The Effect of Hulling and Whitening on Quality of Rice Cultivar Daillman Mazandarani (DM)

Salih, K. Alwan*, Akbar, Arabhosseini*, Mohammed H. Kianmeher and Ali M. Kermani

Department of Agrotechonlogy, College of Aburaihan, University of Tehran, Iran

*Corresponding author Email: salih_alsh1971@yahoo.com; ahosseini@ut.ac.ir

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Abstract

The experiment has been conducted to study of some qualitative characteristics of husking and whitening machines for rice cultivar Daillman Mazandarani, in the laboratories of the Tehran University in 2015. This research uses two types of machines Satake rubber-rolls -THU 35A type and Yanmar rubber - rolls -, ST SO type under three levels of the grain moisture 10-12%, 12- 14% and 14-16% and three levels of clearance between cylinders are 0.4, 0.6 and 0.8 mm. The study is conducted on two axes a hulling which included palea and lemma percentage, broken rice and hardness degree, and whitening which included bran, bench, whiteness percentage and whiteness degree.The results showed that the Satake type machine is significantly better than the Yanmar type machine in all studies properties. As well as grain moisture 10-12% is superior significantly on the two levels 12-14%, 14-16% in all studied traits. In addition of the clearance 0.8 mm significant superior on two levels 0.4,0.6 mm in all studies properties except the hardness degree, whiteness degree and whiteness percentage the which gives the best result with the clearance level 0.4mm, for both two stages husking and whitening.

Keywords: Clearance, machine, grain moisture, rice, husking, whitening

Introduction

Rice is one of the most important grain in Iraq. As rice is the basic food crop and being a tropical plant, it flourishes comfortably in hot and humid climate. (Hussain, 2009) One of the important factors for the grain milling process is the clearance between the cylinders and grain moisture. Ghavami et al. (2005) reported that to have a high quality head rice with minimal breakage, paddy must be harvested at the optimum moisture content as well as found that long and tiny rice kernels were more susceptible to breakage during the milling process as compared to wide short kernels. environment temperature decreased the performance of the rice milling system. They also found that the relative humidity of the milling environment had a significant effect on the milling yield. (Parnsakhorn et al., 2008). Also noted that parboiling processes caused an increase in the hardness of rice. They showed that hardness increases with increase in soaking time and steaming. (Fama et al., 2009) Bran rice is a by-product of rice which is obtained from rice bleaching and it represents about 10% by weight of the grain. Farooq et al. (2005) Whiteness stage is process removed bran from the surface of the grain for the production of white rice desirable by the consumer In Iraq, the degree of whiteness depends a minimum of 32 degrees for rice factory. (Sanchez et al., 2004) Currently, the use of rice bran has been underestimated; it is only used as animal foods. Nowadays, this product is the objective of different research areas, (Yerpude et al., 2015). Removing the husk from grains the rice that is obtain is a brown rice. This outer brown covering is called as bran. The bran is then removed by polishing the grains and thus resulting in a white color rice grain. (Sha et al., 2011). Because degree of milling is

typically used as the major indicator to assess the quality of milled rice. A laboratory scale study of medium grain rice determined mean whiteness values of 41.5 to 45.7, dependent on rice variety and condition. (Jiang et al., 2010). The hardness of grain shows that the me-chemical testing method can accurately detect the rice quality. This new mechanical method can be effectively used in rice quality testing and branding with the advantage of simplicity, accuracy and reliability (Al maamouri et al., 2008). Studied the effect of moisture content on the rice breakage during the milling process. used samples within moisture content 12 to 16% and concluded that rice breakage increased with increase of paddy moisture (Asmat, 2011). Broken rice is rice that broke into another pieces that make it smaller than other normal rice. the percentage of broken rice that being measured so that the user can control the process of producing the rice from paddy so that less broken rice is produced, and high quality of rice will be delivered to consumer. Tan et al. (2000) showed that the quality of the rice can be determined by moisture content, shape, whiteness and number of broken rice grains at less cost. The one of the most important criteria for determining the quality of the rice is head rice yield. The objective of the research was to study of the effect moisture content and clearance between cylinders for two machines (Satake and Yammer) on some qualitative characteristics of the husking which included palea and lemma percentage, breakage percentage and hardness degree, and some qualitative characteristics of the whitening are, percentage of bran, percentage of bench, whiteness percentage and whiteness degree, for rice cultivar DM.

Materials and Methods

The experiment has been carried out in the laboratory of Tehran University in season of 2014-2015. Two types of hulling and whitening machines Satake and Yanmar which are used in this experiment is a main factor , under three levels of moisture content of grain 10-12% ,12-14% and 14-16% is a secondary factor and three levels of clearance between cylinders 0.4, 0.6 and 0.8 mm, which are under secondary factors.

The experience is on two axis:

The first axis includes hulling machines of rice grain, Daillman Mazandarani cultivar. Random samples are taken of paddy grain cultivar (DM) by probe and are collected on a form of heaps and the number of heaps are six. Each heap weights 160kg, according to the method used by (Alsharifi (2010). Paddy is cleaned to remove all exotic matters, broken and immature grains using sieves. Then the random samples are taken from per heaps weight 1000 gm. The initial moisture content of paddy grain is determined by oven drying methods at 103c for 48 h according to the method used by (Sacilik et al., 2003). To obtain the desired moisture content level paddy is kept in an oven at temperature of 43c and monitored carefully for DM cultivar, for determining the moisture content of grain 14-16% then sample is taken and place in Precision divider to get a sample of weight 200 g, then the samples are carefully sealed in polythene bags. Then organization of the Satake type machine on clearance between cylinders 0.8 mm and speed 4.7 m/sec. This sample which weight 200 g is placed in the Satake type machine to remove husk from paddy grain. After taking out the sample from the machine it is placed in cylindrical insulation device of satake type with operating time which is adjusted for 2 minutes and the angle of inclination is 25 degree isolate the broken and whole of grain for all sizes. The following indicators are calculated:

Percentage of Palea and Lemma

The remnants of the husking process and used as food for animals. (Al sharifi, 2010).

$$P_{PL} = \frac{W_{SR} - W_{SbR}}{W_{SR}} \times 100 \quad (1)$$

Where: P_{PL} is percentage of Palea and Lemma (%), W_{sR} is weight sample rice (g) and W_{SbR} is weight sample of brown rice (g).

Proportion of Breakage Rice

The process separating the broken grain from the whole grains. To compute the percentage of the head rice and broken rice is by using 2. (Gbabo et al., 2014)

$$P_{Br}=\frac{W_{br}}{W_s}\times 100 \quad (2)$$

Where P_{Br} is the proportion of breakage rice (%), W_{br} is the weight of breakage grain (g) and W_s is the weight of rice sample used (g).

Degree of hardness

As calculated using the hardness measurement device, as it is taken samples included 50 grains, and it is put on the cylinder the pressure even breaks it. And after the reading is taken of during screen the device.

Then by repeating of the same method and measurements of the previous ones using of the Satake type machine for moisture content of grain 12-14%, 14-16% and clearances 0.6, 0.4 mm, by three replications. Then by repeating the same steps and all accounts for the Yanmar type machine and each moisture content of grain and each clearance .and three replications for rice cultivar DM. As shown in Figure 1, Figure 2 and Figure 3.

Figure 1 The machine (type Satake) which is used for hulling paddy

Figure 2 The machine (type Yanmar) which is used for hulling paddy

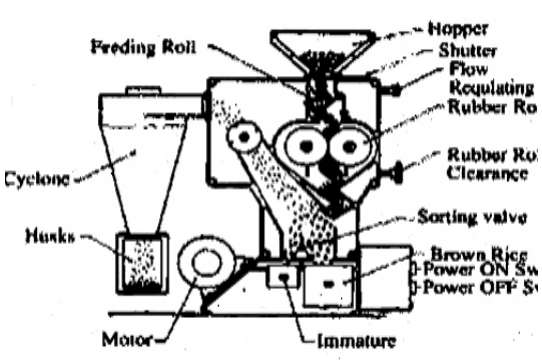

Figure 3 Planner for two machine types Satake and Yanmar which is used for hulling paddy

The second axis includes whitening machines of paddy DM cultivar:

After the husking stage (husk removing) random samples are taken and organization of the machine (Satake type) on clearance 0.8 mm and with the speed 4.7 m/sec for moisture content of grain 14-16%. Then place the sample in the room of whitening machine for 2 minutes and by three replications for DM cultivar . After the whitening process a sample is taken the weight of 200 g from bleached rice and then place the sample in the cylindrical insulation of type Satake and adjust the operating time for 2 minutes and inclination angle is 25 degrees for the purpose of isolating the grain and broken grain of various sizes. The following indicators are calculated:

Percentage of Bran

It is the proportion resulting after whitening process. (Almaamouri et al., 2008)

$$R_B=\frac{W_{Sbr}-W_{br}}{W_{Sbr}}\times 100 \quad (4)$$

Where R_B is bran ratio. (%), W_{Sbr} is weight sample brown rice(g) and W_{br} is weight bleach rice (g).

Percentage Bench

It is rice grain very small called bench (less from half length the cereal) and used as a source

important feeds for animal (Al maamouri et al., 2008).

$$P_{D=}\frac{W_{Dbr}}{W_{Sbr}}\times 100 \quad (5)$$

Where P_D : percentage bench. (%), W_{Dbr} : weight grain from bleach rice (g), and W_{Sbr} : weight sample from bleach rice. (g)

Whiteness Degree (6)

It is measured whiteness degree for rice grain, by measure whiteness degree device, which measure whiteness degree in comparison with magnesium whiteness degree and amounting to 85° during put the rice in the disk inside the machine as well as determine bleach time is 45 Sec, for each moisture content of grain and each clearance for two types machines Satake and Yanmar and three replication. (Roy, 2008)

Percentage of Whiteness

$$P_{W=}\frac{M_{BR-M_{WR}}}{M_{BR}} \times 100 \quad (7)$$

Where P_W is percentage of whiteness (g), M_{BR} is the mass of brown rice before whitening (g) and M_{WR} is the mass of white rice after whitening (g). (Alizadeh et al.,2011)

Then by repeating of the same method and measurements of the previous using of the Satake type machine, moisture content of grain 12-14%, 14-16% and clearances 0.6, 0.4 mm and three replications. Then repeating the same steps and all accounts using of the Yanmar type machine, for each moisture content of grain and each clearance and three replications for rice cultivar DM. As shown in Figure 4, Figure 5 and Figure 6. Results are analyzed statistically by using of the design C R D and tested the difference among treatments for each factor according to the test LSD less significant difference 0.05. (Alsahoeke et al.,1990).

Figure 4 The machine (type Yanmar) which is used for whitening paddy

Figure 5 The machine (type Satake) which is used for whitening paddy

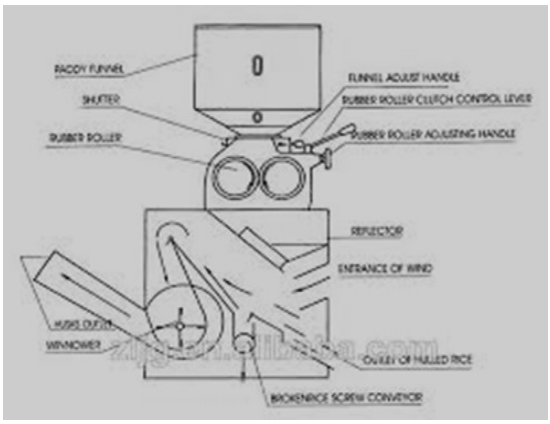

Figure 6 Planner for two machine types Satake and Yanmar which is used for whitening paddy

Results and Discussion

Stage of husking rice

Percentage of palea and lemma

Table 1 shows the influence of the type of machine, clearance, and grain moisture on the Percentage of palea and lemma. The results indicate that the Satake type machine is significantly better than the Yanmar machine. The results get to are 18.938 and 18.515% respectively, by a decrease of 2.2%. This is due to the fact that machine nature , as well as how deal with of grain when removal husk when using Satake type machine as compared with Yanmar type machine. These findings are consistent with the findings of (Hussain, 2009), Increasing of the grain moisture leads to increase of the percentage of palea and lemma, and the results are 18.167, 18.743 and 19.269 %, respectively, by an increase of 3.1 and 2.8% respectively. Because of removal part of grain with husk when grain moisture increase, hence increase percentage of palea and lemma. These findings are consistent with the findings of (Al sharifi,2010). In addition, increasing the clearance between cylinders leads to decrease the percentage of palea and lemma, and the results are 19.189, 18.775 and 18.215%, by a decrease of 2.2 and 3.1%. This is due to the fact that removing of the high percentage of husks when clearance between cylinders decreased. These results are consistent with the results gained by (Asmat, 2011). The levels of the percentage of palea and lemma at different condition is shown in Figure **7**.

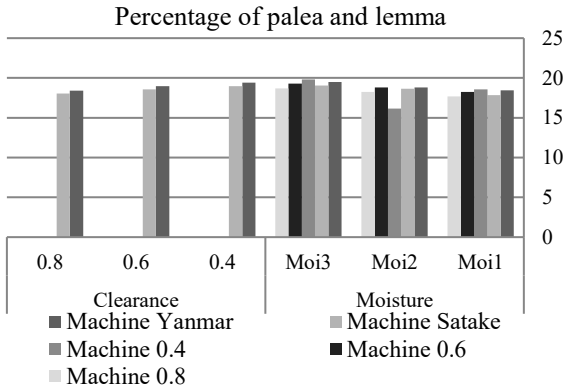

Figure 7 The effect of machine type, clearance and grain moisture on palea and lemma percentage

Breakage percentage

Table 2 shows the influence of the type of machine, clearance, and grain moisture on the percentage of breakage grain. The results indicate that the Satake type machine is significantly better than the Yanmar type machine. The results get to are 8.232 and 7.343% respectively. The percentage of breakage grain decreased 12.1% This is due to the fact that high pressure on grain leads to increase percentage of breakage grain when using Yanmar type machine as compared with Satake type machine. These findings are consistent with the findings of (Al maamouri et al.,2008). But when increasing of the clearance between cylinders leads to decrease the percentage of breakage grain, and the results are 8.789, 7.773 and 6.801%, by a decrease of 13.1 and 14.3%, because of less pressure and flow of grain easily with increasing clearance between cylinders. These results are consistent with the results gained by (Ghavami et al., 2005). However, increasing the grain moisture leads to increase of the breakage percentage, and the results are 7.049, 7.709 and 8.604%, respectively, by an increase of 9.3 and 11.6% respectively. because of removal part of grain with husk when grain moisture increase, hence increase percentage of breakage grain. These findings are consistent with the findings of (Alsharifi, 2010). The levels of the percentage of breakage grain at different condition is shown in Figure 8.

Table 1 The effect of machine types, clearance and grain moisture on the percentage of palea and lemma

The overlap between machines, grain moisture and clearance					
Machines	Grain moisture	Clearance between cylinder			The overlap between machines and moisture
		0.4	0.6	0.8	
Yanmar	10-12%	19.023	18.504	17.926	18.484
	12-14%	19.327	18.900	18.238	18.821
	14-16%	19.936	19.557	19.032	19.508
Satake	10-12%	18.142	17.967	17.443	17.850
	12-14%	19.004	18.709	18.284	18.665
	14-16%	19.703	19.016	18.369	19.030
L.S.D = 0.05			0.194		0.112
Average of clearance		19.189	18.775	18.215	
L.S.D = 0.05			0.079		
Machines	The overlap between machines and clearance				Average of machines
Yanmar		19.429	18.987	18.398	18.938
Satake		18.950	18.564	18.032	18.515
L.S.D = 0.05			0.112		0.065
Grain moisture	The overlap between grain moisture and clearance				Average grain moisture
10-12%		18.583	18.235	17.684	18.167
12-14%		19.165	18.804	18.261	18.743
14-16%		19.819	19.287	18.700	19.269
L.S.D = 0.05			0.137		0.079

Table 2 The effect of machine types, clearance and grain moisture on the breakage proportion %

The overlap between Machines ,Grain Moisture and Clearance					
Machines	Grain moisture	Clearance between cylinder			The overlap between machines and moisture
		0.4	0.6	0.8	
Yanmar	10-12%	8.604	7.791	6.272	7.556
	12-14%	9.042	8.375	7.107	8.175
	14-16%	9.968	8.871	8.055	8.964
Satake	10-12%	7.928	6.139	5.560	6.543
	12-14%	8.155	7.328	6.247	7.243
	14-16%	9.038	8.132	7.562	8.244
L.S.D = 0.05			0.196		0.113
Average of clearance		8.789	7.773	6.801	
L.S.D = 0.05			0.080		
Machines	The overlap between machines and clearance				Average of machines
Yanmar		9.204	8.345	7.145	8.232
Satake		8.374	7.200	6.456	7.343
L.S.D = 0.05			0.113		0.065
Grain moisture	The overlap between grain moisture and clearance				Average of grain moisture
10-12%		8.266	6.965	5.916	7.049
12-14%		8.599	7.851	6.677	7.709
14-16%		9.503	8.502	7.808	8.604
L.S.D = 0.05			0.138		0.080

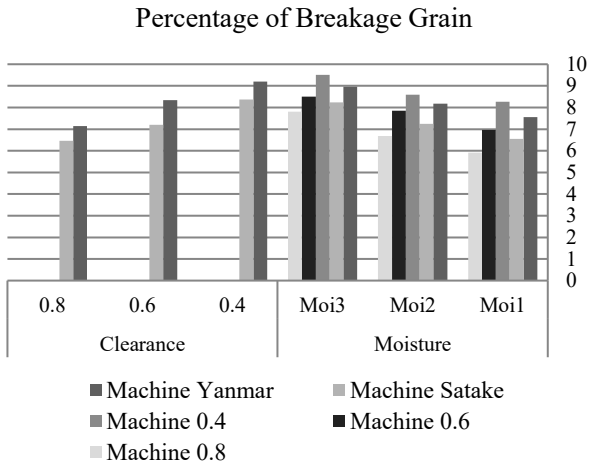

Figure 8 The effect of machine types, clearance and grain moisture on breakage percentage

Hardness degree

Table 3 shows the influence of the type of machine, clearance, and grain moisture on the degree of hardness (degree). The results indicate that the Satake type machine is significantly better than the Yanmar type machine. The results that gained from this process are 6.818and 6.304 degree respectively, by a decrease of 8.1%, Because of remove high proportion of husk with using Satake type machine as compared with Yanmar type machine hence hardness degree decreased. These findings are consistent with the findings of Parnsakhorn et al. (2008). Increasing of the clearance between cylinders leads to increase the degree of hardness, and the results are5.637 ,6.584 and 7.462 degree, and by an increase of 13.3and 16.7%, this is due to the fact that remove husk less of grain the manufacturer, leads to increasing of the hardness degree with increasing clearance between cylinders. These results are consistent with the results that gained by Alsharifi (2010) .While when increasing of the grain moisture leads to increase of the hardness degree , and the results are 6.036, 6.512 and 7.134 degree, respectively, by an increase of 7.8 and 9.6% respectively, when increasing the grain moisture, leads to not to be broken when the pressure hence increase of the hardness degree These findings are consistent with the findings of Jiang et al. (2010).The levels of the hardness degree at different condition is shown in Figure 9.

Table 3 The effect of machine types, clearance and grain moisture on the degree of hardness

		The overlap between machines ,grain moisture and clearance			
Machines	Grain moisture	Clearance between cylinder			The overlap between machines and Moisture
		0.4	0.6	0.8	
Yanmar	10-12%	5.129	6.170	7.209	6.169
	12-14%	5.866	6.891	7.787	6.848
	14-16%	6.639	7.502	8.167	7.436
Satake	10-12%	5.015	5.845	6.848	5.903
	12-14%	5.210	6.202	7.115	6.176
	14-16%	5.960	6.892	7.647	6.833
L.S.D = 0.05			0.208		0.120
Average of clearance		5.637	6.584	7.462	
L.S.D = 0.05			0.085		
Machines	The overlap between machines and clearance				Average of machines
Yanmar		5.878	6.854	7.721	6.818
Satake		5.395	6.313	7.203	6.304
L.S.D = 0.05			0.120		0.069
Grain moisture	The overlap between grain moisture and clearance				Average of grain moisture
10-12%		5.072	6.007	7.028	6.036
12-14%		5.538	6.547	7.451	6.512
14-16%		6.299	7.197	7.907	7.134
L.S.D = 0.05			0.147		0.085

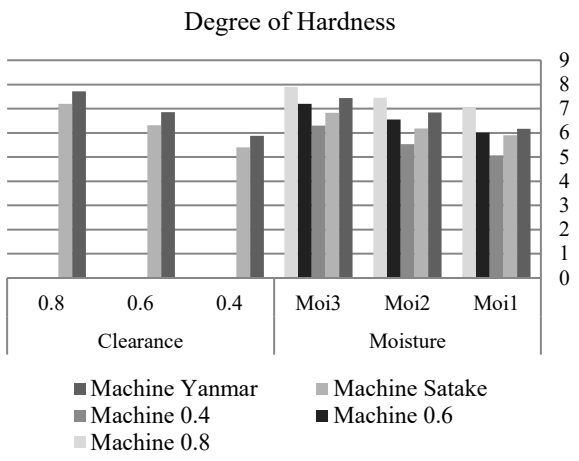

Figure 9 The effect of machine types, clearance and grain moisture on hardness degree

Stage of whitening rice

Bran percentage

Table 4 shows the influence of the type of machine, clearance, and grain moisture on the bran percentage. The results indicate that the Satake type machine is significantly better than the Yammer type machine. The results get to are 5.725 and 4.901% respectively, by a decrease of 12.1%, because of type and efficiency of machine they using in the manufacture process. These findings are consistent with the findings of (Fama et al., 2009),While when increasing of the clearance between cylinders leads to decrease the percentage of bran ,and the results are 6.145, 5.302 and 4.493%, by a decrease of 15.8 and 4.0%, This is due to the fact that less of the husk which removing from the grain when increase clearance between cylinders, These results are consistent with the results that gained by (Roy, 2008). As well as when increasing of the grain moisture leads to increase of the bran percentage, and the results are 4.791, 5.258 and 5.890%, respectively with high rate 9.7 and 12.0% respectively, because of they contain on high proportion of moisture leads to increase of the bran percentage. These findings are consistent with the findings of (Sanchez et al., 2004). The levels of the bran percentage at different condition is shown in Figure 10.

Table 4 The effect of machine types, clearance and grain moisture on the proportion bran

Machines	The overlap between machines, grain moisture and clearance				
	Grain moisture	Clearance between cylinder			The overlap between machines and moisture
		0.4	0.6	0.8	
Yanmar	10-12%	5.899	5.638	4.099	5.212
	12-14%	6.091	5.788	5.097	5.659
	14-16%	6.882	6.046	5.986	6.305
Satake	10-12%	5.895	4.186	3.032	4.371
	12-14%	5.992	4.615	3.967	4.858
	14-16%	6.111	5.539	4.775	5.475
L.S.D = 0.05			0.090		0.052
Average clearance		6.145	5.302	4.493	
L.S.D = 0.05			0.036		
Machines	The overlap between Machines and Clearance				Average mchines
Yanmar		6.291	5.824	5.061	5.725
Satake		5.999	4.780	3.924	4.901
L.S.D = 0.05			0.052		0.030
Grain moisture	The overlap between Grain moisture and Clearance				Average grain moisture
10-12%		5.897	4.912	3.565	4.791
12-14%		6.041	5.202	4.532	5.258
14-16%		6.497	5.793	5.381	5.890
L.S.D = 0.05			0.063		0.036

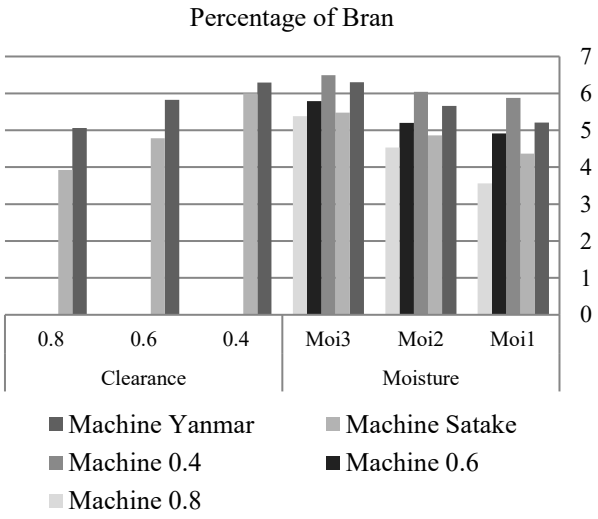

Figure 10 The effect of machine types, clearance and grain moisture on percentage of bran

Bench percentage

Table 5 shows the influence of the type of machine, clearance, and grain moisture on the percentage of bench. The results indicate that the Satake type machine is significantly better at different condition is shown in Figure 11. than the Yanmar type machine. The results get to are 4.876 and 4.377% respectively, by a decrease of 11.4%, because of type and efficiency of machine they using in the manufacture process. These findings are consistent with the findings of (Asmat,2011), while when increasing the clearance between cylinders leads to decrease of the bench percentage ,and the results are 5.499, 4.641 and 3.739%, by a decrease of 18.4 and 24.1%, This is due to the fact that increasing the damocles effort on grain when decrease clearance between cylinders leads to increasing of the bench percentage . These results are consistent with the results that gained by (Tan et al.,2000) ,In addition increasing the grain moisture leads to increase of the bench percentage , and the results are 4.072 , 4.590 and 5.216%, respectively ,by an increase of 12.7 and 13.6% respectively, when increasing of the grain moisture leads to smash grain hence increase of the bench percentage .These findings are consistent with the findings of (Al maamouri et al.,2008).The levels of the bench percentage

Table 5 The effect of machine types, clearance and grain moisture on the proportion of bench %

		The overlap between machines, grain moisture and clearance			
Machines	Grain moisture	Clearance between cylinder			The overlap between machines and moisture
		0.4	0.6	0.8	
Yanmar	10-12%	5.292	3.949	3.117	4.119
	12-14%	5.849	4.963	3.933	4.915
	14-16%	6.038	5.830	4.911	5.593
Satake	10-12%	5.035	4.040	3.003	4.026
	12-14%	5.204	4.180	3.411	4.265
	14-16%	5.574	4.884	4.059	4.839
L.S.D=0.05			0.261		0.151
Average of Clearance		5.499	4.641	3.739	
L.S.D=0.05			0.106		
Machines	The overlap between Machines and Clearance				Average of machines
Yanmar		5.726	4.914	3.987	4.876
Satake		5.271	4.368	3.491	4.377
L.S.D=0.05			0.151		
Grain moisture	The overlap between grain moisture and clearance				Average of grain moisture
10-12%		5.164	3.994	3.060	4.072
12-14%		5.527	4.571	3.672	4.590
14-16%		5.806	5.357	4.485	5.216
L.S.D=0.05			0.185		0.106

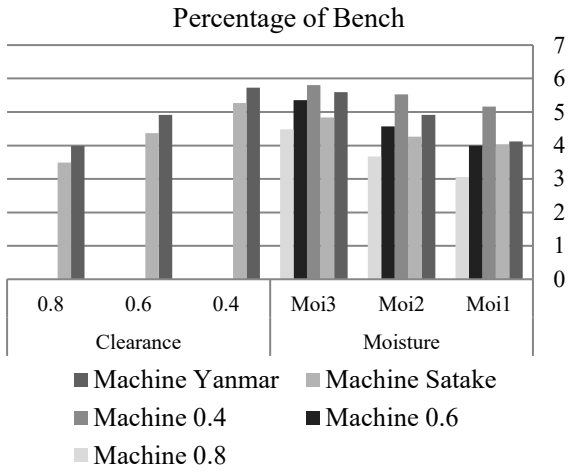

Figure 11 The effect of machine types, clearance and grain moisture on percentage of bench

Degree of whiteness

Table 6 shows the influence of the type of machine, clearance, and grain moisture on the degree of whiteness (degree). The results indicate that the Satake type machine is significantly better than the Yanmar type machine. The results get to 31.6 and 32.4 degree respectively by an increase of 2.5%. Because of easily remove the husk of the grain with using Satake type machine as compared with Yanmar type machine hence increasing degree of whiteness .These findings are consistent with the findings of Roy (2008). In addition increasing the clearance between cylinders leads to decrease of the whiteness degree and the results are 32.9, 32.0 and 31.2 degree, by a decrease of 2.8 and 2.5%, This is due to the fact that increase percentage of bran when decreasing clearance between cylinders and reflected on increasing degree of whiteness. These results are consistent with the results gained by (Farooq et al., 2005) .While when increasing the grain moisture leads to decrease of the whiteness degree , and the results are 32.9, 32.1 and 31.1 degree, respectively by a decrease of 2.5 and 3.2% respectively, this is due to the fact that obstruction the polished process, when increasing grain moisture, and this leads to decrease of the whiteness degree. These findings are consistent with the findings of Yerpude et al. (2015).The levels of the degree of whiteness at different condition is shown in Figure 12.

Table 6 The effect of machine types, clearance and grain moisture on the degree of whiteness

Machines	The overlap between machines, grain moisture and clearance				
	Grain moisture	Clearance between cylinder			The overlap between machines and moisture
		0.4	0.6	0.8	
Yanmar	10-12%	33.5	32.1	31.6	32.4
	12-14%	32.6	31.7	31.0	31.7
	14-16%	31.1	30.8	30.1	30.7
Satake	10-12%	34.4	33.3	32.6	33.4
	12-14%	33.4	32.6	31.4	32.5
	14-16%	32.6	31.4	30.5	31.5
L.S.D = 0.05			0.256		0.148
Average clearance		32.9	32.0	31.2	
L.S.D = 0.05			0.104		
Machines	The overlap between machines and clearance				Average machines
Yanmar		32.4	31.5	30.9	31.6
Satake		33.5	32.4	31.5	32.4
L.S.D = 0.05			0.148		0.085
Grain moisture	The overlap between grain moisture and clearance				Average grain moisture
10-12%		33.9	32.7	32.1	32.9
12-14%		33.0	32.1	31.2	32.1
14-16%		31.9	31.1	30.3	31.1
L.S.D = 0.05			0.181		0.104

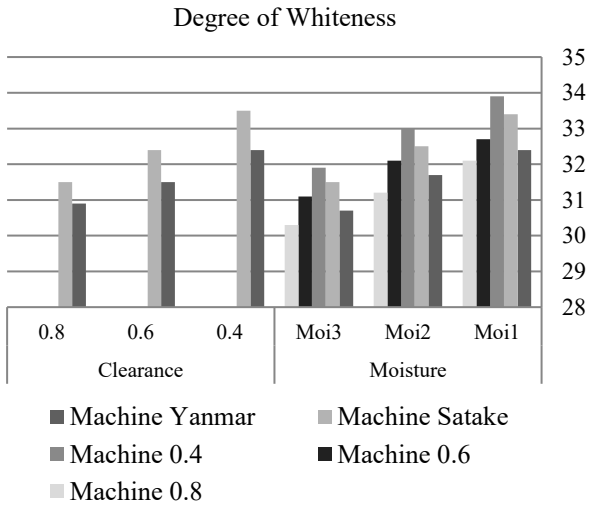

Figure 12 The effect of machine types, clearance and grain moisture on degree of whiteness

Percentage of whiteness

Table 7 shows the influence of the type of machine, clearance, and grain moisture on the percentage of whiteness. The results indicate that the Satake type machine is significantly better than the Yanmar type machine. The results get to are 9.795 and 10.256%, respectively, by an increase of 4.7%. This depend on time period for each machine to acquire on white color of the rice .These findings are consistent with the findings of Alizadeh et al. (2011).While when increasing the moisture content of grain leads to decrease of the whiteness percentage , and the results are 10.607, 10.024 and 9.445%, respectively with low rate 5.8 and 6.1% respectively, when increasing grain moisture leads to adhesion of the husk on rice grains to acquire brown color allowance white. These findings are consistent with the findings of Sha et al., 2011. In addition increasing the clearance between cylinders leads to decrease of the percentage of whiteness, and the results are 10.529, 10.072 and 9.474%, by a decrease of 4.5 and 6.3%, because of removing of the high percentage of husk and bran with decreasing of the clearance between cylinders leads to increasing of the whiteness percentage. These results are consistent with the results that gained by Tan et al., 2000. The levels of the whiteness percentage at different condition is shown in Figure 13.

Table 7 The effect of machine types, clearance and grain moisture on the percentage of whiteness

Machines	The overlap between machines, grain moisture and clearance				
	Grain moisture	Clearance between cylinder			The overlap between machines and moisture
		0.4	0.6	0.8	
Yanmar	10-12%	11.038	9.140	9.906	10.434
	12-14%	10.108	9.957	9.248	9.771
	14-16%	9.961	10.359	8.434	9.178
Satake	10-12%	11.256	9.955	10.183	10.779
	12-14%	10.740	10.122	9.969	10.277
	14-16%	10.073	10.899	9.105	9.711
L.S.D = 0.05			0.129		0.074
Average clearance		10.529	10.072	9.474	
L.S.D = 0.05			0.052		
Machines	The overlap between machines and clearance				Average machines
Yanmar	10.369		9.819	9.196	9.795
Satake	10.690		10.325	9.752	10.256
L.S.D = 0.05			0.074		0.043
Grain moisture	The overlap between grain moisture and clearance				Average grain moisture
10-12%	11.147		10.629	10.044	10.607
12-14%	10.424		10.039	9.608	10.024
14-16%	10.017		9.547	8.769	9.445
L.S.D = 0.05			0.091		0.052

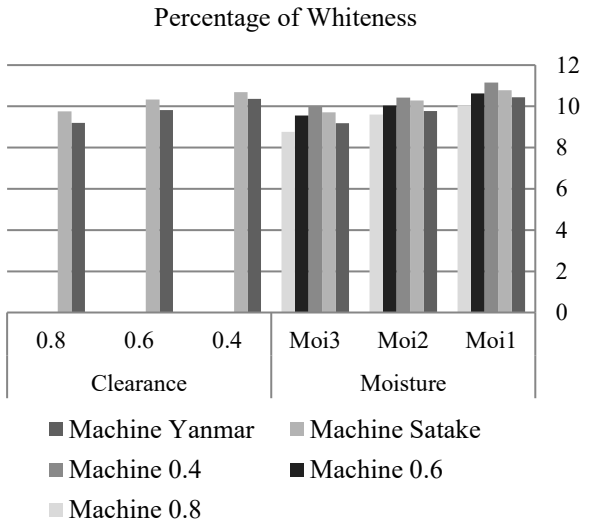

Figure 13 The effect of machine types, clearance and grain moisture on percentage of whiteness

Discussion

The outcome of the investigation showed that the protected cultivation and cultivar selection are two effective tools to manage the harvesting period in watermelon growing. The first harvest date coinciding between 18-27 of June in open field cultivation for early season genotypes can be brought to the end of May and beginning of June by low tunnel cultivation, at the middle of May in high Tunnel and at the beginning of May and even the end of April in non-heated greenhouse cultivations. These results are in agreement with the results obtained by Tseklee (1981) and Ruggeri (1981). It seems to be possible to take the first harvesting date at the middle of April and even the beginning of April when the high tunnels and greenhouse are heated. However, for this purpose, it is necessary to establish a new experiment and to realize an economic analysis considering the price of crop and fuel expenses.

From the point of yield, the best results were obtained in high tunnels. Under low tunnel and high tunnel yield was observed to be 30% and 60% higher than open field growing, respectively. These differences were due to effectiveness of plastic tunnels that kept the plants close to the biological optimum temperature requirement during growing period. The results obtained by Belik and porokhnya (1974), Pakyurek and Kaska (1992) support our observations. The yield of greenhouse cultivation was found to be lower than tunnels and it was similar in open field growing. The fact that the yield in high and low tunnels was higher than greenhouse seems to be contradictory. But there is no contrast here. Sowing and planting were not done on the same date for all cover systems. Because sowing for greenhouse cultivation was done earlier than high and low tunnels, the temperature in greenhouse were lower than high and low tunnels. This resulted in low yield in greenhouse.

Differences observed over time from sowing to harvest between cover systems can be explained by sum degrees day's requirements of watermelon (Onsinejad, 1993). From the point of maturing-duration, significant differences were found among genotypes. It was concluded that yield emergence could be changed 20 days, 25 days, 45 days and 50 days in open field, low tunnel, high tunnel and greenhouse growing, respectively between earliest and latest season genotypes. When the genotype and covering patterns are considered together, harvesting period could be spread in to 3 months.

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