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IMPACT OF ADDING RUBBER STRIPS TO REEL AND SOME INDICATORS ON THE PERFORMANCE OF JOHN DEERE COMBINE HARVESTER 1450 CWS

Yousif Y.hilal [1], Saleh. S. A. Al-Slevani [2], Othman M. M. Tofeq [3]

Department of Agricultural Machines and Equipment, College of Agriculture and Forestry, University of Mosul, Iraq 1,2,3

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Correspondence Email: yousif.yakoub@uomosul.edu.iq

ABSTRACT

There is an increasing interest in developing combine harvesters due to the excessive losses and costs of wheat harvesting. Modifying a new concept can promote the mechanized process for wheat combine harvesters. Therefore, the research aims to examine new modifications in John Deere 1450 CWS combine harvester reel to suit reaping winter wheat under drought and study the effect of the harvester setting parameters on efficiency, percentage of header losses (PHL), total loss percentage (TL), and total harvest loss percentage (THL). A randomized complete block design is used to analyze a factorial experiment with split–split plot and Duncan's test to assess the significant influence of reel modification, reel rotational speed, and harvester forward speed on PHL, THL, TL, and efficiency. The performance of the modification was tested in terms of losses, and the results confirmed the efficiency of the modified reel for wheat harvesting. Furthermore, the results showed that the use of the rubber strips provided the lowest PHL (9.30%), THL (12.57 %), and TL (14.12 %) values with an increase in efficiency performance indicators with counts of 84.46 %. Moreover, PHL, THL, and TL had risen from 5.79 to 17.44%, 7.23 to 20.56%, and 8.59 to 22.15 % for increasing the reel rotational speed from 30 to 60 rpm. Finally, Efficiency indicators recorded the highest significant loss with increased harvester forward speed. The superiority of the forward speed of 5.2 km.hr^{-1}, with the lowest PHL, THL, and TL values over the forward speed of 6.2 km.hr^{-1}.

INTRODUCTION

Iraq's agricultural sector faces serious food security challenges after the recent escalation of conflict in the country's central agrarian region (Zarei, 2020). In addition to climate change, the most crucial contemporary challenge and its impact on decreased precipitation and surface water levels over the past 30 years. It reflects that the country's water source has fallen to less than 60 % of its natural levels in rivers, lakes, and water reservoirs (Saleh *et al.*, 2020). The water resource shortages have negatively impacted Iraq's wheat agricultural sector; therefore, Iraq has moved to one of its largest importers (Al-Ansari *et al.*, 2021).

Wheat and barley are grown in both irrigated conditions and rain-fed. Wheat is the main crop in northern and central Iraq, occupying 95% of the site. Wheat yield is the fundamental source of income for the majority (75%) of Iraqi farmers. Annual production depends on moisture availability (Mahmud, 2021). In the past decade, total combined wheat production ranged from 1.3 million metric tons to 3.5 million metric tons between 2008 and 2014, while total barley production varied from

404,000 metric tons to 1.1 million metric tons between 2008 and 2010 (Hameed, 2019).

Drought has become a vital cause of production reduction and farmland ecosystem degradation. It is a major climate change disaster affecting wheat yield production and growth. The deficiency leads to severe global and regional food security problems, and significant food-producing countries worldwide have been threatened by climate change and dryness for a long time (Geng *et al.*, 2023).

The critical shortage of irrigation water during the winter season due to deep decreases in rainfall along the Iraqi rivers. In addition, the politics of restricted water releases from Iraq's neighboring countries caused stress on soil moisture content, which caused significant harm to winter crops and reduced production over vast areas of Iraq. These shortages heavily impacted Northern provinces, reducing wheat area and production (United Nations, 2022).

Northern Iraq is the main winter wheat-producing area and is pivotal in economic development, massive contribution to overall national food-grain production, and national food security (Awchi and Kalyana, 2017). The northern governments typically account for 41% of Iraq's total wheat production (USDA, 2022). According to statistics from Norwegian Refugee Council (NRC) the average drought-affected area of crops was over a third (37%), and 30 % of farmers reported wheat and barley crop failure. Therefore, solving the drought impacts on wheat growth and yield is essential for mitigating drought disasters (NRC,2021).

The mechanization of winter wheat (under drought conditions) harvesting has been a long-term objective of producers and farmers on broad fields in developing countries. Many semi-arid regions, especially in Iraq, have extensive crop yield variability due to agronomic factors and year-to-year fluctuations in environmental variables such as water limitations and temperature. Therefore, wheat growth faces many issues. One of the critical issues is the agronomic traits (e.g., biomass, plant height, yield, and components of yield). With a changing climate, the effect of drought is predicted to become more intense and frequent on agronomic traits of crop yield, and it has become more significant. A change in agronomic traits under climate change alters the crop yield, including the growth parameters such as plant height, biomass at harvest, and components of harvestable net.however, this information is required to develop agricultural practices to minimize drought's effect. The continuation of the traditional methods of harvesting operations harms production (Zhang *et al.*, 2018; Yu *et al.*, 2018; Huang *et al.*, 2020; Liang and Wada, 2023).

Dry and poor seasons can cause wheat yield to be patchy and short.harvesting these crops will be challenging, so machinery settings or header fronts must be adjusted to effectively cut and convey a high proportion of heads from the cutter bar into the harvester to reduce grain losses.

The instructions issued by DPIRD (2022) provide information to help Australian farmers in dry seasons. This information includes first adjusting harvester settings or modifying the front to improve harvest efficiency and reduce grain losses, especially for short, patchy, and low-yielding crops; second, attaching similar material to a finger-tine reel or black plastic Corflute to sweep material onto the belt or table. Third, extend the fingers forward of the knife, keep the knife sections in good repair, and adjust them correctly on the knife guard. Finally, change the rotor setup, concave clearance, sieve, and wind settings.

In several areas of Iraq, prolonged drought has led to the emergence of short-height wheat and other agronomic traits. harvesting wheat can be a challenge in these situations. Particular attention must be given to operation control, machine adjustments, and cutting height. In a wheat case with drought, getting the wheat heads into the combine with less straw will take much work. Sometimes, the reel may need to effectively relocate the crop back from the cutter bar to the auger and hold it in place during cutting. Short-cutting will mean more contact potential with the ground and reduced surface residue levels, likely negatively impacting moisture storage (USDA, 2009; Al-Slevani *et al.*, 2022).

Producers and farmers in dryland production systems must remember that in very low-yielding wheat years. It is possible to preserve what little crop residue is present, which will significantly impact evaporative losses and the productivity of the next crop. New equipment for many farmers may need to be more economical, and working with a conventional head of combine harvester is expected behavior. In this case, adjusting the reel to get the best movement of the heads from the cutter bar to the auger is a traditional behavior. Therefore, the main merit of this study was to examine new modifications in John Deere's combine harvester reel to suit reaping winter wheat under drought. The second is to study the effect of the harvester setting parameters on wheat yield losses to estimate the optimum condition for operation and achieve the lowest gathering loss.

MATERIALS AND METHODS

Experiments Site and ambient conditions

The performances of machinery and humans are affected by field and ambient conditions and the description of crops. Therefore, it is essential to present the field and weather conditions during the harvester process. Numerous soil samples were collected from 0 to 40 cm levels of depth with increasing 10 cm for each depth at different parts of the field. Clay is the soil texture of the experimental area (56.5% clay, 27.95 % silt, and 15.55% sand). The soil bulk density and the moisture content were measured by the methods described by Black *et al.* (1983). The soil penetration was measured by the penetrometer tool using the practices described by Gill and Berg (1967), as presented in Table (1). Monthly weather averages are collected from World Weather website (World Weather, 2023), which include average high and low temperatures, precipitation, average rainfall days, cloud, humidity, and wind Table (2).

Table (1): Shows soil properties

Depth (cm)	Bulk density (cm^{-3}. g)	Moisture content (%)	Cone indicator ($kN.m^{-2}$)
0-10	1.40	14. 2	542
10-20	1.52	17.7	550.7
20-30	1.73	20.6	555.8
30-40	1.25	21.6	445.4

The experiments were conducted in a wheat field (36°56'47.1"N 42°46'53.9" E) in the Sumel district in Dohuk governorate, North of Iraq. Sumel District rises 440 m above sea level and is 470 km north of Baghdad. It is also far from the Turkish and

Syrian borders, about 65 and 180 km, respectively. The study site and a field view are shown in Figure (1).

Table (2): Monthly averages of weather condition in Sumel district (World Weather, 2023).

Month	Average High Temp (C°)	Average Low Temp (C°)	Precipitation (mm)	Average Rainfall (Days)	Average Cloud (%)	Average Humidity (%)	Average Wind ($km.h^{-1}$)
January	9	1	155.3	8	35	54	5.8
February	11	2	98.7	8	38	64	6.4
March	15	5	142.9	9	40	60	6.8
April	21	10	83.6	8	31	56	7.4
May	28	15	32.5	5	19	38	8.2
June	35	21	2.2	1	6	24	8.4
July	39	24	0.3	0	0	19	10.4
August	39	23	0.3	0	3	15	9.1
September	34	19	1	0	5	18	8.3
October	26	14	43.8	4	14	26	7.3
November	17	7	82.6	4	32	45	5.8
December	12	3	132	7	28	55	5

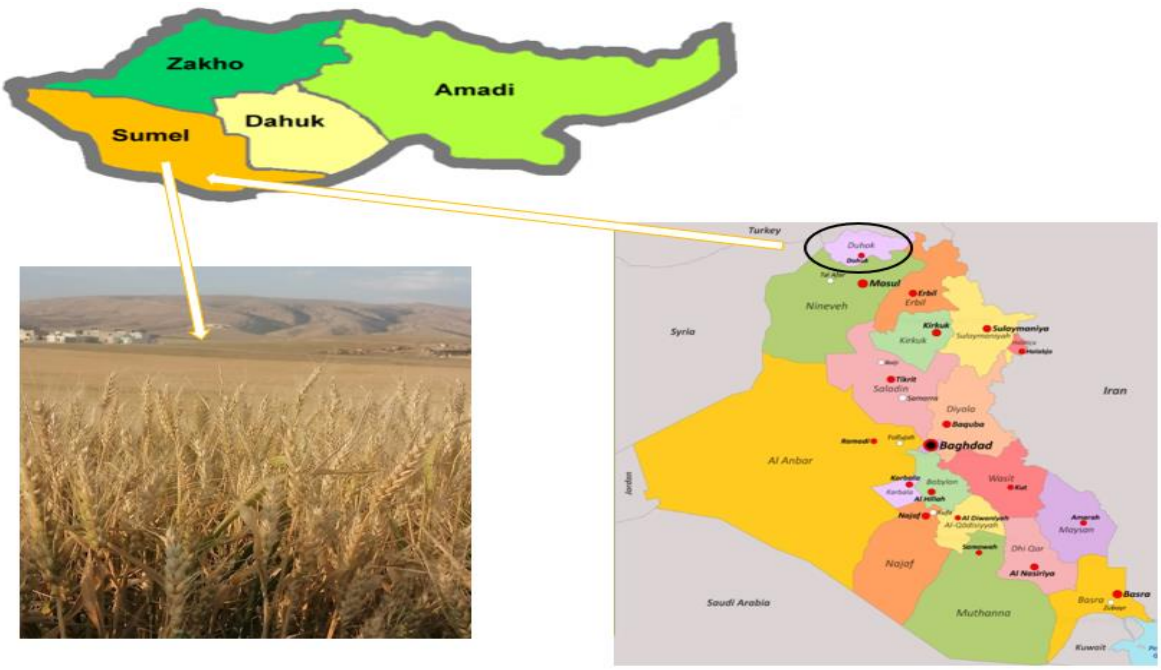

Figure (1): The experiment site and a view of the field.

Description of the wheat crop

The wheat crop that was cultivated is of the Mexipak variety. The most important characteristics of this variety are moisture 8.4%, total protein 11.2%, ash 1.83%, and specific weight 77.6 $kg.hectoliters^{-1}$, the weight of 1000 grains is 29.2 grams, the average hardness of the grain is 10.55 $kg.\ cm^{-2}$. Protease 3.615 and 111.596 $units.\ ml^{-1}$, Amylase 0.155 and 4.797 $units.ml^{-1}$ for specific activity and activity, respectively. Before harvest, spikes were 190 per square meter of various sizes and 25-30 cm crop height.

The modification of combine harvester

A John Deere wheat combine harvester model 1450 CWS with an engine type of PVX 6068 HZ. Its capacity, cylinders, and Power of 6788 cm^3 (6.8 L), 6 and 132 kW/180 KM, respectively. header width 485 cm (working), 365 – 580 cm alternative widths, 61 and 130 cm for diameter and width of cylinder threshing mechanism. As for dimensions, the A John Deere wheat combine harvester has an overall length (with header), width (with header), width (without header), and height (with cab) of 7.9, 4.9, 3.65, and 3.98 m, respectively. The total weight (with cab) of 10500 kg. The combine harvester was set up according to the manufacturer's instructions, and the cutting and threshing mechanism was adjusted for the wheat crop.

The modifications were performed in a laboratory at the Department of Agricultural Machines and Equipment, College of Agriculture and Forestry, University of Mosul, Mosul, Iraq. The modification aimed to enhance the effectiveness and efficiency of the John Deere wheat combine harvester and reduce grain losses during the harvesting process under drought conditions. The header modification includes adding rubber strips for a reel to assist grain growers in harvesting short crops under drought conditions. It will help feed cut material from low yields into the front of the header to reduce grain loss. The modification comprises four frames from wood with dimensions of 107 cm in length, 12 cm in width, and 4 cm in thickness for each. It is important to stagger the wooden frame as the second section goes around the reel. Rubber strips are fixed on the wooden frame with the exact frame dimensions, as shown in Figure 2. The rubber strip is a 1.8 mm black high-density polyethylene (HDPE) sheet with specific thermoplastic polyurethane (TPU) characteristics because it is easily fitted and has the advantage of higher wear resistance.

Figure (2): Reel with rubber strips for John Deere wheat combine harvester model 1450 CWS

Statistical Design and evaluation of wheat crop losses

A randomized complete block design is used to analyze a factorial experiment with split–split plot and Duncan's test was applied to assess the significant impact of reel modification, reel rotational speed, and harvester forward speed on PHL, THL, TL, and efficiency. The reel modification is arranged as the main plot factor with two levels, including reel with rubber strips and reel without rubber strips. Reel rotational speeds were considered a subplot factor; the reel rotational speeds were 30, 45, and 60 rpm. The harvester forward speed was considered in the split–split plot with two speeds (5.2 and 6.2 km.hr^{-1}) **.**

Evaluating the performance of the rubber strips and factors has been done in the field. A 65 cm x 38.5 cm frame was used to estimate the natural loss before starting harvester processes in the field. Measurements were taken at ten random locations, and the Hamzah and Alsharifi (2020) equation was used to calculate the percentage of natural loss. The PHL was estimated using the described method (Al-Slevani *et al.*,2022). The PHL is calculated from the following equations (1 and 2)**.**

$$HL = (\text{TGH} - \text{TGNL})\text{x1000grain weight x }4\text{x}10^{-2} \; (1)$$

$$\text{PHL} = \left({}^{HL}/_{TFP}\right)X100 \; (2)$$

Where:

HL: Header loss

TFP: Total field production

TGH: Total grains in the head

TGNL: Total grains counted in the natural losses

Threshing, separation, and cleaning loss percentages were expressed as percentages from the equation proposed by Srivastava *et al.*, (2006) and Hamzah and Alsharifi (2020).

The total yield is achieved by summing the net yield inside the harvester tank, total harvest loss, and natural losses. The THL, TL, and efficiency are calculated from the following equations: 3, 4 and 5 (Al-Slevani *et al.*, 2022):

$$\text{THL} = \textit{percentage of header losses} + \textit{Percentage of threshing losses} + \textit{Percentage of separation and cleaning losses} \; (3)$$

$$\text{T}L = THL + \textit{natural loss percentage} \; (4)$$

$$Efficiency = \frac{\textit{Net yield}}{\textit{Net yield} + \textit{Total harvest loss}} \; x\,100 \; (5)$$

RESULTS AND DISCUSSION

Effect of reel modification, reel rotational speed, and harvester forward speed on PHL, THL, TL, and efficiency

The obtained results in Table (3) illustrate the effect of reel modification, reel rotational speed, and harvester forward speed on PHL, THL, TL, and efficiency. The results showed that the PHL, THL, TL, and efficiency significantly differ between adding rubber strips to the reel and the reel without rubber strips in the harvest operation. The rubber strips provided the lowest PHL, THL, and TL values with an increase in efficiency performance indicators, with discounts of 9.30%, 12.57 %, 14.12 %, and 84.46 %, respectively. The PHL, THL, and TL recorded the highest significant values, while efficiency behavior was reversed with the reel without rubber strips. The reason for this result is that the reel should be placed about 15-25 cm above the cutter bar for minimum loss, a height lower than the low height of the crop. Wheat crops with lower height cannot be cut by the cutter, and seeds drop when they get into contact with reel wheel. Therefore, the reel with rubber strips pushes the most significant amount of low wheat yield into the cutter by slowly rotating.

The main effects of reel rotational speed were highly significant for PHL, THL, and TL Table (3). The mean of the reel rotational speed showed the most significant loss related to maximum reel rotational speed. The lowest PHL, THL, and TL were related to minimum reel rotational speed. The increased reel rotational speed significantly super fatted PHL, THL, and TL. The rate of increase in PHL, THL, and TL was almost the same as reel rotational speed; for example, PHL, THL, and TL had increased from 5.79 to 17.44%, 7.23 to 20.56% and 8.59 to 22.15 % when the reel rotational speed has risen from 30 to 60 rpm, respectively. PHL, THL, and TL were recorded 15.18, 17.41, and 18.85% at the reel rotational speed of 45 rpm. These outcomes are harmonious with (Chaab *et al.*, 2020), who concluded that total loss increases with the increasing speed of a rotational reel. Still, there was no significant difference between treatments of reel rotational speed for efficiency. A reel rotational speed of 30 rpm is superior in having the highest efficiency compared to a reel rotational speed of 45 and 60 rpm. At the reel rotational speed of 30 rpm (higher values), the efficiency was 74.51%. In comparison, with a reel rotational speed of 60 rpm (lower values, it was 72.58 %).

Table (3) shows the effect of the harvester's forward speed on the PHL, THL, TL, and efficiency, respectively. Statistics analysis indicates that the impact of the harvester's forward speed showed significant differences in PHL, THL, and TL.

Table (3): The individual effect of reel modification, reel rotational speed, and harvester forward speed on PHL, THL, TL, and efficiency.

Factors	Traits			
	PHL %	THL %	TL %	Efficiency %
Reel Modification				
Reel with rubber strips	9.30 b	12.57 b	14.12 b	84.46 a
Reel without rubber strips	16.30 a	17.56 a	18.94 a	62.59 b
Reel Rotational Speed rpm				
30	5.79 c	7.23 c	8.59 c	74.51 a
45	15.18 b	17.41 b	18.85 b	73.48 a
60	17.44 a	20.56 a	22.15 a	72.58 a
Harvester forward speed $km.hr^{-1}$				
5.2	11.46 b	13.33 b	14.70 b	74.89 a
6.2	14.14 a	16.80 a	18.36 a	72.15 a

The efficiency indicators achieved the highest consequential loss with increased harvester forward speed. The superiority of the forward speed of 5.2 $km.hr^{-1}$, with the lowest PHL, THL, and TL values over the forward speed of 6.2 $km.hr^{-1}$.however, the highest value of TL was recorded at a forward speed of 6.2 $km.hr^{-1}$, the harvesting efficiency decreased with increasing the harvester's forward speed. For instance, the difference in the efficiency value between the forward momentum of 5.2 km.hr^{-1} and the forward speed of 6.2 km.hr^{-1} were 74.89 and 72.15 %. The results are proportional to the theory that the forward speed function significantly influences percentage losses. This trend agrees with studies by (Khater *et al.* 2023). The decreasing harvesting efficiency and increased total losses with the increasing harvest speed because of higher harvesting speeds. It becomes difficult to control the combine harvester, which tends to increase the total harvesting time, thereby causing decrease in harvesting efficiency (Al-Rajabow, 2007 and Amponsah *et al.*, 2017).

Effect of interactions between the reel modification and reel rotational speed on PHL, THL, TL, and efficiency

Table (4) shows significant variations in the influence of the interaction between reel modification and reel rotational speed in percentage losses on the PHL, DL, TL, and efficiency. The reel with rubber strips showed the lowest loss ratio for all reel rotational speeds, outperforming the reel without rubber strips. The addition of reel rubber strips at a reel rotational speed of 30 rpm had the lowest harvester losses of 4.20 ,6.02and 7.39 % for PHL, THL, and TL, with an increase in the efficiency of the harvester's performance by 87.60 %, as presented in Table (4). At the same time, the highest PHL, THL, and TL were 22.20, 23.95, and 25.41% at a reel without rubber strips and a reel rotational speed of 60 rpm. The rotates of a reel without rubber with a low crop height and increased tines hit the spikes harshly, resulting in increased losses and reduced efficiency. The influence of an increase in a reel rotational speed led to a significant rise in PHL, THL, and TL for both reel types. The reel rotational speed of 30 rpm outperformed the reel rotational speed of 45 and 60 rpm, with the lowest percentage of crop loss, especially in the PHL, which caused more than two-thirds of the THL. Where the values were (4.20, 11.03 and 12.69 %) and (7.38, 19.33 and 22.20 %) for a reel with rubber strips and without rubber strips with a reel rotational speed of 30, 45 and 60 rpm, respectively.

Table (4): The influence interactions of the reel modification and rotational speed on PHL, THL, TL, and efficiency.

Factors		Traits			
Reel Modification	Reel Rotational Speed rpm	PHL %	THL %	TL %	Efficiency %
Reel with rubber strips	30	4.20 f	6.02 f	7.39 f	87.60 a
	45	11.03 d	14.52 d	16.07 d	85.37 ab
	60	12.69 c	17.18 c	18.90 c	80.30 abc
Reel without rubber strips	30	7.38 e	8.44 e	9.79 e	66.55 bcd
	45	19.33 b	20.29 b	21.63 b	61.42 cd
	60	22.20 a	23.95 a	25.41 a	59.79 d

Effect of interactions between the reel modification and harvester forward speed on PHL, THL, TL, and efficiency

The reel modification and harvester forward speed significantly affected PHL, THL, TL, and efficiency Table (5). The highest PHL, THL, and TL values at interactions between the reel without rubber strips and a forward speed of 6.2 km.hr $^{-1}$ were 18.00, 19.58, and 21.09 %. While the lowest value was 8.32, 11.12, and 12.61% at interactions between the reel with rubber strips and a forward speed (5.2 km.hr $^{-1}$). Significant differences exist concerning the efficiency values at interactions between the reel modification and harvester forward momentum Table (5). The efficiency recorded the highest discounts with decreased forward speed. Meantime, the efficiency value recorded the lowest deals with interactions between 6.2 km.hr $^{-1}$ and the reel without rubber strips, which was 61.68 %. In contrast, the efficiency is significantly higher at interactions between the reel with rubber strips and a forward speed of 5.2 km.hr^{-1}. This may be due to the overlap of the effect of adding rubber strips and the low rate, which positively affects directing the common crop towards the cutting axis. An increase in the reel speed and harvester ground speed caused the fans to hammer more on the spikes and break or loosen them, leading to a rise in the yield loss. These observations agree with the results obtained by (Fadavi *et al.*, 2017) and (Chaab *et al* .2020) .

Table (5): The impact interactions of the reel modification and harvester forward speed on PHL, THL, TL, and efficiency.

Factors		Traits			
Reel Modification	Harvester forward speed km.hr^{-1}	PHL %	THL %	TL %	Efficiency %
Reel with rubber strips	5.2	8.32 d	11.12 d	12.61 d	88.11 a
	6.2	10.28 c	14.02 c	15.63 c	80.81a
Reel without rubber strips	5.2	14.60 b	15.54 b	16.80 b	63.50 b
	6.2	18.00 a	19.58 a	21.09 a	61.68 b

Effect of interactions between the reel rotational speed and harvester forward speed on PHL, THL, TL, and efficiency

The harvester reel rotational speed of 30 rpm at a forward speed of 5.2 km.hr $^{-1}$ had the lowest harvester losses of 4.28, 5.46, and 6.81 % for PHL, THL, and TL, with a higher efficiency of 81.38 %, as shown in Table (6). The highest THL of 24.78 % was at a reel rotational speed of 45 rpm at a forward speed of 6.2 km.hr $^{-1}$, these observations agree with the results obtained by Broster, *et al.*, (2016), who found that increasing the harvester's forward speed from 6 to 8 km.hr^{-1} led to a significant increase in grain loss from 0.98% to 5.03%, primarily when the harvester was operating at total capacity.

Effect of interactions between the reel modification, reel rotational speed, and harvester forward speed on PHL, THL, TL, and efficiency

Table (7) shows the influence of triple interactions between the reel modification, reel rotational speed, and harvester forward speed on PHL, THL, TL, and efficiency. The PHL, THL, and TL were significantly higher at the reel with rubber strips and considerably lower than that of a reel without rubber strips at all rotational speeds and forward speeds. In contrast, the losses at the reel rotational speed of 30 rpm and forward speed of 5.2 km were considerably lower than that of all other interactions.

Table (6): The impact interactions of the reel rotational speed and harvester forward speed on PHL, THL, TL, and efficiency.

Factors		Traits			
Reel Rotational Speed rpm	Harvester forward speed km.hr $^{-1}$	PHL %	THL %	TL %	Efficiency %
30	5.2	4.28 f	5.46 f	6.81 f	81.38 a
	6.2	7.30 e	9.00 e	10.37 e	65.58 a
45	5.2	10.46 d	11.63 d	12.92 d	77.62 a
	6.2	19.90 a	20.19 a	24.78 a	71.40 a
60	5.2	16.64 c	19.37 c	20.81 c	73.26 a
	6.2	18.24 b	21.75 b	23.50 b	71.90 a

The triple interaction of the reel with rubber strips and reel rotational speed of 30 rpm at a forward speed of 5.2 km was superior and recorded the lowest in the trait of PHL (3.10 %). The characteristics of THL and TL (4.53 and 5.91%) and their highest efficiency reached (95.75 %) contrasted to the rest of the interactions for the same traits mentioned as a result of obtaining the lowest loss ratios in its units, especially the PHL and the TL due to improved cutting efficiency. The interaction of the reel without rubber strips, reel rotational speed of 45 rpm at a forward speed of 6.2 km was recorded as the highest value of PHL (25.32 %).

Table (7): The influence of the triple interactions between the reel modification, reel rotational speed, and harvester forward speed on PHL, THL, TL, and efficiency.

Factors			Traits			
Reel Modification	Reel Rotational Speed rpm	Harvester forward speed km.hr $^{-1}$	PHL%	THL%	TL%	Efficiency %
Reel with rubber strips	30	5.2	3.10 k	4.53 l	5.91 l	95.75 a
		6.2	5.30 j	7.52 j	8.87 j	91.20 a
	45	5.2	5.46 i	6.39 k	7.70 k	86.17 ab
		6.2	7.58 h	9.71 i	11.07 i	84.00 ab
	60	5.2	12.10 f	16.15 f	17.88 f	84.59 ab
		6.2	13.28 e	18.21 e	19.91 e	65.07 bc
Reel without rubber strips	30	5.2	9.29 g	10.49 h	11.88 h	66.09 bc
		6.2	14.48 d	19.33 d	21.08 d	67.02 bc
	45	5.2	13.34 e	13.55 g	14.78 g	64.04 bc
		6.2	25.32 a	27.04 a	28.48 a	58.81 c
	60	5.2	21.18 c	22.60 c	23.74 c	60.37 c
		6.2	23.21 b	25.30 b	27.09 b	59.22 c

As well as the highest value of THL and TL (28.48 and 27.04 %) with the lowest efficiency value (58.81%). At the same time, the interaction of a reel without rubber strips and a reel rotational speed of 60 rpm at a forward speed of 6.2 km was achieved as the second lowest efficiency value (59.22 %). The highest PHL, THL, and TL values were 23.21, 25.30 and 27.09 %, respectively, with significant differences compared to the rest of the interaction.

CONCLUSIONS

The following conclusions can be drawn from the results:

1. The rubber strips reduced the force of the reel hitting the plants, which was reflected positively on the PHL, THL, and TL values with an increase in efficiency performance indicators with counts of 84.46 %.
2. PHL, THL, and TL had risen from 5.79 to 17.44%, 7.23 to 20.56%, and 8.59 to 22.15 % when the reel rotational speed increased from 30 to 60 rpm, respectively.
3. The efficiency indicators achieved the highest considerable loss with increased harvester forward speed.

In conclusion, the result of the field evaluation confirmed the best performance of the rubber strips added to the cutting unit in the combine harvester when harvesting wheat in drought conditions.

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CONFLICT OF INTEREST

The authors state that there are no conflicts of interest with the publication of this work.

تأثير إضافة شرائط مطاطية إلى مضرب الضم وبعض العوامل على أداء الحاصدة المركبة John Deere CWS 1450

يوسف يعقوب هلال [1]، صالح صبري السليفاني [2]، عثمان مؤيد توفيق [3]
قسم المكائن والآلات الزراعية/ كلية الزراعة والغابات/ جامعة الموصل/ الموصل/ العراق [1،2،3]

الخلاصة

هناك اهتمام متزايد بتطوير الحاصدات بسبب الخسائر والتكاليف الباهظة لحصاد القمح. يمكن أن تؤدي بعض التعديلات الاولية لآلة الحصاد وحسب ظروف الحصاد وحالة المحصول ومواصفات الحقل إلى تعزيز العملية الآلية لحاصدات القمح. لذلك يهدف البحث إلى دراسة التعديلات الجديدة في مضرب الضم للحاصدة John Deere لتلائم حصاد القمح تحت ظروف الجفاف ودراسة تأثير عوامل ضبط الحاصدة على مؤشر الكفاءة ونسبة فقد الحبوب عند مضرب الضم (PHL) ونسبة الفقد الكلية (TL) والنسبة المئوية لخسائر الحصاد الإجمالية (THL). تم استخدام تصميم القطاعات العشوائية الكاملة لتحليل تجربة عاملية باستخدام اختبار دنكن متعدد المدى لتقييم التأثير الحاصل من اضافة شرائط مطاطية لمضرب الضم، وسرعة دورانها

والسرعة الأمامية للحصاد على النسبة المئوية لفقد الحبوب عند مضرب الضم (PHL) ونسبة الفقد الكلية (TL) والنسبة المئوية لخسائر الحصاد الإجمالية (THL) والكفاءة. تم اختبار أداء مضرب الضم المحور في الخسائر وأكدت النتائج كفاءة المضرب المعدل في حصاد القمح. علاوة على ذلك، أظهرت النتائج أن استخدام الشرائط المطاطية يوفر PHL (9.30%) و THL (12.57%) و TL (14.12%) مع زيادة في مؤشرات أداء الكفاءة بمقدار 84.46%. اضافة الى ذلك، ارتفعت معدلات PHL وTHL وTL من 5.79 إلى 17.44%، ومن 7.23 إلى 20.56%، ومن 8.59 إلى 22.15% بزيادة سرعة دوران مضرب الضم من 30 إلى 60 دورة في الدقيقة. وأخيرا، سجلت مؤشرات الكفاءة أعلى خسارة معنوية مع زيادة سرعة الحاصدة. تفوق السرعة الأمامية 5.2 كم/ساعة، مع أدنى قيم PHL وTHL وTL على السرعة الأمامية البالغة 6.2 كم/ساعة.

الكلمات المفتاحية: ظروف الجفاف، سرعة امامية، ضبط الحاصدة، دوران مضرب الضم.

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