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Effect of irrigation withholding on two rice varieties at different growth stage as affected by different sowing dates

Ali abdalla basyouni abou-khalifa

Rice Research and Training Center, Filed Crops, Research Institute, ARC, Egypt

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ABSTRACT

A field experiment was conducted at Rice research and training center (RRTC) – Sakha, kafr- El sheikh, governorate, Egypt in 2010 season to study Response of some rice cultivars (H1 hybrid rice and Giza 177 inbred rice) to different methods of irrigation withholding under different sowing dates. Nitrogen fertilizer was used as urea form (46.5% N) in two splits; 2/3 were added as basil and mixed in dry soil before irrigation water and 1/3 was added at panicle initiation. Under different five sowing dates, April 10th, April 25th , May 10th, May 25th and June 10th. Three irrigation withholding, (W1) Irrigation withholding after 10 days from complete heading. (W2) Irrigation withholding after 15 days from complete heading. (W3) Irrigation withholding after 20 days from complete heading. Seedling age at transplanting was 26 days from sowing and by 20X20 cm planting spacing. All agricultural practices were applied as recommended for each cultivar. A split split plot design with four replication was used, five sowing dates allocated in the main plots. Three irrigation withholding were allocated in sub-plots and two rice cultivars were allocated in the sub-sub plots. Main results induced that maximum tillering, panicle initiation, heading dates, grains filling rates (G F R) at five stages, Leaf area index, and grain yield (Ton/ha) were the highest value at (5-10 days after complete heading) growth stage with (W2) of two rice varieties under five sowing dates. So sowing dates at April 25th gave the highest value to all studied characters with H1 hybrid rice variety. While June 10th date of sowing with Giza 177 inbred rice gave the lowest value with all traits under study. The interaction between H1 hybrid rice variety with (W2) irrigation withholding gave the highest value of leaf area index, GFR at different stages. And H1 with April 25th date of sowing gave the highest value of L.A.I. and chlorophyll content.

Keywords: Irrigation withholding, rice growth characters and yield.

INTRODUCTION

Rice is an important crop in Egypt. So, many research papers were presented to study the effect of irrigation withholding under different sowing dates on rice production. The variation in rice production could be attributable to different climates when other conditions are suitable. The optimal growing season of already growing cultivars has been determined by changing sowing dates of rice. Singh and Parsed (1999) **[20]**, Hari et al., (1999) **[7]**, Pirdashfy et al., (2000**[17]**). found that delaying sowing decreased the grain, straw yield, harvest index, tiller number, panicle length, number of grain/panicle and fertility percentage. Sherief et al., (2000) **[18]**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. As compared with the planting in April 25th, however, late planting in May 25th or June 10 significantly reduced the above mentioned characteristics. (Song et al 1990) **[21]**, and larger leaf area index (LAI) during the grain-filling period, but the physiological basis for heterosis remains unknown. El-Hity et al. (1987) **[4]** found that the number of days from sowing up to panicle initiation (P.I), Maximum tillering (M.T.), heading dates (H.D.) and grain yield (T/ha) were drastically reduced with delay of sowing time.

Rice grain filling and ripening are affected by many environmental factors, including water, temperature, radiation, and soil nutritional conditions (Yoshida, 1981**[27]**). Grain dry matter increase is supported by available assimilates, as defined by C assimilation during the grain filling period plus assimilate reserve stored in the straw (Cock and Yoshida, 1972**[2]**; Weng et al, 1982). Shortage of assimilate supply due to inhibition of photosynthetic processes is one of the major factors determining grain filling**[2]** (Matsushima and Wada, 1958; Yoshida, 1981 **[27]**; Evans, 1996**[6]**; Egli, 1998) **[3]**. Inhibition of photosynthesis during the grain filling period due to environmental stresses such as shading or water deficit can result in a major reduction in grain dry matter in rice (Kobata and Takami, 1986**[10]**; Kobata and Moriwaki, 1990; **[11]** Takami et al., 1990) **[24]**. These studies showed clearly that potential grain growth was not realized when available assimilate failed to meet the assimilate requirement. Other work suggests that potential grain growth rate (i.e. ability of the grain to fill, or sink strength) is influenced by change in environmental conditions (e.g. radiation, temperature, and fertilizer application) during the early phase of grain filling (Tanaka and Matsushima, 1963; Yoshida, 1981 **[27]**; Tashiro and Wardlaw, 1990**[25]**; Sumi et al., 1996**[22]**; Egli, 1998) **[3]**.

It has been shown that shortage of available assimilate caused by shading during the early grain filling period (approximately the first 10 days after heading) restricts final grain weight at the fully ripe stage, even if the shading is removed during the remainder of the grain filling period (Tanaka and Matsushima, 1963; Nagato and Chaudhry, 1970; Nagato et al., 1971**[14]**). Assimilate supply during the first 10 days after heading, coupled with varied planting dates or fertilizer conditions, also affects the final percentage of grain filled.) Tsukaguchi et al., 1996**[26]**; Horie et al., 1997**[8]**). In both wheat and rice, reductions in grain weight or filling percentage (decline in potential of grain growth) from shortage of assimilate supply are believed to be due to reduction in the number or size of cells in the endosperm (Singh and Jenner, 1984**[19]**; Nakamura et al., 1992**[15]**; Horie et al., 1997**[8]**). In the first 10 d after flowering, cell division and expansion in the endosperm of most grains ends and starch deposition begins (Hoshikawa, 1967**[9]**; Egli, 1998**[3]**). From previous studies, however, it is doubtful that assimilate supply to the grain during the early grain filling period alone defines potential grain growth and determines final grain weight. If assimilate supply to rice is restricted by shading or unfavorable cultivated conditions in the first 10 d of the grain filling period, the grain may be profoundly affected, as grain growth rate is generally highest within the 2 wk after heading (Yoshida, 1981). **[27** The larger part of the active phase of grain dry matter increase may thus encounter restricted assimilate supply. Assimilate shortfall during the rest of the grain filling period could also cause reduction of final grain weight. Past experiments (Tanaka and Matsushima, 1963**[12]**; Nagato and Chaudhry, 1970**[13]**; Nagato et al., 1971**[14]**; Tsukaguchi et al., 1996**[26]**; Horie et al., 1997**[8]**). demonstrated that rice plants that suffered from severe deficiency of assimilate supply due to short-term soil desiccation during the early and middle grain filling periods exhibited grain dry matter increases as large as no stressed plants did when the water deficit was redressed. It can thus be hypothesized that potential grain dry matter increase is not inevitably determined by shortage of assimilate supply during the early grain filling period when plants are grown under unfavorable environmental conditions .

Our objective was to test the hypothesis that shortage of assimilate supply to grain by shading during the early grain filling period of the first 10 days after heading does not reduce the rice grain weight at harvest if assimilate supply during the rest of the grain filling period is improved by thinning. Larger leaf area index (LAI) during the grain-filling period, but the physiological basis for heterosis remains unknown Peng (1998) **[16]**. El-Khoby (2004) **[5]** showed that delaying sowing date sharply decreased the leaf area index, dry matter production and chlorophyll content. In addition, delaying sowing date up to June 15th significantly reduced the period from sowing to heading. Abou Khalifa (2005**[1]**) found that number of days from sowing up to maximum tillering, panicle initiation and heading date was significant affected by different sowing dates. The number of days was higher under early sowing (April 20th) and gradually decreased with delayed sowing up to May 20th.

MATERIALS AND METHODS

A field experiment was conducted at Rice Research and training center (Sakha—kafr El sheikh – Egypt). In 2010 rice growth season to study response of some rice varieties to three dates for irrigation withholding under different dates of sowing. Two rice varieties were namely, H1 (SK-2034H), Giza 177 tested.

Three dates for Irrigation withholding were used namely. (W1) Irrigation withholding after 10 days from complete heading. (W2) Irrigation withholding after 15 days from complete heading. (W3) Irrigation withholding after 20 days from complete heading. Seedling age at transplanting was 26 days from sowing by 20X20 cm planting spacing.

Five sowing dates were used at April 10th, April 25th , May 10th, May 25th and June 10th.) with seedling age of 26 days which transplanted in hills spaced 20X20 cm for all rice varieties in 3X5 M plots. All cultural practices were applied as recommended for each rice varieties. Split-split plot design with four replications was used. Sowing dates were allocated in the main plots, Irrigation withholding designated in sub-plot while rice varieties occurred in sub-sub plot. Nitrogen fertilizer was used in the urea form (46.5%N) for two splits (2/3 dose was applied mixed in the dry soil before flooding. 1/3 dose was added at panicle initiation stage of each rice variety). Irrigation withholding for 10 days after transplanting was done for all treatments under study. Maximum tillering, Panicle Initiation and heading dates were recorded for each variety considering the number of days from sowing up to maximum tillering, Panicle Initiation and 50% heading respectively. After complete heading, leaf area index and total chlorophyll content in the leaves of plants were recorded using chlorophyll meter 5 SPAD-502 Minolta Camera Co. Ltd., Japan. (Futuhara et al., 1979). Ten panicles were taken every three days to recorded grains filling in each plot. Before harvest. Number of tillers /hill was counted. Average number of tillers for five hills. Calculated Root length (cm): it was determined for each sample in cm was measured as the distance between soil surfaces up to the top of roots. Grain yield was measured from 12 m^2 (3 X 4 m) in the center of sub-plot. Grain yield was adjusted to 14 % moisture content determined according to Yoshida (1981) harvest index = (Economic yield/ Biological yield) (RRTC 2002), 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 RRTC (2002).Sink capacity = number of spikelets per m^2 (Yoshida and Parao 1976), Spikelets-leaf area ratio = number of spikelets/ unit leaf area.RRTC(2002).ten panicles were randomly elected from each sup 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.

RESULTS AND DISCUSSION

Table (1): Effect of Sowing dates on Number of days up to Maximum tillers, panicle initiation, and heading dates.

Characters / Treatments	April 10th	April 25th	May 10th	May 25th	June 10th	B.V.P	P.S.P
maximum tillering stage							
Rice variety							
H 1	68	63	61	59	58		
Giza 177	64	60	57	55	53		
panicle initiation stage							
Rice variety							
H 1	72	68	63	61	80		
Giza 177	67	65	60	58	55		
Flowering stage							
Rice variety							
H 1	102	95	94	92	90	67	12
Giza 177	99	93	91	87	85	64	14

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 RRTC (2002).

Data in table (1): showed that number of days from sowing up to maximum tillering, panicle initiation and heading date were gradually decreased from April10th up to June 10th. No significant effect in between April 25th , May 10th sowing dates for maximum tiller, panicle initiation and heading date. H1 gave the highest value of M.T, P. I, H D.and basic vegetative phase compared with Giza 177. While Giza 177 surpassed H1 of photoperiod sensitive phase. Therefore H1 was the best of varieties for sowing at late date. These data are in agreement with those reported by Singh and Parsed (1999), Hari et al., (1999), Pirdashfy et al., (2000). Abou Khalifa (2005)

Data in table (2): Showed that May 10th gave the highest value to chlorophyll content in leaves at (H.D) heading date, (M.S) milky stage. While April 25th gave the highest value of chlorophyll content at (D.S) doughy stage and (Ma.S) maturity stage the obtained data are in a good harmony with those reported by Peng (1998). El-Khoby (2004) and abou Khalifa (2005).W1 gave the lowest value of chlorophyll content at different stages, leaf area index and Spikelets-leaf area ratio. But no significant effect between W2 and W3 of chlorophyll content at different stages, leaf area index and Spikelets-leaf area ratio. H1 hybrid rice surpassed G177 to chlorophyll content at different stages, leaf area index and Spikelets-leaf area ratio. While no significant effect between H1 and G177 of chlorophyll content at doughy and maturity stages. These data are in agreement with those reported by (Tanaka and Matsushima, 1963; Nagato and Chaudhry, 1970; Nagato et al., 1971; El-Hity et al. (1987), Tsukaguchi et al., 1996 and Horie et al., 1997).

Table (2): Chlorophyll content, at different growth stages, Leaf area index and leaf ratio to some rice varieties as affected by irrigation withholding under different sowing dates

Characters / Treatments	Chlorophyll content at different stages				Leaf area Index	Spikelets-leaf area ratio
	H.D	M.S	D.S	Ma.		
Sowing dates						
April 10th	40.78	39.74	38.38	32.81	4.53	19.29
May 25st	42.84	41.51	41.01	36.27	4.99	21.23
May 10th	43.23	42.03	40.82	34.17	4.70	19.40
May 25th	41.56	39.67	38.23	30.41	4.43	17.31
June 10th	40.11	38.40	35.43	26.83	3.92	10.80
LSD at 5%	*0.43*	*0.28*	*0.41*	*0.42*	*0.06*	*0.28*
CV%	*3.5*	*2.5*	*3.4*	*4.5*	*4.8*	*6.2*
Irrigation Withholding						
W 1	41.34	39.49	37.71	29.30	4.03	18.48
W2	41.81	40.36	38.72	32.65	4.68	17.27
W3	41.97	40.97	39.90	34.35	4.84	17.07
LSD at 5%	*0.59*	*0.59*	*0.56*	*0.74*	*0.004*	*0.66*
CV%	*3.3*	*3.5*	*3.2*	*5.3*	*4.0*	*8.7*
Rice varieties						
H1	42.07	40.61	38.95	31.99	4.62	21.58
G. 177	41.34	39.93	38.60	32.21	4.41	13.63
LSD at 5%	*0.64*	*0.70*	*0.55*	*1.06*	*0.15*	*0.77*
CV%	*3.0*	*3.5*	*2.6*	*6.3*	*6.4*	*8.4*

(W1) Irrigation withholding after 10 days from complete heading. (W2) Irrigation withholding after 15 days from complete heading. (W3) Irrigation withholding after 20 days from complete heading. H.D heading date, (M.S) milky stage, (D.S) dough stage and (Ma.S) maturity stage.

Table (3): Light penetration and grain filling rate of some rice varieties at different stages as affected by irrigation withholding under sowing dates

Characters / Treatments	Light penetration at different stages			Grain Filling Rates				
	H.D	10 DAH	20 DAH	G.F(1-5) DAH	G.F(5-10) DAH	G.F(10-15)DAH	G.F.R(15-20)DAH	GFR(20-25)DAH
Sowing dates								
April 10th	615	1061	2672	0.32	0.80	1.37	0.52	0.34
May 25st	512	1018	2478	0.32	0.86	1.31	0.56	0.31
May 10th	684	1132	2856	0.47	0.97	1.17	0.44	0.17
May 25th	857	1177	3272	0.53	0.97	1.15	0.40	0.13
June 10th	960	1096	3789	0.54	0.93	1.02	0.38	0.10
LSD at 5%	*18.04*	*56.72*	*83.08*	*0.02*	*0.02*	*0.04*	*0.03*	*0.02*
CV%	*8.5*	*7.6*	*12.4*	*10.7*	*7.6*	*10.2*	*5.3*	*3.7*
Irrigation Withhold.								
W 1	752	1190	3220	0.41	0.91	1.02	0.40	0.13
W2	734	1075	3007	0.42	0.91	1.24	0.47	0.25
W3	691	1024	2813	0.47	0.92	1.34	0.51	0.25
LSD at 5%	*19.50*	*41.71*	*61.61*	*0.04*	*0.04*	*0.08*	*0.02*	*0.03*
CV%	*6.2%*	*8.8*	*6.3*	*10.3*	*8.9*	*15.4*	*7.1*	*3.9*
Rice varieties								
H1	579	983	2369	0.43	0.93	1.34	0.50	0.27
G. 177	872	1209	3658	0.44	0.89	1.06	0.43	0.15
LSD at 5%	*32.68*	*122.1*	*85.76*	*0.04*	*0.03*	*0.12*	*0.03*	*0.04*
CV%	*8.7*	*12.3*	*7.2*	*5.7*	*6.0*	*18.5*	*4.2*	*7.9*

Data in table (3): June10th sowing date gave the highest value of light penetration at different stages. While April 25th gave the lowest value of light penetration may be due to increase leaf area index at April 25th for first sample at 5th days after complete heading. Grain filling rates were increased gradually by increasing the delay of sowing from April 10th up to June10th. For second sample 10th days after complete heading growth stage gave the highest value of grain filling rate with May 10th, May 25th sowing dates. While April 10th sowing date gave the highest value of grain filling rate at 15, 20 and 25 days after complete heading. W1 gave the highest value of light penetration. While W2 gave the lowest value of light penetration. So grain filling rate at 5, 10 and 15 days after complete heading were gradually decreased by increase number of days from complete heading up to 20th days after complete heading. But no significant effect to W2 and W3 at delay of growth stages (20 and 25th days after complete). G 177 surpassed H1 of light penetration. No significant effect between G177 and H1 rice varieties to grain filling rate at stage (5 days after complete heading). While H1 hybrid rice surpassed G177 rice variety of (G F R) at the different stages of 10, 15, 20 and 25 days after complete heading. These data are in agreement with those reported by ;Yoshida, 1981;Cock and Yoshida, 1972; Weng et al, 1982,Matsushima and Wada, 1958; Evans, 1996; Egli, 1998;Kobata and Takami, 1986; Kobata and Moriwaki, 1990; Takami et al., 1990,Tanaka and Matsushima, 1963; Tashiro and Wardlaw, 1990;

Sumi et al., 1996; Egli, 1998, Tanaka and Matsushima, 1963; Nagato and Chaudhry, 1970; Nagato et al., 1971), Hoshikawa, 1967; Egli, 1998.

Fig .1.Chlorophyll content as affected by irrigation withholding at different stages (W1) Irrigation withholding after 10 days from complete heading. (W2) Irrigation withholding after 15 days from complete heading. (W3) Irrigation withholding after 20 days from complete heading.

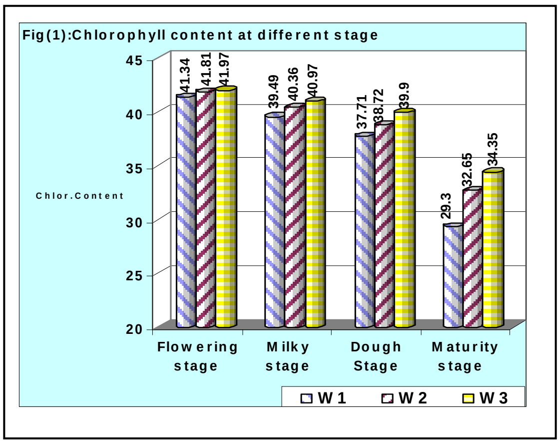


Fig .1. found that chlorophyll content gave the highest value at flowering stage. So Chlorophyll content at the different stages were gredualy decreased from flowering stage up to Maturity stage. W3 surpassed other irrigation withholding treatments at late growth stages. El-Khoby (2004).

Figure (A-1, 2): Grain filling rate as affected by sowing dates and irrigation withholding under different growth stage. {S1 first stage (1-5 days after complete heading), S2 second stage (5-10), S3 third stage (10-15 D.A.C.), S4 (15-20 D.A.C.), S5 (20-25D.A.C.)}.

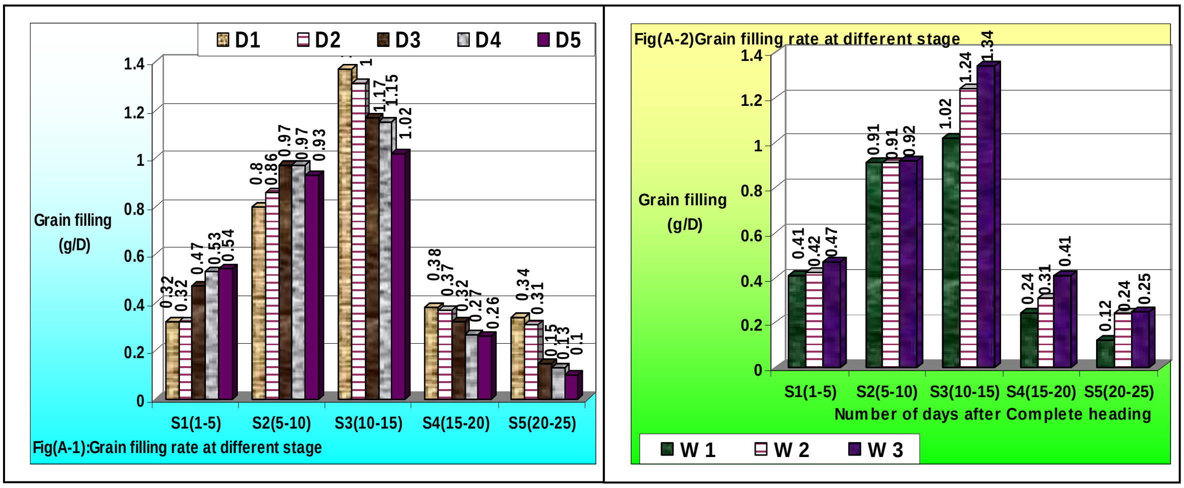


Fig A- 1, 2. Found that grain filling rate was gradually increased by increase number of days from complete heading up to S3 (10- 15 DAC) with five sowing dates and three irrigation withholding treatments. June 10th sowing date surpassed other dates of sowing to grains filling rate at first stages. No significant effect in grains filling rate at 5th and 10th days after complete heading under late date for sowing. Maybe due to speed the transition of sugar and starch from leaves and stems to panicles at first growth stages to the late date for sowing. No significant effect in between (W2 and W3) irrigation withholding treatments at second and third growth stage (5 and 10 days after complete heading on grains filling rate. While S4 and S5 (15, 20 days after complete heading) growth period gave the lowest value of grains filling rate. Therefore the best of date for irrigation withholding 10th days after complete heading at first dates but at complete heading at late date for sowing rice. These data are in agreement with those reported by; Yoshida, 1981; Cock and Yoshida, 1972; Weng et al, 1982, Matsushima and Wada, 1958; Evans, 1996; Egli, 1998; Kobata and Takami, 1986

Fig A-3. Fund that grains filling rate was increase by increased number of days from complete heading up to S3 (10 days after complete heading) so H1 surpassed G177 of grains filling rate. While no significant effect to H1 and G177 rice varieties at first growth stages. Whoever G 177 rice variety under late of growth stage gave the lowest of grains filling rates. (Tanaka and Matsushima, 1963; Nagato and Chaudhry, 1970; Nagato et al., 1971).

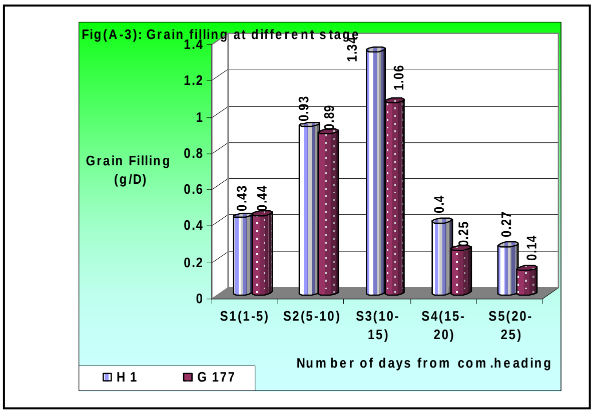
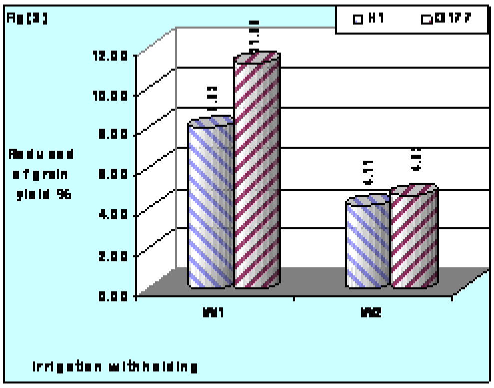


Table (4): Number of grains/panicle, number of panicles/ hill, panicle length (cm), number of spikelets/m^2 *1000, sterility%, grain yield (T/ha) and water efficiency % to some rice varieties as affected by irrigation withholding under different dates of sowing.

Characters / Treatments	Number of grains/ panicle	Number of panicle / hall	Panicle length (CM)	Number of Spikelets /M2*1000	Sterility%	Grain yield (T/ha)	Water Efficiency (%)
Sowing dates							
April 10^{th}	148	23	19.56	88	19.54	10.48	8.27
May 25^{st}	150	28	21.00	106	17.71	11.08	4.98
May 10^{th}	139	26	17.94	91	19.28	10.68	5.90
May 25^{th}	131	23	16.33	76	19.98	9.32	2.72
June 10^{th}	123	13	12.78	42	27.34	8.87	1.43
LSD at 5%	***4.17***	***0.41***	***0.41***	***1.63***	***0.19***	***0.12***	***0.20***
CV	***2.5***	***6.1***	***8.0***	***6.8***	***9.5***	***4.0***	***9.4***
Irrigation Withholding							
W 1	133	22	15.77	76	26.63	9.36	9.61
W2	138	23	18.00	82	19.18	10.30	4.37
W3	144	23	18.80	84	16.50	10.59	-
LSD at 5%	***2.18***	***1.10***	***0.53***	***2.85***	***0.83***	***0.13***	***0.69***
CV%	***3.7***	***11.2***	***7.0***	***8.2***	***10.3***	***2.9***	***12.3***
Rice varieties							
H1	150	27	18.96	101	21.55	10.72	4.05
G. 177	127	19	16.09	60	19.98	9.45	5.28
LSD at 5%	***2.42***	***0.81***	***0.76***	***2.94***	***2.44***	***0.17***	***0.61***
CV%	***3.4***	***6.9***	***8.4***	***7.0***	***11.9***	***3.2***	***16.5***

Data in table (4): showed that sowing date at April 10^{th} gave the highest value of Number of grains/panicle, number of panicles/ hill, panicle length (cm), number of spikelets/m^2 *1000, , grain yield (T/ha) and water efficiency % followed by May 10^{th}. While June 10^{th} gave the lowest value of all the precedent attributes. Whoever April 25^{th} gave the lowest value of sterility %. While June 10^{th} gave the highest value of sterility %. (W3) surpassed other irrigation withholding treatments of Number of grains/panicle, number of panicles/ hill, panicle length (cm), number of spikelets/m^2 *1000, grain yield (T/ha) and water efficiency % .No significant effect in between W2 and W3 of number of panicles/ hill, panicle length (cm), number of spikelets/m^2 *1000, grain yield (T/ha). H1 hybrid rice surpassed G 177 of number of grains/panicle and grain yield (T/ha). H1 gave the highest value of sterility % compared with G177 rice varieties. Therefore the best of period for sowing rice crop from April 10^{th} up to May 10^{th} , So the best of period for irrigation withholding at 5-10 days after complete heading under different sowing date. The best of variety H1 hybrid rice. These data are in agreement with those reported by; Singh and Parsed (1999), Hari et al., (1999), Pirdashfy et al., (2000).



Reduced grain yield % of some rice varieties

Data in fig (3): found that reduced of grain yield about (8.03, 11.20 %) obtained from (W1). While, reduced of grain yield (4.11, 4.63 %) was obtained from (W2) treatment to H1 and G177 rice verities respectively. Number of days to use irrigation water for rice crop were decreased about 20 days compared the recommended treatment. Therefore it was saving irrigation water about 1500 M3 /fed. Therefore water efficiency = 5000 (kg/fed)/ (6000 m^3 – 1500 m^3). So each 1m^3 irrigation water was resulted about 1.11 kg rice grains. Reduced of grain yield is uneconomical reduced at w2. Therefore W2 is the best of treatment for irrigation withholding without uneconomical reduced grain yield. So each Fadden is use 4500 m^3 under new recommendation for irrigation water to rice crop. Therefore, rice has become as the same of maize crop to use irrigation water at new recommendation.

Chlorophyll content and leaves area index were gave highest value at complete heading stage. While Light penetration was the lost value at it. So the highest value for carbohydrate component during period complete heading to 10 days from complete heading. Therefore grain filling rate was gradually increase from complete heading up to 10 days after complete heading.

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