INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
1560–8530/2001/03–1–35–38
http://www.ijab.org

Agronomic Traits of Direct Seeded Fine Rice as affected by Seeding Density and Planting Time

MUHAMMAD ASLAM, SHAMSHAD HUSSAIN SHAH AND M. SHAFI NAZIR
Department of Agronomy, University of Agriculture, Faisalabd–38040, Pakistan

ABSTRACT

Effect of seeding density and planting time on agronomic traits of direct seeded fine rice was studied for two consecutive years. The seeding density comprised of 75, 100 and 125 kg ha^{-1} while the planting times were Ist and 3rd week of June and Ist week of July. Crop planted during the third week of June with a seed rate of 100 kg ha^{-1} due to improved yield contributing parameters produced significantly maximum grain yield of 5.32 t ha^{-1} while delayed planting during the Ist week of July with a seed rate of 125 kg ha^{-1} resulted in the minimum grain yield of 3.45 t ha^{-1}.

Key Words: Rice; Seeding density; Planting time; Planting method

INTRODUCTION

At farmers' fields sub-optimal plant population and improper sowing time are considered to be the major constraints to high rice yield. Optimum plant population contributes to high yield, which relates directly to seeding density and not to tillering ability (Janoria, 1989). Normal tillering is the best for good yield as in case of excessive tillering about 40% tillers do not produce panicles (Dingkuhn *et al.*, 1991). The maximum population with low tillering may be achieved through direct seeding which also reduces crop establishment cost. Previous studies (Naranswamy *et al.*, 1982; Pedroso, 1984a; Park *et al.*, 1990) have indicated that rice paddy yield can be improved by increasing plant density and early sowing. Thus to improve yield potential of fine rice, optimum level of seeding density and planting time needs to be precisely determined. The present study was, therefore, planned to evaluate the effect of different seeding densities and planting times on morphological traits of fine rice Basmati-385 under the agro-ecological conditions of Faisalabad in irrigated environment.

MATERIALS AND METHODS

The experiment was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad during 1996 and 1997. Basmati-385 was used as test crop. Except for the experimental treatments, all other agronomic practices were normal and uniform for all experimental units. The experimental soil was sandy-clay loam having pH 7.8, organic matter 0.72%, total nitrogen 0.05%, available phosphorus 5.99 ppm and K 183 ppm.

The treatments comprised of three seeding densities [75 kg (S_1), 100 kg (S_2) and 125 kg (S_3) ha^{-1}] and three seeding dates [Ist week of June (D_1), third week of June (D_2) and Ist week of July (D_3)]. The experiment was laid out in a RCBD in split plot arrangement with four replications. The net plot size was 2 m x 3 m. The seeding dates were kept in main plots and seeding densities in subplots. Seed was soaked in water for 24 hours prior to seeding and treated with fungicide Topsin-M @ 3 g kg^{-1} seed. Recommended basal dose of 120-75-75 kg NPK ha^{-1} was applied in the form of urea (46% N), single super phosphate (18% P_2O_5) and sulphate of potash (50% K_2O), respectively. The whole quantity of phosphorus and potassium and half of nitrogen were applied prior to seeding and the remaining half of N was applied in equal splits each at tillering and panicle initiation. To overcome the zinc deficiency, zinc sulphate (20%) was applied @ 25 kg ha^{-1} 30 days after seeding. A granular insecticide Sunfuran-3G (Carbafuran) was applied twice @ 20 kg ha^{-1} against leaf folder and stem borer.

Data on different morphological traits collected were recorded using standard procedures and analyzed statistically by using Fisher's analysis of variance technique. Least significant difference test (LSD) at 0.05 P was employed to compare the treatment means (Steel & Torrie, 1984).

RESULTS AND DISCUSSION

Seeding density and planting time significantly affected the number of tillers m^{-2} during both the years. The interaction of main effects was non-significant in 1996 and significant in 1997 (Table I).

During 1996, the maximum tillers 852.9 m^{-2} were recorded when the seed used ha^{-1} was 125 kg against the minimum of 651.8 in 75 kg ha^{-1}. Higher number of tillers m^{-2} recorded in seeding density of 125 kg ha^{-1} was attributable to more seed rate, as reported by Sharma (1992). Planting during third week of June produced the maximum tillers m^{-2} (773.6) against the minimum of 702.8 in Ist week of July during 1996. More number of tillers m^{-2} recorded in planting during third week of June in 1996 was attributed to more seedlings m^{-2} and optimum growth period resulting in more tillering as compared to seeding during Ist week of July.

Table I. Effect of seeding density and planting time on yield and yield components of fine rice (cv. Basmati-385) during 1996 and 1997

Treatments	Number of tillers m^{-2}	PBT	SP	1000-grain weight (g)	GY	HI
		1996				
Seeding densities (kg ha^{-1})						
S_1=75	651.8 c	437.0 c	141.4 b	20.54 a	3.71 b	26.28 a
S_2= 100	737.5 b	485.9 b	150.4 a	20.65 a	4.11 a	26.33 a
S_3= 125	852.9 a	515.8 a	123.3 c	18.83 b	3.60 c	22.72 b
LSD	15.68	16.03	5.20	0.39	0.10	0.60
Planting times						
D_1=Ist week of June	765.8 a	521.8 a	139.2 b	20.08 ab	3.70 b	23.84 b
D_2=(Received ; Accepted) 3rd week of June	773.6 a	512.1 a	164.0 a	20.32 a	4.04 a	25.98 a
D_3=Ist week of July	702.8 b	404.9 b	111.8 c	19.17 b	3.68 b	25.58 a
LSD	9.70	23.7	0.54	0.12	1.33	
		1997				
Seeding densities (kg ha^{-1})						
S_1=75	540.0 c	443.0 c	137.6 b	20.39 b	4.03 b	25.60 a
S_2= 100	632.5 b	485.3 b	150.5 a	21.46 a	4.61 a	25.35 a
S_3= 125	697.1 a	499.2 a	128.3 c	19.55 c	3.80 c	20.62 b
LSD	22.76	17.31	4.63	0.62	0.15	0.78
Planting times						
D_1=Ist week of June	682.3 a	466.0	136.7 b	20.60 a	4.13 b	23.59 b
D_2=3rd week of June	635.7 a	473.6	158.7 a	20.77 a	4.62 a	25.05 a
D_3=Ist week of July	608.6 b	487.9	120.8 c	20.03 b	3.70 c	22.89 b
LSD	10.41	NS	7.29	0.44	0.18	0.91

PBT=Panicle bearing tiller m^{-2}; SP=Number of spikelets $panicle^{-1}$; GY =Grain yield; HI=Harvest index

During 1997, significantly the maximum number of tillers m^{-2} (712.85 and 706.59) was recorded (Table II) when crop was seeded @ 125 kg ha^{-1} and sown during 3rd week of June or Ist week of July (S_3D_2 and S_3D_3). By contrast, significantly the minimum tiller m^{-2} (512.29 and 525.85) were recorded when crop was seeded @ 75 kg ha^{-1} and sown during Ist week of July or Ist week of June (S_1D_1 and S_1D_3, respectively).

Table II. Yield and yield components of Basmati-385 as affected by seeding density and planting time interaction during 1997.

Inter-action	No. of tillers m^{-2}	Panicle bearing tillers $^{-1}$	Grain yield (t ha^{-1})	Harvest index (%)
S_1D_1	525.85 d	440.9 de	4.10 cd	24.49 c
S_1D_2	581.89 c	451.0 de	4.50 b	24.10 c
S_1D_3	512.29 d	437.2 e	3.50 e	21.70 d
S_2D_1	675.03 b	462.5 cd	4.35 bc	26.43 ab
S_2D_2	615.59 c	476.7 bc	5.32 a	27.55 a
S_2D_3	606.89 c	516.7 a	4.15 cd	21.17 d
S_3D_1	674.88 b	494.6 ab	3.93 d	25.36 bc
S_3D_2	712.85 a	493.2 ab	4.02 b	24.40 c
S_3D_3	706.59 ab	509.7 a	3.45 e	18.91 e
LSD (0.05)	33.84	23.7	0.27	1.34

No. of spikelets $panicle^{-1}$ and 1000-grain weight (g) were non-significant

Seeding density significantly affected the number of panicle bearing tillers m^{-2} during 1996 and 1997. During 1996, significantly the maximum number of panicle bearing tillers m^{-2} (515.8) was recorded in seeding density of 125 kg ha^{-1} and the minimum (437.0) in 75 kg ha^{-1}. The greater number of panicle bearing tillers m^{-2} recorded in 125 kg ha^{-1} was ascribed to more seedling density and number of tillers m^{-2} as compared to 100 and 75 kg ha^{-1}. Similar results have been reported by Sharma (1994b) who stated that with increasing seed rate, the number of panicle bearing tillers m^{-2} was increased significantly.

Planting time significantly affected the number of panicle bearing tillers m^{-2} only during 1996. Planting during the Ist week of June (D_1) although produced more panicle bearing tillers m^{-2} (521.8) than that planted during the Ist week of July (D_3) but was on a par with D_2 (3rd week of June) producing on an average 512.1m^{-2}. These results are in agreement with the findings of Lee and Jun (1998) who reported that early seeding produced the maximum number of panicle bearing tillers m^{-2}. The interaction of seeding density and planting time was non-significant during 1996. However, during 1997, the interaction of main effects was significant (Table II). Crop seeded @ 100 kg ha^{-1} and sown during Ist week of July (S_2D_3) produced significantly the maximum number of tillers m^{-2} (516.7) but was on a par with S_3D_3, S_3D_1 and S_3D_2against the minimum of 437.2 tillers m^{-2}recorded when crop was sown during Ist week of July and seeded @ 125 ha^{-1} (S_1D_3).

Spikelets panicle^{-1} were affected significantly both by seeding density and planting time during 1996 and 1997. During 1996, the maximum number of spikelets panicle^{-1} (150.4) was recorded in seeding density of 100 kg ha^{-1} (S_2) against the minimum (123.3) in 125 kg ha^{-1} (S_3). The same trend was exhibited in 1997. The more number of spikelets panicle^{-1} recorded in S_2 was attributed to optimum number of panicle bearing tillers m^{-2}, which resulted in better development of panicle. These results are in consonance with those of Gravois and Helms (1992) who reported that as seeding rate increased, the number of florets panicle^{-1} was significantly decreased.

As regards planting time the maximum spikelets panicle^{-1} (164.0) were recorded in plots sown during third week of June (D_2) and the minimum (111.8) in Ist week of July (D_3) planting during 1996 and a similar trend was noted in 1997. The equivalent figures were 158.7 and 120.8 in D_2 and D_3, respectively. Higher number of spikelets panicle^{-1} recorded in plots sown during third week of June (D_2) due to optimum number of tillers m^{-2} resulting in normal development of panicle. Similar findings have been reported by Lee and Jun (1998) who reported that spikelets panicle^{-1} were reduced significantly as seeding was delayed. The interaction between main effects was non-significant during both the years.

Seeding density had significant effect on 1000-grain weight in both the years. Significantly more 1000-grain weight (20.65 g) was recorded in S_2 than S_1 against the minimum of 18.83 g in S_3 during 1996. The equivalent figures during 1997 were 21.46, 20.39 and 19.56 for S_2, S_1 and S_3, respectively. Higher 1000-grain weight in S_2 was attributable to optimum number of tillers m^{-2}, optimum filled spikelets panicle^{-1} and more normal kernel m^{-2}resulting in more high density grains. Similar results have been reported by Pedroso and Mariot (1986) who stated that 1000-grain weight was reduced with higher seeding density.

Planting time also affected the grain weight significantly in both the years. In 1996, the maximum 1000-grain weight (20.32 g) was recorded in D_2 against the minimum of 19.17 g in D_3. Similar trend was observed in 1997. More 1000-grain weight in D_2 was attributed to optimum photoperiod availed by this treatment for growth, development and starch filling in the grains. The interaction of seeding density and planting time was non-significant during both the years.

Grain yield was affected significantly by seeding density and planting time in both the years. The interaction between main effects was non-significant in 1996 and significant in 1997.

During 1996, significantly higher grain yield (4.11 t ha^{-1}) was recorded at a seeding density of 100 kg ha^{-1} (S_2) against the minimum of 3.60 t ha^{-1} in S_3.Higher grain yield recorded in S_2 was attributed to more number of panicle bearing tillers m^{-2}, greater number of spikelets panicle^{-1}, optimum normal kernels m^{-2}and more 1000-grain weight than in S_1 and S_3. Similar findings have been reported by Counce and Well (1990) and Sharma (1992) who stated that higher grain yield at optimum population was the result of increase in tillering and number of spikelets panicle^{-1}.

Planting time had significant effect on grain yield ha^{-1} in 1996. Higher grain yield (4.04 t ha^{-1}) was recorded in D_2 as compared to D_1 (3.78 t ha^{-1}), which was on par with D_3 (3.68 t ha^{-1}) during 1996. Higher grain yield recorded in crop planted during third week of June (D_2) was ascribed to more number of panicle bearing tillers m^{-2}, optimum number of spikelets panicle^{-1}, greater number of normal kernels and higher 1000-grain weight in contrast to D_1 and D_3. The results of Singh *et al.* (1997) and Hong *et al.* (1996) are in line with these findings, who reported that yields were higher with early seeding than with late seeding. They also stated that major yield components were number of panicle bearing tillers, number of spikelets panicle^{-1} and 1000-grain weight. However, in 1997, significantly the maximum paddy yield (5.32 t ha^{-1}) was obtained when crop was seeded @ 100 kg ha^{-1} and sown during 3rd week of June (S_2D_2) against the minimum of 3.45 t ha^{-1} (Table II) when the crop was seeded @ 125 kg ha^{-1} and sown during Ist week of July (S_3D_3). More yield recorded in S_2D_2 was due to favorable interaction of S and D at this level. Similar results have been reported by Naranswamy *et al.* (1982), Pedroso (1984a) and Park *et al.* (1990) who indicated that rice paddy yield can be improved by increasing plant density only at earlier sowing dates and it tended to decrease at highest densities and late sowing.

Harvest index was significantly affected by seeding density and planting time during both the years. However, the interaction of main effects was significant only in 1997 (Table II). In 1996, although significantly higher harvest index (26.33%) was recorded in S_2 than S_3 (22.72%) but it was on a par with S_1 (26.28%).

Higher harvest index recorded in S_2 was attributed to more grain yield and lower straw yield in this treatment in contrast to S_3. These results are corroborated with the findings of Park *et al.* (1990) who reported that higher planting density tended to increase grain yield and decrease harvest index. Planting time also affected the harvest index significantly in 1996. The maximum harvest index (25.58%) was recorded in D_2, which was at par with D_3 (25.53%) against the minimum of 23.84% in D_1 during 1996. During 1997, significantly the maximum harvest index (27.55%) was recorded when crop was seeded @ 100 kg ha^{-1} and sown during 3rd week of June (S_2D_2) against significantly the minimum of 18.91 recorded in S_3D_3 (when crop was seeded @ 125 kg ha^{-1} and sown during Ist week of July).

REFERENCES

Counce, P.A. and B.R. Wells, 1990. Rice plant population density effects on early-season nitrogen requirement. *J. Prod. Agri.,* 3: 390–3.

Hong-K.P., J.Y. Kim, J.D. Kang, G.M. Shon and W.K. Shin, 1996. Effect of cool and hot weather on growth and yield in various growing seasons and cropping patterns of rice (*Oryza sativa L.)*. *RAD. J. Agric. Sci.*, 38: 291–8

Janoria, M.P., 1989. A basic plant ideoptype for rice. *Int. Rice Res. Newsl.*, 14: 12–3.

Kumi, K. and G.R. Das, 1993. Performance of direct seeded rice varieties under post-flood situation. *Int. Trop. Agric.*, 11: 74–6.

Lee, K.S. and J.H. Jun, 1998. Identifying optimum seeding time for direct seeding on a wet field surface in reclaimed saline soil in Korea. *Int. Rice Res. Newsl.*, 23: 29–30.

Naranaswamy, S., Y.Y. Rao, K. Ramaseshaiah and V.S. Rao, 1982. Effect of time and method of sowing rice in puddled soil during wet season. *Oryza,* 19: 47–52 (*Field Crop Absts.,* 36: 10260; 1983).

Park, S.T., S.C. Kim, Y. Son, S.K. Lee and G.S. Chaung, 1990. Studies on major cultivation methods for dry direct rice sowing in Yeongnam area. *Res. Reports of the Rural Dev. Admin. Rice,* 32: 18–28 (*Rice Abst.,* 14: 2192; 1991).

Pedroso, B.A., 1984a. Sowing density for irrigated rice. *Empresa catarinensa de Pesquisa Agropecuaria, :* 242–6 (*Rice Abst.*, 9: 1056; 1986).

Pedroso, B.A. and C. Marriot, 1986. Sowing density and spacing between rows. *Instituto Rio Grandense do Arroz,* 165–8 (*Rice Absts.,* 11: 1942; 1988).

Sharma, A.R., 1992. Effect of varying seed rates and transplanting colonal tillers on the performance of rice under intermediate deep water conditions (0-80 cm). *J. Agri. Sci.,* 119: 171–7 (*Field Crop Absts.*, 46: 3339; 1993).

Sharma, A.R., 1994. Effect of seed rate and row spacing on the performance of early and late maturing rice cultivars in mixed crop systems under intermediate deep water conditions (15-50 cm). *J. Agri. Sci.,* 122: 201–5 (*Rice Absts.*, 17:1581; 1994).

Singh, K.M., S.K. Pal, U.N. Verma, R. Thakur and M.K. Singh, 1997. Effect of time and methods of planting on performance of rice (*Oryza sativa L.)* cultivars under medium lands of Bihar Plateau. *Indian J. Agron.,* 42: 443–5.

Steel, R.G.D. and J.H. Torrie, 1984. *Principles and Procedures of Statistics.* McGraw Hill Book Co. Inc. Singapore, pp: 172–7.

(Received 12 November 2000; Accepted 12 December 2000)