GENETIC VARIABILITY, HERITABILITY, GENETIC ADVANCE AND CLUSTER ANALYSIS FOR SOME PHYSIOLOGICAL TRAITS AND GRAIN YIELD AND ITS COMPONENTS IN RICE (*ORYZA SATIVA L.*)

BY

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ABSTRACT

The present investigation was carried out at the Rice Research and Training Center, Sakha, Kafr EL-Sheikh, Egypt, during 2007 and 2008 seasons to study the developmental pattern of different growth stages four very early maturing (below 115 days) as compared with that of an early (up to 125 days), medium maturing (up to 140 days) and late maturing (above 140 days). The genetic variability of some physiological traits and grain yield and its components for the tested genotypes were also assessed. All the twenty four varieties required almost 3 weeks to reach 3-leaf stage although they differed in total duration, seedling height and plant height. Vegetative phase was mainly responsible for the variation in the total duration of the variety. Marginal variation observed in reproductive and ripening phases among the varieties. The period from 5- leaf stage to panicle initiation which represents panicle development stage was shorter for early maturing varieties and overlap's both vegetative developmental stage with the reproductive developmental stage (panicle initiation).Broad sense heritability estimates were high (ranged between 86 to 99.4%)for all studied traits. The expected genetic advance from selection appeared to be effective and ranged between 3.56 % to 44.88 %over the two seasons. The cluster analysis were carried out using 3 parameters i.e, vegetative period, days to heading and reproductive period. Since reproductive phase was almost constant and had a very low range, the cluster was mainly influenced with days to heading and vegetative stage period.

Key words: *Rice, Genetic Variability, Genetic Advance, Physiological.*

INTRODUCTION

Rice is considered the most popular and important field crop in Egypt for several reasons: as a staple food after wheat for the Egyptian population, as a second exporting crop after cotton, as a land reclamation crop for improving the productivity of the saline soils widely spread in North delta and coastal area, and finally it is a social crop in which all farmers family member could gain money during its growing season. Rice productivity and production have remarkably increased year after year according to the percentage replacement of the rice area with the modern varieties to realize a maximum yield average (9.9 t/ha) in the year 2004 against (5.7 t/ha) for the past period 1986-1988. Because adopting of the new short duration rice varieties, about 30% of the irrigation water consumption was saved every year, (Aidy and Maximos 2006).

The prediction of genetic advance is a prerequisite for crop improvement breeding programs especially when large populations are subjected to selection. Facilitated by obtaining phenotypic and genotypic coefficients of variation in the absence of which field evaluation of every genotype would be physically less feasible. Hence there is need to study variability. Variability for different traits in the source population is a prerequisite for crop improvement since all attempts of breeding and selection would be futile unless major portion of variability is heritable. Mruthunjaya and Mahadevappa (1995) reported that the success of crop improvement program depends on the definition and assembly of the required genetic variations and selection for yield through high heritable traits, excluding the environmental components. Vergara and Chang (1976) divided the total duration of rice crop into three major growth phases as (1) vegetative phase (from germination to panicle initiation), (2) reproductive phase (from panicle initiation to flowering) and (3) repining phase (from flowering to maturity).

The current investigation aims to study the behavior of different growth stages for the tested genotypes that differs mainly in their growth duration and relationship between growth duration and grain yield and what the period which the breeder can play major role to produce new varieties short duration with high grain yield (critical period which if shorter the grain yield decreased).

MATERIAL AND METHODS

Twenty four rice varieties included very early maturing group below 115 days (HR 5824-B-3-2-3, M202, M101 and M201), early maturing group below 125 days (Sakha 103, GZ 6522-15-1-1-3, Giza 177and Sakha 102,), medium duration up to 140 days (GZ 6214-4-1-1-1,Giza 182, GZ 6296-12-1-2-1-1, Giza 178, SK2034H1, CT9852-3-2-1-4-PM, Sakha 104, GZ 6903-2-2-1, Sakha 101, GZ 6910-28-1-3-1 and GZ 6906-1-1-1-1) and late type having maturity above 140 days (Giza176, Giza 181, IR50, IR8 and Giza 171) were grown in 2007 and 2008 seasons at the Rice Research and Training Center, Sakha , Kafr EL-Sheik, Egypt. The experiment was laid out in a Randomized Complete Block Design (RCBD) with four replications. The seeds were direct seeded in dry soil followed by irrigation and single seed per hill was maintained in the nursery, thirty days after sowing, seedlings of each genotype were individually transplanted in the permanent field in three rows (5 meters long) and 20 x 20 cm spacing. Plot samples were taken 7 days intervals to determine panicle initiation stage. Plant height was recorded at 5 leaf stage and at maturity. Ear baring tillers (EBT) was measured at harvest, while the total number of tillers was recorded at panicle initiation stage. Each variety in a replication was represented by 3 rows with 20 cm spacing and 25 plants in each row. Total chlorophyll content in the flag leaf was recorded using chlorophyll meter (5 SPAD-502 minolta Camera Co. ltd., Japan) at heading stage. Panicle primordium initiation character (3 mm length approximately) was recorded by dissecting the main culm of five plants randomly taken from each variety per replication. Combined analysis of variance was used (after performing homogeneity test) to estimate the genotypic variance ($\sigma^2 g$), environmental variance ($\sigma^2 e$), genotypic x environmental variance ($\sigma^2 gy$), phenotypic variance ($\sigma^2 ph$), genotypic (GCV) and phenotypic (PCV) coefficient of variation components according to the formula suggested by Burton (1952) as follows:

$$\text{Genotypic variance } (\sigma^2 g) = \frac{M1 - M2}{ry}$$

Environmental variance ($\sigma^2 e$) = M3

Phenotypic variance ($\sigma^2 ph$) = $\sigma^2 g + \sigma^2 gy + \sigma^2 e$

Where: M1 = Mean squares due to varieties within treatment, M2 = Mean square due to varieties x year interaction,

M3 = Mean squares due to error, and

r = Number of replication.

$$\text{Phenotypic coefficient of variability (P.C.V)} = \frac{\sigma^2 ph}{X} \times 100$$

$$\text{Genotypic coefficient of variability (G.C.V.)} = \frac{\sigma^2 g}{X} \times 100$$

Other genetic parameters, i.e. heritability (H^2) and genetic advance upon selection (ΔG) were calculated as follows:

Heritability (H^2): was estimated as the percent ratio of genotypic variance to phenotypic variance (Hansen *et al*, 1956).

$$H2\ (\%) = \frac{\sigma^2 g}{\sigma^2 Ph} \times 100$$

Genetic advance upon selection (ΔGS) and as percent of the mean ($\Delta G\%$) were computed according to Johnson et al., (1955) as follows:

$$\Delta GS = K.\ H^2\ \sigma^2 ph$$

$$\Delta G\% = \frac{\Delta G}{X} \times 100$$

Where K is the selection differential and equals 2.06 at selection intensity of 5%.

The difference among varieties means were compared using Duncan Multiple Range Test DMRT (as mentioned by Duncan, 1955).

All recommended agricultural practices were applied for the permanent rice field. Weeds were chemically controlled by 2 liter stern.

RESULTS AND DISCUSSION

1-Mean performance:

Growth stages and duration:

Results showed that , the vegetative phase take 42 days in HR 5824-B-3-2-3, 62 days in M202 (as a very early group), 65 days in Sakha 103, 68 days in GZ 6522-15-1-1-3 (early), 71 days in GZ 6214-4-1-1-1, 73 days in GZ 6903-1-2-2-1 (medium) and 99 days in Giza 171 (late type), Table (1). Panicle initiation in very early varieties was much quicker compared to early, medium and late duration varieties.

A narrow range of 19 days to 33 days of reproductive phase was observed in M201 (very early) as well as Giza 171 (as late type), Table (1), indicating the variation in reproductive phase is very narrow among the tested varieties regardless their total duration, these results are agreement with those obtained by Tanaka *et al.* (1964).

Regarding to days to heading, data in Table (2) revealed that rice varieties are varied in their number of days to heading in 2007 and 2008 seasons and their combined data. It was clear that HR 5824-B-3-2-3 and M202 rice varieties were earlier heading (74 and 81 days, respectively) representing the very early group followed by Sakha 103 and GZ 6522-15-1-1-3 (93 and 90 days respectively) as early maturing group, GZ 6214-4-1-1-1 and Giza 178 (101 days as medium maturing group while, Giza 171 exhibited 132 days (late variety). These differences among rice varieties might be attributed to the genetic diversity among all genotypes under this study. Similar trends were found by Sedeek (2001).

Concerning the repining phase, varieties of different maturity groups showed very less variation for repining phase (Table, 2), it took a range of 22 days (CT 9852-3-2-1-2-4-PM) to 35 days (HR 5824-B-3-2-3, GZ 6522 -15-1-1-3 and IR8) of different maturity groups. This clarify indicated the very less variation in repining phase and generally varied from 25 to 35 days.

Therefore it could be concluded that variation in total duration (seed to seed) between the different groups is largely due to the differences in vegetative phase (57 days). Meanwhile, variation in reproductive phase (14 days) and ripening phase (13 days) was very less.

Table (1): Vegetative phase and reproductive stage of rice varieties in 2007 and 2008 seasons and combined data.

varieties	Vegetative stage (days)			reproductive stage(days)		
	2007	2008	combined	2007	2008	combined
Very early varieties						
HR5824-B-3-2-3	42.0p	42.0q	42.0o	33.0a	31.0bc	32.0a
M202	62.0n	61.0m	62.0m	19.0j	20.0j	20.0h
M101	60.0o	59.0n	60.0n	23.0h	24.0gh	24.0f
M201	68.0k	67.0jk	68.0jk	18.0j	19.0j	19.0h
Early varieties						
Sakha 103	64.0m	66.0k	65.0k	28.0ef	28.0e	28.0d
GZ 6522-15-1-1-3	67.0kl	68.0j	68.0j	22.0hi	23.0hi	23.0fg
Giza 177	72.0hij	72.0hi	72.0hi	21.0i	22.0i	22.0g
Sakha 102	66.0l	64.0l	65.0l	25.0g	25.0fg	25.0e
Medium varieties						
GZ 6214-4-1-1-1	71.0j	71.0i	71.0i	29.0de	30.0cd	30.0bc
Giza 182	80.0g	80.0g	80.0g	27.0f	28.0e	28.0d
GZ 6296-12-1-2-1-1	73.0hi	72.0hi	73.0hi	31.0bc	30.0cd	31.0b
Giza 178	74.0h	72.0hi	73.0hi	28.0ef	29.0de	29.0cd
SK 2034 H1	80.0g	81.0g	81.0g	25.0g	25.0fg	25.0e
CT 9852-3-2-1-4-PM	89.0d	90.0d	90.0d	30.0cd	31.0bc	31.0b
Sakha 104	74.0h	73.0h	74.0h	30.0cd	31.0bc	31.0b
GZ 6903-2-2-1	74.0h	72.0hi	73.0hi	32.0ab	33.0a	33.0a
Sakha 101	90.0d	90.0d	90.0d	27.0f	28.0e	28.0d
GZ 6910-28-1-3-1	87.0e	88.0e	88.0e	28.0ef	29.0de	29.0cd
GZ 6906-1-1-1-1	84.0f	85.0f	85.0f	31.0bc	30.0bcd	31.0b
Late varieties						
Giza 176	90.0d	91.0d	90.0d	30.0cd	31.0bc	31.0b
Giza 181	89.0d	90.0d	90.0d	33.0a	31.0bc	32.0a
IR 50	94.0c	93.0c	94.0c	25.0g	25.0fg	25.0e
IR 8	97.0b	95.0b	96.0b	25.0g	26.0f	26.0e
Giza 171	99.0a	98.0a	99.0a	33.0a	32.0ab	33.0a

In a column, means followed by the same letter are not significantly different at the 5% level by DMRT.

Table (2): Days to heading (days) and ripening stage of rice varieties in 2007 and 2008 seasons and combined data.

varieties	Days to heading (days)			Ripening stage(days)		
	2007	2008	combined	2007	2008	combined
Very early varieties						
HR5824-B-3-2-3	75.0r	73.0o	74.0o	35.0a	34.0q	35.0a
M202	81.0q	81.0n	81.0n	29.0de	30.0de	30.8de
M101	83.0p	83.01	83.01	30.0d	29.0e	30.0e
M201	86.0o	86.01	86.01	28.0e	30.0de	29.0e
Early varieties						
Sakha 103	92.0lm	94.0i	93.0i	28.0e	29.0e	29.0e
GZ 6522-15-1-1-3	89.0n	91.0j	90.0j	35.0a	34.0a	35.0a
Giza 177	93.01	94.0i	94.0i	32.0c	33.0ab	33.0b
Sakha 102	91.0m	89.0k	90.0k	34.0ab	35.0a	34.0a
Medium varieties						
GZ 6214-4-1-1-1	100.0k	101.0h	101.0h	30.0d	31.0cd	31.0cd
Giza 182	107.0g	108.0e	108.0e	23.0g	24.0g	24.0g
GZ 6296-12-1-2-1-1	104.0i	102.0h	103.0h	26.0f	27.0f	27.0f
Giza 178	102.0j	101.0h	102.0h	33.0bc	34.0a	34.7a
SK 2034 H1	105.0hi	106.0f	106.0f	30.0d	32.0bc	31.0cd
CT 9852-3-2-1-4-PM	119.0cd	121.0b	120.0b	21.0h	22.0h	22.0h
Sakha 104	104.0i	104.0g	104.0g	35.0a	34.0a	35.0a
GZ 6903-2-2-1	106.0gh	105.0fg	106. g	34.0ab	33.0ab	34.3ab
Sakha 101	117.0e	118.0c	118.0c	28.0e	29.0e	29.0e
GZ 6910-28-1-3-1	115.0f	117.0c	116.0c	30.0d	31.0cd	31.0cd
GZ 6906-1-1-1-1	115.0f	115.0d	115.0d	30.0d	32.0bc	31.0cd
Late varieties						
Giza 176	120.0c	122.0b	121.0b	30.0d	31.0cd	31.0cd
Giza 181	122.0b	121.0b	122.0b	28.0e	29.0e	29.0e
IR 50	118.0d	118.0c	118.0c	32.0c	31.0cd	32.0cd
IR 8	122.0b	121.0b	122.0b	35.0a	34.0a	35.0a
Giza 171	132.0a	131.0a	132.0a	28.0e	27.0f	28.0f

In a column, means followed by the same letter are not significantly different at the 5% level by DMRT.

Chlorophyll content and flag leaf area:

Data in Table (3) showed that rice varieties varied significantly in their chlorophyll content. M201 rice variety recorded the highest value (51 SPAD), while, CT 9852-3-2-1-2-4-PM gave the lowest one (34.5 SPAD). The differences among those varieties for chlorophyll content may be attributed to nature of the varieties, which is mainly affected by the genetic and partially by the environmental factors such as fertilizer, soil condition and weather. Similar findings were reported by Abd Alla (1996)

Regarding flag leaf area, data in Table (3) indicated that rice varieties differ significantly in their flag leaf area. Giza 181 gave the highest flag leaf area (44.1 cm^2), while, HR 5824-B-3-2-3 recorded the lowest one (18.5 cm^2). The differences among the rice varieties for their flag leaf area mainly attributed to nature of variety, similar trend found by Hammoud (2005).

Table (3): Flag leaf area (cm^2) and Chlorophyll content (SPAD) of rice varieties in 2007 and 2008 seasons and combined data.

varieties	Flag leaf area (cm)			Chlorophyll content (SPAD)		
	2007	2008	combined	2007	2008	combined
Very early varieties						
HR5824-B-3-2-3	18.4 n	18.5 o	18.5 q	43.6 d	43.0 de	43.3 fg
M202	42.3 b	41.5 c	41.9 c	50.0 ab	49.3 b	49.7 b
M101	37.6 d	37.0 ef	37.3 f	49.0 b	48.7 b	48.8 b
M201	40.3 c	40.4 d	40.4 e	51.0 a	51.0 a	51.0 a
Early varieties						
Sakha 103	29.4 k	29.6 kl	29.5 m	43.0 def	42.7 de	42.8 gh
GZ 6522-15-1-1-3	37.0 de	37.6 e	37.3 f	42.0 ef	41.7 ef	41.8 hi
Giza 177	27.3 m	27.2 n	27.2 p	43.9 cd	44.0 cd	44.0 d-g
Sakha 102	28.7 kl	28.4 m	28.6 o	43.4 de	42.7 de	43.1 g
Medium varieties						
GZ 6214-4-1-1-1	30.6 ij	30.4 jk	30.5 kl	41.5 f	41.0 fg	41.3 i
Giza 182	41.1 c	41.3 c	41.2 d	37.2 h	36.0 ij	36.6 kl
GZ 6296-12-1-2-1-1	29.4 k	29.4 l	29.4 mn	45.43 c	44.0 cd	44.7 cd
Giza 178	42.8 b	43.0 b	42.9 b	43.0 def	42.7 de	42.8 gh
SK 2034 H1	43.1 b	43.7 ab	43.4 b	39.0 g	40.0 gh	39.5 j
CT 9852-3-2-1-4-	30.6 ij	30.4 jk	30.5 kl	34.0 j	35.0 jk	34.5 m
PM	31.2 i	30.8 j	31.0 k	44.0 cd	45.0 c	44.5 cde
Sakha 104	32.6 h	32.1 i	32.4 j	43.0 def	44.0 cd	43.5 efg
GZ 6903-2-2-1	34.1 fg	33.1 h	33.6 i	45.6 c	45.3 c	45.5 c
Sakha 101	33.4 g	33.2 h	33.3 i	39.03 g	38.7 h	38.9 j
GZ 6910-28-1-3-1	28.4 l	28.3 m	28.4 o	44.6 cd	44.0 cd	44.3 def
GZ 6906-1-1-1-1						
Late varieties	30.3 j	30.4 jk	30.4 l	45.3 c	44.0 cd	44.7 cd
Giza 176	44.1 a	44.1 a	44.1 a	36.5 hi	36.4 ij	36.5 kl
Giza 181	36.5 e	36.6 f	36.6 g	34.0 j	34.0 k	34.0 m
IR 50	34.8 f	34.2 g	34.5 h	35.2 ij	36.0 ij	35.6 l
IR 8	29.3 k	28.3 m	28.8 no	38.0 gh	36.7 i	37.5 k
Giza 171						

In a column, means followed by the same letter are not significantly different at the 5% level by DMRT.

Seedling height at panicle initiation and plant height at harvest:

The seedling height up to 5 leaf stage and plant height at harvest showed significant differences among the twenty four varieties of different duration groups (Table, 4). Giza 171 recorded the longest seedling height at 5 leaf stage and plant height at harvest (29.5 and 128 cm respectively), while, Sakha 101 recorded the shortest seedling height (17.8cm) and HR 5824-B-3-2-3 recorded the shortest plant height at harvest 77.5cm).These differences mainly due to their different in genetic background.

Growth stage and tillering:

Tiller development in all the varieties was generally observed in 4^{th} week i.e. just after 5 leaf stage. The variation in tiller number among of different duration groups even within the very early types was observed from 5^{th} week on-wards; active vegetative phase is the period to acquired maximum tillers (Tanaka *et al* 1964). The period of tiller development (number of days) extended from5 leaf stage to panicle initiation stage i.e. 13 days in HR 5824-B-3-2-3, 31 days in M202 (very early), 35days in Sakha103 (early), 41 days in GZ 6214-4-1-1-1 (medium) and 68 days in Giza 171 (late type). In the very early rice group the period for tillers development in the vegetative phase was very much shorter as compared to early, medium and late varieties. This is mainly attributed to low grain yield of very early rice.

The vegetative development particularly, tillers development overlapped with the reproductive stage especially in the very early group. Similar findings in very early rice varieties were also observed by Mohanty and Srivastava (1990), due to these overlapping stages the very early varieties showed more number of ear bearing tillers at maturity than the total tillers observed at panicle initiation (Table, 5), indicating that in these varieties produces more tillers even after panicle initiation i.e. still producing tillers after it had come productive (formed). While, this was not the case in the other groups, in the early, medium and late varieties, where the number of ear bearing tillers at maturity in general were less than the total number of tillers at panicle initiation stage. It means some developed tillers at panicle initiation being unproductive. Though the late developed tillers in the very early maturing group did produce normal panicles, it didn't mature at the same time as tillers produced before panicle initiation and was in general later in maturity.

Table (4): Seedling height (cm) at 5 leaf stage and plant height (cm) at harvest of rice varieties in 2007 and 2008 seasons and combined data.

varieties	Seedling height (cm) at 5 leaf stage			plant height (cm) at harvest		
	2007	2008	combined	2007	2008	combined
Very early varieties						
HR5824-B-3-2-3	25.3cde	27.0bcd	26.2cd	77.0l	78.0n	77.5m
M202	27.0b	28.0b	27.5b	98.0h	98.0gh	98.0h
M101	25.0def	25.0ef	25.0efg	123.0b	125.0b	124.0b
M201	23.0gh	24.0fg	23.5ijk	94.0j	93.0k	93.5j
Early varieties						
Sakha 103	25.0def	26.0de	25.5def	98.0h	97.0hi	97.5h
GZ 6522-15-1-1-3	25.3cde	26.3cde	25.8de	99.0gh	98.0gh	98.5gh
Giza 177	26.0bcd	27.0bcd	26.5bcd	101.0f	100.3f	100.6f
Sakha 102	27.0b	28.0b	27.5b	107.0d	106.0d	106.5d
Medium varieties						
GZ 6214-4-1-1-1	26.6bc	27.6bc	27.2bc	96.0i	96.0ij	96.0i
Giza 182	23.6fgh	24.0fg	23.8hij	99.0gh	97.0hi	98.0h
GZ 6296-12-1-2-1-1	22.3hi	23.0gh	22.6k	87.0k	86.0m	86.5l
Giza 178	23.3gh	24.3fg	23.8hij	99.0gh	97.0hi	98.0h
SK 2034 H1	24.3efg	25.3ef	24.8e-h	103.0e	103.0e	103.0e
CT 9852-3-2-1-4-PM Sakha 104	24.0efg	25.0ef	24.5f-i	103.0e	103.0e	103.0e
GZ 6903-2-2-1	27.0b	28.0b	27.5b	107.0d	107.0d	107.0d
Sakha 101	21.0i	22.0h	21.5l	96.0i	95.0j	95.5i
GZ 6910-28-1-3-1	17.6j	18.0i	17.8m	88.0k	88.0l	88.0k
GZ 6906-1-1-1-1	23.0gh	23.0gh	23.0jk	96.0i	96.0ij	96.0i
Late varieties	27.0b	28.0b	27.5b	95.0ij	95.0j	95.0i
Giza 176						
Giza 181	24.0efg	24.0fg	24.0g-j	100.0fg	99.0fg	99.5fg
IR 50	24.0efg	25.0ef	24.5f-i	100.0fg	99.0fg	99.5fg
IR 8	24.3efg	25.0ef	24.6fgh	98.6gh	98.0gh	98.3gh
Giza 171	25.0def	26.0de	25.5def	119.6c	120.0c	119.8c
	29.0a	30.0a	29.5a	127.6a	128.3a	128.0a

In a column, means followed by the same letter are not significantly different at the 5% level by DMRT.

Table (5): Number of tillers/plant at panicle initiation and number of panicles/plant at harvest of rice varieties in 2007 and 2008 seasons and combined data.

varieties	Number of tillers/plant			number of panicles/plant		
	2007	2008	combined	2007	2008	combined
Very early varieties						
HR5824-B-3-2-3	14.0hi	13.0i	14.0k	16.0j	15.0j	16.0n
M202	18.0f	17.0g	17.0h	18.0hi	16.0ij	17.0lm
M101	14.0hi	14.0hi	14.0jk	17.0ij	16.0ij	17.0m
M201	13.0i	14.0hi	14.0k	18.0ghi	17.0hi	18.0kl
Early varieties						
Sakha 103	16.0g	17.0g	16.0i	21.0bcd	20.0def	20.0efg
GZ 6522-15-1-1-3	20.0e	21.0ef	20.0g	20.0def	19.0efg	20.0ghi
Giza 177	16.0g	17. 0g	17.0hi	20.0d-g	19.0e-h	19.06hij
Sakha 102	15.0gh	15.0h	15.0j	19.0e-h	18.0fgh	19.0ijk
Medium varieties						
GZ 6214-4-1-1-1	22.0cd	23.0abc	22.0def	19.0fgh	18.0gh	18.0jk
Giza 182	24.0b	23.0abc	24.0 bc	22.0ab	21.0a-d	22.0bcd
GZ 6296-12-1-2-1-1	23.0bc	22.0bcd	23.0c-f	22.0abc	21.0a-d	21.0b-e
Giza 178	22.0cd	22.0bcd	22.0 ef	22.0ab	21.0abc	22.0abc
SK 2034 H1	23.0bc	23.0abc	23.0cde	20.0cde	20.0def	20.0fgh
CT 9852-3-2-1-4-PM	23.0bc	22.0cde	22.0def	20.0def	20.0def	20.0fgh
Sakha 104	23.0bc	23.0abc	23.0cde	22.0ab	21.0a-d	22.0bcd
GZ 6903-2-2-1	20.0e	21.0def	21.0g	21.0bcd	21.0bcd	21.0 c-f
Sakha 101	23.0bc	24.0ab	23.0bcd	22.0ab	21.0a-d	22.0abc
GZ 6910-28-1-3-1	21.0de	20.0f	22.0 g	22.0ab	22.0ab	22.0ab
GZ 6906-1-1-1-1	20.0e	20.0f	22.0g	22.0ab	21.0a-d	22.0bcd
Late varieties						
Giza 176	22.0cd	22.0cde	22.0f	20.0def	20.0cde	20.0fgh
Giza 181	24.0b	23.0abc	24.0bc	20.0cde	20.0def	20.0fgh
IR 50	24.0b	24.0a	24.0ab	21.0bcd	21.0bcd	21.0c-f
IR 8	26.0a	24.0a	25.0a	23.0a	22.0a	23.0a
Giza 171	23.0bc	23.0abc	23.0b-e	21.0bcd	20.0cde	21.0d-e

In a column, means followed by the same letter are not significantly different at the 5% level by DMRT.

Panicle length and number of filled grains/panicle:

Regarding to panicle length, rice varieties differ significantly in this trait. IR 50 as late type gave the longest panicle (28.0cm), while HR 5824-B-3-2-3 (very early) recorded the shortest one (16.0cm).Theses differences among rice varieties mainly due to genetic background.

Regarding number of filled grains/panicle, data in Table (6) indicted significant differences among the 24 rice varieties for this trait in two seasons and their combined analysis. SK2034H1 (medium) and IR 50 (late) varieties gave the highest number of filled grains/panicle (171 and 172 grains, respectively). While, HR 5824-B-

3-2-3(very early) gave the lowest number (79grains), the differences in number of filled grains/panicle could be attributed to genotypes. Similar trend was found by Ebaid and El-Rewainy (2005).

Table (6): Panicle length (cm) and Number of filled grains/panicle of rice varieties in 2007 and 2008 seasons and combined data.

varieties	Panicle length (cm)			Number of filled grains/panicle		
	2007	2008	combined	2007	2008	combined
Very early varieties						
HR5824-B-3-2-3	16.3k	16.0i	16.2k	80.0n	79.0r	80.0n
M202	21.3h	21.0f	21.2h	140.0f	140.0h	140.0f
M101	21.3h	21.0f	21.2h	123.0k	123.0n	123.0k
M201	19.7i	20.0g	19.8i	100.0m	100.0q	100.0m
Early varieties						
Sakha 103	22.0g	22.0e	22.0g	127.0i	125.0m	126.0i
GZ 6522-15-1-1-3	20.0i	20.0g	20.0i	130.0h	127.0l	128.0h
Giza 177	20.0i	20.0g	20.0i	122.0k	120.0o	121.0k
Sakha 102	24.0d	23.7c	23.9d	125.0j	123.0n	124.0j
Medium varieties						
GZ 6214-4-1-1-1	18.0j	18.0h	18.0j	116.0l	115.0p	116.0l
Giza 182	24.0d	24.0c	24.0d	160.0c	158.0d	159.0c
GZ 6296-12-1-2-1-1	22.4g	22.1e	22.3g	116.0l	115.0p	115.0l
Giza 178	23.0f	23.0d	23.0f	154.0d	152.0e	153.0d
SK 2034 H1	24.0d	23.8c	23.9d	176.0a	166.0b	171.0a
CT 9852-3-2-1-4-PM	25.0c	25.0b	25.0c	135.0g	133.0j	134.0g
Sakha 104	22.1g	23.0d	22.6g	136.0g	134.0j	135.0g
GZ 6903-2-2-1	22.0g	22.0e	22.0g	129.0h	127.0l	128.0h
Sakha 101	22.0g	22.0e	22.0g	149.0e	147.0g	148.0e
GZ 6910-28-1-3-1	22.1g	22.0e	22.1g	116.0l	114.0p	115.0l
GZ 6906-1-1-1-1	22.2g	22.0e	22.1g	131.0h	129.0k	130.0h
Late varieties						
Giza 176	22.2g	22.0e	22.1g	141.0f	138.0i	140.0f
Giza 181	26.0b	25.3b	25.7b	154.0d	149.0f	152.0d
IR 50	28.0a	28.0a	28.0a	175.0a	170.a	172.0a
IR 8	23.5e	23.0d	23.3e	165.0b	162.0c	164.0b
Giza 171	21.2h	21.0f	21.1h	140.0f	139.0hi	140.0f

In a column, means followed by the same letter are not significantly different at the 5% level by DMRT.

1000-grain weight and grain yield/plant:

Data in Table (7) revealed a significant difference among the rice varieties in their 1000-grain weight in the two seasons and their combined data. M101 (very early) and GZ 6906-1-1-1-1 (medium) gave the highest value of 1000-grain weight (31.5 and 30.0 grams, respectively). While, HR 5824-B-3-2-3 (very early) and Giza 178 (medium) gave the lowest one (21.3 and 21.5 grams, respectively). These differences may be due to the differences in their genetic structures. These results are in agreement with those obtained by Hammoud *et al.* (2006).

Table (7):1000-grain weight (g) and grain yield/plant (g) of rice varieties in 2007 and 2008 seasons and combined data.

varieties	1000-grain weight (g)			Grain yield/plant		
	2007	2008	combined	2007	2008	combined
<u>Very early varieties</u>						
HR5824-B-3-2-3	21.00l	21.66kl	21.33m	33.0m	35.0mn	34.0n
M202	24.33ij	24.66h	24.50j	32.6m	34.0n	33.3n
M101	31.33a	31.66a	31.50a	46.6j	47.0k	46.8k
M201	21.66l	22.33jk	22.00m	35.0l	36.0m	35.5m
<u>Early varieties</u>						
Sakha 103	24.66hi	24.66h	24.66j	52.0h	53.0hi	52.5i
GZ 6522-15-1-1-3	27.66c	28.66c	28.16c	47.0j	48.0jk	47.5k
Giza 177	27.00cd	27.0ef	27.00def	40.0k	41.0l	40.5l
Sakha 102	27.66c	27.66de	27.66cd	52.0h	53.6h	52.8i
<u>Medium varieties</u>						
GZ 6214-4-1-1-1	26.66de	27.33e	27.00def	47.0j	49.0j	48.0k
Giza 182	27.00cd	27.33e	27.16de	47.0j	48.3jk	47.6k
GZ 6296-12-1-2-1-1	25.66fg	25.66g	25.66hi	49.0i	51.3i	50.2j
Giza 178	21.66l	21.33l	21.50m	55.0g	57.3g	56.1h
SK 2034 H1	23.66j	23.66i	23.66k	76.0a	79.6a	77.8a
CT 9852-3-2-1-4-PM Sakha 104	26.00efg	26.33fg	26.16ghi	56.7fg	59.0fg	57.8g
GZ 6903-2-2-1	26.33def	26.33fg	26.33fgh	65.0d	68.0d	66.5d
Sakha 101	27.66c	27.33e	27.50cd	58.0f	60.0f	59.0g
GZ 6910-28-1-3-1	26.66de	26.33fg	26.50efg	71.6b	74.0b	72.8b
GZ 6906-1-1-1-1	27.66c	28.33cd	28.00c	69.0c	70.0c	69.5c
<u>Late varieties</u>	29.66b	30.33b	30.00b	63.0e	65.0e	64.0f
Giza 176						
Giza 181	25.33gh	25.66g	25.50i	65.0d	66.0e	65.5de
IR 50	26.33def	26.33fg	26.33fgh	68.0c	69.6cd	68.8c
IR 8	24.33ij	24.66h	24.50j	64.0de	65.0e	64.5cf
Giza 171	26.33def	26.33fg	26.33fgh	67.0c	69.6cd	68.5c
	27.66c	26.66fg	26.60efg	56.6fg	59.0fg	57.8g

In a column, means followed by the same letter are not significantly different at the 5% level by DMRT.

Regarding grain yield/plant, the rice varieties differed significantly in their grain yield in the two seasons of the study and combined. SK 2034 H1 and Sakha 101 (medium varieties) produced the highest grain yield/plant (77.83 and 72.83 grams, respectively). On the other hand HR 5824-B-3-2-3, M202 and M201 (very early varieties) produced the lowest grain yield/plant (34.0, 33.33 and 35.5 grams respectively). The superiority of SK 2034H1 and Sakha 101 rice varieties in grain yield/plant might be due to their higher number of panicles/plant, number of filled grains/panicle and their agronomic efficiency. These results are in agreement with those obtained by Abd EL-Wahab *et al.* (1998).

Genetic parameters:

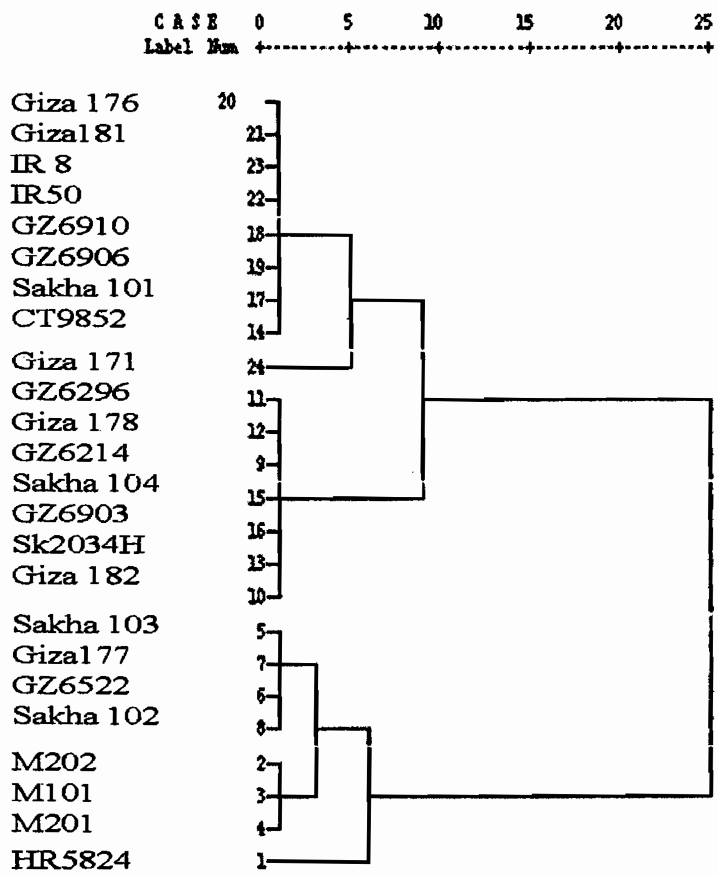
Phenotypic and genotypic coefficients of variability, heritability and genetic advance for each trait are presented in Table (8). The rice varieties showed a wide range of variation for all studied traits over the two seasons, where mean squares for all traits were highly significant. Thus, selection for these traits among these varieties would be effective in all cases. Similar results were obtained by Aly *et al.* (1984). The genetic coefficient of variability (G.C.V) for some physiological and yield and its components ranged between 9.31 and 22.5 % over the two seasons. The relatively high genetic coefficient of variability for physiological and yield and its components indicated that these traits might be more genotypically predominant and it would be possible to achieve further improvement in them. However, the phenotypic coefficient of variability was higher than the genotypic one in all studied characters, but the most portion of P.C.V was contributed by the genotypic component, less by environmental component.

Heritability percentage is estimated as a ratio between the genotypic variance and the total phenotypic variance. Estimates of heritability in broad sense were high for all studied traits and ranged between 86 and 99.4% (Table, 8), high heritability estimates are useful while, making selection based on phenotype. High heritability coupled with high genetic advance (Table, 8) were observed for vegetative phase, number of days to heading, flag leaf area, number of filled grains/panicle and grain yield/plant. This indicates that selection process for these traits would certainly bring improvement in the genotypes. Burton (1952) reported that genotypic coefficient of variability, together with heritability estimates would give a clear picture about the extent of advance to be expected from selection, therefore the expected gain from selection ($\Delta g\%$) would be a better indicator for selection response. With regard to Burton (1952), all the studied traits showed relatively high G.C.V with high heritability estimates in broad sense. Accordingly, the expected genetic advance (Δg %) from selection appeared to be effective for these traits. In conclusion, genetic improvement would be feasible among the tested genetic background for further enhancement of such physiological parameters which decimally results in a higher yield potential.

Table (8): Estimates of phenotypic and genotypic coefficients of variability, heritability and expected genetic advance for14 traits in 24 genotypes of rice (*Oryza sativa L.*) combined data (2007 and 2008).

Characters	Parameters									
	Means	Ms genotype	Error	Ph	G	G.C.V	P.C.V	Heritability	ΔG	ΔG%
Vegetative phase	76.78	1123.54	1.016	188.55	187.19	17.82	17.88	99.4	28.11	36.61
Reproductive phase	27.4	101.01	1.01	17.97	16.81	14.96	15.5	93.5	8.16	29.78
Days to heading	104.2	1413.73	1.080	273.14	235.52	14.73	14.77	99.3	31.5	30.14
Repining phase	30.4	71.256	1.024	13.12	11.83	11.32	11.91	90.2	6.72	22.11
Seedling height (cm)	24.99	35.06	0.727	6.43	5.87	9.68	10.16	91.3	4.77	19.08
Plant height (cm)	100.31	739.98	1.05	124.31	123.32	11.07	11.11	99.2	22.78	22.71
No. of tillers/plant	20.32	80.44	0.644	14.12	13.39	18.01	18.45	94.8	7.32	36.02
No. of panicles/plant	19.98	20.659	0.7189	4.03	3.47	9.31	10.10	86.0	3.56	17.81
Flag leaf area (cm)	33.81	239.88	0.249	40.23	39.97	18.69	18.75	99.3	12.96	38.33
Chlorophyll content (SPAD)	42.03	128.93	0.834	22.32	21.48	11.02	11.23	96.2	9.35	22.24
Panicle length (cm)	22.1	35.756	0.06079	6.15	5.95	11.04	11.22	96.7	4.94	22.4
No. of filled grains/panicle	133.87	2869.22	1.038	480.62	477.93	16.33	16.37	99.4	44.88	33.53
1000-grain weight(g)	25.9	37.81	0.315	6.51	6.31	9.69	9.85	96.9	5.1	19.69
Grain yield/plant(g)	55.73	943.926	1.091	158.35	157.33	22.5	22.57	99.4	25.73	46.16

Fig. (1): Hierarchical cluster analysis based on vegetative stage



Cluster analysis:

Hierarchical cluster analysis based on vegetative stage are presented in fig. (1). as shown in the figure, two main groups were formed at only 25% similarity. The first group (A) represented 16 genotypes all of them belonged to medium and late maturing groups while, the remaining (B) eight represented the very early and early groups. The large group A sub grouped at almost 85% similarity into two groups A1 and A2. a further divergence occurred in A1 group at 95% similarity to out yield two subgroups A11 and A12. A11 represented 8 genotypes four late genotypes (Giza 176, Giza 181, IR 50 and IR8) and four medium varieties, i.e., GZ6910-28-1-3-1, GZ6906-1-1-1-1, Sakha 101 and CT 9852-3-2-1-2-4-PM. The four medium duration genotypes, however, recorded long period at vegetative stage explain their clustering with the late maturing varieties. A12 group had only one very late variety Giza 171, With 99 days at vegetative stage. This clearly indicates the genotypes grouping based on their vegetative period length. The main A1 group had genotypes with vegetative period ranged from 85 to 99 days, meanwhile, the other main sub group A2 consisted of seven genotypes i.e, GZ 6296-12-1-2-1-1, Giza 178, GZ 6214-4-1-1-1, Sakha 104, GZ 6903-1-2-2-1, SK 2034H and Giza 182. It is worthnoting that though all medium duration varieties almost had some total duration, but their clustering in different groups based on the length of vegetative stage period. Although the A1 seven genotypes are all medium duration varieties, but they had relatively shorter vegetative period than the other four genotypes that were clustered with late duration group, their vegetative period ranged from 71 days to 81 days. The main group B also represented both the very early and early group genotypes. This group was spited near 90% similarity into two sub groups B1 and B2. The former group B1 was again sub grouped into two groups B11 and B12. B11 consisted of the four early genotypes, i.e, Sakha 103, Giza 177, GZ 6522-15-1-1-3 and Sakha 102. B12 had three genotypes from the very early group i.e., M202, M101and M201 with vegetative period ranging from 60-68 days. HR 5824-B-3-2-3 formed a sub cluster group B2since it had the shortest vegetative period at all where it recorded only 42 days. Conclusions, the clustering were show to be influenced mainly with vegetative stage period and with lesser extend with days to heading. Though B group consisted of 8 japonica rice varieties, the A group was not the case, it had japonica, indica and indica japonica varieties and hence, the clustering was not able to classify genotypes based on their pedigree in all cases.

Correlation coefficient

The relationships among the studied traits represented as correlation coefficient are presented in Table (9). The correlation coefficient was statistically estimated as reported by Gómez and Gomez (1983). A significant positive correlation between seedling height at 5 leaf stage and plant height at harvest stage. Meanwhile, highly significant and positive correlation were observed between vegetative stage (from seeding to panicle initiation), reproductive stage (from panicle initiation to heading) and days to heading. These results were in a agreement with that of Takane *et al.* (1997).

As for as the correlation coefficient between physiological characters and grain yield is concern significant and highly significant positive correlations were found between each of vegetative stage, days to heading and reproductive stage with grain yield. While, significant and negative correlation was observed between chlorophyll content and grain yield. Also, positive correlations were observed between yield components and physiological characters i.e., days to heading, vegetative stage, flag leaf area with no. of filled grains/panicle. Also, no. of panicles/plant was positively correlated with days to heading, no. of tillers/plant and vegetative stage.

Regarding the correlation between grain yield and its components, grain yield was highly significant and positively correlated with no. of panicles/plant, no. of filled grains/panicle and panicle length. Also, no. of panicles were highly significant and positively correlated with no. of filled grains/panicle and panicle length. These findings were in agreement with Yolanda and Das (1995) and Ashvani *et al.* (1997).

The results also showed higher values of significant and positive correlation between vegetative stage at almost all studied traits compared to that of the values of reproductive stage and ripping stage (Table, 9). For vegetative stage correlation values were higher of reproductive stage correlation values and the later were even higher than ripping stage correlation values. These findings clearly reflects the relative significance of each of the three stages and their effect on plant growth and reproductively. Thus vegetative stage again proved to be the most important factor determining grain yield among all growth stages. Plant breeders could in turn utilize such critical and determental factor for breeding very early maturing varieties without significant yield reduction.

Table (9): Correlation coefficient among some physiological characters and yield and its components.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Plant height		.24	.43*	.21	.15	.11	.38	.25	.36	-.10	-.01	.18	-.22	.44*
2. Days to heading			.18	.77**	.82**	.75**	.58**	.57**	.96**	.52**	-.32	.07	-.65**	-.18
3. 1000-grain weight				.19	.05	.14	.02	.07	.19	.07	-.08	-.10	-.011	.10
4- Grain yield					.70**	.72**	.62**	.60**	.75**	.42*	.03	.17	-.50*	-.30
5. No. of tiller/plant						.77**	.72**	.54**	.79**	.43*	-.20	.27	-.66**	-.21
6. No. of panicles/plant							.57**	.54**	.73**	.34	-.07	.15	-.47*	-.31
7. No. of filled grains/panicle								.77**	.66**	-.03	-.12	.60**	-.53**	-.11
8. Panicle length									.62**	.07	-.27	.46*	-.56**	-.19
9. Vegetative stage										.27	-.31	.21	-.62**	-.18
10.Re-productive stage											-.13	-.42*	-.40	-.06
11. Ripping stage												-.17	.21	.24
12. Flag leaf area													-.05	-.22
13. Chlorophyll Content														-.05
14. Seedling height														

*correlation is significant at the 0.05 level (2- tailed).
** correlation is significant at the 0.01 level (2- tailed).

REFERENCES

Abd Alla, A.B. (1996). Effect of some cultural treatments on rice. M.Sc. Thesis, Fac., Agric., Moshtohor, Zagazig University, Egypt.

Abd El-Wahab, A.E. (1998). Physiological behavior of Egyptian rice cultivars under different nitrogen levels. Egypt. J. APPL. Sc., 13 (4): 15-25.

Aidy, I.R. and M.A. Maximos (2006). Rice varietal improvement in Egypt during the last two decades: achievements and future strategies. Egypt J. Agric. Res.

Aly, A.E.; M.I. Shaalan and M.A. Shaalan (1984). Phenotypic and genotypic variability in some local and introduced rice cultivars and strains (Oryza Sativa L.). Alex. J. Agric. Res. 29: 97-103.

Ashvani, P.: R.K. Sharma: R.P.S. Dhaka: K.P.S. Arya and A.Panwar (1997). Correlation of yield and yield components in rice (*Oryza Sativa L.*). Advances in Plant Sciences, 10(1):217-220.

Burton, G.W. (1952). Quantitative inheritance in grasses. Proc. Sixth Inter. Grassland Cong 1: 277-283.

Duncan, B.D. (1955). Multiple range and multiple F. test. Biometrics, 11: 1- 42.

Eabid, R.A. and I.M. EL-Rewainy (2005). Response of some Egyptian rice cultivars to different levels of nitrogen fertilizer. Egypt. J. of Agric. Res. vol. 83. No. 5B: 359-367.

Gomez, K.A. and A.A. Gomez (1983). Statistical procedures for Agricultural research. Second Edition. 680p.

Hammoud, S.A.; A.B. Khattab; S.E.M. Sedeek and A.B. EL-Abd (2006). Genetic analysis of grain yield, panicle traits and some grain quality in Rice (*Oryza Sativa L.*). The first field Crops Conference, Field Crops Research Institute, ARC, Egypt. 157-170.

Hammoud, S.A.A. (2005). Genetic behavior of some agronomic characters in two rice crosses. Egypt. J. of Agric. Res. vol. 83. No. 5B: 305-322.

Hansen, G.H; H.F. Robinson and R.E. Comstock (1956). Bio-metrical studies of yield in segregating population of Korean bespedese. Agron. J., 48: 267-282.

Johnson, H.W.; H.F. Robinson and R.E. Comstock (1955). Estimates of genetic and environmental variability in soybean. Agron. J. 47: 314-318.

Mohanty, K.K. and D.P. Srivastava (1990). Comparative studies on developmental stages of very early maturing varieties with other duration groups in rice. *Oryza,* 27 (4): 399-403.

Mruthunjaya, C. Wali and M. Mahadevappa (1995). Genetic variability, heritability and genetic advance for yield and its contributing characters in ratoon crops rice (*Oryza Sativa L.*). Mysore J. agric. Sci., 29: 285-288.

Sedeek, S.E.M. (2001). Studies of morphological and agronomical characteristics of some early varieties and lines of rice. M.Sc. Thesis Agric., Sci., Tanta University, Egypt.

Takane, M.: Y. Futsuhara:F. Kikuchi and H. Yamaguchi (1997). Inheritance of morphological characters. Science of Rice Plant, Vol (3) Genetics. Food and Agriculture Policy Research Center, Tokyo.

Tanaka, A.,: S.A. Navasero: C.. Garcia: F.T. Parao and E. Ramirez (1964). Growth habit of the rice plant in the tropics and it effect on nitrogen response. Int. Rice Res. Inst., Tech. Bull.3, 1-80.

Vergara, B.S.and T.T. Chang (1976).The flowering response of the rice plant to photoperiod: a review of literature. Int. Rice Res. Inst., Tech. Bull. 8, 75.

Yolanda, J.L. and L.D.V. Das (1995). Correlation and path analysis in rice (*Oryza Sativa L.*). Madras Agric. J. 82(11): 576-578.

الملخص العربي

التنوع الوراثي, درجة التوريث, التحسين الوراثي والشجرة الوراثية لبعض الصفات الفسيولوجية ,محصول الحبوب ومكوناته في الأرز

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أجريت هذه الدراسة في مركز البحوث والتدريب في الأرز -كفرالشيخ – مصر أثناء موسمي الزراعة ٢٠٠٧ و٢٠٠٨ لدراسة مراحل النمو المختلفة في الأرز للأصناف المبكرة جدا (اقل من ١١٥ يوم) ومقارنتها مع الأصناف المبكرة (١٢٥ يوم), والأصناف المتوسطة (١٤٠) يوم والأصناف المتأخرة جدا (أكثر من ١٤٠يوم) لدراسة التنوع الوراثي للأصناف تحت الدراسة لبعض الصفات الفسيولوجية والمحصول ومكوناته.

تحتاج الأصناف تحت الدراسة إلى حوالي ثلاثة أسابيع لتصل إلى مرحلة ثلاثة أوراق بالرغم من اختلافها في طول فترة النمو وطول البادرة وطول النبات. المرحلة الخضرية كانت هي المسئولة أساسا عن الاختلافات في طول فترة النمو للصنف بينما الاختلافات في مرحلة التكاثر ومرحلة امتلاء الحبوب كانت ضئيلة جدا بين الأصناف. المرحلة من خمسة أوراق وحتى تكوين السنيبلة كانت قصيرة للأصناف المبكرة جدا ويوجد تداخل بين المرحلة الخضرية ومرحلة التكاثر في هذه المجموعة.

درجة التوريث بالمعنى الواسع كانت عالية لكل الصفات المدروسة. التحسين الوراثي المتوقع من الانتخاب أظهر فعالية تتراوح بين ٣,٥٦ – ٤٤,٨٨% في كلا الموسمين. الشجرة الوراثية تم عملها بناء على مراحل النمو المختلفة وتم تقسيم الأصناف إلى مجموعات.