



THE TIGHTNESS OF CYLINDRICAL BALES AND DAMAGE OF FLAX STRAW WHEN HARVESTING IT WITH PICKUP BALERS

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Abstract: *The paper investigates the influence of the baler feed to the pins of the picking up drum on the damage of straw stalks in a bale considering the distance of the straw layer from the centre of a bale to its periphery. It also explains the change in the straw damage from the centre of a bale to its periphery. The author analyzes the damage of straw stalks in a bale depending on its tightness when using pickup balers with chambers of variable and invariable capacity.*

Key words: *baler feed, mechanized technologie, pickup balers, regulators of balers*

1 STATING OF PROBLEM

One of the components of technical service in agricultural production is the ensuring of effective use of machines in agriculture in general and in its separate branches. Until quite recently one of the leading branches of agriculture in Polissia of Ukraine was flax cultivation. In the question of branch revival one of the important places belongs to the introduction of the picking of long-fibred flax in the production of mechanized technologies. In the problem of mechanized production of long-fibred flax several questions are still not solved. This questions concern evaluation of the use of balers, which have different chambers, while picking up straw. In this article some of this questions are expected to be solved.

2 ANALYSIS OF LAST RESEARCHES AND PUBLICATIONS

Pickup balers, production of which was adjusted in Ukraine, Belarus, Russia and foreign countries, have chamber of variable and invariable capacity. They are also called pickup bailers with variation and semi variation chamber [1]. Pickup bailers form packages of straw in the form of bales of appropriate weight, diameter and height (width). Besides mentioned parameters bales are evaluated by their tightness (volumetric weight) and the damage of straw stalks in them.

Tightness of straw layers in the bales, formed by pickup balers with the chambers of variable capacity, is lessening from the centre to periphery. In the bales, formed by pickup balers with the chambers of invariable capacity, tightness is rising [2]. However, learning of the damage of stalks needs further researches.

Aim of the research is to increase the effectiveness of the use of pickup balers while picking the straw of long-fibred flax. Tasks of the research: 1) to analyse the change of the damage of straw stalks in bales which are formed by pickup balers PR-1.2L and PPR-110 with chambers of variable and invariable capacity, depending on the baler feed to the pins of the picking up drum considering the distance along the radius of the bale from its centre to periphery; 2) to research the character of the change of straw stalks damage in the bale along its radius depending on the distance from bale's centre to periphery in research pickup balers according to their different working speed; 3) to find out the influence of the tightness of bales on the damage of stalks in the bale.

Object and methodology of the research. Object of the research was technologic process of the picking of flax straw with the use of pickup baler PR-1.2L with a chamber of variable capacity and PPR-110 with a chamber of invariable capacity, which ganged up with a tractor MT3-80. Pickup baler PR-1.2L was regulated to form bales, which had the same diameter and width as the bales, which were formed by pickup baler PPR-110. Picking machines were used with the speed 4.26 km/h, 7.25 and 8.90 km/h, having set up regulators of the tightness of pickup balers' bales in maximal position. Baler feed to the pins of the picking up drum was calculated according to the formulas, which are mentioned in the book [4]. Weight of formed bales was calculated, their diameter and width. And the tightness of the packages of flax straw was calculated. According to the radius of the bale on the distances from its centre to periphery $R_p = 0,175$ m, $0,300$ m, $0,425$ m i $R_p = 0,550$ m places for the selection of the examples of straw were marked. 100 stalks were selected for the determination of the amount of damaged. Processing of experimental data [5] is realized with the use of standard computer programmes.ee

Results of the research. With the change of the movement speed of pickup machines from 4,26 to 8,90 km/h baler feed to one range of the pins of the picking up drum in pickup baler PR-1.2L fluctuated between 221 and 452 mm. In pickup baler PPR-110 baler feed to one range of the pins of the picking up drum fluctuated between 187 to 391 mm. On the picture 1, a experimental meanings of the damage of straw stalks in the bale $\Pi_{\text{сш}}$ are shown depending on the baler feed to the pins of the picking up drum S_z of the pickup baler PR-1.2L with a chamber of variable capacity and pickup baler PPR-110 with a chamber of invariable capacity on different distances along the radius of the bale from its centre to periphery.

From the picture 1, a it is clear that change of $\Pi_{\text{сш}}$ from S_z can be shown by the equations of lines with negative meaning of angular coefficients. Appropriate equations with the determined coefficients R_2 are shown in the table 1. From the picture 1, a it is clear that during the formation of bales by pickup baler with a chamber of invariable capacity with a radius of bale 0.175 and 0.300 m damages of stalks are less than during the formation of bales by pickup baler PR-1.2L with a chamber of variable capacity. However, with a further removal of a distance from bale's centre to periphery, damages of stalks in the bale, which is formed by pickup baler PPR-110 with a chamber of invariable capacity, excel stalks damages in the bales, which are formed by pickup baler with a chamber of invariable capacity.

According to the angular coefficient of the equations of $\Pi_{\text{сш}}$ change depending on S_z (picture 1) intensity of lessening of stalks damage in the bales, formed by pickup baler PR-1.2L with a removal from bale's centre to periphery, becomes slower and in the bales, formed by pickup baler PPR-110, it increases.

In the bales, formed by pickup baler PR-1.2L with a chamber of variable capacity, stalks damage with their removal from the bale's centre to periphery in researched scope of the speed of machine's movement is changed according to concave parabolas of second order, which look like:

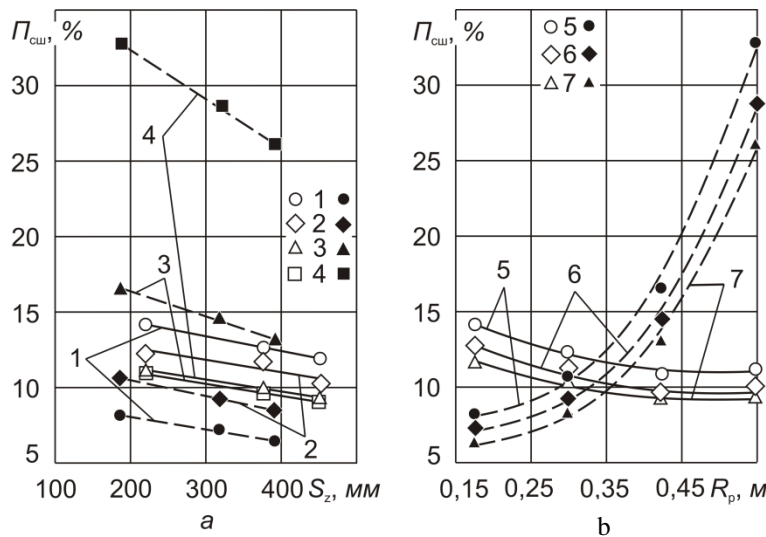


Fig.1 Intensity of lessening the stalks damage

Picture 1 – Change (a) of straw stalks damage in the bale on different distances along its radius from centre to periphery of package depending on Sz pickup baler feed to the pins of the picking up drum and dependence (b) on the stalks damage Π_{cw} in the baler on the distance along its radius R_p from centre to periphery of package on different speeds of pickup balers movement (continuous lines - pickup baler PR-1.2L; stippled lines - pickup baler PPR-110): 1 – radius is 0.175 m; 2 — 0.300 m; 3 - 0.425 m; 4 — 0.550 m; 5 — speed v_p is 4.26 km/h; 6 — v_p is 7.25 km/h; 7 — v_p is 8.90 km/h.

Tab. 1 Equation of the change of straw stalks damage in the baler Π_{cw} (%) considering its radius depending on Sz (mm) pickup baler feed to the pins of the picking up drum

Distance along the radius of baler from its centre to periphery R_p , m	Pickup baler		
	PPR-110 with the chamber of invariable capacity		
	R^2	Equation of relation	R^2
0,175	0,995	$\Pi_{cw} = 9,66 -$	0,996
0,300	0,820	$0,00825 S_z$	0,996
0,425	0,970	$\Pi_{cw} = 12,62 -$	0,996
0,550	1,000	$0,0106 S_z$	0,998
		$\Pi_{cw} = 19,63 -$	
		$0,0165 S_z$	
		$\Pi_{cw} = 38,95 -$	
		$0,0326 S_z$	

- at speed 4.26 km/h when $R^2 = 0.988$;
- at speed 7.25 km/h when $R^2 = 0.948$;

- at speed 8.90 km/h
when $R_2 = 0.987$,

where Π_{CIII} is stalks damage in the baler considering the distance along the radius of baler from its centre to periphery, %; R_p is a distance along a radius of baler from its centre to periphery, m; R_2 is a coefficient, which determines the measure of approximation of experimental data to approximate dependence.

From the graphs shown on the picture 1, b we can see that at the increase of the distance R_p stalks damage lessens at first, but at future increase of the distance to $R_p = 0.550$ m stalks damage increases.

Other character of Π_{CIII} changes depending on R_p belongs to the bales, which are formed by pickup baler PPR-110 with a chamber of invariable capacity. To clarify the character of such change equating of experimental data is realized according to the equation of lines with positive angular coefficient. Equating of degree and exponential functions and parabolas of second order of dependence is also realized. In the table 2 equations of appropriate approximating dependences and the results of calculation of the meanings of R_2 -coefficients are given. From the data given in the table 2 we can see that the best approximation to experimental data is provided by their equating according to equations of parabolas of the second order. On the picture 2 there is graphic interpretation of dependences under research, which corresponds to approximation of experimental data, received at movement speed 7.25 km/h and having set up regulators of the bales tightness in maximal position.

Tab. 2 To clarify the character of straw stalks damage change in the baler Π_{CIII} (%) at different speeds of machine PPR-110 movement depending on the distance along the radius R_p (m) of baler from its centre to periphery.

Speed of machine movement, km/h	Pickup baler PPR-110 with a chamber of invariable capacity	
	Equation	R^2
Rectilinear dependence		
4.26	$\Pi_{\text{CIII}} = 64.00 R_p - 6.200$	0.864
7.25	$\Pi_{\text{CIII}} = 56.00 R_p - 5.400$	0.866
8.90	$\Pi_{\text{CIII}} = 51.04 R_p - 5.002$	0.864
Degree function		
4.26	$\Pi_{\text{CIII}} = 52.178 R_p^{1,152}$	0.873
7.25	$\Pi_{\text{CIII}} = 45.731 R_p^{1,152}$	0.875
8.90	$\Pi_{\text{CIII}} = 41.655 R_p^{1,159}$	0.874
Exponential function		
4.26	$\Pi_{\text{CIII}} = 3.825 \exp(3.710 R_p)$	0.960
7.25	$\Pi_{\text{CIII}} = 3.357 \exp(3.707 R_p)$	0.961
8.90	$\Pi_{\text{CIII}} = 3.013 \exp(3.729 R_p)$	0.961
Parabola of second order		
4.26	$\Pi_{\text{CIII}} = 18.502 - 96.080 R_p +$	0.993
7.25	$220.800 R_p^2$	0.993
8.90	$\Pi_{\text{CIII}} = 16.080 - 83.200 R_p +$	0.993
	$192.000 R_p^2$	
	$\Pi_{\text{CIII}} = 14.688 - 76.560 R_p +$	
	$176.000 R_p^2$	

Taking into consideration data of the picture 2, predicted change of Π_{cm} depending on R_p concerning balers, which are formed by pickup baler PPR-110 with a chamber of invariable capacity, can be presented as dependences, which are shown by stippled curves on the picture 1, b. With the increase of speed of pickup baler PPR-110 from 4.26 to 8.90 km/h (more than twice) straw stalks damage in all scope of the research of baler radius change reduces 1.26 times. With the increase of the distance of the baler along its radius from the centre of package to periphery 3.14 times straw stalks damage at all speeds of pickup baler movement increases 4 times.

Between average stalks damage in the baler Π_{cp} (%), which is calculated according to the meanings of damages in the cut of stalks examples, which are selected on different distances along the radius of package from its centre to periphery, and the tightness of balers ρ_{pr} (kg/m³) correlative relation has being found. Coefficient of correlation between Π_{cp} and ρ_{pr} concerning pickup bailer PR-1.2L with a chamber of variable capacity was 0.998 and concerning pickup baler PPR-110 with a chamber of invariable capacity it was 0.994. According to the conditions of the research maximal average stalks damage in the balers formed by pickup bailer PR-1.2L was 12.1 % and in the balers formed by pickup baler PPR-110 it was 17.0 %. According to the data of many years in the limits of change of balers tightness from 70 to 130 kg/m³ with its increase on 10 kg/m³ stalks damage increases in the balers formed by pickup bailer PR-1.2L on 1.0...1.2 % and in the balers formed by pickup bailer PPR-110 – on 1.2...1.5 %.

Picture 2 – To determine the character of straw stalks damage change in the baler formed by pickup baler PPR-110 with a chamber of invariable capacity depending on the radius of package during the equating: 1- by the straight line; 2 – by degree function; 3 – by exponential dependence; 4 – by parabola of the second order.

6 CONCLUSIONS

With the increase of baler feed to the pins of the picking up drum from 187 to 452 mm straw stalks damages in the formed balers, considering the distance along the radius of package from its centre to periphery, reduce according to rectilinear dependences with the authenticity according to R2 coefficients in the limits 0.820...1.000. According to the set of regulators of balers tightness in maximal position with the increase of feed on 10 mm in bales formed by pickup bailer PR-1.2L with a chamber of variable capacity, damage reduces on 0.078...0.098 % and in the bales formed by pickup baler PPR-110 with a chamber of invariable capacity it reduces on 0.082...0.326 %. With the increase of the distance along the bale radius from its centre to periphery from 0.175 to 0.550 m in the pickup bailer with a chamber of variable capacity with the feed increase intensity of damage reduction slows down and in the pickup baler with a chamber of invariable capacity it increases. In the pickup baler PR-1.2L with a chamber of variable capacity with a change of distance along baler radius from its centre to periphery from 0.175 to 0.550 straw stalks damage changes according to concave parabola of the second order. At first it reduces when the radius is increased to 0.425 m and it increases a bit when radius is increased to 0.050 m. In the bales, which are formed by pickup baler PPR-110 with a chamber of invariable capacity in the limits of movements speed change from 4.26 to 8.80 km/h with the distance increase along bale radius from its centre to periphery stalks damage increases with the speeding up according to curvilinear dependence from 6.4...8.1 to 26.1...32.8. When radius is increased 3.14 times stalks damage is increased more than 4 times. With the increase of tightness of formed bales stalks damage in them increases according to rectilinear dependence.

To our mind, future researches should be directed to the search of quantitative change of stalks damage in bales, which are formed by pickup bailers with chambers of variable and invariable capacity, depending on the position of regulators of bales tightness.

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Аннотация

Исследовано влияние подачи пресс-подборщика на пальцы подбирающего барабана на повреждение стеблей тресты в рулоне с учетом расстояния слоя тресты от центра рулона к его периферии. Освещено изменение повреждения тресты в рулоне по его радиусу. Проанализировано повреждение стеблей тресты в рулоне в зависимости от его плотности при использовании пресс-подборщиков из прессующими камерами изменяемого и постоянного объемов.

Анотація

ЩІЛЬНІСТЬ РУЛОНІВ І ПОШКОДЖЕННЯ ЛЬОНОТРЕСТИ ПРИ ЇЇ ЗБИРАННІ ПРЕС-ПІДБИРАЧАМИ

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Досліджено вплив подачі прес-підбирача на пальці підбирального барабана на пошкодження стебел трести в рулоні з урахуванням відстані шару трести від центра рулону до його периферії. Висвітлена зміна пошкодження трести в рулоні по його радіусу від центра до периферії. Проаналізовано пошкодження стебел трести в рулоні залежно від його щільності при використанні прес-підбирачів з пресувальними камерами змінного і сталого об'ємів.