AGRO-QUALITATIVE RESPONSES OF DIRECT SEEDED FINE RICE TO DIFFERENT SEEDING DENSITIES

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Effect of different seeding rates (20,40,60,80,100 and 120 kg ha^{-1}) on agro-qualitative traits of direct seeded fine rice was studied during year 2000 and 2001. The results revealed that seeding density of 80 kg ha^{-1} gave significantly the greater panicle bearing tillers m^{-2}, spikelets panicle^{-1} and 1000-grain weight. Grain yield showed an increase of about 30% at 80 kg ha^{-1}. Kernel protein and amylose contents were also increased at the same seeding rate as compared to the rest of the treatments.

Key words: Rice; direct seeding, seeding density

INTRODUCTION

More than 90% of the world rice is produced and consumed in Asia where there is more than 60% of the world population (Bhambhro, 2001). In Pakistan, rice is the second most important food as well as a cash crop which occupies 11% of the country's cropped area. Besides, rice contributes in our national economy by earning a lot of foreign exchange, its share in Pakistan's export is 6.5% (Anon., 2003). At present, Pakistan is growing rice on an area of 2225.2 thousand hectares with an average yield of 2013 kg ha^{-1} (Anon.,2003) which is far less than the potential yield realized at different research stations or at the farms of progressive growers in Pakistan. The yield gap (50-60%) between potential and actual yield at farmers' field is attributed to several agronomic constraints of which low plant density per unit area and improper sowing methods are the most important ones and have a direct bearing on the ultimate yield of rice. In Punjab rice is commonly cultivated by transplanting the nursery, which is a time consuming and cumbersome method and entails a lot of expenditure on raising nursery, its uprooting, transportation and transplanting. Direct sowing is another method of rice cultivation which requires only two man hours to sow the same area (Hashimoto *et al.*, 1978). Several reports indicated that besides lower labour and time involvement there is no fundamental difference between direct sowing and transplanting if good management is practiced in rice culture (Prasad, 1981). Maximum genetic potential of a variety cannot be harvested without ensuring proper plant population. 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 which is not required (Dingkuhn *et al.*, 1991). The appropriate plant population with maximum fertile tillering may be activated through direct seeding which also reduces crop establishment cost. Controversial views about the seed rate necessitate to look into the combination of suitable seed rate. The present study was, therefore, planned to determine the impact of different seeding densities on growth, yield potential and quality of direct seeded fine rice.

MATERIALS AND METHODS

The study was conducted at the research area of the Agronomy Department, University of Agriculture, Faisalabad during 2000 and 2001. The experiment was laid out in a randomized complete block design and replicated four times having a net plot size of 2 x 3 m. Rice variety "Super Basmati" was used as a test crop. The experimental treatments comprised the seeding densities of 20,40,60, 80,100 and 120kg ha^{-1}. The crop was directly seeded through a single row hand drill at optimum soil moisture conditions on 25th of June during both seasons on a well prepared seed bed in 20cm spaced rows. A fertilizer dose of 100-67-63 kg NPK ha^{-1} in the form of urea, single super phosphate (SSP) and Murate of potash (MOP) was applied. All P and K and 1/3rd N was applied at sowing while the remaining dose of N fertilizer was applied in two splits i.e., 30 and 55 days after sowing. All agronomic operations and practices except those understudy were kept normal and uniform for all the treatments. Observations on growth, yield components and quality parameters viz., plant height, number of panicle bearing tillers m^{-2}, number of spikelets panicle^{-1}, 1000-grain weight, grain yield, sterility percentage, kernel protein and amylose contents were recorded during both the years(2000 and 2001). The data collected were statistically analysed using Fisher's Analysis of Variance technique and treatments mean were compared by LSD at 0.05 probability (Steel and Torrie, 1984).

RESULTS AND DISCUSSION

Results pertaining to different agro-qualitative traits of direct sown fine rice as affected by different seeding rates along with statistical interpretation are presented (Table 1). The year effect on the given parameters remained non-significant, therefore, only two-year average data are presented and discussed.

panicle[-1] against S_6 and S_3 which were at par with each other but did not differ significantly from S_1, S_2 and S_5. Similarly S_1, S_2, S_3 and S_5 were at par with one another.

More number of spikelets panicle[-1] recorded for S_4 might be due to optimum number of panicle bearing tillers as a result of which development of panicle was improved causing more appropriation between the

Table 1. Effect of seeding density on growth, yield and quality of direct sown rice.

Treatments (Seeding density (S)	Plant height (cm)	Number of panicle bearing tillers m[-2]	Number of spikelets panicle[-1]	1000-grain weight (g)	Grain yield (t ha^{-1})	Sterile spikelets (%)	Kernel protein concentration (%)	Kernel amylose concentration (%)
S_1 = 20 kg ha^{-1}	94.94	357.25 d	141.96 ab	19.98 a	2.15 d	9.28 c	7.97 a	22.02
S_2 = 40 kg ha^{-1}	94.56	385.62 cd	139.66 ab	19.45 b	2.29 cd	10.5 c	7.65 ab	21.99
S_3 = 60 kg ha^{-1}	95.88	394.87 bc	134.84 bc	19.92 a	2.70 b	11.12 bc	7.51 b	22.12
S_4 = 80 kg ha^{-1}	94.58	443.00 a	146.08a	20.09 a	3.36 a	10.79 bc	7.99 a	22.64
S_5 = 100 kg ha^{-1}	94.12	428.00 ab	140.84 ab	19.51 b	3.32 a	13.14 ab	7.59 ab	22.00
S_6 = 120 kg ha^{-1}	95.04	393.62 c	128.33 c	18.98 c	2.32 c	14.70a	7.26 b	21.99
LSD (5%)	NS	34.14	9.00	0.39	0.15	2.36	0.46	NS

Means in a column having different letters differ significantly at $P \leq 0.5$
NS = Non-significant

Plant height

Data pertaining to plant height (Table 1) revealed that there was a non-significant effect of different seeding rates on the plant height although it ranged between 94.12 cm and 95.88 cm. On the contrary, Sharma (1992) reported an increase in plant height by increasing the seeding rate.

Number of panicle bearing tillers m[-2]

Number of panicle bearing tillers m[-2] varied significantly by different seeding densities. Significantly the greater number of panicle bearing tillers was recorded for S_4 (443.00) against the minimum in S_1 (357.25). Whereas S_5 partially differentiated from S_4 and S_3. Similarly S_3 partially differed from S_2 and S_6.

More number of panicle bearing tillers at seed rate of 80 kg ha^{-1} (S_4) might be due to optimum plant population hence more appropriation between the panicles for resource utilization resulted in more number of fertile tillers per unit area. Similar findings were reported by Shukla (1974) who stated that higher plant density than optimum decreased the number of effective tillers per unit area.

Number of spikelets panicle[-1]

Number of spikelets panicle[-1] was significantly affected by different seeding rates (Table 1). Although, a seeding density of 80 kg ha^{-1} (S_4) produced significantly the greater number (146.08) of spikelets

panicles and more number of spikelets. These results are supported by those of Prasad et al. (1999) who reported that line sowing gave maximum fertile spikelets panicle[-1] when seeded @ 80kgha[-1].

1000-grain weight

1000-grain weight was also significantly affected by different seeding rates (Table 1). A perusal of the data revealed that significantly higher 1000-grain weight was recorded for S_4 (20.09g), S_3 (19.92 g) and S_1 (19.98 g) against the lower in S_6 (18.98 g). S_1, S_3 and S_4 were statistically similar with one an other but differed from S_2 and S_5 which in turn were statistically similar.

The higher 1000-grain weight was probably due to optimum number of tillers m[-2], less competition among panicle bearing tillers, more filling of starch in grains and better kernel development. Similar results have been reported by Pedroso and Mariot (1986) who reported lower grain weight with higher seeding density.

Grain yield

Data given in Table 1 showed significant effect of different seeding densities on grain yield ha^{-1}. Significantly the higher grain yield (3.36 t ha^{-1}) was recorded for S_4 against the minimum in S_1 and S_2. However, S_4 was statistically similar to S_5. Next best treatment regarding the grain yield was S_3.

Higher grain yield obtained by S_4 was ascribed to optimum number of panicle bearing tillers m^{-2} and normal kernels with higher 1000-grain weight. Increase or decrease in seeding density than 80 kg ha^{-1} (S_4) reduced the yield potential probably due to lack of appropriation between assimilate supply and number of spikelets per unit area. At higher planting density there were less spikelets per panicle and yield depends more on the spikelets per panicle. Similar results have been reported by Bhattacharjee (1978) who stated that increasing seeding rate from 40 to 100 kg ha^{-1} in direct sown rice increased paddy yield from 2.76 to 3.48 t ha^{-1} but increasing seeding rate from 120 to 160kg ha^{-1} was not effective in increasing paddy yield.

Sterile spikelets

Percentage of sterile spikelets was significantly affected by different seeding densities (Table 1). Significantly the higher percentage (14.70) of sterile spikelets was recorded for S_6 (120 kg ha^{-1}) against S_1, S_2, S_3 and S_4 which were at par with one another. However, S_6 was statistically similar to S_5.

Higher percentage of sterile spikelets recorded for S_6 was attributed to more planting density and severe competition for photosynthates at reproductive stage which resulted in high sterility of spikelets particularly at lower location of panicle. These results are in agreement with those of Wade and Porter (1975) who stated that percentage of empty florets was affected by higher seeding rates.

Kernel protein concentration

Significant effect of different seeding rates on kernel protein concentration was observed. Although ,significantly the higher protein concentration (7.99%) was recorded for S_4 than S_3 and S_6but was statistically similar to S_1, S_2 and S_5.

Higher protein concentration in S_1 and S_4 was attributed to more 1000-grain weight with maximum compaction of starch resulting in more protein concentration contrast to S_6. These results are in line with those of Karim *et al* (1992) who stated that protein concentration tend to decrease as seeding density was increased.

Kernel amylose concentration

Effect of seeding density on kernel amylose concentration remained non-significant (Table 1). However, it varied from 21.19% to 22.64%. These results are in contradictory with those of Karim *et al.* (1992) who reported the significant effect of seeding density on kernel amylose concentration.

CONCLUSION

The results led to the conclusion that fine rice (Super Basmati) should preferably be directly sown at seeding density of 80 kg ha^{-1} to get maximum paddy yield with profitable results under agro-ecological conditions at Faisalabad, Pakistan.

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