International Journal of Agriculture, Environment & Biotechnology
Citation: IJAEB: 7(2): 219-224 June 2014
DOI: 10.5958/2230-732X.2014.00237.X

Agronomy

Weed Dynamics and Dry Seeded Rice Productivity in Relation to Sowing Time, Variety and Weed Control in Sub-Tropical and Semi-arid Region of Punjab

Harjeet Singh Brar and M.S. Bhullar

Punjab Agricultural University, Ludhiana, Punjab-141 004, INDIA

Email: hsbrar86@gmail.com

Paper No. 201 Received: February 20, 2014 Accepted: April 23, 2014 Published: May 18, 2014

Abstract

A field experiment was conducted at Ludhiana, during *kharif* 2008 to study effects of sowing time, variety and weed control on weed dynamics and productivity of dry/direct seeded rice. Six sowing dates (dry seeding on 0 (June 5), 7, 14, 21, 28 days after nursery sowing (DANS) and transplanting 28 DANS) in main plots and combinations of two varieties (PR 115 and PAU 201) and two weed control treatments (3 hand hoeings at 20, 40, 60 days and pendimethalin 0.75 kg pre-emergence followed by bispyribac-sodium 0.030 kg/ha as post emergence) in sub plots were evaluated in a split plot design with three replications. Transplanted crop recorded the lower population of all weeds sp and similar in dry seeding on 0 DANS. Population of all weed sp was lower under early sowing of crop on 0, 7 and 14 DANS as compared to delayed sowings. Population of *Echinochloa* sp, *Leptochloa chinensis, Digitaria sanguinalis, Cyperus rotundus* and *Cyperus iria* did not vary among seeding dates; *Ammania baccifera* and *Caesulia axillaris* intensity was significantly higher in 21 and 28 DANS as compared to early seeding dates. Weed density did not vary among rice varieties. Sequential application of herbicides effectively controlled *Echinochloa sp* and *D sanguinalis* while control of *Eragrostis sp* and *L chinensis* was very poor. Herbicides control broad leaf weeds and sedges except *Cyperus rotundus.* Transplanted crop recorded the highest rice grain yield and was at par to dry seeding 0 DANS but significantly higher than dry seeding on later dates. The grain yield of transplanted crop was 11.9, 22.1, 20.8, 41.7 and 71.4% higher as compared to dry seeding on 0, 7, 14, 21 and 28 DANS, respectively. Rice varieties recorded similar grain yield. Three hand hoeings gave significantly higher grain yield than herbicides. Rice seeding directly on 0, 7 and 14 DANS produced similar grain yield under herbicides and three hand hoeings; further delay in seeding significantly reduced grain yield under herbicides as compared to hand hoeings.

Highlights

Direct seeding on day of nursery sowing of rice with short or medium duration variety gave rice grain yield similar to transplanted crop and pre and post emergence herbicides is desirable for achieving effective weed control in dry seeded rice.

Keywords: Dry seeded rice, sowing time, variety and weed.

Rice is the major source of calories for half the world's population as well as in our country (Roy and Bisht, 2012). It is the main food staple after wheat. Traditionally, in Punjab state, it is raised by puddled transplanting which causes high losses of water through puddling, surface evaporation and percolation. An alternate method of rice planting which reduces water and labour demand needs to be explored; direct/dry seeded rice (DSR) is one of the options. The success of DSR, however, lies in effective weed control. The weed flora in DSR consists of aerobic and anaerobic grasses, broad-leaves and sedges which emerge in several flushes during the crop growth period. The risk of crop yield loss due to competition from weeds is higher in DSR than for transplanted rice because of the absence of the size differential between the crop and weeds and, the suppressive effect of standing water on weed growth at crop establishment (Rao *et al.*, 2007) and the yield losses vary from 5 to 100%. Sowing time has significant influence on weed species composition and intensity. Optimum planting time is location specific which may vary with the variety. Optimum planting time for DSR vary from 10 May at Srinagar (Chopra *et al.*, 1998), 01 June at Ghumsar Udayagiri, Orissa (Padhi, 1995) and 10 June at Ludhiana (Gill *et al.*, 2006). A short duration (125d) and early maturing rice variety PR 115 gave highest yield of DSR followed by medium (140d) variety PR 111 at Ludhiana, Punjab (Gill *et al.*, 2006). In this investigation, efforts were made to find out the effects of sowing time, variety and weed control on weed dynamics and productivity of dry seeded rice under sub tropical semi arid conditions of Punjab.

Materials and Methods

A field experiment was conducted at the Research Farm, Department of Agronomy, Punjab Agricultural University Ludhiana (30° 56'N latitude and 75° 52'E longitude) during *kharif* 2008. Ludhiana represents sub-tropical and semi-arid climate with very hot and dry summer from April to June, hot and humid conditions form July to September, cold winters from November to January and mild climate during February and March. In summer, maximum temperature rises above 42°C and frequent frosty spells are experienced in winter, especially during December and January. The mean annual rainfall is 704 mm in the region, three-fourth of which occurs in July and August. The experimental soil was sandy loam, pH 7.1, low in organic carbon (0.32%) and available N (252.7 kg N/ha), medium in available P (12.9 kg P/ha) and available K (246.1 kg K/ha). The field experiment comprised 24 treatment combinations viz. six sowing dates (dry seeding on 0 (June 5), 7, 14, 21, 28 days after nursery sowing (DANS) and transplanting 28 days after nursery sowing) assigned to main plots and, four combinations of two rice varieties-PR 115 (short duration of 125d) and PAU 201(mid duration of 144d) and two weed control treatments (pendimethalin 0.75 kg/ha pre-emergence followed by bispyribac-sodium 0.030 kg/ha as post emergence 25 days after seeding/transplanting, 3 hand hoeings at 20, 40, 60 days after seeding/transplanting) to sub plots and replicated three times in a split plot design. The rice was seeded in moist soil with hand drill in 20cm spaced rows using 30 kg seed/ha. The soil was kept moist throughout and irrigation was stopped two weeks before crop harvest. The data on population of different weed species was recorded at 60 days placing 50 cm square at two spots in a plot and crop growth parameters i.e. plant height, number of tillers, dry matter and LAI were also recorded at same time. The weed flora in the experimental field consisted mainly of grasses (*Digitaria sanguinalis*, *Echinochloa spp*, *Eleusine aegyptiacum*, *Leptochloa chinensis* and *Eragrostis spp*), broad leaves (*Ammania baccifera* and *Caesulia axillaries*) and sedges (*Cyperus rotundus*, *Cyperus iria* and *Cyperus compressus*).

Results and Discussion

A. Effect on weeds

Population of *Echinochloa* sp, *L chinensis and D sanguinalis* did not vary among sowing dates except *Eragrostis* sp which was higher under rice seeded on 28 DANS than all the other dry seeding dates and transplanted treatment (Table 1). *A baccifera* and *C axillaris* infestation was significantly higher in rice seeded directly on 21 and 28 DANS as compared to all the other dry seeding dates and transplanted treatment; dry seeding on 0 DANS recorded similar population of these two weed sp to transplanted treatment. Seeding dates did not influence intensity of *C rotundus* and *C iria.* However, dry seeding rice on 7, 14 and 28 DANS recorded significantly higher *C compressus* intensity as compared to other sowing dates; Direct sowing of crop on 21 DANS coinside with rainfall and conditions become wet which led to lower population of few weed sp than earlier sown crop. Rice seeded directly on 0 DANS recorded the lowest density of grassy and broad leaf weeds similar to transplanted treatment; the delay in dry seeding increased weed population of all weed sp as compared to early seeding dates. Standing water in transplanted crop did not allow weeds to germinate and

grow. Weed population did not vary among rice varieties. Among weed control, pendimethalin f.b. bispyribac gave effective control of *Echinochloa sp* and *D sanguinalis* and recorded similar population to that of three hoeings; poor control of *Eragrostis sp* and *L chinensis* by these herbicides significantly increased their population as compared to three hand hoeings which removed different flushes of these weeds. Pendimethalin provided effective control of broadleaf weeds and proved as effective as three hoeing. The herbicides were ineffective against *C rotundus* and its intensity was higher than three hoeings; effective control of *C iria* and *C compressus* by bispyribac reduced their intensity at par to three hoeing. Density of most of weed sp under herbicides was statistically similar to three hand hoeing due to effective control of majority of weeds by the sequential application of herbicides. Hand hoeings twice was highly effective in controlling weeds in dry seeded rice (Kathiresan and Manoharan, 2002; Singh *et al.,* 2004) and had higher weed control efficiency than herbicides (Behera and Jena, 1998).

B. Effect on crop growth and yield

(a) Crop growth

Transplanted crop was taller than all the direct sowing treatments except 0 and 14 DANS (Table 2). Low weed pressure (Table 1) in transplanted crop. Direct sowing on 0 DANS produced the highest number of tillers and was at par to direct sowing 7 DANS. The delay in direct sowing recorded reduced the tiller population, because the emergence count decreased with delayed planting (data not shown) which reflected in lower number of tillers as compared to early planted crop. Higher plant density, early onset of active tillering phase due to absence of transplanting shock and a long tillering phase might be the possible reasons for significant more tillers per unit area in direct sown as compared to transplanted crop. Similar trend has also been reported by Schnier *et al.*, (1990b); Dingkuhn *et al.*, (1990b); Goel and Verma, (2000). Dry matter accumulation of crop sown directly on 0, 7, 14 DANS

Table 1: Effect of sowing time, variety and weed control on weed population in dry seeded rice.

Treatment	Weed count at 60 DAS (No/m^2)								
	Grasses			Broad leaves			Sedges		
	Echinochloa sp	Eragrostis sp	Leptochloa chinensis	Digitaria sanguinalis	Ammania baccifera	Caesulia axillaris	Cyperus rotundus	Cyperus iria	Cyperus compressus
Sowing time									
Direct sowing 0 DANS (June 5)	1.0 (0.0)	1.3 (0.46)	1.3 (1.4)	2.8 (8.80)	1.0 (0.00)	1.0 (0.0)	3.0 (10.2)	1.4 (1.4)	1.4 (1.8)
Direct sowing7 DANS (June 12)	1.0 (0.0)	1.5 (1.85)	1.6 (2.3)	2.7 (7.88)	1.2 (0.93)	2.6 (7.4)	3.4 (12.0)	2.1 (6.5)	3.2 (11.6)
Direct sowing 14 DANS (June 19)	1.1 (0.5)	1.6 (2.78)	3.4 (15.3)	2.0 (4.17)	1.9 (5.10)	1.3 (0.9)	3.9 (16.2)	2.0 (5.6)	2.6 (7.9)
Direct sowing 21 DANS (June 26)	1.0 (0.0)	1.0 (0.00)	2.9 (9.7)	1.4 (1.85)	3.2 (14.36)	4.4 (21.3)	6.6 (54.2)	2.4 (8.8)	1.0 (0.0)
Direct sowing 28 DANS (July 3)	1.1 (0.5)	2.1 (5.10)	2.6 (10.7)	1.7 (3.24)	3.4 (15.75)	4.0 (23.2)	5.1 (27.3)	2.1 (6.0)	2.7 (8.8)
Transplanting 28 DANS (July 3)	2.3 (6.9)	1.3 (0.46)	2.0 (4.6)	1.8 (3.71)	1.1 (0.46)	1.5 (2.3)	1.9 (4.0)	1.6 (2.8)	1.0 (0.0)
CD (p=0.05)	NS	0.6	NS	NS	1.3	1.0	NS	NS	0.7
Variety									
PR 115	1.2 (1.1)	1.4 (1.70)	2.4 (7.5)	2.2 (5.71)	2.1 (7.10)	2.8 (12.5)	4.0 (19.6)	2.1 (6.2)	2.0 (4.9)
PAU 201	1.3 (1.5)	1.4 (1.83)	2.3 (7.2)	2.0 (4.17)	1.9 (5.10)	2.1 (5.9)	4.0 (21.8)	1.7 (4.2)	2.0 (5.1)
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Weed control									
Pendimethalin 0.75kg f.b. Bispyribac 0.03 kg ha^{-1}	1.4 (2.2)	1.6 (2.78)	2.6 (10.7)	2.3 (6.18)	1.8 (5.25)	2.4 (9.7)	4.4 (22.9)	1.9 (5.4)	2.1 (6.0)
Hand hoeings (20, 40 and 60 DAS)	1.1 (0.5)	1.2 (0.77)	2.0 (4.6)	1.8 (3.71)	2.1 (6.95)	2.5 (9.0)	3.6 (18.5)	1.9 (4.9)	1.8 (4.0)
CD (p=0.05)	NS	0.3	0.3	NS	NS	NS	0.6	NS	NS

Data subjected to sq. root transformation. Figures in parenthesis are means of original values. DANS: - days after nursery sowing

Table 2: Effect of sowing time, variety and weed control on weed dry matter accumulation, yield and yield attributes in dry seeded rice

Treatment	Effect on crop growth at 90 DAS				Effect on crop	
	Plant height (cm)	No. of tillers / m^2	Dry matter accumulation (t/ha)	Leaf area index (LAI)	1000-seed weight (g)	Grain yield (t/ha)
Sowing time						
Direct sowing 0 DANS (June 5)	47.27	644	12.2	6.86	23.68	5.04
Direct sowing7 DANS (June 12)	39.23	627	13.8	6.63	22.83	4.62
Direct sowing 14 DANS (June 19)	46.90	465	11.3	6.18	22.45	4.67
Direct sowing 21 DANS (June 26)	36.31	500	9.2	6.73	21.17	3.98
Direct sowing 28 DANS (July 3)	39.78	478	8.6	4.72	21.22	3.29
Transplanting 28 DANS (July 3)	50.35	397	11.3	4.84	24.19	5.64
CD (p=0.05)	8.99	86	2.0	0.55	1.77	0.60
Variety						
PR 115	46.34	515	10.5	5.85	22.49	4.47
PAU 201	40.28	492	11.6	6.14	22.69	4.62
CD (p=0.05)	3.00	NS	NS	0.20	NS	NS
Weed control						
Pendimethalin 0.75kg f.b. Bispyribac 0.03 kg ha^{-1}	43.33	487	10.6	5.90	22.35	4.36
Hand hoeings (20, 40 and 60 DAS)	43.29	520	11.4	6.09	22.82	4.72
CD (p=0.05)	NS	28.4	0.6	NS	0.44	0.21

DANS: - days after nursery sowing

was at par, but statistically higher than the crop sown on 21 and 28 DANS. The late sown crop received less time period for vegetative growth produced less number of tillers and dry matter accumulation decreased as compared to early sown crop. The transplanted crop accumulated less dry matter than direct seeded rice as the seedling in transplanted crop got transplanted shock and less number of tillers. Gill *et al.,* (2006) also reported that direct seeded rice produced significantly more dry matter than the transplanted rice. Thakur (1997); Goel and Verma, (2000) also recorded more dry matter accumulation in DSR. LAI did not vary statistically among direct sowings except direct sowing on 28 DANS recorded significantly low LAI than earlier sowings. Transplanted crop produced significantly lower LAI thanall direct sown dates except 28 DANS. Higher LAI in direct sowing was attributed to more plant density (Schnier *et al.,* 1990a; Dingkuhn *et al.,* 1990b).

Among varieties, PR 115 produced significantly taller than PAU 201 at 90 days (Table 2). It was due to the difference in genetic trait of the cultivars (Sethi, 1997). Number of tillers and crop dry matter accumulation did not vary statistically among varieties. Rice cv. PAU 201 produced significant higher LAI than PR 115.

The weed control treatments did not influence plant height as both the treatments that kept the weed pressure to low level because at initial stage, plants did not compete for light and showed similar plant height, but three hand weeding registered significantly higher number of tillers and dry matter accumulation as compared to pendimethalin 0.75 kg/ha f.b. bispyribac sodium 0.03 kg/ha at 90 days. The herbicides kept the weeds under check till 60 days and more weed competition after 60 days, especially of broad leaf weeds, reduced tiller number and dry matter production in herbicidal treatment. Repeated hand weeding done at 20, 40 and 60 days removed all the flushes of weeds, increased solar radiation interception and tiller number increased.

(b) Crop yield

Direct seeding on 0, 7 and 14 DANS produce heavier grain as compared to direct sowing on 21 and 28 DANS (Table 2). Late direct seeded rice got less time for vegetative growth led to lower crop dry matter (Table 1) and grain filling synchronized with low temperature which increases the grain sterility (Janardhan *et al.,* 1980) and small grain resulted in reduced test weight. Transplanting treatment yielded the highest test weight and was at par with direct sowing on 0, 7 and 14 DANS but superior to direct sowing on 21 and 28 DANS. The transplanted treatment produced the highest rice grain yield and was at par with direct seeding on 0 DANS and significantly higher than other direct

seeding dates (Table 2). The rice grain yield in transplanted treatment was 11.9, 22.1, 20.8, 41.7 and 71.4% higher as compared to direct seeding on 0, 7, 14, 21 and 28 DANS, respectively. Rice seeded directly on 0, 7 and 14 DANS yielded at par but significantly higher than that seeded on 21 and 28 DANS. Test weight and grain yield did not vary among rice varieties.

Three hand weedings produced significantly higher grain yield than. Low weed pressure (Table 1) in hand weeded plots created more favorable condition for crop to grow and grain weight increased.

Three hand hoeings produced significantly heavier grains and higher rice grain yield as compared to sequential application of pendimethalin 0.75 kg ha^{-1} f.b. bispyribac sodium 0.03 kg ha^{-1}. Lower weed pressure in hand hoed plots helped the crop produce more number of tillers and dry matter which increased the grain yield than herbicide treated plots.

The interaction effect revealed that rice seeding directly on 0, 7 and 14 DANS produced similar grain yield under herbicides and three hand hoeings (Table 3); further delay in rice seeding significantly reduced the grain yield under herbicides as compared to hand hoeings (Table 3). Higher weed pressure under late sowings put more competition which reduced the grain yield under herbicide treated plot while three hoeings successfully removed the weeds even under late sowings.

Table 3: Interaction effect of sowing time and weed control treatments on grain yield (t/ha) in rice.

Sowing time	Weed control	
	Pendi 0.75 f.b. Bispyribac 0.03 kg ha^{-1}	Hand hoeings (20, 40 and 60 DAS)
Direct sowing 0 DANS	4.78	5.29
Direct sowing7 DANS	4.51	4.73
Direct sowing 14 DANS	4.63	4.72
Direct sowing 21 DANS	3.56	4.39
Direct sowing 28 DANS	2.87	3.72
Transplanting 28 DANS	5.83	5.46
CD at 5%	0.52	

DANS: - days after nursery sowing

Conclusion

Rice seeded directly on day of nursery sowing produced similar grain yield to transplanted crop. Short and medium duration varieties recommended for transplanted culture are equally good for dry seeding also. Sequential application of pre and post emergence herbicides is desirable for achieving effective weed control in dry seeded rice.

References

Behera, A. K., and S. N. Jena. 1998. Weed control in direct seeded, rainfed upland rice (*Oryza sativa*). *Indian Journal of Agronomy* **43**: 284-290.

Chopra, R. S., G. M. Khan, A. S. Bali, and M. H. Shan. 1998. Response of direct seeded rice to moisture regimes and sowing dates in Kashmir valley. *Oryza* **35:** 279-281.

Dingkuhn, M., H. F. Schnier, S. K. De Datta, K. Dorffling, C. Javellana, and R. Pamplona. 1990b. Nitrogen fertilizer of direct seeded flooded vs. transplanted rice. II. Interactions among canopy properties. *Crop Science* **30:** 1284-1292.

Gill, M. S., A. Kumar, and P. Kumar. 2006. Growth and yield of rice (*Oryza sativa*) cultivars under various methods and time of sowing. *Indian Journal of Agronomy* **51**:123-127.

Goel, A. C., and K. S. Verma. 2000. Comparative study of direct seeding method in Punjab. *Intensive Agriculture* **41**:22-23.

Janardhan, K. V., K. S. Murthy, and N. D. Dash. 1980. Effect of low light during ripening period on grain yield and translocation of assimilates in rice varieties. *Indian Journal of Plant Physiology* **23:** 163-168.

Kathiresan, G., and M. L. Manoharan. 2002. Effect of seed rate and methods of weed control on weed growth and yield of direct sown rice (*Oryza sativa*) *Indian Journal of Agronomy* **47**: 212-215.

Padhi, A. K. 1995. Response of rainfed upland rice to sowing time. *Oryza* **3**:124-126.

Rao Upendra, A., A. B. Reddy, and D. Reddy. 2007. Influence of age of seedlings and integrated nitrogen management on NPK uptake by late planted rice (*Oryzasativa* L.). *Crop Research* **34**: 6-9.

Roy S, and P. S. Bisht. 2012. System of Rice Intensification: A possible way to sustainable rice production. *International Journal of Agriculture, Environment and Biotechnology* **5:** 177-184.

Schnier, H. F., M. Dingkuhn, S. K. De Datta, K. Mengal, and J. E. Faronilo. 1990b. Nitrogen fertilization of direct seeded flooded *vs* transplanted rice. 1. Nitrogen uptake, photoynthesis, growth and yield. *Crop Science* **30:** 1276-1284.

Sethi, P. K. 1997. Physiological basis of yield variation in hybrid rice M.Sc. (Ag.) thesis submitted Orissa University of Agriculture and Technology, Bhubaneswar, India. pp 97.

Singh, U. P., Y. Singh, R. K. Singh, and O. N. Singh. 2004. Evaluation of rice genotypes for medium deep, water-logged rice eco-system of eastern Uttar Pradesh. *Oryza* **41:** 53-54.

Thakur, R. B. 1997. Influence of time of nursery seedling on performance of high yielding rice varieties of different maturity duration. *Oryza* **34:** 47-50.

