Original Research Article

CA- Based Planting Techniques and Weed Management Practices Influence on Nutrient Content and Their Uptake in Dry Direct-Seeded Rice (*Oryza sativa* L.)

REVIEW

ABSTRACT

Conventional established rice leads many challenges in crop production like soil health degradation, decline in water table and labour scarcity which ultimately increases the cast of production. To address these issues of transplanted rice; different conservation agricultural (CA) based crop establishment in combination with suitable weed management options were planned to sustain rice productivity. The two year field trial was conducted during the *kharif* season of 2018 and 2019 at Research Farm, Banaras Hindu University, Varanasi. The experiment was planned in split plot design having four planting techniques in main plot and five weed management practices in sub-plot and replicated thrice. Results shows that N, P, K content in grain and straw were not significantly influenced by planting techniques and weed management practices. However, N, P and K uptake by both grain and straw found significantly differ due to execution of various treatments. Results reveal that conventional-till DSR recorded highest N, P and K uptake by both grain and straw over the reduced-till DSR (Rotavator single pass), farmer's practice (Conventional transplanting) and remains at par with zero-till DSR during both the year of study. Among the weed management practices two hands weeding (at 20 DAS and 40 DAS) recorded highest N, P and K uptake by crop during both the years of investigation. With respect to herbicidal treatments, highest N, P and K uptake by crop was recorded under application of pendimethalin 1 kg ha^{-1} (pre-em) followed by (*fb*) chlorimuron + metsulfuron (4g +

4g ha^{-1}) at 20 DAS over the pendimethalin 1 kg ha^{-1} (pre-em) *fb* pyrozosulfuron (30g ha^{-1}) at 20 DAS however it remains statistically similar to bispyribac-sodium + chlorimuron + metsulfuron (25g + 4g + 4g ha^{-1}) at 20 DAS during both the year of study. Based on the results, it is concluded that conventional-till DSR and pendimethalin 1 kg ha^{-1} (pre-em) *fb* chlorimuron + metsulfuron (4g + 4g ha^{-1}) at 20 DAS except hands weeding was found better for N, P and K uptake by both grain and straw of rice crop.

Keywords: *Direct-seeded rice (DSR); planting techniques; reduce-tillage; weed management and zero-tillage.*

1. INTRODUCTION

Rice (*Oryza sativa* L.) is one of the leading cereals of the world which belongs to family poaceae (Gramineae). About 90% of the world's rice is produced and consumed in Asia to provide up to three-fourths of the total calories required by 520 million Asians. The term 'rice is life' is most appropriate for India as this crop play vital role in country's food security [1]. The most common growing method of rice is manual transplanting of seedlings in puddled soils by creating an impermeable soil layer. The conventional transplanted rice leads to problems of destruction of the soil structure; water requirement is very high, labour crisis and high cost of cultivation. Globally, rice consumes only 800-1000 liter of water to produce 1 kg paddy whereas, about 3,000-5,000 litres of water is required in south Asian countries [2] depending on the different rice cultivation methods. Therefore, to overcome water scarcity and labour problem in rice production system, farmers are gradually shifting towards less-water demanding techniques. Among rice growing eco-systems, direct-seeded rice (DSR) has emerged as an alternate and pragmatic approach to tackle the issues of water scarcity, labour shortage and imparting sustainability to the rice cultivation [3], [4], [5]. Dry-DSR is gaining popularity regarding its high water use, labor use and energy use efficiencies [6].

Preponderance of weed in direct-seeded rice is severe and is one of the serious limiting factors in realizing the yield potential of direct-seeded rice [7], [8]. Weed infestation during early period of crop growth caused yield reduction to the tune of 33-74 % or sometimes reduction in productivity of DSR by up to 75-80% [9], [10] depending upon the type of the weeds and their infestation. Therefore, an appropriate weed management strategy has always been a major focus to overcome the risk of crop failure in DSR system. Though manual weeding is considered to be best, but unavailability of labours and increased wages are the emerging constraints in recent past. Moreover, hand weeding is time consuming and sometime is not possible due to inaccessibility due to continuous rains and soil condition. Weed control through herbicide becomes more important because weeds and rice emerge simultaneously in DSR system. Hence, the present

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investigation was conducted to find out most suitable crop establishment method with appropriate combination of herbicide to fetch maximum productivity and economics in direct-seeded rice.

2. MATERIALS AND METHODS

2.1 Experimental Site

The experimental site is situated at 25^{o}18' North latitude and 83^{o}03' East longitudes with an elevation of 75.70 meters above the mean sea level which comes under subtropical climate having semi-arid to sub-humid areas and sometime subjected to extreme weather conditions i.e. extremely hot in summer and cold in winters. The total rainfall of 777.7 mm and 1113.7 mm was received during the crop season in 2018 and 2019 respectively. The maximum and minimum temperature in first year and second year during experimentation remained normal. The mean weekly maximum relative humidity recorded in the range of 77 to 93% and 82 to 95% in the first and second year, respectively. While, mean weekly minimum humidity recorded ranged between 70 to 88% and 41 to 82% in the first and second year, respectively. The soil of the experimental site was homogeneous in fertility status with uniform textural make up. The alluvial soils (order-inceptisols) of Indo-Gangetic plains in general are deep, flat, well drained with low available nitrogen and medium in available phosphorus and potassium.

2.2 Design and Treatments Details

The experiment was conducted at Research farm of Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during the *kharif* season of 2018 and 2019. The experiment was laid out in split plot design which involves four planting techniques *viz*., farmer's practice (Conventional Transplanting), zero-till DSR, reduced-till DSR (Rotavator single pass) and conventional-till DSR assigned in main plot treatments and five weed management practices *viz*., pendimethalin 1 kg ha^{-1} (pre-em) *fb* chlorimuron + metsulfuron (4g + 4g ha^{-1}) at 20 DAS, pendimethalin 1 kg ha^{-1} (pre-em) *fb* pyrozosulfuron (30g ha^{-1}) at 20 DAS, bispyribac-sodium + chlorimuron + metsulfuron (25g + 4g + 4g ha^{-1}) at 20 DAS, Hand weeding at 20 and 40 DAS and Weedy check were assigned in sub-plot treatments in a split-plot design with three replications.

2.3 Field Preparation

After harvesting of *Rabi* wheat, the field was deep ploughed by mouldboard plough in summer and left open to expose weeds seed and eggs of harmful insects. Pre-sowing light irrigation was applied before field preparation. When the field reached at optimum moisture; experimental field was laid out as per the treatment specification and sowing was done by using seed rate 30 kg ha^{-1} for nursery raising in transplanted rice and 60 kg ha^{-1} in DRS. Rice variety HUR-105

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(Malviya Sugandh-105) known for its promising performance under irrigated conditions of Varanasi region of the Eastern Uttar Pradesh was used as test crop for the investigation.

2.4 Nutrient Application

Irrespective of the treatment, an equal dose of 120 kg N, 60 kg P_2O_5, 60 kg K_2O and 5 kg $ZnSO_4$ ha^{-1} was applied in all the treatments through urea (46% N), DAP (46% P_2O_5), muriate of potash (60% K_2O) and zinc sulphate monohydrate (33%) respectively. Whole dose of P and K and half of N were applied at the time of field preparation. Remaining half dose of nitrogen were split up into two equal parts and applied at the time of maximum tillering and panicle initiation stage. Zinc fertilizer was applied at the time of field preparation as basal. Two spray of fungicide propiconazole @ 200 ml ha^{-1} and copper oxychloride @ 500 g ha^{-1} mixed in 500 litres water was done to control the brown spot disease of rice.

2.5 Data Collection

2.5.1 Soil properties

Initial soil chemical properties (Table1) analysis was done before the commencement of experiment by standard procedure. Firstly, a representative soil samples from plough layer were collected, oven dried and processed. The pH and EC of soil was measured with the help of a pH meter and conductivity meter respectively by maintaining the soil-water ratio of 1:2.5 as described by Jackson [11]. The organic carbon content in soil was estimated by Walkely and Black method [12], available N, P and K in soil sample were analysed by Modified macro-Kjeldahl method by Subbiah and Asija [13], ascorbic acid procedure using a blue filter (660 mμ) paper of Olsen et al. [14] and neutral normal 1N NH4OAc (pH 7.0) by Jackson [11] respectively.

Table 1. The initial soil chemical properties of experimental field (plough layer)

Particulars	Values		Method employed	Reference
	2018-19	2019-20		
Chemical analysis				
pH (1: 2.5 of Soil: Water)	7.22	7.33	Glass electrode digital pH meter	Jackson (1973)
Electrical conductivity (dSm^{-1}) at 25°C	0.26	0.29	Using ELICO conductivity bridge	Jackson (1973)
Organic carbon (%)	0.41	0.43	Walkley and Black rapid titration method	Walkley and Black (1934)
Available nitrogen	226.12	234.54	Alkaline permanganate method	Subbiah and Asija (1956)

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(kg ha^{-1})				
Available phosphorus (kg ha^{-1})	17.24	19.15	0.5 M $NaHCO_3$ (pH 8.5) spectrophotometric method	Olsen *et al*. (1954)
Available potassium (kg ha^{-1})	179.38	186.49	Flame photometric method using neutral normal ammonium acetate extract	Jackson (1973)

2.5.2 Plant sample analysis

The typical plant samples (grain and straw) from harvested crop were collected separately, oven dried then grind in willey mills and analysed for N, P, and K content. N was estimated by using modified Kjeldahal method as described by Jackson [11], P by Vanadomolybdate phosphoric yellow colour method as described by Jackson [11], K by Flame photometer as described by Jackson [11] and subsequently their uptake by grain; straw and total uptake (grain + straw) was worked out as per standard method.

2.5.3 Data analysis

The date recorded from the experimentation was subjected to statistical analysis by using analysis of variance as described by Gomez and Gomez [15] and the comparisons were made at 5 per cent level of significance.

3. RESULTS AND DISCUSSION

3.1 Nutrients Content

Critically examine of data (Table 2), it is found that nitrogen (N), phosphorus (P) and potassium (K) content in grain and straw were not reached up to the level of significant due to the execution of different planting techniques and weed management practices during both the years of study. Moreover, highest N, P and K content was recorded under farmer's practice (C.T.) among planting techniques than reduced-till DSR (Rotavator single pass), zero-till DSR and conventional-till DSR. In case of weed management practices weed free plot (two hands weeding at 20 and 40 DAS) recorded lowest N, P and K content in grain and straw over other herbicidal treatments during both the years of investigation. These results are in line with the research findings of Sanjay et al. [16]. Among the herbicidal treatments, highest N, P and K content in grain and straw was recorded under application of pendimethalin 1 kg ha^{-1} (pre-em) *fb* pyrozosulfuron (30g ha^{-1}) at 20 DAS than by bispyribac-sodium + chlorimuron + metsulfuron (25g + 4g + 4g ha^{-1}) at 20 DAS and pendimethalin 1 kg ha^{-1} (pre-em) *fb* chlorimuron + metsulfuron (4g + 4g ha^{-1}) at 20 DAS, during both the years. The higher nutrient content in this treatment might be due to higher availability of nutrient and less competition of weeds. The maximum nutrients content is mainly attributed due to this method had more weed population resulted more partitioning of nutrient among the individual weed over rice crop subsequently more nutrients uptake by crop is made possible. The results are close proximity with the research findings of Sanjay et al. [16].

3.2 Nutrients (N, P and K) uptake by grain and straw

The uptake of N, P and K by grain and straw was significantly influenced by different planting techniques and weed management practices during both the year of experimentation (Table 3). Among the planting techniques, conventional-till DSR recorded highest N, P and K uptake by grain and straw over reduced-till DSR (Rotavator single pass) and farmer's practice (C.T.) and it remains statistically at par with zero-till DSR during both the years of investigation. The results was primarily due to good crop establishment as, this method decreases the weed density and their dry weight, more plant dry matter accumulation and minimum nutrient depletion by weeds and subsequently more availability of these nutrients to the crop which ultimately increased N, P and K uptake by crop efficiently. These results are in close line with the research findings of Chongtham et al. [17].

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Two hands weeding (at 20 and 40 DAS) recorded highest N, P and K uptake by grain and straw due to zero competition of input resources between crop and weeds resulting, more availability of these input resources to the main crops over any other herbicidal treatments. Kumar et al. [18] also have similar opinion. However, among the herbicidal treatments, the highest value of N, P and K uptake by grain and straw was recorded under pendimethalin 1 kg ha^{-1} (pre-em) *fb* chlorimuron + metsulfuron (4g + 4g ha^{-1}) at 20 DAS over pendimethalin 1 kg ha^{-1} (pre-em) *fb* pyrozosulfuron (30g ha^{-1}) at 20 DAS and it remains statistically at par with application of bispyribac-sodium + chlorimuron + metsulfuron (25g + 4g + 4g ha^{-1}) at 20 DAS. All the weed management practices recorded significantly more N, P and K uptake by grain and straw over weedy check during both the years of observation. The highest uptake of N, P and K in this treatment might be due to the marked improvement in dry matter production, yield attributes and minimum crop weed competition. These observations are close agreement with the research findings of Kumar et al. [18] and Verma et al. [19].

4. CONCLUSION

From the present study, it is concluded that rice crop establish by farmer's practice (C. T.) was recorded highest N, P and K content in grain and straw with minimum N, P and K uptake by crop. However, conventional-till DSR was recorded maximum N, P and K uptake by grain and straw. Among the different herbicidal treatments, application of pendimethalin 1 kg ha^{-1} (pre-em) *fb* chlorimuron + metsulfuron (4g + 4g ha^{-1}) at 20 DAS was found superior with respect to maximum N, P and K uptake by crop over other herbicidal treatments.

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1. **Table 2.** Effect of planting techniques and weed management practices on nitrogen, phosphorus and potassium content in grain and straw in DSR at harvest.

Treatments	N content in grain (%)		N content in straw (%)		P content in grain (%)		P content in straw (%)		K content in grain (%)		K content in straw (%)	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Planting techniques												
Farmer's practice (Conventional Transplanting)	1.17	1.16	0.73	0.72	0.32	0.31	0.127	0.126	0.34	0.33	1.49	1.48
Zero till-DSR	1.14	1.13	0.70	0.69	0.29	0.28	0.123	0.122	0.31	0.30	1.46	1.45
Reduced-till DSR (Rotavator single pass)	1.15	1.14	0.71	0.70	0.30	0.29	0.124	0.123	0.33	0.31	1.47	1.46
Conventional till- DSR	1.10	1.09	0.69	0.68	0.28	0.27	0.119	0.118	0.30	0.29	1.42	1.41
SEm ±	0.02	0.02	0.02	0.02	0.02	0.02	0.016	0.016	0.02	0.02	0.02	0.02
CD (*P*=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Weed management practices												
Pendimethalin 1 kg ha^{-1} (Pre-em) *fb* Chlorimuron + Metsulfuron (4g + 4g ha^{-1}) at 20 DAS	1.11	1.10	0.70	0.69	0.29	0.28	0.121	0.120	0.31	0.30	1.43	1.42
Pendimethalin 1 kg ha^{-1} (Pre-em) *fb* Pyrozosulfuron (30 ha^{-1}) at 20 DAS	1.15	1.14	0.72	0.71	0.31	0.30	0.126	0.125	0.33	0.32	1.47	1.46
Bispyribac-sodium + Chlorimuron + Metsulfuron (25g + 4g + 4g ha^{-1}) at 20 DAS	1.14	1.13	0.71	0.70	0.30	0.29	0.122	0.121	0.33	0.31	1.46	1.45
Hand weeding at 20 and 40 DAS	1.10	1.09	0.68	0.67	0.27	0.26	0.120	0.119	0.29	0.28	1.42	1.41
Weedy check	1.20	1.19	0.73	0.72	0.32	0.31	0.127	0.126	0.35	0.32	1.52	1.51
SEm ±	0.01	0.01	0.02	0.02	0.02	0.02	0.013	0.013	0.02	0.02	0.01	0.01
CD (*P*=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3. Effect of planting techniques and weed management practices on nitrogen, phosphorus and potassium uptake by grain and straw in DSR at harvest.

Treatments	N uptake by grain (kg ha^{-1})		N uptake by straw (kg ha^{-1})		P uptake by grain (kg ha^{-1})		P uptake by straw (kg ha^{-1})		K uptake by grain (kg ha^{-1})		K uptake by straw (kg ha^{-1})	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Planting techniques												
Farmer's practice (Conventional Transplanting)	34.09	36.30	21.53	23.85	5.63	6.33	3.43	4.19	9.16	10.07	73.82	78.57
Zero till-DSR	44.92	48.67	32.62	36.65	9.65	11.06	8.30	10.74	13.43	15.05	94.46	102.68
Reduced-till DSR (Rotavator single pass)	41.26	43.46	24.34	27.17	7.88	8.52	5.71	6.53	11.57	12.12	88.86	92.50
Conventional till- DSR	46.60	50.61	34.43	38.26	10.57	12.03	9.65	11.56	14.47	16.25	97.01	105.89
SEm ±	1.15	1.28	2.27	3.15	0.88	1.06	1.19	1.42	1.05	1.06	4.67	5.41
CD (*P*=0.05)	3.99	4.44	7.86	10.91	3.05	3.67	4.13	4.91	3.63	3.65	16.17	18.71
Weed management practices												
Pendimethalin 1 kg ha^{-1} (Pre-em) *fb* Chlorimuron +	46.80	51.08	32.54	36.99	9.94	11.24	8.86	10.56	14.03	15.57	100.02	107.90

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Metsulfuron (4g + 4g ha^{-1}) at 20 DAS												
Pendimethalin 1 kg ha^{-1} (Pre-em) *fb* Pyrozosulfuron (30 ha^{-1}) at 20 DAS	42.86	43.64	27.61	28.48	8.01	8.70	6.15	7.29	12.11	12.82	89.49	91.19
Bispyribac-sodium + Chlorimuron + Metsulfuron (25g + 4g + 4g ha^{-1}) at 20 DAS	44.68	48.80	31.38	35.00	9.18	10.42	6.99	8.72	13.22	14.68	94.71	102.71
Hand weeding at 20 and 40 DAS	54.51	58.37	38.94	45.33	11.66	13.14	10.52	12.79	16.25	17.99	114.44	126.24
Weedy check	19.73	21.90	10.67	11.61	3.38	3.92	1.32	1.92	5.18	5.81	44.03	46.50
SEm ±	1.10	1.15	2.24	2.89	0.77	0.80	1.11	1.23	0.86	1.05	3.96	4.10
CD (*P*=0.05)	3.18	3.31	6.44	8.33	NS	NS	3.20	3.53	2.48	3.04	11.41	11.80

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