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Adoption Status of Crop Production Practices in Direct Seeded Rice: A Case Study of Kapurthala District of Punjab (India)

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ABSTRACT

The labor scarcity amid lockdown due to COVID-19 and reduced labor migration from other states made timely rice establishments a big challenge for the farmers in Punjab. The direct seeded rice (DSR) emerged as economically viable option for timely rice establishment, but several farmers faced difficulties in DSR during *kharif*--2020 and therefore, adopted diverse crop production and management practices. A detailed survey was conducted in different blocks of Kapurthala district (Punjab) and data were collected from randomly selected 106 farmers. The results showed that 13.2 per cent of total farmers completely failed in DSR. There was large variation in different crop production and management practices followed by the farmers. Seed rate varied between 19.9 and 22.2 kg ha^{-1} and was significantly higher in Kapurthala, while lowest in Dhilwan block. Nitrogenous fertilizer application was higher by 13.0 and 5.7 per cent in Sultanpur Lodhi and Nadala blocks than the district average of 167.9 kg N ha^{-1}. Phosphoric and potash fertilizer application rates varied between 6.7 and 12.1 kg P ha^{-1} and 3.3 and 9.7 kg K ha^{-1}, respectively. Rice grain yield varied between 64.3 and 70.2 q ha^{-1} under DSR, as compared with 71.3 and 76.3 q ha^{-1} under puddled transplanted rice (PTR). The irrigation water productivity varied between 3.6 and 4.4 kg ha^{-1} mm^{-1} in DSR, compared with 3.3 and 3.6 kg ha^{-1} mm^{-1} under PTR. The results highlight the lack of proper knowledge and adoption of recommended practices for DSR technology among farmers, which require further intensive extension efforts for creating awareness in between them.

INTRODUCTION

The conventional puddled transplanting of rice (PTR) is water, capital, energy and labor-intensive practice (Bhatt et al., 2019; Singh et al., 2020a; Bhatt et al., 2021). In Punjab region, timely rice establishment through PTR depend exclusively on migratory labour (50 million men days) (Dhillon and Vatta, 2020). The lockdown imposed in the region due to pandemic of COVID-19 intensified the problem of labor scarcity, particularly in rural areas which affected farm operations. After lockdown, about one million laborers moved back to their native states with almost no outlook of returning in the near future (Chaba and Damodara, 2020). Due to labor shortage, the seedling transplantation charges were exorbitant (Rs. 10,000 to 17,000 ha^{-1}). Therefore, the direct seeded rice (DSR) which has been the time efficient and economically viable option, was adopted by large number of farmers in the state. Majority of the farmers adopted DSR technique of rice establishment for the first time in their fields, and experienced several problems related to crop production and management practices. The lack of past experience regarding component technologies related to DSR, some farmers failed in targeting potential rice grain yield due to inefficient management of weeds, nutrient deficiencies, heavy mouse attack, poor germination owing to deep placement of seeds, rodent attack etc. (Rohila et al., 2018). However, farmers' fields are intensively

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managed ecosystems (Singh and Benbi, 2020), and therefore, farmers adopt diverse crop production and soil management practices to solve location specific problems (Singh et al., 2019). Therefore, the present study was conducted during March, 2021 in Kapurthala district (Punjab), India to study the adoption status of different crop production and management practices in DSR.

METHODOLOGY

The study was conducted in Kapurthala district of Punjab extends between longitudes of 31º 22´46´´ N and latitude of 75º 23´ 05´´ E, and lies between the Beas River and the Kali-Bein River, known as floodplains or *Bet* area (Singh and Singh, 2007). The economy of the district has been predominantly agricultural, and wheat, rice, sugarcane, potato and maize are the major crops in the district. For the purpose of the study, data were collected from all the five blocks of the district. Blockwise list of DSR growers was collected from Department of Agriculture & Farmers' Welfare. Respondents from each block were selected in proportion to the total number of DSR growers through randomized sampling procedure. Thus, data were collected from 106 respondents from all 5 blocks of the Kapurthala district viz. Sultanpur Lodhi (n=22), Kapurthala (n=23), Phagwara (n=20), Nadala (n=21) and Dhilwan (n=20) during March, 2021. Respondents selected for the study were between age group of 26-65 years, having agriculture experience of more than 5 years. For the purpose of data collection, a semi-structured schedule was developed. Data from the respondents were collected through faced to face interviews using interview schedule developed for the purpose of the study. The information regarding soil type, irrigation water availability, electricity connection, method of rice establishment (viz. dry DSR or *tarr wattar* DSR), seed rate, fertilizers application and the number of irrigations applied etc. was collected from the respondents using semi-structured schedule. The data were subjected to analysis of variance (ANOVA) using IBM SPSS for Windows 21.0 (IBM SPSS 21.0, Inc., Chicago, U.S.A.). The mean differences were separated by the Least Significant Difference (LSD) *post hoc* test at 95 per cent confidence interval. The treatment means different at $p<0.05$ were considered statistically significant. Lower case letters indicate statistical difference between the rice establishment methods, while the uppercase letters indicate statistical difference between administrative blocks. Line bars in figures indicate standard error from mean.

RESULTS AND DISCUSSION

The study revealed that 41.9-68.2 per cent of total cultivable land with the selected farmers was brought under DSR, with the highest in Sultanpur Lodhi and the lowest are shift in Dhilwan block. On an average, 54.2 per cent of total area under rice cultivation was shifted to DSR in the study region during kharif 2020. Electric motors of 3 to 15 HP employed with 224 ft bore-wells and delivery of 94 ft. The majority of soils were medium to heavy textured in Sultanpur Lodhi, Kapurthala, Phagwara and Nadala blocks, while light to heavy textured soils in and Dhilwan block.

Input uses in direct seeded rice

The quantity of seed used for rice establishment under DSR technique in different blocks of Kapurthala district delineated in Table 1. The seed rate used for crop establishment under DSR varied between 19.9 and 22.2 kg ha^{-1} with a mean seed rate of 21.4±0.5 kg ha^{-1}. Seed rate was significantly ($p<0.05$) higher in Kapurthala, while the lowest in Dhilwan block. These results revealed a non-significant difference in seed rate used by the farmers of Sultanpur Lodhi, Phagwara and Nadala blocks in DSR technique. Same seed rate uses for crop establishment under DSR has been reported in Punjab by Dhillion and Mangat (2015).

The results revealed a large variation in nitrogenous fertilizer use (146.7-189.7 kg N ha^{-1}) by the farmers of Kapurthala district in DSR (Table 1). Data showed that nitrogenous fertilizer application in DSR by the farmers of Sultanpur Lodhi and Nadala was higher by 13.0 and 5.7 per cent than the district average of 167.9 kg N ha^{-1}. Nitrogenous fertilizer application rate in DSR was significantly higher in Sultanpur Lodhi, compared to the others blocks. Phosphatic fertilizer application rate varied between 6.7 and 12.1 kg P ha^{-1} in DSR, with a significantly higher application rate in Dhilwan block, while the lowest in Sultanpur Lodhi than the other blocks. As compared with the average phosphatic fertilizer application rate of 10.6 kg P ha^{-1} in DSR in the Kapurthala district, phosphatic fertilizer application rate was higher in Nadala and Dhilwan blocks by 14.1 and 87.7 per cent, respectively. These results revealed that fertilizer-K application rate varied between 3.3 and 9.7 kg K ha^{-1} (mean=6.4±1.3 kg K ha^{-1}), and was significantly higher in Dhilwan block, followed by Nadala while the lowest in Kapurthala and Sultanpur Lodhi blocks, which did not differ significantly (Table 1). Zinc application in DSR was significantly higher in Nadala block, compared with the other blocks by 1.9-3.4 times. Similarly, for the management of iron (Fe) deficiency in DSR, Fe application was significantly higher in Nadala block, while the lowest in Dhilwan block. Therefore, there is an urgent need to disseminate the technology on efficient use of chemical fertilizers in direct seeded rice (Singh et al., 2019).

Table 1. Seed rate and fertilizers used in DSR in Kapurthala district

Particular	Administrative blocks					
	Kapurthala (n=18)	Sultanpur Lodhi (n=19)	Phagwara (n=20)	Nadala (n=20)	Dhilwan (n=15)	Overall (n=92)
Seed rate (kg ha^{-1})	22.2c (0.5)	21.7b (0.6)	21.5b (0.6)	21.5b (0.5)	19.9a (0.4)	21.4 (0.5)
Fertilizer-N (kg N ha^{-1})	146.7a (7.7)	189.7d (7.4)	159.7b (6.4)	177.4c (8.3)	163.9b (10.6)	167.9 (3.9)
Fertilizer-P (kg Pha^{-1})	7.8ab (1.3)	6.7a (1.8)	8.3b (1.9)	12.1c (2.3)	19.9c (2.2)	10.6 (1.0)
Fertilizer-K (kg K ha^{-1})	3.5a (0.9)	3.3a (0.6)	7.4b (2.7)	8.3a (2.7)	9.7d (3.2)	6.4 (1.3)
Fertilizer-Zn (kg Zn ha^{-1})	4.9a (1.2)	8.8c (2.6)	7.5bc (2.1)	16.8d (2.3)	6.2b (1.3)	9.0 (1.1)
Fertilizer-Fe (kg Fe ha^{-1})	—	5.5c (2.3)	3.9b (1.3)	7.9d (2.2)	2.7a (0.5)	5.1 (0.9)

†*Values in the parenthesis indicate standard error from mean*

Table 2. Yield of rice under DSR and PTR technique

Administrative blocks	Grain yield (q ha^{-1})		% difference in yield over DSR
	DSR	PTR	
Kapurthala (*n*=18)	66.5aB (1.2)	74.2bC (0.7)	12.1D (1.5)
Sultanpur Lodhi (*n*=19)	70.2aC (1.7)	76.3bD (0.9)	7.8A (2.4)
Phagwara (*n*=20)	64.3aA (1.4)	72.2bA (0.7)	13.6F (2.3)
Nadala (*n*=20)	65.3aA (1.3)	73.5bB (1.0)	11.1C (1.7)
Dhilwan (*n*=15)	64.3aA (2.0)	71.3bA (1.9)	9.7B (1.3)
Mean (*n*=92)	66.1 (0.7)	73.6b (0.5)	10.2 (0.9)

†*Values in the parenthesis indicate standard error from mean*

Table 3. Number of irrigations, irrigation water applied and the water productivity of DSR and PTR in different blocks in Kapurthala district

Administrative blocks	Number of irrigations applied under		Irrigation water applied (mm)		Irrigation water productivity (kg ha^{-1} mm^{-1})		% saving in irrigation water over PTR
	DSR	PTR	DSR	PTR	DSR	PTR	
Kapurthala (*n*=18)	24.4aD (1.4)	29.9bC (0.6)	1833.3aC (93.5)	2245.8bC (41.4)	4.0bC (0.3)	3.3aA (0.1)	18.8b (3.2)
Sultanpur Lodhi (*n*=19)	21.7aA (0.9)	28.5bB (0.4)	1626.3aA (70.1)	2139.5bB (30.0)	4.4bC (0.2)	3.6aD (0.1)	23.1d (2.4)
Phagwara (*n*=20)	22.3aB (0.9)	28.2bB (0.4)	1668.8aA (65.0)	2111.3bB (32.3)	4.0bC (0.1)	3.4aB (0.1)	20.4c (2.5)
Nadala (*n*=20)	25.4aE (1.2)	29.3b (0.4)	1905.0a (91.9)	2193.8bB (31.7)	3.6b (0.2)	3.4aB (0.1)	14.9a (2.5)
Dhilwan (*n*=15)	22.7aB (0.6)	26.9bA (0.5)	1700.1aB (44.9)	2020.2bA (39.1)	3.8bB (0.2)	3.5aC (0.1)	15.5a (2.3)
Total(*n*=92)	23.3C (0.5)	28.6B (0.2)	1748.6B (38.1)	2146.5B (17.5)	4.0C (0.1)	3.4B (0.1)	18.4 (1.7)

†*Values in the parenthesis indicate standard error from mean*

Grain yield of rice established under DSR and PTR

Rice grain yield varied between 64.3 and 70.2 q ha^{-1} (mean = 66.1 q ha^{-1}) under DSR technique, as compared with 71.3 and 76.3 (mean=73.6 q ha^{-1}) under PTR (Table 2), it may be due to controlled weeds and higher available nutrient with moisture (Bhatt and Kukal, 2015). The results revealed that rice grain yield was significantly lower in DSR, compared with the PTR in all 5 blocks in Kapurthala district. On an average, rice grain yield under DSR was lower by 10.2 per cent than the PTR. The rice grain yield in DSR and PTR was significantly lower in Dhilwan block, while was the highest in Sultanpur Lodhi block. This could be the reason for the highest adoption of the DSR in Sultanpur Lodhi block. These results revealed that rice grain yield under DSR technique was lower by 7.8-12.1 per cent in different blocks, which could be enhanced by providing training to the farmers regarding recommended cultivation practices (Gill and Bhullar, 2021).

The number of irrigations applied by the farmers under DSR technique varied between 21.7 and 25.4 (mean = 23.3), while under PTR the number of irrigations varied between 26.9 and 29.9 (mean = 28.6) (Table 3). In all 5 blocks, the number of irrigations applied to rice under DSR technique were lower, compared to the PTR. On average, 5.3 irrigations were saved under DSR than the PTR in Kapurthala district. The saving in number of irrigations was equivalent to the saving of 397.9 mm of irrigation water (Table 3). The irrigation water productivity estimated as a ratio of rice grain yield per unit of the irrigation water applied varied between 3.6 and 4.4 kg ha^{-1} mm^{-1} in DSR, compared with 3.3 and 3.6 kg ha^{-1} mm^{-1} under PTR. It indicates that the saved water could be diverted to other potential sectors (Bhatt et al., 2021). Across the different blocks, the irrigation water productivity was higher under DSR, as compared to the PTR due to lack of puddling operation in the former system, similar observations were recorded by Bhatt and Kukal, (2015).

CONCLUSION

These results showed large variation in crop production and management practices adopted by the farmers in different blocks of Kapurthala, which leads to large variation in yield potential. Although the average yield of rice under DSR technique was lower, but there exists immense potential for yield maximization by the adoption of recommended crop production practices. The study highlights the need of intensive extension efforts for the dissemination of different technologies particularly the efficient nutrient management and the irrigation water management in rice establishment through DSR technique. It could be concluded that DSR is really a viable technique with great potential to establish rice crop under labor scarcity and for saving irrigation water.

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