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Determination of Morphological Characteristics Affected by Different Agronomical Treatments in Rice (IR6874-3-2 Promising Line)

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Abstract: In order to study the effects of transplanting date, planting spaces and nitrogen fertilization on morphological characteristics of rice promising line a field experiment was carried out in the Rice Research Institute of Iran (Amol). Experimental design was arranged in a split plot factorial in basis of completely randomized block design with three replications. Some agronomical traits such as panicle length, grain number per panicle, filled grains percentage, 1000 grains weight, fertile tiller numbers, flag leaf area, flag leaf angle, grain yield and harvest index were measured. Results showed that the effect of transplanting date on grain number per panicle was significant at 0.01 probability level. Also the effect of planting spaces on grain number per panicle and fertile tiller was significant at 0.05 and 0.01 probability level, respectively. Nitrogen fertilizer levels had significant effect on, flag leaf area, flag leaf angle, panicle length, 1000 grains weight and grain yield. According to results, 1000 grains weight, harvest index and filled grains percentage had the most correlation with grain yield, respectively. For this line, transplanting date at May 12, planting space at 20×20 cm and 115 kg N ha^{-1} for the best performance of yield attributes were recommended.

Key words: Rice, transplanting date, planting spaces, nitrogen, flag leaf

INTRODUCTION

Rice is vital to more than half of the world population. It is the most important food grain in the diets of hundred of millions of Asians, Africans and latin Americans living in the tropics and subtropics (Yoshida, 1981). Projection based on population growth rate in countries where rice is the main crop indicate that rice production must increased approximately 65% from a 1990 value of 473 million tons to 781 million tons by 2020, to meet the rice demand for growing population (IRRI, 1989). Studies investigating the effect of seeding date on rice grain yields have been sporadically conducted since the 1930 (Faw and Johnston, 1975; Gravois and Helms, 1998). Seeding date primarily influences the length of the vegetative growth period of rice and early seeded rice requiring a greater number of days to accumulate the same number of degree-day units compared with later seeded rice (Norman *et al*., 2001). Seeding rice before the predicted optimum periods would only lengthen the time between seeding and emergence; increase production costs from the use of recommended seed treatments, higher seeding rates; a longer period for pest control and possibly result in poor stand establishment (Slaton, 2001). The time between seeding and seedling emergence decreases as seeding date is delayed and soil and air temperature increase (Norman *et al*., 2000). Similarly, the time between seedling emergence and heading declines as seeding date is delayed, but the accumulated number of growing degree-day units remains relatively (Norman *et al*., 2001). Almost all yield contributing characters were influenced significantly by planting density (Islam and Hossain, 2002). Wider spacing had linearly increasing effect on the performance of individual plants. The plants grown with wider spacing had more solar radiation to absorb for better photosynthetic process and hence performed better as individual (Baloch *et al*., 2002). Rice leaf area index and CGR were affected by fertilizers especially nitrogenous fertilizers (Fageria *et al*., 1997). Plant height increased with higher levels of nitrogen and application of different levels of nitrogen had significant influence on grain yield (Sarkar *et al*., 2004). For maximizing yield, manipulation of cultural technologies like transplanting date, planting density and nitrogen fertilization are, therefore essential. Selection of suitable transplanting date, planting density and optimum rate of fertilizer are important factors for maximizing rice production.

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MATERIALS AND METHODS

The experiment was conducted at the Rice Research Institute of Iran Deputy of Mazandaran (Amol) located in north of Iran (52°22′ N, 36°28′ E, altitude 28 m). This experiment was laid out in split plot factorial in basis of completely randomized block design with three replications. The plot size was 12 m^2. Main factor was transplanting date in three levels (including May 2, May 12, May 22) and minor factors were planting spaces and amount of nitrogen fertilizer (including 16×30 cm, 20×20 cm, 25×25 cm and 92, 115, 135 kg N ha^{-1}, respectively). All plots received 100 kg P_2O_5 ha^{-1} and 100 kg K_2O ha^{-1} before transplanting. The nitrogen fertilizer in the form of urea was applied at the rate of 92 kg, 115 kg and 132 kg N ha^{-1} in two split doeses. Half of nitrogen fertilizer was applied before transplanting while the remaining quantity applied as a top dressing in the maximum tillering stage. Standards cultural practices were carried out untill the crop was mature. Five hills (excluding border hills) were randomly selected from each plot in flowering stage for measuring the flag leafs angle and area. Six hills (excluding border hills) were randomly selected from each plot prior to harvest for measure yield components. Grain yield was determined from harvest area of 5 m^2 adjusting to 14% moisture content. All statistical tests were done using the Statically Analysis System (SAS, Institute, 1996) and mean values were compared by Duncan Multiple Rang Test (DMRT).

RESULTS AND DISCUSSION

Effect of transplanting date: The effect of transplanting date had a significant effect on total grain number per panicle at 0.01 probability level (Table 1). Data in Table 2 showed that the highest grains number per panicle (141.85) were produced at first transplanting date (May 2). Transplanting date had not significant effect on the other morphological characteristics in this research. Hatami (2002) got almost the similar results.

Effect of planting spaces: Planting spaces had significant effect on total grain number per panicle and fertile tiller at 0.05 and 0.01 probability levels, respectively (Table 1). The highest grain number per panicle (133.47) and the highest fertile tiller number (17.52) were obtained at first planting spaces (16×30 cm) and third planting spaces (25×25 cm), respectively (Table 2). Mian and Gaffur (1970) got almost the same result. They reported that in wide spacing the performance of individual hill was better with close spacing.

Effect of nitrogen fertilization: The most of the yield contributing characters are influenced significantly by fertilizer treatment. Nitrogen fertilizer levels had a significant effect on panicle length, 1000 grains weight, flag leaf area, flag leaf angle and grain yield (Table 1). Table 2 showed that the highest panicle length (29.37 cm), flag leaf area (0.65 m^2), grain yield (8.55 ton ha^{-1}) and the

Table 1: Mean squares of morphological characteristics of rice (IR6874-3-2 promising line)

Source of variation	df	Flag leaf area (m^2)	Flag leaf angle (°)	Total grain per panicle (No)	Panicle length (cm)	Filled grain (%)	1000 grains weight (g)	Fertile tiller (No)	Grain yield (t ha^{-1})	Harvest index (%)
Rep	2	0.069 ns	187.19 ns	1474.01 ns	1.05 ns	50.00 ns	3.28 ns	46.64 ns	1.36 ns	8.13 ns
‡TD	2	0.028 ns	199.82 ns	6598.98**	0.92 ns	135.35 ns	54.65 ns	49.95 ns	4.03 ns	155.40 ns
Error (a)	4	0.012	45.22	255.90	0.54	37.44	24.88	16.14	0.62	48.40
‡PS	2	0.013 ns	24.06 ns	814.03*	1.24 ns	2.53 ns	16.62 ns	130.72**	3.22 ns	36.2 0ns
‡N	2	0.093**	394.93**	579.17 ns	10.33**	2.45 ns	33.68*	7.20 ns	3.65*	0.54 ns
PS×N	4	0.007 ns	49.82 ns	627.48*	6.35**	3.29 ns	9.00 ns	5.77 ns	1.05 ns	37.73 ns
TD×PS	4	0.012 ns	48.25 ns	628.61*	0.19 ns	93.66 ns	9.00 ns	3.20 ns	0.39 ns	28.18 ns
TD×N	4	0.023 ns	77.47*	458.68 ns	0.64 ns	31.65 ns	11.02 ns	1.58 ns	0.34 ns	35.36 ns
TD×PS×N	8	0.008 ns	84.04**	300.78 ns	1.60 ns	5.32 ns	8.74 ns	1.90 ns	0.63 ns	21.36 ns
Total Error	48	0.018	23.50	232.35	37.07	11.20	9.96	4.22	1.01	22.30
CV (%)		22.580	16.32	11.98	3.03	4.35	11.33	13.67	12.12	9.90

‡. TD, PS, N = transplanting date, planting spaces and nitrogen fertilizer respectively, ns, *,** = non significant, significant at 0.05 and 0.01 probability level, respectively

Table 2: Mean comparison of morphological characteristics of rice promising line under different treatments

Treatment		Flag leaf area (m^2)	Flag leaf angle (°)	Total grain per panicle (No)	Panicle length (cm)	Filled grain (%)	1000 grains weight (g)	Fertile tiller (No)	Grain yield (t ha^{-1})	Harvest index (%)
Transplanting date	May 2	0.63 a	29.70 ab	141.85 a	28.81 a	79.29 a	27.67 a	13.57 a	8.44 ab	49.43 a
	May 12	0.57 a	27.00 b	110.74 b	29.16 a	76.31 a	26.55 a	16.03 a	8.56 a	48.65 a
	May 22	0.58 a	32.44 a	129.05 c	28.87 a	74.91 a	29.37 a	15.45 a	7.84 b	44.94 a
Planting spaces	16×30 cm	0.62 a	30.74 a	133.47 a	29.17 a	76.60 a	27.06 a	14.17 b	8.23 ab	47.62 a
	20×20 cm	0.60 a	28.89 a	123.17 b	28.74 a	77.18 a	27.90 a	13.37 b	8.65 a	46.54 a
	25×25 cm	0.57 a	29.50 a	125.00 b	28.93 a	76.73 a	28.63 a	17.52 a	7.97 b	48.85 a
Nitrogen fertilizer (kg N ha^{-1})	92	0.54 b	33.89 a	121.91 a	28.24 b	75.76 a	28.04 ab	14.42 a	7.86 b	47.57 a
	115	0.59 ab	28.85 b	129.29 a	29.23 a	77.12 a	28.88 a	15.28 a	8.44 a	47.83 a
	138	0.65 a	26.38 b	130.45 a	29.37 a	77.64 a	26.67 b	15.36 a	8.55 a	47.62 a

Mean with similar letter(s) in each column are not significantly different at the 0.05 probability level according to DMRT

least flag leaf angle (26.38°) were obtained at third nitrogen fertilizer level (138 kg N ha^{-1}). Islam and Altaf Hossain (2002) reported that fertilizer treatments had significant effect on yield components of fine rice.

Interaction of transplanting date and planting space: Effects of transplanting date and planting spaces on yield and other crop characters of IR6874-3-2 promising line are presented in Table 3. The highest flag leaf area (0.66 m^2) was observed in the first transplanting date in case of 16×30 cm planting space. Flag leaf angle was influenced significantly by this interaction. The highest flag leaf angle (33.49°) was observed in third transplanting date in case of 25×25 cm planting space and the least flag leaf angle was produced in second transplanting date with 25×25 cm planting space. In the first transplanting date the highest panicle length (28.98 cm) was observed in 16×30 cm planting space and the highest total grain per panicle (148.4), filled grain percentage (82.27) and grain yield (8.95 t ha^{-1}) were obtained in 20×20 cm planting space. Also in the first transplanting date the highest 1000 grains weight (29.04 g), fertile tiller number (16.14) and harvest index (51.78) were observed in 25×25 cm planting space. In the second transplanting date (May 12) the highest panicle length (29.51 cm), total grain per panicle (119) and filled grain percentage (79.06) were obtained in 16×30 cm planting space while the highest grain yield (8.79 t ha^{-1}) was obtained in 20×20 cm planting space. In this transplanting date the highest 1000 grains weight (27.17 g), fertile tiller number (19.16) and harvest index (50.94) were produced in 25×25 cm planting space. In third transplanting date (May 22) the highest panicle length (29.58 cm), total grain per panicle (136.91), filled grain percentage (75.8) and harvest index (45.53) were obtained in 16×30 cm planting space while the highest yield (8.22 t ha^{-1}) was produced in 20×20 cm planting space. In May 22 transplanting date, the highest 1000 grains weight (29.69 g) and fertile tiller number (17.25) were obtained in 25×25 cm planting space.

Interaction of transplanting date and nitrogen fertilizer: Results showed (Table 4) that in first transplanting date the highest total grain per panicle (144.1), flag leaf angle (34.39°) and harvest index (50.45) were observed in case of 92 kg N ha^{-1} also the highest panicle length (29.33 cm), filled grain percentage (79.83), 1000 grains weight (29.48 g), fertile tiller number (14.29) and grain yield (8.78 t ha^{-1}) were produced with 115 kg N ha^{-1}. In this transplanting date the highest flag leaf area (0.76 m^2) and the least flag leaf angle (26.17°) were obtained in case of 138 kg N ha^{-1}. In the second transplanting date the highest grain number per panicle (118.27), filled grain percentage (78.48), 1000 grains weight (26.83 g) and the least flag leaf angle (25.83°) were obtained in case of 115 kg N ha^{-1}; also in this transplanting date the highest panicle length (29.82 cm), fertile tiller number (16.21), flag leaf area (0.62 m^2), grain yield (9.03 t ha^{-1}) and harvest index (50.53) were produced with 138 kg N ha^{-1}. In the third transplanting date the highest 1000 grains weight (30.34 g) and harvest index (46.75) were obtained in case of 115 kg N ha^{-1} also in May 22 transplanting date the highest panicle length

Table 3: Interaction effect of transplanting date and planting space on morphological parameters of rice promising line (IR6874-3-2)

Transplanting date	Planting spaces (cm)	Flag leaf area (m^2)	Flag leaf angle (°)	Total grain per panicle (No)	Panicle length (cm)	Filled grain (%)	1000 grains weight (g)	Fertile tiller (No)	Grain yield (t ha^{-1})	Harvest index (%)
May 2	16×30	0.66a	29.78ab	144.51ab	28.98b	74.95b	25.60b	12.83cd	8.35abc	49.29ab
	20×20	0.64ab	28.00bc	148.40a	28.74b	82.27a	28.39ab	11.74d	8.95a	47.24abc
	25×25	0.58ab	31.28ab	132.64bcd	28.79b	80.66a	29.04ab	16.14ab	8.03cd	51.78a
May 12	16×30	0.63ab	29.72ab	119.00e	29.51a	79.06ab	26.05ab	14.88bc	8.40abc	48.04abc
	20×20	0.55b	27.55bc	97.08f	28.78b	74.74b	26.43ab	14.07bcd	8.79ab	46.95abc
	25×25	0.55b	23.72c	116.16e	29.19ab	75.15b	27.17ab	19.16a	8.51abc	50.94a
May 22	16×30	0.56b	32.72ab	136.91abc	29.58a	75.8b	29.54a	14.81bcd	7.94cd	45.53bc
	20×20	0.61ab	31.11ab	124.04de	28.72b	74.54b	28.90ab	14.31bcd	8.22bc	45.44bc
	25×25	0.58ab	33.49a	126.22cde	28.71b	74.39b	29.69a	17.25a	7.38d	43.86c

Means with similar letter(s) in each column are not significantly different at the 0.05 probability level according to DMRT

Table 4: Interaction effect of transplanting date and nitrogen on morphological parameters of rice promising line (IR6874-3-2)

Transplanting date	Nitrogen (kg ha^{-1})	Flag leaf area (m^2)	Flag leaf angle (°)	Total grain per panicle (No)	Panicle length (cm)	Filled grain (%)	1000 grains weight (g)	Fertile tiller (No)	Grain yield (t ha^{-1})	Harvest index (%)
May 2	92	0.53bc	34.39ab	144.10a	28.07d	78.80ab	28.43abc	12.53c	8.08bc	50.45a
	115	0.61bc	28.50cd	141.77a	29.33ab	79.83a	29.48ab	14.29abc	8.78a	49.96a
	138	0.76a	26.17d	139.68ab	29.06b	79.25a	25.12c	13.89bc	8.48abc	47.90ab
May 12	92	0.52c	28.28cd	101.06e	28.24d	74.21bc	26.32bc	15.75ab	8.10bc	48.61ab
	115	0.58bc	25.83d	118.27cd	29.42ab	78.48ab	26.83abc	16.14ab	8.57ab	46.81ab
	138	0.62b	26.89d	112.92de	29.82a	76.25abc	26.50abc	16.21a	9.03a	50.53a
May 22	92	0.56bc	39.00a	120.58cd	28.41cd	74.26bc	29.39ab	14.99abc	7.42d	43.64b
	115	0.59bc	32.22bc	127.83bc	28.97bc	73.06c	30.34a	15.40abc	7.96cd	46.75ab
	138	0.59bc	26.10d	138.76ab	29.23b	77.41abc	28.40abc	15.98ab	8.15bc	44.43b

Means with similar letter(s) in each column are not significantly different at the 0.05 probability level according to DMRT

Table 5: Interaction effect of planting space and nitrogen on morphological parameters of rice promising line (IR6874-3-2)

Planting spaces (cm)	Nitrogen (kg ha^{-1})	Flag leaf area (m^2)	Flag leaf angle (°)	Total grain per panicle (No)	Panicle length (cm)	Filled grain (%)	1000 grains weight (g)	Fertile tiller (No)	Grain yield (t ha^{-1})	Harvest index (%)
16×30	92	0.55bc	33.11ab	130.36b	28.79c	75.68a	28.14ab	14.33b	7.63bc	47.11ab
	115	0.60b	30.90bcd	143.32a	29.01c	76.99a	28.12ab	14.07b	8.59a	48.00ab
	138	0.70a	28.22bcde	126.73bc	29.72ab	77.13a	24.93b	14.13b	8.48a	47.77ab
20×20	92	0.57bc	31.78abc	117.35c	27.07d	75.42a	27.91ab	12.92b	8.67a	48.56ab
	115	0.60b	28.89bcde	118.30c	29.98a	77.94a	28.21ab	13.20b	8.55a	46.79ab
	138	0.63ab	26.00de	133.88ab	29.19bc	78.20a	27.60ab	13.10b	8.75a	44.27b
25×25	92	0.50c	36.78a	118.03c	28.86c	76.18a	28.09ab	16.03ab	7.30c	44.03ab
	115	0.58bc	26.78cde	126.26bc	28.72c	76.43a	30.32a	18.57b	8.18ab	48.73ab
	138	0.64ab	24.93e	130.74b	29.21bc	77.59a	27.49ab	17.96b	8.44a	50.81ab

Means with similar letter(s) in each column are not significantly different at the 0.05 probability level according to DMRT

Table 6: Correlation between morphological characteristics of rice (IR 6874-3-2 promising line)

Characters	Flag leaf area	Flag leaf angle	Total grain per panicle	Panicle length	Filled grain	1000 grains weight	Fertile tiller	Grain yield	Harvest index
Flag leaf area	1								
Flag leaf angle	-0.05ns	1							
Total grain per panicle	0.04ns	-0.07ns	1						
Panicle length	0.07ns	0.012ns	0.086ns	1					
Filled grain	-0.01ns	-0.19ns	0.44**	0.12 ns	1				
1000 grains weight	0.07ns	-0.07ns	0.09ns	-0.12ns	0.14 ns	1			
Fertile tiller	-0.19ns	-0.07ns	0.26*	0.09ns	-0.16 ns	0.15ns	1		
Grain yield	0.09ns	-0.19ns	0.12ns	0.21ns	0.23*	0.35**	0.11ns	1	
Harvest index	-0.09ns	-0.13ns	0.16ns	-0.07ns	0.16 ns	0.06 ns	0.06ns	0.29**	1

*,** = non significant, significant at 0.05 and 0.01 probability level, respectively

(29.23 cm), grain number per panicle (138.76), filled grain percentage (77.41), fertile tiller (15.98), flag leaf area (0.9 m^2), grain yield (8.15 t ha^{-1}) and the least flag leaf angle (26.1°) were observed in 138 kg N ha^{-1}. Hatami (2002) and Mohadesi (2000) got almost the similar results.

Interaction of planting space and nitrogen: In the first planting spaces (16×30 cm) the highest 1000 grains weight (28.14 g), fertile tiller number (14.33) and flag leaf angle (33.11°) were obtained in case of 92 kg N ha^{-1} also maximum grain number per panicle (143.32), grain yield (8.59 t ha^{-1}) and harvest index (48) were produced with 115 kg N ha^{-1}. In this planting space the highest panicle length (29.72 cm), filled grain percentage (77.13), flag leaf area (0.7 m^2) and the least flag leaf angle (28.22°) were observed in case of 138 kg N ha^{-1}. In second planting space (20×20 cm) the highest flag leaf angle (31.78°) and harvest index (48.56) were obtained in case of 92 kg N ha^{-1} while the greatest panicle length (29.98 cm), 1000 grains weight (28.21g) and fertile tiller number (13.2) were observed with 115 kg N ha^{-1} also maximum grains number per panicle (133.88), filled grain percentage (78.2), flag leaf area (0.63 m^2), grain yield (8.75 t ha^{-1}) and the least flag leaf angle (26°) were produced in case of 138 kg N ha^{-1} in this planting space. In third planting space (25×25 cm) the highest 1000 grains weight (30.32 g) and fertile tiller number (18.57) were obtained in 115 kg N ha^{-1} while the greatest (Table 5). Panicle length (29.21 cm), grain number per panicle (130.74), filled grain percentage (77.59), flag leaf area (0.64 m^2), grain yield (8.44 t ha^{-1}), harvest index (50.81) and the least flag leaf angle (24.93°) were produced in case of 138 kg N ha^{-1}.

According to these results, morphological characteristics of IR6874-3-2 promising line had correlation with grain yield (Table 6). Flag leaf angle had a negative and flag leaf area had a positive correlation with grain yield. The minimum flag leaf angle was obtained in 138 kg N ha^{-1} while the maximum grain yield was observed in use of this quantity of nitrogen too (Table 2). 1000 grains weight, harvest index and filled grain percentage had the most correlation with grain yield respectively. For rice promising line (IR6874-3-2) transplanting date at May 12, planting space at 20×20 cm and 115 kg N ha^{-1} for the best performance of yield attributes were recommended.

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