Losses and efficiency of wheat harvester at different reel and cutting heights

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Abstract

Experiment was conducted in Qushtapa village southern Erbil, Kurdistan Region of Iraq, during the summer season of 2024 for measuring losses of wheat harvester and efficiency. Randomized complete block design (RCBD) with three replications by using two factors: cutter bar heights (10, 20 cm) and the second factor was reel heights (60, 80, 100 cm). The results showed losses decreased in all harvester units while efficiency increased with increasing cutting height. A cutting height of 10 cm reduced total combine harvester losses by 5.50% and increased harvester efficiency to 94.56%. Additionally, decreasing the reel height also reduced the overall losses of the combine harvester. Lowest losses were 4.63 % and higher combine efficiency was 95.42 % at interaction cutting bar height 10 cm with reel height 100 cm. Conclusion that grain losses decrease and the efficiency of the combine harvester increase at increasing cutting bar height and reducing the reel height. Moreover, proper reel adjustment and selecting cutting bar height can reduce losses and increase harvester efficiency.

Keywords: Crop, Harvester, Cutting height, Threshing unit, Efficiency and Losses.

1. Introduction

Wheat is a very important crop that is grown in different world and provides the staple food of millions of people. It holds a special place among food grains because it is a source of carbohydrates and protein. About 20% of its calories come from wheat, and it contains 11-12% protein. In Iraq, wheat is the main crop in the region, (2). On the other hand, increasing productivity and reducing harvest losses could convey an important role for sludge in maintaining food security, (9). Combined

Combined harvesters are used to harvest small grains, wheat, corn and other cereal crops. The use of combine harvesters is an efficient and affordable solution to reduce labor costs in wheat harvesting in general worldwide, (11). Combine harvesters play an important role in increasing agricultural productivity and saving time, (8). Combine harvesting losses depend on two main factors: the condition of the crop itself and the way the combine machine operates, (14). During mechanical harvesting of wheat, errors in the adjustment of operating parameters can be due to increased grain losses, (7). The primary losses associated with mechanical wheat harvesting include head loss, cutting and separation losses, and cleaning losses, (4). Also, when wheat is

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harvested by a machine after the process, the shaking of the head can cause some grains to go down, due to less adhesion between the grains and the wheat spikes, (4). When the feed rate is too high, the broken cloths accumulated on the screen surface become deeper, making the cleaning conditions more difficult and causing increased grain loss, (4). Combine harvest losses can be categorized into several types, such as natural losses (preharvest), losses during platform cutting (head losses), erosion losses, losses during the cleaning phase, and body losses, (16), damage to the head, caused by bars, is not given much importance, as the header unit is a major component that touches the windows strongly. Wheat crops that were low in height were not cut and the seeds dropped when in contact with the engine. Wheat losses are divided into two types: (1) preharvest losses and (2) harvest losses. Pre-harvest damage occurs due to birds, weather and other natural factors, this may be uncontrollable. Harvest losses are caused by the combine harvester and the way the harvester works from separation. Proper combine setup and early harvesting can minimize those losses in a spectacular way, (18). The aim of this study was to examine the relationship between cutter height settings and wheat loss while also analyzing the impact of reel height variations on the extent of crop loss. Additionally, the study sought to determine the optimal cutter and reel height settings to minimize losses and enhance harvesting efficiency.

2. Materials and Methods / Methodology

2.1. Study Sites

The study was conducted in the summer of 2024, on a farm located in the village of Qushtapa in southern Erbil province within the Iraqi Kurdistan Region. Wheat was sown using the Hawler 4 seeder at a rate of 50 kg per dunum (one dunum equal 2500 m^2). The crop yielded 1,500 kg per hectare with a moisture content of 11%. On average, there were 300 spikes per square meter, with a total spike weight of 36.2 grams per square meter. The seed weight before harvest was recorded at 18.5 grams. The soil was classified as silty clay loam and was initially plowed using a moldboard plow. It was then loosened and prepared with a disc harrow before wheat was sown in the field using a seed rate machine.

2.2. Experimental design and study parameters

Randomized complete block design (RCBD) with three replications by using two factors: cutter bar heights (10, 20 cm) and the second factor was reel heights (60, 80, 100 cm). each block consisted of 6 plots, with an average of 12 plots, and each block is 50 m length and 6 m width. The dimensions of each experimental plot were 6m x 5 m with an average land area (1050 m^2). The basis for selection of treatment levels was cutting unit loss, wheat cutting unit loss, wheat sorting and packing unit losses, all harvester combines losses with combine operational performance, where treatments were recorded after harvesting the combine.

2.3. New Holland Combine harvester

The combine used for harvesting in the field was a New Holland TC5070, a conventional, self-propelled combine (SCR, New Holland). The combine is equipped with features such as air-conditioning, all-wheel drive, cab and damage monitoring, shown in (Figure 1).

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Some of the characteristics of the combine are specified in Table 1.

Table 1. Some specifications of New Holland TC5070 combine harvester.

Characteristics	Values/Types	Unit
Engine Power	167	kw
Fuel tank Engine capacity	400	Liters
Transmission	Hydraulic	-
Speed Combine Harvester	20 – 25	Km/h
Cutting Unit's Working Width	4.57	m
Combine length	8.35	m
Combine width	3.19	m
Combine height	3.90	m
Grain tank capacity	3.600	L
Combine weight	9.6	Tons
Header height	1	m
Header length	4.50	m

Fig. 1. The New Holland combine harvester which used in field trials

2.4. Parameters of the study

2.4.1. Pre-Harvest Loss (LPH)

To evaluate the wheat spike that fallen on the ground naturally and using a 1 m^2 of wooden frames, we collected each block in 10 random places and then calculated as a gram of weight to determine the damage of the wheat in the field, The discoveries of this study are closely compatible with the source's research by (20).

2.4.2. Losses of cutting height unit (LC)

This is calculated by collecting the grains and ears that have fallen to the ground, measuring their weight, and then determining the ratio after subtracting the pre-harvest grain weight. A $1m^2$ frame was randomly used in each block to collect samples, and then the loss ratio was calculated, The discoveries of this study are closely compatible with the source's research by (19).

2.4.3. Threshing Losses (LTh):

To estimate the percentage of wheat blight damage using $1m^2$ square frames in each wheat harvest order, the grain heads or wheat spikes that ended up falling off the combine during harvest were then collected. The shear damage can be expressed as a percentage from the equation described by (5):

$$\text{Percentage of threshing losses} = \frac{\text{Mass of unthreshed grains}}{\text{Total mass grains}} \times 100 \quad \ldots\ldots\ldots (1)$$

Where:

Threshing losses = (unthreshed grain losses + grain damage +grain losses) …….. (2)

2.4.4. Percentage of separation and cleaning unit losses (LSC)

Percentage of separation and cleaning losses: the percentage of total grain entering the combine that is lost due to separation and cleaning is the amount of grain that is lost with straw, according to (16):

$$\text{Percentage of separation losses} = \frac{\text{mass grain lost with straw}}{\text{mass total grain yield}} \times 100 \quad \ldots\ldots\ldots\ldots (3)$$

2.4.5. All Combine harvester losses (AL)

To estimate all losses of quantitative loss of wheat yield, which includes the efficiency of the combine during the harvesting process by counting, collecting and determining grain losses on the wheat spike cutting unit, wheat threshing, wheat separation and cleaning.

AL= LC + LTh + LSC …….. (4)

AL= All Losses combine harvester.

LC = Losses Cutting Unit

LTh = Losses Thrashing Unit

LSC = Losses Separation and Cleaning Unit

- **Calculating the total yield combine harvester is as follows, accordin to research by (19):**

Total Yield = Net yield in the harvester tank + Yield lost during harvest + Yield lost before harvest ……... (5)

2.4.6. Combine performance efficiency (CPE)

The performance efficiency of a combine harvester in the field depends on several factors, including the machine's design, field conditions, crop type, and operator expertise, and efficiency are calculated from the following equations (1):

$$\text{Harvester performance efficiency} = \frac{Net\ Yield}{Net\ yield + Total\ harvester\ losses} \times 100 \quad \ldots\ldots\ldots (6)$$

3. Data analysis

The data collected where analysis by using statistical analysis of variance for statistical program (15), while the comparison for mean value was done by Duncan multiple range test and treatment means was tested at significant level $P \leq 0.05$.

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4. Results and discussion

4.1. Effect of Cutter bar height on the quantitative loss ratio of wheat crop

4.1.1. Losses of cutter bar unit (%)

Cutting height unit had a significant effect on the quantitative reduction loss rate in wheat yield shown in (Table 2). The lowest damage was recorded at a cutter bar height of 10 cm, with a loss rate of 2.96 %, while the maximum damage occurred at a height of 20 cm, resulting in a loss rate of 3.58 %. This represents a difference in wheat yield of 0.62% between the two-cutting height. When the cutting unit operates at heights between 10 cm and 20 cm, spikes may remain in the soil in some areas, leading to increased damage. Cutting at these heights can cause spikes to spread, break, or scatter during the process. Conversely, reducing the cutting height from 20 cm to 10 cm may significantly reduce wheat weight losses (%). Mcneil et al., (10) suggested that thicker stem at lower cutting heights offer greater resistance to the cutting bar, resulting in increased vibration, and grain loss. Therefore, maintaining cutting heights within an optimized range is crucial for minimizing yield losses.

4.1.2. Losses ratio of threshing unit (%)

Table 2 indicates that cutting height had a significant effect on erosion damage, at the second cutter bar height of 20 cm, the maximum weight loss percentage reached 2.96 %. In contrast, the lowest wilt damage rate was recorded at the first cutter bar height of 10 cm, where the weight loss rate of wheat spikes was 2.40 %. The difference in wilt damage rate between the two cutting heights was 0.56%. The lower values at the 10 cm cutting height may be attributed to a reduction in the number of uncut grains, a decrease in the negative impact force, or a reduction in tensile strength, which makes the grains less adhesive. Additionally, optimal drum speed may have contributed to reduced wheat grain breakage. This pattern is aligning with the findings of (13). The findings are also consistent with those of Basavaraja et al. (3), who determined that wheat grain losses during the threshing process of 0.44 kg per quintal. Higher losses in the threshing unit occur as the proportion of plant residues containing spikes decreases. This leads to a greater number of spikes coming into contact with the components of the threshing unit, such as the concave and drum, resulting in increased grain losses over time (17).

4.1.3. Losses ratio of separation and cleaning unit (%)

From (Table 2), we observed how the two levels of cutter bar height unit affected the loss in the separation and packing units during harvesting at Qushtapa farm. The highest weight loss was recorded at the first cutter bar height of 10 cm, with a weight loss of 0.22 %. In contrast, the lowest weight loss was recorded at the second cutter bar height of 20 cm, which reached 0.16 %. The difference in weight loss between the two heights was 0.06%, indicating that the 20 cm cutter bar height resulted in a lower wilt damage rate compared to the 10 cm height. Additionally, a high heading rate can overwhelm the sorting mechanism, particularly when the wheat is wet or mixed with weeds. This can hinder the complete separation and cleaning of the grain, further contributing to losses.

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4.1.4. All losses ratio of combine harvester (%)

Table 2 shows the results of using two different cutter bar heights their effects on the proportion of combine harvester losses during harvesting in Qushtapa farm. The damage rate at the second cutter bar height of 20 cm, had the greatest impact on overall harvester combines losses with the maximum damage recorded at 6.90 %. In contrast, the first height of cutter bar 10 cm, was the least affected, with a damage rate of 5.50 %. The difference in damage rate on all combine harvesters between the two-cutter bar height 10 and 20 cm, was 1.4%. The reasons for the difference may be due to the high cutter bar unit which affects the increased losses of the cutting unit, threshing unit and separation and cleaning unit during the combine harvester operation in the field, but the lower kettle bar unit affects all combine harvester losses. A cutting height of 10 cm results in the highest loss percentages for harvester units, leading to a significant increase in total harvester and overall losses. Pawar et al. (12) reported that the total field loss of wheat harvested using a combine harvester in India was 4.20%. The findings of this study align closely with that result. Increasing the height of the combine harvester's cutter bar leads to a rise in losses across all units, including the cutter bar, threshing, separation, and cleaning units. As a result, the overall losses of the combine harvester increase (17).

4.1.5. Performance efficiency (%)

Table (2) shows the importance of combine efficiency on quantitative wheat yield losses which has a complete impact on the total wheat yield. In the first cutter bar height of 10 cm resulted in the most affected combine efficiency with a loss rate of 94.56 %, compared to the second cutting height of 20 cm resulted in the lower effect on combine efficiency, when the loss rate was 93.39 %. Here the wheat weight difference between the effect of cutting heights was 1.17%. This result may be due to the low effect of the combine efficiency on the height of the wheat harvesting unit in the cutter bar, and also the higher of the cutter bar unit during the combine operation in the field may increase harvest losses and further reduce combine efficiency.

Table 2. Effect of cutter bar heights % on studied characteristics.

Cutter bar heights	Studied characteristics				
	Losses of cutter bar unit %	Losses of threshing unit %	Losses of separation and cleaning unit %	All losses of combine harvester %	Performance efficiency %
10 cm	2.96 **b**	2.40 **a**	0.22 **a**	5.50 **b**	94.56 **a**
20 cm	3.58 **a**	2.96 **a**	0.16 **b**	6.90 **a**	93.39 **b**

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* Least is the best

-Different letters on the means, there are a significantly difference between them. By using Duncan's test to the level (0.05).

4.2. Effect of Reel height on the quantitative loss ratio of wheat crop

4.2.1. Losses of cutter bar unit (%)

Table 3 shows that the height of the reels had the low effect on the scattering spikes wheat rate of the cutting height unit. The minimum damage was recorded at a reel height of 60 cm, where the wheat damage weight after combine harvesting was 2.98 %, In contrast, the maximum scattered spikes was recorded at 80 cm reel height, with a scattered spikes wheat weight of 3.49 %, resulting in a difference of 0.51% in the wheat weight percentage between the two heights. Interestingly, the damage rates between 80 cm and 100 cm reel heights, with scattered spikes wheat weights were recorded of 3.49 and 3.40 %, respectively. These results were significantly higher compared to the damage recorded at the lowest reel height of 60 cm. The difference in damage weight between the second (80 cm) and third (100 cm) reel heights was only 0.09%. The lower reel height (60 cm) may result in less wheat weight loss in the cutting height unit. This outcome could be attributed to the spikes -cutting unit's ability to evenly cut the wheat spikes at the lowest reel height during harvest. Conversely, the reel heights may lead to increased damage due to unevenness in the cutter bar unit, causing more breakage and the throwing of wheat spikes during reel position. Jalali and Abdi, (6) stated that to minimize cutting losses, the reel should be positioned 15-25 cm above the cutter bar and set lower than the lowest height of the crop.

4.2.2. Losses of threshing unit (%)

Table 3 shows that reel height had a significant effect on the percentage of wheat scattered spikes caused by the threshing unit during combine harvesting operations. The third reel height (100 cm) recorded the lower loss rate of 2.47 %, which is a favorable result due to reduced losses. In contrast, the second reel height (80 cm) recorded the highest loss rate of 2.85 %, with a weight percentage difference of 0.38% mean (38%). This result may be attributed to increased wheat spike uptake at higher reel heights, which aligns with the height of the cutter bar unit. Alternatively, it may be due to unevenness in the wheat cutting process at these reel heights. Higher reel heights can have a greater impact on percentage losses due to reduced collection and pickup efficiency by the cutter bar unit, as well as increased breakage of wheat spikes.

4.2.3. Losses of separation and cleaning unit (%)

Table 3 presents a comparative analysis of the impact of three-reel heights (60, 80, and 100 cm) on wheat losses during post-collection separation and cleaning in combine harvesting. The third reel height (100 cm) resulted in the lowest damage, with a wheat weight loss ratio of 0.18%, mean (18 %). In contrast, the first- and second-reel heights (60 and 80 cm) showed higher losses, with a wheat weight loss ratio of 0.20%, mean (20 %), with a difference of 2%. The results indicate that reel height has a significantly greater effect on reducing separation and cleaning losses than that of very low ones. These results can be explained by the increased efficiency in wheat spike collection

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after the harvester passes, which significantly reduces the separation of grains and their movement through process the feeding rates. The minimal loss levels are likely due to precise equipment adjustments, such as optimizing the reel position both forward and backward with low and high of the cutter bar during harvesting. Additionally, favorable environmental factors and enhanced product quality, which minimize the presence of foreign materials, also play a role in reducing losses.

4.2.4. All losses of combine harvester (%)

The percentage of damage showed significant differences among the three-reel heights (60, 80 and 100cm) on the all damage of the combine harvester in the harvesting operation in Table 3. Minimum damage of combine harvester was recorded at 100cm height, wheat weight ratio of 5.80 %, while maximum damage on all losses combine harvester recorded was 6.76 %, at second reel height of 80cm. Wheat damage rate 0.96%, mean (96%). Also, at the lowest reel height of 60 cm the damage rate of wheat on the harvester combines when 6.01 %, was recorded which differed from the third reel height of 21% which was (21 %). Here it is clear to us that the increase in weight loss is due to the difference in the height of the relay, which may be due to more breakdown of the wheat and the increase in scattering spikes wheat with the feeding rate. Or raising the reel may cause the wheat spikes to spread and get out of their way. Increasing the height of the reel may increase the total losses of the combine harvester and the weeding, separation and cleaning of wheat after the process of harvester combine.

4.2.5. Performance efficiency (%)

Table 3 explained that first reel height significantly affected combine efficiency at 60 cm height, maximum loss was recorded (94.42 %), and minimum combine efficiency loss when (93.68 %) at second reel height 80cm, wheat weight percentage difference between first and second height (60 and 80 cm) with 0.74% which was (74 %). However, at the first- and second-reel heights (60 and 100 cm), the efficiency of the harvester was significantly affected when the results (94.42 and 94.31 %) were obtained compared to the second reel height. That result may be due to more efficiency of the harvester combine which affected more wheat yield loss. These results may be attributed to the high role of reel during combine harvesting, which significantly affects performance efficiency and affects wheat yield. Improper reel height can contribute to a reduction in the overall amount of wheat harvested.

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Table 3**.** Effect of Reel heights % on Studied characteristics.

Reel heights	Studied characteristics				
	Losses of cutter bar unit %	Losses of threshing unit %	Losses of separation and cleaning unit %	All losses of combine harvester %	Performance efficiency %
60 cm	2.98 **a**	2.80 **a**	0.21 a	6.01**a**	94.42 **a**
80 cm	3.49 **a**	2.85 **a**	0.21 a	6.76 **a**	93.68 **a**
100 cm	3.40 **a**	2.47 **a**	0.18 **a**	5.80 **a**	94.31 **a**

* Least is the best

-Different letters on the means, there are a significantly difference between them. By using Duncan's test to the level (0.05).

4.3. Effect of the interaction between the cutter bar and reel height on the quantitative loss ratio of wheat crop

4.3.1. Losses of cutter bar unit (%)

Table 4 shows that there is a statistically significant difference in the interaction effect between cutting height and reel height on the process of some parameter's unit contain: cutter bar cutting losses, wheat threshing unit, separation and cleaning unit, all combine harvester losses and combine harvester performance. The minimum rate between cutting height of 10cm with first reel height 60cm were reached 2.66 %. The maximum amount that from the first cutting height of 10cm to the second reel height of 80cm the data value reached 3.53%, on the cutter bar unit losses, the reason for the lower wheat loss at the first reel height due to lower cutter bar during harvest however higher reel may cause more spike breakage during cutting with the difference between the position reel heights being 0.87 %. It is also shown in the same table 2.73 % was recorded from the height of cutting 10 cm with the third height of reel 100 cm. The result that the loss is greater than the second reel height may be due to the uptake of the wheat spike into the combine head during harvesting, where the difference in data rate with the first reel height is 0.07 %. As shown in Table 4, the second of cutting height (20cm) with the same reel height indicated as (60cm) gave the best results for the loss cutting unit recorded data values up to (2.66 and 3.29 %). Also, while the first reel height (60cm) with the second cutting bar height (20cm) recorded damage, the cutting unit (3.29% %) recorded the least damage of wheat spikes while the third reel height reached 4.06 %. Using more reel lifts may further cause the spikes to break and fall to the ground causing further damage to the wheat crop. In general, we can observe that the threshed unit loss rate increases when increasing the reel height when combine harvester for both cutter bar heights.

4.3.2. Losses of threshing unit (%)

From Table 4 shows that both the cutting height of the harvester and the higher reel

which had less effect on the loss of threshing units. For the threshing units' loss, third reel height 100 cm and first cutting height which was the minimum reached 2.20 %, the maximum was recorded at the same cutting height 60 cm and first reel height 2.62 %. The highest loss was 3.24 % is indicated for the second cutting height 20 cm and reel height 80 cm, while the minimum damage of 2. 73 % was recorded at the same 20 cm height and the third reel height 100 cm. The reason for this result may be due to the combine harvester's harvesting and threshing losses which are represented by the broken grains and threshed or unthreshed spikes gathered behind the combine harvester process.

4.3.3. Losses of separation and cleaning unit (%)

The results also showed that there was minimal effect in terms of the interaction between cutting height × reel height on the losses of the separation and cleaning unit as shown in Table (4). The minimum damage rate was 0.18 % for damage loss on wheat separation and cleaning recorded for treatment of interaction between first cutting height of 10 cm to third reel height of 100 cm, and maximum damage rate of 0.26 % was taken between cutting height to 60 and 80 cm, respectively. Whereas, for the interaction treatment between the second cutting height of 20 cm to the second reel height of 80 cm, the minimum loss ratio reached 0.15 %. Also, at the same cutting height of 20 cm for the third reel height, the highest rate was recorded at 0.18 %. The reason for this may be a lack of standing weeds within the field at harvest contributing to higher loss rates on separation and cleaning, or it may be due to irregularities in the crosscut where large amounts of wheat enter the harvester.

4.3.4. All losses of combine harvester (%)

Damage loss of all Combine harvesting was significantly affected by the interaction between cutting height and reel height which were recorded in (Table 4). The minimum rate on all combine harvester losses was 4.63 % in the interaction between first cutting height 10 cm to third reel height 100 cm, while the maximum rate recorded was 6.23 %, from cutting height 10 cm to second reel height 80 cm. The difference rate losses between them reached 1.6 %, and the results showed that from the second cutting height of 20 cm to the first reel height of 60 cm, the loss rate reached 6.46 %, there was minimum loss, but maximum loss of all harvesting combine 7.28 %, was recorded due to intermediate treatment of cutting height to second reel height was 80 cm where the difference of wheat yield loss rate was 0.82 %. In Table 4 the results showed that losses between the first cutting height interactions of 10 cm and reel heights of 60, 80 and 100 cm were significantly lower than harvesting combine losses in the interaction between second cutting height and reel heights of 60, 80 and 100 cm. This affected results at cutting height to 10 cm cut height less than the second cutting height 20 cm. Combiner harvest losses were also significantly different ($P < 0.05$) between first cutting height level 10 cm and reel heights 60, 80 and 100cm, versus second cutter bar unit height 20 cm for the same height of reel 60, 80 and 100 cm. This reduction in losses may be attributed to lower losses in the cutting, separation, and cleaning units. Also, it may be due to of the raising of the different between the cutting height with the reel height more damaging and affect the loss of the threshing, separation and cleaning unit. In general, these heights should be improved depending on the wheat type, field conditions, and machine design to minimize damage.

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4.3.5. Performance efficiency (%)

In Table 4 the results show the effect of two treatments of the interaction between the height of the cutting wheat crop and the height of the reels on all the efficiency performance losses of the harvester combine. The results interaction between the cutting height (10, 20 cm) and the position height of the reels (60,80, 100 cm) after combine harvesting in the field showed us that the results indicated that the damage was influenced by the interaction between the cutting height wheat crop. Harvester combine efficiency losses were significantly different when ($P < 0.05$) between cutting height and reel height. Losses from 10cm cutting height to 100 cm reel height, which was estimated to be 95.12 %, which was more effective than same 10cm cutting height to 80cm height, data value reached 94.10 %, the difference between highest rate and lowest performance efficiency rate was (1.02%). Also, from the second cutting height of 20 cm to the first reel height of 60 cm, the harvester combines efficiency loss rate of 94.01 %, the highest rate was recorded. While combine efficiency loss at the same cutting height 20 cm for the second reel height 93.24 %, the lowest combine efficiency loss rate was recorded. The difference between the highest rate and the lowest performance efficiency rate was (0.77%) The studied reel (60, 80 and 100 cm) recorded the best results for performance efficiency when (94.01% and 93.24%) were obtained. At the same time, we see that the first cutting height of the cutter bar 10 cm and the position reel heights (60, 80 and 100cm) recorded the best efficiency of the harvester combine which ranged between (95.12% and 94.01%) after combine harvesting.

Table 4**.** The interaction effect of Cutter bar height and Reel heights % on Studied characteristics.

Cutter bar height	Reel height	Studied characteristics				
		Losses of cutter bar unit %	Losses of threshing unit %	Losses of separation and cleaning unit %	All losses of combine harvester %	Performance efficiency %
10 cm	**60 cm**	2.66 **b**	2.62 **a**	0.26 **a**	5.55 **ab**	94.82 **ab**
	80 cm	3.53 **ab**	2.44 **a**	0.26 **a**	6.23 **ab**	94.10 **ab**
	100 cm	2.73 **b**	2.20 **a**	0.18 **a**	4.63 **b**	95.12 **a**
20 cm	**60 cm**	3.29 **ab**	2.97 **a**	0.16 **a**	6.46 **ab**	94.01 **ab**
	80 cm	3.44 **ab**	3.24 **a**	0.15 **a**	7.28 **a**	93.24 **b**
	100 cm	4.06 **a**	2.73 **a**	0.18 **a**	6.96 **a**	93.49 **b**

* Least is best

-Different letters on the means, there are a significantly difference between them. using Duncan's test to the level (0.05).

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5. Conclusion

The concluded of the study indicated that the different between two cutting heights and three-reel heights had a significant effect on reducing the losses of quantitative loss ratio of Wheat grain yield. Among the interaction between cutting the wheat at a height of 10 cm and setting the reel height at 60 cm indicate the most positive impact in minimizing losses associated with head cutting unit, threshing losses, separating and cleaning, and the all losses of the combine harvester. This improvement is attributed to the increased efficiency of the combine harvester under these conditions. Additionally, the interaction between the 20 cm cutting height and different reel heights (60, 80, and 100 cm) during combine harvester operation in the field also affected yield losses. Conclusion that grains losses decrease and the efficiency of the combine harvester increase at increasing cutting bar height and reducing the reel height. Moreover, proper reel adjustment and selecting cutting bar height can reduce losses and increase harvester efficiency.

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