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Effect of Planting Methods and Cultivars on Rice Grain Quality

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ABSTRACT

The present investigation was carried out, during 2019-2020 summer growing seasons at the experimental field of rice department program, Sakha, Kafr El-Sheikh, Egypt. Three planting methods; transplanting, drill and broadcasting method were used for three rice cultivars; japonica type (Sakha 108), indica japonica type (Egyptian hybrid rice 1), and indica type (Giza 181). As split plot design with four replications was used for three planting method allocated in the main plots, while the three rice cultivars were allocated in sup-plots. Main results indicated that transplanting method gave the highest value of husking grain ratio, grain length, grain width, grain thickness, grain size, and bulk density for paddy rice, the same results for Measure Cylinder (Softly), Measure Cylinder (Strongly), brown rice grains to paddy %, grain shape. Also, transplanting method gave the highest value for grain length, grain width and grains thickness as well as grain size for brown rice. In addition, rigidity head rice and large broken (Crack and Broken), whiteness degree for brown rice, and milled rice, protein content, amylose content. While broadcasting method gave the lowest value of all a precedent attribute. While, Giza 181 gave the highest value of grains length, grains thickness and paddy rice grain size, rigidity head rice and large broken traits under two seasons. While Egyptian hybrid 1 gave the lowest value of all a precedent attribute in both seasons.

Keywords: rice, planting method, grain quality, yield, husking rice grain, protein content, amylose content, rigidity of rice grain

INTRODAUCTION

Rice has played a critical role in Egypt's economy, ranking second only to wheat. Rice, which is the preferred food by most Egyptian, sharing with about 20% to the per capita cereal consumption. The Egyptian consumers prefer cooked rice to be moist and sticky. There are a lot of deferent planting methods in agriculture production, such as hand transplanting, mechanical transplanting, direct seeding, and throwing seedlings (Ehsanullah *et al.* 2007; Rani and Jayakiran 2010). When planting methods change, rice varieties and cultivation techniques should be changed. To promote the development of a high-quality rice industry and to strengthen Egypt's rice industry overall, it is necessary to investigate the differences in rice quality between different japonica types, indica, and indica x jabonica rice grown using different planting methods.

Rice quality is comprised of four components: processing quality, appearance quality, cooking and eating quality, and nutritional quality (Webb 1991). Rice quality is affected by by factors such as the paddy ecological environment, soil conditions, planting management techniques, growing conditions, and storing methods, in addition to genetic characteristics of rice varieties (Sajwan *et al.* 1990; Bonazzi *et al.* 1997; Abud-Archila *et al.* 2000; Han *et al.* 2004). According to some studies, the variation in the appearance quality of 44 aromatic rice varieties was greater than of other rice qualities, and the amplitude variation of chalkiness rate and degree exceeded 50%. (Chen *et al.* 2013). The amplitude variations in brown rice, milled rice, and head milled rice rates were less than 5%. The effects of paddy ecological environment and cultivation measures on rice quality have been extensively researched. The majority of studies concluded that temperature during the grain-filling stage has a significant impact on rice grain quality (Krishnan *et al.* 2011). Scientists and breeders are increasingly focused on improving rice quality. Grain quality is a broad concept that encompasses a wide range of characteristics ranging from physical to biochemical and physiological properties. Starch and protein are the two main components of rice endosperm and, as such, are important indicators of quality. Growing and environmental conditions, such as planting methods, have been shown to have a significant impact on grain quality. Transplanting is a traditional method of planting rice in Egypt, but economic factors, rising labour costs, and recent changes in rice production have resulted in a shift to new planting methods such as broadcasting and dibbling. Milling properties, appearance, nutritional value, and cooking quality are the four main quality traits that are widely used to assess quality (Yu *et al.* 2008). The milling quality of the grain determines the final yield and broken kernel rate of milled rice after harvesting. Head rice is more valuable and popular among consumers than broken rice. The quality of cooking is determine the ease of cooking as well as the firmness and stickiness of cooked rice, which are influenced by eating properties. The appearance of the grain after milling is associated with size and shape. Cooking quality is primarily influenced by the amylose content, which is one of the two types of starch in the grain, as well as by protein content, gelatinization temperature, and gel consistency.

Protein content is very important factor in determining nutrition value; it can increase the viscosity of

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rice food (Chen *et al*. 2012). Glutalin (Oryzenin) is the key protein fraction in rice, and lysine is the most limiting amino acid. Rice protein contains eight essential amino acids and can meet other nutritional needs (Parengam *et al*. 2010). Rice, on the other hand, has a more complete amino acid balance when compared to other cereal grains. The total protein content ranged between 7.24 and 8.85 percent (Bhat & Riar 2017). Rice varieties with a high protein content are more resistant to abrasive milling than rice varieties with a low protein content (Perez *et al*. 1996). Rice proteins are thought to have the highest biological value of any cereal protein (Eggum 1973). The amino acid content of a rice grain can be used to estimate its protein quality (Chen *et al*. 1986). Because essential amino acids cannot be produced in the body, they must be consumed in sufficient quantities in the normal human diet. It has been reported that aspartic and glutamic acids (non-essential amino acids) influence the taste of rice (Kasai *et al*. 2001). Rice has a high level of amino acids and protein content when compared to other cereal varieties (Thomas *et al*. 2015). Previously, Kamara *et al*. (2010) reported that the concentration of amino acids found in rice grains has a significant influence on the sensory qualities of cooked rice, thereby influencing the overall acceptability of a rice variety. Demand for more palatable rice and rice products with known health benefits will soon increase. Identifying cultivars with the appropriate quality traits to use as breeding materials for eating quality and rice product development is therefore critical, taking full advantage of the large phenotypic diversity among rice cultivars (Toledo & Burlingame 2006). Transplanting has long been a popular traditional method of rice cultivation (Chen *et al*. 2007)

The main goals of the study were to reveal the changes in rice quality of different of rice type groups japonica, indica, and indica x jabonica rice varieties under different planting methods, as well as to provide a theoretical and practical foundation for high-quality rice production under various planting modes.

MATERIALS AND METHOD

A field experiment was conducted at rice research department (Sakha, kafr El-sheikh, Egypt). In 2019 and 2020 rice growing season to study the effect of three planting method for three rice varieties were namely, Sakha 108 Japonica type, H1 (Egyptian hybrid rice 1) indica x japonica type, and Giza 181 Indica type on the rice grain quality and grain yield/plant traits.

Three planting method were used namely; transplanting method, drilling and broadcasting method were sown at 1st May and 26 days age of seedling. Soil sample from the experimental sites were collected from 0-30 cm depth. Some samples were taken to analysis followed by Black *et al.* (1965).The results of analysis are presented in Table (1).

Nitrogen fertilizer was used as Urea form 46.5% N in two splits; 2/3 was added as basil and mixed in dry soil before flooding irrigation water and 1/3 was added at panicle initiation. 1st May was sowing date with seedling age transplanted 26 days from sowing by 20x20 cm planting spacing. All cultural practices were applied as recommended for all rice varieties the same. Split plot design with four replications was used. Planting method was allocated in the main plots and rice varieties were designated in sup-plot. Grain yield was measured from 12 m^2 (3 X 4 m) in the center of sub-plot and moisture content determined for grain yield adjusted to 14 % according to Yoshida (1981).

Table 1. Soil chemical analysis of the experimental sites.

Soil characters	2019	2020	mean
PH	7.8	7.7	7.75
EC	1.6	1.7	1.65
Organic matter %	2.2	2.6	2.40
Total N%	0.32	0.39	0.355
Available P ppm	17.95	20.20	19.08
Available K ppm	685.0	598.0	641.5
Available Zn ppm	1.4	1.9	1.65
Total soluble salts (mg/L)	10	14.0	12.0

Data were collected for the following grain quality characters:

1- Grain dimensions:

For determination of kernel dimensions, thirty representative milled grains from each variety per replicate were taken from each plot harvest.

Grain length:

Grain length is a measure of milled rice grain in a maximum dimension in mm; and measured from the base to the top of the grain. Grain length was characterized according to standard evaluation system for rice, IRRI (1996) as follows:

Grain type	Length (mm)
Very long (VL)	Over 7.50
Long (L)	6.61 – 7.50
Medium (M)	5.51 – 6.60
Short (S)	≤ 5.50

Grain width:

Width of milled rice grain was measured from the ventral side to the dorsal side at the widest point of grains in millimeters.

Grain shape:

The shape of milled rice grain was determined by the length (L): width (W) ratio following the standard evaluation system for rice (IRRI,1996) as follows:

Grain shape	**Length:** Width ratio
Long	above 4
Fine (Slender)	3.1 – 4
Coarse (bold)	2 - 3
Round	Less than 2

2- Milling recovery:

The representative seed samples, at 14 % moisture content by Satake Hulling Machine and milled by using laboratory test tube milling machine designed at the International Rice Research Institute (IRRI) for 60 seconds.

Husking grain ratio:

$$\text{Husking grain ratio} = \frac{\text{paddy rice weight (g)} - \text{Brown rice weight (g)}}{\text{Total rough rice weight (g)}} \times 100$$

Hulling (%):

Duplicate 150 grams of rough rice from each variety were used for hulling percentage determination. It was calculated according to Khush *et al.* (1979) as follows

$$\text{Hulling \%} = \frac{\text{Brown rice weight (g)}}{\text{Total rough rice weight (g)}} \times 100$$

Milling (%):

The objective of rice milling is the removed of bran and germ with the minimum breakage of the endosperm. It was determined also according to Julino (1971) and Ghosh *et al.* (1971) as follows:

$$\text{Milling \%} = \frac{\text{Total milled rice weight (g)}}{\text{Total rough rice weight (g)}} x\ 100$$

Head rice:

The hole grains (head rice) were separated according to the broken size (less than 1/4th of grain length) with rice-sizing device and then weighted. Head rice percentage was determined as follows:

$$\text{Head rice \%} = \frac{\text{Weight of head rice (g)}}{\text{Milled rice weight (g)}} x\ 100$$

3- Cooking and eating quality:

Amylose content (%):

Amylose content % was determined according to the methods of Williams *et al.* (1958) as follows:

Amylose content was determined by reference to a standard curve and expressed on a dry weight basis. Plot the absorbance values at 620 mu. Against the concentration of anhydrous amylase (mg) and determine the conversion factor. The dilution factor of 20 for the sample was included in the conversion factor.

The following scale was used for classifying amylose content (AC):

Amylose Content	Scale
Waxy rice:	
Amylose content	< 7 %
Non waxy rice:	
Very low amylose content	7 – 10 %
Low amylose content	10 – 20 %
Intermediate amylose content	20 – 25 %
High amylose content	> 25 %

Total nitrogen content was meagered by the classical Kjeldahl method and protein content was calculated by multiplying the values of total nitrogen by 5.95 factor. The amino acid structure was detected in acid hydrolysates of grain sam¬ples using automatic amino acid analyser type AAA 881 Mikroteknike as described by Speckman *et al.* (1958). Grain length was determined as average of 15 grains of rough rice per genotype. Whiteness degree of brown rice and white rice grains were measured as whiteness tester machine. Bulk density for Paddy rice grains and brown rice grain were Measured by Brauer grain balance and Measure Cylinder for softly and strongly. The statistical analysis of variance was done according to Gomez and Gomez (1984) using IRRISTAT software.

RESULTS AND DISCUSSION

The data in Table (2) Showed that Grain moisture content, Un-husked grain and Husking grains ratio were significantly affected by different planting method and some rice varieties. Transplanting method gave the highest of value grain moisture content (G.M.C.) for brown rice and husking grain ratio, but it was recorded lowest value of (G.M.C) for paddy rice grain and Un-husked grain. While broadcasting method gave the lowest value of (G.M.C) for brown rice and husking grain ratio, but reduced (G.M.C) for paddy rice. As such drill method gave the highest value of Un-husked grain %. Sakha 108 japonica variety was surpassed others varieties of (G.M.C) for brown rice and husking grain ratio in both seasons, while Giza 181 gave the highest value of (G.M.C) for paddy rice and Un-husked grain traits. H1 hybrid rice was in between for other varieties, except Un-husked grain was increased with H1 in both seasons. These results are in agreement with those reported by El-Kholy (1991), Abdelmotaleb (1998), Chen *et al.* (2011), Ali *et al.* (2012), Chen *et al.* (2014), Gautam *et al.* (2018), Bassuony and Zsembeli (2019) and Dou *et al.* (2021).

Table 2. Grain moisture content (G.M.C.), un-husked Grain % and husking grain ratio as affected by planting method and some rice varieties.

Characters	Grain Moisture Content				Un-husked Grain %		Husking grain ratio	
	paddy rice		Brown rice					
Treatments	2019	2020	2019	2020	2019	2020	2019	2020
Planting method								
Transplanting	14.18	14.35	13.32	13.17	2.31	2.60	97.69	97.40
Drill	14.46	14.59	13.19	13.09	2.49	2.76	97.51	97.24
Broadcasting	14.67	14.99	13.07	13.03	2.48	3.07	97.50	96.93
LSD at 5%	0.25	0.33	0.13	0.07	0.10	0.24	0.10	0.24
Rice Cultivars								
Sakha 108	14.02	14.31	13.32	13.19	2.36	2.50	97.64	97.50
H1	14.56	14.75	13.18	13.10	2.42	2.86	97.58	97.14
Giza 181	14.73	14.87	13.07	13.00	2.50	3.07	97.50	96.93
LSD at 5%	0.37	0.29	0.13	0.10	0.07	0.29	0.07	0.29
P.M x R.C	ns	ns	ns	ns	ns	ns	**	**

The results showed that transplanting method gave the highest value of grain length (7.46 and 7.39), grain width (4.08 and 4.05), grain thickness (1.83 and 1.82) and paddy grain size (55.70and 54.47) in both seasons, respectively. While broadcasting method gave the lowest value of all a precedent attribute in both seasons. Giza 181 variety gave the highest value of grain length and paddy rice grain size, while, Sakha 108 variety surpassed it for grains width and grains thickness but H1 hybrid rice was in between for other varieties in both seasons (Table 3).

Table 3. Grain length, grain width, grain thickness and paddy rice grain size as affected by planting method and some rice varieties.

Characters	Grain rice shape for paddy rice						Paddy rice grain size (mm^3)	
	Grain length (mm)		Grain width (mm)		Grain thickness (mm)			
Treatments	2019	2020	2019	2020	2019	2020	2019	2020
Planting method:								
Transplanting	7.46	7.39	4.08	4.05	1.83	1.82	55.70	54.47
Drill	7.37	7.33	4.06	4.02	1.82	1.82	54.76	53.63
Broadcasting	7.27	7.20	4.03	4.01	1.80	1.80	52.74	51.97
LSD at 5%	0.09	0.10	0.02	0.02	0.01	0.02	2.85	3.24
Rice Cultivars								
Sakha 108	6.78	6.74	4.17	4.19	2.27	2.27	64.18	64.11
H1	6.57	6.51	4.07	4.09	1.62	1.59	43.32	42.31
Giza 181	8.75	8.68	3.93	3.98	2.23	2.18	76.68	75.31
LSD at 5%	1.20	1.19	0.12	0.13	0.02	0.02	6.77	6.45
P.M x R.C	ns	ns	ns	ns	ns	ns	ns	ns

The obtained data are in the same trend with those reported by khush *et al.* (1979), Abou-khalifa (1996), Matouk *et al.* (1996), Pan *et al.* (2013), Chen *et al.* (2014), El-Dalil1 *et al.* (2016), Jin-long *et al.* (2018), Potkile *et al.* (2018), and Dou *et al.* (2021).

The data in table (4) recorded that transplanting method gave the highest value of Bulk density for paddy grains the same Brauer grains balance, Measure Cylinder (Softly), Measure Cylinder (Strongly) and Brown rice grains to paddy %. However, broadcasting method gave the lowest value with each a precedent attribute in both seasons. As well as Sakha 108 variety surpassed others varieties of Bulk density for paddy grains rice and brown rice grains to paddy %. H1 hybrid rice gave the lowest value with each a precedent attribute except a brown rice grain to paddy % was increased in both seasons. While Giza 181 variety was in between of the other genotypes in both seasons. These data are in a complete conformity with those obtained by IRRI (1975), El-Hissewy and El-Kady (1990), El-Rewiny (1996) Abou-khalifa (1996), Ahmed *et al.* (2002), Ali *et al.* (2016), El-Dalil1 *et al.* (2016), Gautam *et al.* (2018), Jin-long *et al.* (2018), Potkile *et al.* (2018), Bassuony and Zsembeli (2019) and Dou *et al.* (2021).

Table 4. Bulk density for paddy grains rice, brauer grains balance, measure cylinder (Softly), measure cylinder (Strongly) and brown rice recovery to paddy % as affected by planting method and some rice varieties.

Characters	Bulk density for paddy grain (Kg/L)						Brown rice recovery to paddy %	
	Brauer grain balance		Measure Cylinder (Softly)		Measure Cylinder (Strongly)			
Treatments	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**
Planting method:								
Transplanting	0.63	0.63	1.58	1.56	0.74	0.73	80.28	79.86
Drill	0.62	0.60	1.56	1.55	0.73	0.71	79.86	79.52
Broadcasting	0.60	0.59	1.54	1.52	0.71	0.70	79.54	79.20
LSD at 5%	0.02	0.02	0.02	0.02	0.02	0.01	0.37	0.33
Rice Cultivars								
Sakha 108	0.60	0.59	1.53	1.51	0.72	0.70	80.89	80.70
H1	0.60	0.58	1.50	1.48	0.68	0.66	79.69	79.20
Giza 181	0.65	0.64	1.65	1.64	0.78	0.77	79.10	78.68
LSD at 5%	0.03	0.03	0.08	0.08	0.05	0.05	0.91	1.05
P.M x R.C	Ns	ns	ns	ns	ns	ns	**	**

Furthermore, Table (5) indicated that transplanting method gave the highest value of grains rice shape for brown rice for (grain length, grain width and grains thickness) as well as brown rice grains size followed by drill method. While broadcasting method performed lowest value with all a precedent attribute. Giza 181 gave the highest value of grains length, and brown rice grains size in both seasons. While Sakha 108 a surpassed of grains width and grains thickness. H1 was in between of the other genotypes in both seasons. These data are in confirming the previous results by Aidy *et al.* (1988).

Table 5. Grains rice shape for brown rice (length, width, and thickness of grains and brown rice grains size as affected by planting method and some rice varieties

Characters	Grain rice shape for brown rice						brown rice grain size (mm^3)	
	Grain length (mm)		Grain width (mm)		Grain thickness (mm)			
Treatments	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**
Planting method:								
Transplanting	5.91	5.84	3.10	3.05	2.15	2.12	39.39	37.76
Drill	5.81	5.76	3.03	2.99	2.13	2.11	37.50	36.34
Broadcasting	5.73	5.63	2.98	2.95	2.09	2.09	35.69	34.71
LSD at 5%	0.09	0.10	0.06	0.05	0.03	0.01	1.78	1.45
Rice Cultivars								
Sakha 108	5.35	5.33	3.12	3.07	2.16	2.15	36.05	33.18
H1	5.03	4.98	3.03	2.99	2.12	2.09	32.31	31.12
Giza 181	7.33	7.19	2.95	2.93	2.09	2.07	45.19	43.61
LSD at 5%	1.31	1.26	0.08	0.07	0.03	0.04	6.96	6.60
P.M x R.C	ns	ns	ns	ns	ns	ns	ns	ns

Highly significant of rigidity head rice and large broken (Crack and Broken) with transplanting method followed by drill method in both seasons. While broadcasting method gave the lowest value with all a precedent attribute. Giza 181 Indica variety was surpassed others varieties of rigidity head rice and large broken followed by Sakha 108 variety. On the other direction, H1 hybrid rice scored the lowest value of all a precedent attribute in both seasons (Table 6). The obtained data are in a good harmony with those reported by Radwan (1987), Radwan (1994), Matouk *et al.* (1996), Ahmed *et al.* (2002), Chen *et al.* (2011), Ali *et al.* (2012), Gautam *et al.* (2018), Jin-long *et al.* (2018), Potkile *et al.* (2018), Bassuony and Zsembeli (2019) and Dou *et al.* (2021).

Transplanting method gave the highest value of whiteness degree for brown rice, milled rice, protein %, Amylose content and grain yield. In contrast, broadcasting method gave the lowest value with all a precedent attribute in both seasons. For drill method was in between of the other genotypes. Giza 181 surpassed others varieties of whiteness degree of brown rice, protein content % and Amylose content. The Japonica cultivar Sakha 108 gave the highest value of grain yield and Whiteness degree of milled rice. H1 gave the lowest value for all a precedent attribute in both seasons. These data are in a complete conformity with those obtained by Abou-khalifa (1996), Abdelmotaleb (1998), Ali *et al*. (2012), Pan *et al*. (2013), Chen *et al*. (2014), Jin-long *et al*. (2018), Potkile *et al*. (2018), Bassuony and Zsembeli (2019) and Dou *et al*. (2021).

Table 6. Rigidity head rice, and rigidity for large broken (Crack and broken) as affected by planting method and some rice varieties.

Characters	Rigidity Head rice				Rigidity (Large broken)			
	Crack		Broken		Crack		Broken	
Treatments	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**
Planting method								
Transplanting	5.84	5.82	9.54	9.50	3.47	3.44	6.75	6.71
Drill	5.81	5.79	9.50	9.47	3.44	3.42	6.71	6.65
Broadcasting	5.77	5.76	9.47	9.45	3.39	3.34	6.67	6.64
LSD at 5%	0.03	0.03	0.03	0.03	0.04	0.05	0.04	0.04
Rice Cultivars								
Sakha 108	5.61	5.60	8.34	8.30	2.41	2.38	5.35	5.29
H1	5.57	5.54	8.25	8.22	2.25	2.23	5.27	5.24
Giza 181	6.25	6.23	11.92	11.90	5.64	5.59	9.50	9.46
LSD at 5%	0.38	0.38	2.10	2.10	1.91	1.90	2.42	2.42
P.M x R.C	ns	ns	ns	ns	ns	ns	ns	Ns

Table 7. Whiteness degree, protein %, amylose content and grain yield (t/ha) as affected by planting method and some rice verities.

Characters	Whiteness degree				Chemical analyses for Rice grains				Grain yield (t/ha)	
	Brown rice		milled rice		Protein content %		Amylase content (%)			
Treatments	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**
Planting method										
Transplanting	21.76	21.67	37.21	37.10	7.43	7.37	21.94	21.86	11.87	11.84
Drill	21.63	21.57	37.09	37.05	7.38	7.25	21.78	21.63	11.84	11.80
Broadcasting	21.41	21.41	37.01	36.96	7.34	7.19	21.51	21.34	11.81	11.78
LSD at 5%	0.18	0.13	0.01	0.07	0.05	0.09	0.22	0.26	0.03	0.03
Rice Cultivars										
Sakha 108	19.62	19.57	37.36	37.25	6.29	6.22	20.08	19.98	12.34	12.30
H1	19.43	19.43	37.20	37.10	6.22	6.17	19.60	19.42	12.25	12.22
Giza 181	25.75	25.64	36.75	36.75	9.64	9.41	25.56	25.43	10.92	10.90
LSD at 5%	3.59	3.55	0.31	0.26	1.95	1.86	3.31	3.32	0.79	0.75
P.M x R.C	ns	ns	ns	ns	**	**	**	**	ns	ns

Furthermore, Fig. (1) revealed that the interaction between planting method and the investigated genotypes was highly significant regarding all studied characters.

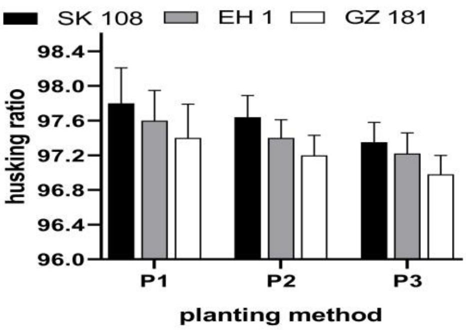

Fig. 1. Effect of interaction between rice verities and planting method on Husking Ratio.

SK108 = Sakha 108, EH1= Egyptian hybrid rice (EH1), GZ181 = Giza 181P1= transplanting method P2 = Drill method P3= broadcasting method

Fig (1) shows husking ratio as influenced by the interaction between planting method and genotypes during 2019 and 2020 seasons. Obviously, transplanting method caused high in husking ratio which different by method of transplanted in case of all genotypes. While, it was interesting to note that the tested genotypes were affected differently by method of transplant. The results showed that Sakha 108 japonica variety was the highest value of husking ratio with transplanting method. Meanwhile, Giza 181 indica variety under broadcast planting method scored the lowest value of husking ratio these data are in a complete conformity with those obtained by Abou-khalifa (1996), El-Kholy (1991), Ahmed *et al.* (2002, El-Dalil1 *et al.* (2016), Gautam *et al.* (2018), Potkile *et al.* (2018) and Dou *et al.* (2021).

Furthermore, brown rice recovery was increased as it was affected by the interaction between planting method and genotypes during the two seasons of study. It could be noticed that increase in such character was occurred when the genotypes were planted in the different of planting method, (Fig. 2).

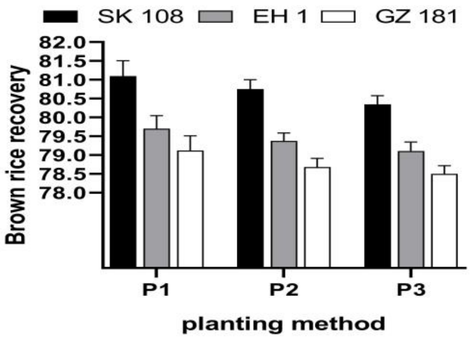

Fig. 2. Effect of interaction between rice verities and planting method on brown rice recovery

***SK108* = Sakha 108, *EH1= Egyptian hybrid rice (H1), GZ181* = Giza 181*P1= transplanting method P2 = Drill method P3= broadcasting method*Further,**

Sakha 108 japonica variety showed the highest value of brown rice recovery with the three-planting method. While Giza 181 indica variety was reduced brown rice recovery with the three-planting method. Similar results were reported previously by El-Hissewy and El-Kady (1990), Ahmed *et al.* (2002), Chen *et al.* (2011), Ali *et al.* (2012), Pan *et al.* (2013), Chen *et al.* (2014), Ali *et al.* (2016), El-Dalil1 *et al.* (2016), Potkile *et al.* (2018) and Dou *et al.* (2021).

Fig (3) represents protein content % as influenced by the interaction between the planting method and genotypes during 2019 and 2020 seasons. Protein content % increased significantly just when genotypes were planted in different method of planting and it different gradually by different of planting method and maximized in transplanting method. The lowest increase was computed for Sakha 108 and Egyptian hybrid 1 (H1), meantime the highest increase was estimated for Giza 181, but no-significant effect between H1 hybrid rice and Sakha 108 rice variety under different planting methods. While H1 hybrid rice with broadcasting method gave the lowest value of protein content %. These results are in agreement with those reported by El-Kady *et al.* (1991), Abou-khalifa (1996), Ahmed *et al.* (2002), Chen *et al.* (2011), Ali *et al.* (2012), Pan *et al.* (2013), Chen *et al.* (2014), Ali *et al.* (2016), El-Dalil1 *et al.* (2016), Gautam *et al.* (2018), Jin-long *et al.* (2018), Potkile *et al.* (2018), and Dou *et al.* (2021).

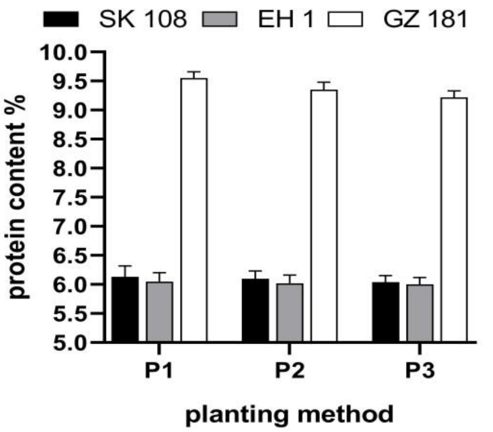

Fig. 3. Effect of interaction between rice verities and planting method on protein content %.
SK108 = Sakha 108, *EH1= Egyptian hybrid rice (H1),*
GZ181 = Giza 181P1= transplanting method P2 = Drill method P3= broadcasting method

The results presented in Fig. (4) revealed that the interaction between planting method and investigated genotypes were significant and highly significant along the seasons of study. The results showed that the most affected genotype was Giza181 rice variety gave the highest value of amylose content %. While brodcasting method with Egyptian hybrid 1 rice gave the lowest value of amylose content. The obtained data are in a good harmony with those reported by to khush *et al.* (1979), Abou-khalifa (1996), Matouk *et al.* (1996), El-Rewiny (1996), Chen *et al.* (2014), El-Dalil1 *et al.* (2016), Gautam *et al.* (2018), Jin-long *et al.* (2018), Potkile *et al.* (2018) and Dou *et al.* (2021).

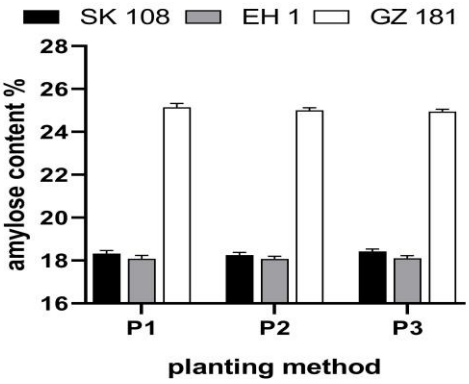

Fig. 4. Effect of interaction between rice verities and planting method on Amylose content content %.
SK108 = Sakha 108,EH1= Egyptian hybrid rice (H1),GZ181 = Giza 181P1= transplanting method
P2 = Drill method P3= broadcasting method

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تأثير طرق الزراعة والاصناف على صفات جودة حبوب الارز

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اجريت هذه الدراسة بمزرعة البحوث الزراعية بسخا خلال موسمي الزراعة 2019 و 2020 لدراسة تاثير ثلاث طرق زراعة - الشتل والتسطير والبدار - لثلاثة اصناف من الارز سخا 108 صنف يابانى قصير الحبة وهجين مصرى واحد صنف يابانى هندى متوسط الحبة والصنف جيزه 181 هندى طويل الحبة على جودة حبوب الارز. صممت التجربة فى القطع المنشقه مرتين فى اربعة مكررات حيث وضعت طرق الزراعة في قطع الأرض الرئيسية، ووضع الأصناف في القطع تحت الرئيسيه. أوضحت النتائج إلمتحصل عليها أن طريقة الشتل أعطت أعلى القيم لنسبة تقشير الحبوب، طول الحبة، عرض الحبه، سمك الحبه، حجم الحبه، الكثافة الظاهرية لحبوب الأرز الشعير، نفس النتائج تم الحصول عليها من استخدام الاسطوانة المرنه والاسطوانة الصلبه لطريقة الزراعة بالشتل لصفات النسبة المئوية لحبوب الأرز البني إلى الأرز الشعير، شكل الحبوب، طول الحبة وعرض الحبة وسماكة الحبوب وكذلك حجم الحبة للأرز البني. بالإضافة إلى صلابة الأرز والارز السليم والمكسور ودرجة البياض للأرز البني والأرز الأبيض والنسبة المئوية لحبوب الأرز البني إلى الأرز الشعير، والنسبة المئوية للبروتين، محتوى الأميلوز ومحصول الحبوب (طن/هكتار). بينما أعطت طريقة البدار أقل قيمة لجميع الصفات السابقة. وكذلك فاق صنف سخا 108 الصنفين الأخرين فى عرض (مم) وسماكة الحبوب (مم). حيث تم زيادة الكثافة الظاهرية لحبوب الأرز غير المقشورة (كجم/لتر) والنسبة المئوية لحبوب الأرز البني إلى الأرز الشعير. بينما أعطى الصنف جيزه 181 أعلى القيم لطول وسمك الحبوب وحجم حبة الأرز غير المقشور وصلابة الأرز السليم والكسر الكبير. بينما أعطى الصنف هجين مصرى 1 أقل القيم لجميع الصفات السابقة في كلا الموسمين. كما أعطى التفاعل بين صنف أرز سخا 108 مع طريقة الشتل أعلى القيم لنسبة المئوية لتقشير والنسبة المئوية للبروتين ومحتوى الأميلوز واستعادة الأرز البني. بينما أعطت الصنف جيزة 181 مع طريقة البدار أقل القيم لنسبة التقشير والنسبة المئوية للبروتين ومحتوى الأميلوز واسترداد الأرز البني.