

Investigation of the Effective Factors on Threshing loss, Damaged Grains Percent and Material Other than Grain to Grain Ratio on an Auto Head Feed Threshing Unit

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Abstract: Problem Statement: Regarding to considerable production of rice crop in Iran, study and investigation about optimization of different stages of this product processing seems necessary. The threshing of rice is a process which must be accomplished desirability. **Approach:** In this study, the effective factors effects on threshing loss, damaged grain percent and Material Other than Grain (MOG) to grain ratio, were investigated on a head feed threshing unit. Independent variables were included speed drum in five levels, variety in two levels and moisture content of crop in two levels. Experiments were arranged as a split-split plot fitted into randomized complete block with four replications. **Results:** Results showed moisture content of crop, variety and speed drum factors had significant effects on threshing loss, damaged grains percent and MOG to grain ratio. The means of threshing loss and damaged grains percent were excessive when the tests were doing with dry crop. The most of means of threshing loss and damaged grains percent were allocated to Hashemi and Khazar varieties, respectively. The most of MOG to grain ratio means obtained when the tests were accomplished with Hashemy variety at wet condition of crop. **Conclusions/Recommendations:** The optimum of drum speed was obtained 650 rpm. It is better that threshing of paddy has been conducted in wet condition. Increasing of drum speed increased the MOG to grain ratio significantly.

Key words: Rice, threshing loss, damaged grains, MOG to grain ratio, threshing unit

INTRODUCTION

In world food production, the rice is the second most important crop after wheat. The area of rice planting has been estimated at about 615 ha in Iran. So application of each method to reduce threshing and damaged grains percent is very essential, especially when frequent rains happen at harvesting time. For the present, the paddy is threshed by manual threshers in Iran. These machines have low capacity and also they are not able to thresh wet paddy in high capacity. Furthermore, these machines require strong and professional person to feed the paddy into threshing unit. Recently, an axial flow thresher type is constructed by locally workshops in some regions of Gilan province in Iran. These threshers haven't capability to thresh the new and wet harvested paddy with long stalks. To emit these problems, an auto- head feed threshing unit was designed and fabricated in Tarbiat Moddaress University, Tehran, Iran (Fig. 1). At this study, the effects of depended factors including drum speed in five levels, crop moisture content in two levels and rice variety in two levels were investigated on threshing loss and damaged grains percent.



Fig. 1: A view of experimental paddy threshing unit

It should be mentioned, this type of thresher has not investigated more by the researchers in Iran. Saeed *et al.*^[10] was evaluated a hold-on paddy thresher imported from Korea to Pakistan country. The data analysis in their experiments showed that the highest output of 537 kg h⁻¹ with the efficiency of 99.2% was obtained at drum speed of 500 rpm (17.3 ms⁻¹) and feed rate of 1300 kg h⁻¹. Suzuki^[12] during the evaluation of

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head feed combines reported that the damaged grain percent is less than 0.5% with paddy grain moisture content of 25 % (w.b.) and drum speed of 10.3 m sec⁻¹. Ezaki^[6] evaluated a head feed combine and reported that the damaged grain increases intensively when the drum speed increases to the over of 15 m sec⁻¹.

The mentioned and the other researches were accomplished according to crop conditions such as rice variety and moisture content^[7,8,9]. Therefore it was necessary that the new threshing unit to be evaluated for the paddy conditions in the northern provinces of Iran.

MATERIALS AND METHODS

The hold-on paddy thresher which was used in this study has been showed in Fig. 1. This machine has two main parts, including threshing unit and feeding unit. It is powered through 7.5 hp Mitsubishi diesel engine. Power from the engine to the threshing drum is transmitted by pulleys and V-shaped belt. For transmitting the power to sprocket of the feeding unit, a spiral gearbox is used at the end of threshing drum shaft. Also, a shaft is fitted between output of gearbox and the sprocket. This gearbox decreases the rotatory speed of drum shaft. At the beginning of the experiment, crop bands were put on feed tray and then were fed horizontally into the driven feed chain. Then paddy stalks stand between retentive rail and chain while the straw passes between drum and concave and consequently grains separated form panicle and the crop are threshed. The grains which passed from the concave were collected by inclined plate and poured via chute into a box. The distance between two sprockets was selected as the crop was caught by feeding unit and then was transported out of the threshing unit after threshing. The threshing of panicles take place completely between the wire loops of drum and arc plate of concave. Two rice varieties (Hashemi and Khazar) which were commonly transplanted in the Gilan province of Iran were used in this study. These varieties were used at two moisture condition i.e., wet and dry. Grain and stalks Moisture content were measured according to ASAE standard (ASAE, 2003)^[4]. The moisture content of grain and stalk was presented in Table 1. The wet condition of experimental varieties is similar to the new harvested paddy moisture content condition. The dry condition is stated that the paddy expose to sun at duration one day.

At the initial test of the thresher, damaged and unthreshed grains were not considerable with the drum

speed of 450 rpm and chain speed of 3.5 cm sec⁻¹^[2]. Consequently for studing the effects of drum speed and crop moisture content on the threshing loss and damaged grain percent, it has been decided to use the drum speed, lower and higher than 450 rpm. In the experiment, drum speed levels were selected 250, 450 650, 850 and 1050 rpm. To produce these speeds, gearbox was detached from the end of drum shaft. An electromotor with different diameters of pulleys and V-shaped belt used to rotate the sprocket of driven shaft in feeding unit (Fig. 2). As shown in Fig. 2a, cover is opened and elements of threshing and feeding parts could be seen well. The manner of feeding has been showed in Fig. 2b.

Table 1: Moisture content of grain and stalks of experimental varieties (%w.b.)

Wet condition (new harvested)				Dry condition (Exposed to sun at duration one day)			
Hashemi		Khazar		Hashemi		Khazar	
Grain	Stalk	Grain	Stalk	Grain	Stalk	Grain	Stalk
18.3	65.39	20.40	61.19	10.00	21.23	12.2	18.19



(a)



(b)

Fig. 2: (a): A view of threshing unit as threshing and feeding parts powered separately by a diesel engine and a electromotor (b): The machine in feeding position

Independent variables were included speed drum in five levels, variety in two levels and moisture content of crop in two levels. Experiments were arranged as a split-split plot fitted into randomized complete block with four replications. To compare of the means, Duncan's Multiple Range Test was used.

RESULTS

The result of the analysis of variance of the dependent variables has been showed in Table 2.

Threshing loss: The results showed that the effects of independent variables (crop moisture content, variety and drum speed) and their interactions were significant on the threshing loss (Fig. 3). The comparison of the main effects means revealed that drying of crop significantly increased the threshing loss from 3.044-3.670%. The results of the comparison of means has been showed in Table 3.

The threshing loss means of the Hashemi variety was higher than the Khazar variety. The means values have different significantly at probability level of 5%. With increasing of drum speed, threshing loss means from 250 to 650 rpm was decreased significantly at probability level of 5%. It was reached to zero at 650 rpm.

In general, during the tests with Hashemi variety, the dry condition of crop caused the threshing loss

mean increased significantly from 3.563-5.912% but during the tests with Khazar variety, the threshing loss has decreased significantly from 2.521-1.425%. The results of means interactions of the moisture content condition of crop and drum speed revealed that threshing loss of only two levels of drum speed namely 250 and 450 rpm mean was considerable. At the other levels of drum speed, threshing loss was negligible. At the tests with wet condition of crop, with increasing of drum speed from 250-450 rpm, the mean of threshing loss decreased from 13.799-1.422%. About the tests with each of two varieties, increasing of drum speed decreased threshing loss significantly at 5%.

Damaged grain percent: In general, drying of crop caused that the damaged grains percent increased significantly from 1.29-2.884% (Fig. 4).

To increase drum speed from 250-650 rpm, the mean of damaged grains percent was equal to zero. But higher drum speed increased significantly damaged grains percent from 2.829% at 850 rpm to 5.107% at 1050 rpm.

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Table 2: Analysis of variance of threshing loss, damaged grains percent and MOG to grain ratio

Source of variation	Degree of freedom	Threshing loss		Damaged grains percent		Ratio MOG/grains	
		Mean square	F Ratio	Mean square	F Ratio	Mean square	F Ratio
Blocks	3	0.021	0.386 ^{ns}	0.405	0.691 ^{ns}	0.4700	0.0544 ^{ns}
Moisture(M)	1	7.838	144.125 ^{**}	7.069	12.062 [*]	108.3200	12.539 [*]
Error	3	0.054		0.586	-	8.6390	-
Variety(V)	1	152.849	3343.462 ^{**}	3.011	9.2046 [*]	222.9420	49.047 ^{**}
(M × V)	1	59.099	1292.751 ^{**}	1.502	4.59 ^{ns}	164.9420	36.288 ^{**}
Error	6	0.046		0.327	-	4.5450	-
Drum speed(N)	4	704.120	8369.4790 ^{**}	85.955	161.665 ^{**}	468.5180	139.237 ^{**}
(M × N)	4	5.590	66.4431 ^{**}	3.088	5.808 ^{**}	5.1820	1.540 ^{ns}
(N × V)	4	107.318	1275.6330 ^{**}	2.445	4.599 ^{**}	24.1120	7.166 ^{**}
(M × V × N)	4	36.220	430.5320 ^{**}	0.573	1.0781 ^{ns}	43.1240	12.816 ^{**}
Error	48	0.084		0.532	-	3.3658	-

^{ns}: No significant, ^{*}: Significant at the probability level of 5%, ^{**}: Significant at the probability level of 1%

Table 3: Results of the comparison of the main effects means (on the dependent variable)

The conditions of crop moisture	Variety				Drum speed (rpm)				
	Wet	Dry	Hashemy	Khazar	250	450	650	850	1050
Threshing loss	3.04a	3.67b	4.74a	1.98b	15.16a	1.63b	0.00c	0.00c	0.00c
Damaged grains percent	1.29a	1.88b	1.39a	1.78b	0.00c	0.00c	0.00c	2.83b	5.11a
MOG to grain ratio	7.57a	9.87b	7.06a	10.40b	3.52e	5.37d	6.72c	10.97b	17.08a

Note: Unsimilar letters shows significantly different at probability level of 5%

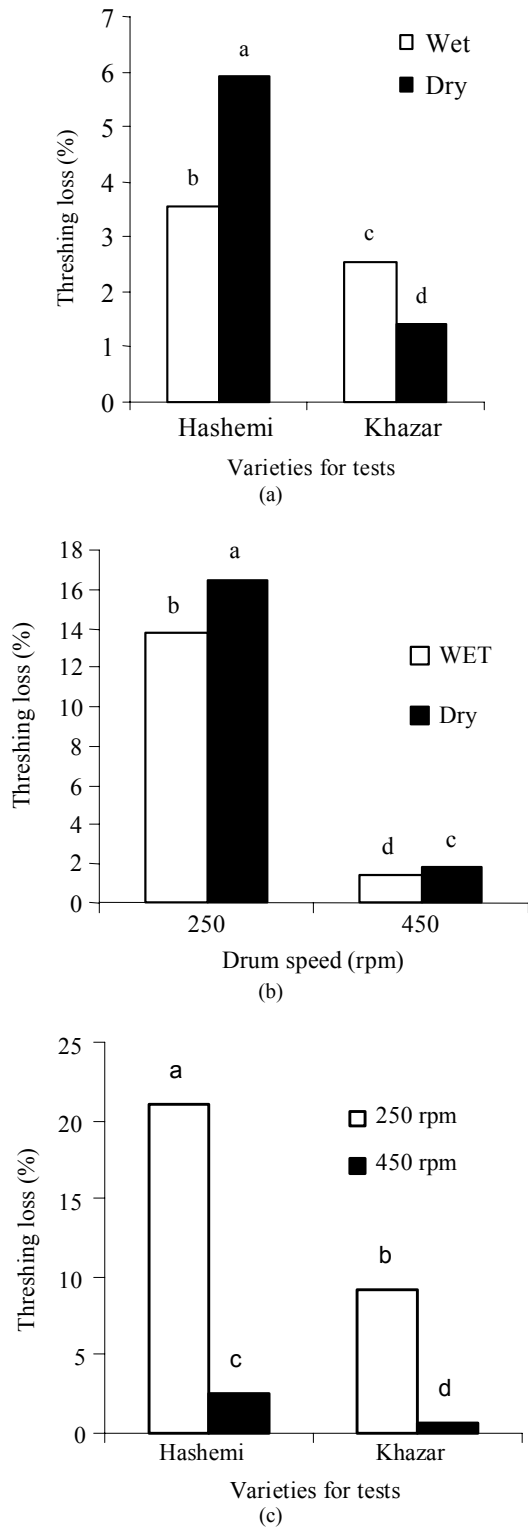


Fig. 3: The comparison of the interaction of the means on the threshing loss

The comparison results of means interactions effects on damaged grains percent showed in Fig. 4. At tests with Khazar variety, damaged grains percent increased significantly. Thus, a decrease in grain moisture content in Khazar variety caused the strength of grains decreased against of impact force (Fig. 4a). At each two moisture content condition of crop (wet and dry), with increasing of drum speed, damaged grains percent increased significantly (Fig. 4b). Also at the tests with each two varieties, the mean of damaged grain percent was increased significantly.

MOG to grain ratio: The comparison of main means of independent variables on MOG to grain ratio has been showed in Table 3. The values of the effects of crop conditions were different significantly at probability level of 5%. Therefore drying crop has made the strength of MOG on stalks decrease.

At the tests with each two crop moisture content conditions, with increasing drum speed from 650 rpm, MOG to grain ratio increased significantly (Fig. 5b). Also MOG to grain ratio means were increased significantly with increasing drum speed from 650 rpm at the test which related to each two varieties in the experiment (Fig. 5c).

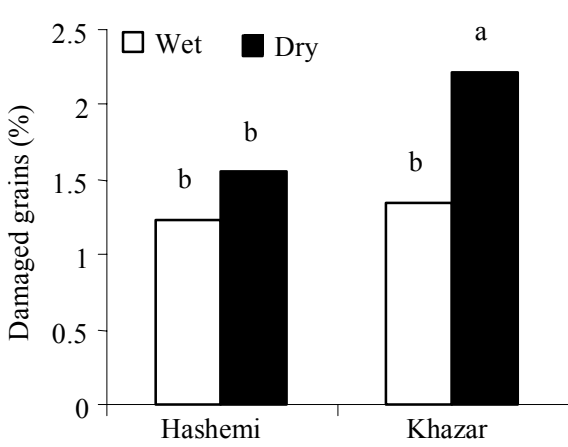
DISCUSSION

Threshing loss: The findings in Fig. 3 are similar to the results of [5, 6, 10, 11, 12]. Also increasing in threshing loss because of drying of crop may be due to increase of detachment force of grain from panicle.

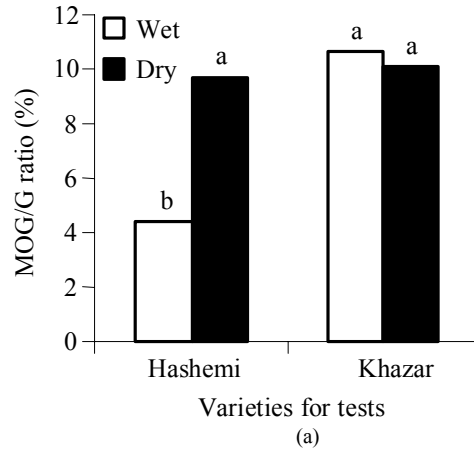
In general, the threshing loss means in the dry condition of crop is more than the wet condition. It is may be due to increasing of threshing force and or the friction between paddy and drum elements. The decrease in threshing loss was due to higher impact to the panicles during threshing process at higher drum speed.

Optimum drum speed was resulted 650 rpm. Because the damaged grains percent has been equal to zero at this level of drum speed [1, 2, 3].

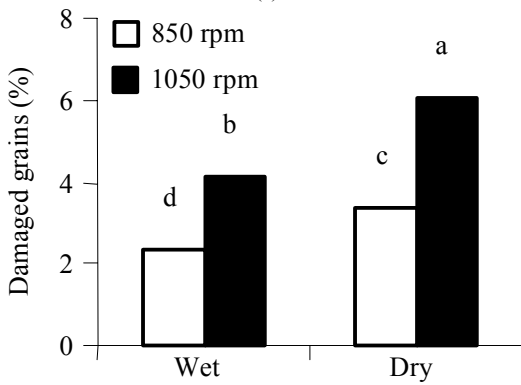
It should be mentioned that the differences in physical properties of varieties caused that during the tests with Hashemi variety the threshing loss mean increased significantly at the dry condition of crop but during the tests with Khazar variety, the threshing loss decreased significantly.



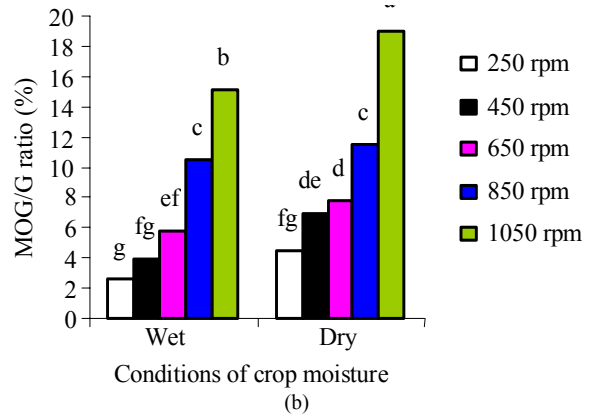
Varieties for teste
(a)



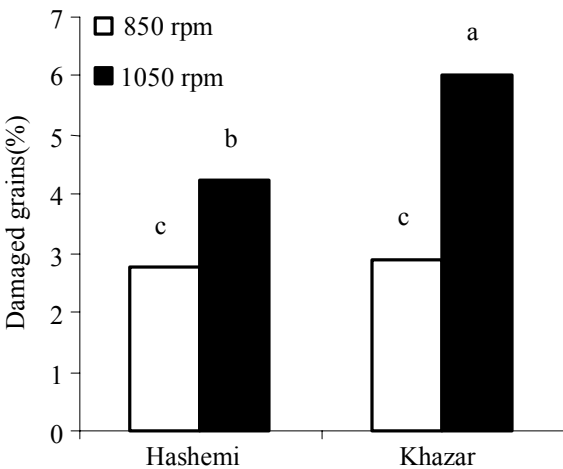
(a)



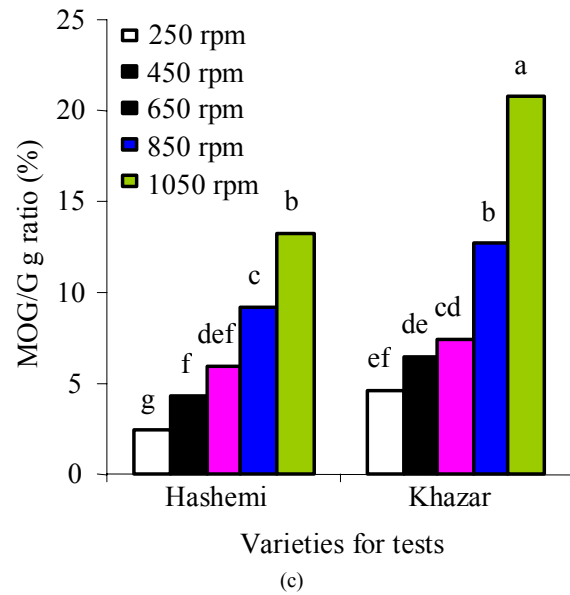
Conditions of crop moisture
(b)



(b)



Varieties for test
(c)



(c)

Fig. 4: The comparison of means interactions effects on damaged grains percent

Fig. 5: The comparison of means interactions of dependent variable on MOG to grain ratio

Damaged grain percent: The findings in Fig. 4 are similar to the results of^[14]. Also Comparison of means interactions of variety and crop conditions (wet and dry) revealed that with drying Hashemy variety, damaged grains percent has not varied significantly.

The mean of damaged grains percent of Hashemy variety was lower than Khazar variety at propability level of 5%. Consequently, strength of Hashemy variety against of impact force of tresher teeth is higher than Khazar variety.

MOG to grain ratio: The effects mean of Khazar variety was significantly higher than Hashemi variety. Thus cleaning efficiency of the Hashemy variety decreased at wet condition. With increasing of drum speed, MOG/G ratio was significantly increased. Because the compact force on stalks is increased with increasing drum speed.

During the tests with Hashemi variety, MOG to grain ratio was lower in wet condition of the crop than dried crop. But at the tests with Khazar variety, MOG to grain ratio was not different at each two crop moisture content condition (Fig. 5a). This different of interaction was due to variation of mechanical and physical properties in two varieties.

CONCLUSION

Overall these results of obtained from the study which has been summarized as follows:

- At all tests, the stalks flow axially through the drum without clogging between drum and concave and also in chain conveyor and rail
- The effects of crop moisture content condition, variety and drum speed were significant on threshing loss
- In general, mean of threshing loss in Hashemi variety was higher than Khazar variety
- In general, mean of threshing loss at dry condition of crop was higher than wet condition of crop
- Optimum speed of drum was 650 rpm because threshing loss and damaged grains percent were equal to zero at this level of drum speed
- The main effects of crop moisture content conditions, variety (at probability level of 5%), drum speed (at probability level of 1%) and double interactions (at probability level of 1%) were significant on the damaged grains percent

- Damaged grains percent at wet moisture content condition of crop was lower than at dry moisture content condition of crop. Thus, it is better that threshing of paddy has been conducted in condition of wet i.e. when it has been harvested newly
- The means of damaged grains percent with Khazar variety was higher than Hashemi variety
- The main effects of crop moisture content conditions (at probability level of 5%), variety and drum speed and their interactions (at probability level of 5%), drum speed and interactions (at probability level 1%) were significant on the MOG/Ratio
- MOG to grain ratio with Khazar variety is higher than Hashemi variety at probability level of 5%
- In general, MOG to grain ratio at tests with dry crop was higher than wet crop
- Increasing of drum speed increased the MOG to grain ratio significantly

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