Affecting on threshing machine types, grain moisture content and cylinder speeds for maize, Cadiz variety

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Abstract: The effect of thresher machines on maize/Cadiz planting was studied based on some technical indicators. Two types of maize threshing machines (Local MTL and MGI-TY 60) were tested under three revolutions of threshing cylinder (200, 250 and 300 rpm). The experiments were conducted in a factorial experiment under complete randomized design with three replications. The results showed that the Local MTL threshing machine was significantly better than MGI-TY 60 threshing machine in all studied conditions. For Local MTL, the machine productivity, power consumption, cracked grain percentage, broken maize, threshing efficiency and grain cleaning were recorded 1.96 t h^{-1}, 11.36 kW, 4.024%, 5.973%, 83.918%, 88.845% respectively while there were 1.147 t h^{-1}, 12.23 kW, 4.374%, 6.729, 83.263% and 87.483% respectively under the same operating conditions for MGI-TY 60. The revolution of threshing cylinder 200 rpm was significantly superior to the other two levels of 250 and 300 rpm in maize grains breakage, cracked maize grains, whole maize grains and maize grains cleanliness. While the maize grain moisture content at range of 15% was significantly superior to the other ranges of 17% and 19% in all studied conditions.

Keywords: maize, moisture content, thresher velocity, Cadiz cultivar, thresher

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1 Introduction

Corn, or maize, is one of the most important crops in the world. About 700 million metric tons of this nutritious and valuable plant are harvested annually worldwide. Corn is a summer annual crop. It is mainly used for livestock feed, not to mention its rapidly increasing production for ethanol, a renewable fuel and is being used in hundreds of other products worldwide. In the best threshing process, corn grains whit lowest level of moisture and less revolution number of threshing machine (Najim, 2000), that there is an effect of the characteristics of the machine, resulting in increased production and low energy consumption (Alwan et al., 2016). Maize is staple foods for the population of Western countries, contributing about 50% of dietary fiber intake (Vitaglione et al., 2008). The mechanical properties of grain settling depends on the properties of the single grain, friction between particles, inter-particle contact geometry and load history. Having tested the performance of the fabricated machine, it could be concluded that the shelling efficiency, cleaning efficiency, grain recovery efficiency, Sheller performance index, total grain losses decrease and output capacity increased. At 13% moisture contents of maize and at 886rpm shelling speed. The best moisture content of maize for shelling (Pavasiya et al., 2018). The moisture content has a different influence on grains properties. Study of (Shepherd et al. 2012) showed that, when grains were subjected to uniaxial compression, it behaved as an elastic-plastic-viscous body which exhibited creep, stress relaxation and elastic after effects. If the amount of grain moisture content is high, it makes them enter the phase of the plasticity which makes corn threshing very difficult. Therefore, it needs more time to complete threshing, which leads to the decrease of machine productivity (Balasubramanian et al., 2011).

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. The screen opening size is the most significant factor affecting the corn fineness. Also, grain moisture contents increased up to 12% plasticizes and caused a transformation from brittle-elastic (ASAE, 2000).

The increase in moisture content caused a reduction in the friction coefficient between grains (Dziki, 2004). Energy required for grinding these materials was measured. Among the four materials, grass had the highest specific energy consumption (27.6 kW ht^{-1}), and corn stover had the least specific energy consumption (11.0 kW h t^{-1}), at 3.2 mm screen size (Velu et al., 2006). Increasing the forward speed of thrashing machine increased the machine productivity in which the velocity of speed of threshing cylinder machine is toward more controls. In this case, the operator is responsible for managing this important parameter (Humburg, 2016). Studied the effect of flax thresher system partial mechanized complete and were results which obtain that the unthreshred seed losses decreased by decreased seed moisture content (El-Gayar., 2005). Maize shelling is defined as removal of 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 (Ayetigbo, 2001). Shelling efficiency, cleaning efficiency, grain recovery efficiency and output capacity were high which were at highest values at 13% moisture contents of maize and at 886 rpm shelling speed. Thus, shelling of maize at 13% moisture content dry basis using 886 rpm shelling speed resulted into the highest efficiencies and capacity of the machine when compared with other moisture contents and shelling speeds (Aremu et al., 2015).

Al Saadi and Al Ayoubi (2012) explained that there was a significant effect on energy consumption between each of threshing machine types and grain moisture content. Also, they concluded that lower energy consumption was found with higher grain moisture content consequently dropping the threshing machine capacity. AbuKhair et al. (2005) reported that regulating of threshing machine operation had a direct effect on its productivity. With best adjusting of threshing machine, the machine reduces the percentage of grain breaking then increases machine efficiency that translate to ascending the machine productivity. Maize production process using scientific technology methods for sheller process is give productively high by adopting modern technological methods to reduce the percentage of loss and increase profit .as also recommend works and other development works must do to introduce new technologies and increase perception of farmers and other users (Dawit, 2016).

The machine productivity is affected by the speed of threshing cylinder, as well as grain moisture content. When increase speed sheller and grain moisture, it leads to increase the maize grains breakage and decrease the total machine productivity (AlSharifi, 2007). The materials produced in the process of simulation were compared with those in the experiments as the effect of moisture content on physical and mechanical properties of maize done by Lupu et al. (2015). They found that the force, energy and modulus of elasticity decreased with an increase in the content of the moisture in the kernel, like at the wheat individual kernels compression. Meanwhile, the surface area and the kernel deformation are increasing with the increasing moisture content.

The main goal of this research was to study the effect of threshing machines on maize specification under Local MTL and MGI-TY 60 threshing machines at different speeds of threshing cylinder and different ranges of grain moisture content.

2 Materials and methods

This study was conducted in 2017 to evaluate Local MTL and MGI-TY 60 threshing machines performance. The experiments were done at three levels of grain moisture contents (15%, 17% and 19%) and three revolution number of threshing cylinder (200, 250 and 300 rpm).

The cadiz cultivar was selected for the experiments and the samples were taken by the probe which collected on the form of heap. The heaps number were six and the mass of each heap was 250 kg. The random samples of maize ear taken from each heap were cleaned using sieves to remove all foreign matters, broken and immature grains. Two types of threshing machines (Local MTL and MGI-Ty 60) were also for experiments with different speeds of 200, 250 and 300 rpm. The maize thresher Local MTL machine has the power of Ac 220 V, Single-Phase required motor 5 Hp, productivity 1500 kg h^{-1}, dimension

1026×471×990 mm, rate of revolution of a motor RPM 1800 r m^{-1} and it can be operated using an internal combustion engine or electric motor and the electric motor is adopted in this experiment (Figure 1). Maize thresher MGI-Ty 60 machine has the power of Ac 220 V, Single -Phase required motor 3 Hp, RPM 1800 r m^{-1}, productivity 1500 kg h^{-1}, dimension 1030×260×700 mm (Figure 2). The initial moisture content of corn was determined by oven drying methods at 103°C for 48 h (Sacilik et al., 2003). The maize of Cadiz cultivar was kept in an oven at temperature of 43°C and monitored carefully for determining the moisture content of grain under all out let of samples at 19%. The production process, power required, percentage of breakage, threshing efficiency, percentage of carked, whole maize grains and percentage of grains cleanliness were calculated for each running test.

Figure 1 Machine (type Local MTL) used for thresher maize

Figure 2 Machine (type MGI-TY 60) used for thresher maize

2.1 Machine productivity

Basically, the thrashing machine productivity depends on the type of the machine as well as the size and moisture content of the grain and thrashing efficiency. It can be calculated from the Equation (1) that investigated by AlSharifi et al. (2017) as follows:

$$q = \frac{W \times 60}{T \times 1000} \quad (1)$$

where, q is machine production (t h^{-1}); W is output mass (g), and T is time (min).

2.2 Power required

Power required is the power, which is consumed by a machine to perform a specific job. The power required for this research is calculated using Equation (2) by AlSharifi et al. (2018).

$$P = \frac{\sqrt{3}}{1000} \cdot v \cdot I \cdot \cos\varphi \cdot E_{FE} \quad (2)\#$$

where, P is power consumed (kW); V is voltage (V) and I is the electric current (A), and cos(φ) is the angle between the current and voltage while (E_{FE}) is the efficiency of the motor (assuming as 90%).

2.3 Cracked grain

Kernel cracks is the most important factor contributing to maize breakage during threshing. It can be calculated by using Equation (3) that investigated by Al Saadi and Al Ayoubi (2012).

$$P_{Cg} = \frac{W_{Cg}}{W_S} \times 100 \quad (3)\#$$

where, P_{Cg} is proportion cracked grain (%); W_{Cg} is mass cracked grain (g); W_S is the total mass of sample (g).

2.4 Maize grains breakage

The Equation (4) is used to calculate the percentage of the all grain damage and broken during threshing process (Alsharifi et al., 2016).

$$P_{Br} = \frac{W_{br}}{W_S} \times 100 \quad (4)$$

where, P_{Br} is the percentage of breakage (%); W_{br} is the mass of breakage grain (g), and W_S is the mass of maize sample used (g).

2.5 Whole maize grains

Percentage of whole grain represents the amount of whole grains resulting from the threshing process (Equation (5)) (Ali and Shatti, 2006).

$$P_{Fg} = \frac{W_{Fg}}{W_S} \times 100 \quad (5)$$

where, P_{Fg} is the percentage of whole grain (%); W_{Fg} is mass whole grain (g), and W_S is mass of maize sample used (g).

2.6 Grain cleanliness

After threshing process, a randomized of 1000 g grains are taken to calculated the percentage of grains cleaning, by Equation (6) that investigated by Ghonimy and Rostom (2004).

$$G_C = \frac{W_S - W_I}{W_S} \times 100 \quad (6)$$

where, G_C is the percentage of grain cleanliness (%); W_S is mass of sample (g) and W_I is mass of impurities (g).

2.7 Threshing efficiency

The threshing efficiency is determined by using Equation (7) (Alsharifi et al., 2017).

$$E_E = \frac{W_S - W_{mU}}{W_S} \times 100 \quad (7)\#$$

where, E_E is the threshing efficiency (%); W_{mU} is the mass unpeeled maize (g) and W_S is the mass of maize sample used (g).

The results were analyzed statistically using the design complete randomized design (CRD) and the difference among treatments for each factor was tested according to the least significant difference (LSD) test (Alsahoeke and Creama, 1990).

3 Results and discussion

3.1 Machine production

Table 1 shows the influence of machine type, speed of threshing cylinder and maize grain moisture content on the machine productivity (t h^{-1}). The results indicated that increasing the speed of threshing cylinder led to the increase of machine productivity, and the results were 1.092, 1.148 and 1.275 t h^{-1} respectively. Because of the low pressure on the grain in the threshing chamber, machine production increased with the increased speed of threshing cylinder. These results are consistent with the results that gained by Alsharifi et al. (2017). For different maize grains moisture contents, the grain moisture of 15% indicated the highest machine production of 1.235 t h^{-1}, and the grain moisture content of 19% indicated the lowest machine production of 1.117 t h^{-1}. This is due to the fragility of the maize grains and the pressure increasing, which leads to increase the machine production with the decrease of maize grains moisture content. This is consistent with Shepherd et al. (2012). However, the Local MTL machine type was significantly better than the MGI-TY 60 machine type and the results were 1.196 and 1.147 t h^{-1}. This is due to the efficiency and engineering design of the machine and finishing the works with less time as compared with the MGI-TY 60 machine type. These results are consistent with the results gained from Humburg (2016). The interaction among parameters of maize thresher Local MTL machine type, maize grains moisture content of 15% and the speed of threshing cylinder 300 rpm caused the best result of 1.396 t h^{-1}. The machine production is shown in Figure 3 at different conditions for machine type, maize grains moisture content and speed of threshing cylinder.

Table 1 Effect of thresher type, speed of threshing cylinder and grain moisture content on machine production

Machines	Grain Moisture	Speed of threshing cylinder (rpm)			The overlap between machines and moisture
		200	250	300	
Local MTL	15%	1.189	1.203	1.396	1.261
	17%	1.103	1.178	1.299	1.193
	19%	1.090	1.110	1.202	1.134
MGI-TY 60	15%	1.122	1.196	1.313	1.210
	17%	1.061	1.113	1.247	1.140
	19%	0.996	1.087	1.191`	1.091
LSD=0.05		N.S			N.S
Average speed of threshing cylinder		1.092	1.148	1.275	
LSD=0.05		0.082			
Machines	The overlap between machines and speed of threshing cylinder				Average of machines
Local MTL	1.124	1.164		1.299	1.196
MGI-TY 60	1.050	1.132		1.250	1.147
LSD=0.05		N.S			0.076
Grain moisture	The overlap between maize grain moisture content and speed of threshing cylinder				Average of grain moisture
15%	1.151	1.200		1.355	1.235
17%	1.082	1.146		1.273	1.167
19%	1.043	1.099		1.197	1.117
LSD=0.05		0.102			0.082

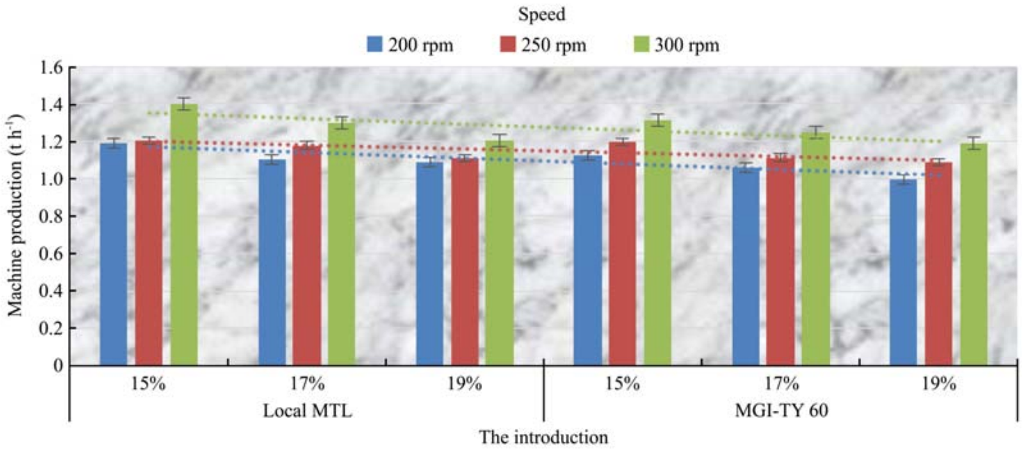

Figure 3 Effect of speed of threshing cylinder and grain moisture on the machine production for two machines

3.2 Power required

The influence of machine type, speed of threshing cylinder and maize grain moisture content on the power required (kW) was shown in Table 2. The threshing cylinder speed of 300 rpm has the lowest power, which required of 10.787 kW, and threshing cylinder speed of 200 rpm has the highest power required of 12.734 kW. From Table 3, it is indicated that the Local MTL machine type was significantly better than the MGI-TY 60 machine type (11.361 and 12.234 kW respectively), due to the energy consumption and concluded that the energy consumption depends on the type of machine whenever the organization of the machine is well he energy consumption is less These results are consistent with the results from Al Saadi and Al Ayoubi (2012). The increasing of the grain moisture led to the increase of the power required and the results were 10.929, 11.749 and 12.713 kW respectively, at different grain moisture contents. This is due to the increased Damocles effort on grains during the threshing process, hence increases the capacity consumed with the increasing maize grains moisture content. This is consistent with Alwan et al. (2016). The interaction among parameters of Local MTL machine type, maize grains moisture content of 15% and the speed of threshing cylinder 300 rpm caused the best result of 9.901 kW. The power required is shown in Figure 4 at different conditions for both machine type, maize grains moisture content and speed of threshing cylinder.

Table 2 Effect of thresher type, speed of threshing cylinder and maize grain moisture content on power required (kW)

Machines	Grain Moisture	Speed of threshing cylinder (rpm)			The overlap between machines and moisture
		200	250	300	
Local MTL	15%	11.263	10.841	9.901	10.668
	17%	12.086	11.081	10.109	11.092
	19%	13.001	12.930	11.033	12.320
MGI-TY 60	15%	12.428	11.029	10.112	11.189
	17%	13.615	12.138	11.466	12.406
	19%	14.009	13.206	12.099	13.105
LSD=0.05		N.S			N.S
Average speed of threshing cylinder		12.734	11.871	10.787	
LSD=0.05			0.103		
Machines	The overlap between machines and speed of threshing cylinder				Average of machines
Local MTL	12.117	11.617	10.348		11.361
MGI-TY 60	13.351	12.124	11.226		12.234
LSD=0.05		N.S			0.089
Grain moisture	The overlap between maize grain moisture content and speed of threshing cylinder				Average of grain moisture
15%	11.846	10.935	10.006		10.929
17%	12.851	11.609	10.788		11.749
19%	13.505	13.068	11.566		12.713
LSD=0.05		0.178			0.103

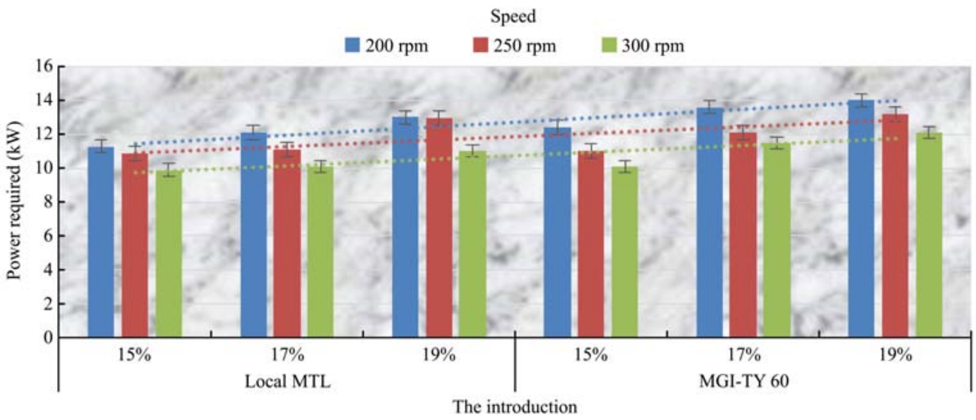

Figure 4 Effect of speed of threshing cylinder and grain moisture on the power required for two machines

3.3 Cracked maize grains

Table 3 shows the influence of machine type, speed of threshing cylinder and maize grains moisture content on the cracked maize grains percentage (%). The results indicated that increasing the speed of threshing cylinder led to increase the cracked maize grains percentage, and the results were 3.324%, 4.168% and 5.104% respectively for different levels of speed of threshing cylinder. Additionally, there are not so much impact of blows when speed of threshing cylinder decreased, hence the cracked maize grains percentage decreased. These results are consistent with the results from AlSharifi (2007). At the grain moisture of 15%, the result indicated the lowest cracked maize grains percentage of 3.458%. Moreover, the grain moisture of 19% prsented the highest cracked maize grains percentage of 5.104%. This is due to the fragility of the maize grains and the increasing pressure, which leads to the increase of cracked maize grains percentage with maize grain moisture content increase. This is also consistent with Balasubramanian et al. (2011). However, the Local MTL machine type was significantly better than the MGI-TY 60 machine type for the results of 4.024% and 4.374%. This is due to the efficiency and engineering design of the machine and finishing the works with less time as compared with the MGI-TY 60 machine type (Abu Khair et al., 2005). The interaction among parameters of Local MTL machine type, maize grains moisture content of 15% and the speed of threshing cylinder 200 rpm caused the best result of 2.561%. The cracked maize grains is shown in Figure 5 at different conditions for machine type, maize grains moisture content and speed of threshing cylinder.

Table 3 Effect of thresher type, speed of threshing cylinder and maize grain moisture content on the cracked maize grains (%)

Machines	Grain Moisture	Speed of threshing cylinder (rpm)			The overlap between machines and moisture
		200	250	300	
Local MTL	15%	2.561	3.012	3.983	3.155
	17%	3.095	4.126	5.038	4.086
	19%	4.021	4.977	5.492	4.830
MGI-TY 60	15%	2.911	3.466	4.902	3.760
	17%	3.129	4.313	5.419	4.288
	19%	4.227	5.112	5.881	5.023
LSD=0.05		N.S			0.033
Average speed of threshing cylinder		3.324	4.168	5.104	
LSD=0.05		0.110			
Machines	The overlap between machines and speed of threshing cylinder				Average of machines
Local MTL	3.226	4.038	4.808		4.024
MGI-TY 60	3.422	4.298	5.401		4.374
LSD=0.05		0.033			0.041
Grain moisture	The overlap between maize grain moisture content and speed of threshing cylinder				Average of grain moisture
15%	2.736	3.239	4.398		3.458
17%	3.112	4.222	5.229		4.188
19%	4.124	5.045	5.687		4.952
LSD=0.05		N.S			0.110

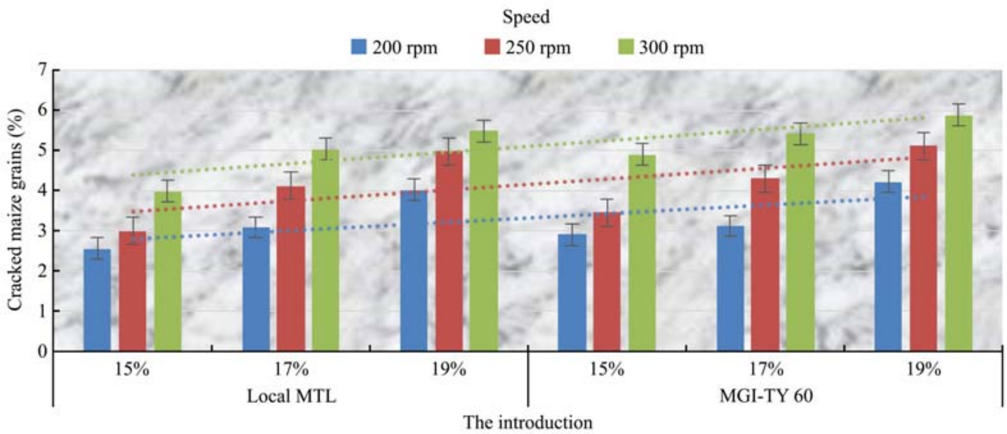

Figure 5 Effect of speed of threshing cylinder and grain moisture on the cracked maize grains for two machines

3.4 Maize grains breakage

The maize grains breakage percentage was affected by the influence of machine type, speed of threshing cylinder and maize grain moisture content (Table 4). The Local MTL machine type was significantly better than the MGI-TY 60 machine type. The results were reported 5.973% and 6.929 % respectively. This is due to the percentage of breakage increasing during shelling process, leads to increase he breakage percentage when used the Local MTL machine type as compared with MGI-TY 60 machine type. These results are consistent with the results From Vitaglione et al. (2008). The threshing cylinder speed of 200 rpm had the lowest maize grains breakage of 5.608%, and the speed of threshing cylinder of 300 rpm had the highest maize grains breakage of 7.322%. The increasing of the grain moisture led to the increase of the maize grains breakage and the results were 5.465%, 6.588% and 7.346% respectively, at different grain moisture contents. This is due to the fragility of the grain and easily break when the moisture of grain during threshing stage increased. This is consistent with Najim (2000). The interaction among parameters of Local MTL machine type, maize grains moisture content of 15% and the speed of threshing cylinder of 200 rpm caused the best result of 4.203%. The maize grains breakage is shown in Figure 6 at different conditions for machine type, maize grains moisture content and speed of threshing cylinder.

Table 4 The effect of thresher type, speed of threshing cylinder and maize grain moisture content on the maize grains breakage (%)

Machines	Grain Moisture	Speed of threshing cylinder (rpm)			The overlap between machines and moisture
		200	250	300	
Local MTL	15%	4.203	5.091	5.311	4.868
	17%	5.174	6.102	7.121	6.132
	19%	6.213	7.004	7.813	7.010
MGI-TY 60	15%	5.042	6.118	7.024	6.061
	17%	6.105	7.027	7.998	7.043
	19%	6.911	7.469	8.667	7.682
LSD=0.05		0.134			0.056
Average speed of threshing cylinder		5.608	6.469	7.322	
LSD=0.05			0.079		

Machines	The overlap between machines and speed of threshing cylinder			Average of machines
Local MTL	5.107	6.065	6.748	5.973
MGI-TY 60	6.019	6.871	7.896	6.929
LSD=0.05		0.112		0.042

Grain moisture	The overlap between maize grain moisture content and speed of threshing cylinder			Average of grain moisture
15%	4.623	5.605	6.168	5.465
17%	5.640	6.565	7.559	6.588
19%	6.562	7.237	8.240	7.346
LSD=0.05		0.125		0.079

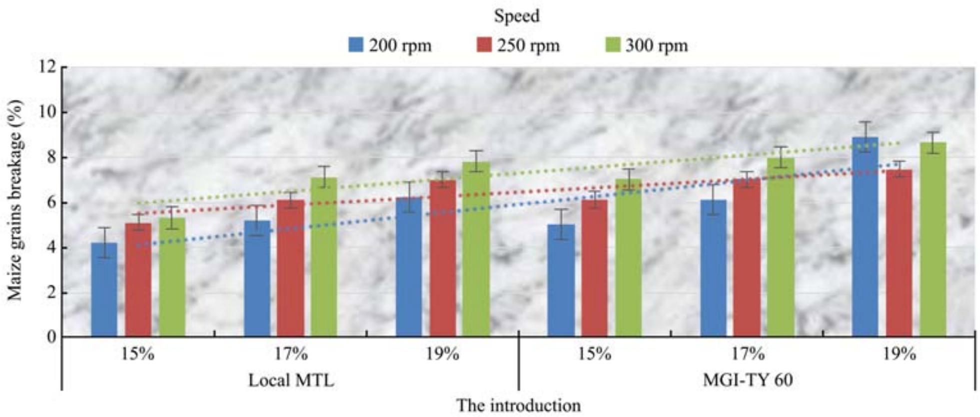

Figure 6 Effect of speed of threshing cylinder and grain moisture on the maize grains breakage for two machines

3.5 Whole maize grains

Table 5 shows the influence of machine type, speed of threshing cylinder and maize grain moisture content on the whole maize grains (%). The results indicated that increasing the speed of threshing cylinder led to the decrease of whole maize grains and the results were 77.730%, 76.535% and 75.201% respectively for different levels of speed of threshing cylinder. This is due to that increased maize grains breakage leads to the decrease of whole maize grains with increased speed of threshing cylinder. These results are consistent with the results that gained by Alwan et al. (2016). The maize grains moisture content of 15% presented the highest whole maize grains of 77.726%, and the moisture content of 19% presented the lowest whole maize grains of 75.145%. This is due to the fragility of the grains and easily break it when increased moisture of grain during thresher stage hence decreased whole maize grains. This is consistent with Alsharifi et al. (2016). However, the Local MTL machine type was significantly better than the MGI-TY 60 machine type and the results were 4.024% and 4.374%. This is due to the efficiency and engineering design of the machine and finishing the works with less time as compared the MGI-TY 60 machine type (Pavasiya et al2018). The interaction among parameters of Local MTL machine type, maize grains moisture content of 15% and the speed of threshing cylinder200 rpm caused the best result of 79.783%. The whole maize grains are shown in Figure 7 at different conditions for machine type, maize grains moisture content and speed of threshing cylinder.

Table 5 Effect of thresher types, speed of threshing cylinder and maize grain moisture content on the whole maize grains (%)

Machines	Grain Moisture	Speed of threshing cylinder (rpm)			The overlap between machines and moisture
		200	250	300	
Local MTL	15%	79.783	78.063	76.433	78.092
	17%	78.091	76.816	75.509	76.805
	19%	76.813	75.787	74.364	75.655
MGI-TY 60	15%	78.985	77.034	76.055	77.356
	17%	77.312	76.675	75.171	76.373
	19%	75.396	74.834	73.673	74.634
LSD=0.05		0.262			0.162
Average speed of threshing cylinder		77.730	76.535	75.201	
LSD=0.05		0.120			
Machines	The overlap between machines and speed of threshing cylinder				Average of machines
Local MTL		78.229	76.889	75.435	76.851
MGI-TY 60		77.231	76.181	74.966	76.126
LSD=0.05		0.162			0.041
Grain moisture	The overlap between maize grain moisture content and speed of threshing cylinder				Average of grain moisture
15%		79.384	77.549	76.244	77.726
17%		77.702	76.746	75.340	76.596
19%		76.105	75.311	74.019	75.145
LSD=0.05		0.209			0.120

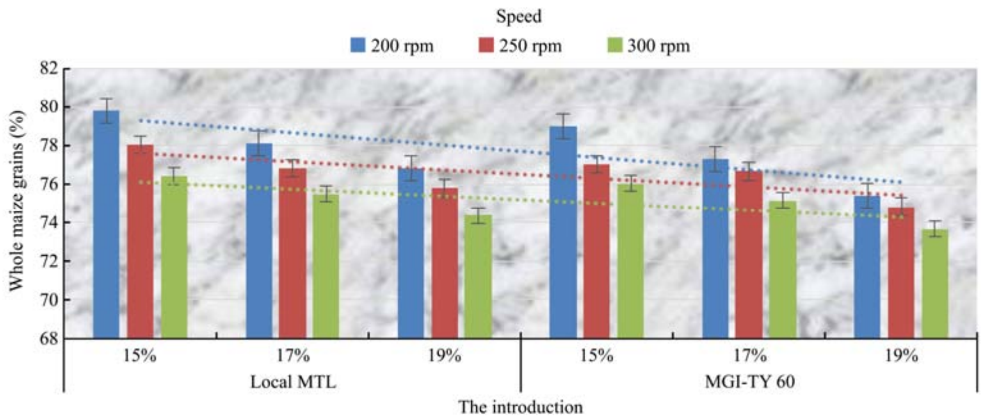

Figure 7 Effect of speed of threshing cylinder and grain moisture on the whole maize grains for two machines

3.6 Thresher efficiency

The influence of machine type, speed of threshing cylinder and maize grains moisture content on the thresher efficiency were shown in Table 6. The threshing cylinder speed of 200 rpm had the highest thresher efficiency of 86.234%, and 300 rpm had the lowest thresher efficiency of 81.511%. From Table 6, it indicated that the Local MTL machine type was significantly better than the MGI-TY 60 machine type (83.918% and 83.263% respectively). Attributed to that the mechanical properties i.e compressive strength and tensile strength on grains sheller and which characterized it Local MTL machine type as compared with MGI-TY 60 machine type. These results are consistent with the results that gained by Al Saadi and Al Ayoubi (2012). The increasing the grain moisture led to the decrease of the thresher efficiency, and the results were 85.255%, 83.932% and 81.586% at different maize grains moisture contents. This is due to the increase of grain moisture content also leads to obstruct the thresher process hence decreasing thresher efficiency. This is consistent with Aremu et al. (2015). At the speed of 200 rpm showed the highest thresher efficiency of 86.234% while the lowest thresher efficiency of 81.511% was reached the speed of 300 rpm. This is due to the decrease maize grains breakage by decreasing the speed of threshing cylinder hence increased thresher efficiency. This is consistent with Pavasiya et al., (2018) that the interaction among parameters of Local MTL machine type, maize grains moisture content of 15% and the speed of threshing cylinder of 200 rpm caused the best result of 88.821%. The thresher efficiency is shown in Figure 8 at different conditions for machine type, maize grains moisture content and speed of threshing cylinder.

Table 6 Effect of thresher type, speed of threshing cylinder and maize grain moisture content on the threshing efficiency (%)

Machines	Grain Moisture	Speed of threshing cylinder (rpm)			The overlap between machines and moisture
		200	250	300	
Local MTL	15%	88.821	85.044	83.237	85.707
	17%	86.175	84.196	82.134	84.168
	19%	84.973	80.681	80.003	81.886
MGI-TY 60	15%	87.713	84.530	82.186	84.809
	17%	86.019	83.565	81.505	83.695
	19%	83.705	80.155	79.998	81.286
LSD=0.05		0.123			0.034
Average speed of threshing cylinder		86.234	83.029	81.511	
LSD=0.05			0.042		
Machines	The overlap between machines and speed of threshing cylinder				Average of machines
Local MTL	86.656	83.307	81.791		83.918
MGI-TY 60	85.811	82.750	81.230		83.263
LSD=0.05		0.034			0.044
Grain moisture	The overlap between maize grain moisture content and speed of threshing cylinder				Average of grain moisture
15%	88.267	84.787	82.712		85.255
17%	86.095	83.881	81.820		83.932
19%	84.339	80.418	80.00		81.586
LSD=0.05		0.109			0.042

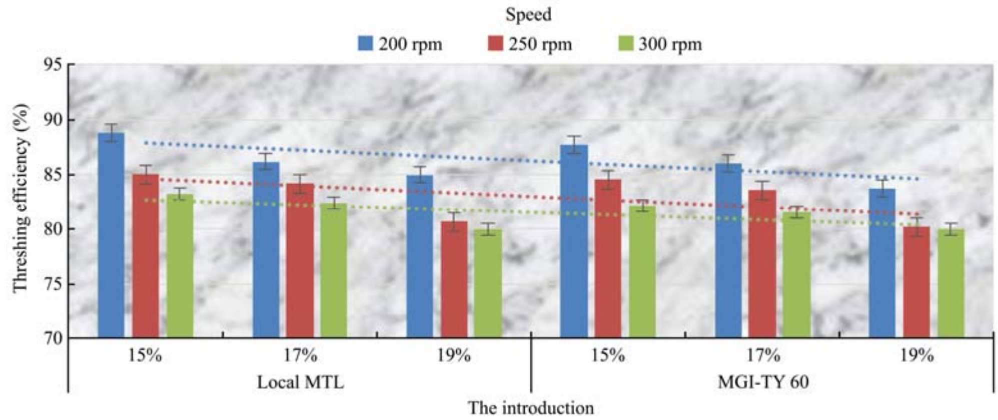

Figure 8 Effect of speed of threshing cylinder and grain moisture on the threshing efficiency for two machines

3.7 Maize grains cleanliness

Table 7 shows the influence of machine type, speed of threshing cylinder and maize grain moisture content on maize grains cleanliness (%). The results indicated that increasing the speed of threshing cylinder led to the decrease of maize grains cleanliness, and the results were 88.973%, 88.210% and 87.304% respectively for different levels of speed of threshing cylinder. This is due to that the remove part of grain with impurities with increasing speed of threshing cylinder hence grain cleanliness decreased. These results are consistent with the results that gained by El-Gayar (2005). The maize grains moisture content of 15% presented the highest grain cleanliness of 89.252%, while the maize grains moisture content of 19% presented the lowest grain cleanliness of 87.190%. Also, increased straw with increasing grain moisture leads to the maize grains cleanliness decrease. This is consistent with Alsharifi et al. (2016). However, the Local MTL machine type was significantly better than the MGI-TY 60 machine type and the results were 88.859% and 88.483%. Because of high quality in thresher process, less capacity when Local MTL machine type, was used to compare with MGI-TY 60 machine type hence decreased grain cleanliness percentage (Ghonimy and Rostom, 2004). The interaction among parameters of Local MTL machine type, maize grains moisture content of 15% and the speed of threshing cylinder 200 rpm caused the best result of 90.787%. Maize grains cleanliness is shown in Figure 9 at different conditions for machine type, maize grains moisture content and velocity speed of threshing cylinder.

Table 7 Effect of thresher type, speed of threshing cylinder and maize grain moisture content on maize grains cleanliness (%)

Machines	Grain Moisture	Speed of threshing cylinder (rpm)			The overlap between machines and moisture
		200	250	300	
Local MTL	15%	90.787	90.123	90.003	90.304
	17%	89.391	88.834	87.770	88.598
	19%	88.265	87.771	86.659	87.565
MGI-TY 60	15%	89.442	88.065	87.092	88.199
	17%	88.171	87.801	86.330	87.434
	19%	87.783	86.663	85.998	86.815
LSD=0.05		0.287			0.156
Average speed of threshing cylinder		77.730	76.535	75.201	
LSD=0.05			0.176		
Machines	The overlap between machines and speed of threshing cylinder				Average of machines
Local MTL	89.481	88.909	88.144		88.845
MGI-TY 60	88.465	87.510	86.473		87.483
LSD=0.05		0.156			0.099
Grain moisture	The overlap between maize grain moisture content and speed of threshing cylinder				Average of grain moisture
15%	90.115	89.094	88.548		89.252
17%	88.781	88.318	87.050		88.049
19%	88.024	87.217	86.329		87.190
LSD=0.05		0.263			0.176

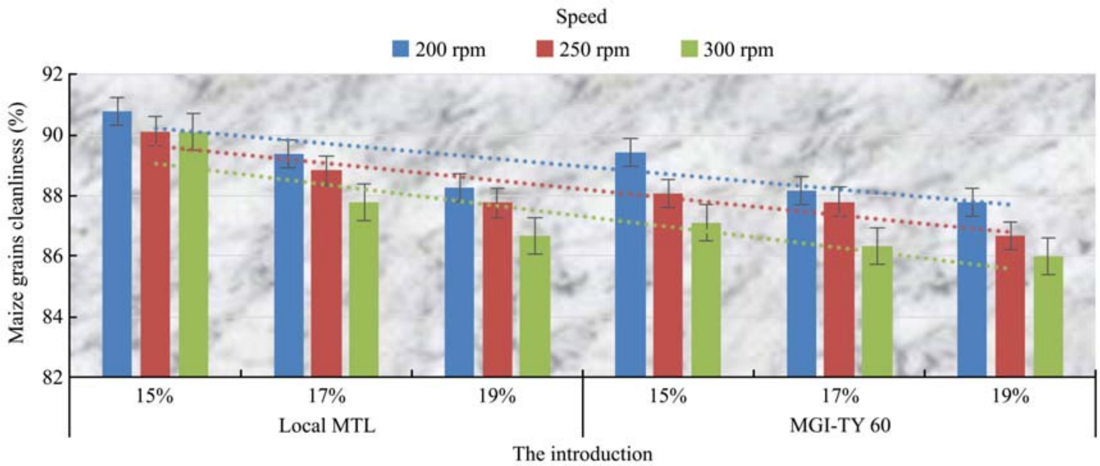

Figure 9 Effect of speed of threshing cylinder and grain moisture on the maize grains cleanliness for two machines

4 Conclusions

The Local MTL machine type is significantly better than the MGI-TY 60 machine type. The maize grains moisture content 15% was superior significantly to other two levels 17% and 19%. Additionally, the speed of threshing cylinder of 200 rpm was superior significantly to other two speeds of threshing cylinder in all studied properties. The overlap between the Local MTL machine type and maize grains moisture content 15% was also superior significantly. The overlap between the Local MTL machine type and the speed of threshing cylinder was 200 rpm, as compared with the overlap of the MGI-TY 60 machine type with moisture content and speed of threshing cylinder in all studied properties. The best results were obtained from the interaction among Local MTL machine type, grain moisture 15%, and speed of threshing cylinder of 200 rpm in some studied properties,

5 Recommendations

The present recommends to carry out future studies using other of machinery types and other varieties of maize, or conduct other organizations on machine and the moisture content of grain to know their effect on the qualitative characteristics of maize.

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