

## **YIELD POTENTIAL, GENETIC DIVERSITY, CORRELATION AND PATH COEFFICIENT ANALYSIS IN RICE UNDER VARIABLE ENVIRONMENTS**

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### **ABSTRACT**

The present study was carried out at Agronomy Department, Faculty of Agriculture, Kafrelsheikh University, Egypt during the two successive seasons 2013 and 2014. The material of this study included thirteen rice genotypes viz, Sakha 102, Sakha 104, Sakha 105, Sakha 106, Giza 177, Giza 178, IET 1444, IRAT 170, IRAT 112, Hybrid rice 2, Moroberekan, WAB 878 and Gaori. Such genotypes were sown on three different sowing dates i.e. 15<sup>th</sup> April, 1<sup>st</sup> May and 15<sup>th</sup> May under three nitrogen fertilization levels; 40, 60 and 80 kg N/fed. Split plot design with three replications was used for each sowing date. The present investigation was undertaken to study yield potential, genetic diversity, correlation and path analysis as well as genetic variability of the aforementioned rice genotypes under the different sowing dates. The mean squares due to sowing dates, nitrogen levels, genotypes and the first order as well as the second order interactions were significant or highly significant for most of the studied characters. The first sowing date (15<sup>th</sup> April) recorded the most desirable estimates for panicle length, number of spikelets/ panicle, number of grains/ panicle, fertility percentage, 1000-grain weight and grain yield. The intermediate nitrogen level (60 kg N/fed) recorded the most favorable values for grain yield, number of grains/panicle and panicle length. As a mean over sowing dates and nitrogen levels, grain yield was maximized in case of Hybrid rice 2, IET 1444 and Giza 178. Hybrid rice 2 recorded the most desirable estimates of number of grains/ panicle and number of panicles/ panicles either under the first or the second sowing dates associated with the highest nitrogen level.

Grain yield revealed significant positive correlation with each of, panicle length, number of spikelets/ panicle, number of grains/panicle and number of panicles/ plant under all sowing dates, suggesting that grain yield can be improved in these rice genotypes through selection based on these traits. The relationship between most pairs of traits was approximately constant and showed the same direction under all environments (sowing dates). Path coefficient analysis revealed that under the third sowing dates, number of grains/ panicle detected the highest positive direct effect on grain yield followed by number of panicles/ plant and days to 50% heading; 0.80, 0.626 and 0.378, respectively. While, number of spikelets/ panicle, fertility percentage and number of panicles/ plant recorded the highest positive direct effect on grain yield under the intermediate sowing date. Moreover, number of spikelets/ panicle and panicle length were the most contributors at early sowing date. Grain yield exhibited higher PCV and GCV estimates compared with the other traits under all sowing dates while, such estimates were minimized in case of fertility percentage.

The heritability estimates in broad sense were either moderate or high for all the characters under consideration under all sowing dates. Number of days to 50% heading showed estimates of broad sense heritability more than 98% under all sowing dates. While, such estimates were less than 80% in case of number of panicles/ plant; 76.46% (under the first sowing date), grain yield; 71.28% (under the intermediate sowing date) and number of grains/ panicle; 58.3% (under the third sowing date). The genetic advance under selection as percentage of mean was found to be high for grain yield; 29.9, 36.6 and 30.3% for the three sowing dates, respectively. High

heritability estimates coupled with high genetic advance were recorded for number of number of days to 50% heading, plant height and panicle length. Moreover, moderate heritability estimates associated with high genetic advance were observed for grain yield.

Based on cluster analysis, the genotypes were categorized into four clusters. The First cluster contained 4 genotypes; Giza 177, Sakha105, Sakha106 and Gaori. The second group included Sakha 102, Sakha 104 and hybrid rice 2. The third cluster including two indica rice genotypes; Giza 178 and IET 1444. There are two sub groups in cluster four. Moroberekan rice variety was separated into one sub group. The other sub group including drought tolerance genotypes; IRAT 170, IRAT and WAB 878. The Dendrogram of cluster analysis classified the nine traits in two clusters. The first one comprised grain yield and three of major yield-related traits viz., number of panicles/plant, 1000-grain weight and panicle length. There were two sub groups in cluster two. One of the sub group belonged to cluster two included heading date, plant height and fertility percentage. While, number of grains/ panicles and number of spikelets/ panicle were separated in the other sub group.

## **INTRODUCTION**

Rice (*Oryza sativa* L.) is one of the three most important grain crops in the world. Grain yield is a complex character and it is a final outcome of multiplication interactions between various yield-related characters. Hybridization followed selection in segregated generations consider an important method in rice breeding. Selection of genotypes with all possible desirable yield contributing traits is the most important criteria in any crop improvement program (Sweta and Singh, 2010). The studies on the correlation provide information about interrelationship between grain yield and yield components, which are very useful for selection program. Previous results showed that grain yield was positively correlated with each of number of productive tillers/ plant and number of grains/ panicle (Surek and Beser, 2003); days to heading, panicle length, plant height and number of panicles/ plant (Babar *et al.*, 2007) and number of spikelets/ panicle and panicle length (Geethadevi *et al.*, 2000). Similar results reported that grain yield was positively correlated with each of number of panicles/ plant and number of grains/ panicle (Ramanjaneyulu *et al.*, 2014); plant height and panicle length (Shabier *et al.*, 2013) and heading date (Kole *et al.*, 2008, Ullah *et al.*, 2011 and Lakshmi *et al.*, 2014). Grain yield exhibited significant positive correlation with number of productive tillers/ plant, panicle length, spikelet fertility and number of grains/ panicle (Gopikannan and Ganesh, 2013). The correlation studies revealed that number of days to 50% heading was positively correlated with 1000-grain weight and grain yield, while plant height was positively correlated with each of panicle length and number of grains/ panicle (Sarker *et al.*, 2014). Panicle length had positive and significant association with number of grains/ panicle and number of productive tillers/ plant (Gopikannan and Ganesh, 2013). Number of grains/ panicle had positive correlation with panicle length and grain yield (Gunasekaran *et al.*, 2010). Rashid *et al.* (2014) reported that number of panicles/ plant had strong positive correlation with each of number of days to 50% heading, number of grains/ panicles and grain yield.

Splitting the total correlation into direct and indirect effects (path analysis) assist in identifying characters that are important in selection program to improve grain yield. Path analysis in rice were earlier studied by many investigators like El-Hity and El-Keredy (1992), Samonte *et al.* (1998), Surek and Beser, 2003), Babar *et al.* (2007), Statish *et al.* (2009), Nagaraju *et al.* (2013) and Sarker *et al.* (2014). Number of productive tillers/ plant, number of grains/ panicle and plant height showed positive direct effect on grain yield (Babu *et al.*, 2012). Number of grains/ panicle exhibited the maximum positive direct effect on grain yield followed by number of panicles/ plant and plant height (Nagaraju *et al.*, 2013). Genotypic (GCV) and phenotypic (PCV) coefficient of variability are useful in detecting the amount of variability among genotypes (Idris *et al.*, 2012). Heritability estimates is an important parameter which helps the breeder to select a plant trait that is high heritable (Akhtar *et al.*, 2011). High estimates of heritability coupled with high genetic advance were observed for number of days to first flowering, number of productive tillers/ plant, number of filled grains/ panicle, number of spikelets/ panicle and grain yield (Satheeshkumar and Saravanan, 2012). Study of genetic diversity through cluster analysis helps and improves the chances of selecting better sergeants for various traits (Lingaiah *et al.*, 2014). The present investigation was undertaken to study yield potential, genetic diversity, correlation and path analysis as well as genetic variability of some rice genotypes under different sowing dates and nitrogen levels.

## **MATERIALS AND METHODS**

This investigation was carried out at the Agronomy Department, Faculty of Agriculture, Kafrelsheikh University, Egypt during the two successive seasons 2013 and 2014. The material of this study included thirteen rice genotypes viz., IRAT 170, IRAT 112, Hybrid rice 2, Moroberekan, WAB 878, Gauri (kindly provided by RRTC, Sakha, Egypt) beside Giza 177, Giza 178, Sakha 102, Sakha 104, Sakha 105, Sakha 106 and IET 1444. Such genotypes were sown on three different sowing dates i.e. 15<sup>th</sup> April, 1<sup>st</sup> May and 15<sup>th</sup> May under three nitrogen fertilization levels; 40, 60 and 80 kg N/fed. Split plot design with three replications was used for each sowing date. Nitrogen levels allocated in main plots and rice genotypes were arranged in the sub plots. The seeds of each sowing date were sown in nursery using plastic trays; 60 x 30 x 3 cm. Thirty days old seedlings were transplanted individually in the sub plot. Each sub plot was 1.4 x 3 m area and consisted of 7 rows, 3 m long and 20 cm apart. Nitrogen in the form of urea (46% N) was applied in two equal doses one half was incorporated in the dry soil before flooding and the other was applied after 45 days from the first dose. All standard agronomic recommendations were followed. Observations were recorded on an individual plant basis for nine characters namely; number of days to 50% heading, plant height, panicle length, number of spikelets/ panicle, number of grains/ panicle, fertility percentage, number of panicles/ plant, 1000- grain weight beside grain yield which determine from the total weight of grain from each plot (the five inner rows) and then converted to calculate grain yield (ton/ fed).

Analysis of variance was conducted for each season according to Snedecor and Cochran (1967). The variances of the error from separate analysis of the data were subjected to homogeneity test (Bartlett, 1937). The combined analysis was computed for the data of the two seasons according to Cochran and Cox (1957). Data over the two seasons were subjected to phenotypic correlation and path analysis according to Svab (1973). Phenotypic and genotypic coefficients of variability were estimated according the method stated by Burton (1952). The expected genetic advance from selection was estimated according to Johnson *et al.*, (1955). Broad sense heritability for each sowing date over nitrogen treatments was calculated according to Singh and Chaudhary (1985). Duncan's multiple rang test was used for the comparison between environments means (Duncan, 1955). The standardized mean values of each character were used to the furthest Neighbour cluster analysis using appropriate procedures of the program SPSS 10 (SPSS 1995).

## **RESULTS AND DISCUSSION**

### **Analysis of variance and significance:**

As shown in Table (1) the differences among the genotypes were highly significant for all the studied characters. This indicating the presence of a wide range of genetic variability among the genotypes. Also, the mean squares due to sowing dates and nitrogen treatments as well as all interaction effects viz., nitrogen x sowing dates, genotypes x sowing dates, genotypes x nitrogen and genotypes x nitrogen x sowing dates were significant or highly significant for all the studied characters, except for nitrogen x sowing dates in case of panicle length.

### **Main effects:**

Data presented in Table (2) showed that the most favorable estimates of number of days to 50% heading, plant height were obtained under the third sowing date (May, 15). Under such sowing date the plants were earlier by about 18 days, shorter by about 10 cm compared with the first sowing date. On the other hand, rice plants which sown in April, 15 exhibited the most favorable estimates of panicle length (22.1 cm), number of spikelets/ panicle (153), number of grains/ panicle (139.4), fertility percentage (91.5%), 1000-grain weight (25.3 g) and grain yield (3.08 ton/fed.). Furthermore, the most desirable number of panicles/ plant (16.5) was recorded under the second sowing date.

Highly significant effects of nitrogen fertilization levels were detected for all the studied traits (Table 2). Data illustrated in Table (2) showed that the application of nitrogen fertilization at the rate of 60 kg N/fed caused significant increase in grain yield, number of grains/ panicle and panicle length. Moreover, number of days to 50% heading, plant height, panicle length, number of spikelets/ panicle, number of grains/ panicle and number of panicles/ plant increased with increasing nitrogen fertilization up to 80 kg N/fed.

**Table (1): Analysis of variance and mean squares for the studied characters (combined data over two seasons).**

Source of variation	Days to 50% heading	Plant height (cm)	Panicle length (cm)	No. of spikelets/ panicle	No. of grains/ panicle	Fertility (%)	No. of panicles / plant	1000-grain weight (g)	Grain yield (ton/fed.)
Blocks	232.7**	469.1ns	86.8**	2826.3**	3049.5**	194.9**	496.8**	4.3*	4.74**
Sowing dates (S)	9533.3**	3719.9**	51.3**	14958.6**	24176.0**	1290.5**	58.3**	110.3**	27.7**
Error (a)	4.38	91.40	1.30	7.30	33.10	2.26	0.13	0.35	0.002
Nitrogen level (N)	232.9**	717.5**	28.2**	14129.7**	5494.7**	622.8**	141.9**	13.8**	5.68**
S x N	9.46**	74.6*	3.35ns	2170.5**	1850.9**	72.6**	5.36**	3.08**	0.64**
Error (b)	0.85	21.10	1.39	64.40	62.70	1.50	0.10	0.03	0.01
Genotypes (G)	3402.2**	3988.9**	170.8**	11324.9**	9425.7**	584.5**	148.2**	273.9**	5.65**
S x G	36.9**	79.3**	2.48**	759.8**	567.4**	47.6**	9.04**	4.0**	0.79**
N x G	5.52**	20.5**	1.52**	308.8**	234.0**	13.3**	5.74**	4.2**	0.26**
S x N x G	3.67**	25.1**	0.74**	415.4**	344.7**	14.2**	2.37**	1.27**	0.22**
Error (C)	0.343	0.18	0.02	13.35	7.8	0.86	0.11	0.04	0.01

\*, \*\* and ns: Significant at .05 and .01 levels of probability and not significant, respectively

On the other side, adding 40 kg N/fed improved significantly fertility percentage and 1000-grain weight. Previous studies revealed that adding 80 or 120 kg N/ ha improved all the yield attributing characters compared with the control (Chopra and Chopra, 2000). Also, Maiti *et al.* (2003) reported that increasing nitrogen level up to 140 kg N/ ha caused an increase in number of panicles/ plant, number of grains/ panicles and grain yield.

Highly significant differences were detected among the tested genotypes for all the studied traits. Results over the two seasons, sowing dates and nitrogen level showed that the most favorable estimates of grain yield (3.49 ton/ fed) and number of panicles/ plant (20.6) were detected for the Hybrid rice 2 and IET 1444, respectively. Also, Giza 178 rice cultivar exhibited the most beneficial estimates for fertility percentage (94.1%) and number of grains/ panicle (160.1). Moroberekan rice genotypes recorded the highest value of 1000-grain weight (28.7 g) and plant height (116.3 cm). Moreover, WAB 878 detected highest estimates for number of days to 50% heading (122 days), panicle length (26.8 cm) and number of spikelets/ panicle (174).

#### **Interaction effects:**

The interaction among genotypes, sowing dates, nitrogen fertilization for grain yield and two of the major yield components (number of grains/ panicle and number of panicles/ plant) over the two seasons are presented in Table (3). The most favorable mean number of grains/ panicle (186.5) was recorded through IET 1444 rice variety when it sown at the second sowing date and fertilized with 80 kg N/ fed. Under the two other sowing dates, Giza 178 rice cultivar recorded the maximum estimates for such trait associated with the highest nitrogen level.

**Table (2): Means of grain yield and its related characters as influenced by sowing dates, nitrogen fertilization and rice genotypes over the two seasons.**

Variable	Days to 50% heading	Plant height (cm)	Panicle length (cm)	No. of spikelets/panicle	No. of grains/panicle	Fertility (%)	No. of panicles / plant	1000-grain weight (g)	Grain yield (ton/fed.)
Sowing dates (S):									
April, 15	110.6 a	97.5 a	22.1 a	153.0 a	139.4 a	91.5 a	15.9 b	25.3 a	3.08 a
May, 1	100.1 b	90.5 b	21.8 a	148.0 b	131.0 b	88.8 b	16.5 a	24.6 b	2.77 b
May, 15	92.6 c	86.3 c	20.8 b	131.4 c	111.4 c	84.9 c	15.1 c	23.4 c	2.12 c
F. test	**	**	**	**	**	**	**	**	**
Nitrogen levels (N):									
40 kg/ fed.	99.7 c	88.8 c	21.0 b	131.8 c	119.4 b	90.8 a	14.6 c	24.7 a	2.40 b
60 kg/ fed.	101.0 b	91.7 b	21.8 a	147.8 b	130.2 a	88.1 b	16.0 b	24.6 b	2.78 a
80 kg/ fed.	102.5 a	93.7 a	21.9 a	152.8 a	132.1 a	86.3 c	16.8 a	24.1 c	2.79 a
F. test	**	**	**	**	**	**	**	**	**
Genotypes (G):									
IRAT 170	108.2 d	101.4 b	22.9 d	157.8 e	127.3 e	80.8 k	14.3 h	27.1 c	2.31hi
IRAT 112	111.6 c	97.5 d	22.7 e	166.8 c	136.4 d	81.5 j	14.1 i	27.4 b	2.25 j
Giza 177	91.9 j	85.1 ij	19.2 j	126 i	110.0 i	87.3 f	15.0 g	26.1 e	2.38 g
Giza 178	97.7 g	84.9 j	22.2 f	170.1 b	160.1 a	94.1 a	17.3 d	18.5 m	2.83 e
Sakha 102	94.0 h	94.1 f	21.0 g	127.5 i	117.0 g	91.8 e	15.3 f	25.4 g	2.74 f
Sakha106	88.1 l	91.8 k	17.5 l	116.9 k	102.2 j	87.0 f	14.1 hi	25.9 f	2.33 h
Hybrid rice 2	101.0 e	88.7 h	23.2 c	142.8 g	124.0 f	86.4 g	19.6 b	22.4 j	3.49a
Moroberekan	120.4 b	116.3 a	23.6 b	148.3 f	137.1 d	92.4 cd	11.1 j	28.7 a	2.10 k
IET 1444	100.7 f	95.0 e	22.9 d	164.0 d	153.9 b	93.4 b	20.6 a	20.0 l	3.32b
Sakha 105	91.3 k	85.3 i	20.2 h	122.8 j	112.9 h	92.8 c	15.5 ef	26.4 d	2.40 g
Sakha 104	93.8 h	92.2 g	19.4 i	133.3 h	122.8 f	92.0 de	18.2 c	25.1 h	2.93 d
WAB 878	122.2 a	100.9 c	26.8 a	174.0 a	147.1 c	84.8 h	15.6 e	24.6 i	3.24 c
Gaori	92.9 i	65.2 l	18.9 k	123.3 j	103.6 j	84.1 i	15.1 g	20.2 k	2.29 i
F. test	**	**	**	**	**	**	**	**	**
Interactions:									
S x N	**	*	ns	**	**	**	**	**	**
S x G	**	**	**	**	**	**	**	**	**
N x G	**	**	**	**	**	**	**	**	**
S x N x G	**	**	**	**	**	**	**	**	**

\* , \*\* and ns: Significant at .05 and .01 levels of probability and not significant, respectively

**Table (3): Means of number of grains/ panicle, number of grains/ panicle and grain yield as influenced by the interaction between sowing dates, nitrogen levels and rice genotypes (data over two seasons)**

Sowing date	Genotypes	Number of grains/ panicle			Number of panicles/ plant			Grain yield (ton/ fed)		
		Nitrogen levels (kg/ fed.)			Nitrogen levels (kg/ fed.)			Nitrogen levels (kg/ fed.)		
		40	60	80	40	60	80	40	60	80
	IRAT 170	131.0	138.0	143.7	12.1	13.8	12.7	2.70	3.20	3.50
	IRAT 112	144.0	134.6	164.0	11.0	12.1	14.2	2.33	2.70	3.01
	Giza 177	111.8	114.0	120.2	15.0	15.1	16.2	2.60	3.02	3.20
	Giza 178	175.0	180.0	180.8	17.6	17.7	19.0	3.60	3.72	4.20
	Sakha 102	121.2	131.0	139.0	13.9	15.7	16.0	2.71	2.86	2.99
	Sakha106	115.2	98.8	121.0	15.8	15.9	13.7	2.20	2.82	3.00
April, 15	Hybrid rice 2	125.0	134.8	151.1	19.0	20.7	21.7	3.39	3.92	4.30
	Moroberekan	134.8	152.0	157.0	10.5	11.4	12.3	2.11	2.20	2.29
	IET 1444	165.0	173.0	182.0	18.3	20.7	20.9	3.40	4.02	4.20
	Sakha 105	118.0	137.2	123.7	15.3	15.7	20.9	2.71	3.20	2.72
	Sakha 104	123.2	145.0	137.0	15.5	18.0	20.7	3.10	3.59	2.79
	WAB 878	148.0	154.0	164.5	12.4	18.0	15.7	3.20	3.50	3.70
	Gaori	103.0	114.4	123.2	13.7	15.2	15.9	2.38	2.50	2.78
	IRAT 170	115.4	154.0	126.0	15.0	19.1	17.2	2.38	2.41	1.87
	IRAT 112	131.0	151.2	143.0	15.0	16.0	16.7	1.90	2.70	2.22
	Giza 177	108.0	109.3	112.8	14.4	15.9	16.7	1.89	2.38	2.26
	Giza 178	140.0	172.0	160.7	14.9	17.2	19.5	2.30	3.02	2.44
	Sakha 102	100.0	114.0	125.0	14.7	16.3	17.0	2.59	3.40	3.24
	Sakha106	88.2	106.8	117.2	12.7	15.3	14.0	2.00	2.51	2.68
May, 1	Hybrid rice 2	122.4	124.0	168.3	17.6	21.2	21.7	3.40	4.10	4.42
	Moroberekan	129.0	136.0	143.2	9.0	9.7	13.7	2.10	2.30	2.19
	IET 1444	160.0	165.7	186.5	20.5	21.0	22.5	3.24	3.53	3.70
	Sakha 105	101.2	114.2	121.7	14.6	15.1	16.3	2.30	2.56	2.11
	Sakha 104	119.0	123.0	152.0	17.5	18.5	21.3	3.01	3.70	4.10
	WAB 878	135.0	150.0	161.0	15.4	18.1	17.1	3.05	3.70	3.78
	Gaori	94.8	102.3	127.6	14.4	15.6	17.3	2.01	2.31	2.85
	IRAT 170	120.0	128.0	90.0	11.6	13.2	14.3	1.46	1.63	1.64
	IRAT 112	114.3	121.0	124.0	12.7	14.7	15.2	1.63	1.79	1.92
	Giza 177	102.0	104.2	107.9	13.2	13.3	15.4	1.76	2.01	2.35
	Giza 178	127.0	140.1	160.0	15.3	16.8	18.3	1.94	2.04	2.22
	Sakha 102	97.2	113.0	113.0	14.0	14.8	15.9	1.89	2.61	2.38
	Sakha106	75.2	94.0	104.2	13.5	14.6	12.0	1.56	2.27	1.96
May, 15	Hybrid rice 2	109.0	113.7	68.2	17.2	18.9	19.7	2.37	2.72	2.80
	Moroberekan	126.0	141.3	115.0	11.3	10.2	12.4	2.05	2.07	1.60
	IET 1444	118.4	137.0	96.9	19.7	20.1	20.4	2.47	2.60	2.74
	Sakha 105	94.0	113.0	92.8	13.2	13.3	15.0	2.13	2.01	1.84
	Sakha 104	97.0	114.1	95.0	17.3	17.0	18.4	2.06	2.28	1.74
	WAB 878	130.0	141.8	138.6	14.7	15.2	14.1	2.66	2.84	2.69
	Gaori	85.2	89.0	93.0	13.7	16.2	14.3	1.69	2.10	1.95
	LSD. (0.05)	4.50			0.53			0.16		

On the other hand, Gaori recorded the lowest number of grains/ panicle (85.2) associated with the latest sowing date and the first nitrogen fertilization.

Number of panicle/ plant was significantly affected by the interaction between rice genotypes, nitrogen levels and sowing dates. IET 1444 rice variety produced maximum number of panicles/ plant (22.5) when it fertilized with 80 kg N/ fed under the second sowing date. Contrary, Moroberekan gave lowest values (10.2) associated with the third sowing date and 60 kg N/ fed.

On the other hand hybrid rice 2 recorded the most favorable estimates of grain yield (4.42 ton/ fed.) when it sown in May, 1 and fertilized 80 kg N/ fed. While, Sakha 106 rice cultivar revealed lowest value of grain yield under the third sowing date and the first nitrogen level.

#### **Correlations:**

Grain yield is a complex character and an integrated function of yield-related traits. Therefore, identifying the characters which are closely related and which have contributed to grain yield becomes a pre-request for improving grain yield through selection. The correlation supply information about interrelationship among grain yield and its component traits, which is very useful in selection program. The phenotypic correlation coefficient between grain yield and the eight characters on one side, and among the agronomic characters themselves on the other side under three sowing dates combined over three nitrogen fertilizer levels, 13 rice genotypes and two years are presented in Table (4). The correlation studies revealed strong positive correlation between grain yield and each of panicle length, number of spikelets/ panicle, number of grains/ panicle and number of panicles/ plant under all sowing dates. Suggesting that, grain yield can be improved in these rice genotypes by using these traits as selection criteria. Also, grain yield was significantly and positively correlated with plant height (0.186) under the second sowing date and with fertility percentage under the third sowing date (0.209). Similar results were also obtained by Kumar *et al.* (2011). They found strong positive correlation between grain yield and number of panicles/ plant. Previous results showed that grain yield per plant exhibited highly significant positive correlation with number of filled grains/ panicle, total number of grains/ panicle and number of panicles/ plant (Satheeshkumar and Saravanan, 2012). Rashid *et al.* (2014) reported that grain yield showed significant and positive correlation with each of days to heading, number of panicles/ plant and number of filled grains/ panicle. Number of days to 50% heading showed highly significant positive correlation with plant height, panicle length, number of spikelets/ panicle, number of grains/ panicle and 1000-grain weight. This was true under all sowing dates. While, it was negatively correlated with each of number of panicles/ plant (under the first sowing date) and fertility percentage (under the first and the second sowing dates). Similar results were also obtained by Sarker *et al.* (2014). They found that number of days to 50% heading showed highly significant positive correlation with 1000-grain weight and grain yield.



**Table (4): Phenotypic simple correlation coefficient among the studied characters under three sowing dates combined over three nitrogen levels, 13 rice genotypes and two years.**

Characters	Treat.	Heading date	Plant height	Panicle length	Number of spikelets / panicle	No. of grains/ panicle	Fertility (%)	Number of panicles / plant	1000-grain weight
Grain yield	S1	0.046	0.027	0.474**	0.597**	0.623**	-0.013	0.642**	-0.582**
	S2	0.073	0.186*	0.304**	0.539**	0.607**	0.137	0.663**	-0.345**
	S3	0.169	0.008	0.362**	0.286**	0.368**	0.209*	0.594**	-0.258**
Heading date	S1		0.737**	0.734**	0.588**	0.495**	-0.283**	-0.269**	0.241**
	S2		0.769**	0.88**	0.577**	0.479**	-0.296**	-0.045	0.28**
	S3		0.704**	0.878**	0.66**	0.557**	-0.181	-0.108	0.273**
Plant height	S1			0.658**	0.458**	0.446**	-0.065	-0.121	0.436**
	S2			0.72**	0.447**	0.467**	0.049	0.023	0.484**
	S3			0.567**	0.471**	0.471**	0.063	-0.089	0.527**
Panicle length	S1				0.683**	0.659**	-0.115	0.213*	-0.063
	S2				0.678**	0.649**	-0.116	0.264**	0.016
	S3				0.678**	0.632**	-0.053	0.193*	0.05
No. of spikelets/ panicle	S1					0.917**	-0.274**	0.168	-0.231*
	S2					0.937**	-0.271**	0.521**	-0.305**
	S3					0.913**	-0.116	-0.01	0.095
No. of grains/ panicle	S1						0.108	0.34**	-0.376**
	S2						0.077	0.562**	-0.369**
	S3						0.293**	0.086	0.026
Fertility (%)	S1							0.39**	-0.288**
	S2							0.035	-0.088
	S3							0.205*	-0.08
No. of panicles/ plant	S1								-0.529**
	S2								-0.441**
	S3								-0.456**

S1= sowing in April, 15

S2 = sowing in May, 1

S3= Sowing in May, 15

Plant height had positive and significant association with panicle length, number of spikelets/ panicle, number of grains/ panicle and 1000-grain weight, such results were true under all sowing dates. These results were, in general, agreement with the findings of Rashid *et al.* (2014). They found that plant height was significantly correlated with number of grains/ panicle, number of panicles/ plant and grain yield. Panicle length revealed significant positive association with all the studied traits, except with fertility percentage and 1000-grain weight as it revealed non-significant correlation estimates. Previous results showed that panicle length had positive and significant association with number of grains/ panicle and number of productive tillers/ plant.

Significant positive correlation for number of spikelets/ panicle was detected with number of grains/ panicle (under all sowing dates) and with number of panicles/ plant (under the second sowing date). Other inter-character correlation revealed that number of grains/ panicle was significantly and positively correlated with each of fertility percentage (under the third

sowing date) and with number of panicles/ plant (under the first and the second sowing dates). These results were, in general, agreement with those of Sarker *et al.* (2014). They found that number of filled grains/ panicle was significantly associated with plant height and number of panicles/ plant.

Fertility percentage showed positive and significant correlations with number of panicles/ plant; 0.39 (under early sowing date) and 0.205 under the third one. However, its correlation with 1000-grain weight was negative and significant (under the first sowing date) and negligible under the two other sowing dates. On the other hand, number of panicles/ plant and 1000-grain weight were negatively correlated under all sowing dates, this may be due to their compensatory relationship. These results were in general agreement with those obtained by Shabier *et al.* (2013), Sarker *et al.* (2014) and Ramanjaneyulu *et al.* (2014). From the aforementioned results of correlations, it is clear that relationship between most pairs of traits were approximately constant and showed the same direction under all environments, suggesting the possibility of selection for common traits for genetic improvement of yield under wide range of environments (El-Marakby *et al.*, 2007). Furthermore, selection of genotypes with high mean performance for panicle length, number of spikelets/ panicle, number of grains/ panicles and number of panicle/ plant will improve grain yield.

**Path analysis:**

Simple correlation does not provide adequate information about the contribution of each character towards grain yield. Therefore, path coefficient analysis was practiced to find out the relative importance of each character towards grain yield variations. Each component had a direct effect acting alone and indirect influence acting in combination with other variables. Path coefficient analysis between grain yield and each one of the specified traits under three sowing dates combined over three nitrogen fertilizer levels, 13 rice genotypes and two years are presented in Table (5). It is clear from the results that the direct effect of heading date was positive and moderate (0.378) on grain yield under the third sowing date while, it was negative under the other sowing dates. The direct effect of plant height was positive; 0.158 and 0.251 on grain under the first and the second sowing dates, respectively. Similar results were obtained by Mehetre *et al.* (2003) who reported that the direct effect of days to flowering on grain yield was negative. Other results showed that days to 50% heading and plant height exhibited positive direct effect on grain yield (Sweta and Singh, 2010)

The positive correlation of panicle length under the first sowing date (0.474) could mainly be attributed to its direct effect (0.276) and somewhat to its indirect effect through number of spikelets/ panicle (0.228). Although, panicle length was positively correlated with grain yield (under the second and the third sowing dates) but its direct effect on grain yield was negative. This indicated that these character influenced grain yield by its high positive indirect effects through number of spikelets/ panicle (1.83) under the intermediate sowing date and through heading date (0.332) and number of grains/ panicle (0.504) under the third sowing date. Previous results revealed

that panicle length had the highest positive direct effect on grain yield (Bagheri *et al.*, 2011).

Number of spikelets/ panicle had the highest direct effect on grain yield; 1.746 (under the second sowing date) and detected a sizable direct effect (0.333) under the first sowing date. Although, the direct effect of such trait under the third sowing date was negative, it had a positive correlation with grain yield. This may be due to its indirect positive effect on grain yield through heading date (0.25) and number of grains/ panicle (0.728). The results of path analysis indicated that the direct effect of number of grains/ panicles was negative under the intermediate sowing date but its indirect effect via number of spikelets/ was high (1.635). So, the positive correlation of number of grains/ panicles with grain yield under such sowing date (0.607) may be mainly due to its indirect effect through number of spikelets/ panicle. On the other side, high positive direct effect (0.80) of number of grains/ panicle on grain yield was detected under the third sowing date. Other studies showed that number of grains/ panicle had highest direct effect on grain yield (Bagali *et al.*, 1999 and Zahid *et al.*, 2006). Contrary, Akhtar *et al.* (2011) reported that number of grains/ panicle showed negative direct effect on grain yield but positive indirect effect through 1000-grain weight.

Fertility percentage showed positive direct effect on grain yield (0.612) under the intermediate sowing date. But such effects were negative under the two other sowing dates. However, the direct effect of fertility percentage on grain yield was negative under the latest sowing date, its positive correlation with grain yield may be mainly due to its positive indirect effect through number of grains/ panicle (0.234) and number of panicles/ plant (0.129). Number of panicles/ plant showed positive direct effect on grain yield under the second and the third sowing dates (0.439 and 0.626, respectively). Under the third sowing date, the positive correlation of number of panicles/ plant (0.594) with grain yield could mainly be attributed to its direct effect (0.626) on grain yield. The estimates of direct effects of 1000-grain weight on grain yield were negative under the first and the second sowing dates but such effects were positive under the third sowing date (0.148).

**Table (5): Path coefficient analysis of direct and indirect effects on grain yield for three sowing dates averaged over 13 rice genotypes, three nitrogen levels and two years.**

Characters	Sowing dates	Heading date	Plant height	Panicle length	Number of spikelets / panicle	No. of grains/ panicle	Fertility (%)	Number of panicles / plant	1000-grain weight	Total r (x, y)
Heading date	S1	-0.368	0.117	0.203	0.196	0.011	0.062	-0.093	-0.082	0.046
	S2	-0.193	0.193	-0.042	1.008	-0.654	-0.181	-0.02	-0.038	-0.073
	S3	0.378	-0.271	-0.045	-0.326	0.444	0.02	-0.068	0.04	0.169
Plant height	S1	-0.272	0.158	0.182	0.153	0.011	0.014	-0.042	-0.148	0.057
	S2	-0.149	0.251	-0.034	0.780	-0.637	0.03	0.010	-0.066	0.186*
	S3	0.266	-0.385	-0.029	-0.233	0.376	-0.007	-0.056	0.078	0.01
Panicle length	S1	-0.270	0.104	0.276	0.228	0.016	0.025	0.074	0.021	0.474**
	S2	-0.170	0.181	-0.047	1.831	-0.886	-0.071	0.116	-0.002	0.304**
	S3	0.332	-0.218	-0.051	-0.335	0.504	0.006	0.121	0.007	0.362**
No. of spikelets/ panicle	S1	-0.217	0.073	0.189	0.333	0.023	0.060	0.058	0.078	0.597**
	S2	-0.112	0.112	-0.032	1.746	-1.279	-0.166	0.228	0.041	0.539**
	S3	0.25	-0.181	-0.035	-0.494	0.728	0.013	-0.007	0.014	0.286**
No. of grains/ panicle	S1	-0.182	0.071	0.182	0.306	0.025	-0.024	0.117	0.128	0.622**
	S2	-0.093	0.117	-0.031	1.635	-1.366	0.047	0.247	0.05	0.607**
	S3	0.210	-0.181	-0.032	-0.451	0.80	-0.032	0.054	0.004	0.368**
Fertility (%)	S1	0.104	-0.01	-0.032	-0.091	0.003	-0.219	0.135	0.098	-0.013
	S2	0.057	0.012	0.006	-0.473	-0.105	0.612	0.015	0.012	0.137
	S3	-0.068	-0.024	0.003	0.057	0.234	-0.109	0.129	-0.012	0.209*
No. of panicles/ plant	S1	0.099	-0.019	0.059	0.056	0.008	-0.085	-0.345	0.18	0.642**
	S2	0.009	0.006	-0.013	0.909	-0.768	0.022	0.439	0.06	0.663**
	S3	-0.041	0.034	-0.010	0.005	0.069	-0.022	0.626	-0.068	0.594**
1000-grain weight	S1	-0.089	0.069	-0.017	-0.077	-0.009	0.063	-0.183	-0.339	-0.582**
	S2	-0.054	0.122	-0.001	-0.532	0.503	-0.054	-0.193	-0.135	-0.345**
	S3	0.103	-0.203	-0.003	-0.047	0.021	0.009	-0.286	0.148	-0.258**

S1= sowing in April, 15

S2 = sowing in May, 1

S3= Sowing in May, 15

The aforementioned results are, in general, agreement with those reported by Satheeshkumar and Saravanan (2012). They found that number of days to first flowering, panicle length, number of spikelets/ panicle, number of grains/ panicle, fertility percentage and number of panicles/ plant exhibited positive direct effect on grain yield. They also reported that the maximum positive direct effects were observed for number of filled grains (2.08), number of spikelets/ panicle (1.86) and number of productive tillers/ plant (1.52). Gopikannan and Ganesh (2013) reported that panicle length, spikelet fertility and number of filled grains/ panicle expressed high and positive direct effect on grain yield. These results were also harmony with those obtained by Nagaraju *et al.* (2013) and Sarkar *et al.* (2014).

**Genetic parameters:**

Data of variance components, coefficients of variability, broad sense heritability and genetic advance under three sowing dates combined over three nitrogen fertilizer levels, 13 rice genotypes and two years, are presented in Table (6). The results showed that the genotypic variance ( $\sigma^2_g$ ) were highly significant for all the studied characters under all sowing dates, indicating a wide range of genetic variability among rice genotypes. Furthermore, the genotype by environments (sowing dates) interaction was highly significant for all the character under consideration. The genotypic coefficient of variation ranged from 5.84 to 16.49% (under the first sowing date), from 5.05 to 21.05% (under the second sowing date) and from 6 to 24.01% (under the third sowing date). The highest genotypic as well as phenotypic coefficients of variation were obtained in case of grain yield (under the first and the second sowing dates) and plant height under the third sowing date.

Among the studied characters, number of spikelets/ panicle, number of grains/ panicles, number of panicles/ plant and grain yield recorded more than 15% variation at phenotypic level. High genetic coefficients of variability for the aforementioned traits indicated that these traits might be more genotypically predominant and it would be possible to achieve further improvement from them. These results are in agreement with the previous results of zahid *et al.* (2006). Similar results were also obtained by Akhtar *et al.* (2011). They found that number of grains/ panicle, number of panicles/ plant and grain yield exhibited high phenotypic and genotypic coefficients of variability. The highest PCV and GCV were recorded for number of productive tillers/ plant; 26.06 and 24.69%, respectively and grain yield; 22.56 and 21.94%, respectively (Satheeshkumar and Saravanan, 2012). Previous studies showed that the maximum PCV and GCV were detected by number of spikelets/ panicle followed by number of productive tillers/ panicle (Devi *et al.*, 2012). The heritability estimates in broad sense were either moderate or high for all the character under consideration under all sowing dates. Number of days to 50% heading showed estimates of broad sense heritability more than 98% under all sowing dates. While, such estimates were less than 80% in case of number of panicles/ plant; 76.46% (under the first sowing date), grain yield; 71.28% (under the intermediate sowing date) and number of grains/ panicle; 58.3% (under the third owing date).

Table (6): Estimates of variance components, phenotypic (PCV), and genotypic (GCV) coefficients of variability, broad sense heritability ( $H^2_{bs}$ ) and genetic advance ( $\Delta g$ ) for all the studied traits under three sowing dates (data over three nitrogen levels, 13 rice genotypes and two seasons).

Parameters	Sowing dates	Heading date	Plant height	Panicle length	Number of spikelets / panicle	No. of grains/panicle	Fertility (%)	Number of panicles / plant	1000-grain weight	Grain yield
$\sigma^2 G$	S1	115.37**	147.7**	5.1**	547.5**	445.8**	25.68**	6.04**	11.75**	0.258**
	S2	126.6**	160.3**	7.08**	442.9**	396.7**	19.9**	6.48**	11.34**	0.34**
	S3	142.9**	431.7**	7.02**	310.2**	228.3**	26.0**	4.79**	7.49**	0.129**
$\sigma^2 GE$	S1	1.08**	10.76**	0.39**	46.9**	44.6**	3.10**	1.56**	0.66**	0.063**
	S2	1.06**	9.98**	0.31**	129.3**	98.42**	3.43**	1.00**	0.33**	0.122**
	S3	1.44**	2.67**	0.28**	190.3**	157.0**	6.50**	0.82**	1.22**	0.04**
$\sigma^2 e$	S1	0.07	0.01	0.03	19.3	11.39	0.69	0.31	0.06	0.010
	S2	0.82	0.06	0.02	12.3	5.74	1.50	0.01	0.02	0.015
	S3	0.13	0.46	0.01	8.5	6.3	0.40	0.003	0.05	0.001
$\sigma^2 ph$	S1	116.52	158.48	5.52	613.7	501.7	29.47	7.90	12.47	0.331
	S2	128.49	170.31	7.41	584.46	500.87	24.83	7.49	11.69	0.477
	S3	144.51	434.78	7.31	509.04	391.6	32.87	5.62	8.76	0.169
PCV	S1	9.76	12.92	10.62	16.20	16.07	5.93	17.90	13.96	18.68
	S2	11.32	14.42	12.50	16.3	17.08	5.61	16.7	13.90	24.9
	S3	13.00	24.20	13.00	17.20	17.8	6.8	15.8	12.6	19.3
GCV	S1	9.71	12.48	10.21	15.29	15.15	5.84	15.65	13.55	16.49
	S2	11.24	13.99	12.21	14.20	15.20	5.05	15.5	13.69	21.05
	S3	12.90	24.01	12.70	13.40	13.6	6.0	14.6	11.7	16.86
$(H^2_{bs})$	S1	99.0	93.2	92.39	89.21	88.85	87.14	76.46	94.23	77.95
	S2	98.4	94.1	95.50	75.80	79.20	80.10	86.50	97.01	71.28
	S3	98.9	94.01	96.0	60.90	58.3	79.01	85.2	85.5	76.27
$(\Delta g)$	S1	22.01	24.17	4.47	45.53	41.0	9.74	4.43	6.85	0.92
	S2	22.97	25.3	5.36	37.75	36.51	8.21	4.88	6.83	1.01
	S3	24.27	42.50	5.35	27.8	23.8	9.3	4.62	5.21	0.65
$(\Delta g (\%))$	S1	19.9	24.8	20.21	29.76	29.41	10.65	28.20	27.1	29.90
	S2	22.95	28.0	24.60	25.51	27.87	9.25	29.74	27.80	36.6
	S3	26.20	49.3	25.7	21.1	21.3	11.0	27.7	22.3	30.3

\*and \*\*: Significant at .05 and .01 levels of probability, respectively.

S1= sowing in April, 15

S2 = sowing in May, 1

S3= Sowing in May, 15

Previous studies showed that number of days to maturity, number of grains/ panicle and plant height recorded high estimates of broad sense heritability (Akhtar *et al.*, 2011). The estimates of heritability in broad sense were observed to be high in magnitude for all characters and ranged from 74.96 in case of fertility percentage to 99 % for 1000-grain weight (Satheeshkumar and Saravanan, 2012). Sellammal *et al.* (2014) reported that days to 50% flowering showed high heritability estimates.

The genetic advance under selection as percentage of mean was found to be high for grain yield; 29.9, 36.6 and 30.3% for the three sowing dates, respectively. While, such estimates were minimized in case of fertility percentage. High heritability estimates coupled with high genetic advance were recorded for number of days to 50% heading, plant height and panicle length. Moreover, moderate heritability estimates associated with high genetic advance were observed for grain yield. Previous results showed that number of spikelets/ panicle recorded high heritability estimates along with high genetic advance (Ghosh and Sharma, 2012).

#### **Cluster analysis:**

The genetic diversity of the thirteen rice genotypes was studied by using cluster analysis based on the mean performance of the character under consideration. The genotypes were categorized into four clusters (Fig.1). The First cluster contained 4 genotypes; Giza 177, Sakha105, Sakha106 and Gaori. Such genotypes were distinguished by early heading, short plants, short panicles and lower number of spikelets and grains/ panicle. The second group included Sakha 102, Sakha 104 and hybrid rice 2 which detected medium estimates of heading date, plant height and 1000-grain weight. The third cluster including two indica rice genotypes; Giza 178 and IET 1444 which possess higher number of grains/ panicle, high spikelet fertility and high grain yield. There are two sub groups in cluster four. Moroberekan rice variety was clearly separated into one sub group. This genotype detected highest estimates of days to 50% heading, plant height and 1000-grain weight. The other sub group including drought tolerance genotypes; IRAT 170, IRAT and WAB 878. Such genotypes distinguished with late maturity, tall plants and large panicles. The genotypes from between clusters can be utilized in hybridization program to improve grain yield (Lingaiah *et al.*, 2014). Previous results showed that some of Egyptian rice genotypes possess high degree of similarity (Sarker *et al.*, 2005). Based on cluster analysis, 32 rice cultivars were classified in four groups (Florence *et al.*, 2010).

The Dendrogram of cluster analysis classified the nine traits in two clusters (Fig. 2). The first one comprised grain yield and three of major yield-related traits viz., number of panicles/ plant, 1000-grain weight and panicle length. There were two sub groups in cluster two. One of the sub group belonged to cluster two included heading date, plant height and fertility percentage. While, number of grains/ panicles and number of spikelets/ panicle were clearly separated in one sub group. These results were, in general, harmony with those obtained from characters association.

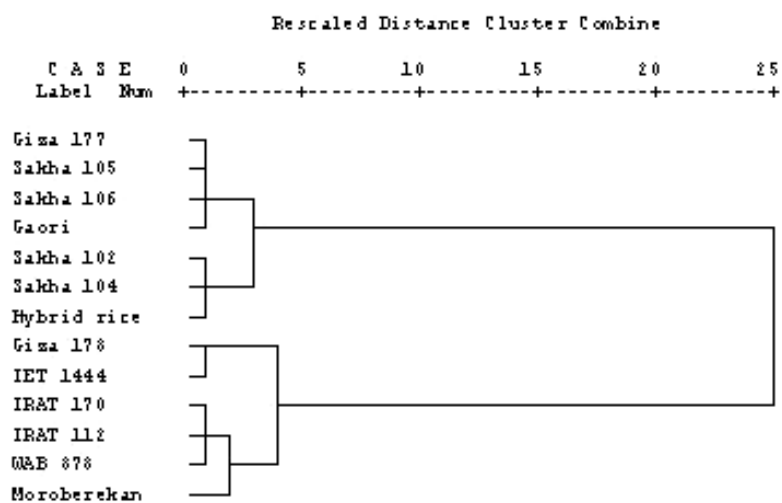


Fig. (1) Dendrogram for 13 rice genotypes based on morphological traits

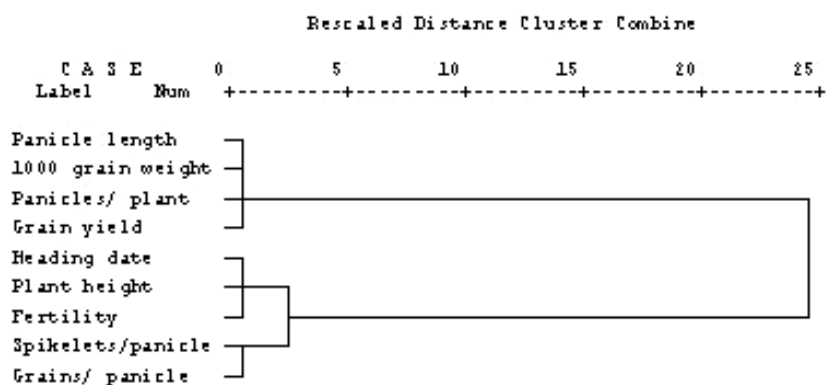


Fig. (2) Dendrogram for nine rice characters.



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## تقدير المحصول و التباعد الوراثي و الارتباط وتحليل معامل المرور في الارز تحت ظروف بيئية مختلفة

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اجريت هذه الدراسة بقسم المحاصيل بكلية الزراعة جامعة - كفر الشيخ خلال عامى ٢٠١٣ و ٢٠١٤ . و يهدف هذا البحث الى دراسة التباعد الوراثي و بعض المقاييس الوراثية بالاضافة الى معاملى الارتباط و المرور لمجموعة من الصفات الكمية لثلاثة عشرة تركيبا وراثيا فى الارز زرعت فى ثلاث عروات (١٥ ابريل، ١ مايو، ١٥ مايو) تحت ثلاث معدلات تسميد (٤٠ ، ٦٠ ، ٨٠ كجم نيتروجين/ فدان). و كانت اهم النتائج المتحصل عليها ما يلى:

كانت قيم التباين الراجعة للاختلافات لكل من مواعيد الزراعة و مستويات التسميد و التراكيب الوراثية كذلك التفاعل بينهم عالية المعنوية لمعظم الصفات تحت الدراسة.  
سجل ميعاد الزراعة المبكر افضل القيم لصفات طول الدالية و عدد السنبيلات بالدالية و عدد الحبوب بالدالية و نسبة الخصوبة و كذلك محصول الحبوب.

سجل المستوى المتوسط من النيتروجين أعلى القيم لصفات محصول الحبوب و عدد الحبوب بالدالية و طول الدالية

اظهرت الاصناف 2 Hybrid rice و Giza 178 و IET 1444 أعلى القيم لمحصول الحبوب (كمتوسط عبر جميع البيئات) ، كذلك سجل صنف الأرز الهجين أفضل القيم لصفات عدد الحبوب بالدالية و عدد الداليات لكل نبات سواء عند الزراعة في الميعاد المبكر او المتوسط تحت المستوى الأعلى من النيتروجين.

اظهرت النتائج ان هناك تلازما موجبا بين صفة المحصول و كل من طول الدالية و عدد السنبيلات بالدالية و عدد الداليات لكل نبات تحت جميع العروات مما يدل على اهمية هذه الصفات في برامج الانتخاب لتحسين محصول الحبوب في هذه الاصناف، و كانت علاقة الارتباط بين معظم الأزواج من الصفات ثابتة ولها نفس الاتجاه تقريبا تحت العروات الثلاثة.

اوضحت نتائج معامل المرور انه - تحت ظروف الزراعة المتأخرة - كانت صفة عدد الحبوب بالدالية هي الأكثر مساهمة في تباين كمية المحصول و تلتها صفة عدد الداليات لكل نبات ثم صفة عدد الايام من الزراعة حتى طرد 50% من النباتات لدالياتها (0.8 و 0.626 و 0.378. للصفات السابقة على التوالي)، في حين كانت صفات عدد السنبيلات بالدالية و نسبة الخصوبة و عدد الداليات لكل نبات هي الأكثر تأثيرا في حالة الميعاد المتوسط اما في حالة الميعاد الزراعة المبكر فكانت عدد السنبيلات بالدالية و طول الدالية هي الأكثر مساهمة في تباين صفة المحصول.

سجلت صفة محصول الحبوب أعلى القيم لمعامل الاختلاف المظهري و الوراثة تحت مواعيد الزراعة المختلفة في حين سجلت صفة نسبة الخصوبة اقل هذه القيم.

كانت قيم المكافئ الوراثة بصفة عامة عالية او متوسطة لكل الصفات موضع الدراسة تحت كل مواعيد الزراعة، وقد سجلت صفة عدد الايام من الزراعة حتى طرد 50% من النباتات لدالياتها أعلى القيم لدرجة التوريث (اكثر من 98%) تحت كل مواعيد الزراعة في حين سجلت صفة المحصول قيما متوسطة (78% و 71.3% و 76.3% تحت الثلاثة مواعيد على التوالي).

اظهرت صفة محصول الحبوب أعلى القيم للتحسين الوراثة المتوقع من الانتخاب (29.9% و 36.6% و 30.3% للثلاثة مواعيد على التوالي)، و قد ارتبطت القيم العالية للتحسين الوراثة المتوقع من الانتخاب بالقيم العالية للمكافئ الوراثة لصفات عدد الايام من الزراعة حتى طرد 50% من النباتات لدالياتها و ارتفاع النبات و طول الدالية، في حين ارتبطت القيم المتوسطة لدرجة التوريث بالقيم العالية للتحسين الوراثة المتوقع من الانتخاب في حالة صفة محصول الحبوب.

اظهر تحليل التباعد الوراثة انه يمكن تقسيم التراكيب الوراثة موضع الدراسة الى اربعة مجموعات. و قد اشتملت المجموعة الاولى على التراكيب الوراثة Giza 177 و سخا 105 و Sakha 106 و Gaori . اما المجموعة الثانية فقد اشتملت على الاصناف Sakha 102 و Sakha 104 و Hybrid rice 2 . و تضمنت المجموعة الثالثة على الصنفين Giza 178 و IET 1444 . اما المجموعة الثالثة فقد اشتملت على تحت مجموعتين، الاولى منها احتوت على تركيب وراثي واحد هو Moroberekan و الثانية اشتملت على الثلاثة اصناف الأكثر تحملا للجفاف وهي IRAT 170 و IRAT112 و WAB 878 . كما اوضحت نتائج التباعد الوراثة ايضا ان الصفات المدروسة امكن تقسيمها الى مجموعتين، الاولى و تضم صفة المحصول و عدد الداليات لكل نبات و طول الدالية و وزن الالف حبة. اما المجموعة الثانية فتضم تحت مجموعتين، الاولى و تشمل عدد الايام من الزراعة حتى طرد 50% من النباتات لدالياتها و ارتفاع النبات و نسبة الخصوبة. في حين احتلت عدد السنبيلات/ دالية و عدد الحبوب بالدالية تحت المجموعة الثانية، وهذه النتائج متفقة بصفة عامة مع تلك النتائج المتحصل عليها من علاقة الارتباط بين الأزواج المختلفة من الصفات و بالتالي يمكن للمربي ان يستخدم التباعد الوراثة مع اداء التركيب الوراثة في الانتخاب لتحسين محصول الحبوب.