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DIFFERANTRAL RESPONSE OF SOME RICE CULTIVARS TO SEEDLING AGE AND PLANT SPACING AND THEIR EFFECT ON GROWTH TRAITS AND YIELD

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ABSTRACT

Two field experiments were carried out at Rice Research and Training Center, Sakha, Kafr El-Sheikh, in the summer seasons of 2019 and 2020 aiming to study the effect of three rice cultivars (Giza 178, Sakha107 and Sakha 108) to three seedling ages (20, 25 and 30 days after planting) and three transplanting spaces (15 × 20, 20× 20 and 25× 20 cm) as well as their interactions on growth characters, yield and its attributes. The results showed that cultivars significantly differed for all traits; Sakha 108 rice cultivar produced the maximum values for growth characters :leaf area index,crop growth rate ,relative growth rate and net assimilation rate as well as yield attributes :number of tillers/m², number of panicle/m², panicle length (cm), number of total grains/panicle, 1000 - grain weight (g) and grain yield (t/fed).While the lowest values of these traits were recorded by Giza 178 rice cultivar. Seedling age had a significant effect on all studied charactaristies. Younger seedlings (20 day old) produced significantly the highest mean values. While the minimum values of the previous traits were obtained when plants were transplanted at 25 day old seedlings.Plant spacing significantly affected on all traits. Wider spacing (25 × 20cm) gave maximum number of tillers/m², number of panicles/ m², panicle length (cm), number of grains/panicle, 1000 - grain weight (g) and grain yield (t/fed), while closer spacing (15 × 20 cm) gave the lowest values. A significant effect was found for the interaction between the three factors on the traits under study. The highest values of all traits were recorded when using Sakha 108 cultivar, youngest seedling age (20 day old) and widest spacing between hills (25 × 20 cm).On the other hand, the lowest mean values were recorded when using Giza 178 rice cultivar, the oldest seedling age (30 day old) and closest spacing between hills (15×20cm) in both seasons. In general, it could be recommended using Sakha108 rice cultivar with seedling age of 20 days and plant spacing of 25 × 20 cm under transplanting.

Keywords**: *Oryza sativa L, Rice cultivars, Seedling age, Transplanting space.***

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the important cereal crops in the world as well as in Egypt and the principle food for more than half of the world people. The need to raise grain yield of rice per unit land area is considered a native goal to meet the consistent demand from this crop. Various factors rice production, such as cultivars, seedling age, transplanting spacing between hills, planting method, nitrogen fertilization and other important agronomic practices. High yielding ability cultivar is a very important facter to raise productivity. For this reason,the breeders and agronomists are aiming to evaluate the new promising cultivars under the old traditional practices for scoping light on the best cultivar that can be used on a large scale .Many investiglators indicated that rice cultivars significantly differed in grain yield and its attributing characters, as reported by El- Hissewy *et al* (2002), Abdel- Rahman *et al* (2004), El-Bably *et al* (2007), El-Maksoud 2008 and Zaki *et al* (2009).

Seedling age is considered in most cases the limiting factor for grain yield and quality. The youngest seedling recorded the highest significant values of grain yield and most of its components.In this regard, Chopra *et al* (2002) found that thirty-five day old seedlings had a greater number of panicles/hill, panicle length, 1000 seed weight and seed yield than 55 to 65 day old seedlings. Kewat *et al* (2002) indicated that transplanting seedlings of 21 and 28 day old recorded significantly higher grain and straw yields. BESIDES,Upandhyay *et al* (2003) reported that 20 and 30 day old seedlings produced significantly higher grain yield compared to growing 40- and 50 - day old seedlings. Sreedhar and Ganesh (2010).stated that rice yield decreased with transplanting the older seedlings. On the other hand, Molla (2001) found that twenty-eight day old seedlings produced more tillers, panicles/m² and grain yield than 21- day old seedlings.

Transplanting spaces (plant spacing) is another factor that greatly influences the growth, development, yield and yield components of rice. Optimum plant spacing ensures the plants to grow properly utilizing more solar radiation and nutrients (Roy *et al* 2018). When planting density exceeds an optimum level, competition among plants for light and nutrients becomes severe and. consequently the plant growth slows down and the grain yield decreases (Dejen 2018). The tillering habit and growth of spikelets panicle^{-1}depend to a huge extent on the spacing of plant that is the key factor for the difference of yield in rice unit-1area (Singh *et al* 2017).plays on essential role in increasing rice crop productivity. In that respect, Chopra and Chopra (2004) noticed that widder spacing of 20 × 15 and 30 × 15 cm recorded significantly higher number of panicles than the closer spacing of 15 × 15 cm. However, the seed yield was not affected due to diffenent spacing.Shinde *et al* (2005) indicated that wider spacing of 30 cm produced significantly higher grain yield (t/ha) attributed mainly to significantly highier number of panicles/m², longer panicle and higher 1000 - grain weight compared with closer spacing of 25 cm. On the other hand, Patra and Nayak (2001) found that closer spacing of 15 × 10 cm gave significantly higher panicles/m², grain and straw yields as compared to wider spacing of 20 ×10 cm. However, panicle length, panicle weight and 1000- grain weight was not influenced significantly by the spacing. Kewat *et al* (2002) indicated that transplanting seedlings at closer spacing of 20 × 10 cm produced significantly the highest grain and straw yields than the wider spacing of 20 × 15 cm, but was comparable to 15 × 15 cm spacing.This might be due to equal area that was provided in each planting geometry/hill. Gunri *et al* (2004) and Pol *et al* (2005) recorded the same rasults.

The present investigation aimd to evaluate the effect of seedling age,spacing among plants, rice cultivar and their interactions on physiological growth, yield and yield components under the system of rice intensification (SRI) practices.

MATERIALS AND METHODS

Two field experiments were carried out at Rice Research and Training Center, Sakha, Kafr El-Sheikh, summer seasons of 2019 and 2020. Experiments aimed to study the differntial responses of three rice cultivars (Giza 178, Sakha107 and Sakha 108),Table(1) to three seedling ages (20, 25 and 30 days after planting) and three transplanting spaces (15 × 20, 20× 20 and 25× 20 cm) as well as their interactions with respect to growth characters, yield and its attributes. Rice grains of the studied cultivars that were obtained from the nursery seedbed preparations were well performed.

The nursery land was fertilized with calcium super phosphate (15.5% P_2O_5) at the rate of 4 kg/kirat (175 m²) on the dry soil before plowing. Nitrogen form of urea (46% N) was added at the rate of 3 kg/kirat (175 m²) after the last plow and before leveling. Seeds of rice cultivars at the rate of 60 kg/fed. were planted dry seed on dry soil and then irrigated on 6th May. Weeds were chemically controlled with Saturn (50%) at seven days after sowing. And then transplanted was done on 21st, 26th and 31st in 2019 and 2020 seasons.

Table 1. The studied three Egyptian rice cultivars and their pedigree and type.

Genotype	Parentage	Type	Origin	Released
Giza 178	**Giza175/Milyang 49**	**Indicia-Japonica**	**Egypt**	**1995**
Sakha 107	**Giza 177/Bl.1**	**Japonica**	**Egypt**	**2016**
Sakha 108	**Sakha 101/HR5824-B-3-2-3//Sakha 101**	**Japonica**	**Egypt**	**2018**

The permanent field was well performed, calcium super phosphate (15.5 % P_2O_5) was added at the rate of 100 kg P_2O_5/fed. On the dry soil before plow, the land was flushed with water. Nitrogen fertilizer in the form of Urea (46% N) was added at the rate of 69 kg N/fed in three parts. The first part was added before transplanting the seedlings, the second was added after 30 days from sowing, and the third was added after 20 days from the second one. Transplanting was done by using 20, 25 and 30 - day old seedlings under 15 × 20, 20 × 20 and 25 × 20cm spacing between hills, under the system of rice intensification (SRI). Weeds were chemically controlled with Saturn 50% EC at the rate of 2 L/fed. The experimental plot was 3 m width and 4 m length, resulted in an area of 12 m^2 (1/350 fed).The previous crop was wheat(*Triticum aestivum* L.) in both seasons. The common agricultural practices for growing rice were followed according to the recommendations of Ministry of Agriculture and Land Reclamation, except the factors under study. SRI watering management was followed (Irrigation was when the onset of cracking of the soil, or once a week). Plant samples from 1/4 m^2 were taken at random from the sub-plot at age of 30, 45 and 60 days after transplanting to record the following traits: leaf area index (LAI), crop growth rate (CGR),relative growth rate (RGR) and net assimilation rate (NAR) according to Radford (1967). The experiments were carried out in a split split plot design with three replications. The three cultivars (Giza 178 , Sakha 107and Sakha 108) were randomly arranged in the main plots, while the sub plots were allotted to three seedling ages (20, 25and 30 days) and the sub sub plots were devoted to three transplanting spaces (15 × 20, 20 × 20 and 25 × 20 cm).All data of this study were subjected to the statistical analysis of variance (ANOVA) for the split split plot design as mentioned by Gomez and Gomez (1984), by using means of "MSTAT-C" computer software package. Least Significant Difference (LSD) method was used to test the differences among treatment means at 5% level of probability as described by Snedecor and Cochran(1989).

RESULTS AND DISCUSSION

Growth traits analysis:

Data in Table (2) show significant differences among cultivars for growth traits; Sakha 108 (the recent cv.) gave the highest mean value for leaf area index, crop growth rate (g/m^2/week), relative growth rate (g/g/week)and net assimilation rate (g/m^2/week) in both seasons. While Giza 178 rice cultivar gave the lowest mean values. Leaf area index, crop growth rate, relative growth rate and net assimilation rate was significantly affected by seedling age. The highest mean value of leaf area index, crop growth rate, relative growth rate and net assimilation rate on the both seasons. was recorded when using the youngest seedling (25 day old) in the first and second seasons. On the other hand, the oldest seedling age (30 day old) gave the lowest value of these traits. These results are in agreement with those obtained by Archana *et al* (2017). Plant geometry of 15x15 cm recorded the maximum tillering and complete heading stage of the crop. The highest leaf area index in closer plant geometry might be due to more number of leaves produced per unit area .The significant reduction of net assimilation rate with increase in plant geometry at maximum tillering and complete bearing stage (all the growth stages) was recorded at 25x20cm as compared to 15X20 cm and 20x20 cm. The differences increased orderly up to growth stage and then declined slowly up to harvest under climatic conditions.

Table 2. Means of leaf area index (LAI), crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate(NAR) of rice as affected by cultivar, seedling age and transplanting space during 2019 and 2020 seasons.

Characters / Treatments	LAI						CGR (g/m²/week)			
	2019			2020			2019		2020	
	30	45	60	30	45	60	30-45	45-60	30-45	45-60
A- Rice cultivars:										
Giza178	3.150	3.686	4.608	3.209	4.043	4.690	55.490	81.120	59.984	82.581
Sakha107	3.310	3.873	4.841	3.372	4.248	4.928	58.294	85.240	63.031	86.776
Sakha108	3.428	4.010	5.012	3.556	4.480	5.197	60.359	88.259	66.480	91.524
F. test	*	*	*	**	*	*	*	*	*	**
LSD at 5 %	1.06	1.32	1.47	1.14	0.89	1.22	1.59	1.47	1.34	3.49
B seedling ages:										
20 days	3.386	3.962	4.952	3.469	4.371	5.070	59.629	87.182	64.850	89.280
25 days	3.291	3.850	4.813	3.380	4.257	4.938	57.965	84.75	63.178	86.979
30days	3.211	3.757	4.696	3.288	4.143	4.807	56.549	82.687	61.467	84.622
F. test	*	*	*	*	*	*	*	*	*	**
LSD at 5 %	0.54	0.89	1.06	1.02	0.93	1.36	0.97	1.13	2.51	2.76
C-Transplanting spaces										
15×20cm	3.071	3.593	4.491	3.217	4.053	4.701	54.086	79.086	60.130	82.782
20×20 cm	3.370	3.943	4.929	3.395	4.275	4.960	59.352	86.786	63.460	87.367
25×20cm	3.447	4.033	5.041	3.525	4.443	5.154	60.692	88.747	65.905	90.732
F. test	*	*	*	*	*	*	*	*	*	**
LSD at 5 %	1.17	1.38	1.61	1.22	1.02	1.29	2.03	1.53	2.38	1.98
D- The interactions										
A×B	*	*	*	*	*	*	*	*	*	**
A×c	*	*	*	*	*	*	*	*	*	**
B ×C	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
A×B ×C	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2. Cont.

Characters / Treatments	RGR (g/g/week)				NAR (g/m²/week)			
	2019		2020		2019		2020	
	30-45	45-60	30-45	45-60	30-45	45-60	30-45	45-60
A- Rice cultivars:								
Giza178	0.477	0.644	0.479	0.504	174.79	299.01	192.49	333.87
Sakha107	0.482	0.651	0.484	0.509	192.95	330.14	212.54	368.62
Sakha108	0.486	0.656	0.489	0.514	206.91	353.92	236.40	410.03
F. test	*	*	*	*	*	*	*	*
LSD at 5%	0.19	0.21	0.24	0.18	2.68	4.16	6.52	5.38
20 days	0.485	0.655	0.487	0.512	207.12	346.12	224.96	390.24
25 days	0.481	0.649	0.484	0.509	190.86	326.28	213.54	370.27
30days	0.479	0.647	0.481	0.506	181.67	310.66	202.93	352.01
F. test	*	*	*	*	*	*	*	*
LSD at 5%	0.18	0.11	0.13	0.13	2.97	3.97	4.06	4.77
C-Transplanting spaces								
15 × 20cm	0.475	24.37	0.479	0.504	162.20	284.16	193.44	335.52
20 × 20 cm	0.484	25.28	0.485	0.509	189.24	342.20	215.45	373.49
25 × 20cm	0.486	25.73	0.488	0.514	223.22	356.71	232.55	403.52
F. test	*	**	*	*	*	*	*	*
LSD at 5 %	.0.24	0.21	0.17	0.22	3.18	4.57	5.64	5.61
D- The interactions								
A × B	*	*	*	NS	*	*	**	**
A × c	*	**	*	NS	*	*	*	*
B × C	NS	NS	**	NS	NS	NS	*	*
A × B × C	*	*	NS	NS	NS	NS	NS	NS

***, ** indicate significant at 0.05 and 0.01 probability levels respectively.**

Yield and its attributes:

Effect of cultivar:

Data in Table (3) indicated that the three tested cultivars significantly differed in all studied yield characters in both seasons. Sakha 108 rice cultivar significantly produced the highest number of tillers/m², number of panicles/m², panicle length (cm), number of total grains/panicle, 1000- grain weight and grain yield (t/fed), while Giza 178 rice cultivar produced the lowest mean values. Differential performance of the three cultivars may be attributed to differences in genetic background and constitution of these three cultivars. These results are in accordance with those reported by El-Kassaby *et al* (2012).

Effect of seedling age:

Data presented in Table (3) indicated that all measured traits were significantly affected by seedling age. The highest number of tillers/m², number of panicles/m², panicle length (cm), number of total grains/panicle, 1000- grain weight and grain yield (t/fed), were produced when using the youngest seedling (25 day old) in the first and second seasons. On the other hand, the oldest seedling age (30 day old) gave the lowest values of these traits. These results are in agreement with those obtained by Khusrul and Aminul (2009) and Salem *et al* (2011). On other hand, Molla (2001) found that twenty-eight day old seedling produced more tillers, more panicles/m² and higher grain yield than 21 day old seedling. Similar results were also reported by Mohammad *et al* (2004).

Effect of transplanting space:

The statistical analyses of data in Table (3) show that all measured traits were significantly affected by transplanting space. The highest number of tillers/m², number of panicles /m², panicle length (cm), number of total grains/panicle, 1000- grain weight and grain yield (t/fed) were produced when using the widest spacing between hills (25 × 20 cm) in both seasons. While the lowest values were obtained when using the closest spacing between hills (20 × 20 cm).

Table 3. Means of number of tillers/m², number of panicles/m², panicle length (cm), number of total grains/ panicle, 1000- grain weight and grain yield(t/fed) of rice as affected by cultivar, seedling age and transplanting space during 2019 and 2020 seasons.

Characters / Treatments	Number of tillers/m²		Number of panicles /m²		Panicle length (cm)		Number of total grains/ panicle		1000-grain weight		Grain yield (t/fed)	
	2019	2020	2019	2020	2019	2020	2019	2020	20019	2020	2019	2020
A-Rice cultivars:												
Giza178	398.77	406.19	382.94	389.52	21.93	22.07	137.18	136.98	24.58	24.74	3.673	3.721
Sakha107	419.02	426.82	399.82	406.60	22.89	23.19	147.25	148.16	25.14	25.16	4.123	4.246
Sakha108	433.86	450.18	418.38	434.67	23.28	23.91	156.36	151.09	25.73	25.48	4.499	4.537
F.test	**	**	**	**	*	*	**	**	**	**	**	**
LSD at 5 %	3.55	3.17	2.62	3.08	0.23	0.21	5.73	5.91	0.23	0.21	0.31	0.28
B seedling ages:												
20 days	428.56	439.14	411.02	418.69	25.29	24.68	158.82	152.26	24.38	25.49	4.337	4.334
25 days	416.62	427.82	403.82	412.83	22.68	22.93	151.14	146.89	25.34	25.03	4.127	4.119
30 days	406.47	416.23	386.30	399.26	20.13	21.56	130.83	137.08	25.74	24.86	3.845	4.134
F.test	**	**	**	**	**	**	**	**	**	**	**	**
LSD at 5 %	4.21	3.14	2.81	3.32	0.26	0.20	7.61	7.43	0.18	0.21	0.36	0.24
C-Transplanting spaces:												
15×20 cm	388.77	407.18	371.68	392.79	21.91	23.69	139.82	130.53	24.41	24.37	3.542	3.477
20×20 cm	426.62	429.73	413.86	417.34	22.25	23.06	148.78	150.37	25.46	25.28	4.425	4.257
25×20 cm	436.26	446.28	415.60	420.65	23.95	22.42	152.19	155.33	25.59	25.73	4.546	4.889
F.test	**	**	**	**	*	*	**	**	**	**	*	*
LSD at 5 %	3.42	2.52	3.14	3.51	0.22	0.17	5.22	6.04	.0.23	0.21	0.36	0.31
D-The interactions:												
A×B	**	NS	NS	NS	**	*	**	**	*	NS	*	**
A×c	NS	**	NS	**	**	NS	NS	**	NS	**	*	**
B×C	NS	**	**	**	**	**	**	**	NS	NS	**	**
A×B×C	**	**	.**	**	NS	NS	**	**	*	*	*	*

***, ** indicate significant at 0.05 and 0.01 probability levels respectively.**

The suitable transplanting space is an effective factor on yield increases. Optimum plant spacing ensures the plants to grow properly both in their aerial and underground parts through different utilization of solar radiation and nutrients. The optimum transplanting spaces depends on different factors that most important of these factors include: plant characteristics, growth period duration, planting time and methods, soil fertility, plant size, available moisture, sun shine, planting pattern and situation of weeds. These results are in agreement with those obtained by Archana *et al* (2017).These increases in all traits maybe due to the regular space between plants that enabled solar radiation to penetrate effectively and to pass through all canopies and make plants well in photosynthesis process.

Effect of the interaction between cultivar and seedling age:

Data in Table (4) indicated that the interaction between cultivar and seedling age had a significant effect on some measured traits.

Table 4. Means of number of tillers/m² , number of panicles/m² , panicle length (cm), number of total grains/panicle, 1000- grain weight and grain yield (t/fed), of rice as affected by the interaction between cultivar and transplanting age during 2019 and 2020 seasons.

Characters / Treatments		Number of tillers/m²	Panicle length (cm)		Number of total grains/ panicle		1000- grain weight	Grain yield (t/fed)	
		2019	2019	2020	2019	2020	2019	2019	2020
Cultivars	Ages								
Giza178	20day	421.79	23.86	23.89	149.36	147.92	23.66	3.940	3.859
	25day	399.33	21.51	22.28	138.91	137.40	24.92	3.824	3.621
	30 day	375.19	20.42	20.04	123.27	125.62	25.17	3.213	3.647
Sakha 107	20day	439.82	25.96	24.88	161.62	151.99	24.30	4.229	4.482
	25 day	428.94	21.92	23.14	148.44	147.09	25.15	4.076	4.141
	30 day	388.30	20.79	21.55	131.65	145.40	25.97	4.022	4.079
Sakha 108	20day	424.07	26.05	25.27	165.48	156.87	25.18	4.743	4.643
	25 day	421.59	24.61	23.37	166.07	156.18	25.95	4.457	4.493
	30 day	455.92	19.18	23.09	137.54	140.22	26.07	4.243	4.412
F. test		**	**	*	**	**	*	*	*
LSD at 5 %		2.28	0.11	0.18	5.87	5.87	0.27	0.21	0.12

***, ** indicate significant at 0.05 and 0.01 probability levels respectively.**

The highest mean values were number of tillers/m² in the first season, panicle length (cm), number of total grains/panicle in the first and second seasons, 1000- grain weight in first season and grain yield (t/fed) in the first and second seasons. These figures were recorded when using Sakha 108 rice cultivar and youngest seedling age (25 day old). On the other hand, the lowest mean values of these characters were obtained when using Giza178 rice cultivar and the oldest seedling age (30 days).

Effect of the interaction between cultivar and transplanting space

The results in Table (5) indicated that the interaction between cultivar and transplanting space on all measured traits had a significant effect.

Table 5. Means of number of tillers /m², number of panicles /m², panicle length (cm), number of total grains/ panicle, 1000- grain weight and grain yield of rice as affected by the interaction between cultivars and transplanting spaces during 2019 and 2020 seasons.

Characters / Treatments		Number of tillers/m²	Number of panicles/m²	Panicle length (cm)	Number of total grains/panicle	1000-grain weight	Grain yield (t/fed)	
		2020	2020	2019	2020	2020	2019	2020
Cultivars	Spaces							
Giza178	15×20cm	388.73	374.39	19.97	128.11	23.71	3.269	3.309
	20×20cm	403.81	393.26	21.03	138.02	25.02	3.802	3.832
	25×20cm	420.03	393.92	24.79	144.81	26.00	3.906	3.986
Sakha 107	15×20cm	406.69	394.86	20.36	130.96	24.51	3.279	3.517
	20×20cm	426.30	416.14	22.17	151.61	24.84	4.582	4.273
	25×20cm	441.47	403.46	26.14	159.91	25.13	4.841	4.312
Sakha 108	15×20cm	426.12	403.12	23.00	132.52	24.89	3.628	3.614
	20×20cm	453.08	442.62	23.19	154.85	25.69	4.579	4.486
	25×20cm	471.37	458.57	29.65	166.50	25.86	5.341	5.448
F. test		**	**	**	**	**	*	**
LSD at 5 %		1.66	1.75	0.11	5.87	0.20	0.21	0.12

***, ** indicate significant at 0.05 and 0.01 probability levels, respectively.**

The highest mean number of tillers/m² and number of panicles/m² in the second season, panicle length (cm) in the first season, number of total grains/panicle and 1000- grain weight in the second season and grain yield (t/fed) in the first and second seasons, were recorded when using Sakha 108 rice cultivar and widest spacing between hills (25 × 20 cm). On the other hand, the lowest mean values of these traits were produced when using Giza178 rice cultivar and closest spacing between hills (15 × 20 cm).

Effect of the interaction between seedling age and transplanting space:

The results in Table (6) showed the effect of the interaction between seedling age and transplanting space on some measured traits. The interaction was significant. The highest number of tillers/m² was obtained in the second season, number of panicles/m², panicle length cm, number of total grains/panicle and grain yield (t/fed) in the first and second seasons. Highest values were recorded when using the youngest seedling age (20 day old) and the widest spacing between hills (25 × 20 cm). On the other hand, the lowest values of these traits were obtained when using the oldest seedling age (30 days old) and closest spacing between hills (15 × 20 cm). Transplanting space is another important factor that can play an important role in boosting yield of rice. It influences the tiller formation, solar radiation interception, total sunshine reception, nutrient uptake, rate of photosynthesis and other physiological phenomena and ultimately affects the growth and development of rice plant. In densely populated rice field the inter-specific competition between the plants is high in which sometimes results in gradual shading and lodging and thus favors increased production of straw instead of grain. It is, therefore, necessary to determine the optimum plant spacing and number of seedlings per hill for high yield in each new cultivar. These results are in good accordance with those reported by Chandrakar *et al* (2008), as well as Sreedhar and Ganesh (2010). Studying the effect of three seedling ages(12, 14 and 16 day old) under three spacing's (30 × 30,25 ×25 and 20 × 20 cm),they found that 16 day old seedlings planted under (25 × 25 cm) spacing recorded the highest values for seed yield and its attributes.

Table 6. Means of number of tillers/m², number of panicles/m², panicle length (cm), number of total grains/panicle and grain yield of rice as affected by the interaction between transplanting age and transplanting space during 2019 and 2020 seasons.

Treatments \ Characters		Number of tillers/m²	Number of panicles/m²		Panicle length (cm)		Number of total grains/panicle		Grain yield (t/fed)	
		2020	2019	2020	2019	2020	2019	2020	2019	2020
Ages	Spaces									
20 day	15×20 cm	377.70	364.19	356.22	21.14	20.79	126.19	122.89	3.147	3.277
	20×20 cm	389.93	408.77	376.19	22.05	21.14	141.85	143.17	4.236	3.879
	25×20cm	518.05	460.10	523.66	23.68	23.11	208.42	190.72	5.529	5.828
25 day	15×20cm	390.41	373.25	387.63	21.27	21.66	138.82	133.96	3.379	3.508
	20×20 cm	406.88	415.10	434.06	21.97	22.38	144.48	143.72	4.245	4.268
	25×20cm	452.57	423.11	416.8	24.80	24.75	170.12	162.99	4.733	4.479
30 day	15×20 cm	398.20	377.60	434.52	23.32	26.70	154.45	134.74	3.653	3.655
	20×20cm	483.06	417.71	441.77	22.73	23.77	160.01	164.22	4.482	4.504
	25×20cm	338.21	453.38	321.49	14.34	14.21	78.03	112.28	3.343	3.979
F. test		**	**	**	**	**	**	**	**	**
LSD at 5 %		2.18	5.25	2.89	0.23	0.25	6.90	6.90	0.25	0.19

***, ** indicate significant at 0.05 and 0.01 probability levels, respectively.**

Effect of the interaction between cultivar, seedling age and transplanting space

Data in Table (7) indicated that the interaction between cultivar, seedling age and transplanting space on some yield traits was significant. The highest number of tillers/m², number of panicles/m², number of total grains/panicle and 1000- grain weight in the first and second seasons, respectively were recorded when using the recent cv. Sakha 108, the youngest seedling age (20 day old) and the widest spacing between hills (25× 20 cm).On the other hand, the lowest mean values of these traits were obtained when using Giza178 rice cultivar, the oldest seedling age (30 day old) and the closest spacing between hills (15 × 20 cm). The higher yield with low transplanting space might be due to higher percentage of productive to total tillers and more interception of light. Also, grain filling is the process of remobilization from stored reserves, particularly from stem, leaves, and from current photosynthesis.

Table 7. Means of number of tillers/m² , number of panicles/m², number of total grains/panicle 1000-grain weight and grain yield of rice as affected by the interaction between cultivar, seedling age and transplanting space during 2019 and 2020 seasons.

Treatments \ Characters			Number of tillers/m²		Number of panicles/m²		Number of total grains/panicle		1000-grain weight		Grain yield	
			2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Cultivars	Ages	Spaces										
Giza178	20 day	15×20cm	329.37	337.14	314.68	329.31	128.12	136.82	22.71	4.885	3.685	4.885
		20×20cm	341.19	353.18	329.33	346.17	133.71	141.78	23.06	4.965	3.765	4.965
		25×20cm	358.17	364.07	341.81	353.14	146.17	156.03	23.28	4.675	3.975	4.675
	25 day	15×20cm	343.17	349.88	329.96	337.92	131.27	143.77	22.91	4.325	3.325	4.325
		20×20cm	356.08	362.14	338.39	351.19	149.55	153.92	23.28	4.368	3.568	4.368
		25×20cm	362.17	371.16	341.14	359.22	156.49	164.14	23.62	4.781	4.181	4.781
	30 day	15×20cm	357.17	365.03	340.97	346.32	137.89	146.73	22.98	4.685	3.685	4.685
		20×20cm	364.28	377.88	351.37	355.91	151.28	159.73	23.42	4.362	3.662	4.362
		25×20cm	371.19	379.41	359.83	364.87	163.36	165.17	23.94	4.372	4.172	4.372
Sakha 107	20 day	15×20cm	331.82	342.28	326.83	336.09	133.82	142.18	22.82	4.397	3.697	4.397
		20×20cm	346.17	355.13	334.18	349.23	146.08	157.13	23.35	3.985	4.185	3.985
		25×20cm	352.82	362.28	342.13	356.14	155.66	163.22	23.61	3.985	3.985	3.985
	25 day	15×20cm	345.77	359.82	339.79	342.91	146.22	151.94	22.86	4.012	4.012	4.012
		20×20cm	357.38	367.45	341.33	355.14	159.14	163.58	23.54	4.325	4.325	4.325
		25×20cm	366.17	379.55	349.17	362.98	165.22	174.27	23.66	4.329	4.329	4.329
	30 day	15×20cm	352.89	362.18	346.72	352.39	155.36	162.93	22.92	4.752	4.752	4.752
		20×20cm	361.72	382.09	355.93	373.14	164.10	169.55	23.78	4.391	4.391	4.391
		25×20cm	369.74	392.13	362.39	382.39	177.25	178.36	23.86	4.351	4.351	4.351
Sakha 108	20 day	15×20cm	339.27	351.35	327.96	343.39	141.62	143.69	22.92	3.987	3.987	3.987
		20×20cm	346.27	369.46	336.41	352.17	153.56	158.83	23.64	4.125	4.125	4.125
		25×20cm	351.18	373.17	345.19	362.78	164.21	168.17	23.98	4.239	4.239	4.239
	25 day	15×20cm	349.83	362.17	354.37	353.14	152.91	162.82	23.02	4.398	3.998	4.398
		20×20cm	358.17	373.22	342.14	361.08	161.33	169.83	23.87	4.785	4.085	4.785
		25×20cm	363.46	381.59	352.83	372.44	172.39	177.21	24.02	3.875	4.275	3.875
	30 day	15×20cm	360.15	372.19	349.25	361.88	161.52	164.36	23.11	4.251	4.251	4.251
		20×20cm	364.59	388.22	352.93	377.17	177.31	178.82	23.92	4.397	4.397	4.397
		25×20cm	372.55	394.07	361.44	384.08	183.62	189.73	24.08	4.562	4.562	4.562
F.test			**	**	**	**	**	**	*	*	*	*
LSD at 5 %			3.95	2.87	7.03	3.03	9.71	9.75	0.46	0.36	0.71	0.64

***,** indicate significant at 0.05 and 0.01 probability levels, respectively.**

So, it may be inferred that the effectiveness of grain filling is decided by the conditions of particular tiller. Hence, planting of fewer seedlings resulted in higher grain yield. In the present studies the plant spacing of 25 × 20 cm significantly recorded higher panicle length, panicle weight more Number of total grains/panicle [1]and grains panicle^{-1}.Efficient utilization of growth resources, less intra species competition coupled with higher availability of nutrients among the widely spaced crop plants may be ascribed the reason for superiority in yield components of rice. Similar findings were obtained by Sreedhar and Ganesh (2010).and Amitabh *et al* (2020), who revealed that 25- day aged seedling was found to be superior to other ages of seedlings in terms of grain yield and 10- day aged seedlings was considered to be superior in terms of straw yields. A significant difference was also found in grain and straw yields due to spacing and there was a trend of increasing yield by closer spacing (15 cm × 15 cm) due to maximum effective tillers hill^{-1} and grains panicle^{-1} unit^{-1} area. So, 25 day old seedling with 15 cm × 15 cm spacing may be recommended for the transplanted plants for obtaining maximum yield. EL-Habet *et al* (2018) indicated that the combination of all the genotypes under study with the space of 25x20 cm and fertilization of 165 kg N/ha produced the same greatest grain yield except GZ7112 which gave the least grain yield. Straw yield of all the genotypes was nearly the same under both medium space (20x20cm) and narrow space (15x20) cm when fertilized by 165 kg N/ha especially GZ9057 which produced the highest straw yield under the same space and level of nitrogen.

Finally, for improving the productivity of rice crop under the conditions of the present study, it is suggested to use Sakha 108 rice cultivar with the youngest seedling age (20 day old) and the widest distance between hills (25× 20 cm).

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الاستجابة المتباينة لبعض أصناف الأرز لعمر الشتلة ومسافات الزراعة وتأثيرهما على صفات النمو والمحصول

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اجريت تجربتين حقليتين بمزرعة مركز البحوث والتدريب في الارز – سخا– كفرالشيخ خلال موسمى الزراعة ٢٠١٩ و٢٠٢٠م وذلك لدراسة الاستجابة المتباينة لكلا من عمر الشتلة ومسافات الزراعة على النمو و المحصول ومكوناته لثلاث أصناف أرز وهى جيزة ١٧٨ و سخا ١٠٧ وسخا ١٠٨. تم تنفيذ التجربة في تصميم قطع منشقة مرتين حيث وضعت الأصناف (جيزة ١٧٨وسخا ١٠٧ وسخا ١٠٨) في القطع الرئيسية وعمر الشتلة (٢٠, ٢٥ و ٣٠ يوم من زراعة المشتل) في القطع المنشقة الأولى و المسافة بين الشتلات (١٥×٢٠, ٢٠× ٢٠ و٢٥ ×٢٠سم) فى القطع المنشقة الثانية. وتشير أهم النتائج المتحصل عليها إلى مايلى: إختلفت الأصناف فيما بينها فى تأثيرها على كلا من صفات النمو ومنها دليل مساحة الاوراق ومعدل نمو المحصول ومعدل النمو النسبى ومعدل صافى التمثيل الضوئى وصفات المحصول ومكوناتة ومنها عدد الاشطاء/م٢ , عدد الداليات/م٢ , طول الدالية سم, عدد الحبوب الممتلئة بالدالية , وزن الألف حبة ومحصول الحبوب للفدان, وسجل صنف سخا ١٠٨ أعلى هذه القيم يلية صنف سخا ١٠٧ بينما أعطى الصنف جيزة ١٧٨ أقلها. أثر عمر الشتلات على كل الصفات المدروسة , فقد أعطى أقل عمر للشتلات (٢٠ يوم من الزراعة) أعلى القيم بينما أعطى أكبر الشتلات عمرا (٣٠ يوم من الزراعة) أقلها. أثرت مسافات الزراعة بين الجور تأثيرا معنويا على كل الصفات المدروسة, وأعطت المسافات الواسعة (٢٥×٢٠سم) أعلى هذه القيم بينما كان أقلها عند إستخدام المسافات الضيقة (١٥×٢٠سم) بين الجور. أثر التفاعل بين عوامل الدراسة تأثيرا معنويا على معظم الصفات تحت الدراسة وكان أعلى هذه القيم عند شتل صنف سخا ١٠٨ والزراعة بأصغر الشتلات عمرا (٢٠ يوم من الزراعة) وزراعتها على أوسع مسافة (٢٥×٢٠سم). بينما كان أقل هذه القيم عند زراعة صنفى جيزة١٧٨ وسخا ١٠٧ وأكبر الشتلات عمرا (٣٠ يوم من الزراعة) والزراعة على أقل مسافة (15×٢٠سم) بين الجور. من النتائج المتحصل عليها فى هذه الدراسة فإنه يمكن التوصية بزراعة صنف أرز سخا١٠٨ وأختيارشتلات صغيرة العمر (٢٠ يوم من زراعة المشتل) وزراعتها على أوسع مسافة بين الجور(٢٥ × ٢٠سم). وذلك للحصول على أعلى إنتاجية من محصول الأرز.

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