АУЫЛ ШАРУАШЫЛЫҒЫН МЕХАНИКАЛАНДЫРУ ЖӘНЕ ЭЛЕКТРЛЕНДІРУ
МЕХАНИЗАЦИЯ И ЭЛЕКТРИФИКАЦИЯ СЕЛЬСКОГО ХОЗЯЙСТВА
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TEST RESULTS OF THE FS-1,4 MOCK-UP SAMPLE AND THE FS-2,1 EXPERIMENTAL SAMPLE OF THE COMBINED UNIT FOR PRE-SOWING TILLAGE AND SEED SOWING IN THE CONDITIONS OF THE SOUTHERN REGION OF KAZAKHSTAN

Abstract

The main part of the territory of Kazakhstan is located in a sharply continental arid climate. On 80% of the territory of the republic, the amount of precipitation is not enough for the normal development of tilled crops, especially sugar beets, soybeans, and vegetables that are most demanding on moisture.

Combined tools imported to the Republic of Kazakhstan from near and far abroad are not adapted to the soil and climatic conditions of Kazakhstan and are expensive.

The existing soil-cultivating implements (with working tools of a passive type, i.e. rigidly fixed to the frame or rotating under the influence of the soil reaction) consist in a small and practically uncontrolled degree of crumbling, the formation of a compacted “sole” below the cultivation zone, poor undercutting and destruction weeds, etc. In addition, to work with these implements, fairly heavy tractors are required, which have high traction forces and consume significant power for self-propelling. The listed shortcomings are very significant and have been known for a long time, and the fact that they have not yet been established casts doubt on the possibility of their elimination when using hordes with passive-type working ornans. Over the past 40-50 years, these tools have not changed technologically, practically[1, s.391].

Thus, the prerequisites for the widespread use of combined aggregates are the biological and agrotechnical compatibility of the simultaneous performance of a number of technological operations, the reduction in the number of passes of equipment across the field, and the reduction in labor and energy costs for the cultivation of agricultural crops. crops, and in particular, vegetables [2, s.17].

The developed combined machine FS-2.1 is designed for pre-sowing tillage and sowing in one pass, which significantly reduces the level of costs compared to the traditional scheme for pre-sowing soil preparation and sowing. The advantage is the reduction of sowing time by half, as well as saving fuel and lubricants by 20-25% and retain moisture in the soil and reduce energy costs during sowing.

Key words: *field tests, combined tool, agrophysical indicators, deformation area, density, hardness, crumbling, soil ridges, milling.*

Introduction

Pre-sowing tillage is the last and responsible operation before sowing. Carrying out pre-sowing tillage in the world practice combined sowing units with active and passive working bodies. Aggregates with passive working bodies mainly consist of cultivator or loosening paws and rolling rollers of the planed, tubular and ring-spur type. Sowing units with active working bodies consists of an active harrow with vertical and horizontal working bodies.

In order to form a seed layer in accordance with the agrotechnical requirement, it is necessary to perform loosening, leveling, crumbling and compaction of the soil to the depth of seed embedding. For the implementation of favorable soils for seeds, the lower layer should have a density of 0.9-1.3 g / cm^3, and lumps with a diameter of 1-25mm (at least 80%) should prevail in the soil, the field surface should be leveled, the permissible ridge is 3-4cm. Foreign tillage machines do not correspond to the specific soil and climatic conditions of Kazakhstan: they bring large lumps of soil to the surface of the field; they do not perform leveling and decompression of soils to the desired size and depth; they do not create a fractional composition of the soil that meets agrotechnical requirements, according to which the content of a finely lumpy fraction of soil up to 20mm in size should be at least 80% [3, s.97].

Sowing units with active working bodies are not common in the Southern zone of Kazakhstan. For this purpose, LLP "SPC of Agrcultural Engineering" has developed a combined unit for pre-sowing tillage and seed sowing FS-2.1 with active working bodies of horizontal L-shaped arrangement. The FS-2.1 seeder provides tillage and sowing in one pass of leguminous and industrial crops on arable and stubble backgrounds [4, 5].

Laboratory and field tests of a mock-up sample and research tests of an experimental sample were carried out at the Scientific and Production Center of Agroengineering LLP.

Research methods

When conducting scientific research on the choice of the type, parameters and operating modes of the working bodies of the combined machine for pre-sowing tillage and sowing seeds FS-2.1, the classical provisions of theoretical mechanics, theory of mechanisms and machines, continuum mechanics, agricultural mechanics were used.

When choosing the working bodies, the peculiarities of the soils, the irrigated farming zone of the South of Kazakhstan were taken into account. The long-term data on the agrophysical state of the soils of the southern zone of Kazakhstan during the technological operations for their processing were analyzed. Previously, attention was paid to the dynamics of humidity, density, hardness and crumbling.

A laboratory installation was made for field testing of the working bodies of the combined gun. Research tests of the mock-up and experimental sample were carried out in the fields of the KazNIIZiR LLP according to the following regulatory documentation:

-GOST 20915-75 "Agricultural machinery. Methods for determining test conditions";

-ST RK 1560 -2006 Tests of agricultural machinery. Machines and implements for deep tillage. Methods for evaluating functional indicators.

-ST RK 1559 -2006 Tests of agricultural machinery. Machines and implements for surface tillage. Methods for evaluating functional indicators.

-GOST 20915-2011 "Testing of agricultural machinery. Methods for determining test conditions". Interstate standard.

-GOST 33687-2015 "Machines and implements for surface tillage. Test methods". Interstate standard.

-GOST 33677- 2015 "Machines and implements for row-to-row and row tillage. Test methods". Interstate standard.

-GOST 24055-2016 "Agricultural machinery. Methods of operational and technological assessment". Interstate standard.

-GOST 12.2.111-85 "System of occupational safety standards (SSBT). Agricultural machines mounted and trailed. General safety requirements". Interstate standard.

The design documentation for the experimental sample was developed in accordance with GOST 2.001-93 "Unified system of design documentation. General provisions"**.**

Results and their discussion

To create optimal conditions for seed germination, it is necessary to bring the content of the soil fraction of less than 20 mm in size to at least 80%, reduce the surface ridge to 3 cm, create a soil density in the seed area of no more than 1.0 g / cm3 and form a compacted bed for sowing them. The density of the soil after its treatment in the upper layer should not exceed 1.3 g / cm3. In

this regard, milling working bodies should provide the indicators of pre-sowing soil treatment set by agricultural requirements for the South of Kazakhstan.

Tests of a Mock-up sample. Laboratory and field tests of a mock-up sample of a combined unit for pre-sowing tillage and seed sowing FS-1,4 were carried out in 2020 on light chestnut soil of medium loamy mechanical composition in the fields of KazNIIZiR LLP, on operations of pre-sowing milling soil preparation and seed sowing (Figure 1).

During the tests , the following results were obtained:

The test conditions were typical for this zone. Humidity, density and hardness of the soil in the 0-20 cm layer were 14.2%; 0.83 g/cm3 and 0.9 MPa.

The functional indicators are shown in Table 1. The results of the initial technical examination showed that the model sample of the combined unit meets the requirements of the technical specification. No defects and damages were detected during the external inspection of the combined unit under test. The bolted connections are not weakened, the welds are made qualitatively. The quality of the painting of the gun is satisfactory. During the running-in of the machines, adjustments were made to install the working bodies to a given depth. The limits of the adjustments corresponded to the technical task.

Table 1 - Functional indicators of the FS-1,4 mock-up sample

Indicators	Values of indicators	
	according to the technical task	according to the test results
Previous operation		Harrowing
Soil type and name by mechanical composition	Soil of any type and mechanical composition	Medium loamy light chestnut soil
Soil moisture, %, by layers, cm 0-5 5-10 10-15 15-20	30-75%	 12,0 13,8 15,1 14,9
Soil moisture, %, by layers, cm 0-5 5-10 10-15 15-20	-	 0,3 0,7 0,8 0,8
Soil hardness, MPa in layer, MPa	before 2,5	0,5
Field surface ridges, ± cm	before ± 5см	2,1
- arithmetic mean, (cm) - standard deviation, ± σ(cm) - coefficient of variation, γ (%)		2,1 1,4 66,6
Sealing depth specified cm	8	
Sealing depth actual cm Average value, (cm) Average deviation, ±σ(cm) Coefficient of variation, γ (%)	 7,6 0,4 5,3	
The seeding rate set at p.m/ piece is 5		
The actual seeding rate per item m/ pc Average value, (pcs) Average deviation, ±σ(pcs) Coefficient of variation, γ (%)	 4,4 0,8 18,2	
The interval between seeds is 25cm		
mean value, (cm) mean deviation, ±σ(cm) coefficient of variation, γ (%)	24,6 1,7 6,9	

Figure 1 – Mock-up sample of a combined unit for pre-sowing tillage and sowing seeds FS-1,4 in operation

Agrophysical indicators of the soil after the performed technological operations of the combined unit for pre-sowing tillage and seed sowing: density, hardness, removal of soil lumps to the surface parameters of the formed strip, as well as the quality of seed sowing corresponded to agricultural requirements and setting values.

The actual seeding depth corresponded to the installation, the average value according to the experience was 5.1 cm. The interval between seeds is comparable to the set values and the average for experience is 24.6 cm . The average number of seeds is 4.4 per linear meter. The ridge of the field surface after passing the machine was ± 3 cm.

According to the results of the R&D carried out, it can be noted that the mock-up of a combined unit for pre-sowing tillage and sowing seeds to tractors of the 0.6 and 14 kN traction class performing operations for pre-sowing and sowing seeds steadily performed the technological process. . The qualitative indicators of tillage were satisfactory. The density, hardness, ridges of the soil and its crumbling after the passage of the machines corresponded to agricultural requirements and technical specifications.

Testing of an experimental sample. Based on the terms of reference, an experimental model of the machine was developed and the results of field tests conducted in 2021, an experimental sample of a combined unit for pre-sowing tillage and sowing seeds for tractors of the 0.6...14 kN traction class was manufactured in LLP "SPCAE", which was assembled with experimental working bodies for conducting research tests for pre-sowing tillage and seed sowing having the following parameters: number of knives 8; the angle of soil crumbling with L-shaped knives is 20 °; the height of the reservoir is 55 mm; the length of the knife is 125 mm; the seeding rate is 9.3 cm and the interval between seeds is 10.1 cm.

Research tests of an experimental sample of a combined unit for pre-sowing tillage and seed sowing FS-2.1 on a dump background were carried out in the fields of KazNIIZiR LLP for pre-sowing tillage and seed sowing. The test conditions for this operation are given in Table 2.

Table 2 – Test conditions

Indicators	Values of indicators	
	according to the Technical Task	according to the test results
Previous operation	Autumn plowing	Autumn plowing
Soil type and name by mechanical composition	Soil of any type and mechanical composition	Medium loamy light chestnut soil
Soil moisture, %, by layers, cm 0-5 5-10 10-20	before 20%	 7,6 8,7 9,8
Soil moisture, %, by layers, cm 0-5 5-10 10-20	before 2,0	 0,6 1,03 1,25
Soil hardness, MPa in layer, cm: 0-5 5-10 10-20	before 2,5	 0,7 1,5 2,0
Field surface ridges, ± cm	before ± 5	8,0

According to Table 2, the test conditions met the requirements of the terms of reference. Soil conditions during the tests were typical for this zone and gray-earth soils. The main indicators: humidity, density, soil hardness in a layer of 0-20 cm, respectively, amounted to 11.4%; 1.12 g / cm 1.2 MPa. The surface ridges are ± 8.0.

The functional performance indicators of the experimental sample of the combined machine for operations on pre-sowing soil preparation for row crops and seed sowing are shown in Table 3

Table 3– Functional parameters of the experimental sample FS-2.1

Indicators	Values of indicators	
	According to agricultural requirements	according to the test results
Unit (power machine + gun)		Belarus 80/82 + FZ-2.1
The speed of the unit, km/h		10
Depth of tillage, cm:	-	
- installation: cm - actual: cm		12,0 11,8
Soil density, g/cm^3 by layers, cm		
0-5	before 1,0	0,61
5-10 10-20		0,80 1,20
Soil hardness, MPa, by layers, cm		
0-5	before 1,0	0,72
5-10		0,89
10-20		1,18
Soil crumbling, % by fractions, mm		
>50	The content of soil fractions with a size of less than 20mm not less than 70%	-
50-20		2,7
20-10		43
<10		54,3
Field surface ridges, ± cm	not less 3	2,3

Qualitative and agrophysical indicators of the performance of technological operations with combined tools

Technological operations	Band width, cm	Processing depth, cm	Seed sowing depth, cm	The number of seeds sown per linear meter of the row, pcs
Milling, loosening of strips, sowing of seeds	32,9	10,8	4,8	9,3

Technological operations for tillage	Deadlines for implementation	Agrophysical indicators of the soil				
		Surface ridges,± см	Soil crumbling, %			
			Size of fractions, mm			
			100-50	50-20	20-10	<10
Milling of strips, loosening of strips, sowing of seeds	10.05	2,3	-	2,7	43	54,3

Figure 2 shows the corn crops carried out during the tests of the combined unit. Figure 3 shows an experimental sample of the machine in operation.

Figure 2 - development of corn plants

Figure 3 – Experimental sample of a combined unit for pre-sowing tillage and sowing seeds FS-2.1 in operation

Primary technical expertise. According to the examination data, the experimental sample of the combined machine submitted for testing met the requirements of the technical specification.

The submitted technical documentation is sufficient to perform operations to prepare the experimental sample for operation and conduct research tests.

The evaluation of the manufacturing quality of the combined machine was carried out immediately before the start of research tests.

The test conditions were typical for this zone.

From May 3 to May 10, the experimental sample was tested for operations on pre-sowing soil preparation and sowing of row crops. The test conditions met the requirements of the technical specification. Soil conditions during the tests were typical for this zone and gray-earth soils. The main indicators: humidity, density, soil hardness in a layer of 0-20 cm, respectively, amounted to 11.4%; 1.12 g / cm 1.2 MPa. The surface ridges are ± 8.0[6, s.134].

The functional indicators of tillage were satisfactory and corresponded to agricultural requirements.

All the results obtained in terms of the parameters of the formed strip, the depth of its processing, the quality of sowing seeds corresponded to agricultural requirements and setting values.

The quality of tillage by machines was satisfactory and corresponded to the agricultural requirements for the technological operation. After the passage, the soil density in the 0-20 cm layer, respectively, was 0.90 g /cm3, hardness 0.94 Mpa. The depth of tillage was stable, deviations from the installation depth were insignificant: the coefficient of variation, respectively, for machines was 10.2%; the mean square deviation of 0.3 cm. The content of the finely lumpy fraction of the soil after the passage was 97.3%. The fraction content with a size of more than 50 mm was within acceptable values (respectively for the machine: 3.7%) as well as the ridges of the soil surface (2.3 cm). There were no breakdowns and failures in the operation of combined guns on the dump background [7, s.11-14].

Conclusion according to the results

The model FS-1,4 and the experimental sample FS-2,1 of the combined machine for pre-sowing tillage and seed sowing are operable, steadily perform the technological process, the functional indicators of their work correspond to agricultural requirements. Energy indicators - traction resistance corresponds to the power of tractors of class 14.20kN. Primary technical examination according to the examination data, the experimental sample of the combined machine submitted for testing met the requirements of the terms of reference [8, s.3].

What are the advantages of using. The design of the combined sowing tool is adapted to work on soils of various mechanical composition in the South of Kazakhstan and to its production at agricultural machinery enterprises in Kazakhstan. Unlike single operating machines, a combined tool for pre-sowing soil preparation by combining several operations reduces the load on the soil of the chassis of machine-tractor units and thereby prevents the destruction of its structure, reduces the negative impact on the agrophysical properties of the soil - air and water permeability, reduces moisture loss due to evaporation. During the operation of the combined tool, a compacted seedbed is formed and thereby provides an influx of moisture to the seeds, a stable depth of their embedding, which improve their germination [9, 10].

The use of combined arms in advanced technologies will reduce operating costs and specific capital investments by 20-25%.

What are your plans for the future. The results of the conducted research will be used in the design and manufacture of a prototype of a combined gun this year. In the future, our institute will continue to work on improving this combined guns FS-1,4, FS-2,1 and prepared technical documentation for its serial production.

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ҚАЗАҚСТАННЫҢ ОҢТҮСТІК ӨҢІРІ ЖАҒДАЙЫНДА ТОПЫРАҚТЫ СЕБУ АЛДЫНДА ӨҢДЕУГЕ ЖӘНЕ ТҰҚЫМ СЕБУГЕ АРНАЛҒАН ҚҰРАМДАСТЫРЫЛҒАН ҚОНДЫРҒЫНЫҢ ФС-1.4 МАКЕТТІК ЖӘНЕ ФС-2.1 ТӘЖІРИБЕЛІК ҮЛГІСІН СЫНАУ НӘТИЖЕЛЕРІ

Аңдатпа

Қазақстан территориясының негізгі бөлігі күрт континенттік құрғақ климатта орналасқан. Республика аумағының 80% жауын-шашын мөлшері егістік дақылдардың, әсіресе қант қызылшасының, соя бұршақтарының, ылғалға аса қажет көкөністердің қалыпты дамуы үшін жеткіліксіз.

Қазақстан Республикасына алыс-жақын шетелдерден әкелінетін құрама құралдар Қазақстанның топырақ-климаттық жағдайына бейімделмеген және қымбат тұрады.

Қолданыстағы топырақ өңдейтін құрал-саймандар (пассивті түрдегі жұмыс құралдарымен, яғни рамаға қатты бекітілген немесе топырақ реакциясының әсерінен айналатын) ұсақ және іс жүзінде бақыланбайтын күйреу дәрежесінен, тығыздалған «табанның» пайда болуынан тұрады. өсіру аймағынан төмен, нашар шабылған және жойылатын арамшөптер және т.б. Сонымен қатар, осы құралдармен жұмыс істеу үшін жоғары тарту күштері бар және өздігінен жүру үшін айтарлықтай қуатты тұтынатын жеткілікті ауыр тракторлар қажет. Көрсетілген кемшіліктер өте маңызды және бұрыннан белгілі және олардың әлі белгіленбегені пассивті типтегі жұмыс орнандары бар ордаларды пайдалану кезінде оларды жою мүмкіндігіне күмән келтіреді. Соңғы 40-50 жыл ішінде бұл құралдар технологиялық, іс жүзінде өзгерген жоқ. [1, б.391].

Осылайша, біріктірілген агрегаттарды кеңінен қолданудың алғы шарттары бірқатар технологиялық операцияларды бір уақытта орындаудың биологиялық және агротехникалық үйлесімділігі, егіс алқаптары бойынша техниканың өту санын азайту, жұмыс күші мен энергия шығындарын азайту болып табылады. ауыл шаруашылығы дақылдарын өсіру. дақылдар, атап айтқанда, көкөністер[2, б.17].

Жасалған ФС-2.1 құрама машинасы егіс алдындағы топырақ өңдеуге және бір өтуде себуге арналған, бұл егіс алдындағы топырақ дайындау мен себудің дәстүрлі схемасымен салыстырғанда шығындар деңгейін айтарлықтай төмендетеді. Артықшылығы – егіс уақытын екі есе қысқарту, сонымен қатар жанар-жағармай 20-25% үнемдеу және топырақта ылғалды ұстап тұру және егіс кезінде энергия шығынын азайту.

Кілт сөздер: егістік сынақтары, құрама құрал, агрофизикалық көрсеткіштер, деформация ауданы, тығыздық, қаттылық, үгілу, топырақ жоталары, ұнтақтау.

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РЕЗУЛЬТАТЫ ИСПЫТАНИЙ МАКЕТНОГО ОБРАЗЦА ФС-1,4 И ЭКСПЕРИМЕНТАЛЬНОГО ОБРАЗЦА ФС-2,1 КОМБИНИРОВАННОГО АГРЕГАТА ДЛЯ ПРЕДПОСЕВНОЙ ОБРАБОТКИ ПОЧВЫ И ПОСЕВА СЕМЯН В УСЛОВИЯХ ЮЖНОГО РЕГИОНА КАЗАХСТАНА

Аннотация

Основная часть территории Казахстана находится в условиях резко-континентального засушливого климата. На 80% территории республики количество выпадающих осадков недостаточно для нормального развития пропашных культур, особенно наиболее требовательных к влаге сахарной свеклы, сои, овощей.

Завозимые в республику Казахстан комбинированные орудия из дальнего и ближнего зарубежья не адаптированы к почвенно-климатическим условиям Казахстана и имеют высокую стоимость.

Сушествующие почвообрабатывающие орудий (с рабочими оргнами пасивного типа, т.е. жестко закрепленными на раме или совершающими вращательное движение под действием реакции почвы) заключается в малой и практически не регулируемой степени крошения, образовании уплотненной «подошвы» ниже зоны обработки, плохом подрезании и уничтожении сорной растительности и т.д. Кроме того, для работы с этими орудиями требуется достаточно тяжолые тракторы, обладающие большыми тяговыми усилиями и потребляющие значительную мощность на самопередвижение. Перечисленные недостатки весьма существенны и известны давно, и тот факт, что они до сих пор не установлены, вызывает сомнение в возможности их ликвидации при использовании ордий с рабочими орнанами пасивного типа. За последние 40-50 лет эти орудия в технологическом отношении, практический, не изменились [1, с.391].

Таким образом, предпосылками к широкому распространению комби-нированных агрегатов является биологическая и агротехническая сов-местимость одновременного выполнения ряда технологических операций, сокращение числа проходов техники по полю и снижение затрат труда и энергетических средств на возделывание с.-х. культур, и в частности, ово-щей [2, с.17].

Разработанная комбинированная машина ФС-2,1 предназначен для предпосевной обработки почвы и посева в один проход, это значительно снижают уровень затрат по сравнению с традиционной схемой проведения предпосевной подготовки почвы и сева. Плюсом является сокращение сроков проведения посевных работ в два раза, а так же экономия ГСМ на 20-25% и сохранить влагу в почве и снизить энергозатраты при посеве.

Ключевые слова: полевые испытания, комбинированное орудие, агрофизические показатели, площадь деформации, плотность, твердость, крошение, гребнистость почвы, фрезерование.