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Physiological evaluation of some hybrid rice varieties under different sowing dates

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Abstract

A field experiment was conducted at the experimental farm of Rice research and training centre (RRTC), Sakha, kafr- El sheikh governorate, Egypt in 2008 rice season for physiological evaluation of some hybrid rice varieties under different sowing dates. Four hybrid rice H1, H2, GZ 6522 and GZ 6903 were evaluated at six different sowing dates, April 10th, April 20th, May 1st, May 10th, May 20th and June 1st. A split plot design with four replications was used as six sowing dates were allocated in the main plots, and four rice varieties in sub plots. Results indicated that early date of sowing (April 20th) is the best time of sowing for important properties such as maximum tillering (MT), panicle initiation (PI), heading date (HD), number of tillers per M^2, plant height and root length at PI and HD stage, chlorophyll content, number of days to PI and HD, leaf area index, sink capacity, spikelets/ leaf area ratio, Number of grains per panicle, Panicle length (cm), 1000 grain weight (g), number of panicles per M^2, five Panicle weight (g) and grain yield (T/ha). Sterility percent was the lowest value in April 20th sowing date. Sowing in 1st June has given the lowest value for all studied traits. H1 hybrid rice variety surpassed other varieties for studied characters except for number of days to panicle initiation and heading date.

Keywords: *Normal soil; Rice crop; sowing dates; hybrid rice; Physiological characters; yield.*

Abbreviations: MT_Maximum tillering; PI_Panicle initiation; HD_Heading Dates; LAI_Leaf area index; Light penetration

Introduction

The variation in rice production could be attributed to different climates when other conditions are suitable. The optimal growing season of common cultivars has been determined by examining different sowing dates in rice. Delaying in sowing has decreased grain, straw yield, harvest index, number of tiller, panicle length, number of grain/panicle and fertility percentage (Singh and Parsed, 1999; Hari et al., 1999; Pirdashfy et al., 2000). Sharief et al., (2000) studied the effect of sowing dates (April 25th, May 10th, May 25th and June 10th) on yield and yield components of rice. They found that early sowing dates (May 10) had marked effect on number of panicles/m^2, number of filled grains/panicle, 1000-grain weight, grain and straw yields/fed. However, as compared with the planting in April 25th, late planting in May 25th or June 10th significantly reduced the above mentioned characteristics, and larger leaf area index (LAI) during the grain-filling period, but the physiological basis of heterosis remains unknown (Song et al., 1990). Number of days from sowing to panicle initiation (PI), maximum tillering (MT), heading dates (HD) and grain yield (T/ha) has been negatively affected with delay in sowing time (El-Hity et al., 1987; Abou khalifa, 2005). Early sowing date on April 20th has given the highest values of leaf area index (LAI), sink capacity (number of spikelets per M^2 X1000), spikelets/leaf area ratio, panicle length and number of filled grains. H5 hybrid rice cultivar surpassed the other cultivars in leaf area index and sink capacity (McMennamy and O'toole, 1993).

Ritchie et al., (1989); Penning de Varies et al., (1989); Singh and Parsed (1993) indicated that the highest grain yield of rice came from the 2nd sowing. High yield potential of cultivars is determined by both the efficiency of photosynthesis source and the

Table 1. Number of days up to maximum tillering, Panicle initiation, heading dates, BVP and PSP of some hybrid rice as affected by different sowing dates.

Sowing dates / Rice varieties	April 10th	April 20th	May 1st	May 10th	May 20th	June 1st	B.V.P	P.S.P
Number of days maximum tillering (MT)								
Rice varieties								
H1	70	65	60	55	54	52		
H2	73	70	58	56	54	54		
GZ 6522	64	63	54	51	47	46		
GZ 6903	75	73	62	59	55	48		
LSD at 5%	***3.71***							
CV	***3.3***							
Number of days up to panicle initiation(PI)								
Rice varieties								
H1	74	70	62	60	59	57		
H2	77	74	64	61	59	59		
GZ 6522	68	67	58	56	52	51		
GZ 6903	80	77	66	64	60	53		
LSD at 5%	***3.1***							
CV	***2.4***							
Number of days up to 50 % heading								
Rice varieties								
H1	108	105	95	95	94	92	73	14
H2	112	107	96	95	94	94	77	18
GZ 6522	102	101	96	91	87	86	67	16
GZ 6903	115	112	100	99	95	88	80	27
LSD at 5%	***3.13***							
CV	***1.7***							

B.V.P= basic vegetative phase*: = (the highest date to heading – 35 days).****PSP= photoperiod sensitive phase;*** *= (the highest date of heading – the lowest date to heading.*

sink capacity of spikelets to receiving leaf photosynthesis. Scientists have used different methods of enlarging sink capacity for higher yields. The net photosynthetic rate (Pn) of a cultivar was correlated with the chlorophyll content of leaves (Liu et al., 1984). Chlorophyll concentration was higher in late-sown rice than early-sown rice. More than 80% of the seasonal variation in rice yield was attributed to variation in spikelet number/m^2 (Yoshida and Parao, 1976). The cultivar Akenohoshi was bred in the National Agricultural Research Centre for Western Region, Japan, from *indica* x *japonica* rice which is a high yield variety and carries abundant spikelets, but grain ripening is lower and grain yield is less than other high-yield cultivars (Sibayama, 1988; Jiang et al., 1988).

Several hypotheses have been proposed to account for the poor grain ripening of NPT lines and *indica*x *japonica* rice, including inferior assimilate accumulation capacity in the panicle or spikelet (Komatsu et al., 1985; Yamaguchi et al., 1996; Khush and Peng, 1996). It has also been suggested that morphological impediments such as the arrangement of spikelets or vascular bundle connections for assimilate transport restrict grain ripening in NPT lines and *indica* x *japonica* rice. Alternatively, it has been suggested that inadequate assimilate supply during the early grain-filling period limits grain ripening (Jiang et al., 1988; Xu et al, 1997). Assimilate supply is a dominant key factor in determining grain ripening in rice, because grain dry matter increase capacity is fairly stable and also grains are sink dominated organs. Therefore, the grain dry matter is highly dependent on the assimilate supply under diverse environmental conditions (Takami et al., 1990; Kobata et al., 2000; Kobata and

Uemuki, 2004). Second generation NPT lines have now been developed by crossing between *indica* and improved tropical *japonica* to improve grain yield. These second generation NPT lines have superior yields than first generation lines (Peng et al., 2004). The new Japanese *indica*x *japonica* rice 'Takanari', that was released after Akenohoshi, has the higher yield potential (Xu et al., 1997). In this study we are trying to evaluate one of the most important agricultural factors, sowing date, which possibly affect on different agronomical traits and yield of hybrid rice. Furthermore, relation among different yield components in hybrid rice will be discussed.

Materials and methods

A field experiment was conducted at Rice Research and training center (Sakha-kafr El sheikh–Egypt) in 2008 rice growth season for physiological evaluation of some hybrid rice varieties under different sowing dates. Four hybrid rice H1, H2, GZ 6522 and GZ 6903 were used for this purpose. Six sowing dates April 10th, April 20th, May 1st, May 10th, May 20th and June 1st. 26 day old seedling were transplanted into the 4×4 M plots in 20×20 cm planting spaces. A unique agronomical practice was applied to all rice varieties as recommended. The split plot design with four replications was used. Sowing dates were allocated in the main plots, while rice varieties put in sub plots. Nitrogen fertilizer was used in the urea form (46.5%N) for two splits (2/3 of dose were mixed in the dry soil before irrigation and 1/3 dose added at panicle initiation stage). Maximum tillering (MT), panicle initiation (PI) and heading dates were recorded for each variety considering the number of days from sowing to maximum tillering, panicle initiation and 50% heading, respectively. After complete heading, leaf area index was recorded using leaf area meter and total chlorophyll content in the leaves of plants was recorded using chlorophyll meter (5 SPAD-502 Minolta Camera Co. Ltd. Japan). Plant height was also measured from ground surface up to the top of the main panicle. Number of tillers and average number of tillers for five hills were calculated. The seedling and plant were precisely pulled out from the soil to keep whole root and then transferred to the laboratory to determine the whole plant height (cm) it was determined for each sample from the base of root to the end of the tallest leaf. The root length (cm) was also determined by the same way as in plant length. Grain yield was measured from 12 m^2 (3×4 m) in the center of sub-plots. Grain yield was measured at 14 % grain moisture content according to Yoshida and Parao (1976). Harvest index (HI)=grain yield/biomass yield, basic vegetative phase (BVP)=the highest date to heading–

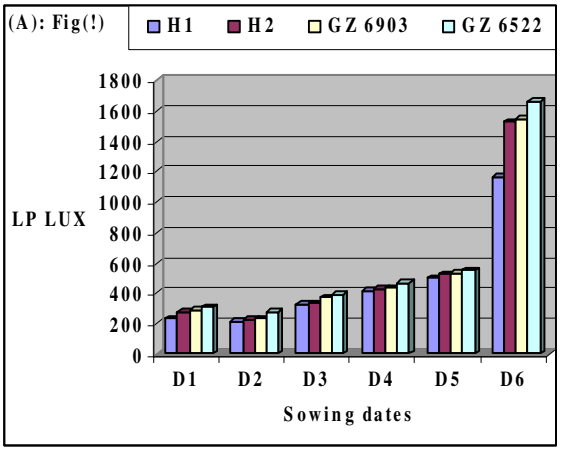

Fig 1. Effect of sowing dates on light penetration (Lux).

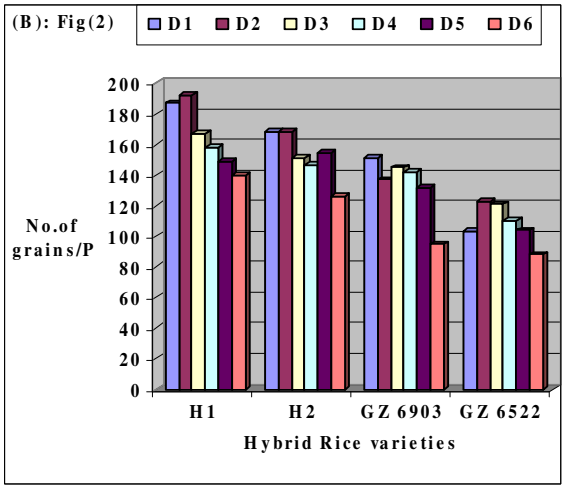

Fig 2. Number of grains per panicle as affected by some hybrid rice under different sowing dates.

35 days, photoperiod sensitive phase (PSP)= the highest date of heading – the lowest date to heading, Sink capacity=number of spikelets per m^2 and Spikelets/leaf area ratio=number of spikelets/unit leaf area (Yoshida and Parao 1976) were also measured. Ten panicles were randomly selected from each sub plot to determine 1000-grain weight and number of grain per panicle. Data collected were subjected to statistical analysis of variance according to Gomez and Gomez (1984) using IRRISTAT computer program.

Table 2. Number of tillers / M2, (plant height, Root length at PI & HD stage) as affected by some some hybrid rice under different sowing dates.

Characters / Treatments	Number of tillers /M^2	PI stage		HD stage	
		Plant height	Root length	Plant height	Root length
Sowing dates					
April 10th	361	62	31.08	97.08	15.50
April 20th	404	65	31.08	97.75	17.22
May 1st	373	63	30.65	95.08	15.77
May 10th	347	61	29.92	93.17	15.23
May 20th	306	59	28.92	91.50	14.17
June 1st	254	58	25.75	89.00	13.36
LSD at 5%	32.22	2.59	1.09	1.39	1.10
CV	8.40	3.6	3.10	1.3	6.20
Rice varieties					
H1	374	62	31.17	95.44	16.77
H2	353	57	29.82	91.28	15.80
GZ 6522	304	64	27.83	93.56	12.99
GZ 6903	332	62	29.44	95.44	15.27
LSD at 5%	21.89	2.48	1.11	2.12	0.83
CV	6.70	4.0	3.70	2.2	5.40

Results and discussion

Sowing date is very important factor for increasing grain yield which is closely related to the growth duration. Therefore study of physiological characters of some hybrid rice varieties was essential to select new varieties. Results showed that number of days from sowing towards June 1st were gradually decreased MT, PI and HD due to loosing growing time (Table 1). GZ 6903 surpassed other varieties in this case. GZ 6522 had the lowest Number of days from sowing to MT, PI and HD. GZ 6903 variety gave the highest value of BVP and PSP thus GZ 6903 is highly sensitive for light and temperature. This hybrid therefore is highly sensitive to different sowing dates. These findings have been confirmed on other rice varieties such as promising lines (Singh and Parsed, 1999; Hari et al., 1999; Pirdashfy et al., 2000).

Sowing at April 20th has given the highest value of number of tillers, plant height and root length at PI and HD stages in all hybrids (Table 2). A highly significant variation among the four tested rice hybrid was recorded. H1 was higher than other verities on Number of tillers, and (plant height and root length) at PI and HD stages. Root length at PI had highest value compare to HD stage, possibly due to higher activity of rice plants on early growing stages.

Sowing at June 1st showed the lowest value for all studied properties in all varieties. The H1 variety has showed the lowest value of light pentration under the first date of sowing (Fig 1), while GZ6522 had the highest value of light pentration at latest sowing date (June 1st). It is possibly because of higher leaf area index at earlier than late sowing dates. The highest sink capacity and number of grains/panicles and lowest value sterility value (%) were obtained from varieties sown on April 20th (Table 3). Sowing in 10th of April has given the highest value of Spikelets/leaf area ratio. H1 showed the highest value of sink capacity, spikelets/leaf area ratio and number of grains/panicles. GZ6522 had the lowest value for all studied properties. The lowest sterility was observed in H1 hybrid rice (Yoshida and Parao 1976; El-Hity et al., 1987).

Numbers of grains/panicles were remarkably influenced by different sowing dates (Fig 2) where sowing H1 hybrid at 10th April showed the highest and June 1st the lowest values. Planting rice hybrids later than 10th of May can cause reduction of desirable yield traits. Sowing at April 20th has given the highest value of panicle length, 1000 grain weight, number of panicles, panicle weight, and grain yield (Table 4). There has not been seen a significant difference in cultivation dates of April 10th, April 20th

Table 3. Sink capacity, Sterility%, Spikelets-leaf area ratio and Number of grains/panicle as affected by sowing dates of some hybrid rice varieties.

Characters / Treatments	Sink capacity	Sterility %	Spikelets –leaf area ratio	Number of grains / panicle
Sowing dates				
April 10th	54	4.2	0.95	153
April 20th	61	3.6	0.88	155
May 1st	53	3.8	0.84	146
May 10th	46	4.3	0.84	139
May 20th	39	5.1	0.80	135
June 1st	29	6.4	0.65	112
LSD at 5%	5.30	0.63	0.03	5.35
CV	9.6	11.5	10.6	5.00
Rice varieties				
H1	61	3.5	1.01	165
H2	51	3.9	0.89	152
GZ 6522	32	6.2	0.63	108
GZ 6903	43	4.7	0.89	134
LSD at 5%	4.13	0.58	0.10	9.83
CV	8.80	12.6	11.4	7.10

Sink capacity = (Number of spikelets/M2)*1000
Sterility % = (Number of unfilled grains /Total of grins per panicle)*100

Table 4. Effect of sowing dates on Panicle length (cm), 1000-grain weight (g), Number of panicles/ M2, Panicle weight (g) and grain yield (T/h).

Characters / Treatments	Panicle length(cm)	1000-grain weight (g)	Number 0f panicles/ M^2	5 Panicle weight (g)	Grain yield (T/h)
Sowing dates					
April 10th	21.46	24.01	350	20.4	11.47
April 20th	22.42	27.62	394	21.6	12.44
May 1st	21.22	26.37	363	20.9	11.51
May 10th	20.30	25.93	340	20.5	8.28
May 20th	20.20	25.08	298	18.6	6.13
May 30th	18.63	19.98	250	18.0	5.33
LSD at 5%	0.89	1.11	30.22	1.19	1.58
CV	3.7	3.80	8.10	5.10	3.3
Rice varieties					
H1	21.16	25.74	365	21.7	9.84
H2	20.99	25.08	346	20.5	9.75
GZ 6522	20.01	23.94	294	17.6	8.38
GZ 6903	20.65	24.56	324	20.1	8.79
LSD at 5%	0.76	0.96	20.89	1.35	1.67
CV	3.60	3.90	6.20	6.70	4.00

and May 1st. Therefore the best time for rice planting is the periods between April 10th and May 1st. The June 1st is the worse cultivation date and reduces all plant properties and consequently grain yield. This can be due to reduction in leaf area index, number of productive tillers, panicle weight and filling period and increasing in sterility %. H1 hybrid rice surpassed other varieties in important traits such as panicle length, 1000-grain weight, panicle weight and grain yield (Xu et al., 1997 and Sherief et al., 2000).

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