions. (Tables 5 and 6).

Table 5 – Laboratory germination of forage crop seeds

№	Type	Laboratory germination, %
1	Zea mays (Corn)	92
2	Sorghum-sudangrass hybrid	87
3	African millet	89
4	Payza	85

Table 6 – Identification of annual forage crop seeds purity

№	Type	Variety	Seeds purity, %
1	Zea mays (Corn)	Turgai 5/87	99,63
2	Sorghum-sudangrass hybrid	Solaris	97,3
3	Payza	Krasava	98,5
4	African millet	Sogur	97,9

During the phase of full emergence, the field germination of plants was determined (Table 7).

Table 7 – Field germination of forage crops

Type	Germinated on		Amount of plants, pieces		Field germination, %
	1division	On 1 square meter	1м^2	On 1 division area.	
Zea mays (Corn)	147	7	3	63	42,86
African millet	210	10	5	105	50,0
Payza	210	10	5	105	50,0
Sorghum-sudangrass hybrid	210	10	6	126	60,0

During the field period, phenological observations were conducted in order to see the growth and development of plants.

Phenology. Recording of plant development stages including germination, tillering, shooting (branching), 5th leaf, 8-9 leaves, ear emergence, flowering, ear formation (for maize), ear flowering (for maize), seed ripening (milk, milk-wax, and full maturity).

Harvesting and yield assessment of forage crops were observed in August. The climatic conditions during the plant growth period contributed to the yield formation of forage crops (Table 8).

Table 8 – Harvest of the green mass and dry matter of crops and one year forage crop hybrids

№	Type	Variety (hybrid)	Green mass, c/ha	Dry matter, c/ha
1	Zea mays (Corn)	Turgai 5/87	195,2	25,4
2	Sorghum-sudangrass hybrid	Solaris	209,1	32,6
3	African millet	Krasava	185,6	21,7
4	Payza	Sogur	175,5	20,8

In terms of yield production, the sorghum-sudangrass hybrid produced a yield of green mass at 209.1 t/ha and dry matter at 32.6 t/ha. African millet and teff produced slightly lower yields of dry matter compared to maize, at 21.7% and 20.8%, respectively, compared to 25.4% for maize. In the steppe zone conditions, it had an earlier onset and a longer duration of maximum biomass growth compared to other hybrids.

During the post-harvest period, selected plant samples were sent to the agrochemical laboratory of "Agrokomplex-expert" LLP to determine the productivity of forage crops (Table 9).

Table 9 – Chemical analysis of forage crop mass of one year crop varieties (data from «Agrokomplex-expert» LLP)

Variety/ Nutrition of green mass	Zea mays (Corn)			Sorghum-sudangrass hybrid		
	stems	leaves	overall	stems	leaves	overall
1 кg of dry matter consist, %						
Carotene, mg/kg	20,5	21,2	41,7	19,6	21,9	41,5
Starch	4,1	1,8	5,9	6,7	0,6	7,3
Sugar	6,5	2,8	9,3	5,2	4,7	9,9
Digestible protein	1,99	6,54	8,53	2,09	7,25	9,34
Phosphorus	0,2	0,26	0,46	0,17	0,25	0,42
Calcium	0,5	0,34	0,84	0,49	0,46	0,95
Metabolizable energy, MJ	4,9	4,73	9,63	6,26	4,97	11,23
Moisture	4,7	3,7	8,4	7,5	4,2	11,7
Dry matter	95,3	96,3	191,6	92,5	95,8	188,3
Crude protein	4,9	10,8	15,7	5,5	11,7	17,2
Crude fat	0,1	2,6	2,7	0,4	1,5	1,9
Crude ash	9,8	7,1	16,9	6,0	6,5	12,5
Crude fiber	59,6	60,9	120,5	49,8	59,1	108,9
NEM	-	-	-	-	-	-
Digestibility coefficient	0,19	0,18	0,37	0,38	0,20	0,58

Note: NEL – non azotic extractive matters

At the end of August, samples were taken to determine the sugar content in the biomass of plants (Table 11).

Table 11 - Sugar content in the green mass of forage crops

№	Type	Sugar content amount, %
1	Zea mays (Corn) (control)	14,41
2	Sorghum-sudangrass hybrid	19,63
3	Payza	12,91
4	African millet	11,66

Table 11 indicates, that the highest sugar content was provided by the sorghum-sudangrass hybrid – 19.63%, while pearl millet and African millet accumulated sugars at 12.91% and 11.66%, respectively, compared to 14.41% in the control.

Conclusion. Among the studied non-traditional annual forage crops, the sorghum-sudangrass hybrid become the most productive crop of all. It produced a yield of green mass equal to 209.1 tons/ha and dry matter of 32.6 tons/ha. This is 12.9% and 22.7% more than the Turgai 5/87 maize. Maize and the sorghum-sudangrass hybrid Solaris are the most balanced feeds in terms of raw protein and crude fiber amount. Raw protein content in maize is 11.7%, while in the sorghum-sudangrass hybrid it equals to 12.6%. The crude fiber content in maize is 29.2%, which is insignificantly higher than in sorghum-sudangrass hybrid which is 27.4%. The sorghum-sudangrass hybrid is the most saccharine culture of all studied - 19.63%, which is 33.2% more than in maize. Paiyza and african millet have lower yields compared to maize and sorghum-sudangrass hybrid. Based on the research results, it can be concluded that non-traditional annual forage crops may be promising for cultivation in the steppe zone of Northern Kazakhstan. They are characterized by high yields, resistance to adverse conditions, and good forage qualities.

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ТҮЙІН

Мақалада Солтүстік Қазақстанның дала аймағындағы өнімділік бойынша дәстүрлі емес жылдық жемшөп дақылдарын салыстырмалы бағалау нәтижелері келтірілген. Зерттеу нысаны құмай-судан буданы, жүгері, пайза және африкалық тары сорттары мен будандары болып табылады. Зерттеу мақсаты: Солтүстік Қазақстанның дала аймағы жағдайында жемшөп дақылдарының өнімділігі бойынша салыстырмалы бағалау жүргізу. Зерттеу тақырыбының өзектілігі Солтүстік Қазақстанның дала аймағы үшін жаңа, неғұрлым өнімді және құрғақшылыққа төзімді жемшөп дақылдарын таңдау және енгізу болып табылады. Зерттеу міндеттеріне Солтүстік Қазақстанның дала аймағында жемшөп дақылдарын өсіру ерекшеліктерін зерттеу; жемшөп дақылдарының өнімділігіне салыстырмалы бағалау жүргізу; Солтүстік Қазақстанның дала аймағында өсіру үшін ең перспективалы жемшөп дақылдарын анықтау жатады. Жұмыстың ғылыми маңыздылығы Солтүстік Қазақстанның дала аймағы жағдайында әртүрлі жемшөп дақылдарының салыстырмалы өнімділігі туралы жаңа мәліметтер алу болып табылады. Жұмыстың үлесі: Солтүстік Қазақстанның дала аймағы жағдайында әртүрлі жемшөп дақылдарының салыстырмалы өнімділігі туралы алынған деректер ауыл шаруашылығы өндірісінің тиімділігін арттыруға мүмкіндік береді. Жұмыстың практикалық маңыздылығы мен құндылығы Солтүстік Қазақстанның дала аймағында жемшөп дақылдарын өсіру үшін неғұрлым перспективалы дақылдарды таңдау, сондай-ақ ауыл шаруашылығы өндірісіне бейімделу технологияларын енгізу бойынша ұсынымдар әзірлеу болып табылады. Жұмыста келесі зерттеу әдістері қолданылды: Б.А. Доспеховтың тәжірибелік іс әдістемесі, Д. Брауннның өсімдіктерді есепке алу әдісі, Н.М. Бақаевтың топырақ ылғалдылығын анықтау әдістемесі; зертханалық талдаулар; өнімді деректерді математикалық өңдеу. Зерттеу нәтижелері бойынша құмай-суданк гибридінің ең жоғары өнімділікті қалыптастырғаны анықталды: 209,1 ц/га жасыл масса және 32,6 ц/га құрғақ зат. Жүгері мен құмай-судан буданы шикі ақуыз мен шикі жасұнық құрамы бойынша жемшөптің тепе-теңдігін көрсетті. Пайза мен африкалық тары жүгері мен құмай-судан буданына қарағанда аз, бірақ жеткілікті жоғары өнімділікке ие.

РЕЗЮМЕ

В статье представлены результаты сравнительной оценки нетрадиционных однолетних кормовых культур по продуктивности в условиях степной зоне Северного Казахстана. Объектом исследований являются сорта и гибриды сорго-суданкового гибрида, кукурузы, пайзы и африканского просо. Целью исследований: провести сравнительную оценку кормовых культур по продуктивности в условиях степной зоны Северного Казахстана. Актуальность темы исследований заключается в подборе и внедрении новых, более урожайных и устойчивых к засухе кормовых культур для степной зоны Северного Казахстана. К задачам исследований относятся изучить особенности возделывания кормовых культур в степной зоне Северного

Казахстана; провести сравнительную оценку урожайности кормовых культур; определить наиболее перспективные для возделывания в степной зоне Северного Казахстана кормовые культуры. Научная значимость работы заключается в получении новых данных о сравнительной урожайности различных кормовых культур в условиях степной зоны Северного Казахстана. Вклад работы: полученные данные о сравнительной урожайности различных кормовых культур в условиях степной зоны Северного Казахстана позволят повысить эффективность сельскохозяйственного производства. Практическая значимость и ценность работы заключается в разработке рекомендаций по выбору наиболее перспективных для возделывания в степной зоне Северного Казахстана кормовых культур, а также для внедрения адаптивных технологий в сельскохозяйственное производство. В работе использованы следующие методы исследования: методика опытного дела Б.А. Доспехова, метод учета растительности Д. Брауна, методика определения влажности почвы Н.М. Бакаева; лабораторные анализы; математическая обработка урожайных данных. По результатам исследований установлено, что сорго-суданковый гибрид сформировал наибольшую урожайность: 209,1 ц/га зеленой массы и 32,6 ц/га сухого вещества. Кукуруза и сорго-суданковый гибрид показали сбалансированность кормами по содержанию сырого протеина и сырой клетчатки. Пайза и африканское просо имеют меньшую, но достатточно высокую урожайность, чем кукуруза и сорго-суданковый гибрид.

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