EFFECT OF CULTIVARS AND HARVEST DATES ON SOME TRAITS OF YIELD IN RICE

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ABSTRACT

A field experiment was carried out at Rice Researches Station in Mashkhab, Najaf in 2020 and 2021 seasons to study the effect of cultivars and harvest date on some traits of rice yield. Randomized complete block design was applied within split-plot with four replications. Five cultivars of rice (Amber 33, Yasmin, Dijlah, Amber-albaraka and Furat 1) were distributed in the main plots and five harvest dates (harvest at physiological maturity and harvest after 7, 14, 21 and 28 days of physiological maturity) in the sub-plots. The results showed significant difference among cultivars, and superiority cultivars of Dijlah, Furat 1 and Yasmin in recording the highest yield due to its superiority in number of grains per panicle or weight of grain. It can be concluded that traits of grain number in panicle and weight of 1000-grain were among the most influential traits in determining the grain yield, and date of harvest plays an active role in determining the traits of yield. Third harvest date was the best in grain yield, and early harvest before that date would cause loss of yield for all cultivars due to the high grain moisture, and delay after that date would cause a loss of yield as a result of shattering ratio of grain, in addition to difference of cultivars in recording shattering ratio according to harvest date. It can be recommended planting cultivars of Dijlah, Furat 1 and Yasmin, as they achieved the highest yield, and considering the harvest date 14 days after physiological maturity the best date to obtain the highest grain yield.

Key words: biological yield, infertility percentage, weight of 1000-grain, number of grains per panicle, panicle length
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تأثير الأصناف ومواعيد الحصاد في بعض صفات الحاصل في الرز

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المستخلص

نفذت تجربة حقلية في حقول محطة أبحاث الرز في المشخاب / النجف الاشرف للموسمين 2020 و 2021 م لدراسة تأثير الأصناف وموعد الحصاد في بعض صفات حاصل الرز. طبق تصميم القطاعات الكاملة المعشاة بترتيب الألواح المنشقة وبأربعة مكررات. وزعت خمسة أصناف من الرز (عنبر 33 و ياسمين و دجلة و عنبرالبركة و فرات 1) في الألواح الرئيسية، وخمسة مواعيد للحصاد (الحصاد عند النضج الفسلجي والحصاد بعد 7 و 14 و 21 و 28 يوم من النضج الفسلجي) في الألواح الثانوية. أظهرت النتائج فروق معنوية بين الاصناف، وتفوقت الأصناف دجلة وفرات 1 وياسمين في تسجيل أعلى حاصل لتفوقها في صفة عدد الحبوب في الدالية أو وزن ألف حبة. ويمكن ان نستنتج ان هاتين الصفتين من أكثر الصفات تأثيراً في تحديد حاصل الشلب. وان موعد الحصاد له دور فاعل في تحديد صفات الحاصل مع ملاحظة ان موعد الحصاد الثالث كان الأفضل في حاصل البذور وأي تبكير في الحصاد قبل هذا الموعد يسبب فقد في الحاصل لكل الأصناف بسبب ارتفاع الرطوبة للحبوب، واي تأخير بعد هذا الموعد يسبب فقد في الحاصل نتيجة انفراط نسبة من الحبوب مع اختلاف الأصناف في تسجيل نسب الانفراط باختلاف موعد الحصاد. ويمكن التوصية بزراعة الأصناف دجلة وفرات 1 وياسمين كونها حققت أعلى حاصل واعتبار موعد الحصاد 14 يوم بعد النضج الفسلجي أفضل موعد للحصول على أعلى حاصل حبوب.

الكلمات المفتاحية: الحاصل البيولوجي، نسبة عدم الخصب، وزن ألف حبة، دليل الحصاد، عدد الحبوب بالدالية، طول الدالية
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INTRODUCTION

Rice (*Oryza sativa* L.) is considered a main and an important grain crop in the world (26) and the second most important food crop in the world after wheat, among more than 30 food crops (8). It accounts for approximately 26% of cereal production and about 20% of the world's total cereal trade. The global production of rice is 861 million tons, with a cultivated area about 172.23 million dunums, with mean yield of 1253kg dunam^{-1}, and considered one of the main crops of economic importance to achieve food security locally and globally. The growing demand for rice, production must increase by 70% for the next three decades to feed 7.1 billion people by 2050 (12). Accordingly, it is necessary to develop a strategy for rice cultivation, with the need to understand the performance of rice during its growth stages to reduce and confront obstacles in the cultivation of rice in some of its different cultivars commonly cultivated in the provinces where rice is grown. Most of the genotypes of the rice crop vary in the nature of its vegetative growth and grain yield, and accordingly, the variety and the date of harvest affect the traits of the grain and yield. Also, several studies have been conducted on many crops through applying different agricultural practices under abiotic stress or not to induce callus in vitro and improving the germination, field emergency, seedling growth, growth, quality and grain yield and its components using deferent independent factors in addition to cultivars and harvest date such as; varieties, seed soaking, seed activation temperature, plant extracts (16, 27), growth regulators (17, 32), stimulating deteriorated seeds, inducing callus *in vitro*, stimulating seeds under salt stress and drought stress, soaking the seeds, spraying the vegetative part, and etc. to enhance field germination (24), germination characteristics (19), germination of deteriorated seeds and inducing callus *in vitro* (18), seedling growth under salt stress and drought stress (5, 13, 20), field emergence and grain yield (2), field emergence (22), growth (23), and yield and its components (3, 25). Several researches conducted in different countries of the world proved the importance of the harvest date in determining the yield. The process of determining the appropriate harvest date is one of the important processes that serve the development and preservation of the crop. The high moisture content of the grain during harvest leads to more losses due to poor quality grain. Especially that the very early harvest leads to a high percentage of immature grain, which reduces the yield. As for the late harvest, it leads to shattering of the grain. Adequate seed moisture content contributes to reducing losses during and after harvest. This study was aimed to:

1. Determine the appropriate date or moisture content of the grain for harvesting.
2. Reducing the percentage of grain shattering.
3. Increase production rate.

MATERIALS AND METHODS

Field experiment was carried out at the fields of Rice Researches Station in Mashkhab, Najaf during 2020 and 2021 seasons. Randomized complete block design was applied within split-plot with four replications. Five cultivars (Amber 33, Yasmin, Dijlah, Amber-albaraka and Furat 1) were distributed in the main plots, and five harvest dates (harvest at physiological maturity and harvest after 7, 14, 21 and 28 days of physiological maturity) in sub-plots. The following traits were studied:

1. Panicle length (cm): It was measured from panicle bearing node to its end at physiological maturity for ten panicles had taken at random.
2. Number of panicles per square meter: It was calculated for one square meter per experimental unit after each harvest date.
3. Number of grains per panicle: It was calculated for ten panicles taken from ten plants randomly at full maturity.
4. Weight of 1000-grain (g): It was calculated for a random sample of filled grain taken from the total yield of each treatment at each harvest date, 1000-grain were weighed with a sensitive electronic balance and based on 14% moisture (35).
5. Infertility percentage (%): Ten panicles were chosen to calculate the number of empty glumes and divided on total number of grains, and multiplied by 100.
6. Moisture content of grain at harvest (%): It was calculated by a field hygrometer by taking the grain of ten panicles for each experimental unit and mixing them, then took a known

amount, then mashed to put in the device for measure the moisture content.

7. Biological yield (ton ha^{-1}): One square meter was harvested at each harvest date for each treatment, then plants were separated manually and left it to dry by exposing to sun directly with stirring, then plants were weighed to calculate the biological yield, then results were converted to ton ha^{-1} for the same sample which the grain yield was taken for.

8. Harvest index (%): It was calculated according to the equation: (grain weight / biological yield weight) × 100% (6).

9. Yield of grain (ton ha^{-1}): It was calculated from harvested unit area (1 m^2) after thrashing the plants manually, then weighing the grain and adjusting the weights based on the moisture content of 14%, then converting the grain yield to ton ha^{-1}.

Analysis of variance was carried out according to randomized complete block design within split-plot with four replications, and means were compared using least significant difference (LSD 0.05) test (34).

RESULTES AND DISCUSION

Panicle length (cm): Results of table (1) indicated that rice cultivars differed significantly at the length of panicle in 2020 and 2021 seasons.

Table 1. Effect of cultivars, harvest date and their interaction on length of the panicle (cm) of rice during seasons 2020 and 2021

Cultivars	Harvest date at/or after physiological maturity for the 2020 season: At physiological maturity	7 days later	14 days later	21 days later	28 Days later	Means
Ambar 33	29.6	29.1	28.8	29.0	29.3	29.2
Yasmin	21.8	21.9	22.1	21.8	22.1	21.9
Dijlah	26.4	26.2	26.3	25.9	25.6	26.1
Ambar-albaraka	24.7	24.8	24.7	24.6	24.5	24.7
Furat 1	22.8	22.8	22.4	21.9	22.6	22.5
Means	25.1	25.0	24.9	24.7	24.8	
LSD 0.05		cultivars 1.0	harvest dates N.S		interaction N.S	
Cultivars	Harvest date at/or after physiological maturity for the 2021 season: At physiological maturity	7 days later	14 days later	21 days later	28 Days later	Means
Ambar 33	28.6	28.1	28.6	28.0	28.3	28.3
Yasmin	23.3	22.6	22.9	23.3	22.8	23.0
Dijlah	25.4	25.9	25.2	25.0	26.1	25.5
Ambar-albaraka	24.5	23.7	24.0	24.7	24.7	24.3
Furat 1	23.4	22.9	22.7	23.6	23.4	23.2
Means	25.0	24.6	24.7	24.9	25.1	
LSD 0.05		cultivars 0.7	harvest dates N.S		interaction N.S	

Amber 33 cultivar recorded the highest mean of panicle length during both seasons, which reached 29.2 and 28.3 cm, respectively, compared with mean of Yasmin cultivar, which recorded the lowest mean during both seasons without significant difference with mean of Furat 1 cultivar with mean 21.9 and 23.0 cm, respectively. This could be due to genetic differences that affected this trait which related to plant height (Table 3). These results are agreeing with Al-Mashhadani (7), or perhaps difference between cultivars was because of genetic differences in action of genes of superiority and dominance, which were reflected in their differences on this trait (31). Results showed that there wasn't significant effect of harvest dates and interaction in this trait during both seasons (Table 1).

Number of panicles (panicle m^{-2})

Results at table (2) showed that there was significant effect of cultivars on panicles number per square meter during seasons 2020 and 2021, and superiority of Anbar-albaraka cultivar with the highest mean 385.8 and 354.1 panicle m^{-2}, respectively, compared with Anbar 33 cultivar, which recorded the lowest mean 257.2 and 275.0 panicle m^{-2} during both seasons, respectively, (Table 2). Difference of cultivars at panicles number could be due to

the difference in their branching ability, as well as their variance in terms of the number of branches that arise and its ability to carry the panicles. This agrees with another results (4, 7) at variation of cultivars and genotypes of rice in branching ability and panicles number per square meter. Results also showed that there weren't significant effects of harvest dates at this trait, and results also showed that there wasn't significant interaction between cultivars and harvest dates in mean of number of branches carrying panicle m^{-2} during both seasons (Table 2).

Table 2. Effect of cultivars, harvest date and their interaction on number of panicles per square meter of rice during seasons 2020 and 2021

Cultivars	Harvest date at/or after physiological maturity for the 2020 season: At physiological maturity	7 days later	14 days later	21 days later	28 Days later	Means
Ambar 33	254.0	267.2	252.5	261.2	251.2	257.2
Yasmin	278.8	280.3	281.0	284.8	276.8	280.3
Dijlah	295.0	296.8	289.5	300.8	304.5	297.3
Ambar-albaraka	384.5	381.3	386.5	392.8	384.0	385.8
Furat 1	283.0	292.0	284.5	287.0	280.8	285.5
Means	299.1	303.5	298.8	305.3	299.5	
LSD 0.05	cultivars 19.9		harvest dates N.S		interaction N.S	
Cultivars	Harvest date at/or after physiological maturity for the 2021 season: At physiological maturity	7 days later	14 days later	21 days later	28 Days later	Means
Ambar 33	275.8	276.0	275.0	274.8	273.5	275.0
Yasmin	280.8	281.5	283.8	281.2	283.5	282.1
Dijlah	303.0	312.8	307.0	299.0	295.5	303.4
Ambar-albaraka	357.2	354.2	358.8	351.0	349.5	354.1
Furat 1	295.0	294.5	291.0	287.8	286.0	290.9
Means	302.4	303.8	303.1	298.8	297.6	
LSD 0.05	cultivars 10.7		harvest dates N.S		interaction N.S	

Number of grains per panicle

Data at table (3) showed that there were significant differences between cultivars at grain number per panicle during both seasons 2020 and 2021. Yasmin cultivar recorded the highest mean 151.7 and 160.1 grain $panicle^{-1}$, respectively, while Amber-albaraka cultivar came last with a mean 76.5 and 71.5 grain $panicle^{-1}$, respectively, (Table 3). A reason for increase at number of grain per panicle for cultivars, Yasmin, Furat 1, Amber 33, and Dijlah and decrease for Anbar-albaraka cultivar maybe due to decrease at number of branches bearing effective panicle m^{-2} for cultivars Yasmin, Dijlah, Anbar 33 and Furat 1 compared to Anbar-albaraka cultivar (Table 2), in addition, this trait is greatly affected by environmental conditions and this trait is part of the function that receives products of photosynthesis and it is considered natural condition that reflects existence of compensatory mechanism between these two components. This result agrees with result of another studies (7). Results at table (3) indicated that harvest dates were significantly different with grain number per panicle for both seasons, mean decreases for this trait because of delay in harvesting until last date (28 days of physiological maturity), especially for Furat 1 cultivar, and the highest mean grain number per panicle was achieved at first harvest date (physiological maturity), it was reached 134.4 and 137.1 grain $panicle^{-1}$ for both seasons, respectively, with decrease in grain number per panicle with delay of harvest date for both seasons until last harvest date, when the lowest mean was 120.1 and 124.9 grain $panicle^{-1}$ for both seasons, respectively, (Table 3). Perhaps decreases at grain number per panicle whenever date of harvest is delayed, indicates that those grain shattered from panicles with delay of harvest date, and this agrees with Al-Tai (9) and Jewel et al. (21). Effect of interaction was significant during both seasons 2020 and 2021. Anbar al-Baraka cultivar recorded the lowest mean at

fifth harvest date 69.8 and 65.5 grains panicle^{-1}, respectively, while Yasmin cultivar recorded the highest mean at first harvest date 157.5 grain panicle^{-1} during first season, and as well as Yasmin and Furat1 cultivars recorded the highest mean at first harvest date with same mean 164.8 grain panicle^{-1} during second season (Table 3).

Table 3. Effect of cultivars, harvest date and their interaction on number of grains per panicle of rice during seasons 2020 and 2021

Cultivars	Harvest date at/or after physiological maturity for the 2020 season					
	At physiological maturity	7 days later	14 days later	21 days later	28 Days later	Means
Ambar 33	149.7	149.0	146.0	140.5	134.0	143.8
Yasmin	157.5	156.7	153.0	148.2	143.0	151.7
Dijlah	133.2	129.8	126.0	124.0	121.8	127.0
Ambar-albaraka	80.5	80.2	77.5	74.2	69.8	76.5
Furat 1	151.2	150.2	147.2	141.5	131.8	144.4
Means	134.4	133.2	129.9	125.7	120.1	
LSD 0.05		cultivars	harvest dates	interaction		
		14.4	8.7	21.8		
	Harvest date at/or after physiological maturity for the 2021 season					
Cultivars	At physiological maturity	7 days later	14 days later	21 days later	28 Days later	Means
Ambar 33	148.8	149.5	150.0	148.8	146.2	148.7
Yasmin	164.8	162.8	160.2	157.8	155.0	160.1
Dijlah	131.9	129.8	131.5	127.0	124.5	128.9
Ambar-albaraka	75.2	74.3	74.0	68.5	65.5	71.5
Furat 1	164.8	158.0	156.5	136.9	133.5	149.9
Means	137.1	134.9	134.4	127.8	124.9	
LSD 0.05		cultivars	harvest dates	interaction		
		7.2	4.4	11.0		

Weight of 1000-grain (g)

Results at table (4) showed that there were significant differences between cultivars at this trait during both seasons 2020 and 2021. Amber-albaraka cultivar gave the highest weight of 1000-grain with mean 28.1 and 28.5 g, respectively. Yasmin cultivar recorded the lowest mean 20.0 and 19.7 g during both seasons, respectively, (Table 4). Superiority of Anbar-albaraka cultivar may be attributed to its grain type that consider very long type according to its genetic material nature, in other words it has high grain weight genetically, in addition to being given the least grain number per panicle for 2020 season, so the weight increased according to compensation mechanism, and same case with the Dijlah and Furat1 cultivars. These results agree with another studies (7, 15, 29). Results at table (4) showed that effect of harvest dates were significant at weight of 1000-grain for both seasons. In first season, third harvest date at 14 days after physiological maturity gave the highest mean 24.1 g without significant difference with mean of grain weight that produced from second harvest date (7 days after physiological maturity) 23.5 g, while harvest date at physiological maturity recorded the lowest mean 21.8 g without significant differences with last harvest date. Third harvest date recorded the highest mean 23.8 g compared with first harvest date at physiological maturity, which achieved the lowest mean weight of 1000-grain, which was 21.5 g during second season (Table 4). Low weight of 1000-grain at physiological maturity could be due to grain were harvested with high moisture content, which leads to embryo breathing and loss percentage of dry matter. In this process, also, the decrease in weight of 1000-grain at third date (14 days after physiological maturity) after its highest mean on first date (at physiological maturity) to percentage of dry matter loss that occurs as a result of respiration of grain after physiological maturity as a result of rain or dew and relative humidity, which affects increase in consumption of carbohydrates or dry matter accumulated due to respiration. Delaying harvest reduces grain weight and also agrees with the results of another studies (35) in slow and gradual decrease at weight of

1000-grain after appropriate harvest date. Results indicated to significant differences at effect of interaction during both seasons 2020 and 2021. At third harvest date, Amber-albaraka cultivar gave the highest mean of 28.9 and 29.3 g during both seasons, respectively, while Amber 33 cultivar at last harvest date gave the lowest mean 18.9 g at first season and Yasmin cultivar gave the lowest mean 18.3 g at first harvest date at second season. This agrees with Zadeh et al. (36).

Table 4. Effect of cultivars, harvest date and their interaction on weight of 1000-grain (g) of rice during seasons 2020 and 2021

Cultivars	Harvest date at/or after physiological maturity for the 2020 season					
	At physiological maturity	7 days later	14 days later	21 days later	28 Days later	Means
Ambar 33	19.7	21.7	22.0	19.7	18.9	20.4
Yasmin	19.2	20.5	21.4	19.8	19.0	20.0
Dijlah	21.9	23.9	24.1	23.2	22.6	23.1
Ambar-albaraka	27.4	28.2	28.9	28.0	28.0	28.1
Furat 1	20.9	23.3	23.9	23.3	22.7	22.8
Means	21.8	23.5	24.1	22.8	22.2	
LSD 0.05		cultivars	harvest dates	interaction		
		0.7	0.8	1.7		
	Harvest date at/or after physiological maturity for the 2021 season					
Cultivars	At physiological maturity	7 days later	14 days later	21 days later	28 Days later	Means
Ambar 33	19.0	20.5	21.2	21.0	19.9	20.3
Yasmin	18.3	19.4	20.6	20.1	20.3	19.7
Dijlah	20.8	23.3	24.5	24.1	23.6	23.3
Ambar-albaraka	28.1	28.5	29.3	28.4	28.2	28.5
Furat 1	21.3	22.6	23.2	22.5	21.7	22.3
Means	21.5	22.9	23.8	23.2	22.7	
LSD 0.05		cultivars	harvest dates	interaction		
		0.6	0.5	1.6		

Infertility percentage (%)

Results at table (5) indicated to significant differences between the cultivars at percentage of infertility during both seasons 2020 and 2021, while effect of harvest dates and interaction didn't differential significantly at this trait for both seasons. Yasmine cultivar recorded the lowest means 5.9 and 6.8% for both seasons, respectively, while Amber-albaraka cultivar achieved the highest sterility rate due to the fact that it produced the highest number of panicles per unit area in contrast, Amber 33 and Yasmine cultivars produced the lowest rate of sterility and recorded the lowest number of panicles per square meter. This result agrees with Surek and Beser (35) in decrease in maturity of the spikelets in rice when the number of panicles per unit area is increased, and there was intense competition between panicles number for manufactured metabolites in period when there could be fluctuations in arrival of elements to pollen in order to complete the grain setting, and this is a reason for failure to fertilize number of them to fertile and production of grain sites, but grain doesn't grow or it was empty, and this increase rate of sterility, and decrease of fertility could be attributed to unfavorable climatic conditions, such as high temperatures (more than 40°C), and low humidity, and hot blowing winds that contribute to creating empty grain sometimes, and the panicle bears at its top antique white, leafy spikelets that dry out and then fall off after a short period of time. In many cases, this may be attributed to miscarriage anthers and ovaries, and could be the differences between cultivars in percentage of infertility due to the different cultivars in duration of green leaves remaining and effective to carry out process of photosynthesis as well as length of duration for grain full, speed and rate of transmission of products of photosynthesis and number and size of vascular bundles for transporting photosynthetic products active factors involved in decrease or increase at percentage of infertility. These and other factors could be contributing to decrease or increase at percent

of infertility. This is agreeing with Mohammed et al. (29). These results are also in agreement with results of another studies (7) about different cultivars at percent of infertility, and Yasmin cultivar achieved the lowest mean percentage of infertility. Results at table (5) showed insignificant effect for harvest dates and interaction at percentage of infertility for both seasons, and these results agree with results of Jewel et al. (21) in significant the effect of rice cultivars on infertility trait and the insignificance effect of harvest dates and the interaction.

Table 5. Effect of cultivars, harvest date and their interaction on infertility percentage (%) of rice during seasons 2020 and 2021

Cultivars	Harvest date at/or after physiological maturity for the 2020 season					
	At physiological maturity	7 days later	14 days later	21 days later	28 Days later	Means
Ambar 33	8.3	8.1	8.0	8.0	7.9	8.1
Yasmin	6.1	5.8	5.9	6.0	5.7	5.9
Dijlah	9.4	9.4	9.7	9.2	8.7	9.3
Ambar-albaraka	15.8	15.2	15.6	16.2	15.5	15.6
Furat 1	12.2	12.2	11.1	11.3	11.8	8.2
Means	9.7	9.5	9.4	9.4	9.2	
LSD 0.05		cultivars	harvest dates	interaction		
		1.3	N.S	N.S		
Cultivars	Harvest date at/or after physiological maturity for the 2021 season					
	At physiological maturity	7 days later	14 days later	21 days later	28 Days later	Means
Ambar 33	8.1	7.8	7.2	7.9	6.9	7.6
Yasmin	6.9	6.8	6.6	6.8	7.0	6.8
Dijlah	8.8	9.2	8.8	8.6	9.2	8.9
Ambar-albaraka	14.6	13.4	14.8	14.2	14.8	14.4
Furat 1	10.0	9.4	9.6	8.7	9.2	9.4
Means	9.7	9.3	9.4	9.2	9.4	
LSD 0.05		cultivars	harvest dates	interaction		
		1.5	N.S	N.S		

Moisture percentage of grain at harvest (%)

Results at table (6) indicated to significant differences between cultivar, harvest dates and interaction on percentage of moisture at harvest for both seasons 2020 and 2021. In first season, Yasmine and Amber-albaraka cultivars gave the highest mean for moisture content at harvest 20.7% for both seasons, while Furat 1 cultivar recorded the lowest mean 20.1% (Table 6). Results of the same table showed that there were significant differences between cultivars at percentage of grain moisture at harvest during second season. Dijlah cultivar recorded the highest mean of the trait reaching 21.8%, while Furat 1 cultivar recorded the lowest mean 19.9%. Differences in moisture content of cultivars could be due to genetic variances and grain different in their chemical and biological components. This agrees with Siebenmorgen (33) that optimum moisture content of grain for harvest differs in different cultivars. Results of the same table showed that there were significant differences between dates of harvest in percentage of grain moisture at harvest for both seasons 2020 and 2021 with gradual and clear decreases in moisture content of grain when harvest delay, the highest moisture content of grain at harvest date was recorded at physiological maturity, with mean 25.9 and 26.5% for both seasons, respectively, compared with the last harvest, which recorded the lowest grain moisture content 16.5 and 16.1% for both seasons, respectively, (Table 6). Decrease in grain moisture percentage due to delay harvest date that led grain to loss moisture whenever harvest date is late, and this is normal because plant stops growing and absorbing moisture and nutrients after this stage, and this is

agreeing with Badawi (10) in presence of significant effect of harvest dates on grain moisture content. Results at table (6) indicated to significant differences effect of interaction on this trait during both seasons. Amber-albaraka cultivar at physiological maturity recorded the highest mean 26.4%, and Yasmin cultivar at the last harvest date recorded the lowest mean 16.1% during first season. In second season, Dijlah cultivar at first harvest date recorded the highest mean 27.3% compared to Anbar-albaraka cultivar at the last harvest date which gave the lowest mean 15.6%. Dijlah cultivar at first harvest date recorded the highest mean 27.3% compared to Anbar-albaraka cultivar at last harvest date, which recorded the lowest mean 15.6%.

Table 6. Effect of cultivars, harvest date and their interaction on moisture percentage of grain at harvest (%) of rice during seasons 2020 and 2021

	Harvest date at/or after physiological maturity for the 2020 season					
Cultivars	**At physiological maturity**	**7 days later**	**14 days later**	**21 days later**	**28 Days later**	**Means**
Ambar 33	**25.7**	**22.3**	**18.9**	**18.3**	**17.1**	**20.4**
Yasmin	**26.4**	**23.9**	**19.1**	**18.1**	**16.1**	**20.7**
Dijlah	**25.7**	**23.2**	**19.2**	**18.1**	**16.6**	**20.6**
Ambar-albaraka	**26.4**	**23.1**	**18.9**	**18.4**	**16.6**	**20.7**
Furat 1	**25.5**	**22.9**	**18.1**	**17.9**	**16.3**	**20.1**
Means	**25.9**	**23.1**	**18.8**	**18.2**	**16.5**	
LSD 0.05		**cultivars**	**harvest dates**	**interaction**		
		0.6	**0.6**	**1.4**		
	Harvest date at/or after physiological maturity for the 2021 season					
Cultivars	**At physiological maturity**	**7 days later**	**14 days later**	**21 days later**	**28 Days later**	**Means**
Ambar 33	**26.5**	**23.8**	**19.8**	**17.9**	**16.4**	**20.9**
Yasmin	**26.1**	**24.2**	**20.0**	**17.8**	**15.8**	**20.8**
Dijlah	**27.3**	**25.6**	**20.8**	**18.5**	**16.7**	**21.8**
Ambar-albaraka	**27.1**	**24.0**	**20.3**	**19.1**	**15.6**	**21.2**
Furat 1	**25.6**	**21.5**	**19.5**	**17.0**	**15.9**	**19.9**
Means	**26.5**	**23.8**	**20.1**	**18.1**	**16.1**	
LSD 0.05		**cultivars**	**harvest dates**	**interaction**		
		0.4	**0.5**	**1.1**		

Biological yield (ton ha^{-1})

Results at table (7) indicated to significant differences between cultivars at biological yield (ton ha^{-1}) during both seasons 2020 and 2021. In the first season, it was noted that Anbar-albaraka cultivar gave the highest mean 12.946 ton ha^{-1} without significant differences with Dijlah and Anbar 33 cultivars, while Yasmin cultivar to come lastly with mean 10.849 ton ha^{-1}. In the second season, Dijlah cultivar recorded the highest mean 13.769 ton ha^{-1}, followed by Anbar 33 and Anbar-albaraka cultivars without significant differences with mean 13.393 and 13.353 ton ha^{-1}, respectively, then Furat 1 cultivar came after with significant difference with mean 12.091 ton ha^{-1}, and Yasmin cultivar came lastly with mean 10.661 ton ha^{-1}. The differences between cultivars in biological yield could be attributed to their difference in branching ability (Table 2) and grain yield (Table 9). This result agrees with (1,7, 30). Results at table (7) indicated to significant differences of harvest dates effect on biological yield during both seasons 2020 and 2021, where mean decreased with delay of harvest date, and first harvest date (at physiological maturity) was characterized by the highest mean 12.903 and 13.530 ton ha^{-1} for both seasons, respectively. Then harvest date (7 days after physiological maturity) came second without a significant difference with mean 12.737 and 13.131 ton ha^{-1} during both seasons, respectively, compared with last harvest date (28 days after physiological maturity) with the lowest mean during both

seasons 11.189 and 11,503 ton ha^{-1} A decrease of biological yield after harvest at physiological maturity could be indicate a decrease at dry weight of shoot due to loss part of leaves and plant branches due to delay of harvest date and which was noticeable decrease after third harvest date due to the increase percentage of grain shattering, and these results agree with (9, 21). Results indicated to significant effect of interaction on biological yield, and Dijlah cultivar at first harvest date gave the highest mean 13.743 and 14.635 ton ha^{-1}, while Furat 1 cultivar at last harvest date had the lowest mean 9.632 ton ha^{-1} during first season, and Yasmine cultivar with mean 9.518 ton ha^{-1} during second season. This result agrees with (9).

Table 7. Effect of cultivars, harvest date and their interaction on biological yield (ton ha^{-1}) of rice during seasons 2020 and 2021

Cultivars	Harvest date at/or after physiological maturity for the 2020 season					
	At physiological maturity	7 days later	14 days later	21 days later	28 Days later	Means
Ambar 33	13.383	13.141	13.063	12.174	11.786	12.707
Yasmin	11.456	11.246	11.047	10.538	10.957	10.849
Dijlah	13.743	13.493	13.063	12.483	11.845	12.925
Ambar-albaraka	13.540	13.555	13.283	12.630	11.723	12.946
Furat 1	12.391	12.251	12.003	10.838	9.632	11.423
Means	12.903	12.737	12.492	11.733	11.189	
LSD 0.05		cultivars	harvest dates	interaction		
		0.575	0.503	1.133		
	Harvest date at/or after physiological maturity for the 2021 season					
Cultivars	At physiological maturity	7 days later	14 days later	21 days later	28 Days later	Means
Ambar 33	14.048	13.792	13.553	12.985	12.590	13.393
Yasmin	11.266	11.101	11.028	10.392	9.518	10.661
Dijlah	14.635	14.309	14.006	13.382	12.513	13.769
Ambar-albaraka	14.237	13.691	13.462	12.992	12.385	13.353
Furat 1	13.463	12.761	12.530	11.194	10.509	12.091
Means	13.530	13.131	12.916	12.189	11.503	
LSD 0.05		cultivars	harvest dates	interaction		
		0.600	0.575	1.271		

Harvest Index (%)

Results at table (8) indicated to significant differences between cultivars during both seasons 2020 and 2021. In the first season, Dijlah cultivar gave the highest mean 48.4%, followed by Yasmin and Furat 1 cultivars without significant difference with mean 48.1 and 47.4%, respectively. In the second season, Yasmin cultivar recorded the highest mean 46.7% without significant difference with Dijlah and Furat 1 cultivars with mean 46.2 and 45.5%, respectively, whereas, Amber-albaraka and Amber 33 cultivars, recorded the lowest mean 29.4 and 29.2%, respectively, without significant differences between them in first season, and the same in the second season with mean 28.9 and 28.3%, respectively, (Table 8). Cultivars variation at harvest index could be attributed to their variation in their field traits, which was reflected on dry matter and grain yield. Cultivars differ in their ability to distribute products of photosynthesis to sinks, which led to their difference in this trait, in addition, superiority of Dijlah, Furat 1 and Yasmin cultivars in this trait due to their superiority in grain yield, and this prove that these cultivars are more efficient in converting dry matter from source (vegetative parts) to sink (grain). This is in line with (1, 7, 9).

Table 8. Effect of cultivars, harvest date and their interaction on harvest index (%) of rice during seasons 2020 and 2021

Cultivars	Harvest date at/or after physiological maturity for the 2020 season					
	At physiological maturity	7 days later	14 days later	21 days later	28 Days later	Means
Ambar 33	25.8	30.8	33.6	28.6	27.1	29.2
Yasmin	38.0	46.8	53.3	52.4	50.0	48.1
Dijlah	39.0	44.6	53.5	52.6	52.2	48.4
Ambar-albaraka	24.8	30.2	33.5	30.8	27.8	29.4
Furat 1	34.1	49.6	53.3	49.0	51.0	47.4
Means	32.3	40.4	45.4	42.7	41.6	
LSD 0.05		cultivars	harvest dates	interaction		
		2.1	2.5	5.3		
	Harvest date at/or after physiological maturity for the 2021 season					
Cultivars	At physiological maturity	7 days later	14 days later	21 days later	28 Days later	Means
Ambar 33	23.4	29.3	32.3	29.2	27.4	28.3
Yasmin	39.9	50.7	54.5	45.6	42.7	46.7
Dijlah	38.7	46.4	50.4	48.9	46.7	46.2
Ambar-albaraka	26.5	293	32.6	29.4	26.5	28.9
Furat 1	36.1	45.3	52.5	48.2	45.4	45.5
Means	32.9	40.3	44.5	40.3	37.8	
LSD 0.05		cultivars	harvest dates	interaction		
		1.9	2.1	4.4		

Results indicated to significant differences between harvest dates on harvest index for both seasons 2020 and 2021. In the first season, third harvest date (14 days of physiological maturity) had the highest mean 45.4% compared to harvest date at physiological maturity, which recorded the lowest mean 32.3%. In the second season, plants that harvested at third harvest date recorded the highest mean 44.5% compared to the lowest mean 32.9% at harvest at physiological maturity (Table 8). Perhaps the low of harvest index at physiological maturity indicates a decrease in grain yield, as it was harvested with high moisture content, which caused embryo to breathe and consume part of its food stock, which affected on grain weight. In fourth and fifth harvest dates, harvest index decreased due to effect of harvest delay that led to decrease of grain number per panicle and weight of 1000-grain (Tables 3 and 4). Interaction effect was significant on harvest index for both seasons 2020 and 2021. In the first season, Dijlah cultivar at third harvest date gave the highest mean 53.5%, while Amber-albaraka at first harvest date gave the lowest mean 24.8%. In the second season, Yasmin cultivar, at the third harvest date, gave the highest mean 54.5%, while Amber 33 cultivar at physiological maturity gave the lowest mean 23.4% (Table 8). This in line with Al-Tai (9).

Grain yield (ton ha^{-1})

Results at table (9) indicated to difference of cultivars effect significantly on this trait for both seasons 2020 and 2021. Dijlah cultivar gave the highest yield for both seasons, with mean 6.213 and 6.343 ton ha^{-1}, respectively, while Anbar 33 cultivar recorded the lowest yield during both seasons, with mean 3.732 and 3.785 ton ha^{-1}, respectively, (Table 9). Perhaps the superiority of Dijlah cultivar because it gave high number of panicles per square meter and high number of grain per panicle with high grain weight, which was positively reflected to increase grain yield per unit area (Tables 2, 3 and 4), respectively. This in line with another results (7) about genotypes and cultivars that differed at grain yield per unit area.

Table 9. Effect of cultivars, harvest date and their interaction on grain yield (ton ha^{-1}) of rice during seasons 2020 and 2021

Cultivars	Harvest date at/or after physiological maturity for the 2020 season					
	At physiological maturity	7 days later	14 days later	21 days later	28 Days later	Means
Ambar 33	3.498	4.078	4.396	3.509	3.178	3.732
Yasmin	4.359	5.256	5.890	5.507	4.972	5.197
Dijlah	5.323	6.043	6.970	6.555	6.175	6.213
Ambar-albaraka	3.318	4.085	4.450	3.880	3.250	3.797
Furat 1	4.229	6.078	6.358	5.295	4.898	5.371
Means	4.146	5.108	5.613	4.949	4.495	
LSD 0.05		cultivars	harvest dates	interaction		
		0.256	0.358	0.752		
	Harvest date at/or after physiological maturity for the 2021 season					
Cultivars	At physiological maturity	7 days later	14 days later	21 days later	28 Days later	Means
Ambar 33	3.293	4.034	4.360	3.799	3.437	3.785
Yasmin	4.486	5.638	6.008	4.742	4.068	4.988
Dijlah	5.674	6.609	7.038	6.552	5.841	6.343
Ambar-albaraka	3.747	4.087	4.392	3.828	3.287	3.868
Furat 1	4.851	5.778	6.573	5.369	4.777	5.475
Means	4.410	5.229	5.674	4.858	4.282	
LSD 0.05		cultivars	harvest dates	interaction		
		0.733	0.321	0.733		

Results at table (9) showed significant difference at harvest dates effect on grain yield, and plants that harvested at third harvest date gave the highest mean 5.613 and 5.674 ton ha^{-1} for both seasons, respectively, while the lowest mean 4.146 ton ha^{-1} was belong to first harvest date for first season, and to last harvest date with mean 4.282 ton ha^{-1} for second season. Results showed a clear decrease in grain yield after and before third harvest date (14 days after physiological maturity), so in comparison with this date, grain yield decreased by 11.8 and 20% at fourth and fifth dates, respectively during first season and by 14.3 and 24.5%, respectively, for second season. Also, in comparison with first and second harvest date, results showed significant decrease at grain yield, especially at physiological maturity. In the first season, grain yield decreased by 26.2 and 9.0%, respectively, and by 22.2 and 7.8%, respectively, for second season. Results of interaction effect (Table 9) was significant during both seasons, and Dijlah cultivar at third harvest date recorded the highest grain yield mean 6.970 and 7.038 ton ha^{-1} for both seasons, respectively, while Amber 33 cultivar at last harvest date recorded the lowest mean 3.178 ton ha^{-1} in the first season and 3.293 ton ha^{-1} at physiological maturity in the second season. This is agreeing with significance of interaction effect between cultivars and harvest dates on cultivars grain yield (9, 21). Third harvest date gave the highest grain yield for all cultivars, and decreased when belong to before and after this date. When comparing grain yield of each cultivar at third harvest date with first and second harvest dates, it can be noticed that Amber 33 cultivar at first and second harvest dates decreased by 20.5 and 7.3%, respectively, during first season, and by 24.6 and 7.6%, respectively, during second season, and Yasmin cultivar decreased by 26.0 and 10.7%, respectively, during first season, and by 25.3 and 6.2%, respectively, during second season, and Dijlah cultivar decreased by 23.3 and 13.4%, respectively, during first season, and by 19.5 and 6.1%, respectively, during second season, and Amber-albaraka cultivar decreased by 25.4 and 8.3%, respectively, during first season, and by 14.6 and 6.8%, respectively, during second season, finally, Furat 1 cultivar decreased by 30.4 and 4.4%, respectively, during first season and 26.2 and 12.0%, respectively, during second season. Also, when comparing grain yield of each cultivar at third harvest date with fourth and fifth harvest dates, it can be noticed that Amber 33 cultivar decreased by 20.0 and 27.8%, respectively, during first season, and

by 13.0 and 21.1%, respectively, during second season, and Yasmin cultivar decreased by 6.5 and 15.6%, respectively, during first season, and by 21.1 and 32.2%, respectively, during second season, and Dijlah cultivar decreased by 6.1 and 11.5%, respectively, during first season, and by 7.0 and 18%, respectively, during second season, Anbar-albaraka cultivar decreased by 12.9 and 27.0%, respectively, during first season and by 12.8 and 25.1% during second season, and finally, Furat1 cultivar decreased by 16.8 and 23.0%, respectively, during first season, and by 17.8 and 27.3%, respectively, during second season. Decrease of grain yield at first harvest date (at physiological maturity) maybe indicated that grain contained high moisture ratio which led to difficult of grain separating from axis of spike and damage it, in addition to high content of grain moisture when harvest may have led to grain respiration after harvest and loss a lot of its nutritional content which reduced its weight (Table 4) and that reflected on grain yield, and this is consistent with (35) who proved decrease of dry matter and grain yield as result of grain respiration after physiological maturity. A noticeable decrease at grain yield after the third harvest date maybe indicate to grain shattering and their weight decreases. This is agreeing with another study (14) that referred to harvest delay causes grain shattering and expose grain to bird's attack and other natural pests. This is agreeing with (35) delaying the harvest date reduced grain weight and yield. Also. This is in line with (9, 11) effect of harvest time on grain yield was significant, and with (21, 28) different grain yield according to different harvest dates.

CONCLUSIONS

It can be concluded that grain number per panicle and weight of 1000-grain are among the most influential traits to yield determining, and grain harvest before harvest date (14 days after physiological maturity) reduces grain yield due to high moisture content of grain, especially when harvest at stage of physiological maturity, and delaying harvest after harvest date (14 days after physiological maturity) reduces seed vigor and yield due to low grain weight and loosening of grain, especially at harvest after 28 days after physiological maturity. Dijlah, Furat 1 and Yasmin cultivars recorded shorter growth period and higher yield than Amber 33 and Amber-albaraka cultivars. Harvest date effect on grain loss ratio and shattering, especially before and after optimum harvest date (14 days after physiological maturity). It can be recommended planting Dijlah, Furat 1 and Yasmin cultivars, as they have achieved the grain highest yield, and harvest date is adopted 14 days after physiological maturity in their harvest to obtain the highest grain yield, any early or delay in this date will negatively affect the yield, especially for Furat 1 cultivar.

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