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

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Abstract

A field experiment was carried out during two consecutive *kharif* seasons of 2017 and 2018 at research farm of TCA, Dholi, Muzzafarpur of Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar to study the effect crop establishment methods (puddled transplanting, unpuddled transplanting and dry direct seeded rice) nutrient levels (75% RDF, 100% RDF and 125% RDF) and weed management practices (weedy check, hand weeding twice, bispyribac sodium + pyrazosulfuron and brown manuring) on yield attributes of hybrid rice. Amongst crop establishment methods, puddled transplanting produced maximum number of panicles/m² (364.37 and 376.06), length of panicles (27.21 and 27.73), number of grains/panicles (237.31 and 243.35), number of filled grains/panicles (229.56 and 236.66) and test weight (24.18 and 24.33) which was found significantly superior over other method of sowing. 125% RDF recorded highest yield attributes viz. number of panicles/m² (359.92 and 370.57), length of panicles (27.64 and 28.15), number of grains/panicles (229.54 and 239.49), number of filled grains/panicles (220.77 and 230.72) and test weight (24.22 and 24.32) but was found at par with 100% RDF and the both significantly surpassed over 75% RDF during both years. Among weed management practices, maximum number of panicles/m², length of panicles, number of grains/panicles, number of filled grains/panicles and test weight was recorded under hand weeding twice but was showed similar to combined application of bispyribac-sodium + pyrazosulfuron and both had significantly higher than the application of brown manuring. The minimum yield attributing characters was recorded under weedy check which was significantly lower than weed management practices.

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

Introduction

More than 90% of the world rice is produced and consumed in Asia, which is a native for 60% of the earth's population. With the increasing food demand by the growing population, rice will continue to be primary source of food. The world's total area under rice is 161.1 mha and production is about 480.3 MT along with the productivity of 2.98 t/ha (STATISTA -The statistics portal, 2016-17). Rice is the first most important crop in India where it is grown in an area of 44.1 mha area with an annual production of 106.7 MT and average productivity is 2.4 t/ha. However, in Bihar, rice is cultivated on 32.2 lakh ha area with the production of 64.89 lakh tons and the productivity is 2.02 t/ha (Directorate of Economics Statistics, Govt. of Bihar, 2016). 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). 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) ^[15]. Among various essential plant nutrients, the macro nutrients NPK are crucial for determining the yield and quality.

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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. Though hand weeding is considered as an effective weed management method to be the best, the undependable labour availability and escalating wages in many cases have given impetus to the development and use of herbicides which can control broad spectrum of weeds. To control weeds for extended period during crop growth pre and post emergence herbicides or two herbicides combination can be applied. 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 attribute 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, 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

Number of panicle/m²

Data pertaining to number of panicles revealed that it was significantly influenced by crop establishment methods during both the years. Significantly higher number of panicles was recorded under puddled transplanting (364.37 and 376.06) as compared to unpuddled transplanting (329.59 and 339.64) and direct seeded rice (288.92 and 295.88). Direct seeded rice recorded significantly lower number of panicle then unpuddled transplanting in both the years. Similar results

were reported by Shan *et al.* (2012) [16] and Bhardwaj *et al.* (2018) [2].

Remarkable improvement in number of panicles was observed with increasing levels of nutrient in both years. 125% RDF (359.92 and 370.57) produced significantly more number of panicles than 75% RDF (282.10 and 288.75), and found at par with 100% RDF (340.86 and 352.25). The decrease in nutrient levels decreased the number of panicles and the lowest number of panicles was recorded at 75% RDF. Increase in number of panicles/m² with increasing fertilizer levels might be due to increased photosynthetic rate, better accumulation of photosynthates and increased physiological activities of the plant. This finding was corroborated by Murthy *et al.* (2015) [9], Kumar *et al.* (2017) [6, 14, 17] and Singh *et al.* (2017) [6, 17].

Considerable variations in panicles number recorded due to various weed management during both the years. Hand weeding twice recorded maximum panicles numbers (376.56 and 386.68) which was found significantly higher than combined application of bispyribac-sodium + pyrazosulfuron (357.95 and 370.47) and brown manuring (308.96 and 319.36) during both the years. Combined application of bispyribac-sodium + pyrazosulfuron also found significant over brown manuring. However, all the weed management practices produced significantly more number of panicles as compared to weedy check (268.04 and 272.26) during both the years. This might be due to minimum weed population and biomass at different growth stages resulting in availability of more congenial environment for plant growth and development. These results are in close conformity with the findings of Walia *et al.* (2008) [22] and Kumar *et al.* (2013) [7].

Panicle length (cm)

The data showed that there was a significant effect of crop establishment techniques on panical length of rice during both the years. Maximum panical length was recorded with puddled transplanting which was (27.21 and 27.73) but significantly superior over unpuddled transplanting (26.41 and 27.03) and direct seeded rice (25.91 and 26.31) during both years. However, direct seeded rice also recorded significantly lower (25.91 and 26.31) panical length than unpuddled transplanting during both the years. The panicle length in puddle transplanted rice was significantly longer as compared to direct seeded crop because of more space, sunlight and nutrients availability, whereas higher weed densities in direct seeded crop hinders the development of panicle length and other yield attributes Hussain *et al.* (2013) [5]. This finding was corroborated by Bhardwaj *et al.* (2018) [2].

The experimental data on fertilizer level showed that fertilizer levels had significant effect on length of panicle. The panicle length recorded at 125% RDF (27.64 and 28.15) and 100% RDF (27.28 and 27.79) being at par and significantly recorded our 75% RDF (24.61 and 25.13) in both the years. Continuous supply of nutrients in balanced amount throughout the growth period augmented production of sufficient photosynthates and their effective translocation from source to sink. This has further enhanced the source and sink sizes and resulted in increase panicle length. Singh *et al.* (2014) [18, 19], Murthy *et al.* (2015) [9], Patel *et al.* (2015) [11], Kumar *et al.* (2017) [6, 14, 17] and Singh *et al.* (2017) [6, 17] found similar findings in their study.

It is apparent from the data that the weed management practices caused significant variation in panicle length. The

significantly longer panicle was recorded under hand weeding twice (28.06 and 28.57) which was found statistically at par with combined application of bispyribac-sodium + pyrazosulfuron (27.42 and 27.99) and both significantly superior over brown manuring (25.93 and 26.46) during both the years. Minimum panicle length was recorded under the weedy check (24.62 and 25.07). That might be due to weed control measures at critical growth stages which could have improved growth and yield attributes of plant. Significant lowest panicle length was recorded under weedy check plot might be due to multiple weed problems. Kumar *et al.* (2013)^[7], Raj *et al.* (2016)^[13] and Ramesha *et al.* (2017)^[14] found similar findings.

Number of grains/panicle

Data pertaining to number of grains/panicle of rice was significantly influenced by crop establishment methods. Significantly higher number of grains/panicle was recorded under puddled transplanting (237.31 and 243.35) which was significantly superior over unpuddled transplanting (224.63 and 231.98) and direct seeded rice (209.83 and 221.09) during both the years. Unpuddled transplanting also significantly enhanced grains/panicle than direct seeded rice. This may be due to more light interception because of wider spacing, that resulted in more dry matter accumulation and partitioning into sink (panicles). These results are substantiated by the findings of Hussain *et al.* (2013)^[5] and Bhardwaj *et al.* (2018)^[2].

It is clear from the data that the effect of fertilizer level turned out to be significant on number of grains/panicle. Application of 125% RDF recorded maximum number of grains/panicle (229.54 and 239.49) but was found at par with 100% RDF (226.71 and 236.43) and the both significantly surpassed over 75% RDF (212.51 and 220.50) during both the years. Similarly, 100% RDF also significantly record our 75% RDF. Continuous supply of 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 i.e number of grains per panicles. These findings are in close agreement with reports of Singh *et al.* (2014)^[18, 19], Patel *et al.* (2015)^[11], Murthy *et al.* (2015)^[9] and Nanda *et al.* (2016)^[10], Kumar *et al.* (2017)^[6, 14, 17] and Singh *et al.* (2017)^[17, 6].

Amongst weed management treatments, Hand weeding twice resulted in higher number of grains/panicle (237.53 and 245.16) which was significantly superior over brown manuring but was found at par with combined application of bispyribac-sodium + pyrazosulfuron (231.23 and 239.61) in both the years. Application of brown manuring (218.39 and 230.26) recorded least numbers of grains/panicle among weed management practices. However, all the weed management practices had significantly greater number of grains/panicle over weedy check (204.54 and 213.54) during both the years. This may be due to less crop weed competition for different growth factors among different weed management practices and assimilate adequate photosynthates and their effective translocation to reproductive parts increased the number of grains per panicles. The highest competition in weedy check plot because higher competition between growth factor i.e moisture, nutrient, sunlight etc. Similar finding was reported by Kumar *et al.* (2013)^[7].

Number of filled grains/panicle

The result revealed that crop establishment methods of rice had significant influence on number of filled grains/panicle during both the years. Puddled transplanting had maximum

filled grains/panicle (229.56 and 236.66) which was found significantly superior over unpuddled transplanting (210.41 and 220.95) and direct seeded rice (192.50 and 205.49) during both the years. Significantly lower number of filled grains/panicle was recorded under dry direct seeded rice than unpuddled transplanting. This result was found because of higher biomass production as contributed by more leaf area, source of carbohydrate production and source sink relationship that maintained positively in producing more number of filled grains in puddled transplanting. These results are substantiated with findings of Hussain *et al.* (2013)^[5] and Bhardwaj *et al.* (2018)^[2].

The result from the data showed that maximum filled grains/panicle was registered under application of highest nutrient level (220.77 and 230.72) which was significantly superior to minimum (194.80 and 203.57) level of nutrient but was statistically at par with 100% RDF (216.90 and 226.81) during both the years. Likewise, 100% RDF also recorded significantly higher filled grains/panicle than 75% RDF during both the years. This might be due to higher assimilation of nutrient which leads to higher dry matter accumulation and transportation towards sink. Effective translocation of assimilates to the sink might have resulted in sound filling of grains as revealed by the highest number of filled grains per panicle. The results of the present experiment confirmed the findings of Murthy *et al.* (2015)^[9], Kumar *et al.* (2017)^[6, 14, 17] and Singh *et al.* (2017)^[6, 17].

Variation in filled grains/panicle due to weed management practices was significant during both the years. All the weed management practices recorded significant higher number of filled grains/panicle than weedy check (186.32 and 192.85). Among the weed management practices maximum number of filled grains/panicle was recorded in hand weeding twice (228.37 and 237.08) which was found significantly superior over combined approach of bispyribac- sodium + pyrazosulfuron (221.44 and 231.82) and brown manuring (207.17 and 219.71) during both the years. However, combined approach of bispyribac-sodium + pyrazosulfuron also found significant over brown manuring. Similar results was reported by Veeraputhiran and Balasubramanian (2013)^[21].

Test weight (g)

It is evident from the data that test weight was significantly influenced by crop establishment methods during both the years. Amongst crop establishment methods, puddled transplanting had maximum (24.18 and 24.33) test weight which was significantly superior to unpuddled transplanting (23.38 and 23.49) and direct seeded rice (22.90 and 22.98) during both the years. Unpuddled transplanting recorded higher test weight over direct seeded rice. Test weight was mainly depending on genetically inherent character of the variety and management factor. Puddling has great significance in rice establishment method, because it facilitates increase in the availability of nutrients, ensures better plant establishment, nutrient transformation and accumulation in reproductive part and controls weeds Prasad *et al.* (2001)^[12]. Similar findings were also observed by Shan *et al.* (2012)^[16].

Fertilizer level also turned out to be significant on test weight of rice during both years. Application of 125% RDF (24.22 and 24.32) recorded maximum test weight but was found at par with 100% RDF (23.98 and 24.09) and the both significantly surpassed over 75% RDF (22.27 and 22.39) during both the years of studies. Increase in test 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) [8], Singh *et al.* (2014) [18, 19] and Srivastava *et al.* (2014) [19].

Data on test weight indicated that weed management practices exerted significant effect on test weight. Among the weed management practices the maximum test weight was recorded in hand weeding twice (24.23 and 24.43) but was found at par

with combined approach of bispyribac-sodium + pyrazosulfuron (23.95 and 24.06) and significantly superior over brown manuring (23.22 and 23.33). Combine application of bispyribac-sodium + pyrazosulfuron also recorded higher test weight than brown manuring. All the weed management practices recorded significantly higher test weight than weed check (22.55 and 22.5) during both years. Similar results was reported by Veeraputhiran and Balasubramanian (2013) [21] and Ramesha *et al.* (2017) [14].

Table 1: Effect of crop establishment methods, nutrient level and weed management on yield attribute of hybrid rice

Treatments	No. of panicle/m ²		Panicle length (cm)		No. of grains/ panicle		No. of filled grains/ panicle		Test weight (g)	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
A. Crop Establishment methods										
Puddled Transplanting	364.37	376.06	27.21	27.73	237.31	243.35	229.56	236.66	24.18	24.33
Unpuddled Transplanting	329.59	339.64	26.41	27.03	224.63	231.98	210.41	220.95	23.38	23.49
Dry Direct Seeded	288.92	295.88	25.91	26.31	209.83	221.09	192.50	205.49	22.90	22.98
SEm (±)	6.76	6.44	0.15	0.17	2.77	3.11	1.89	2.04	0.10	0.11
C.D.(P = 0.05)	20.27	19.31	0.45	0.50	8.32	9.33	5.66	6.12	0.31	0.32
B. Nutrient Level										
RDF 75%	282.10	288.75	24.61	25.13	212.51	220.50	194.80	203.57	22.27	22.39
RDF 100%	340.86	352.25	27.28	27.79	226.71	236.43	216.90	226.81	23.98	24.09
RDF 125%	359.92	370.57	27.64	28.15	229.54	239.49	220.77	230.72	24.22	24.32
SEm (±)	6.76	6.44	0.15	0.17	2.77	3.11	1.89	2.04	0.10	0.11
C.D.(P = 0.05)	20.27	19.31	0.45	0.50	8.32	9.33	5.66	6.12	0.31	0.32
C. Weed Management										
Weedy check	268.04	272.26	24.62	25.07	204.54	213.54	186.32	192.85	22.55	22.59
Hand Weeding	375.56	386.68	28.06	28.57	237.53	245.16	228.37	237.08	24.23	24.43
Bispyribac Sodium + Pyrazosulfuron	357.95	370.47	27.42	27.99	231.23	239.61	221.44	231.82	23.95	24.06
Brown Manuring	308.96	319.36	25.93	26.46	218.39	230.26	207.17	219.71	23.22	23.33
SEm (±)	5.86	5.70	0.39	0.34	2.37	2.44	1.88	1.81	0.16	0.14
C.D.(P = 0.05)	16.53	16.06	1.09	0.96	6.68	6.87	5.30	5.11	0.46	0.40

Conclusion

Among crop establishment methods puddled transplanting method significantly enhanced yield indices of hybrid rice. Application of 125% RDF and 100% RDF being at par recorded similar yield indices of hybrid rice. Hand weeding at 20 and 40 DAS/T and bispyribac-sodium + pyrazosulfuron which was found at par and showed similar response on yield attributing characters of hybrid rice.

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