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EFFECT OF HARVESTING TIME ON GRAIN YIELD AND QUALITY CHARACTERISTICS OF SOME RICE CULTIVARS AT DIFFERENT STORAGE PERIODS

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ABSTRACT: The field experiments were conducted at The Experimental Farm of Sakha Agricultural Research Station, Kafr El-Sheikh, Egypt during 2018 and 2019 seasons to investigate the effect of harvest time on grain yield and its attributes as well as grain quality characteristics of some rice cultivars at different storage periods. The experiments were laid out in a split-plot design, with three replications. The main plots were devoted to harvest time i.e. harvest after 7, 14, and 21-day after irrigation cut-off (DAIC). However, the sub-plots were assigned to rice cultivars (Sakha106, Sakha107 and Sakha 108). The grain quality characteristics were studied at 6, 9 and 12-month after harvesting. Delaying the harvest date to 21-DAIC lead to a significant decrease in number of filled and unfilled grains/panicle, panicle weight and grain yield compared with 7- and 14-DAIC. The inverse was true in 1000-grain weight. Sakha 108 was superior to Sakha 106 and Sakha 107 in grain yield and its attributes. The highest grain yield was obtained from Sakha 108 at harvest time of 14-DAIC. Moisture content, hulling, milling and head rice percentages were gradually decreased by increasing storage period from 6 to 9 and 12-month. The inverse was found in amylose, elongation percentages and gelatinization temperature (GT). The intermediate harvest time 14-DIAC registered the highest values of all grain quality characteristics. Sakha 108 registered the lowest moisture content and the highest values of other grain quality. Generally, Sakha 108 harvested at 14-DAIC achieved the highest grain yield and quality at the 9-month storage period.

Key words: Rice, harvesting times, storage periods, cultivars, quality characters.

INTRODUCTION

Rice *(Oryza sativa* L.*)* is the predominant staple food in diets for more than half of the population worldwide and is pivotal for human nutrition, energy supply, and food security. It supplies adequate energy in the form of calories and is a good source of thiamine, riboflavin, and niacin (Zhu et al., 2010). Rice has been considered one of the most common foods among all cereals for its nutritional quality. It has higher digestibility, biological value, and protein efficiency ratio owing to the presence of a higher percentage of lysine than that of wheat (El-Kady et al., 2013). It is the most important summer cereal crop of traditional rice-growing areas of Egypt and is among the major export commodities. There are important questions concerning the effect of irrigation cut-off and time of harvest on rice grain yield and grain quality that contribute directly to profit. Early harvest may lead to increases in the unfilled and immature grains. These premature grains may result in partially chalky kernels and milk-white kernels and increases the thickness of the bran and aleuronic layers (Hossain et al., 2009). Baktiar et al., (2013) reported that rice harvesting at 30 to 35 days after flowering was found to be suitable for higher grain quality in respect of head rice, elongation (%) and amylose content. Jewel et al., (2016) concluded that harvesting at 30 to 35 days after flowering was found to be suitable for all the grain quality characters, for avoiding immature stage as well as shattering loss.

Storage is an essential step in rice processing after harvest to extend shelf-life and commercial consumption. Effective grain storage techniques are now indispensable in many countries, and strong demand to develop such techniques has been increasing to meet growing requirements for food, about 70% extra food production will be desired by the year 2050 while a high level of grain loss can be more than 20% (Katta et al., 2019). Jungtheerapanich et al., (2017) revealed that the storage efficacy of paddy rice was significantly increased due to increasing storage periods from 2 to 4 and 6 months. El-Dalil (2017) indicated that storing the grains of Giza 179 rice cultivar for 9 months gave the highest values for hulling, milling and broken percentage. Tong et al., (2019) reported that increasing storage period of paddy rice led to a decrease in breakdown grains and an increase in head rice yield. Also, rice grain aging occurring during storage is inevitable and responsible for the changes in rice appearance, milling, eating, cooking, and nutritional quality. Katta et al., (2019) revealed that rice grain quality characters were reduced with increasing storage periods from 6 to 12, 18 and 24 months. Marques et al. (2014) showed that milling characteristics in terms of broken percentage and head rice yield showed non-significant differences among the varieties. Hence, this study was established to examine the effect of harvest time at different storage periods on grain yield and its component as well grain quality characters of some rice cultivars.

MATERIALS AND METHODS

Two field experiments were conducted at The Experimental Farm of Sakha Agricultural Research Station, Kafr El-Sheikh, Egypt during the 2018 and 2019 seasons. The purpose was to investigate the effect of different harvesting time on grain yield and component as well as grain quality characters of some rice cultivars at different storage periods. All experiments were preceded by barley crop (Hordum spp.). The soil was clay with pH 8.05 and 8.20 and an organic matter content of 1.65 and 1.60 %. The total N was 520 and 500 ppm in both seasons, respectively. The experiments were laid out in a split-plot design, with three replications. The main plots were devoted to three harvesting times namely harvest after 7, 14 and 21 days after irrigation cut-off (DAIC). Irrigation cut-off was done after 20 days of heading. The sub-plots were assigned to three rice cultivars: Sakha 106, Sakha107, and Sakha108. The sub plot size was 16 m^2 (4 ×4 m). The experimental sites and the nursery were well ploughed and leveled. The experimental sites and the nursery were well ploughed and leveled. Nitrogen, phosphorus, and zinc ($Zn\ SO_4$) as well as all other cultural practices were applied as recommended. Seeds of rice cultivars, at the rate of 120 kg/ha each, were soaked in sufficient water for 24 hours and incubated for another 48 hours to enhance each germination. The experiments were sown on the 2nd and 5th of May in the two seasons of study, respectively. Seedlings were carefully pulled from the nursery after 30 days from sowing and distributed through the plots. Seedlings were manually transplanted in 20 x 20 cm spacing between hills and rows, at the rate of 2-3 seedlings/hill. The other usual agricultural practices of growing rice were performed as the recommendation of Rice Research and Training Center .

At harvest, the number of panicles of ten random hills was counted and then, conformed to the number of panicles/hill. Ten panicles were collected randomly

from each sub plot to estimate number of filled grain and unfilled grain per panicle and 1000-grain weight. The central area of 4 m^2 (2 x 2 m) of each sub plot was harvested to obtained grain yield. The moisture content of grain yield was adjusted to 14 % and then the yield of the 4 m^2 was computed and transferred to tons per hectare.

About 3 kg of paddy rice grains were taken from each sub plot and dried in open air until moisture content reached 14 %, then samples were stored in a well-ventilated store in gunny package for 6, 9, and 12 months after harvest time during 2018/19 and 2019/20 seasons. At each storage period, moisture content and milling recovery (hulling, milling and head rice percentage) was measured, according to the method described by Juliano (1971) and IRRI (1996). Amylose content was determined by auto-analyzer based on the iodine-colorimetric method (Juliano, 1971). Gelatinization temperature (G.T) is the temperature at which the starch in rice begins the process of cooking. At this point the starch granules take in water and lose their crystalline nature, a change that is irreversible. Temperature of gelatinization process was distinguished (Little *et al.,* 1958).

The combined analysis for the three storage periods was done in each experiment in each season. Data collected were statistically analyzed using the analysis of variance technique in field experiments and combined analysis for the three storage periods in each experiment according to Gomez and Gomez (1984). Duncan's Multiple Range Test was used to compare the treatment means (Duncan 1955). All statistical analyses were accomplished using the analysis of variance technique using "COSTAT" statistical software package.

RESULTS AND DISCUSSION

Grain yield and yield attributes:

Data in Table 1 show that number of panicle/ hill did not significantly affected by harvest time in both seasons. This is because the number of panicle per hill is mostly complete at the heading date. Delaying the harvest date to 21 days after irrigation cut-off (DAIC) lead to a significant decrease in the number of filled and unfilled grains/panicle and panicle weight compared with 7 and 14 DAIC, which not differ in these respects in the two seasons. Delay in harvesting results in low moisture content in grains which may increase the losses percentage and consequently decreased the total grains/panicle. These results agree with those found by Atapattu et al (2018) and Ilieva et al., (2019). On the other hand, 1000-grain weight was substantially increased by delaying the harvest date to 14 and 21 DAIC than early harvest at 7 DAIC in both seasons. Early harvest date might be affected grain filling by reducing the period of active grain filling resulted in bad panicle characteristics producing low panicle fertility, more immature grain and light 1000-grain weights. Similar findings were reported by Dewedar (2004), Hossain et al. (2009), Afifah, et al., (2015), Atapattu et al (2018), and Yang, et al., (2019).

Data in Table 1 show that harvest time had a significant effect on grain yield (t/ha) in both seasons. Harvest time at 7 and 14 DAIC, being insignificant, resulted in a markedly increase in grain yield compared with the harvest time at 21 DAIC in the two seasons. Harvest time at 14 DAIC achieved the highest grain yield through increasing some yield attributes such as the number of filled grains / panicle, 1000-grain weight and panicle weight. These results are in a quite agreement with those reported by Dewedar (2004), Hossain et al. (2009), Afifah, et al., (2015), Atapattu et al (2018), and Yang, et al., (2019).

Table 1: Grain yield and some yield attributes of some rice cultivars as affected by harvest time in 2018 and 2019 seasons.

Treatment	No. of panicle/hill		No. of filled grains/ panicle		No. of unfilled grains / panicle		Panicle weight (g)		1000-grain weight (g)		Grain yield (t/ha)	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Harvest time (DAIC):												
7	19.38	19.72	103.24a	113.99a	9.32a	9.57a	3.31a	3.57a	24.96b	25.30b	9.68a	9.68a
14	19.63	19.95	100.62a	107.37a	8.21a	8.68a	3.08a	3.33a	26.03a	26.49a	10.27a	10.27a
21	19.77	20.02	86.13b	98.62c	5.85b	6.53b	2.62b	2.76b	26.52a	26.98a	7.51b	7.51b
F.test	NS	NS	**	**	**	**	*	**	**	**	**	**
Rice cultivar:												
Sakha106	18.10b	18.40b	91.22b	102.31c	10.05a	9.71a	2.54c	2.70c	25.29c	25.71c	8.29c	8.74c
Sakha107	18.07b	18.38b	94.12b	106.27b	7.53b	8.60b	2.96b	3.25b	25.85b	26.27b	9.36b	9.73b
Sakha108	22.60a	22.90a	104.65a	111.41a	5.70c	6.46c	3.51a	3.69a	26.37a	26.79a	10.00a	10.24a
F.test	**	**	**	**	**	**	**	**	**	**	**	**
Interaction	NS	NS	NS	*	NS	NS	NS	NS	*	NS	*	*

DAIC = days after irrigation cut-off. **,* Highly significant and significant at 0.01 and 0.05 levels, respectively. NS= Not Significant. Means of each factor designated by the same letter are not significantly different at 5% level according to Duncan's Multiple Rang Test.

The three rice cultivars significantly varied in all yield attributes in the two seasons (Table 1). The cultivar Sakha 108 was superior to Sakha 107 and Sakha 106 in number of panicle/hill, number of filled /panicle, panicle weight and 1000-grain weight in both seasons. On the contrary, the cultivar Sakha 106 recorded the highest value of unfilled grains number/panicle, while Sakha 108 recorded the lowest one in the two seasons. The superiority of Sakha 108 in panicle weight due to the increase in number of filled/panicle and 1000-grain weight. The results are in accordance with the findings of Metwally et al., (2016) and Howida et al., (2018).

The three-rice cultivars exhibited a significant difference in grain yield in both seasons (Table 1). The cultivar Sakha 108 out-yielded the other two cultivars in grain yield followed by Sakha 107 and Sakha 106. The superiority of Sakha 108 cultivar in grain yield may be due to increase all yield attributes namely number of panicles / hill, number of filled grains / panicle, 1000-grain weight and panicle weight. The results are in accordance with the findings of Metwally et al., (2016).

Results presented in Table 2 showed that the interaction effect between harvest time and rice cultivar on the number of filled grains/ panicle and 1000-grain weight was significant in 2019 and 2018 seasons, respectively. At any cultivar, delaying the harvest date decrease number of filled grains / panicle, while, it increased 1000-grain weight. At the same harvest time, the cultivar Sakha 108 recorded the highest values of filled grains number / panicle and 1000-grain weight. The cultivar Sakha 108 produced the greatest number of filled grains / panicle at the early harvest date 7 DAIC and the heaviest 1000-grain weight at the late harvest date 21 DAIC. However, the cultivar Sakha 106 produced the lowest number of filled grains / panicle at the late harvest date 21 DAIC and the lightest 1000-grain weight at the early harvest date 7 DAIC.

The interaction between harvest time and rice cultivars had a significant effect on grain yield in the two seasons (Table 3). At any cultivar, delaying harvest time to 21 DAIC significantly decreased grain yield compared with the other two harvest times in both seasons. At the same harvest date, Sakha 108 and Sakha 107, being insignificant, surpassed Sakha 106 in grain yield in the two seasons. The highest grain yield was obtained from Sakha 108 at the harvest time 14 DAIC, while the lowest one was obtained from Sakha 106 at the harvest time 21 DAIC. There were no significant difference in grain yield between Sakha 107 and Sakha 108 at the harvest time 14 DAIC in both seasons.

Table 2: Number of filled grains / panicle and 1000-grain weight as affected by the interaction between harvest times and rice cultivars.

Harvest time (DAIC)	No. of filled grains/ panicle (2019)			1000-grain weight (g) (2018)		
	Sakha106	Sakha 107	Sakha 108	Sakha106	Sakha 107	Sakha 108
7	110.06bc	112.52b	119.41a	24.37e	25.04d	25.47cd
14	104.70d	107.38cd	110.02bc	25.52cd	26.11bc	26.46b
21	92.16f	98.91e	104.79d	25.99bc	26.39b	27.19a

DAIC = days after irrigation cut-off. Means of each character designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test.

Table 3: Grain yield (t/ha) as affected by the interaction between harvest times and rice cultivars.in 2018 and 2019 seasons.

Harvest time (DAIC)	2018			2019		
	Sakha106	Sakha 107	Sakha 108	Sakha106	Sakha 107	Sakha 108
7	8.79c	10.06ab	10.74a	9.00d	10.28bc	10.90ab
14	9.62b	10.39a	10.81a	9.99c	10.77ab	11.17a
21	6.46e	7.63d	8.46c	7.22f	8.16e	8.66de

DAIC = days after irrigation cut-off. Means of each factor designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test.

Grain quality characteristics:

Quality characteristics of rice grains (moisture content, hulling, milling, head rice, amylose, and elongation percentages as well as gelatinization temperature "GT") as affected by harvest time, cultivar and storage period in both seasons are presented in Table 4. Data show that moisture content, hulling, milling, and head rice percentages were gradually decreased by increasing storage period from 6 to 9 and 12 months. The highest values of these technological characteristics of rice grains were produced from storage for 6 months, followed by storage for 9 months and then storage for 12 months in both seasons. In contrary, amylose and elongation percentages and gelatinization temperature (GT) were significantly increased as a result of increasing storage periods of paddy rice grains from 6 to 9 and 12 months. The highest amylose, elongation percentages and gelatinization temperature (GT) were obtained from storage rice grains for 12 months, followed by storage for 9 months and then storage for 6 months in both seasons. These results may be due to biological activity in the grain mass, which includes fungi, bacteria, insects, rodents, and sprouting of grain and continued grain respiration. Also, grain deterioration during storage may be due to the damage in the membrane, enzyme, proteins, and nucleic acid. In addition, accumulations over time such degenerative changes result in complete disorganization of membranes and cell organelles. These findings confirm with those stated by Kanlayakrit and Maweang (2013), El-Dalil (2017), Jungtheerapanich et al. (2017), Katta et al. (2019) Tong et al. (2019).

Data in Table 4 show that harvest time significantly affected all studied quality characteristics of rice grains in both seasons. It could be noticed that the early harvest time 7 DIAC gave the highest moisture content in rice grains (15.25 and 14.39 %), followed by intermediate harvest time 14 DIAC and lastly late harvest time 21 DIAC, which recorded the lowest moisture content in rice grains in both seasons. However, the intermediate harvest time 14 DIAC registered the highest hulling, milling, head rice, amylose, and elongation percentages as well as gelatinization temperature (GT) in the two seasons. Whereas, the second-best values of hulling, milling, head rice, amylose, and elongation percentages, as well as gelatinization temperature (GT) were resulted from the early harvest time 7 days DIAC. The lowest values of hulling, milling, head rice, amylose, and elongation percentages as well as gelatinization temperature (GT) were obtained when harvest time delayed to 21 DIAC in both seasons. The increases in moisture content in rice grains at early

Table 4: Quality characteristics of rice grains as affected by harvest time and storage period of some rice cultivars and their interactions in combined analysis for the three storage periods during 2018 and 2019 seasons.

Treatment	Moisture content		Hulling (%)		Milling (%)		Head rice (%)		Amylose		Elongation (%)		Gelatinization temperature (GT)	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Storage period (S):														
6 months	13.7 a	14.2 a	82.00a	80.91	73.42a	70.91a	63.56a	63.79a	19.31c	18.50	31.34c	36.83b	5.63ab	5.74b
9 months	13.7 a	14.1 a	80.90b	80.79	72.22b	69.30b	61.70b	54.23b	20.27b	18.71	35.15b	35.42ab	5.66ab	5.77b
12 months	13.4 b	14.0 b	80.01c	80.17	70.85c	69.06b	60.34c	53.06b	21.20a	18.80	37.28a	37.22a	5.70a	6.48a
F. test	**	*	**	NS	**	**	**	**	**	NS	**	*	*	*
Harvest time (H):														
7 DAIC	15.25a	14.39a	81.37b	80.42b	72.28a	69.68b	61.81	56.13b	20.05b	18.53b	35.80a	35.76b	5.59ab	6.00ab
14 DAIC	13.18b	14.05b	82.96a	83.26a	72.49a	71.65a	62.01	62.40a	21.13a	19.30a	36.96a	39.50a	5.88a	6.48a
21 DAIC	12.58c	13.99b	78.67c	78.19c	71.71b	67.95c	61.78	52.54c	19.60c	18.19b	31.02b	34.22b	5.51b	5.51b
F. test	**	**	**	**	**	**	NS	**	**	**	**	**	*	**
Cultivar (C):														
Sakha 106	13.67ab	14.14b	80.88b	80.91a	72.17ab	70.05b	61.81	57.55b	20.31b	18.64b	34.53b	36.58b	5.63	6.00
Sakha 107	13.73a	14.30a	79.98c	79.18b	71.96b	67.95c	61.78	54.28c	19.85c	17.72c	32.97c	33.02c	5.51	5.74
Sakha 108	13.62b	14.00c	82.14a	81.77a	72.36a	71.28a	62.01	59.24a	20.62a	19.65a	36.28a	39.88a	5.85	6.25
F. test	*	**	**	**	*	**	NS	**	**	**	**	**	NS	NS
Interaction														
S × H	*	NS	**	NS	**	NS	**	*	**	*	**	**	NS	NS
S × C	**	NS	**	*	**	**	**	NS	**	NS	**	*	NS	NS
H × C	*	*	NS	NS	NS	NS	**	**	NS	*	**	**	NS	NS
S × H × C	**	*	**	*	*	**	**	**	**	*	**	**	*	*

DAIC = days after irrigation cut-off. **,* Highly significant and significant at 0.01 and 0.05 levels, respectively. NS= Not Significant. Means of each factor designated by the same letter are not significantly different at 5% level according to Duncan's Multiple Rang Test.

harvest 7 DIAC may be attributed to that rice grains did not reach the appropriate maturity stage, which might increase moisture content and loss of yield with poor quality of grains. However, the increases in quality characters of rice grains by intermediate harvest time 14 DIAC may be ascribed to rice grains reached to suitable grain maturity stage. The right stage for harvest is determined when panicles turn into golden yellow and the grains contain about 20 percent moisture. When the moisture in the paddy grains reaches 16-17 percent in the standing crop in the fields, the crop sustains a heavy loss owing to shattering and damage by birds and rodents. In general, three criteria are taken into consideration to specify the right time of harvesting which are. (i) the moisture content of the grains, (ii) the number of days after planting to flowering, and (iii) the dry matter of the plant or seed. These results are in good accordance with those stated by Hossain et al. (2009), Baktiar et al. (2013), and Jewel et al. (2016).

The obtained results showed that the three studied rice cultivars i.e. Sakha 106, Sakha107, and Sakha108 cultivars significantly differed in quality characters of rice grains (moisture content, hulling, milling, head rice, amylose, and elongation percentages as well as gelatinization temperature "GT") in both seasons as shown in Table 4. It could be observed that Sakha 108 cultivar registered the lowest moisture content percentages and the highest hulling, milling, head rice, amylose and elongation percentages, and gelatinization temperature (GT). Sakha 107 cultivar recorded the highest moisture content percentages and the lowest hulling, milling, head rice, amylose and elongation percentages, and gelatinization temperature (GT) in both seasons. However, Sakha 106 cultivar resulted in the second-best values of moisture content, hulling, milling, head rice, amylose and elongation percentages, and gelatinization temperature (GT) in both seasons. The previously mentioned results might be related to genetic factors which resulted from genetic makeup relations for the studied rice cultivars. The obtained results of this study are partially conformable with reported by Verma et al. (2015), Rather et al. (2016), and Katta et al. (2019).

With regard to the interactions among the studied factors (harvesting and storage periods and rice cultivars), enormous of them were statistically significant in most cases in both seasons as shown in Tables 5 and 6. The second order interaction of storage period x harvest time x rice cultivars will be discussed. Moisture content, hulling, milling, head rice, amylose and elongation percentages as well as gelatinization temperature (GT) were significantly affected by the second order interaction in both seasons. The highest moisture content percentage in grains were recorded when early harvest time 7 DAIC of Sakha 107 rice cultivar at storage for 6 months. However, the lowest moisture content percentage in grains were recorded when delay harvest time 21 DAIC of Sakha 108 rice cultivar at storage grains for 12 months. While, the highest hulling, milling and head rice percentages of rice grains were recorded when intermediate harvest time 14 DAIC of Sakha 108 rice cultivar and storage grains for 6 months. The lowest hulling, milling and head rice percentages of rice grains were recorded when delay harvest time to 21 DAIC of Sakha 107 rice cultivar at storage grains for 12 months. Whereas, the highest amylose and elongation percentages and gelatinization temperature (GT) of rice grains were recorded when intermediate harvest time 14 DAIC of Sakha 108 rice cultivar at storage grains for 12 months,

while, the lowest amylose and elongation percentages and gelatinization temperature (GT) of rice grains were recorded when delay harvest time to 21 DAIC of Sakha 107 rice cultivar at storage grains for 6 months.

Table 5: Moisture content, hulling, milling and head rice percentages as affected by the interaction among harvest time, storage times of some rice cultivars in combined analysis for the three storage periods during 2018 and 2019 seasons.

Treatment			Moisture content (%)		Hulling (%)		Milling (%)		Head rice (%)	
			2018	2019	2018	2019	2018	2019	2018	2019
6 months	7 DAIC	S 106	15.36ab	14.36ab	81.88e-g	80.67b	73.67a	70.67b	63.44a	64.00a
		S 107	15.46a	14.64a	81.33gh	79.55bc	73.67a	69.55bc	63.33a	60.78a
		S 108	15.36ab	14.36ab	83.67b	81.78ab	73.77a	71.78ab	64.33a	65.11a
	14 DAIC	S 106	13.30e-g	14.13b	83.67b	84.00a	73.55a	74.00a	63.22a	68.44a
		S 107	13.46e	14.20b	83.17b	82.89ab	73.33a	71.78ab	63.00a	66.44a
		S 108	13.20f-h	14.00bc	84.78a	86.22a	74.02a	75.11a	64.78a	68.44a
	21DAIC	S 106	12.86i-l	14.10b	80.22i	78.44bc	73.11a	68.44c	63.00ab	60.67a
		S 107	12.90i-k	14.16b	78.55k	77.33c	72.44ab	68.00c	63.33a	59.55ab
		S 108	12.63k-n	14.03bc	81.44f-h	79.55bc	73.22a	68.44c	63.66a	60.67a
9 months	7 DAIC	S 106	15.26a-c	14.33ab	80.97h	80.67b	72.55ab	68.44c	61.44bc	57.11ab
		S 107	15.40a	14.43a	80.22i	78.44bc	72.22ab	68.44c	61.33bc	46.88bc
		S 108	15.13b-c	14.33ab	82.93c	81.78ab	72.77ab	70.67b	61.55bc	57.55ab
	14 DAIC	S 106	13.23e-h	14.13b	82.89cd	82.89ab	72.44	71.78ab	61.66bc	60.66a
		S 107	13.36ef	14.20b	82.00ef	80.67b	72.00ab	67.33c	61.55bc	56.22ab
		S 108	13.16f-h	14.00bc	83.67b	86.22a	72.66ab	74.00a	62.22b	62.77a
	21DAIC	S 106	12.63k-n	14.16b	78.33k	78.44bc	72.22ab	68.44c	62.00b	49.55bc
		S 107	12.76j-m	14.30ab	77.33l	77.33c	70.66c	67.33c	61.33bc	47.11c
		S 108	12.43no	13.83c	79.82j	78.44bc	72.44ab	69.55bc	62.22b	52.89b
12 months	7 DAIC	S 106	15.03cd	14.43a	80.23i	80.66b	71.33b	69.55bc	60.00c	50.89b
		S 107	15.26a-d	14.62a	79.22j	80.66b	70.88c	67.33c	59.78d	48.44bc
		S 108	15.00d	14.03bc	81.89e-g	79.55bc	71.33b	70.66b	60.66c	54.44b
	14 DAIC	S 106	12.86i-l	13.93c	82.26de	81.78ab	71.11b	70.67b	60.88c	59.55ab
		S 107	13.06g-i	14.43a	81.55f-h	80.66b	70.12c	68.44c	60.00c	58.44ab
		S 108	12.96h-j	13.93c	82.67cd	84.00a	71.58b	71.78ab	61.22bc	60.6a6
	21DAIC	S 106	12.36no	14.03bc	77.44l	79.55bc	70.44c	68.44c	59.55d	47.33c
		S 107	12.53mn	14.16b	76.44m	75.11c	70.00c	67.33c	59.50d	44.44c
		S 108	12.16o	13.70c	78.44k	79.55bc	70.88c	69.55bc	61.47bc	50.66b

DAIC= Days after irrigation cut off, S= Sakha. Means of each column designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test

Table 6: Amylose, elongation percentages and gelatinization temperature (GT) as affected by the interactions among harvest time, storage times and rice cultivars in combined analysis for the three storage periods during 2018 and 2019 seasons.

Treatment			Amylose (%)		Elongation (%)		Gelatinization temperature (GT)	
			2018	2019	2018	2019	2018	2019
6 months	7 DAIC	S 106	19.13m	18.75ab	33.57c	35.61b	5.33c	5.66a-c
		S 107	18.06no	18.57ab	32.46c	30.42bc	5.33c	5.66a-c
		S 108	19.28lm	19.92a	35.67b	38.37b	5.66b	6.00a-c
	14 DAIC	S 106	20.23h-k	18.23ab	33.31c	37.34b	5.66b	6.33a-c
		S 107	19.86kl	16.69c	32.61c	35.49b	5.66b	6.00a-c
		S 108	20.76e-i	19.54a	35.37b	39.21b	6.00a	6.33a-c
	21DAIC	S 106	18.85m	17.57b	26.40d	34.57bc	5.66b	5.00c
		S 107	17.69o	16.88c	25.44d	29.31c	5.33c	5.00c
		S 108	19.91j-l	19.13a	27.27d	34.58bc	5.66b	5.33bc
9 months	7 DAIC	S 106	20.53f-j	19.00a	36.25b	36.18b	5.66b	6.00a-c
		S 107	19.93j-l	17.69b	31.38c	29.31c	5.33c	5.33bc
		S 108	20.56f-j	19.97a	41.52a	39.21b	5.66b	6.33a-c
	14 DAIC	S 106	21.12c-f	19.01a	37.83b	38.46b	6.00a	6.33a-c
		S 107	20.86c-h	17.38b	34.60bc	38.35b	5.66b	6.00a-c
		S 108	21.50bc	19.32a	41.11a	40.38ab	6.00a	6.66ab
	21DAIC	S 106	19.05m	18.38ab	30.98c	35.51b	5.33c	5.00c
		S 107	18.72mn	16.88c	28.32cd	30.42bc	5.33c	5.00c
		S 108	20.18i-k	19.45a	32.60c	37.26b	6.00a	5.66a-c
12 months	7 DAIC	S 106	20.79d-i	19.74a	37.24b	38.46b	5.33c	6.33a-c
		S 107	20.74e-i	19.56a	35.97b	33.91bc	5.33c	6.00a-c
		S 108	21.46cb	19.80a	38.15ab	40.38ab	6.00a	6.66a-c
	14 DAIC	S 106	22.13c-f	18.79ab	38.25ab	37.62b	6.00a	7.00a
		S 107	21.25c-e	17.86b	36.67b	37.48b	6.00a	6.66a-c
		S 108	22.48a	20.65a	42.91a	51.13a	6.00a	7.00a
	21DAIC	S 106	20.45g-k	18.66ab	35.66bc	35.61b	5.66b	6.33a-c
		S 107	20.44g-k	17.59b	34.48bc	32.39bc	5.66b	6.00a-c
		S 108	21.08c-g	19.15a	38.04ab	38.37b	5.66b	6.33a-c

DAIC= Days after irrigation cut off, S= Sakha. Means of each column designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test

CONCLUSION

It can be concluded that harvesting after 14 DAIC with Sakha 108 rice cultivar achieved the highest grain yield and quality characteristics at the 9-month storage period.

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تأثير مواعيد الحصاد على محصول الحبوب و صفات جودة الحبوب لبعض أصناف الأرز عند فترات تخزين مختلفة

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الملخص العربي

أجريت تجربتان حقليتان في المزرعة البحثية بمحطة البحوث الزراعية بسخا - كفر الشيخ – مصر، خلال موسمي ٢٠١٨ و ٢٠١٩ م بهدف دراسة تأثير مواعيد الحصاد على إنتاجية محصول الحبوب وصفات الجودة لبعض أصناف الأرز عند التخزين لفترات مختلفة. استخدم تصميم القطع المنشقة مرة واحده في ثلاثة مكررات، حيث احتوت القطع الرئيسية على مواعيد الحصاد وهي الحصاد بعد ٧ و١٤ و٢١ يومًا بعد توقف و نهاية الري (الفطام). في حين احتوت القطع الشقية على ثلاثة أصناف من الأرز و هي: سخا ١٠٦، سخا ١٠٧، سخا ١٠٨. تم دراسة صفات الجودة للحبوب بعد التخزين لفترات مختلفة (٦ و ٩ و ١٢ شهر من الحصاد). أظهرت النتائج أن تأخير الحصاد حتى ٢١ يوم من توقف الرى قد أدى الى النقص المعنوي فى عدد السنيبلات الممتلئة و الفارغة / دالية و وزن الداليات و محصول الحبوب و ذلك بالمقارنة بمواعيد الحصاد بعد ٧ و ١٤ يوم من توقف الري. فى حين زادت وزن الـ ١٠٠٠ سنيبلة معنويا مع تأخير الحصاد الى ٢١ يوم من توقف الرى. تفوق الصنف سخا ١٠٨ على الصنف سخا ١٠٦ و الصنف ١٠٧ فى محصول الحبوب و مكوناته و سجل الصنف سخا ١٠٨ أعلى القيم لمحصول الحبوب عند ميعاد الحصاد ١٤ يوم من توقف الرى. أدت زيادة فترات التخزين من ٦ الى ٩ و ١٢ شهر الى النقص التدريجى فى صفات التبيض (محتوى الرطوبة و نسبة التقشير و التبيض و الحبوب السليمة) فى حين زادت قيم صفات الطبخ (محتوى الأميلوز و نسبة الاستطالة و درجة حرارة الجلتنة) بزيادة فترات التخزين. سجل ميعاد الحصاد عند ١٤ يوم من توقف الرى أعلى القيم لصفات الجودة للحبوب وكذلك سجل الصنف سخا ١٠٨ أقل محتوى للطوبة فى الحبوب و أعلى القيم لباقى صفات الجودة المدروسة.

بصفة عامة، سجل الصنف سخا ١٠٨ عند حصاده بعد ١٤ يوم من توقف الرى أعلى القيم لمحصول الحبوب و صفات الجودة وذلك بعد التخزين لمدة ٩ أشهر.

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