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Influence of crop density on weeds, growth and yield of direct-seeded rice

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ABSTRACT

Field experiment was conducted during *Kharif* 2009 and 2010 to study the effect of rice seed rate (20, 30, 40 and 50 kg/ha) and inter row spacing (15, 20, 25 and 30 cm) on weeds, crop growth and grain yield of direct-seeded rice. Population of *Echinochloa* and *Cyperus* was minimum when DSR was sown with seed rate of 50 kg/ha with 15-20 cm row spacing and it was maximum when lower seed rate of 20-30 kg/ha was used with wider row spacing of 30 cm. Weed biomass was significantly affected by seed rate, being maximum with lower seed rate usage of 20 kg/ha and decreased significantly with each successive increase in seed rate. With the increase in row spacing from 15 to 30 cm, weed biomass increased significantly. Maximum number of tillers was recorded when rice was sown with seed rate of 50 kg/ha with wider row spacing of 30 cm. The seed rates and row spacings did not have any significant effect on effective tillers and grain yield of dry-drilled rice.

Key words: Direct-seeded rice, Grain yield, Row spacing, Seed rate, Weed management

Rice is the most important cereal crop and is the staple diet of 70 per cent of the world's population. Due to receding water table, rising costs of labour for transplanting of paddy and the adverse effects of puddling on soil health, direct-seeded rice (DSR) is gaining popularity (Kumar and Ladha 2011). High seed rates are used in DSR generally to help smother weeds (Dixit *et al.* 2010), compensate for damage by rats and birds, partially overcome the adverse effects of herbicides and compensate for poor crop establishment (Payman and Singh 2008). Crop density and row arrangement also affect the weed growth. Higher crop density can put pressure on the availability of space for weed growth and make the crop more competitive against weeds (Phuong *et al.* 2005, Mahajan *et al.* 2006).

Higher than optimum initial seeding density for obtaining more panicles/m^2 is often accompanied by reduced panicle size, higher rate of spikelet sterility, nitrogen deficiency, reduced tillering, increased proportion of ineffective tillers, more lodging problem and increase chances of rat damage, insect attack and disease infection (Singh and Kumar 2009). There has been increased interest recently in the use of cultural methods in integrated weed management systems (Rao *et al.* 2007). Narrow crop row spacing could be considered as an agronomic tool for weed control. Narrower crop row spacing provided better competition of paddy crop against weeds due to early crop canopy cover which smothered weeds (Payman and Singh 2008, Chauhan and Johnson 2011) and gave rise to higher productive tillers (Lampayan *et al.* 2010) and grain yield of rice (Mahajan and Chauhan 2011). The present study was carried out to study the influence of different seed rates and row spacing of rice on weeds, growth and grain yield of dry-drilled seeded rice.

MATERIALS AND METHODS

The field experiment was conducted at Punjab Agricultural University, Ludhiana during *Kharif* seasons of 2009 and 2010. Ludhiana is situated in Trans-Gangetic Agro-Climatic zone, representing the Indo-Gangetic Alluvial plains at 30°56' N latitude, 75°52' E longitude and at an altitude of 247 m above mean sea level. The total rainfall of 818 and 627.6 mm were received during 2009 and 2010, respectively. Most of the rainfall was received in vegetative phase from 23rd (at sowing time) to 35th standard meteorological week (at 80 days after sowing). The soil of the experimental site was loamy sand (coarse loamy, mixed hyperthermic, Typic Ustipsamments) with normal soil reaction (pH 7.5) and electrical conductivity (0.16 dS/m). The soil was low in organic carbon (0.31%) and available N (251.7 kg/ha) and medium in available P (13.5 kg/ha) and K (164.1 kg/ha). Treatments comprised combinations of four seed rates (20, 30, 40 and 50 kg/ha) and four row to row spacings (15, 20, 25 and 30 cm) and were replicated thrice in a randomised complete block design. Sowing of rice cv. *'PAU 201'* was done during the first week of June using treated seed on

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fine seedbed with single row seed drill as per seed rate and row spacing. Recommended package of practice was followed for raising crop. The crop was harvested manually from net plot area of 3 × 2.40 m in first week of November. The data were statistically analyzed by using statistical procedures. The pooled analysis of two years was done and comparisons were made at 5 per cent level of significance.

RESULTS AND DISCUSSION

Effect on weed population and biomass

Weed flora of the experimental field consisted mainly of grasses, *viz*. *Echinochloa crusgalli* and *Echinochloa colona* and sedges, *viz*. *Cyperus iria, Cyperus compressus* and *Cyperus rotundus*. The pre-emergence spray of pendimethalin 0.75 kg/ha was done which controlled aerobic grasses and broad-leaf weeds associated with DSR. The weed data recorded before post-emergence spray of bispyribac-sodium 0.025 kg/ha at 30 DAS showed that with each increase in seed rate, weed count and biomass decreased significantly as seed rate determines the number of plants per unit area which shows competitive effect against weeds. The density of *Echinochloa* and *Cyperus* spp. was significantly lower with seed rate of 50 kg/ha as compared with 20, 30 and 40 kg/ha of seed rate resulting in low weed biomass. Density of *Echinochloa*/m^2 was significantly lower with seed rate of 40 kg/ha as compared with 20 and 30 kg/ha (Table 1). More weed density in lower seed rates might be due to the presence of gaps and greater space that encouraged the weeds growth. Walia *et al.* (2009) and Mahajan *et al.* (2010) reported that weed biomass decreased linearly with increased seed rates although increasing seed rate beyond the optimum level had no influence on weed density. Payman and Singh (2008) also reported that increasing seed rate from 40-60 kg/ha helped in suppressing the weed density at 30 and 60 DAS. Zhao *et al.* (2007) and Gill *et al.* (2006) also observed that weeds in plots with a lower seeding rate have a better chance to emerge, grow and build up a strong population. Weed biomass decreased linearly with increasing seeding rates from 15 to 125 kg/ha (Chauhan *et al.* 2011). Whereas, Mahajan *et al.* (2010) reported that rice seed rate did not influence density of *Echinochloa colonum*, while density of sedges was

Table 1. Interaction effects of seed rate and row spacings on weeds and growth of direct-seeded rice (mean data of two years)

Seed rate (kg/ha)	Row spacing (cm)				
	15	20	25	30	Mean
Density (no./m^2) of Echinochloa spp. at 30 DAS					
20	2.0	2.4	4.0	4.9	3.3
30	1.9	2.5	3.2	5.1	3.2
40	1.9	2.5	2.9	3.3	2.6
50	1.4	1.5	2.0	2.5	1.9
Mean	1.8	2.2	3.0	3.9	
LSD (P=0.05)	Seed rate: 0.3, row spacing: 0.3, interaction: 0.7				
Weed density (no./m^2) of Cyperus spp. at 30 DAS					
20	93.9	106.7	142.3	221.7	141.1
30	81.6	108.3	137.5	159.6	121.8
40	61.0	85.2	95.4	145.5	96.8
50	29.2	46.5	54.9	102.9	58.4
Mean	66.4	86.7	107.5	157.4	
LSD (P=0.05)	Seed rate: 7.3, row spacing: 7.3, interaction: 14.7				
Weed biomass (g/m^2) at 30 DAS					
20	26.5	27.2	27.9	37.4	29.7
30	16.1	24.5	27.4	31.6	24.9
40	17.1	16.2	18.5	20.3	18.0
50	13.6	14.2	17.8	20.3	16.4
Mean	18.3	20.5	22.9	27.4	
LSD (P=0.05)	Seed rate: 0.3, row spacing: 0.3, interaction: NS				
Rice tillers (no./m^2) at 90 DAS					
20	459.6	503.8	430.0	462.5	464.0
30	441.7	502.9	477.9	491.4	478.5
40	435.8	489.2	575.5	479.2	495.0
50	429.2	476.2	499.2	605.0	502.4
Mean	441.6	493. 0	495.6	509.5	
LSD (P=0.05)	Seed rate: NS, row spacing: 44.8, interaction: 89.5				

influenced resulting in decrease of 34.5 per cent with 240 kg as compared with 15 kg/ha. Density of *Echinochloa* and *Cyperus* spp. was maximum with 30 cm as compared with narrower row spacings of 15, 20 and 25 cm, resulting in more weed biomass.

Weed count was observed to be more due to more space available in wider row spacings. Chauhan and Johnson (2010, 2011) also reported that rice crop sown in wider spacing were vulnerable to weed competition for the longest period (49 days) as compared with narrower spacing (39 days) and had greater weed biomass. Weed population of *Echinochloa* and *Cyperus* was minimum when DSR was sown with seed rate of 50 kg/ha with 15-20 cm row spacing and it was maximum when lower seed rate of 20-30 kg/ha was used for sowing at wider row spacing of 30 cm. *Echinochloa* and *Cyperus* count was statistically similar when DSR was sown with higher seed rate of 50 kg/ha at wider row spacing of 30 cm with DSR sown at seed rate of 20 kg/ha under narrow row spacing of 15 cm. Thus, narrow row spacing under lower seed rate controlled weeds as effectively as higher seed rate of 50 kg/ha, thus by adopting cultural practice of narrow row spacing, additional cost of vital input-seed can be saved. After the application of post-emergence herbicide, no weed population was observed in further periodical observations.

Effect on rice growth

Rice plant height and number of tillers at 90 DAS were significantly affected by row to row spacing. The tiller number increased up to 90 DAS and later on decreased with the advancement of crop age due to mortality of ineffective tillers. Rice plants were significantly taller at narrow row spacing of 15 cm compared with wider row to row spacings of 25 and 30 cm but were statistically at par with 20 cm row spacing (Table 2). Rice plants elongated more for want of light in narrow row spacing. The number of tillers was significantly more when rice was seeded with wider row spacing of 20-30 cm than narrow row spacing of 15 cm (Table 1). Although there is no significant variation in number of tillers produced by direct-seeded rice with increase in seed rate from 20 to 50 kg/ha, but more tillers were produced when rice crop was sown with seed rate of 20-30 kg/ha and spaced at narrower row spacing of 15-20 cm. With increase in seed rate to 40-50 kg/ha, rice crop being seeded at wider row spacing of 25-30 cm produced more number of tillers. Crop dry matter accumulation increased with increase in seed rate and row spacing at 90 DAS although no significant variation was observed (Table 2). Phuong *et al.* (2005) and Chauhan *et al.* (2011) also observed that tillers and biomass of rice increased linearly with increase in seed rate under both weedy and weed-free environments.

Effect on yield of rice

The number of effective tillers tend to increase with increase in seed rate from 20-50 kg/ha but number of grains/panicle decreased, thus, no gain in grain yield was observed. With increase in row spacing from 15-30 cm, non-significant increase in number of effective tillers and grain/panicle was observed. Chauhan and Johnson (2010) observed that rice crop sown in wider spacing produced more grains/panicle. The grain weight/panicle decreased with the increase in seed rate from 20 to 50 kg/ha though the differences were non-significant (Table 2). Grain yield was not influenced statistically by different seed rates suggesting that direct-seeded rice can be drilled with lower seed rate without any yield losses under weed-free conditions and it saves the cost of vital input ‘seed’. Payman and Singh (2008) also reported that increasing seed rate from 40 to 60 kg/ha did not influence the grain yield significantly. Similarly, Zhao *et al.* (2007) reported that under weedfree conditions, grain yield were not influenced by the seed rates within the range of 15 to 125

Table 2. Effect of seed rate and row spacings on growth and yield of direct-seeded rice (mean data of two years)

Treatment	Rice plant height (cm) at 90 DAS	Rice biomass (g/m^2) at 90 DAS	Effective tillers ($no./m^2$)	Grains/panicle (no.)	Grain weight/ panicle (g)	Grain yield (t/ha)
Seed rate (kg/ha)						
20	79.3	1317	312	87	2.2	5.4
30	80.4	1386	314	84	2.1	5.5
40	80.6	1389	320	84	2.1	5.5
50	82.2	1422	322	81	2.0	5.7
LSD (P=0.05)	NS	NS	NS	NS	NS	NS
Row spacing (cm)						
15	83.7	1314	311	83	2.1	5.8
20	81.6	1372	314	83	2.1	5.6
25	79.7	1383	321	85	2.1	5.5
30	77.4	1445	323	85	2.1	5.3
LSD (P=0.05)	3.0	NS	NS	NS	NS	NS

kg/ha. Chauhan *et al.* (2011) also observed that under weed free conditions, number of panicles and grain yield of rice was not influenced by seed rates but under weedy environments, these parameters increased in quadratic relation with increase in seed rate. Numerically, the lowest grain yield was obtained with wider row spacing of 30 cm as compared with narrow row spacings although the differences were non-significant, suggesting that direct-seeded rice can be drilled at 15 cm to 30 cm without any yield losses under weed-free conditions. Lampayan *et al.* (2010) also reported that the grain yield was similar for row spacings ranging from 25 to 35 cm. Whereas, Chauhan and Johnson (2011) reported that aerobic rice grown in 30 cm rows produced less grain yield as compared to that in 15 cm and 10-20-10 cm paired rows.

Thus, optimum seed rate for direct-seeding of rice is 20 kg/ha and optimum row to row spacing varied from 15-30 cm. Sowing rice at narrow row spacing resulted in lower weeds density and biomass in DSR.

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