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Role of Seed Rate and Herbicides on the Growth and Development of Direct Dry-seeded Rice

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ABSTRACT

Field experiments were conducted on loamy sand soils of Department of Agronomy, Punjab Agricultural University, Ludhiana during **kharif** season of 2006 and on sandy loam soil of the seed farms of Ladhowal and Kapurthala during 2007 to find out optimum seed rate and weed management practices in irrigated direct dry-seeded rice. A seed rate of 37.5 to 45 kg/ha depending upon varieties was found optimum for successful cultivation of direct-seeded rice (DSR). Weeds in DSR can be controlled effectively with the integration of post-emergence (25-30 DAS) application of bispyribac 25 g/ha or azimsulfuron 20 g/ha with pre-emergence application of pendimethalin 0.75 kg/ha. Application of pendimethalin alone was found inadequate for controlling complex weed flora of DSR. Integration of pre-emergence application of pendimethalin 0.75 kg/ha with post-emergence application of bispyribac 25 g/ha or azimsulfuron 20 g/ha produced 61.7 and 42.1% higher yield, respectively, than alone application of pendimethalin 0.75 kg/ha.

Key words : Water use efficiency, weed management, complex weed flora

INTRODUCTION

During 2007, rice was grown on 26.21 lakh ha with total production of 101.38 lakh tonnes and average paddy yield of 5802 kg/ha. Rice is the dominating crop during **kharif** season of Punjab state. Farmers prefer rice cultivation as it is a sure crop with mechanized cultivation practices and is disposed off quickly in the market due to minimum support price announced by the central government. The continuous cultivation of rice is leading to deterioration in the physical condition of the soil due to repeated puddling, development of hard pan beneath the plough layer, reduced percolation rate, more wetting period, etc. resulting in low productivity of following crops especially wheat. As rice crop consumes huge quantity of water, so water table of the state is falling at an alarming rate. According to an estimate the fall in water table is 55 cm per year which is large enough and rice is said to be the culprit for this.

To preserve natural resources especially water, there is a need to replace puddled transplanted rice with the direct-seeding technology. Direct-seeding of rice is possible provided there is a good crop establishment as well as adequate weed control methods are available to keep the crop free from weeds (Rao *et al.*, 2007; Rao and Nagamani, 2007). The direct-seeded rice (DSR) offers the advantage of faster and easier planting, ensure proper plant population, reduced labour and hence less drudgery, 10-12 days earlier crop maturity, more efficient water utilization and often higher profit in areas with assured water supply (Datta, 1986). So, the present study was undertaken to work out optimum seed rate as well as weed control methods in direct dry-seeded rice.

MATERIALS AND METHODS

A field experiment was conducted at Research Farm, Department of Agronomy, Punjab Agricultural University, Ludhiana during 2006 and at University Seed Farms (USF) of Ladhowal as well as Kapurthala during 2007. During 2006, three varieties of rice with differential vigour i. e. high (PR 115), medium (PR 116) and low (PR 108) vigour were kept in main plot and three plant densities using three seed rates i. e. 100, 150 and 200 viable seeds/m^2 in sub-plots and two weed control treatments i. e. weed free and partial weedy in sub-sub plots. PR 115 is a short duration variety which takes 125 days from seed to seed, whereas PR 116 and PR 108 are also semi-dwarf varieties which mature in 145 days. The seed requirements for different rice varieties as per seed rate treatments are given in Table 1. Seeding of these respective varieties was done on 10 June 2006 in the dry field (without puddling) by keeping row to row spacing 20 cm. Thereafter irrigations were applied as and when required. In weed free plots broadcasting of sesbania seeds @ 40 kg/ha was made.

Table 1. Seed requirements of different rice varieties

Rice cultivars	Seed rate (kg/ha)		
	100 viable seeds/m^2	150 viable seeds/m^2	200 viable seeds/m^2
PR 115	30.0	45.0	60.0
PR 116	27.5	41.25	55.0
PR 108	25.0	37.5	50.0

Pre-emergence application of pendimethalin 0.75 kg/ha was made as blanket application in the entire experimental plot. Spray of 2,4-D sodium salt 0.8 kg/ha was done 25-30 days after seeding (DAS) in the weed free plots in which sesbania was broadcast and later on all the emerged weeds were removed by hand pulling to keep these plots free from weeds. In partial weedy plots, no weed control method was adopted after the application of pendimethalin.

During 2007, this trial was modified by keeping four seed rate treatments in the main plots and four weed control treatments in sub-plots (split plot design) and it was conducted at University Seed Farms, Ladhowal and Kapurthala and four seed rates i. e. 100, 150, 200 and 250 viable seeds/m^2 were kept in main plot. In sub-plots, application of pendimethalin 0.75 kg/ha as pre-emergence and its integration with post-emergence (25-30 DAS) application of bispyribac 25 g/ha, azimsulfuron 20 g/ha and 2,4-D 0.5 kg/ha were assigned. Dry-seeding (without puddling) of variety PR 115 at Ladhowal was done on 10th June and at Kapurthala on 14th June, 2007 by keeping row to row spacing of 20 cm. The experimental crop was raised by adopting all the recommended agronomic and plant protection measures as for dry-seeded crop. Data on weed dry matter were recorded at 60 DAS with quadrate measuring 50 x 50 cm and expressed as q/ha. Data on plant height, effective tiller, panicle length and grain yield were recorded at the time of crop harvested. Data were subjected to analysis as detailed by Cheema and Singh (1991) in statistical package CPCS-1.

RESULTS AND DISCUSSION

Field at Punjab Agricultural University, Ludhiana

In 2006, three rice varieties with high (PR 115), medium (PR 116) and low (PR 108) vigour showed non-significant differences in plant height and effective tillers. PR 115 variety of rice produced highest grain yield which was significantly higher than PR 108. However, the yield differences for PR 115 and PR 116 were non-significant. Among the seed rate treatments, final plant height was significantly higher with seed rate of 150 and 200 viable seeds per m^2 as compared to 100 viable seeds per m^2. The number of effective tillers per metre row length was also found to be significantly higher with seed rates of 150 and 200 viable seeds per m^2 as compared to 100 viable seeds per m^2. Ghosh and Reddy (1984) found that in alluvial sandy loam soil, the effective tillers increased significantly with the increase in seed rate and were maximum at 150 kg/ha followed by 100 kg/ha and lowest in 50 kg/ha.

The differences in rice grain yield in 150 and 200 viable seeds per m^2 seed rate treatments were non-significant but these treatments were significantly superior to 100 viable seeds per m^2. On an average, the seed rate of 150 viable seeds per m^2 (45 kg/ha for PR 115, 41 kg/ha for PR 116 and 37.5 kg/ha for PR 118) recorded 33.01% higher rice grain yield than 100 viable seeds per m^2 seed rate. Among the weed control treatments weed free crop recorded significantly higher plant height, effective tillers and hence grain yield as compared to partial weedy treatment. All interaction effects were non-significant (Table 2).

Table 2. Effect of rice varieties, seed rate and weed control treatments on yield attributes and grain yield of dry-seeded rice (PAU, Ludhiana, 2006)

Treatments	Plant height (cm)	Effective tillers per metre row length	Rice grain yield (kg/ha)
Main plots (varieties)			
PR-115	56.04	59.1	3991
PR-116	58.28	57.8	3393
PR-108	56.08	49.6	2703
LSD (P=0.05)	NS	NS	680
Sub-plots (seed rates)			
100 viable seeds/m^2	54.37	53.9	2760
150 viable seeds/m^2	58.02	55.5	3671
200 viable seeds/m^2	58.78	57.0	3656
LSD (P=0.05)	2.3	2.8	519
Sub-sub plots (weed control treatments)			
Weed free	58.02	60.7	3817
Partial weedy	56.09	50.2	2909
LSD (P=0.05)	1.86	2.47	899

Interactions : Non-significant.

USF, Ladhowal

Among the seed rate treatments, the differences with respect to plant height were found to be non-significant (Table 3). The dry matter of weeds reduced significantly in 200 and 250 viable seeds/m^2 seed rates as compared to lowest seed rate of 100 viable seeds/m^2. Gill (2008) revealed that seed rate also influenced the weed dry matter effectively as the seed rate increased, the competition among crops increased which shows excellent smothering effect. He reported that the weed dry matter recorded at harvest under 100 and 150 kg/ha reduced by 22.2 and 37.5% under chemical weed control and by 9.0 and 27.3% under integrated weed control, respectively, as compared to the crop raised with 50 kg/ha seed rate. The number of effective tillers per metre row length was significantly more with seed rates of 250, 200 and 150 viable seeds/m^2 compared to the seed rate of 100 viable seeds/m^2. The differences in panicle length due to seed rate treatments were found non-significant. Hence, the rice grain yield was significantly more in these three treatments (250, 200 and 150 viable seeds/m^2) compared to 100 viable seeds/m^2 which may be attributed to higher number of effective tillers and reduction in weeds dry matter. The increase in rice grain yield with 150, 200, 250 viable seeds/m^2 was found to be 20.2, 18.8 and 27.3% as compared to 100 viable seeds/m^2 treatment.

Among the weed control treatments, the post-emergence application of bispyribac 25 g/ha, azimsulfuron 20 g/ha and 2, 4-D 0.50 kg/ha after the pre-emergence application of pendimethalin 0.75 kg/ha was found to be very effective as all these treatments resulted in significant reduction in dry matter accumulation by weeds as compared to pre-emergence application of pendimethalin at 0.75 kg/ha alone. Accordingly, all these treatments produced significantly higher rice grain yield as compared to pre-emergence application of pendimethalin alone. Singh *et al.* (2005) recorded maximum weed control efficacy and grain yield of direct-seeded rice with pre-emergence application of pendimethalin 1.0 kg/ha followed by either one hand weeding or 2,4-D 0.5 kg/ha.

The yield contributing characters i. e. effective tillers per metre row length and panicle length were also significantly higher with the post emergence application of bispyribac 25 g/ha and azimsulfuron 20 g/ha integrated with pre-emergence application of pendimethalin 0.75 kg/ha as compared to application of pendimethalin alone. Rao *et al*. (2007a) reported that pre-emergence application of pendimethalin 1.0 kg/ha as well as pretilachlor 0.750 kg/ha, both supplemented with one hoeing 30 days after sowing, recorded effective control of weeds and gave grain yield at par with conventional method (Rao *et al.*, 2007a). There was 39.2, 29.8 and 33.0% increase in grain yield with post-emergence application of bispyribac 25 g/ha, azimsulfuron 20 g/ha and 2, 4-D 0.50 kg/ha following the pre-emergence application of pendimethalin 0.75 kg/ha over alone application of pendimethalin at 0.75 kg/ha. All interaction effects were found to be non-significant.

USF, Kapurthala

Dry matter of weeds recorded 60 days after sowing was significantly more in lowest seed rate

Table 3. Effect of seed rate and weed control treatments on yield attributes and grain yield of dry-seeded rice (USF, Ladhowal, 2007)

Treatments	Dry matter of weeds (q/ha)	Plant height (cm)	Effective tillers/m row length	Panicle length (cm)	Rice grain yield (q/ha)
Main plots (seed rates)					
100 viable seeds/m^2	2.40	54.9	50.1	24.0	40.70
150 viable seeds/m^2	2.14	54.4	52.6	23.6	48.93
200 viable seeds/m^2	1.98	54.0	52.4	23.9	48.33
250 viable seeds/m^2	1.80	52.5	54.2	23.0	51.80
LSD (P=0.05)	0.43	NS	2.3	NS	5.10
Sub-plots (weed control treatments)					
Pendimethalin 0.75 kg/ha alone	3.76	52.2	47.3	22.7	37.80
Pendimethalin 0.75 kg/ha fb bispyribac 25 g/ha	1.10	56.6	58.6	24.6	52.62
Pendimethalin 0.75 kg/ha fb azimsulfuron 20 g/ha	1.44	55.1	56.0	24.1	49.07
Pendimethalin 0.75 kg/ha fb 2, 4-D 0.50 kg/ha	2.02	51.9	47.4	23.0	50.27
LSD (P=0.05)	0.87	2.5	6.4	1.1	4.21

Interactions : Non-significant.

treatment i. e. 100 viable seeds/m^2 as compared to seed rates of 200 and 250 viable seed treatments. Integration of pendimethalin 0.75 kg/ha (pre-emergence) with post-emergence application of bispyribac 25 g/ha or azimsulfuron 20 g/ha recorded significantly less dry matter of weeds than other weed control treatments. However, alone pre-emergence application of pendimethalin recorded significantly higher dry matter when it was followed by 2,4-D 0.5 kg/ha treatment. The number of effective tillers per metre row length was found to be significantly higher in treatment of 250 viable seeds/m^2 as compared to other seed rate treatments and this treatment was followed by the 200 viable seeds/m^2 seed rate which was significantly higher compared to 150 and 100 viable seeds/m^2 seed rate (Table 4). The population of 100 viable seeds/m^2 produced significantly less rice grain yield as compared to 150, 200 and 250 viable seeds/m^2. There was 41.3, 44.2 and 61.9% increase in rice grain yield with 150, 200 and 250 viable seeds/m^2 seed rates as compared to 100 viable seeds/m^2 treatment.

The pre-emergence application of pendimethalin 0.75 kg/ha followed by post-emergence application of bispyribac 25 g/ha was found to be significantly superior compared to all other herbicidal treatments as it recorded highest rice grain yield (45.06 q/ha). Pre-emergence application of pendimethalin followed by post-emergence application of azimsulfuron 20 g/ha also recorded significantly higher rice grain yield as compared to all other weed control treatments. Pre-emergence application of pendimethalin 0.75 kg/ha alone or followed by 2, 4-D 0.50 kg/ha produced statistically at par rice grain yield but these treatments produced significantly less rice grain yield than pre-emergence application of pendimethalin fb azimsulfuron treatment.

Table 4. Effect of seed rate and weed control treatments on effective tillers and grain yield of dry-seeded rice (USF, Kapurthala, 2007)

Treatments	Dry matter of weeds (q/ha)	Effective tillers/m row length	Rice grain yield (q/ha)
Main plots (seed rates)			
100 viable seeds/m^2	3.7	38.2	23.66
150 viable seeds/m^2	3.2	52.8	33.44
200 viable seeds/m^2	2.7	59.5	34.12
250 viable seeds/m^2	2.5	64.4	38.30
LSD (P=0.05)	0.55	4.8	8.74
Sub-plots (weed control treatments)			
Pendimethalin 0.75 kg/ha alone	5.7	35.6	22.60
Pendimethalin 0.75 kg/ha fb bispyribac 25 g/ha	1.2	73.8	45.06
Pendimethalin 0.75 kg/ha fb azimsulfuron 20 g/ha	1.5	67.4	36.74
Pendimethalin 0.75 kg/ha fb 2, 4-D 0.50 kg/ha	3.6	38.4	25.12
LSD (P=0.05)	1.15	6.2	6.14

Interactions : Non-Significant.

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