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Biometric parameters and physical-mechanical properties of wheat and barley grown on dry lands

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Abstract. In Uzbekistan, wheat is grown on more than 120,000 hectares of dry land, and barley on about 65,000 hectares. Due to the development of animal husbandry on dry lands, along with the grain of wheat and barley, straw is in great demand and it is important to harvest it without losing it. Research is underway to develop a device that would load the straw coming out of it into the back of the combine into large trailers when harvesting grain on dry land. For this purpose, the physical and mechanical properties of wheat and barley grown on dry lands were studied. In dry lands of Uzbekistan, the average grain length in different varieties is mainly in the range of 70-80 cm, and the ratio of grain to straw is in the range of 1: 1.17 - 1: 1.48. The coefficient of friction of grains and ears is 0.34 and 0.32, which is 1.2-1.7 times less than the coefficient of friction of stalks and sawdust. The critical flight speed is 2.0-4.0 m/s in straw sections up to 50 mm in length, 5.0-6.0 m/s in 100 mm, and 12.0-19.0 m/s in sections larger than 100 mm.

1. Introduction

There are totally more than 20 million hectares in Uzbekistan where it can be used for agricultural processes. There are more than 3.2 million hectares of irrigated land, the remaining area (about 17 million hectares) of which is arable land [1, 2]. Currently, agricultural products are grown mainly on irrigated lands. If we take into account the fact that the population of Uzbekistan is growing every year, then in order to ensure food security in the future, we will have to plant crops on dry lands and increase food production.

In Uzbekistan, dry lands are mainly located in the foothills, foothills and slopes, where crops grow due to natural rainfall. Wheat and barley have long been cultivated in the arable lands of Uzbekistan. Wheat and barley are grown on a total area of 1200000 hectares in Uzbekistan, 1 mln and more than a hectare of irrigated land, about 200 thousand hectares of dry land [3, 4]. In the years with normal rainfall, 2.0-2.5 tons/hectare is harvested from dry lands, and in some years 3.0-3.5 tons/hectare. However, as a result of global climate change and rising global temperatures, the amount of precipitation in Uzbekistan is declining from year to year. As a result, in years of low rainfall, most of the dry land is not harvested.



In order to prevent crop losses in years with low rainfall, artificial irrigation technologies and devices using groundwater in dry lands have also been developed and recommended for use [5, 6]. Their use ensures a guaranteed harvest from dry lands. In this regard, Uzbekistan is currently providing comprehensive support for the introduction of these technologies and equipment in agriculture through subsidies and soft loans.

Currently, wheat is grown on more than 120000 hectares of dry land, and barley on about 65000 hectares. Sanzar-6, Tezpishar, Surkhak-5688, Kokbulak, White wheat, Bakhmal-97, Istiqlol-6, Sogdiana sorts of wheat for sowing on dry lands, and barley “Unumli”, “Nutans-799”, “Lalmikor”, “Savruk” sorts are recommended.

Along with grains of wheat and barley grown on dry lands, straw is also in great demand. Because in the hills, foothills and mountain slopes one of the main branches of agriculture is cattle breeding, along with wheat and barley grain, straw is also one of the main fodder for livestock [7-11]. Therefore, along with the grain, it is necessary to harvest the straw without destroying it.

Based on this, we began research on the development of a device that would load the straw coming out of it into large trailers at the rear of the combine when harvesting grain on dry land. To do this, it is important to know the field conditions of dry lands and biometric indicators and physical and mechanical properties of wheat and barley grown [12-19].

Depending on the field conditions and biometric parameters and physical and mechanical properties of wheat and barley, the optimal harvesting method is selected and the rational operating modes of the working parts of the combine are determined. For this purpose, we studied the physical and mechanical properties of wheat and barley grown on dry lands.

2. Methods

According to the observations of the last few years, several sorts of wheat and barley are grown on dry lands in Uzbekistan, but among them Sanzar-6, Tezpishar, Surkhak-5688 wheat sorts and Unumli sorts of barley are grown in the largest areas. Therefore, in our experiments, we studied the size-mass, physico-mechanical, weeding properties and characteristics of these sorts. In studying the size and mass characteristics of grain, its total length, mass, stem length, spike length, width, thickness, mass, number and mass of grain in the grain, grain to straw ratio, and grain and non-grain yield were studied.

In determining the biometric parameters and physical and mechanical properties of wheat and barley grown on rain-fed lands, as well as the classification of agrofon GOST 20915-2011 "Agricultural testing. The methods described in the standard manual "Methods for determining the test conditions" were used. At the same time, along the diagonal of the field planted with wheat and barley on dry lands, grain was harvested from 25 places in different places from 0.25 m², their mass, number of bushes, biometric indicators of 100 plants from each sample were determined. The experiments used electronic scales, measuring rulers, tape measures and electronic calipers with an accuracy of 0.01 g.

The yield of each sorts of wheat and barley depends on their stems, ears and grain, as well as the total biological yield, and the length of the plant makes them up to 40-50 cm, 50-60 cm, 60-70 cm, 70-80 cm, 80-90 cm and larger than 90 cm were divided into groups. The results obtained during the experimental studies were processed and their statistical values (average value - \bar{X} , standard deviation - $\pm \sigma$, coefficient of variation - V) were determined [20].

3. Results and Discussions

According to the obtained results, the biological productivity of Sanzar-6, Tezpishar, Surkhak-5688 and “Unumli” varieties of barley and their distribution by plant height were studied (Tables 1 and 2).

Table 1. Biological yield in different cereal crop sorts

Sort of wheat	Number of stalks, piece/m ²	Yield, t/ha			
		stalk	ear	grain	biological
Sanzar-6	353.6	2.01	2.58	2.47	5.36
Tezpishar	301.4	2.48	2.41	2.04	4.89
Surkhak-5688	302.6	1.97	3.39	2.03	4.59
Unumli	323.2	1.71	4.81	2.62	6.52

The results show that the number of grain bushes ranged from 301.4 pieces/m² to 353.6 pieces/m². At the same time, the total biological yield of varieties was 4.59 t/ha to 6.52 t/ha, while the grain yield was 2.03 t/ha to 2.62 t/ha. The main part of the grain stalks ranged in length from 60 to 90 cm.

Table 2. Distribution by plant height in grain varieties

Sort of wheat	Distribution by plant height, percent					
	40÷50 cm	51÷60 cm	61÷70 cm	71÷80 cm	81÷90 cm	91 cm and higher than it
Sanzar-6	1.33	5.33	6.67	41.33	40	5.33
Tezpishar	-	6.67	20	33.33	31.11	8.89
Surkhak-5688	3.33	6.67	28.33	45.0	16.67	-
Unumli	1.26	1.41	12.63	25.87	43.92	14.91

Their size-mass indicators for grain sorts are given in the table below (Table 3).

Table 3. Size and mass characteristics of grain varieties

Name of indicators	The value of indicators							
	Sanzar-6		Tezpishar		Surkhak-5688		Unumli	
	X	$\pm \sigma$	X	$\pm \sigma$	X	$\pm \sigma$	X	$\pm \sigma$
The total length of the plant, cm	78.1	9.4	72.9	15.8	72.5	9.3	75.6	15.9
The mass of the plant, g	2.5	0.8	2.3	0.9	2	0.98	2.8	1.3
The length of the stems, cm	67.9	8.5	65	7.2	66.4	8.9	68.4	14.6
The length of the ears, cm	10.2	17.4	7.8	1.4	6	1.5	13.2	2.3
The width of the ears, mm	10.5	2	7.6	1.4	8.1	1.7	10.3	2.5
The thickness of the, mm	8.1	1.2	7.1	0.9	7.2	1.3	7.6	1.9
The mass of the ears, g	1.3	0.5	1.04	0.4	1.2	0.6	1.6	0.7
Number of grains in the ear, pieces	30.4	11.6	28.4	9.4	26.7	10.3	25	13.8
Grain mass in ear, g	1.04	0.4	0.78	0.3	1.0	0.5	1.3	0.9
Grain's ratio to straw	1:1.26	-	1:1.4	-	1:1.17	-	1:1.48	-
Yield, t/ha								
- by grain mass	5.36	-	4.89	-	4.59	-	6.52	-
- by grain	2.47	-	2.04	-	2.03	-	2.62	-

From the data given in Tables 6-12, it can be seen that the total length of the plant is 78.1 cm in Sanzar-6, 72.9 cm in Tezpishar, 72.5 cm in Surkhak-5688 and 75.6 cm in Unumli does not differ much from each other, but the yield is 5.36 t/ha by grain mass of Sanzar-6 sort; The grain-to-straw ratio was 2.03 t/ha and the grain-to-straw ratio was 1: 1.26. In the Tezpishar sort, the figures were 4.89 t/ha and

2.04 t/ha, respectively, and in the Surkhak-5688 sort. 4.59 t/ha and 2.03 t/ha and 1: 1.17, in the productive sort 6.52 t/ha and 2.62 t/ha and 1: 1.48.

According to the above mentioned aspects it can be concluded that the average length of grain in Uzbekistan for different sorts is mainly in the range of 70-80 cm, and the ratio of grain to straw is in the range of 1: 1.17 - 1: 1.48. In the experiments, the angle and coefficient of friction of the grain components were also studied. At the same time, the grain moisture content was 16.2-17.4%. Given that both components of the mixture move both longitudinally and transversely within the working parts of the combine, the friction angles and coefficients of these components were studied for their longitudinal and transverse displacement. The experimental results are presented in Table 4.

Table 4. Friction indicators of grain components

Sample	Moving direction	Friction angle, degree			Coefficient of friction		
		X	$\pm \sigma$	V. %	X	$\pm \sigma$	V. %
Stalk	transverse	21° 30'	1° 18'	6.5	0.39	0.03	7.1
	longitudinal	24° 30'	1° 6'	4.4	0.45	0.02	4.8
Sawdust	-	33° 54'	1° 36'	4.8	0.67	0.04	6.2
Ear	transverse	18° 48'	2° 12'	11.6	0.34	0.04	12.5
	longitudinal	21°	1° 36'	7.8	0.38	0.03	8.6
Grain	-	17° 48'	1° 18'	7.3	0.32	0.02	7.8

According to the results, it was found that the grains have the smallest friction angle. In this case, their angle of friction averaged 17° 48'. The grains had a friction angle somewhat closer to the grains, i.e., the friction angle in their transverse displacement was 18° 48', and in the longitudinal displacement it was 21°. This is explained by the presence of grains even inside the ears. This can be clearly seen in determining the friction angle of individual grain shells or sawdust. At the time of the experiments, the friction angle of the sawdust averaged 33° 54', which was about 2 times the friction angle of the grain.

Given that the straw pieces move both transversely and longitudinally along the working surfaces during the work process, when their friction angle was studied in these cases, it was found that the friction angle was 21°30' in transverse motion and 24°30' in longitudinal motion. The results show that the friction of grains and ears is 1.2-1.7 times less than the friction of stalks and sawdust. This suggests that combine harvesters can provide more complete grinding and less damage to the grain, even with slightly less friction during operation.

One of the most important properties of grains and their constituent compounds is their aerodynamic properties. The aerodynamic properties of the components of a grain mixture are mainly understood as the critical flight speed and sailing coefficient. The critical flight speed and sailing coefficient of the components of mixture other grains (MOG) of wheat and other cereals have been studied by many researchers and information about them has been given in various literature sources. From the collected data N.I.Klenins, S.A.Alferovs and I.E.Kojukhovsky, it can be seen that the critical flight speeds and sailing coefficients of the grain mixture components differ from each other (Table 5).

Table 5. Critical flight speed of MOG components and the sail coefficient
(According to NI Klenin, SA Alferov and IE Kojukhovskiy)

Component name	Critical flight speed, m/s	Sailing coefficient, 1/m
Ear without grain	3.5-5.0	0.39-0.8
Parts of straw:		
- till 50 mm	2.0-4.0	
- till 100 mm	5.0-6.0	
- longer than 100 mm	12.0-19.0	0.03-0.07
Sawdust and easy mixtures	0.75-3.25	0.1-0.36

According to them, the critical flight speed is 0.25-3.25 m/s in a mixture of sawdust and light, which is 1.7-3.5 times different from that of grains, and several tens of times different from very light. The critical flight speed is 3.5-5.0 m/s in the grainless ears. The critical flight speed is 2.0-4.0 m/s in straw sections up to 50 mm in length, 5.0-6.0 m/s in 100 mm, and 12.0-19.0 m/s in sections larger than 100 mm.

These indicators of the physical and mechanical properties of wheat and barley should be taken into account when developing a device for a combine harvester for direct straw harvesting

4. Conclusion

In Uzbekistan, the research is being carried out in order to develop a device for harvesting grain on dry land, which is loaded on a combine harvester and loaded on trailers. They were studied due to the importance of physical and mechanical properties of wheat and barley grown on dry lands in the development of the device. According to the results, the average length of grain on dry lands in Uzbekistan is mainly in the range of 70-80 cm for different varieties, and the ratio of grain to straw is in the range of 1: 1.17 - 1: 1.48. The coefficient of friction of grains and ears is 0.34 and 0.32, which is 1.2-1.7 times less than the coefficient of friction of stalks and sawdust. The critical flight speed is 2.0-4.0 m/s in straw sections up to 50 mm in length, 5.0-6.0 m/s in 100 mm, and 12.0-19.0 m/s in sections larger than 100 mm.

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