THE RESULTS OF TESTING THE HARVESTING DEVICE WORK QUALITY OF THE COMBINES ZMAJ 133 AND CLAAS DOMINATOR 48

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Abstract: *One of the main characteristics of combine harvesters is to harvest out crops in one pass, while collecting grains from the field and separating from impurities and straw (material other than grain - MOG), which are being taken back to the field, while the quality of the work varies. The content of impurities, a plain and broken kernels, is not desirable in seed neither in the mercantile grains using in further processing, because it significantly complicates cleaning and storing of grains, and significantly reducing the quality of the product and it's market value. Harvesting device of combines with the traditional scheme of threshing TTO (drum cross-transversal, grain mass flow goes tangentially and straw-shakers oscillatory separate grains), is limiting factor in the combines work , with increasing speed increases the flow of grain mass, increasing losses and impurities in the mass after harvest. The quality of the work is influenced by numerous factors: moisture content, grain-straw ratio, yield levels, compliance of the peripheral speed of underdrum-drum and it' spacing, setting sieves, fan speed, mode of working speed. In cases where these parameters are not properly aligned, performance is significantly distorts, so that a high content of impurities in harvested mass.This paper presents the results of exploitation research of the working quality of harvesting devices of combines ZMAJ 133 and CLAAS D48 in harvesting of rye and triticale in agroecological conditions of Kosovo and Metohia. The objective of our study was to determine the quality of the separation devices of the combines, the contents of the whole healthy, broken, a plain grains and other impurities. Quality threshed mass was determined by taking samples of threshed mass from the combine's bunker, and percentage of healthy, full, broken kernels and impurities have been determined later in the laboratory. It has been applied standard methodology, which refers to the field and laboratory testing, as well as exploitation testing of the combines. Based on these results, it was concluded higher quality work of the threshing device CLAAS D48 in relation to the harvester ZMAJ 133B. In the harvested mass at the combine CLAAS D48, it has been measured the highest content of the whole grains and the average was 97.10%, the lowest has been measured in the combine ZMAJ 133B to 92.19%. The contents of broken grains varied in the range of 0.91% (CLAAS D48) to 2.53% (ZMAJ 133B).*

Key words**:** *Combine, quality, threshing device, cleaning, rye, triticale*.

INTRODUCTION

In the feeding of humans and animals there are being used different grains, and in a recent period, more and more by rye and triticale. Triticale is a relatively new type of very successful small grains, which has became increasingly common in the plant production in Serbia as well as in the world. It is characterized by a high content of proteins. In the varieties being grown in Serbia varies in the range from 14 to 17%, while the lysine exceeds commercial wheat varieties by 10 to 30% (MILOVANOVIĆ et al, 2007). Rye is a cereal that is being grown for seed from which is being prepared bread and other dietary and medicinal products. In the grains of rye are present sufficient quantities of vitamins A, B, E cites OELKE (1990).Rye bread is very tasty, nutritious and long lasting fresh, and is especially recommended for diabetics. It represents a very good fodder, whether it is being used as a green mass, either as grain or products. Harvesting grain crops that are produced either for human consumption or for animal nutrition is being carried out by single-grain combine harvesters, whose main characteristic is that cereal harvest performed in one pass, while collecting grain from the field and separating

from the straws and impurities (material other than grain - MOG), which can dump back to the parcel, while the quality of work in the exploitation conditions is different. It is important combine harvester to achieve the appropriate quality of harvest, to pick the mass into a bunker of the harvester with a high percentage of whole grains, without the presence of impurities and other contaminants. The high content of bleak and broken kernels, as well as the mechanical impurities is not desirable given the fact that it leads to a very difficult cleaning and storing the harvested grains, which decreases rapidly the quality of the harvested mass, and accordingly market value and the profit from the sale. For the quality combine harvesters are being evaluated by the aspect of achieved losses and quality of harvested grains. For quality it is important to combine the working parameters of combine, with the conditions of work during the harvest. In the cases where it is not so, harvesters work less well, so it is being created a relatively " dirty" harvested mass in the bunker harvester (high content of MOG and damaged kernels). The quality of combines work depends on several factors, the most important are: grain moisture, grain: straw ratio, yields, and setting combine for work under the conditions at parcel during harvesting. Monitoring the performance parameters of modern machines is being facilitated by using the navigation system, so as to diminish the effect of overlap during harvesting, even under the conditions of poor visibility (CORDESSES et al, 2000). Combine harvesters for single-harvest of grains can be equipped with different threshing devices, which must be efficient so that harvested mass is over 90% of the whole grains. In the harvested mass whole grains together with healthy grains have to be represented with more than 90% with minimal content of impurities and damaged kernels (ĐEVIĆ et al, 2002). Since MANSOORI and MINAEE (2003) concluded that an increase of rotation speed in cylinder from 750 to 950 rpm would double grain breakage, and it is recommended that cylinder rotational speed of 800 rpm. REHMAN et al, (2003) report that the harvesting with combine in a crop with a low moisture content, brackages and losses were higher (about 6%) compared to the crops with a high content of moisture (1-3%). MALINOVIĆ et al, (2005) studied the harvesting combines and state that the structure of the harvested mass was 94.79-95.37% whole grain, 0.48-0.65 damaged, broken 0,56 to 2,47 and 0,09 to 0,16 mechanical impurities. STRAKSHAS (2006), emphasizes that a well balanced relevenat combine parameters in relation to the condition of the crop, provide a safe harvest with more than 90% of whole grains with minimal losses. While examining different types of harvesters, BARAĆ et al, (2011) indicate that the operation and defined parameters have a significant influence on the quality of the machines work. According to these authors, the highest content of whole grains were measured in bunker of a harvester in 15^{00} 97.34%, in which the content of broken grains was 0.91%. LASHGARI et al, (2008), presents a qualitative analysis of the damage to the wheat during the harvest by combine John Deere 955 and state that the interaction among speed, rotation and spacing underdrum-drum showed a significant effect on grain cracking, so that breakage of grain was 5.47%, with the loss of free grain from 1.5%. Arable land is being used for the cultivation of various crops, whose harvest has to be done with self-propelled or towed harvesters, NIKOLIĆ et al, (2010). The most common are wheat combine which yields approximately 53.87% of the area sown to crops on arable land. CRAESSAERTS et al, (2010) conclude that combines, which are used in the harvest work in different conditions. In order to achieve the best effects of work, it is necessary to adjust optimally combines according to different conditions of terain and crops, keeping in mind that the threshing of grain cleaning, control speed, etc., must be constantly optimized, in order to reach a compromise between the acceptable values and losses in combine, and volume of MOG (material other than grain) in the bunker. MOSTOFI et al, (2011), stated that in order to reduce losses in harvesting and obtaining high content of whole

grains is necessary to determine the precise causes and consequences and make improvements and changes in the existing technical characteristics of the machine.

MATERIAL AND METHODS

Quality evaluation of crop harvester during harvesting of triticale and rye were performed in agroecological conditions of central Serbia (Kragujevac environment, Desimirovac 44° 04' 60 "N, 20 ° 52' 60" E) during the year 2012. Investigations included a grain harvester Claas Dominator 48 and ZMAJ133B. On the first experimental plot was sown triticale variety Tango, on the other rye variety Raša. After selecting the points on the plot, it has been determined the yield of triticale and rye on the diagonal of the plot. It was found that the crops were upright, free from weeds to a great extent, homogeneous, and were not laid out what has been already facilitated the operation of the combine. The average yield of triticale was 6.120 kg ha^{-1}, and rye 2.470 kg ha^{-1}. Tests were carried out thus that first harvest has been done on triticale with both combines at the experimental plot, while the rye harvest has been performed later on the selected plot. Adjustments that are owners harvester performed were used as controls, with which have been compared measurement results that were obtained after our adjustments. After taking samples from the threshed harvester mass in quantity of 30 kgs, it has been determined the quality of work in the laboratory. Sampling was carried out in three replicates. Quality of threshed mass has been expressed through the percentage and weight content of a healthy (whole), broken, plain, bleak and partially damaged kernels, as well as through mechanical impurities. The experiment has been carried out on the trails with a length of 40 m, in three repetitions. Combines were examined so as to performed owners adjustments served as control which were compared with results obtained after our set of relevant parameters. In the experiment have been used bags for samples, stopwatch, tape length 50m, visor rods and markers. The applied methodology was standard for field-testing laboratory and exploitation and for the testing of combine harvesters (ISO 8210). The objectives of this study were to determine the quality of the work, of the tested combines in the investigated area, depending on the defined parameters, comparing with the control. The obtained results are analyzed and presented in tabular form. Table 1 shows the number of technical characteristics of the tested machine.

Table 1

Technical data of exemined combine harvesters

Parameters		Type of combine harvesters	
		ZMAJ 133B (Z133B)	CLAAS Dominator 48 (CD48)
Engine power	(kW)	51.5	55.0
Heder engagement width	(m)	3.05	2.60
Drum width	(mm)	790	1060
Drum diameter	(mm	550	450
Power per header grip	(kWm^{-1})	16.89	21.15
Combine mass	(t)	5.24	5.26
Hopper volume	(m^3)	1.8	3.66
Hopper volume/engagement width	($l\ m^{-1}$)	0.60	1.41
Surface of straw shakers	(m^{-2})	1.97	4.32
Surface of cleaning (m^2)	(m^{-2})	1.52	3.66
Rpm drum	(min^{-1})	420 - 1190	800-1500

RESULTS AND DISCUSSION

Basic data on the state of the crops of rye and triticale on experimental plots on which the test of work quality of threshing devices of combines ZMAJ133B and Claas Dominator 48 has been performed, as well as a data on the working regime of the combines investigated. The data in Table 2 show that the harvesters worked in similar conditions with triticale yield of

6120 kg ha^{-1}, while the yield of winter rye was 2470 kg ha^{-1}. Crops were upright, without a significant presence of weeds, which significantly facilitate the work of the combine.

Table 2

Basic data about crop and combine harvester working regime

Parameters			
Crop		Triticale	Rye
Variety	/	Tango	Rasha
Grain yields	(kg ha^{-1})	6.120	2.470
Plant teksture by	(m^2)	450	360
The average height of the plants	(m)	1.10 m	1.57
Grain moistture	(%)	14.36	13.82
Ratio of grain: straw	/	1:1.10	1: 1.32
Crop condition	/	Vertical without weed	
Combine harvester			
Type harvest combines		ZMAJ 133B	Claas Dominator 48
Fan revolution	(min $^{-1}$)	670	700
Mass flow of the grain	(kg s^{-1})	1.50 and 3.20; 3.35 and 3.68	2.4 and 4.18; 4.19 and 4.57
Working speed	(m s^{-1})	0.87 and 1.24; 0.80 and 1.10	0.92 and 1.30; 0.85 and 1.16
Drum perifer rotation	(m s^{-1})	32.47 and 24.86	37.93 and 29.74
Space underdrum-drum at the entrance	(mm)	18 and 22	18 and 22
Directors	/	G. S. S	G. S. S
Sieve seting: extension, upper, lower	(mm)	15; 11; 5	14; 10; 7

Data on quality work of the threshing devices of the tested grain combines ZMAJ133B and Claas Dominator 48 are shown in table 3. Quality of work of the examined combines has been analyzed by comparing the results obtained with control variant.Adjustments to the defined parameters which have been performed to the harvestersin relation to the control expressed a significant effect on work quality to the investigated combines. Thus, the lowest content of whole grain of triticale has been measured in a harvested mass in the combine's ZMAJ133B bunker, in the control treatment and it was 92.19% (27.65 kg, compared to a sample of 30 kg, which has been taken from the harvester's bunker in 12 a.m.), the operating speed of the combine was 0.87 m s^{-1}. The distance between the underdrum and drum performed at the entrance to the chamber was 18 mm and the peripheral speed of the drum was 32.47 m s^{-1}. A content of plain grains (undeveloped and easy grain) in the control treatment was in the range of 0.90-1.16%, and the corrected variant was in the range 0.83-1.25%.

Analyzing the contents of broken grains in the harvested mass of triticale in bunkers of examined combines, it can be seen that the working devices of CLAAS Dominator 48 in the improved variant, significantly provide less grain breaking compared to the control variant. The minimum content of broken grains of triticale was 0.91% in 3 p.m. (0.27 kg compared to 30 kg sample from the bunker harvester), the peripheral speed of the drum of 29.74 m s^{-1}. The space between the drum and underdrum at the entrance was 22 mm, and the working speed of the combine with a 1.30 m s^{-1}. Another examined harvester showed lower quality of work,

especially in the control, so that the harvested mass of triticale registered the highest content broken grains in the amount of 2.53% (0.96 kg), with the peripheral speed of the drum of 32.47 m s^{-1}, the clearance at the entrance of combine in performing chamber of 18 mm.The minimum content of partially damaged kernels of triticale measured in harvested mass of bunker of another investigated combine (Claas Dominator 48) in the corrected or improved variant and it was 0.85% at 12 a.m., and the highest in the control treatment at the first combine (ZMAJ133B) and was 2.91%. Content of mechanical impurities were in the range of 0.98-1.51% (Table 3).

On experimental plots in central Serbia quality of harvesting devices of combine ZMAJ 133B and Claas Dominator 48, has been analyzed at harvest of rye too. On the basis of the results obtained, which are presented in Table 3, we can see that the devices are tested by performing the combine in an updated version worked better compared to the control, while harvesting device of harvester Claas Dominator 48 worked better than the harvester ZMAJ133B.

The highest average content of whole grain was recorded in 3 p.m. in the harvested mass CLAAS Dominator 48 variants in the regime that we have corrected (harvester operating speed of 1.16 m s^{-1}, the peripheral speed of the drum 29.74 m s^{-1}) and it was for 97.10% (29.13 kg), the space between the drum and underdrum was 22 mm in variants of the regime which we have defined.

Table 3

Quality of threshed mass from hopper of exemined combine harvesters

Combine type	Periphery drum speed (m s^{-1})	Space Underdrum-Drum at the entrance (mm)	Structure of a harvested mass in a combine's bunker (Average Values)										Working speed (m s^{-1}) and time sampling
			Whole Grains		Plain Grains		Broken grains		Partialy damaged		Mechanical impurities		
			kg	%	kg	%	kg	%	kg	%	kg	%	
Quality of harvested mass of triticale from the bunker of examined combines													
ZMAJ 133B	32.47	18	27.65	92.19	0.34	1.16	0.76	2.53	0.87	2.91	0.38	1.21	0.87 (12 a.m.) (control)
	24.86	22	28.65	95.63	0.27	0.90	0.35	1.17	0.49	1.64	0.24	0.66	1.24 (3 p.m.)
Claas Dominator 48	37.93	18	27.94	93.14	0.38	1.25	0.65	2.17	0.58	1.93	0.45	1.51	0.92 (12 a.m.) (control)
	29.74	22	28.93	96.43	0.25	0.83	0.27	0.91	0.26	0.85	0.29	0.98	1.30 (3 p.m.)
Quality of harvested mass of rye from the bunker of examined combines													
ZMAJ 133B	32.47	18	28.16	93.86	0.29	0.98	0.65	2.19	0.59	1.96	0.31	1.03	0.80 (12 a.m.) (control)
	24.86	22	28.91	96.38	0.21	0.71	0.36	1.20	0.29	0.97	0.23	0.74	1.10 (3 p.m.)
Claas Dominator 48	37.93	18	27.75	92.54	0.42	1.39	0.66	2.17	0.58	1.92	0.59	1.96	0.85 (12 a.m.) (control)
	29.74	22	29.13	97.10	0.25	0.83	0.30	1.00	0.21	0.69	0.11	0.38	1.16 (3 p.m.)

The minimum content of whole intact grains has been measured in the harvested mass at ZMAJ 133B combine in the control, and it was 93.86% at 12 a.m. The combine had operating speed of 0.80 m s^{-1}, and the the peripheral speed of the drum of 32.47 m s^{-1}. A content of plain grain (undeveloped and easy grain) was in the control treatment in the range of 0.98-1.39%, and at the corrected version it was in the range 0.71-0.83%.

Threshing device in the variant with the corrections we have made to the state of crops in the experimental plot had significantly lesser rye grain breaking, compared to the control (adjustments which have been are performed by combines owners during operation), for both

investigated combines. Thus, the lowest content of broken rye grains has been measured in the harvested mass at other combine (Claas Dominator 48) in an updated version, and was 1.00% at 3 p.m. (peripheral drum speed 29.74 m s^{-1}, space-underdrum-drum of 22 mm), and the highest in control variant at 12 a.m. (combine ZMAJ 133B) and it was 2.19%. Peripheral drum speed was 32.47 m s^{-1}, the space underdrum-drum at the entrance was 18 mm.

The minimum content of partially damaged rye grains, have been measured in the harvested mass in the bunker of combine Claas Dominator 48 in 3 p.m. and it was to 0.69% (control), with the peripheral speed of the drum of 29.74 m s^{-1} with the underdrum-drum space of 22 mm (corrected version) and highest in the control treatment combines ZMAJ 133B and 1.96% at 12 p.m. hours. Peripheral drum speed was 32.47 m s^{-1}, a space- underdrum-drum at the entrance of 18 mm, and the speed of the combine with a 0.80 m s^{-1}. Considering the presence of mechanical impurities in harvested rye mass, we note that the content ranged from 0.38% in the improved variant up to 1.96% in the control (Table 3).

On the basis of these results it can be noted that the correction parameters defined by the harvesters have done significant effect on quality of work of the investigated combines. The results indicate that the correction of relevant parameters that we have made in all tested parameters affected harvesters to work far better in compared to the control, where the measured significantly higher content of intact whole grains in the harvested mass of both cultures, that are collected and significantly less breaking and partial damaging of the grains.

The results that we obtained in our research match result quoted by other authors (ĐEVIĆ et al., 2002.; MANSOURI and MINAEE, 2003.; MALINOVIĆ et al., 2005.; STRAKSHAS, 2006.; LASHGARI et al.,2008; CRAESSAERTS et al,2010.; BARAĆ et al., 2011.).

CONCLUSIONS

Based on the achieved results on the work quality of the examined harvesting devices of the examined combines it follows:

- The investigation on work quality of combines, during harvesting of rye and triticale have been performed in agroecological conditions of central Serbia (Kragujevac environment, Desimirovac 44 ° 04 '60 "N, 20 ° 52' 60" E);
- Corrections of relevant parameters that we have made in all tested parameters affected harvesters to work far better compared to the control;
- The highest average content of whole intact grains of 97.10% was recorded in the harvested mass of the combine CLAAS Dominator 48 in the improved variant at the rye harvest, and lowest in the control treatment at the combine at harvest ZMAJ 133B in triticale harvesting, and it was 92.19%;
- Harvesting device at combine Class Dominator 48 in an improved variant, has been breaking the grains the least, and broken grains content was at level of 0.91%, while at the combine ZMAJ 133B it has been measured significantly higher content of broken grains in the control, and it was 2.53% (triticale harvest), and a similar effect has been recorded at rye harvest;
- The content of partially damaged grains varied in the range of 0.69% (improved version), to 2.91% in controls;
- The general conclusion of our study is, that the tested combines can be successfully used in harvest of rye and triticale in the region of trials and the wider region, with the better education of the operators, and with necessary correction of the relevant parameters, can come to the full expression.

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