RESULTS OF TESTING OF SEEDS AND QUALITY LOSSES OF HARVESTED MASS DEPENDING ON THE DRUM-UNDERDRUM INTERSPACE AT BUCKWHEAT HARVEST GRAIN COMBINES

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Abstract: *A significant indicator of the quality of harvesting by buckwheat combines is amount of an achieved losses and quality of harvested mass of buckwheat grain. The harvest of buckwheat we can perform multiphase, double phase, and single phase. Quality of combines work depends on a numerous of factors: the state of crops, defining the relevant parameters for combine's work, technical soundness, and operator's skills. When the relevant parameters are not well coordinated, impairs the quality of work is significantly, resulting in increased losses of buckwheat grain and a high proportion of impurities in harvested mass of buckwheat in the combines bunker. The aim of our two-year study was to determine the amount of realized losses of buckwheat seeds by harvest device of combines ZMAJ 132 and ZMAJ 143, depending on the interspace underdrum-drum at the entrance, as well as the quality of harvested mass of buckwheat. The results allow pointing to the shortcomings and advantages of the concept applied various harvest combines. Applied methodology is standard for this issue and relates to the field-testing laboratory and exploitation, during the single-phase harvesting of buckwheat grain. The highest losses on harvesting device were recorded at combine ZMAJ 132 - 9,56 kg ha^{-1} (1.01%) , and the lowest at combine ZMAJ 143- 4.28 kg ha^{-1} (0.45%). The highest content of whole buckwheat grains in harvested mass was at ZMAJ 143 and it was 96.32%, and lowest at combine ZMAJ 132 in amount of 92.55%.*

***Key words*:** *combine, buckwheat, harvest, losses, grain.*

INTRODUCTION

Buckwheat is a special field crop, whose importance comes up from its use value. It is being grown due to high contents of iron, potassium and phosphorous compounds, citric, maleic, and oxalic acid, and high content of vitamins B1, B2, PP and belongs to a group of good dietary products (JOSH et al., 1991), special field crop, whose importance comes up from its use value. Harvest of buckwheat may be multiphase, double-phase and single phase. Single-phase harvesting of buckwheat grain is being done by harvesters. A significant moment is determining the optimal time to harvest buckwheat, indicated by uneven flowering time and maturation of buckwheat grains. Optimum period for single-phase harvesting of buckwheat is when 2/3 of grains get brown, and reddish-brown stem colour, or when the 70 - 80% grains are matured (EDWARDSON, 1996). Well defined relevant parameters precondition for the small grain losses in harvesting device of combines, and good quality of harvested mass. With well-tuned harvesters is possible to achieve low losses on harvesting device (about 1%) and more than 93% whole grain in the harvesters bunker (AULD et al., 1986). Lower combine's speed in buckwheat harvest, good adjustment of peripheral speed, peripheral speed of drum and openness between underdrums and drums at the entrance leads to the reduction of losses to below 1.5%. The upper sieve should be open 16-18 mm, and the bottom 5-10mm, so harvested mass to reach more than 90% whole grain (OPLINGER et al., 1989). Lower rotation speed of drum, and bigger gap at the entrance of drum-underdrum, provides the opportunity to losses on harvesting device do not exceed 1.5%, with high quality of harvested mass (ROBERT L.

MAYERS et al., 1994). Small losses of buckwheat seeds on harvesting device, and over 90% of whole grains, are enabled by low combines speed (about 5 km/h) and the proper selection of a peripheral speed of drum and clearance at the entrance of harvesting device (JIM BEUERLEIN, 2001). Modern grain combines must have efficient harvesting device that allows over 90% pure grain in the harvested mass (VOJVODIĆ, 2002). The structure of harvested mass whole grains were 94.79-95.37%, damaged 0.48-0.65% , broken 0.56-2.47% mechanical impurities 0.09-0.16% (MALINOVIĆ et al., 2005). The same authors state that combines investigated in the conditions of Vojvodina achieve lower performance parameters, and the reason for this is primarily in the sort and location specifics areas where tests were conducted. In the harvesting of buckwheat by JD 6620 combines, space between underdrum and drum was about 20 mm, the number of rotations of ventilator was 600 min^{-1}, and screens open on 10-15 mm above and 5 - 10 mm under, and harvested mass consisted of over 90% whole grains (ROBERT L. MAYERS, 2007). In order to achieve better harvest, desiccation of buckwheat is recommended with 1% magnesium chloride, and after 7 days harvesting to be done (STANIŠIĆ, 2008).

MATERIAL AND METHODS

In terms of northern Kosovo and Metohia during the 2008/09, the two-year investigation conducted with wheat harvesters ZMAJ 132 and ZMAJ 143 in buckwheat harvest. After selecting of a parcel, determined by biological yields of buckwheat by diagonal plot, and the state of crops. Crop was a proper, clean, no weeds, uniform, average plant height of 80.10-88.40 cm. Grain yield amounted to an average of 940 and 960 kg ha^{-1}. The losses have been investigated on the harvesting device of combines. The quality of harvested mass depending on the linear speed combines changes underdrum-drum space at the entrance and peripheral speed of drum (with the same volume of air power and size of the sieve openings). Before determining the loss of harvesting device, is determined by the number of seeds and blossom, which occurred self, wind or rain, acting on 1 m^2. To determine the losses in the harvesting device used is the proper vessel, which was set combines the movement between the front and rear wheels diagonally or obliquely at an angle of 10-20^o with respect to the direction of movement. Quality harvested mass is determined by taking samples from the bunker and combines related to the content of the whole (entire), damaged, broken, poor grains and other inclusions present in harvested weight. The percentage content of individual fractions was subsequently determined in laboratory conditions. The experiment was conducted on track length of 30 m in three repetitions, and the sampling was recorded mode combines the number of samples. Using special plates, the number of seeds in a bowl and found the mass of 1000 grains measured are losses in kg ha^{-1}. The study used containers, stopwatch hour bag samples, router etc. Methodology applied was the standard for this issue, and concerns the laboratory and field-testing combine's exploitation. The results are shown in tables, analyzed statistically, and the degree of significance obtained difference is determined by LSD test.

For comparison table shows the main technical data are examined in table 1 combines.

Table 1

Technical data of exemined combine harvesters

Parameters		Tipe of combine harvesters	
		ZMAJ 132	ZMAJ 143
Engine power	(kW)	51.0	73.1
Heder engagement width	(m)	3.66	4.20
Drum width	(mm)	790	1000
Drum diameter	(mm)	550	600
Power in function of m heders engagement width	($kW\ m^{-1}$)	13.90	17.40
Combine mass	(t)	5.24	7.18
Hopper volume	(m^3)	1.80	3.60
Hopper volume/engagement width	($l\ m^{-1}$)	0.50	0.86

RESULTS AND DISCUSSIONS

Combines, in the ongoing research work in were relatively good conditions, with plenty of grain mass, so that they could develop greater speed. Basic informations on crops and mode combines are shown table 2.

Table 2

Basic data about crop and combine harvester working regime

Parameters	ZMAJ 132	ZMAJ 143
1	2	3
Crop		
Sort	Autochthonic	Autochthonic
Grain yields (kg ha^{-1})	940 and 960	940 and 960
Grain moistture (%)	13.6 и 15.5	13.6 и 15.5
Plant teksture by m^2	450	450
Crop condition	Vertical without weed	Vertical without weed
Combine harvester		
Fan revolution (min^{-1})	670	700
Sieve seting: extension, upper, lower (mm)	15; 11; 5	16; 12; 5
Working speed (m s^{-1})	0.50 and 0.95	0.58 and 1.00
Treshing cocave extroversion (mm)	12; 16; 20	12; 16; 20
Flow rate of cereal mass (kg s^{-1})	1.5; 2.90; 3.20	2.4; 3.08; 4.18
Drum perifer rotation (m s^{-1})	10.55; 13.86; 14.70	14.30; 15.70; 17.27
Directors /	G. S. S	G. S. S

Table No. 3 shows the measured values of losses of buckwheat seeds to exercising device combines ZMAJ 132 depending on the changes to the parameters defined by years of study.

The results indicate that changes the size gap between the door underdrum and drums interact with the change of peripheral drum speed exhibited a significant influence on the measured values of losses of buckwheat seeds to exercising device combines investigated.

Table 3

Losses of harvesting device combine Z132 in dependance of adjusted parameters

Year	Space – underdrum-drum at the entrance (mm)						Periphery drum speed (m s^{-1})	Grain moisture (%)	LSD	
	12		16		20					
	Losses grain od buckwheat									
	kg ha^{-1}	%	kg ha^{-1}	%	kg ha^{-1}	%				
2008	8.89	0.95	8.52	0.91	8.10	0.86	10.55	13.60	0.198	0.263
	9.15	0.97	8.73	0.93	8.30	0.88	13.86			
	9.56	1.01	9.10	0.97	8.75	0.93	14.70			
2009	7.76	0.80	7.39	0.77	6.98	0.73	10.55	15.50	0.167	0.199
	8.11	0.84	7.62	0.79	7.18	0.75	13.86			
	8.59	0.89	7.93	0.83	7.68	0.80	14.70			

Results losses harvesting device combines ZMAJ 132 (table 3) show that in 2008. The largest losses recorded in the interval underdrum-drum of 12 mm, drum peripheral speed of 14.70 m s^{-1} and amounted 9.56 kg ha^{-1}, or 1.01%, and the smallest interval underdrum-drum of 20 mm, peripheral speed of drum 10.55 m s^{-1} and amounted 0.86% and 8.10 kg ha^{-1}.

Minimal losses during the 2009th performing at the device, measured as the interval underdrum-drums at the entrance of 20 mm and amounted to 0.73% (6.98 kg ha^{-1}), with the peripheral speed of the drum 10.55 m s^{-1}, and most of the interval underdrum-drums at the entrance of 12 mm and amounted 8.59 kg ha^{-1}, and 0.89% (peripheral speed of the drum 14.70 m s^{-1}). Testing level achieved significant difference was determined to change the spacing underdrum-drums at the entrance, as well as changes in the peripheral drum speed very significantly affect the amount of realized losses harvesting device.

The results agree with the results of other authors (AULD, 1986; ROBERT L. MAYERS, 1994; JIM BEUERLEIN, 2001). Lower values of measured losses, at harvesting device, in 2009. compared to the 2008th, primarily are explained by the different grain moisture.

Table 4 shows the measured values of losses at harvesting device combines ZMAJ 143 depending on the changes defined parameters.

Table 4

Losses of harvesting device combine ZMAJ 143 in dependance of adjusted parameters

Year	Space – underdrum-drum at the entrance (mm)						Periphery drum speed ($m\ s^{-1}$)	Grain moisture (%)	LSD	
	12		16		20					
	Losses grain od buckwheat									
	$kg\ ha^{-1}$	%	$kg\ ha^{-1}$	%	$kg\ ha^{-1}$	%				
2008	5.20	0.55	4.92	0.77	4.84	0.51	14.30	13.60	0.182	0.225
	5.87	0.62	5.47	0.58	5.15	0.55	15.70			
	6.52	0.69	6.11	0.95	5.83	0.62	17.27			
2009	4.62	0.48	4.45	0.46	4.28	0.45	14.30	15.50	0.144	0.183
	5.23	0.54	5.12	0.53	4.79	0.50	15.70			
	5.87	0.61	5.73	0.60	5.51	0.57	17.27			

Based on the results shown in table 4, observed that the biggest losses at harvesting device combines ZMAJ 143 in 2008. year recorded in the interval underdrdum-drum of 12 mm (drum peripheral speed of 17.27 $m\ s^{-1}$) and amounted to 0.69%, or 6.52 $kg\ ha^{-1}$, and the lowest in the peripheral drum speed of 14.30 $m\ s^{-1}$ and apart underdrum-drum 20 mm and amounted to 4.84 $kg\ ha^{-1}$, and 0.51%. During the second year of testing, the smallest losses in exercising device combines ZMAJ 143 were measured at the interval underdrum-drums at the entrance of 20 mm and amounted to 0.45% (4.28 $kg\ ha^{-1}$), while the highest value losses of buckwheat seeds to performing this device combines measured at the interval underdrum-drums at the entrance of 12 mm - 5.87 $kg\ ha^{-1}$, or 0.61%, with a drum peripheral speed of 17.27 $m\ s^{-1}$. Change of the particles size of space between underdrum and drum at the entrance to the device performing the interaction with the change of peripheral drum speed very significantly affected the value of the loss of buckwheat exercising device combines ZMAJ 143rd.

The results of research, we came to coincide with the results of which have come to other authors (ROBERT L. MAYERS, 1994; OPLINGER, 1989; Jim BEUERLEIN, 2001). Chamber of measured loss at the harvesting device in 2008. compared to the 2009th, primarily to explain the lower grain moisture.

Quality of the harvested mass taken from the bunkers combines investigated for both years is shown in table 5.

Table 5

Quality of threshed grain from hopper of exemined combine harvesters

Combines	Year of investigation	Working speed of combines ($m\ s^{-1}$) and time sampling	Treshed grain structure (%)				
			Whole grain	Damaged	Broken	Plain	Mechanical admixtures
ZMAJ 132	2008	0.50 (9^{00})	92.55	0.98	2.94	1.58	1.95
		0.95 (12^{00})	93.00	0.83	2.78	1.61	1.78
		0.95 (15^{00})	93.29	0.78	2.69	1.63	1.70
	2009	0.58 (9^{00})	93.59	0.94	2.82	1.07	1.58
		1.00 (12^{00})	93.90	0.81	2.70	1.25	1.34
		1.00 (15^{00})	94.10	0.63	2.60	1.31	1.36
ZMAJ 143	2008	0.58 (9^{00})	95.18	0.36	2.54	0.82	1.10
		1.00 (12^{00})	95.27	0.35	2.50	0.93	0.95
		1.00 (15^{00})	95.63	0.30	2.35	0.87	0.85
	2009	0.58 (9^{00})	95.31	0.48	2.38	0.88	0.95
		1.00 (12^{00})	95.62	0.48	2.23	0.87	0.80
		1.00 (15^{00})	96.32	0.25	1.98	0.86	0.59

Based on the results of research on quality of harvested mass combines with similar parameters defined, we can see that the separation authorities ZMAJ 143 combines high-quality work in relation to the harvester ZMAJ 132nd.

The highest content of whole grains observed during both years was recorded on the harvested weight at ZMAJ 143 combines, in the speed of the working mode of 1.00 m s^{-1} 96.32% (15^{00}), and the smallest crowd in harvesting combines ZMAJ 132 - 92.55% (9^{00}), the working speed harvesters from 0.50 m s^{-1}. When the damaged grains in question, we note that the working bodies combines ZMAJ 143 create less damage to the grain of buckwheat as the smallest content of the damaged grain recorded in harvested mass. This weight was 0.25% (15^{00}), which can not be said for working device of combines ZMAJ 132 because the weight of this combines harvested mass, recorded most damaged grain and 0.98% (9^{00}).

The highest content of broken grains measured in harvested weight of buckwheat, was at combines bunkers ZMAJ 132 during the 2008th in 9^{00} and was 2.94%, while the authorities work combines ZMAJ 143 significantly lower, compared to similar grain buckwheat defined parameters, so that the weight of this harvested combines mass, recorded the lowest content of broken grains in the amount of 1.98% in 15^{00} (2009th years). Content poorly grain during the tests varied in the range of 1.31 to 1.58% as it amounted to harvested mass at combine ZMAJ 132, i.e. from 0.82 - 0.93% in harvesting weight at combines ZMAJ 143rd. When the presence of mechanical inclusions in harvested weight of buckwheat in question, based on research results that are shown in table 5 observed that the minimum mechanical impurity either in the mass harvested buckwheat from bunkers combines ZMAJ 143 and 0.59% during the 2009th year (15^{00}), which can not be said to combine ZMAJ 132 for the mass of harvested buckwheat from the bunker of combines, registered the highest mechanical impurity in an amount of 1.95% confluence 2008th in 9^{00}.

Table 6

Average values of exploitational parameters for working of combine

Parameters		Combine harvester	
		ZMAJ 132	ZMAJ 143
Engagement width		3.30	4.10
Average working speed	(m s^{-1})	0.73	0.79
Used time quotient	(-)	0.74	0.80
Colected proceeds	(t ha^{-1})	0.95	0.95
Acreage output pov uc.	(ha h^{-1})	0.70	1.25
Mass output mas. uc.	(t h^{-1})	0.67	1.19
Mechanical work warrant ut. mas. rada	(kWh ha^{-1})	72.85	58.48
Mechanical work warrant ut. mas. rada	(kWh t^{-1})	76.68	61.55

Based on the average values exhibited indicators of exploitation during the tests (table 6), note that can be achieved will make during the exploitation of the examined harvesters mainly on the expected level. Comparing the average exploitation indicators with data from Western Europe and America, we can see that in terms of northern Kosovo and Metohija. Efficient parameters (h ha^{-1}, t h^{-1}), are significantly lower. The reason for this, primarily to be found in sort and location specifics. The coefficient of utilization of time combines ZMAJ 132 (0.74) is slightly lower than expected. The specified value is explained by lush mass sowing of buckwheat, which has often led to congestion of harvesters. Because of significant differences in performance that is the result of different working speeds of combines, harvesters ZMAJ 143 showed lower consumption of machine work and higher productivity compared to the harvesters ZMAJ 132, which correlates like 58.48: 72.85.

CONCLUSIONS

Based on these results we can conclude the following:

-Defined the parameters of the examined harvesters have significantly influenced the quality of the examined harvesters;

-The greatest losses were recorded by keeping the device combines the ZMAJ 132 during the first year of testing and amounts 9.56 kg ha^{-1} (1.01% of biological yield), and lowest in combines ZMAJ 143 in the second year of testing and amounts 4.28 kg ha^{-1} (0.45% of biological yield);

-The greatest content of whole grain buckwheat in harvested mass was at 143 and combines ZMAJ was 96.32%, and lowest in ZMAJ combines 132 and amounted to 92.55%;

-Combine ZMAJ 143 made less damage to the grain of buckwheat during harvests, and has recorded with him low broken grain in an amount of 1.98% in 15^{00} (2009th year), while the highest content of broken grains recorded in harvested mass of buckwheat combines bunkers ZMAJ 132 during the 2008th in 9^{00}, and was 2.94%;

-Interaction of regime change operating speeds investigated combines, gap underdrum-drums at the door and the drum speed periphery losses harvesting devices and quality harvested mass rated as significant;

- Comparing the average exploitation indicators with data from Western Europe and America, we can see that in terms of northern Kosovo and Metohia efficiency parameters (h ha^{-1}, t h^{-1}), significantly lower, and the reason for the sort and site specific;
- Combine ZMAJ 143 worked better than combine ZMAJ 132, so that with proper optimization of labor, and skilled of operator may be expressed fully and successfully in using of single phase buckwheat harvest, in the examined area.

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