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Impact of planting methods and weed control practices on growth, yield and quality of paddy

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Abstract

An experiment was carried out during the *kharif* seasons of 2018 and 2019 to find out Influence of planting methods and weed control techniques on growth, yield and quality of paddy. Four crop planting methods *viz.* transplanted rice, direct seeded rice, drum seeded rice and system of rice intensification (SRI), and four weed control techniques *viz.* (Bispyribac sodium 25 g ai ha⁻¹ at 25 DAS/T, Bispyribac sodium 25 g ai ha⁻¹ at 25 DAS/T + hand weeding at 40 DAS/T, Two hand weeding 20 & 40 DAS/T and Weedy check were tested in Splt Plot Design with three replications. Maximum plant height, number of shoots/m², dry matter accumulation, grain yield, nitrogen uptake by crop was recorded in hand weeding (20 and 40 DAS/T than that of other weed management practices. Among the planting methods, SRI method exhibited maximum plant height, number of shoots/m², dry matter accumulation, grain yield, nitrogen content in grain and straw.

Keywords: Rice, transplanting, SRI and weed management

Introduction

Rice (*Oryza sativa* L.) is the predominant staple food for more than half of the world population because of its caloric contribution and monetary benefits. Rice is cultivated worldwide over an area of about 162.48 million ha with an annual production of about 758.92 million tones. (503.80 million Tones, milled basis) and productivity 4.67 tons per hectare in 2019. It is an excellent source of carbohydrate and to a certain extent provides protein to human diet, so it is used as staple food crop and eaten as cooked rice. It is also used for several preparations and has commercial and industrial importance. Besides, its straw and hull are used as fodder, mulching, packaging, and insulation material as well as in the manufacturing of card board etc. To meet the demand of increasing population and maintain the self-sufficiency, the present production level needs to be increased by 140 million tonnes by 2025 which can be achieved by increasing the rice production by over 2 million tonnes per year in coming decade (Subbaiah, *et al.*, 2000) [10]. This has to be done against the back drop of declining natural resources base such as land, labour, water and other inputs and without adversely affecting the quality of environment. System of Rice Intensification (SRI) refers to a set of practices initially adopted in Madagascar to overcome the problem of soil acidity in early eighties. SRI mainly Emphasises on utilizing early growth vigor of seedlings, facilitates less competition for light and nutrients, enhances resource use efficiency (seeds, water, fertilizer, pesticides) and brings down over dependence on chemical fertilizers, breaking soil anoxia condition and promoting healthy root growth and increased soil microbial activity and thereby enhancing soil organic matter content. SRI method has been found to save 22 and 38 per cent water, respectively during dry and wet season over conventional method. SRI method has potential to produce 16.6% higher grain yield over normal transplanting due to higher growth attributes and total biomass. Weed control is particularly challenging in DSR systems because of the diversity and severity of weed infestation, the absence of standing water layer to suppress weeds at the time of rice emergence, and no seedling size advantage of rice over the weed seedlings as both emerge simultaneously. A variety of herbicides have been screened and found effective for preplant/burn-down, pre-emergence, and post emergence weed control in direct drill-seeded rice systems (Singh *et al.*, 2006 and Anwar *et al.*, 2012) [9, 2].

Materials and Methods

The field experiment was conducted during two consecutive seasons of kharif 2018 and 2019

at Agronomy Research Farm of Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.). District Ayodhya falls under sub-humid climate receiving a mean annual rainfall of about 1200 mm and 90% of which is gotten from mid - June to end of September. Nonetheless, infrequent showers are additionally regular during winter. The winter months are cold and intermittent ices happen during this period. The late spring season is hot and dry and westerly hot breezes prevailed during second fortnight of April to first fortnight of June. The soil was silty loam with pH 7.8. The available N.P. and K content in the soil was 200.30, 19.55 and 300.40kg ha⁻¹ respectively. The treatments comprised four rice planting methods (system of rice intensification, transplanting, drum seeding and direct seeded rice under puddled condition) and four weed control techniques (Bispyribac sodium 25 g ai ha⁻¹ at 25 DAS/T, Bispyribac sodium 25 g ai ha⁻¹ at 25 DAS/T + hand weeding at 40 DAS/T, two hand weeding 20 & 40 DAS/T and Weedy check) and These were tested in split-plot design with three replications. The variety NDR-97 has non-lodging, moderate tillering (9-14), medium broad leaved with delayed senescence. The average yield of this variety is 25-30 quinal per hectare. It is recommended for eastern Uttar Pradesh and also recommended for rainfed and upland area. The recommended dose of Phosphorous and potassium (60 and 40 kg/ha) were applied consistently through single super phosphate and muriate of potash as basal application during the puddling activity and consolidated in the upper soil. Nitrogen was applied at 120 kg/ha through urea in three equivalent split-portions.

The sowing under direct seeding (direct seeding, and drum seeding) treatments, a seed rate of 100 and 20 kg/ha were used for broad-casting and drum seeding treatments, respectively. Sowing in direct seeding plots was done by broadcast and through drum seeder as per treatments. The seed was soaked in water for 12 hours, and piled and covered with moist gunny bag for 24 hours for sprouting. Puddling in drum seeding plots was done just before sowing of seed by giving two cross ploughing with desi plough followed by planking in ponded water, after that sprouted seeds of rice were sown with drum seeder in row at 20cm apart. In direct seeding methods the sowing was done by broadcasting of sprouted seeds but in other methods planting was done in rows at 20cm apart. The date of sowing in the nursery and in main field was kept same and it was done on 28-06-2018 and 30-06-2019, respectively. The plot wise crop was harvested by hand with sickles at the time when upper portion of spikelets looked straw colored and grain has hard, containing 15-18% moisture. First of all, two border rows were reaped around individual plots leaving only the net area. The gathering of each net plot territory was done independently and left the reaped material in same plots for three days for sun drying. After that the reaped material from each net plot was bundled with rope, tagged and finally brought to the threshing floor for threshing of crop.

Plant height was measured from the soil surface to the tip of top most leaf heading and up to the base of panicle after heading, and then average values were calculated for height. The number of shoots/m² at harvest was counted with the help of quadrat (50cm x 50cm) from four places in each plot. The counted shoots were averaged and expressed as number of shoots m⁻². The dry matter accumulation was recorded at harvest stage. An area of 50cmx50cm was used to record the dry matter from each plot and cut samples carefully closed to

the ground surface. After sun drying, these samples were collected in paper bags by cutting in small pieces and put in electric oven at 70±1 °C till constant weight attained. After this the weight was recorded on electronic balance and expressed as dry matter accumulation (gm⁻²). The grains yield obtained by straw and separation of cleared grain of each net plot was weighed in kg and finally makes in q/ha for statistical analysis.

Nitrogen content in grains and straw were determined by Kjeldahl's method followed for determination of nitrogen content in straw and grain as described by Jackson (1973). The oven dried ground crop samples were digested and nitrogen was determined by micro Kjeldahl method (Jackson, 1973). N uptake by each component was worked out separately by multiplying their N concentration with corresponding total dry matter production (Biological yield).

$$\text{N uptake by crop (kg ha}^{-1}\text{)} = \frac{\% \text{ N content} \times (\text{dry weight kg ha}^{-1})}{100}$$

The oven-dried samples of rice grain were analyzed for total nitrogen following Nessler's reagent method. Nitrogen content determined as per the above procedure was multiplied by 6.25 to get the protein content in rice grains.

Results and Discussion

Growth parameters

Plant height: The maximum plant height was observed under SRI methods at par with transplanting method. Likewise, both of the DSR methods also recorded plant height at par to each other. The bispyribac-Na and hand weeding at 40 DAS observed highest plant height, which was significantly better than two hand weeding (20&40 DAS/T), Bispyribac-Na alone and weedy check which was found being at par with two hand weeding at 60 DAS during first year of experiment. This might be due to the fact that taller plants under transplanting methods were probably due to better initial planting, efficient cell division and cell elongation in the meristematic tissues caused due to congestion of plants and lesser weed density and weed dry weight under the effect of these treatments which led to significant increase in the plant height. These are accordance with the findings of Mankotia *et al.* (2006), Khattak *et al.* (2007) [5] and Prasad *et al.* (2001).

Number of shoots

The number of shoots was recorded in SRI and transplanting methods observed significantly highest number of shoots at harvest stage which was better than other methods of planting. However, SRI method was being found to be at par with transplanting method. The maximum number of shoots significantly was recorded under Two hand weeding (20 & 40 DAS/T) which was at par with bispyribac-Na and hand weeding at 40 DAS/T and found superior over bispyribac-Na alone and weedy check. This might be because of the fact that less crop weeds competition under these weed control treatments due to which there was more utilization of nutrients solar energy, moisture and space by the crop plant ultimately caused better growth and development. Similar findings have been reported by Tomar *et al.* (2018) [13], Dubey *et al.* (2017) [3] and Kaushik *et al.* (2012) [4].

Dry matter accumulation

Dry matter accumulation increased significantly due to

different planting methods at harvest stage SRI method produced highest dry matter accumulation as compared to transplanting, drum seeded rice and direct seeded methods. However, it was found statistically at par with transplanting method of planting and lowest dry matter accumulation per unit area observed in direct seeded rice plots during both the years of experimentation. Among the weed management practices two hand weeding (20 & 40 DAS/T) found superior

over rest of the weed management practices and found statistically at par with bispyribac-Na 25g ha⁻¹ and hand weeding at 40 DAS/T. It might be because of the fact that SRI method faced very less completion due to weeds which ultimately accumulated more dry matter. The results are in agreement with the findings of Mankotia *et al.* (2006), Singh *et al.* (2006)^[9] and Thakur *et al.* (2011)^[12].

Table 1: Effect of planting methods and weed control practices on growth parameters and grains yield of paddy crop

Treatment	Plant height (cm) at harvest		Number of shoots/m ² at harvest		Dry matter accumulation (g/m ²) at harvest		Grain yield (q/ha)	
	2018	2019	2018	2019	2018	2019	2018	2019
Planting methods								
Transplanting (20cmx10cm)	75.86	79.46	345.55	348.25	669.88	679.31	31.18	33.40
Direct seeded rice (sprouted & line sowing) (20cm apart)	63.43	65.48	279.23	281.42	529.46	536.92	21.40	22.93
Drum seeded rice (sprouted) (20cmx10cm)	69.08	72.31	312.99	315.44	605.85	614.38	27.35	29.31
SRI (20cm x 20cm)	81.23	82.75	362.23	365.06	694.81	704.60	32.07	34.36
S.Em±	2.12	2.21	9.43	9.50	16.71	16.94	0.825	0.884
CD (P=0.05)	7.34	7.63	32.64	32.89	57.82	58.63	2.856	3.060
Weed control practices								
Bispyribac sodium	69.99	74.86	312.59	315.04	661.83	671.15	27.66	29.64
Bispyribac sodium + Hand weeding 40 DAS/T	80.71	82.80	348.49	351.21	701.18	711.05	33.66	36.06
Two hand weeding 20&40DAS/T	78.17	80.48	356.83	359.61	707.31	717.26	34.09	36.53
Weedy check	60.73	61.86	282.10	284.30	429.69	435.74	16.59	17.77
S.Em±	1.10	1.14	5.14	5.18	10.77	10.92	0.421	0.451
CD (P=0.05)	3.20	3.31	15.01	15.13	31.45	31.89	1.230	1.318

Grains yield

Among planting methods, the SRI method being at par with transplanting produced significantly higher grain yields over all other planting methods. SRI method was probably due to more dry matter production per unit area caused by better nutrient absorption from soil, increased rate of metabolic processes, rate of light absorption, photosynthetic activity and more number of leaves. Transplanting method also recorded significantly more harvest index over rest of the planting methods and found statistically at par with both SRI and drum seeded rice. This might be due to almost similar increase in grain under each method. Under the different weed management practices, the manual weeding twice (20 & 40 DAS/T) being at par with bispyribac-Na 25g ha⁻¹ supplemented with hand weeding at 40 DAS/T produced significantly higher grain as compared to bispyribac Na 25g ha⁻¹ alone and weedy check. The similar findings were reported by Yadav and Singh (2006)^[14].

Interaction effect of different planting methods and weed management practices on grain yield

Grain yield was significantly influenced by Interaction

between planting methods and weed management practices with respect to grain yield during 2018 and 2019. The data given in Table- 2 revealed that grain yield of paddy was affected significantly due to different planting methods at the same level of weed control treatments. The data clearly indicate that SRI and transplanting being at par recorded significantly higher grain yield over direct seeded rice and drum seeding methods, while, drum seeding method proved significantly superior over direct seeded rice method at the same level of weed management practices. The similar trend was observed during both the years experiment. Among different weed management practices treatments, two hand weeding at 20&40 DAS/T and bispyribac-Na 25g ha⁻¹ supplemented with hand weeding at 40 DAS/T stage being at par recorded higher grain yield over bispyribac-Na 25g ha⁻¹ alone and weedy check at the same level of the planting methods. However, bispyribac-Na 25g ha⁻¹ alone recorded significantly higher grain yield over weedy check at all the levels of planting methods, individually during the experimental years of 2018 and 2019. The similar findings were reported by Prasad *et al.* (2001), Singh and Singh (2006)^[9] and Ahmed *et al.* (2015)^[1] and Dubey *et al.* (2017)^[3].

Table 2: Interaction effect of different planting methods and weed management practices on grain yield (q ha⁻¹)

Grain yield 2018				
Treatments	Trans	DSR	Drum	SRI
Bispyribac sodium	30.80	21.15	27.02	31.68
Bispyribac sodium + Hand weeding 40 DAS/T	37.48	25.73	32.88	38.55
Two hand weeding 20&40DAS/T	37.96	26.06	33.31	39.05
Weedy check	18.47	12.68	16.20	19.00
S.Em±	0.84			
CD (P=0.05)	(i) A at same level of B = 2.46			
	(ii) B are different level of A =3.55			
Grain yield 2019				
Treatments	Trans	DSR	Drum	SRI
Bispyribac sodium	33.00	22.66	28.95	33.95
Bispyribac sodium + Hand weeding 40 DAS/T	40.15	27.56	35.23	41.30

Two hand weeding 20&40DAS/T	40.67	27.92	35.68	41.83
Weedy check	19.79	13.58	17.36	20.35
S.Em±	0.90			
CD (P=0.05)	(i) A at same level of B = 2.64			
	(ii) B are different level of A =3.80			

Quality parameter

The system of rice intensification (SRI) attained highest nitrogen uptake by grain and straw which was being at par with transplanting method followed by drum seeded and direct seeded rice. The different weed management techniques influenced the nitrogen uptake by crop significantly due to manual weeding twice (20 & 40 DAS/T) and bispyribac-Na

25g ha⁻¹ coupled with one hand weeding at 40 DAS/T being at par recorded significantly higher values of nitrogen uptake as compared to bispyribac-Na 25g ha⁻¹ alone and weedy check. It might be due to the better weed management practices with respect to dry weight. The results are in accordance with the findings of Singh *et al.* (2005)^[10] and Yadav *et al.* (2009)^[14].

Table 3: Effect of planting methods and weed control practices on quality parameter of paddy crop

Treatment	Nitrogen uptake by				Nitrogen content in (%)				Protein content in grain (%)	
	Grain		Straw		Grain		Straw		2018	2019
	2018	2019	2018	2019	2018	2019	2018	2019		
Planting methods										
Transplanting (20cmx10cm)	37.42	41.08	17.19	18.14	1.20	1.23	0.48	0.49	7.53	7.68
Direct seeded rice (sprouted & line sowing) (20cm apart)	23.97	26.37	14.19	14.15	1.12	1.15	0.45	0.46	7.02	7.16
Drum seeded rice (sprouted) (20cmx10cm)	30.91	33.71	14.95	15.47	1.13	1.15	0.45	0.46	7.07	7.21
SRI (20cm x 20cm)	40.09	43.64	18.71	19.69	1.25	1.27	0.50	0.51	7.79	7.95
S.Em±	0.980	1.071	0.486	0.480	0.034	0.032	0.012	0.012	0.204	0.213
CD (P=0.05)	3.391	3.708	1.681	1.660	NS	NS	NS	NS	NS	NS
Weed control practices										
Bispyribac sodium	32.64	35.57	17.98	17.99	1.18	1.20	0.47	0.48	7.36	7.51
Bispyribac sodium + Hand weeding 40 DAS/T	39.38	43.27	17.14	18.38	1.17	1.20	0.47	0.48	7.35	7.50
Two hand weeding 20&40DAS/T	39.89	43.84	17.22	18.46	1.17	1.20	0.47	0.48	7.34	7.49
Weedy check	19.41	21.32	12.40	12.38	1.17	1.20	0.47	0.48	7.34	7.49
S.Em±	0.491	0.537	0.261	0.257	0.019	0.020	0.008	0.007	0.117	0.115
CD (P=0.05)	1.434	1.568	0.762	0.751	NS	NS	NS	NS	NS	NS

Interaction effect of different planting methods and weed management practices on nitrogen uptake by grains

A critical analysis of data (Table-4) revealed that planting methods influenced the nitrogen uptake by crop significantly at the same level of weed control treatments. The results clearly indicated that SRI and transplanting being at par recorded significantly higher uptake of nitrogen over direct seeding treatments. However, drum seeding method proved significantly superior over direct seeded method with respect to nitrogen uptake by paddy crop, comparing at the same level of weed management practices. The similar types of results were recorded during both the years of experimentation.

Under different weed control treatments, two hand weeding twice 20&40 DAS/T and bispyribac- Na 25g ha⁻¹ and hand weeding at 40DAS/T being at par proved significantly superior over bispyribac-Na alone and weedy check at the same level of planting methods. However, bispyribac-Na 25g ha⁻¹ alone, recorded significantly higher nitrogen uptake by crop over weedy check, individually at same level of planting methods during 2018 and 2019.

Several findings on the performance of different planting methods and weed management practices have been reported by Singh *et al.* (2005)^[10], Shekhar *et al.* (2009)^[8], and Yadav *et al.* (2009)^[14].

Table 4: Interaction effect of different planting methods and weed management practices on nitrogen uptake by grains

Nitrogen uptake by grains 2018				
Treatments	Trans	DSR	Drum	SRI
Bispyribac sodium	37.17	23.78	30.60	39.54
Bispyribac sodium + Hand weeding 40 DAS/T	45.17	28.89	37.18	48.04
Two hand weeding 20&40DAS/T	45.69	29.23	37.62	48.60
Weedy check	22.23	14.22	18.30	23.64
S.Em±	0.98			
CD (P=0.05)	(i) A at same level of B = 2.87			
	(ii) B are different level of A =4.19			
Nitrogen uptake by grains 2019				
Treatments	Trans	DSR	Drum	SRI
Bispyribac sodium	40.64	26.00	33.46	43.23
Bispyribac sodium + Hand weeding 40 DAS/T	49.38	31.59	40.65	52.53
Two hand weeding 20&40DAS/T	49.95	31.95	41.12	53.14
Weedy check	24.30	15.54	20.01	25.85
S.Em±	1.07			
CD (P=0.05)	(i) A at same level of B = 3.14			
	(ii) B are different level of A =4.58			

Conclusion

System of rice intensification and transplanting methods were found more effective in reducing weed infestation and removal of nitrogen by weeds resulted in enhancement in growth, yield and nitrogen uptake by paddy crop. Hand weeding at 20 and 40 DAS and post emergence application of bispyribac sodium @ 25g ai ha⁻¹ at 25 DAS supplemented with one hand weeding at 40 DAS were found most promising to minimized the weed infestation markedly which accelerate the growth parameters and enhanced the yields of paddy and nitrogen uptake by crop. The weeds in weedy plot in conjunction with direct seeding rice removed the highest amount of nitrogen from the soil. Hand weeding at 20 and 40 DAS or post emergence application of bispyribac sodium @ 25g a.i. ha⁻¹ supplemented with hand weeding at 40 DAS in presence of system of rice intensification or transplanting methods of paddy were found most favorable to record the highest values of plant height, dry matter production per unit area, number of shoots and nitrogen uptake by paddy crop.

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