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STUDY THE EFFECT OF ANGULAR SPEED OF SHELLING CYLINDER ON SOME TECHNICAL INDICATORS FOR OPERATING MODIFIED SHELLER MACHINE

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Abstract

This experiment was carried out at 2019, in the factory of shelling corn ears at Al-Musayyib, Babylon governorate, the aim of the research is to determine the effect of g angular speed of shelling cylinder on some technical indicators for operating modified sheller machine by using the effect of the feeding rate 8, 12 and 14kg/h with angular speed of shelling cylinder 900, 1100 and 1300 rpm on some the indicators, such as shelling efficiency, shelling rate, shelling costs and grain damage percentage. This research was done by applying the factorial experiment design within RCBD using four replicates. This study was obtained the results showed the following: increasing of feeding rate from 8, 12 and 14kg/h caused an increasing in shelling rate and grain damage percentage and decrease in the shelling efficiency and shelling cost. Feeding rate 8 (kg/h) indicated significant superiority up on feeding rate 12 and 14(kg/h) achieved higher shelling efficiency and shelling cost, while feeding rate 14(kg/h) achieved higher shelling rate. Increasing the angular speed of shelling cylinder from 900 to 1100 and 1300 rpm caused an increasing in shelling efficiency and shelling rate, and decrease in grain damage percentage.

Key words: Angular speed of shelling cylinder, shelling efficiency, shelling rate, shelling costs and grain damage percentage

Introduction

The maize crop is one of major cereal crops grown in Iraq, in terms of their economic and food importance. Maize contains approximately 72% starch, 10% protein, and 4% fat (Dula, 2019). It enters the nutrition of humans and animals and it's also used in many various of food industries so it has been trend to increasing the production of maize crop, with the increased need to techniques and means to work on shelling corn grains. The researchers (Adewole *et al.,* 2015) reported that the maize shelling is defined as removal of corn grains from the cobs by the initial impact, and rubbing action as the material passes through a restricted clearance between the cylinder and concave bars (Buliaminu, 2011). In recent years the development of industrial revolution led to the development of machines which it's used to shelling corn grains with high efficiency, in this research modified sheller machine for obtaining more shelled corn grains with less damaged seed (Abdulkadir *et al.,* 2009; Onkar, 2017).

Maize shelling is difficult at moisture content above 25%, with this moisture content; grain detachment efficiency is very poor with high operational energy and causing mechanical damage to the seed (Amare et al., 2017; Hussain, 2009). The feeding rate and velocity of conveyor depends fundamentally on the size of sheller machine, diameter and length of shelling cylinder with the main importance of angular speed of shelling cylinder. Modifications corn sheller machine that can be used by the people of the middle to lower and this will improve the quality and quantity of corn shelled save time and as confirmed by the researchers (Taha *et al.,* 2018; Nyongesa, 2014). Mechanical damage for sheller on corn grain has adverse economic effects on the farmer, processor, and eventually the consumer. Machine made of angle steel, cylinder sheller and the conveyor belt are driven by an electric motor to power the electric motor and 900, 1100 and 1300 rpm. Most other parts of the corn shelling machines are manufactured in Iraq.

Materials and Methods

The experiment was carried out in factory of shelling corn grain in Al-musayyib, Ministry of Agriculture at 2019. The grain was shelled at a moisture of 17%. The research conducted by using the factorial experiment design within

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RCBD using four replicates to study two factors:

Feeding rate: This included 8, 12 and 14(kg/h), was done through a conveyor belt driven by an electric motor to power 7 hp.

Angular speed of shelling cylinder: which included speeds of 900, 1100 and 1300 rpm, this was done through a cylinder with a diameter of 150 mm and a length of 950 mm and installed on it plates shaped radially with 6 panels and a distance 25 mm between a plate and another. The speed is controlled by electric motor (Leroy Somer), which is characterized by (three phase - variable speed) and power 20 hp.

Indicators studied:

Shelling efficiency: the following formula given by (Al-sharifi *et al.,* 2019) :

$$E_{sh} \quad \frac{W_T \quad W_{unsh}}{W_T} \quad 100$$

E_{sh} = Shelling efficiency %

W_T = Total weight of shelled grains (kg.).

W_{unsh} = Weight of unshelled grains (kg.).

Shelling rate: It is calculated by using the following equation that is given by (Ali *et al.,* 2018) :

$$Sh_{rate} \quad \frac{W_{sh.}}{T}$$

Sh_{rate} = shelling rate ($kg.h^{-1}$).

W_{sh} = Weight of shelled grains (kg.).

T = Time (h).

Shelling cost: is calculated according to the equation that is given by (El-desoukey, 2007):

$$S_c \quad \frac{P}{H} \quad \frac{1}{a} \quad \frac{i}{2} \quad t \quad r \qquad P_m \quad E_p \quad \frac{0}{175}$$

S↓c = shelling costs (dinar.h↑(-1)).

P = price of the equipment (dinar).

H = working hours yearly.

a = life expected of the machine, year.

i = interest rate (%).

t = taxes and over heads ration (%).

r = repair and maintenance ration (%).

P_m = power of motor (kW).

Ep = electricity cost, $\frac{dinar}{kW}.h$.

O = operator monthly salary (dinars).

175 = the monthly average working hours.

Grain damage percentage: the following formula given determine the percentage of grain damage with weight the split and cracked grains are weighted (El-sharawy, 2015):

$$D_G \quad \frac{W_{se}}{W_s} \quad 100$$

D_c = Grain damage percentage (%).

W_{se} = Weight of split grains (g).

W_s = Total weight of shelled grains (g).

Results and Discussion

The table 1 shows the effect of feeding rate and angular speed of shelling cylinder on shelling efficiency (%). As the results of the statistical analysis showed that there are significant effect feeding rate by using L.S.D at the 0.05 level where the superiority feeding rate 8 (kg/h) on feeding rate 12 and 14 (kg/h) achieved the higher shelling efficiency amounted 98.33%, also registered angular speed of shelling cylinder 1300 (rpm) achieved higher shelling efficiency amounted 96.11% . As shown in table 1 that feeding rate 8 (kg/h) and 1300 (rpm) achieved higher shelling efficiency 100.00 %, while feeding rate 14 (kg/h) and angular speed of shelling cylinder 900 (rpm) achieved less shelling efficiency 78.49 %. The reason of that because an increasing the angular speed of shelling cylinder led to increasing in a shelling efficiency indicated by other researchers (Ilori *et al.,* 2013).

The table 2 shows the effect of feeding rate and angular speed of shelling cylinder shelling rate (kg/h). As the results of the statistical analysis showed that there is significant effect feeding rate by using L.S.D at the 0.05 level where the superiority feeding rate 14 (kg/h) on feeding rate 8 and 12 (kg/h) achieved higher shelling rate amounted 18.68 (kg/h), also registered angular speed of shelling cylinder 1300 (rpm) higher shelling rate amounted 17.93 (kg/h). As shown in table 2 that feeding rate 14 (kg/h) and 1300 (rpm) achieved higher shelling rate 21.96 (kg/h), while feeding rate 8 (kg/h) and angular speed of shelling cylinder 900 (rpm) achieved less shelling rate 9.13 (kg/h). The reason due to the interaction between the angular speed of shelling cylinder and feeding rate led to increase shelling rate this allowed to decrease time required for sheller production as indicated by other researchers (Kumar, 2013).

The table 3 shows the effect of feeding rate and angular speed of shelling cylinder shelling cost (dinar/h). As the results of the statistical analysis showed that there is significant effect feeding rate by using L.S.D at the 0.05 level where the superiority feeding rate 14 (kg/h) on feeding rate 8 and 12 (kg/h) achieved less shelling cost amounted 185.34 (dinar.h^{-1}), also registered angular speed of shelling cylinder 1300 (rpm) less shelling cost amounted 169.03 (dinar.h^{-1}). As shown in table 3 that feeding rate 14 (kg/h) and 1300 (rpm) achieved less shelling cost 158.53 (dinar.h^{-1}), while feeding rate 8 (kg/h^{-1}) and feeding rate angular speed of shelling cylinder 900 (rpm) achieved higher shelling cost 273.53 (dinar.h^{-1}) The shelling cost increased because of the shelling cost proportional inversely with the time of shelling, especially with the less time required for shelling grain when the angular speed of shelling cylinder increased , indicated by other researchers (Aswanda, 2014; Yekinni, 2017).

The table 4 shows the effect of feeding rate and angular speed of shelling cylinder grain damage percentage (%). As the results of the statistical analysis showed that there is significant effect feeding rate by using L.S.D at the 0.05 level where the superiority feeding rate 8 (kg/h) on feeding rate 12 and 14 (kg/h) achieved less grain damage percentage amounted 3.093 (%), also registered angular speed of shelling cylinder 900 (rpm) less grain damage percentage amounted 3.422 (%). As shown in table 4 that feeding rate 8 (kg/h) and 900 (rpm) achieved less grain damage percentage 2.952(%), while feeding rate 14 (kg/h) and angular speed of shelling cylinder 1300 (rpm) achieved higher grain damage percentage 4.169 (%). The reason of increase grain damage percentage because is directly proportional to the angular speed of shelling cylinder, also because that there are so much impact force of cylinder plates on shelled grain when angular speed of shelling cylinder increased hence increasing the grain damage percentage indicated by the researchers (Tastra, 2009; Bako, 2017).

Table 1: Effect of feeding rate and angular speed of shelling cylinder on shelling efficiency (%)

Feeding rate (kg/h)	angular speed of shelling cylinder (rpm)			Average
	900	1100	1300	
8	96.41	98.57	100.00	98.33
1214	85.5378.49	92.7783.36	99.2889.04	92.5383.63
L.S.D		4.29		2.87
Average	86.81	91.57	96.11	
L.S.D		3.36		

Table 2: Effect of feeding rate and angular speed of shelling cylinder on shelling rate (kg/h)

Feeding rate (kg/h)	angular speed of shelling cylinder (rpm)			Average
	900	1100	1300	
8	9.13	11.27	13.59	11.33
1214	12.2915.36	16.9118.72	18.2421.96	15.8118.68
L.S.D		0.660		0.421
Average	12.26	15.63	17.93	
L.S.D		0.492		

Table 3: Effect of feeding rate and angular speed of shelling cylinder on shelling cost (dinar/h).

Feeding rate (kg/h)	angular speed of shelling cylinder (rpm)			Average
	900	1100	1300	
8	273.53	219.05	182.37	224.98
1214	238.48209.15	204.68188.34	166.19158.53	203.12185.34
L.S.D		8.25		6.13
Average	240.39	204.02	169.03	
L.S.D		6.46		

Table 4: Effect of feeding rate and angular speed of shelling cylinder on grain damage percentage (%)

Feeding rate (kg/h)	angular speed of shelling cylinder (rpm)			Average
	900	1100	1300	
8	2.952	3.106	3.220	3.093
1214	3.4753.838	3.6293.974	3.8154.169	3.6403.994
L.S.D		0.318		0.195
Average	3.422	3.570	3.735	
L.S.D		0.214		

Conclusion

1- It can be concluded that the angular speed of shelling cylinder 1300 (m/min) with feeding rate 2.4 (m/s) led to decrease the labor cost and maintenance & repair cost.

2- The angular speed of shelling cylinder 1300 (m/min) with feeding rate 2.4 (m/s) led to an increasing in power consumed cost and shelling cost.

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