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The Effects of Planting Date on Grain Yield and Yield Components of Rice Cultivars

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Shahram Lack, Nasim Mahdian Marani and Mehran Mombeni; The Effects of Planting Date on Grain Yield and Yield Components of Rice Cultivars.

ABSTRACT

This research was conducted in order to investigate the effects of planting date on the grain yield and yield components of three rice cultivars in Khouzestan climatic conditions (South-west Iran), this research was conducted as a split plot using Randomized Complete Block Design (RCBD) with three replications in the 2010 cropping season in the research field of Khuzestan Agricultural Research and Natural Resources Center(Shavoor agricultural research station). In this research, the dates 5th May, 25th May, and 15th June were considered as the main factor in the main plots, and the rice cultivars Hamar, RedAnbarbou, and Danial were regarded as the secondary factors in the sub plots.The results showed that planting date significantly affected grain yield, biological yield, harvest index, 1000 grain weight, fertility percentage, the number of filled grains per panicle and the number of fertile tillers. The second planting date exhibited the highest grain yield with an average of 6018.3 kgha^{-1} and the first planting date assumed the lowest grain yield. The cultivars had a significant difference in terms of the abovementioned attributes. Danial and Hamar cultivars featured the highest grain yield with averages of 5591 and 55549 kgha^{-1} respectively; the lowest amount belonged to Red Anbarbou cultivar.Theinteraction effects of planting date and cultivar was significant on all attributes except for panicle length. The highest grain yield belonged to Danial cultivar in the second planting date with an average of 6902.6 kgha^{-1} while the lowest was obtained for Red Anbarboucultivar on the first planting date. Both delayed and early planting resulted in the decline of grain yield of rice cultivars. The reason for these reductions was the shortening of the vegetative growth period in delayed planting, andthe coincidence of the flowering stage with environmental high temperaturesin earlier planting dates compared to the desirable state. Thus, Danial cultivar on the second planting date is recommended for cropping in Khouzestan climate conditions.

Key words: Rice, Planting date, Rice cultivars, Grain yield, Yield components.

Introduction

Rice (Oryza sativa L.) is one of the world's most important staple food crops. In Asia, it is the main item of the diet of 3.5 billion people. Therefore,the increase in population will require 70 percent more rice in 2025 than is consumed today [1]. For the same purpose, the principal objective in modern agricultures is better understanding of crop’s growth and increment for the optimal usage of natural resources and consequently reaching greater yield. Accordingly, suitable planting date is one of the major factors in efficient agricultural management playing a significant role in production control [2].

The sowing date of the rice crop is important for three major reasons. Firstly, it ensures that vegetative growth occurs during a period of satisfactory temperature and high levels of solar radiation. Secondly, the optimum sowing date for each cultivar ensures the cold sensitive stage occurs when the minimum night temperatures are historically the warmest. Thirdly, sowing on time guarantees that grain filling occurs when milder autumn temperatures are more likely, hence good grain quality is achieved [3]. Alizadeh and Isv and [4] stated that the growth season duration and temperature average have significant effects on rice yield during different growth stages; therefore, planting date plays a substantial role in rice production. Slaton [5] reported that planting earlier than the optimal date leads to lengthening of the time interval between cropping and grain maturity, longer pesticide and weeds control periods, more water consumption, biological yield enhancement and reduction in grain yield. On the contrary, most of the panicles become immature in delayed planting and grain yield is reduced. Grain yield decline is more tangible in long-duration varieties. Murua [6] stated that the increase in temperature during the grain filling period improves the metabolic processes rate

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and, as a result, accelerates the grain filling rate. Dehghan [7] mentioned that variation in planting date might influence crop yield through affecting phenology in vegetative and the reproductive growth stages. Planting date variations also affect the degree and quality of correlation between the yield and yield components. Vang and Obi [8] investigated the effect of planting dates on grain yield and some agronomic characters by early and late seeding. The results indicated that planting date was affected the performance of these traits significantly. Ali *et al*.,[9] and Shimono *et al*., [10] asserted that the minimal temperature of 12 °C is vital for 30 days after sowing rice for producing suitable seedling, and the temperature below 12°C brings about poor germination, low seedling vegetation and reduction in desirable seedling growth. Having applied different plating dates, Shahzad*et al*., [11] concluded that although delayed planting causes grain yield to decrease but promotes the grain's protein content. Delayed planting caused a reduction in grain yield due to shortening of the growth period duration. Noorbakhshian [12] and Pirdashti *et al*., [13] stated that both early and delayed planting dates,compared to the optimal date,would reduce rice grain yield in all regions. Hayat *et al*., [14] reported that the delayed sowing results in the poor emergence and reduces panicle heading per meter square and spikelets per panicle and ultimately yield is affected. Akram *et al*., [15] reported that the number of grains per panicle was significantly affected as sowing date was delayed. Butler *et al*., [16] reported that climatic factors are among uncontrolled agents whose individual variations lead to changes in crop growth conditions. Therefore, it is necessary to determine the thermal requirement of different phenology stages in order to maximally benefit from crops' production potential. Rakesh and Sharma [17] hold the opinion that delay in planting resulted in significant decrease in the number of productive tillers per meter square and ultimately the paddy yield. Iqbal *et al*., [18] reported that the highest yield was obtained when the rice crop was sown earlier in the season. Xu *et al*., [19] showed that yield reduction resulting from the low number of spikelets per area unit can be compensated by increasing the number of spikelets in each panicle. Robert and Walker [20] reported that delayed planting after a certain date reduces the yield potential exponentially because sufficient and needed sunlight is not obtained at the time of high solar radiation. In other words, when sun radiation is maximum, the crop population does not have maximal leaf area to absorb maximal light. Basnayake [21] concluded that if the average of minimal temperature in germination and seedling growth time is lower than 10 °C during a 10-days period, the seedlings are remarkably damaged and transplanting will not be feasible. Shah and Bhurer [22] reported that a higher number of filled grains per panicle was visualized in the early seeding and declined gradually in the successive seeding dates. Acutis [23] proved, via studying the effect of planting date on different rice cultivars, that early planting enhances crop's dry matter accumulation amount and so the grain yield is improved.Having studied the relationship between the yield and yield components of 17 rice cultivars, Mesbah *et al*., [24] inferred that grain yield has a positive and significant correlation with the number of grains per panicle, the number of filled grains per panicle, and the 1000grain weight. Furthermore,the number of grains per panicle and the number of filled grains per panicle are considered as two major effective factors in grain yield.

The most effective wayfor production enhancement is to increase yield per area unit.Accordingly, this research seeks the objective of introducing the best planting date for different rice cultivars so as to achieve maximal yield.

Materials and Methods

This research was conducted in the 2010 cropping season in the research field of Khouzestan Agricultural Researches and Natural Resources (latitude 31°20'N, longitude 48°41'E and altitude 22.). In terms of climate, this region features very warm, dry and long summers and moderate winters. The study was a split-plot experiment, using Randomized Complete Block Design (RCBD) with three replications. Three planting dates including 5th May(D_1), 25th May(D_2) and 14th June(D_3) were considered as the main plots and the subplots consisted of three rice cultivars including Hamr(V_1), Red-Anbarbou (V_2) and Danial (V_3). Rice seed was sown 100 grams per area unit in the nursery field. The seedlings were preserved in nursery for 40 days and the grown seedlings were planted in 25*25 cm^2 distances (5 seedlings per hill) in the main plots. After establishing the seedlings in the main plot, the water level was maintained at the height of 3-4 cm until the end of the crop growth period. 90 kg of nitrogen fertilizer was applied in three steps: 40% at the time of seedling transfer to the main plots, 30% at the start of stemming and the rest 30% in the beginning of the fertility stage as the first and second top dressings.During the growing season, water was dissected for 1-2 days in necessary times in order to prevent negative wetlandeffects. Farm water was dissected before the final harvest to facilitate the harvesting operation. To determine the grain yield and yield components, 25 hills were harvested from each subplot and attributes such as grain yield, biological yield, harvest index,the 1000grainweight, the number of grains per panicle, fertility percentage, panicle length and the number of fertile tillers were evaluated. Grain yield is calculated via the following formula [25]:

$Y= N.W.F.10^{-5}$

Y = grain yield in tones per hectare

N = Number of panicles per area unit
W = 1000 grains weight (g)
F = percentage of filled grains in a panicle
The following equation is used to calculate harvest index (Hashemi Dezfouli*et al*.,1995):
HI = (Grain yield / Biological yield) * 100

Fertility percentage is also computed through multiplication of filled grains ratio and total number of grains by 100. Data variance analysis was conducted using SAS software; mean comparison was done using Duncan multiple range test.

Results and Discussions

Grain Yield:

Planting date significantly affected grain yield (Table 1). The highest grain yield belonged to the third planting date with an average of 6018.3 $kgha^{-1}$. The reason can be attributed to the suitable growth season duration, coincidence of the phenological stages- especially the heading and grain filling stages- with day length and temperature more favorable and positive influence of temperature on dynamic formation of the yield components, and ultimately,the generation of active sinks in addition tothe higher dry matter accumulation capacity. Grain yield in early plantingdate declined due to panicle shedding, low dry matter production and the presence of reduction of plant height (Table 2).

The results were in accordance with the findings of Noorbakhshian [12], Pirdashti *et al*., [13] and Gines *et al.*, [26]. There was a significant difference among cultivars in terms of grain yield (Table 1). The highest grain yield was obtained for Danial and Hamar cultivars with averages of 5591 and 5549.4 $kgha^{-1}$; the lowest amount was observed forRed Anbarboucultivar. This disparity was caused by the difference between cultivars in terms of the growth period duration, panicle emergence time, fertility rate,the number of grains per panicle,the 1000grainweight, and heat-sensitivity level (Table 2). These results were in agreement with the findings of Kawakata and Yajima [27] and Yoshida [28] who suggested a determining role for temperature and day duration on panicle emergence and their impacts on physiological, growth and maturity processes and finally, on the highest grain yield.The interaction effects of planting date and cultivar were significant on grain yield (Table 1).The highest and lowest rice grain yields were observed in the third planting date for Danial cultivar (6902.6 $kgha^{-1}$) and Red Anbarbou cultivar in the first planting date (2159.3 $kgha^{-1}$) respectively (Table 3). All cultivars exhibited their largest yield in the second planting date. Excessive heat during the pollination period and grain filling stage caused disorder in grain formation and grain weight which reduced the grain yield.

Biological Yield:

The planting date effect was significant on biological yield (Table 1). The highest biological yield belonged to the second planting date with an average of 14951.3 $kgha^{-1}$; the reason can be explained by the larger number of panicles per area unit. The biological yield decline in the first planting date wascaused by the high environmental temperature.The decline in the third date occurred due to the reduction in crop growth duration and also decreasing maximal land-covering period and consequently,diminishingabsorption of autumn sunlight. On the other hand, delayed planting enjoyed less biological yield compared to suitable dates because it affected vegetative growth and the number of panicles per square meter (Table 2).The results were in alignment with the findings of Surender Reedy and BuchaReedy [29] who stated that the delayed-planting crops undergo the development stages more rapidly, and each development stage duration decreases exponentially as the delay in planting increases. There was a significant difference between cultivars regarding biological yield (Table 1). The highest and lowest amounts were achieved for Hamar and Danial cultivars respectively (Table 2).The higher biological yield of Hamar can be attributed to this cultivar’s compatibility with warm climatic conditions, the quick recycle after seedling transferas well as more accelerated canopy growth and crop growth rate.Theinteraction effect of planting date and cultivar was significant on biological yield (Table 1). The highest and lowest yields in three of dates were seen in Hamar and Danial cultivars respectively. In the first planting date, considerable amounts of dry matter – particularly following panicle emergence- accumulated in vegetative part due to high panicle infertility level (resulting from heat and absence of active sinks). Yet, the panicle contribution to total dry matter increased in the second and third planting dates because of shortening the vegetative growth duration. Nonetheless, the rate of this increase and dry matter accumulation amount were different depending on the cultivar, planting date and the development stage (Table 3).

Harvest Index:

Planting date influenced the harvest index significantly (Table 1). The highest harvest index belonged to the second planting date with an average of 41.2%.Theremarkable reduction of harvest index in the first date resulted from the impact of high temperature on panicle infertility rate,the decrease in yield components, severe photosynthesis decline along withexceeding respiration and preservation costs of crop population (Table 2). The results matched the findings of Amien *et al*., [30] that reported higher air temperatures would increase the rice plant respiration rate and reduce the net photosynthesis, hence, ultimately reducing plant yield.

Cultivars were significantly different in term of the harvest index (Table 1). Danial cultivar exhibited the greatest harvest index with an average of 44.9%. This result can be justified by the greater capability of the respective cultivar for fertility,a larger number of grains per panicle, higher dry matter accumulation potential, more rapid crop growth rate during the flowering stage and ultimately, better compatibility with ambient warm conditions.

Red Anbarbou cultivar possessed the lowest harvest index (Table 2). Considering the negative relationship between the harvest index and crop height, the higher value of the harvest index in Danial and Hamar can be explained by smaller plant height compared to Red Anbarbou cultivarheight. Xu *et al*.,[19] remarked that high harvest indices in some cultivars mainly resulted from remobilization of large amounts of photosynthetic products from stem and leaf sheath following the panicle emergence. Theinteraction effects of planting date and cultivar were significant on the harvest index (Table 1). The highest and lowest harvest indecies were observed in Danial (49.2%) on the second planting date (26th May) and Red Anbarbou cultivar on the first planting date (Table 3). Theharvest index is completely influenced by the governing thermal conditions on crop growth in a way that the lowest amount of this component was seen on the first planting date under thermal stress conditions;the harvest index enhanced as growth conditions improved. The local heat-sensitive cultivar (Red Anbarbou) reacted by far more remarkably than other varieties.Theharvest index decline on the first planting date can be linked to severe panicle hollowness and the absence of sufficient sinks for absorbing photosynthetic products.

1000Grain Weight:

The planting date effect was significant on the 1000grain weight (Table 1). The highest value of the 1000grain weight belonged to the second and third planting dates with averages of 22.7 and 22.4 g (Table 2). Reduction in the1000grain weight on the first planting date was due to excessive environment heat since the time of panicle emergence and grain components formation and during grain filling duration. The results of this research were in accordance with the findings by Hashemi Dezfuli *et al*., [31]. The cultivars were significantly different in terms of the 1000grain weight (Table 1). The highest value was obtained for Hamar cultivar with an average of 24.299 g. Ostensibly, this condition is caused due to the difference between cultivars in terms of the panicle emergence time, grain size, grain filling duration and the sensitivity level to high environmental temperatures (Table 2). These results were in good agreement with the findings of Yoshida and Hara [32], and Zelifeh [33] who reported that different impressibility of grain weight from temperature and also temperature effect on maturity period duration and final weight besides the relationship between grain size and the filling period.Theinteraction effects of planting date and cultivar were significant on the 100grain weight (Table 1). The highest and lowest 1000grainweight were reported for Hamar cultivar on the second and third plating dates and Red Anbarbou cultivar on the first date (Table 3). With decreasing temperatures during the growth period, grain weight increase rate by Hamar was rapidly far more than othercultivars. Although the results are indicative of the high potential of Hamar cultivar to accumulate dry matter in desirable condition but they somehow imply more sensitivity of grain size of this cultivar to high temperatures during maturity. Under such circumstances, shortening the maturity duration and avoiding ambient warmth are among the solutions which the cultivars compatible with stress conditions would devise to overcome challenges.

Number of Filled Grains:

Planting date significantly influenced the number of filled grains per panicle (Table 1). The highest and lowest numbers of filled grains per panicle respectively belonged to the third and first planting dates (Table 2). Note that grains number in panicle is affected by factors such as panicle growth conditions and the formation of its components including primary and secondary branches and florets before emergence and also panicle fertility rate and photosynthetic products supply during the maturity period. Thus, it seems that due to thermal conditions, lower weight and more panicles infertility and further competition for absorbing photosynthetic products were among the causes of reduction in the number of filled grains per panicle on the first planting date. The results are similarthe findings of Butler*et al*., [16] and Shah and Bhurer [22]. There was a significant difference between cultivars in terms of the number of filled grains (Table 1). The highest number was achieved for Danial cultivar (Table 2). This arises from the thegenetic difference and different cultivars' responses to environmental conditions. The obtained results were in accordance with reports by Yoshida and Parao [34] about the determining impact of rice cultivar potential and environmental conditions on the number of filled grains per panicle.The interaction effects of planting date and cultivar were significant on the number of filled grains per panicle (Table 1). The highest number of filled grains wasobtained for Danial and Red Anbarbou cultivars on the first planting date (Table 3). The decrease in the number of filled grains on the first planting date resulted from factors such

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as higher temperature during the maturity and grain filling stages besides the lower number of fertile florets and disorder in provision of the required photosynthetic matters. The results were in line with reports by Yoshida [35] concerning the contribution of climatic conditions tothe number of filled grains during meiosis division time,the heading stage and maturity period.

Fertility Percentage:

Planting date had a significant effect on panicle fertility percentage (Table 1). The largest percentage belonged to the third planting date with an average of 72.5%. Fertility percentage decline on the first planting date can be attributed to higher environmental temperatures during the reproductive stage, panicle emergence time and also the maturation period. Theresults were in alignment with reports by Yoshida [28, 35] concerning the effect of temperatures lower or higher than the critical limit on the physiological processes related to spikelet formation as well as the impact of weather conditions and adverse climatic factors on fertility decline during the meiosis division and heading stages. The cultivars were significantly different in terms of panicle fertility percentage (Table 1). The lowest fertility percentage was observed in Red Anbarboucultivar (Table 2). Reduced fertility percentage in Red Anbarboucultivar resulted from its high sensitivity to high temperatures. Results were in accordance with the findings of Noorbakhshian [12] who asserted that panicle fertility percentage is the most restrictive factor of rice production in Khouzestan province and the fact that over-heating at the heading stage causes the flowers to be infertile.Theinteraction effects of planting date and cultivar were significant on panicle fertility percentage (Table 1). The highest percentage belonged to Danial cultivar in the third planting date with an average of 76.03% (Table 3). Fertility percentage analysis indicates this percentage is completely influenced by thermal conditions of panicle emergence time because all cultivars exhibited their highest fertility percentage on the third planting date. The results were in agreement with reports by Yoshida [35], and Kato and Yajima[36] concerning the relative importance of day duration and temperature at the time of panicle emergence for panicle fertility percentage and also impressibility of this attribute from cultivar’s properties and environmental conditions.

Number of Fertile Tillers:

Planting date affected the number of fertile tillers significantly (Table 1). The highest percentage belonged to the first and second dates with averages of 322.7 and 319.1 tillers per square meter (Table 2). On the first and second planting dates, temperature contribution to stimulate tillering increased the number of tillers and they eventually became fertile.Thenumber of tillers and tillering period duration decreased due to temperature reduction on the third planting date. The results conformedwith those obtained byRakeshand Sharma[17]. The cultivars had significant different numbers of fertile tillers (Table 1). The highest and lowest numbers were respectively achieved for HamarandRed Anbarbou cultivars (Table 2). Different numbers of fertile tillers might result from genetic differences.Theinteraction effect of planting date and cultivar was significantly effective on the number of fertile tillers (Table 1). The maximum was obtained for Hamar cultivar on the first planting date with an average of 343.7 tillers per square meter (Table 3). The interaction effects of cultivar and planting date showed that the lowest number of fertile tillers was found on the third planting date for all ricecultivars. The tillering capacity of rice cultivars reduced the number of fertile tillers and shortened the tillering period duration owing to lowering of temperature-particularly the irrigation water temperature-on the third planting date. The results were aligned with the findings by Yoshida [35] and Xu *et al*., [19] concerning the influences of environmental temperature, water temperature in particular, and some other environmental factors.

Panicle Length:

The influence of planting date and also the interaction effect of planting date and cultivar on panicle length were not significant but the difference between cultivars was significant in terms of panicle length (Table 1). The greatest length belonged to Red Anbarbou cultivar with an average of 29.4 cm (Table 2). Disregarding temperature, the difference between the cultivars was due to genetic differences because panicle growth is a part of the overall crop growth process. Accordingly, heat-sensitive cultivars such as Red Anbarbou would enjoy greater panicle lengths thanks to their longer growth period duration and larger plant height. Taking into account that panicle is the uppermost crop organ and is subject to more heat featuring further respiration, it can be consequently inferred that having shorter panicles in supportive and semi-supportive cultivars is one of the ways to tolerate or avoid the warmth. Noorbakhshianand Rezaiee [37] stated that long-duration cultivars assume higher plants and greater panicle lengths compared to short-duration cultivars despite having lower grain yield. The reason isthat long-duration cultivars are usually among the local rice cultivars which features higher plants due to a longer vegetative growth period duration.Panicle lengths of these cultivars are normally greater than those of short-duration cultivars.

Table 1: Summary of Variance Analysis Results of Yield and Yield Components.

Sources of Variation	df	Mean square							
		Grain Yield	Biological Yield	Harvest Index	1000 grains weight	Number of filled grains per panicle	Fertility Rate	Fertile Tillers	Panicle Length
Replication	2	241.176	6827.954	0.148	0.011	0.225	2.157	7.815	2.308
Planting	2	1.5487**	7366344.40	566.174*	4.772**	5936.371**	2531.796	21252.481*	973.988^{ns}
Date(PD)	4	16208.431	0**	*	0.091	33.970	**	*	150.712
Ea	2	9371755.849**	91309.503	0.117	68.413*	176.367**	66.676	160.870	5027.083*
Cultivar(C)	4	721001.309**	4.2287**	562.971*	*	302.922**	306.583*	2327.148^{ns}	*
PD*C	1	1372.293	1.0707**	*	0.669**	3.795	*	677.870**	186.831^{ns}
Error	2	0.74	7685.919	46.686**	0.021	2.51	87.535**	22.483	17.712
CV%	-		0.63	0.149	0.66		8.921	1.62	11.18
				1.07			5.25		

* and ** respectively represent significance in 1% and 5% probability values.ns: non-significant.

Table 2: Mean Comparison results of yield and yieldcomponent.

Treatment	Grain Yield (kg/ha)	Biological Yield (kg/ha)	Harvest Index (percents)	1000 grains weight (g)	Number of filled grains per panicle (number/m^2)	Fertility Rate (percents)	Fertile Tillers (number/m^2)	Panicle Length (cm)
Planting Dates								
PD1	3506.7c	13636.4 b	27.0 c	21.351 b	49.0 c	39.1 b	322.7 a	25.9 a
PD2	6018.3 a	14951.3 a	40.3 b	22.422 a	85.5 b	59.1 a	319.1 a	25.6 a
PD3	5418.5 b	13217.5 b	41.2 a	22.741 a	98.6 a	72.5 a	236.8 b	25.2 a
Cultivars								
C1	5549.4 a	16386.6 a	34.0 b	24.299 a	74.6 b	59.5 a	310.0 a	24.0 ab
C2	3803.1 b	13145.1 b	29.5 c	19.057 c	75.7 b	50.2 b	278.1 c	29.4 a
C3	5591.0 a	12273.5 c	44.9 a	23.159 b	82.8 a	61.0 a	290.4 b	23.2 b

* Means followed by similar letters have not significant different (p<o.o5) – Using Duncan Test.
PD1= first planting date(5th May),PD2: second planting date(25th May), and PD3= third planting date(15th June).
C_1= Hamar Cultivar , C_2= Red-Anbarbou Cultivar, and C3= Danial Cultivar.

Table 3: Meancomparison results of yield and yieldcomponent.

Treatment	Grain Yield (kg/ha)	Biological Yield (kg/ha)	Harvest Index (percents)	1000 grains weight (g)	Number of filled grains per panicle (number/m^2)	Fertility Rate (percents)	Fertile Tillers (number/m^2)	Panicle Length (cm)
Planting Date*								
Variety	4683.7 e	17152.8 a	27.3 f	22.923 c	58.7 d	47.83 ef	343.7 a	24.9 a
PD1 C1	2159.3 h	14213.8 e	15.2 g	18.333 f	37.3 e	26.13 g	320.3 bc	30.1 a
PD1 C2	3677.0 g	9542.6 h	38.5 c	22.797 c	51.1 d	43.47 f	304.0 cd	22.6 a
PD1 C3	6128.6 b	16333.2 b	37.5 d	25.010 a	76.1 c	58.80 cde	325.3 ab	24.4 a
PD2C1	5023.7 d	13825.8 e	36.3 e	19.183 e	88.8 b	54.97 bef	301.0 d	29.3 a
PD2 C2	6902.6 a	14695.0 d	47.0 b	23.073 c	91.7 b	63.43 bcd	331.0 ab	23.1 a
PD2 C3	5835.9 c	15673.8 c	37.2 d	24.963 a	89.0 b	71.87 ab	261.0 e	22.8 a
PD3 C1	4226.3 f	11395.8 g	37.1 d	19.653 d	101.1 a	69.53 abc	213.0 g	28.9 a
PD3 C2	6193.2 b	12582.8 f	49.2 a	23.607 b	105.6 a	76.03 a	236.3 f	23.8 a
PD3 C3								

* Means followed by similar letters have not significant different (p<o.o5) – Using Duncan Test.
PD1= first planting date(5th May), PD2: second planting date(25th May), and PD3= third planting date(15th June)
C1= Hamar Cultivar , C2= Red-Anbarbou Cultivar, and C3= Danial Cultivar

Conclusions:

The current research results implied that the reduction or increase in temperature would not necessarily bring about maximal grain yield but instead the respective cultivars are supposed to have active sources and strong and efficient sinks to enable the source to produce a great deal of photosynthetic matters and the sinks must also be capable of accumulating these products to improve the yield. Furthermore, this research proved that a favorable planting date would have a very significant influence on grain yield and its components. Thus, selecting a desirable planting date and using suitable cultivars for certain regionsare specifically important in order to provide sufficient time for input residue distribution, yield improvement and prevention from damage. Consequently, according to this study results, Danial cultivar on the second planting date is recommended to achieve maximal rice yield in Khouzestan province.

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