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Effect of crop establishment methods, nutrient levels and weed management on yield of hybrid rice

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Abstract

A field experiment was conducted during *kharif* seasons of 2017 and 2018 at research farm of TCA, Dholi, Muzzafarpur a campus of Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar to evaluate the effect of three different establishment methods *viz.* puddled transplanting, unpuddled transplanting and dry direct seeded rice with three nutrient levels *viz.* 75% RDF (recommended dose of fertilizer), 100% RDF and 125% RDF and four weed management practices *viz.* weedy check, hand weeding twice (20 and 40 DAS/T), bispyribac sodium (20 g ai/ha) + pyrazosulfuron (20 g ai/ha), and brown manuring on yield of hybrid rice. Amongst crop establishment methods, puddled transplanting produced maximum grain yield, straw yield, harvest index and grain: straw ratio which was found significantly superior over other method of sowing. Application of 125% RDF recorded higher grain yield, straw yield, harvest index and grain: straw ratio but was found at par with 100% RDF and the both produced significantly higher yield over 75% RDF during both years. The weed management practices significantly influenced the grain yield, straw yield, harvest index and grain: straw ratio of rice during both the years. The maximum yield was recorded under hand weeding twice but was found at par with combined application of bispyribac-sodium + pyrazosulfuron and both had significantly higher than the application of brown manuring. The minimum grain yield, straw yield, harvest index and grain: straw ratio was recorded under weedy check which was significantly lower than weed management practices.

Keywords: Puddled transplanting, hand weeding, bispyribac sodium, pyrazosulfuron, brown manuring

Introduction

Transplanting in puddled soil is the most dominant and traditional method of rice establishment in irrigated low land ecosystem. Puddling, reduce water infiltration and to maintain the standing water in the field, which also helps in reducing weed density, preventing leaching losses of plant nutrients, increases water retention capacity and facilitates easier transplanting (De data 1986) [4]. However, the puddled transplanted rice need higher water and labour during transplanting so, inadequacy of irrigation water and scarce labour coupled with higher wages during the peak period of farm operations, invariably lead to delay in transplanting. To overcome this problem, farmers are gradually switching over transplanting under unpuddled conditions. Direct seeding is a good alternative of transplanting and yield potential of direct seeded rice is equivalent to the transplanted rice under good water management and weed control conditions. Weed infestation during early period of crop growth caused yield reduction to the tune of 33-74% or sometimes more depending upon the type of the weeds and their infestation (Rao *et al.* 2007) [14]. Among various essential plant nutrients, the macro nutrients NPK are crucial for determining the yield and quality. It has been noticed that farmers utilize imbalanced dose of N fertilizer which leads to higher insects/disease attack ultimately producing lower yield (Alam and Islam 2011) [1]. Therefore, there is dire need to determine the optimum level of NPK fertilizers which may give maximum crop productivity with minimum losses. In recent years, rice production has increased with the introduction of high yielding varieties, but their maximum yield potential has not been fully realized owing to improper weed management. Weed management is an important key factor for realizing higher crop yields. Uncontrolled weeds reduce the grain yield by 96% in direct seeded rice, 61% in wet direct seeded rice and 40% in transplanted rice (Maity and Mukherjee 2008) [8]. Hence, timely weed management is necessary to get optimum grain yield.

Keeping the above aspects in view the present investigation was carried out to evaluate the effect of crop establishment methods, nutrient levels and weed management on yield of hybrid rice.

Materials Methods

The present investigation was conducted at the Research Farm of Tirhut College of Agriculture, Dholi of Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur,

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Bihar, during two consecutive *kharif* seasons of 2017 & 2018. The Dholi Farm is situated in North Bihar on the southern and Western bank of the river *Burhi Gandak* at 25059 North latitude and 85075 East longitudes with an altitude of 52.9 metre above mean sea level. The experimental field was remained same during both the years of investigation. The experimental field was homogeneously fertile with even topography and uniform textural make up, suitable for paddy crop in *kharif* season. Proper drainage facility was also provided in order to remove excess water during experimental period. The experiment was laid out in split-plot design and replicated thrice. The treatments consisted of three different establishment methods *viz.* puddled transplanting, unpuddled transplanting and dry direct seeded rice was kept in main plot with three nutrient levels *viz.* 75% RDF (recommended dose of fertilizer), 100% RDF and 125% RDF and in sub plot four weed management practices *viz.* weedy check, hand weeding twice (20 and 40 DAS/T), bispyribac sodium (20 g ai/ha) + pyrazosulfuron (20 g ai/ha), and brown manuring. All the treatments received phosphorus and potassium as basal dressing. Nitrogen was applied in three splits *i.e.* 1/2nd as basal, 1/3rd at the active tillering stage and rest 1/3rd at panicle initiation stage. Nitrogen was applied in the form of urea, phosphorus in form of SSP and potassium applied in form of MOP. The crop was sown in rows 20 cm apart using the seed rate of 15 kg/ha for transplanting and 25 kg/ha in direct seeding rice.

Result and Discussion grain yield (q/ha)

Amongst crop establishment methods, puddled transplanting produced maximum (56.71 and 58.47) grain yield which was found significantly superior over unpuddled transplanting (52.54 and 54.01) and direct seeded rice (45.99 and 46.82) during both the years. Unpuddled transplanting also produced significantly higher grain yield than brown manuring in both the years. The increased grain yields in these treatments was perhaps the result of reduced weed density and their dry matter, better weed control efficiency and the improvement of yield attributes like filled grains per panicle, number of grains per panicle, panicle length, number of panicles and panicle length and more nutrient uptake. Similar result was found by Shan *et al.* (2012) [15] Parameshwari and Srinivas (2014) [11] and Bhardwaj *et al.* (2018) [2].

Fertilizer level had significant effect on grain yield. Application of 125% RDF (54.66 and 56.22) recorded higher grain yield but was found at par with 100% RDF (52.57 and 53.97) and the both produced significantly higher grain yield over 75% RDF (48.02 and 49.11) during both years. Increase in grain weight at higher NPK rates might be primarily due to increase in chlorophyll concentration which led to higher photosynthetic rate and ultimately plenty of photosynthates available during grain development. Similar findings have been reported by Mondal *et al.* (2013) [9], Singh *et al.* (2014) [18], Srivastava *et al.* (2014) [20], Kumar *et al.* (2017) [6] and Singh *et al.* (2017) [17].

The perusal of data clearly revealed that weed management practices significantly influenced the grain yield of rice during both the years. The maximum grain yield (57.69 and 59.23) was recorded under hand weeding twice but was found at par with combined application of bispyribac-sodium + pyrazosulfuron (56.47 and 57.70) and both had significantly higher over application of brown manuring (50.66 and 52.49) during first and second year, respectively. The minimum grain yield was recorded under weedy check (42.18 and 42.99) which was significantly lower than weed management

practices. This might be due to lesser crop-weed competition which led to higher growth, better yield characters, lesser weed density and dry weight and thus more economic yield as compared to other treatments. The minimum grain yield was recorded in weedy check might be due to severe weed infestation in the crop field. The weeds growing in weedy check attained higher vigor to compete with the crop plants for growth factors throughout the growing season and thus suppressed the crop plant which could not express the fullest yield potential as was also corroborated by Kumar *et al.* (2013) [7] Veeraputhiran and Balasubramanian (2013) [21], Shendage *et al.* (2017) [16] and Ramesha *et al.* (2017) [13].

Interaction effect

Interaction between crop establishment methods and weed management practices was turned out to be significant on grain yield in both the years. Brown manuring in puddled transplanted condition produced significantly higher grain yield (55.72 and 57.41 q/ha) than hand weeding in direct seeded rice (52.17 and 53.14 q/ha) and application of bispyribac sodium+ pyrazosulfuron in direct seeded rice (51.98 and 52.26 q/ha).

Interaction between nutrient levels and weed management practices was turned out to be significant on grain yield in both the years. Grain yield of rice increased significantly with increasing levels of fertilizer upto 125% RDF in all the weed control treatments except brown manuring. Application of 75% RDF in all the weed control treatments recorded significantly higher grain yield than the application of 125% RDF in weedy check. Similarly, application of 100% RDF in hand weeding twice (58.85 and 60.47 q/ha) and bispyribac sodium+ pyrazosulfuron (57.46 and 58.27 q/ha) produced significantly higher grain yield than the application of 125% RDF in brown manuring (52.31 and 54.11 q/ha).

Straw yield (q/ha)

Straw yield of rice was significantly influenced by crop establishment methods during both years. The puddled transplanting produced significantly higher (80.10 and 81.24) straw yield than unpuddled transplanting (74.73 and 76.20) and direct seeded rice (65.81 and 66.76) during both the years. However, significantly lower straw yield was recorded under direct seeded rice method than other methods in both the years. Puddled transplanting method of establishment recorded significantly higher straw yield compared to direct sowing of rice and unpuddled transplanting due to less crop weed competition in puddle transplanting method which led to taller plants, more number of tillers and dry matter production which in turn resulted in higher straw yield Parameshwari and Srinivas (2014) [11]. Bhardwaj *et al.* (2018) [2] also reported similar results.

A critical examination of data pertaining to nutrient level had significant effect on straw yield during both the years. Application of 125% RDF recorded higher straw yield (77.19 and 78.43) but was found at par with 100% RDF (74.56 and 75.48) and the both significantly surpassed over 75% RDF (68.89 and 70.30). Nutrients in balanced quantity throughout the growth stages assisted the plants to assimilate adequate photosynthates and their effective translocation to reproductive parts increased the yield attributes, grain and straw yield of rice. These findings are in close agreement with reports of Patel *et al.* (2015) [12], Nanda *et al.* (2016) [10] Kumar *et al.* (2017) [6] and Singh *et al.* (2017) [17].

Amongst weed management practices, hand weeding twice recorded significantly higher (81.47 and 82.49) straw yield

which was statistically at par with combined application of bispyribac-sodium + pyrazosulfuron (79.96 and 80.62) and both produced significantly superior over brown manuring (72.10 and 74.22) during both the years. All the weed management methods were significantly enhanced straw yield over weedy check (60.66 and 61.62) during both the years. Rawat *et al.* (2012) reported in his findings that, the crop under hand weeding plots attained lush growth due to elimination of weeds from inter and intra row spaces besides better aeration due to manipulation of surface soil and thus more spaces, water, light and nutrients were available for the better growth and development, which resulted in to superior growth and yield and consequently the highest grain and straw yield of crop. Dixit *et al.* (2008) concluded that, the chemical weed control effectively controlled weeds were till the advanced growth stages of rice, which reduced weed competition favouring better utilization of available resources and it increases the grain and straw yield of crop. Similar finding was found by Kumar *et al.* (2013) [7] Veeraputhiran and Balasubramanian (2013) [21] Shendage *et al.* (2017) [16] and Ramesha *et al.* (2017) [13].

Interaction effect

Interaction between crop establishment methods and weed management practices was observed to be significant on straw yield in both the years. Brown manuring and application of bispyribac sodium+ pyrozosulfuron in puddled transplanted condition produced significantly higher straw yield (78.82 and 80.86 q/ha) than hand weeding in direct seeded rice (74.51 and 74.92 q/ha) in both the years. Similarly, application of bispyribac sodium+ pyrozosulfuron (79.75 and 81.23 q/ha) in unpuddled transplanting also recorded significantly higher straw yield than hand weeding in direct seeded rice.

Interaction between nutrient levels and weed management practices was found to be significant on straw yield. Straw yield increased significantly with increasing levels of fertilizers in all the weed control treatments except bispyribac sodium+ pyrozosulfuron and brown manuring in first year. Application of 100% RDF in hand weeding and bispyribac sodium+ pyrozosulfuron produced significantly higher straw yield than the application of 125% RDF in brown manuring in both the years except application of 100% RDF in combined application of bispyribac sodium+ pyrozosulfuron in second year.

Harvest index (%)

The data showed that there was a significant effect of different crop establishment techniques on harvest index of rice during both the years. Maximum harvest index (41.43 and 41.80) was recorded in puddled transplanted but significantly superior over unpuddled transplanting (41.25 and 41.43) and direct seeded rice (41.11 and 41.17) during both the years. Direct seeded (41.11 and 41.17) recorded significantly lower harvest index than unpuddled transplanting during both the years. This confirms the findings of Jha *et al.* (2011) [5] and Bhardwaj *et al.* (2018) [2].

A close examination of data exhibited that nutrient level had significant effect on harvest index during both years. Application of 125%RDF (41.43 and 41.70) recorded higher harvest index but was found at par with 100% RDF (41.33 and 41.63) and the both significantly surpassed over 75% RDF (41.03 and 41.07) during both the years. Increasing level of nutrient increasing in yield components, grain and straw yield might be due to higher photosynthetic activity because of increased leaf area index, which ultimately promoted dry matter production resulted in higher grain straw yield and harvest index. These results confirmed the findings of Davari and Sharma (2010) [3] and Singh *et al.* (2013) [19].

Weed management practices exerted significant effect on harvest index in both the years. All the weed management practices recorded significant high harvest index than weed check (40.98 and 41.02). Among the weed management practices hand weeding twice (41.44 and 41.74) although recorded higher harvest index but was found at par with combined approach of bispyribac-sodium + pyrazosulfuron (41.38 and 41.69) and significantly higher over brown manuring (41.26 and 41.41) during both years. Harvest index is influenced by the amount of assimilates translocated to the panicle during grain filling which, in turn, depends on yield capacity of the conducting tissues etc. Among the weed management practices, maximum harvest index was recorded in hand weeding twice but was found at par with the bispyribac-sodium + pyrazosulfuron and significantly higher than brown manuring and weedy check. Ramesha *et al.* (2017) [13] found similar finding.

Grain: straw ratio

The result revealed that crop establishment methods had significant influence on grain: straw ratio during both the years. Puddled transplanting caused manifested higher grain: straw ratio (0.708 and 0.719) which was found significantly superior over unpuddled transplanting (0.702 and 0.708) and direct seeded rice (0.698 and 0.700) during both the years. Direct seeded rice also had significantly lower grain: straw ratio than unpuddled transplanting.

The result from the data shown that maximum (0.708 and 0.715) grain: straw ratio was registered under application of highest nutrient level (125% RDF) which was significantly superior to minimum (0.696 and 0.697) level of nutrient (75% RDF) but was found statistically at par with 100% RDF (0.705 and 0.713) during both years. Likewise, 100% RDF was recorded significantly higher grain: straw ratio than 75% RDF during both the years.

Variation in grain: straw ratio due to weed management practices was significant during both the years. All the weed management practices recorded significant grain: straw ratio than weedy check (0.694 and 0.696). Among the weed management practices the maximum grain: straw ratio was recorded in hand weeding twice (0.708 and 0.717) but was found at par with combined approach of bispyribac-sodium + pyrazosulfuron (0.706 and 0.715) and both had significant effect on brown manuring (0.702 and 0.707) during both the years.

Table 1: Effect of crop establishment methods, nutrient level and weed management on yield, harvest index and grain: straw ratio of hybrid rice

Treatments	Grain yield (q/ha)		Straw yield(q/ha)		Harvest index		Grain: straw ratio	
	2017	2018	2017	2018	2017	2018	2017	2018
A. Crop Establishment methods								
Puddled Transplanting	56.71	58.47	80.10	81.24	41.43	41.80	0.708	0.719
Unpuddled Transplanting	52.54	54.01	74.73	76.20	41.25	41.43	0.702	0.708
Dry Direct Seeded	45.99	46.82	65.81	66.76	41.11	41.17	0.698	0.700
S.Em (±)	0.78	0.81	1.07	1.14	0.05	0.10	0.001	0.003

C.D.(P = 0.05)	2.35	2.43	3.22	3.41	0.14	0.30	0.004	0.009
B. Nutrient Level								
RDF 75%	48.02	49.11	68.89	70.30	41.03	41.07	0.696	0.697
RDF 100%	52.57	53.97	74.56	75.48	41.33	41.63	0.705	0.713
RDF 125%	54.66	56.22	77.19	78.43	41.44	41.70	0.708	0.715
SEm (±)	0.78	0.81	1.07	1.14	0.05	0.10	0.001	0.003
C.D.(P = 0.05)	2.35	2.43	3.22	3.41	0.14	0.30	0.004	0.009
C. Weed Management								
Weedy check	42.18	42.99	60.66	61.62	40.98	41.02	0.694	0.696
Hand Weeding	57.69	59.23	81.47	82.49	41.44	41.74	0.708	0.717
Bispyribac Sodium +Pyrozosulfuron	56.47	57.70	79.96	80.62	41.38	41.69	0.706	0.715
Brown Manuring	50.66	52.49	72.10	74.22	41.26	41.41	0.702	0.707
SEm (±)	0.47	0.57	0.70	0.79	0.04	0.07	0.001	0.002
C.D. (P = 0.05)	1.32	1.61	1.98	2.24	0.11	0.21	0.003	0.007

Table 2: Grain yield as influenced by establishment methods X weed management

Treatments	2017				2018			
	Weedy check	Hand weeding	Bispyribac sodium+ pyrozosulfuron	Brown manuring	Weedy check	Hand weeding	Bispyribac sodium+ pyrozosulfuron	Brown manuring
Puddled transplanting	47.43	62.82	60.88	55.72	48.65	65.44	62.38	57.41
Unpuddled transplanting	45.12	58.27	56.36	50.43	45.96	59.98	57.57	52.54
Dry direct seeded	33.98	52.17	51.98	45.85	34.35	52.26	53.14	47.52
SEm (±)	0.81				0.98			
CD (P=0.05)	2.28				2.79			

Table 3: Grain yield as influenced by nutrient levels X weed management

Treatments	2017				2018			
	Weedy check	Hand weeding	Bispyribac sodium+ pyrozosulfuron	Brown manuring	Weedy check	Hand weeding	Bispyribac sodium+ pyrozosulfuron	Brown manuring
75% RDF	38.88	52.49	51.98	48.72	39.83	53.45	52.86	50.30
100% RDF	43.03	58.85	57.46	50.95	44.08	60.47	58.27	53.06
125% RDF	44.63	61.73	59.98	52.31	45.05	63.76	61.97	54.11
SEm (±)	0.81				0.98			
CD (P=0.05)	2.28				2.79			

Table 4: Straw yield as influenced by establishment methods X weed management

Treatments	2017				2018			
	Weedy check	Hand weeding	Bispyribac sodium+ pyrozosulfuron	Brown manuring	Weedy check	Hand weeding	Bispyribac sodium+ pyrozosulfuron	Brown manuring
Puddled transplanting	67.84	88.13	85.61	78.82	68.80	89.62	85.70	80.86
Unpuddled transplanting	64.96	82.41	79.75	71.81	66.34	83.63	81.23	73.61
Dry direct seeded	49.20	74.51	73.86	65.66	49.74	74.20	74.92	68.20
SEm (±)	1.21				1.37			
CD (P=0.05)	3.43				3.88			

Table 5: Straw yield as influenced by nutrient levels X weed management

Treatments	2017				2018			
	Weedy check	Hand weeding	Bispyribac sodium+ pyrozosulfuron	Brown manuring	Weedy check	Hand weeding	Bispyribac sodium+ pyrozosulfuron	Brown manuring
75% RDF	57.09	74.53	73.78	70.14	59.11	75.55	74.90	71.62
100% RDF	61.26	83.13	81.60	72.26	62.72	84.79	80.73	73.70
125% RDF	63.63	86.74	84.50	73.89	63.04	87.12	86.22	77.34
SEm (±)	1.21				1.37			
CD (P=0.05)	3.43				3.88			

Conclusion

Puddled transplanting method significantly enhanced grain and straw yield of rice. While the magnitude of increase was greater than plot where showing with unpuddled transplanting and direct seeding method. Application of 125% RDF and 100% RDF being at par recorded similar grain and straw yield of rice. Hand weeding at 20 and 40 DAS/T and combined applied bispyribac-sodium + pyrazosulfuron was showed similar response on grain and straw yield of rice.

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