Indian Journal of Agronomy **67** (1): 93–96 (March 2022)

Research Communication

Effect of first irrigation scheduling and herbicides on productivity of direct-seeded rice (*Oryza sativa*)

HARPREET SINGH[1], KANWALJIT SINGH SANDHU[2] AND KANIK KUMAR BANSAL[3]

P.G. Department of Agriculture, Khalsa College, Guru Nanak Dev University, Amritsar, Punjab 143 001

Received: April 2021; Revised accepted: February 2022

ABSTRACT

An experiment was conducted during the rainy (*kharif*) season of 2019 at Students' Research Farm, Khalsa College, Guru Nanak Dev University, Amritsar, Punjab. First irrigation timings, viz. I_1, 7 days after sowing (DAS); I_2, 14 DAS and I_3, 21 DAS, as main plot and herbicidal combinations, viz. W_1, pendimethalin 750 g/ha + bispyribac 25 g/ha at 25 DAS; W_2, pendimethalin 750 g/ha + pyrazosulfuron 20 g/ha; W_3, pendimethalin 750 g/ha + pyrazosulfuron 20 g/ha + bispyribac 25 g/ha at 25 DAS; W_4, weedy check and W_5, weed-free as subplot treatments were conducted in a split-plot design with 3 replications. The results showed that, among the first irrigation scheduling, crop-growth parameters (plant height, dry-matter accumulation, leaf-area index); yield attributes (effective tillers, grains/panicle, 1,000-grain weight); grain yield (53.9 q/ha); net returns (₹71,326/ha) and benefit : cost (B : C) ratio (2.69) were maximum in I_1 treatment. Among the herbicidal combinations, crop-growth parameters, yield-attributing characters, grain yield (57.2 q/ha), net returns (₹ 79,800/ha), B : C ratio (3.18) and weed-control efficiency were recorded highest in pendimethalin 750 g/ha + pyrazosulfuron 20 g/ha + bispyribac 25 g/ha at 25 DAS. Inclusion of bispyribac with other herbicides performed better in direct-seeded rice.

Key words: Direct-seeded rice, Economics, Herbicides, Irrigation scheduling, Weed-control efficiency

Rice (*Oryza sativa* L.) is one of the most important food crops in the world. It is major source of food after wheat (*Triticum aestivum* L.) and contains carbohydrate (74.8%), protein (8.4%), fat (2.6%), minerals (phosphorus, calcium, iron etc) amino acids, thiamine, riboflavin, niacin, pigments and dietary fibre. Total production of rice in India during 2018 is estimated to be 172.6 million tonnes produced on area of 44.5 million ha, with the average yield of 3,878 kg/ha (FAO, 2018). Rice is commonly grown by transplanting its seedlings in puddled soil which requires more water and labour leading to less profitability. Others factors threatening the efficiency and sustainability of rice cultivation are inefficient use of fertilizers, climate variability, rising fuel prices, emerging socio-economic changes such as urbanization, migration of labour, preference for non-agricultural work, and concerns about farm-related pollution such as emission of methane gas during puddling (Ladha *et al*., 2009). Thus, scientists have suggested direct-seeded rice (DSR) to address the issue of dwindling precious underground water and increasing labour charges. DSR paves the way for efficient use of land, labour and water resources with certain advantages like water saving by avoiding water used in nursery raising, puddling and maintenance of submergence in transplanted rice (TPR), lower methane emissions, early harvesting, low production costs by avoiding expenditure on nursery raising and planting and better soil physical conditions for the follow-up of wheat crop. The success of DSR, however, lies in effective weed control. However, the risk of crop yield loss due to competition from weeds is higher in DSR than for transplanted rice. Selections of efficient irrigation scheduling and weed-management practices are the major limiting factors. Therefore present study investigates the effect of first irrigation scheduling and weed management in direct seeded rice.

A field experiment was conducted at students' farm Department of Agronomy, Khalsa College, Guru Nanak Dev University, Amritsar, Punjab, during the rainy (*kharif*) season of 2019. The climatic condition under Amritsar district of Punjab is subtropical. The total rainfall received during the crop-growing period was 583.33 mm. The weekly maximum and minimum temperatures, during the experimental period, ranged from 24.3 to 43.6°C and 11.2 to 28.9°C respectively. The soil of the experimental site was

Based on a part of M.Sc. thesis of the first author, submitted to the P.G. Department of Agriculture, Khalsa College, Guru Nanak Dev University, Amritsar, Punjab in 2021 (unpublished)

[1]**Corresponding author's Email**: pannuharpreet09@gmail.com
[1,3]Research Scholar, [2]Assistant Professor (Agronomy), P.G. Department of Agriculture, Khalsa College, Guru Nanak Dev University, Amritsar, Punjab 143 001

sandy loam with irrigated conditions, having *p*H 8.2, low in available N (175.2 kg/ha), medium in available phosphorus (19.8 kg/ha) and available potassium (251.4 kg/ha). The field was prepared by ploughing twice with disc harrow followed by planking. The pre-treated seeds of variety PR 126 with carbendazim 50 wp (Bavistin 50 wp) @ 2 g/kg in 1 litre water were soaked for 10 hours and after shade drying were sown by single-row hand-operated drill in the rows, 20 cm apart at the rate of 8 kg/0.4 ha on 1 June. Recommended dose of nitrogen at 60 kg/0.4 ha was applied in 3 equal splits–4, 6 and 9 weeks after sowing. Irrigation scheduling, viz. I_1, first irrigation 7 days after sowing (DAS) I_2, first irrigation at 14 DAS; and I_3, first irrigation at 21 DAS, and 5 sources of weed management, viz. W_1, pendimethalin 750 g/ha + bispyribac 25 g/ha at 25 DAS; W_2, pendimethalin 750 g/ha + pyrazosulfuron 20 g/ha; W_3, pendimethalin 750 g/ha + pyrazosulfuron 20 g/ha + bispyribac 25 g/ha at 25 DAS; W_4, weedy check; and W_5, weed-free, were laid out in a split-plot design with 3 replications. First irrigation was given according to the treatments, after that crop was irrigated at an interval of 5–6 days. Five plants were tagged at random in net plot area for recording various growth and yield components. The data on various parameters were statistically analysed by using CPCS-1 (Cochran and Cox, 1967).

Growth parameters showed significant variation owing to change in the time of first irrigation to direct-seeded rice (DSR). Plant height, leaf-area index and dry-matter accumulation were significantly maximum with I_1 compared with I_3 treatment. However, I_2 remained at par with both I_1 and I_3 treatment (Table 1). Early availability of moisture in I_1 treatment might have lower the extremely high temperature-related stress and facilitated faster growth. Our findings are in line with Jagannath *et al.* (2017) and Mukhrjee *et al.* (2020). Among the weed-management practices, the highest and lowest growth parameters were recorded in W_5 and W_4 treatments, respectively. Further, in chemical weed-control methods, treatment W_3 performed significantly better than W_1 and W_2 treatments. However, W_3 treatment was at par with W_1. This might be due to less crop-weed competition throughout the crop growth with combined application of 2 pre-emergence (pendimethalin + pyrazosulfuron) and 1 post-emergence (bispyribac) herbicides which led to luxuriant crop growth. These findings are in agreement with observations of Rolaniya *et al.*, (2015).

Effective tillers, grains/panicle and grain yield were significantly influenced by change in timing of first irrigation. Maximum effective tillers, grains/panicle and grain yield were recorded in I_1 treatment followed by I_2 and I_3 treatments. However, I_2 was at par with both I_1 and I_3 treatments. The corresponding per cent increase of I_1 and I_2 treatments over I_3 treatment was 19.4 and 8.8 respectively (Table 1). Though 1,000-grain weight did not vary significantly, it showed similar trend. Higher yield attributes and yield in I_1 treatment might be owing to increased leaf area which enhanced supply of photosynthates from source to sink, resulting in better yield components and yield (Godara *et al.*, 2017). Among the weed-management practices, the highest and lowest yield attributes and grain yield

Table 1. Effect of first irrigation scheduling and herbicides on growth and yield attributes of direct-seeded rice

Treatment	Plant height (cm) at harvesting	Leaf-area index at 90 DAS	Dry-matter accumulation (q/ha)	Effective tillers	Grains/ panicle	1,000-grain weight (g)	Grain yield (q/ha)
Irrigation interval							
I_1	102.14	3.93	135.19	266.8	103.81	22.50	53.92
I_2	95.52	3.70	123.23	249.4	96.46	22.30	49.12
I_3	89.62	3.47	111.76	238.5	90.17	22.10	45.14
SEm±	3.31	0.12	6.14	9.81	4.70	0.11	2.66
CD (P=0.05)	7.09	0.26	13.13	21.0	10.06	NS	5.71
Weed-management practices							
W_1	97.40	3.77	134.51	269.4	98.45	22.36	54.16
W_2	93.51	3.62	121.83	243.8	91.10	22.26	47.31
W_3	99.68	3.85	137.60	276.0	103.72	22.46	57.17
W_4	84.61	3.28	77.36	178.5	80.58	21.92	27.32
W_5	103.59	3.99	145.66	290.3	110.22	22.50	61.01
SEm±	1.16	0.06	3.34	7.28	3.46	0.10	1.45
CD (P=0.05)	3.51	0.13	7.14	15.6	7.42	NS	3.10

I_1, First irrigation 7 DAS; I_2, first irrigation 14 DAS; I_3, first irrigation 21 DAS; W_1, pendimethalin 750 g/ha + bispyribac 25 g/ha at 25 DAS; W_2, pendimethalin 750 g/ha + pyrazosulfuron 20 g/ha; W_3, pendimethalin 750 g/ha + pyrazosulfuron 20 g/ha + bispyribac 25 g/ha at 25 DAS; W_4, weedy check; W_5, weed free; DAS, days after sowing were recorded in W_5 and W_4 treatment respectively. Further, in chemical weed-control methods, treatment W_3 performed significantly better than W_1 and W_2 treatments. However, W_3 treatment was at par with W_1 treatment. The corresponding per cent increase in W_3 over W_1 was 5.55. More grain yield in W_3 might be owing to effective weed-control through combined application of pre- (pendimethalin + pyrazosulfuron) and post-emergence (bispyribac) herbicides which led to better crop growth, less weed density, dry weight and higher yield attributes. Our findings confirm reports of Bhurer *et al*., (2013) and Chakarborti *et al*., (2018).

Dry-matter accumulation of weeds reflects the competing ability of weeds. Dry-matter accumulation by weeds increased progressively with the advancement of crop age. The maximum dry matter was recorded at 60 DAS and at harvesting with I_1, followed by I_2 and I_3 treatments. Weed-control efficiency was maximum with I_3 treatment at harvesting followed by I_2 and I_1 treatments (Table 2). Among the weed-control practices, the lowest and highest weed dry matter at 60 DAS and at harvesting was recorded with W_5 and W_4 treatment. Further, chemical weed-control methods showed that W_3 treatment recorded the lowest weed dry-matter, being significantly better than W_1 and W_2 treatments. The highest weed-control efficiency was recorded under W_5 followed by W_3, W_1 and W_2 treatments. The lowest weed-dry weight and highest weed-control efficiency in W_3 treatment might be owing to the application of bispyribac which showed effective weed control (Rolaniya *et al.,* 2015)

Net returns in I_1 over I_2 and I_3 treatments were ₹ 8,390/ha and ₹ 15,387/ha respectively. Treatment I_1 revealed the maximum benefit: cost ratio, followed by I_2 and the lowest in I_3 treatment. Among the weed-management practices, higher net returns were obtained with W_3, followed by W_5, W_1, W_2 and W_4 treatments. All the chemical weed-control treatments resulted in more net returns than weedy check treatment. Net profit gained in W_3, W_2 and W_1 treatments over W_4 was ₹ 51,774/ha, ₹ 44,393/ha and ₹ 34,713/ha respectively. The highest benefit: cost ratio was obtained by W_3 treatment followed by W_1, W_2, W_5 and W_4 treatments (Table 2).

First irrigation at 7 DAS (I_1) exhibited higher growth, yield-contributing characters, yield (53.9 q/ha), net returns (₹ 71,326/ha) and B : C ratio (2.69). Among the herbicidal combinations, W_3 (pendimethalin 750 g/ha + pyrazosulfuron 20 g/ha + bispyribac 25 g/ha at 25 DAS) treatment showed less degree of crop-weed competition, higher growth, yield attributes, yield (57.2 q/ha), net returns (₹ 79,800/ha) and B : C ratio (3.18). Thus, first irrigation at 7 DAS and herbicidal combination (pendimethalin 750 g/ha + pyrazosulfuron 20 g/ha + bispyribac 25 g/ha at 25 DAS) application may be recommended for direct-seeded rice under sandy-loam conditions in Amritsar, Punjab.

REFERENCES

FAO. 2018. www.fao.org.com

Bhurer, K.P., Yadav, D.N., Ladha, J.K., Thapa, R.B. and Pandey,

Table 2. Effect of first irrigation scheduling and herbicides on weed dry-matter accumulation, weed-control efficiency and economics of direct seeded rice

Treatment	Weed dry-matter accumulation (g/m^2)		Weed-control efficiency (%)	Total returns (₹/ha)	Total cost (₹/ha)	Net returns (₹/ha)	Benefit: cost ratio
Irrigation interval	At 60 DAS	At harvesting					
I_1	8.22 (82.36)	15.85 (320.44)	50.69	97,879	26,553	71,326	2.69
I_2	7.41 (66.94)	14.39 (265.25)	51.91	89,169	26,233	62,936	2.40
I_3	6.80 (57.00)	13.22 (227.80)	53.80	81,932	25,993	55,939	2.15
SEm±	0.22	0.45	–	–	–	–	–
CD (P=0.05)	0.49	0.97	–	–	–	–	–
Weed-management practices							
W_1	8.32 (69.79)	15.81 (257.28)	54.71	97,254	24,835	72,419	2.91
W_2	9.45 (90.01)	17.75 (323.08)	43.12	85,882	23,110	62,772	2.71
W_3	7.11 (51.30)	14.31 (210.58)	62.86	104,834	25,035	79,800	3.18
W_4	11.50 (132.74)	23.57 (564.87)	-	49,586	21,560	28,026	1.30
W_5	1.00 (0)	1.00 (0)	100	110,743	36,760	73,984	2.01
SEm±	0.25	0.64	–	–	–	–	–
CD (P=0.05)	0.54	1.39	–	–	–	–	–

Figures in the parentheses are square root transformed values (sq. root of x+1)

I_1, First irrigation 7 DAS; I_2, first irrigation 14 DAS; I_3, first irrigation 21 DAS; W_1, pendimethalin 750 g/ha + bispyribac 25 g/ha at 25 DAS; W_2, pendimethalin 750 g/ha + pyrazosulfuron 20 g/ha; W_3, pendimethalin 750 g/ha + pyrazosulfuron 20 g/ha + bispyribac 25 g/ha at 25 DAS; W_4, weedy check; W_5, weed free; DAS, days after sowing

K.R. 2013. Efficacy of various herbicides to control weeds in dry direct seeded rice (*Oryza sativa* L). *Global Journal of Biology, Agriculture and Health Sciences* **2**(4): 205–212.

Chakraborti, M., Duary, B. and Datta, M. 2018. Growth and yield of aerobic rice as influenced by different weed management practices in Tripura, India. *International Journal of Current Microbiology and Applied Sciences* **7**(6): 3,715–3,721.

Cochran, W.G. and Cox, G.M. 1967. *Experiment Designs*. Asia publishing House, New Delhi, India.

Godara, S.P., Yadav, A., Yadav, D.B., Gill, G. and Sharma, V.K. 2017. Optimization of irrigation scheduling in direct seeded basmati rice in North-Western Indo-Gangetic plains and its effects on water saving, crop productivity and economics. *Environment and Ecology* **35**(3C): 2,261–2,265.

Jagannath, M.A., Singh, J.K., Sen, A. and Bohra, J.S. 2017. Effect of irrigation and nitrogen management on rice (*Oryza sativa*) under system of rice intensification and its residual effect on lentil (*Lens culinaris*). *Indian Journal of Agronomy* **62**(3): 260–267.

Ladha, J.K., Kumar, V., Alam, M.M., Sharma, S., Gathala, M., Chandna, P., Saharawat, Y.S. and Balasubramanian, V. 2009. Integrating crop and resource management technologies for enhanced productivity, profitability, and .sustainability of the rice-wheat system in South Asia. (In): *Integrated Crop and Resource Management in the Rice–Wheat System of South Asia*. Ladha, J.K., Singh, Y., Erenstein, O. and Hardy, B. (Eds). *International Rice Research Institute,* Los Baños, Philippines, pp. 69–108.

Mukhrjee, B., Ghosh M., Banerjee, S., De, S.K. and Adhikary, S. 2020. Effect of irrigation intervals and hybrids on growth, yield and economics of dry (*boro*) rice (*Oryza sativa*) in New Alluvial Zone of West Bengal. *Indian Journal of Agronomy* **65**(4): 485–488.

Rolaniya, L.T., Vivek, Mishra, A., Dwivedi, A., Kumar, V., Kumar, V. and Punia, M. 2015. Effect of irrigation scheduling and weed management on weed dynamics, water productivity and performance of dry seeded rice. *Green Farming* **6**(6): 1,281–1,286.