Influence of threshing machine type, its speed and grain moisture on the factory maize.

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Abstract :
To ensure a high-quality maize threshing manufacturing process within the factory, various aspects of production must be considered at all crop's processing stages, including the locally designed and developed threshing machine, the threshing cylinder speed and the grains moisture content. The presented study sought to evaluate two threshing machines (DLM- MTM and LM- MTM) in integration with two speed of threshing cylinder TCS2 levels (350 and 500 rpm) and grains moisture content (M) levels (9.5 and 23.5%) carried out in 2023–2024 at the Baghdad University, College of Agricultural Engineering Sciences, in the Department of Machinery and Equipment, Iraq. The study proceeded in a randomized complete block design (RCBD) using a split-plot arrangement, with three factors and three replications. The results showed that the DLM- MTM threshing machine was significantly better than LM- MTM threshing machine in all studied conditions. For DLM- MTM, the machine productivity, power required, percentage, broken maize, threshing efficiency and grain cleaning were recorded 287.97 $kg.hr^{-1}$, 97.31%, 1.125 Kw, and 2.66%, respectively, while there were 272.40 $kg.hr^{-1}$, 98.79%, 1.207 Kw, and 6.87%, respectively under the same operating conditions for LM- MTM. The speed of threshing cylinder 500 rpm was significantly superior to the other level of 350 . While the maize grain moisture content at range of %9.5 was significantly superior to the other range of % 23.5 28.a in all studied conditions.

Keywords: Machines, maize, Cylinder speeds, grains moisture content, threshing
Keywords: Machines, Maize, Cylinder Speeds, Grain Moisture Content, Thresher.

Introduction

Maize (Zea mays)occupies the forefront of the list of necessary food crops, on which the majority of peopled. The introduction may be supported with more recent literatures. depend on it for their food, that the efforts of the research centers at the Ministry of Agriculture are continuing to improve the productivity of this crop, as it follows modern technological methods in the cultivation of high-productivity early maturing varieties, which is reflected in increased production and improvement of the quality of the crop, in addition to directing surplus production to export [3]. The maize productivity provided for processing operations is affected by two factors: To obtain high quality and productivity of rice, it depends on the maize type, its moisture content, and speed cylinders, the number of broken grains, and the damaged maize, all of these factors mentioned are taken place upon receipt of the product by farmers [19,16]. Most researchers in the agricultural machinery field have confirmed that the requirements for the machine development design are determined by the reduction in the ratios of breakage and damage to seeds resulting from the husking process with the highest designed machine productivity [22 .[

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Understanding the mechanism of maize grain impact threshing is key to improving the performance of maize threshing, with less energy consumed, high efficiency in the separation process, and the production of raw maize with the lowest breakage rate [1]. that an increase in broken maize due to increase in the mechanical effort during rice manufacture leads to increase percentage broken maize, increased productivity and threshing efficiency associated with increasing the cylinder speed and moisture content decreased grains [17]. A study [13] that the high productivity rate for maize grains is achieved by increasing the machine practical speeds with a decrease in the grains moisture content [15]. The lower energy consumption is associated with higher grain moisture content consequently dropping the threshing machine capacity. [14], reported that regulating of threshing machine operation has a direct effect on its productivity. With best adjusting of threshing machine, reducing the percentage of grain breaking then increasing machine efficiency that translate to ascending the machine productivity [5.[

The percentage of grains affected increases with the increase in the moisture content grains due to the plasticity of the grains, which makes them vulnerable to damage with the least external effort . [8, 23]. Show that there is a direct relationship between the speed of the threshing machine and the damage grain percentage [2], that there is a direct relationship between the energy consumed amount and the moisture content, that is, the greater the grains moisture, the stronger their adhesion to the shell, which requires greater force to waste, which increases the amount of energy consumed. [7, 18] . During the maize production process, some grains are subjected to cracking and broken, the reason for this is due to the forces exerted on the maize manufactured in the husking chamber. Therefore, all broken ears are removed before the marketing process. [11,6]. The mechanical damage that occurs to the maize grains during the threshing, process depends not only on the threshing machine design but also on the maize physical properties [9,4]. The threshing process depends mainly on the crop type to be manufactured and the machine engineering design[12]. To ensure that maize threshing with high efficiency, its parts must be designed in a way that achieves this[10], that the regulations and modifications of the threshing unit in maize, the design of the threshing unit in maize threshing machines has an effective and direct impact on the proportion of damaged and broken grains as well as on increasing efficiency and productivity

Material and Methods

The study was conducted to modify the thresher cylinder in the maize threshing machine (1).The modification process of the thresher cylinder was summarized by replacing the iron fingers fixed on the rotary axis Fig .1, with flexible metal springs (3) as they reduce the strokes momentum of the working parts of the thresher cylinder on the grains . A sensitive scale with a digital screen was used to weigh the samples, a direct measurement device for the grains moisture content for study samples, an electronic device, the rotating speed of the rotating axis determined by an electronic device (inviter) Reflector J installed on the electrical circuit of

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the engine, the rotating speed of the threshing machine was measured by a laser speed measurement device, An experiment was conducted to study the impact of the development of the homemade yellow corn discernment machine on the studied qualities. The study included the condition of the machine (before development and after development) and under the same working conditions. The study included several of the following qualities: machine productivity, threshing efficiency, amount of energy consumed, and damaged grains percentage .

Figure 1. The machine (DLM-MTM type

Figure.2, locally manufactured cylinder

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Figure 3, development threshing cylinder

Study Factors

The first factor: The threshing machine speed, included TCS1 (350 rpm), and TCS2 (500 rpm .(

The second factor: The grains moisture content GM1 (9.5%), and , GM1(23.5%.(

The third factor : The machine type i.e. undeveloped locally-made machine (LM-MTM), and the developed machine (DLM-MTM.(

The studied qualities:

.2.2.1Machine productivity It was calculated according to[12,17.[

MP= Productivity (kg .hr-1 (

Mp= (Mt)/T×3.6….(1 (

Mt= Total Grain Weight (g(

T=Time (sec (

Threshing efficiency%

The threshing efficiency was determined by [24], calculated from Eq.2.

SE=100-((M2)/(M1))…..(2(

SE= Abandonment Efficiency

M2 = Weight of non-excessive grains (stuck on the case(

M1 = Total Grain Weight

Damage percentage %

The damage ratio was determined by [22], calculated from Eq.3

Gd =(Ma)/(MT)X 100---(3(

Ma = Mass of grains affected

MT= total grain mass (grain only (

Power required Kw

It was calculated according to[7,20[

SER= P(w)/SP(Kg) ×1000 …(4 (

SER = Specified or required power (kW .Ton μu

)Watts) = P wattage (in watts or joules(

Sp= machine yield or machine (kg (

P(w) =is the power consumed (watts) and can be found from the following equation (5) [21,25[

P(W)=(I*V*ŋ*Cosθ)/(1000)=)….(5(

P= Kilowatt (W(

I = Ampere

V = Voltage (220V (

ŋ = Mechanical efficiency (0.95 (

Cosθ = Power factor (0.85(

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The results were analyzed statistically using GenStat 18th edition with design complete randomized design (RCBD) and the difference among treatments for each factor was tested according to the LSD test at α = 0.05 significance level.

Results and Discussion

Technical indicators for the maize threshing machine

Machine productivity (Kg.hr-1(

The influence of threshing cylinders speed, grains moisture content, and machine types on the machine productivity Kg hr-1.The TCS2 of 500 rpm gave higher result, which required of 303.08 Kg hr-1 as compared with TCS1 of 350 rpm, which required of 207.87 Kg hr-1. From Table 1, it is indicated that the DLM-MTM was significantly better than the LM-MTM , for machine productivity 256.82 and 254.12 Kg hr-1respectively, under the same operating conditions for DLM-MTM. The threshing mechanical is the best way to complete the threshing process in the least time, in addition to the regularity of threshing methods for DLM-MTM. [7]. The increasing of grains moisture content led to the decrease of the machine productivity were the GM1 of 9.5% give best of results which required 275 .54Kg hr-1, GM2 of 23.5% required 235.41 Kg hr-1respectively at different grains moisture. Lead to obstruction of the threshing due to overload on a LM-MTM type machine with increase in grains moisture. [19] The interaction among parameters of DLM-MTM, speed TCS2 of 500 rpm and the grains moisture content GM1 of 9.5% caused the best results (331.35 Kg hr-1.(

Threshing efficiency(%)

Table 1, it is indicated that the threshing efficiency of the DLM-MTM is significantly better than LM-MTM , the results were 98.35% and 98.11 % respectively. This due to lack of coherence between machine teeth inside the vacuum chamber and maize grains when grains moisture increased hence machine efficiency decreased, [2]. The influence of speed on the machine efficiency %. At TCS2 of 500rpm has the highest threshing efficiency of 99.02%, and TCS1 of 350 rpm has the lowest threshing efficiency of 97.43%. This is due to the increased vacuum inside the separation chamber resulting from the flow of seeds with increased velocity on one side of the separation chamber [6]. The grains moisture GM1 of 9.5 % give best of results, which required of, 99.72% as compared with GM2 of 23.5%, which required of 96.74%. [15[

Power required(Kw (

DLT- MTM machine emerged superior and showed the lowest average of power required 1.42 Kw, compared to LT MTM machine 5.33kw (Table 1). This may refer to the engineering design of the DLT MTM threshing machine and the worker skill, [3]. The results also indicated significant differences among grains moisture content for power required. The GM2 recorded the topmost average power required of 4.52Kw, while the level of GM1 appeared with the lowest average 2.23 kw. The reason for the high power values is due to the convergence between the cylinders, with minimal effort on the maize grain inside the hulling chamber [12]. The TCS1 speed on record the highest value of 2.97Kw, followed by TCS2 speed which gave of 3.78Kw. The interaction among parameters of DLM-MTM, speed TCS1

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350rpm and the grains moisture GM1 of 9.5% caused the best results (0.46.%(

Damage percentage%

The results shown in the statistical analysis Table. 1, that there is a highly significant effect of the type of machine factor in the damage ratio, there are significant differences, as the treatment of the machine type DLM-MTM on record the highest damage ratio of 1.189%. In contrast, the LM-MTM treatment gave the lowest broken ratio1.175%, respectively. The superiority of the broken rice ratio in the to LM-MTM machine, compared to DLM-MTM machine type, due to homogeneity of machine work performance DLM -MTM represented by the automated design of the threshing room by giving the lowest damage ratios. [2]. The GM1 at 9.5 mm showed the minimal damage maize ratio of (1.035%), while the top damage maize ratio of(1.329%) was for GM2 23.5% clearance. Increasing the damage ratio inside the threshing chamber gave freedom of movement of the grains while extracting the threshed from them, it decreased its receding and friction in the husking chambers, and thus the damage ratio decreased [23]. As for the effect of the threshing cylinders speed on the values of damage maize, as it appears from the results of the statistical analysis of the (Table. 1), the TCS2 was significantly superior to the TCS1, and the results were1.048 % and 1.316 %. In this study is a guide to the suitability of speed with the study factors by giving the best damage ratios for maize grains[21]. The interaction among parameters of LM-MTM, speed TCS2 500rpm and the grains moisture GM1 of 9.5% caused the best results (0.916.%(

Table 1 Effect of cylinder rotation speed, maize grains moisture, and machine type on Technical indicators for the maize threshing machine

Threshing cylinder speed (rpm)	Grains moisture (%)	Threshing machine	MP	TE	DR	PR
TCS1	GM1	**DLM-MTM**	**232.97**	**100%**	**1.114**	**0.46**
		LM-MTM	**217.23**	**98.88**	**1.169**	**2.86**
	GM2	**DLM-MTM**	**185.77**	**96.08**	**1.575**	**1.78**
		LM-MTM	**195.50**	**94.77**	**1.410**	**6.77**
TCS2	GM1	**DLM-MTM**	**320.59**	**%100**	**0.943**	**0.78**
		LM-MTM	**331.35**	**%100**	**0.916**	**4.81**
	GM2	**DLM-MTM**	**287.97**	**97.31**	**1.125**	**2.66**
		LM-MTM	**272.40**	**98.79**	**1.207**	**6.87**
Average of Speed		**TCS1**	**207.87**	**97.43**	**1.316**	**2.97**
		TCS2	**303.08**	**99.02**	**1.048**	**3.78**
Average of moisture		**GM1**	**275.54**	**99.72**	**1.035**	**2.23**
		GM2	**235.41**	**96.74**	**1.329**	**4.52**
Average of machine		**DLM-MTM**	**256.82**	**98.35**	**1.189**	**1.42**
		LM-MTM	**254.12**	**98.11**	**1.175**	**5.33**
	TCS		**28.09**	**0.584**	**0.117**	**0.797**
	GM		**28.09**	**0.584**	**0.177**	**0.797**

LSD=0.05	**TM**	**28.09**	**0.584**	**0.177**	**0.797**
	TCS*GM	**35.55**	**1.068**	**0.158**	**2.97**
	TCS*TM	**35.55**	**1.068**	**0.158**	**2.97**
	TM*GM	**35.55**	**1.068**	**0.158**	**2.97**
	TCS*GM*TM	**56.18**	**1.169**	**0.235**	**1.593**

Threshing cylinder speed . TCS; Grains moisture . GM; Threshing machine . Development of a locally manufactured maize threshing machine DLM-MTM, Locally manufactured maize threshing machine LM-MTM. TM; Machine productivity MP; Threshing efficiency. TE; Damage ratio. DR; . Power required. PR.

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