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RICE STRAW MULCH AND ORGANIC AMENDMENT EFFECTS ON YIELD AND YIELD COMPONENTS OF DRY DIRECT SEEDED *BORO* RICE

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ABSTRACT

An experiment was conducted at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh, during January to June 2019 to find out the effect of rice straw mulch and organic amendments on yield and yield attributes of *Boro* rice under dry direct seeded system. The experiment comprised two sets of treatments viz., (a) Mulch: (i) Rice straw mulch (M_1) and (ii) no mulch (M2) and (b) organic amendments : (i) Control (Recommended Doses of Fertilizers, RDF) (T_1), (ii) RDF + Farm Yard Manure, FYM (T_2); (iii) RDF + Mustard Oil Cake, MOC (T_3); (iv) RDF + FYM + Trico-compost (T_4); (v) RDF + Trico-compost + MOC (T_5); (vi) RDF + FYM + MOC (T_6) and (vii) RDF + Trico-compost (T_7) in a split-plot design with three replications. The results showed that rice straw mulch did not have significant effect on yield and yield attributes of rice. The interaction between rice straw mulch and organic amendment was not significant for grain yield and any other characters. Based on the study results it is concluded that maximum yield of BRRI dhan28 in *Boro* season under dry direct seeded system could be achieved through organic amendment with Mustard Oil Cake @ 0.5 tha^{-1} or Farm Yard Manure @ 5 tha^{-1} + Trico-compost @ 3 tha^{-1} or Trico-compost (TC) @ 3 tha^{-1} in addition to the application of recommended doses of fertilizers (RDF).

Keywords: Boro rice, Mustard oil cake, Trico-compost, Farm yard manure, Field capacity

INTRODUCTION

Rice is mostly cultivated by transplanting of seedling on puddled land and conventionally, continuous standing water is kept in the field for facilitating easy weed control and crop establishment. This system of rice cultivation leads to extreme

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losses of water due to puddling, surface evaporation and percolation. Moreover, this traditional system has high labor demands for uprooting nursery seedlings, puddling fields and transplanting seedlings. The labor requirement for transplanted rice (nursery and transplanting) is higher than drill seeded rice as the former requires labor for seedling uprooting and transplanting (Kaur and Singh, 2017). Rainfall is practically absent in Bangladesh during Boro (winter) season and thus rice cultivation in this season is fully dependent on irrigation. In practice, rice production in conventional system requires large amounts of energy, water and labor which are becoming increasing scarce and expensive. There has been a shift from transplanting to direct seeded rice cultivation in several countries of south-east Asia due to an acute farm labor shortage (Dawe, 2005) and water scarcity (Rahman, 2019).

Dry direct seeded rice cultivation system refers to the process of establishing a rice crop from sowing of seeds directly in the dry cultivated land rather than by transplanting the seedlings from the nursery. The adoption of dry direct-seeded method for lowland rice cultivation would significantly decreases the cost of rice production and also reduce irrigation requirement. Severe weed infestation is the main problem of direct seeded rice (Rehman et al., 2007) which can be reduced by mulching (Maity and Mukherjee, 2008). In addition to weed control, mulching also helps to maintain optimum surface soil moisture for germination and rooting of the crop (Kataria and Thakur, 1987). Mendoza and Samson (1999) reported that rice straw mulching is used for conserving soil moisture in different crops. Furthermore, incorporation of different organic amendments into the soil also has a significant effect on grain yield and related attributes of dry direct seeded *Boro* rice (Sayadat et al., 2018). Since, research work in this line is meager, the present study was therefore, undertaken with a view to evaluating the effect of rice straw mulch and organic amendments on grain yield and related yield attributes of dry direct seeded rice in *Boro* season.

MATERIALS AND METHODS

Site and Soil

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh. The experimental site belongs to the Sonatala soil series of Old Brahmaputra Floodplain Agro ecological Zone (AEZ-9) having non-calcareous dark grey floodplain soils. The land was medium high with moderate drainage facilities and the soil was silt loam with the pH value of 6.50. The soil contained 2.37% organic matter, 0.15% total N, 15.22 ppm available P, 33.11% field capacity and 1.42 g cm^{-3} soil bulk density. The experimental area is under the sub-tropical climate which is characterized by its heavy rainfall during *Kharif* season (April to September) and scanty rainfall during *Rabi* season (October to March). The temperature and rainfall during the experimental period is given in Table 1.

Table 1. Temperature and rainfall of experimental site (November 2018 to April 2019)

Month	Air Temperature (°C)			Rainfall (mm)
	Maximum	Minimum	Average	
November 2018	29.3	17.4	23.4	36.2
December 2018	26.0	13.5	19.8	17.7
January 2019	26.3	12.2	19.2	0.0
February 2019	27.0	25.5	21.3	1.2
March 2019	29.8	17.7	23.8	1.9
April 2019	31.7	22.3	27.0	2.2

Experimental treatments and design

The experiment consisted of two sets of treatments viz., (a) Mulch: (i) Rice straw mulch and (ii) no mulch and (b) organic amendments : (i) Control (Recommended Doses of Fertilizers, RDF) (T_1), (ii) RDF + Farm Yard Manure, FYM (T_2); (iii) RDF + Mustard Oil Cake, MOC(T_3); (iv) RDF + FYM + Trico-compost (T_4); (v) RDF + Trico-compost + MOC (T_5); (vi) RDF + FYM + MOC (T_6) and (vii) RDF + Trico-compost (T_7) and was laid out in a split-plot design with three replications. Mulching was assigned to the main pots and organic amendments in the subplots. The size of each unit plot was 10 m^2 (4.0 m × 2.5 m). The space between block to block was 1.0 m and plot to plot was 0.75 m.

Crop husbandry

Seed of rice variety BRRI dhan28 was sown on dry cultivated land by hand at 25 cm × 15 cm spacing with 4-5 seeds $hill^{-1}$ on 31 January 2019. Before sowing the seeds were primed by soaking in water for 24 hours and then incubated for 30 hours at room temperature. The land was fertilized with N, P, K, S and Zn at 140, 15, 60, 15 and 1.3 kg ha^{-1} in the form of Urea, Triple super phosphate (TSP), Muriate of Potash (MoP), Gypsum and Zinc Sulphate, respectively (FRG, 2012). Trico-compost, Farm Yard Manure (FYM) and Mustard oil cake (MOC) were applied as per experimental specifications. All the fertilizers and manures except urea were applied in different unit of plots at the time of land preparation. Urea was applied in three equal splits at 25, 45 and 65 days after sowing (DAS). Mustard Oil Cake (MOC) was applied at 40 DAS. Mulch (Rice straw) was applied in different unit plots as per layout of the experiment at the rate of 5 t ha^{-1}. A pre-emergence herbicide Pendimethalin (Trade name: Panida 33EC) @ 50 ml/10L of water was applied on 02 February, 2019 in all the plots and then rice straw mulching was done as per

experimental specifications. Weeding was done twice by hand pulling on 21 and 42 DAS, respectively. Only three irrigations were given on 25, 55 and 82 DAS. Soil was kept at moist condition up to panicle initiation (PI) stage for successful growth and development of crop. Standing water was maintained in the field from PI to heading stage but it required one irrigation only as rainfall was sufficient to meet up the condition. Fungicide Nativo was applied at 42 DAS to control fungal diseases. During flowering to ripening stage the crop was subjected to severe infestation by rice bug which was successfully controlled by applying Chloropyriphos (20 EC) @ 1.0 L ha^{-1} twice at 7 days interval.

Sampling, harvesting and processing

The crop was harvested at maturity when about 80% of the grains became golden-yellow in color. Five hills (excluding border hills) were randomly selected for each plot and uprooted before harvesting for recording the necessary data on various plant characters. Crop was harvested from central 1.5 m × 3 m area of each plot to record the yields of grain and straw. Five hills were randomly selected for measuring plant height and tiller production and also to record the data on yield contributing characters. The harvested crop of each plot was separately bundled, properly tagged and then brought to the threshing floor. The crop was threshed by pedal thresher. Grains were sun dried and cleaned. Straw was also sun dried properly. Finally, grain yields were adjusted to 14% moisture basis and converted to ton per hectare.

Statistical Analysis

The collected data were compiled and tabulated in proper form and were subjected to statistical analysis. Data were analyzed using the analysis of variance (ANOVA) technique with the help of a computer package programs STATISTIX10 and mean differences were adjudged by Least Significance Difference Test.

RESULTS AND DISCUSSION

Effect of mulching

The result presented in Table 2 and 3 show that there was no significant effect of rice straw mulch on plant height, number of total tillers $hill^{-1}$, number of effective tillers $hill^{-1}$, number of non-effective tillers $hill^{-1}$, panicle length, number of filled grains $panicle^{-1}$, number of unfilled grains $panicle^{-1}$, weight of 1000-grains, grain yield, straw yield, biological yield and harvest index.

Table 2. Effect of rice straw mulching on growth and yield contributing characters of BRRI dhan28 under dry direct seeded system of cultivation

Mulching	Plant height (cm)	No. of total tillers hill^{-1}	No. of effective tillers hill^{-1}	No. of non-effective tillers hill^{-1}	Panicle length (cm)	No. of filled grains panicle^{-1}	No. of unfilled spikelet panicle^{-1}	1000-grains weight (g)
Rice Straw	94.05	15.68	14.49	1.18	23.49	106.94	15.73	20.01
No Mulch	93.51	15.46	14.4	1.47	23.65	101.9	15.81	19.96
Level of significance	NS	NS	NS	NS	NS	NS	NS	NS
$LSD_{0.05}$	9.663	2.097	1.969	1.007	1.248	11.362	3.005	0.143
CV%	7.49	10.79	11.21	56.98	3.24	6.13	12.91	0.90

The rice straw mulching did not play any significant impact on the growth and yield of rice in the present study while Sayadat et al. (2019) reported significant increase in yield and tiller production in the mulch plots than the no mulch plot in the same location. This might be due to the fact that the soil moisture content in the field remained more or less at around field capacity (25-26%) throughout the period of vegetative growth which means that the crop in the present study did not face any severe drought stress both in mulch and no mulch plots.

Table 3. Effect of rice straw mulching on grain and straw yield of BRRI dhan28 under dry direct seeded system of cultivation

Mulching	Grain yield (t ha^{-1})	Percent increased yield over no mulching (%)	Straw yield (t ha^{-1})	Percent increased yield over no mulching (%)	Biological yield (t ha^{-1})	Harvest index (%)
Rice Straw	4.46	0.67	5.91	5.08	10.32	42.72
No Mulch	4.43	-	5.61	-	10.03	43.96
Level of significance	NS	NS	NS	NS	NS	NS
$LSD_{0.05}$	0.931		0.855		1.507	1.554
CV%	10.80	-	10.35	-	9.80	4.44

ns= Not significant

Effect of organic amendment

Organic amendment had significant effect on number of total and effective tillers hill^{-1}, grain yield, straw yield, biological yield and harvest index but not on plant height, number of non-effective tillers hill^{-1}, panicle length, number of filled and unfilled grains panicle^{-1} and 1000-grains weight (Table 4).

Table 4. Effect of organic amendments on growth and yield contributing characters of BRRI dhan28 under dry direct seeded system of cultivation in *Boro* season

Organic Amendment	Plant height (cm)	No. of total tillers hill^{-1}	No. of effective tillers hill^{-1}	No. of non-effective tiller hill^{-1}	Panicle length (cm)	No. of filled grains panicle^{-1}	No. of unfilled Spikelet Panicle^{-1}	1000-grain weight (g)
T_1	92.08	12.87b	12.04b	0.86	23.58	103.63	15.73	20.02
T_2	93.13	16.04a	14.92a	1.16	23.28	104.6	15.9	19.98
T_3	95.13	16.25a	14.83a	1.42	23.63	104.5	15.8	20.12
T_4	93.21	16.46a	14.55a	1.91	23.12	103.4	15.53	20.03
T_5	92.83	15.88a	14.18a	1.69	23.83	106.67	15.3	19.93
T_6	95.08	15.46a	14.25a	1.21	23.77	103.8	16.07	19.93
T_7	95.00	16.04a	14.93a	1.11	23.78	104.37	16.07	19.87
Level of significance	NS	***	**	NS	NS	NS	NS	NS
$LSD_{0.05}$	3.475	1.244	1.567	1.152	1.113	6.355	1.636	0.420
CV%	3.11	6.70	9.23	76.54	3.96	5.11	8.71	1.77

In a column, the figures with same letter (s) or without letter do not differ significantly, whereas figures with dissimilar letter (s) differ significantly; ** = Significant at 1% level of probability, ***= Significant at 0.01% level of probability and ns= Not significant [T_1=Control, Recommended Doses of Fertilizers (RDF); T_2= RDF + Farm Yard Manure (FYM) @ 5 tha^{-1}; T_3 =RDF +Mustard Oil Cake (MOC) @ 0.5 t ha^{-1}; T_4 =RDF + Farm Yard Manure (FYM) @ 5 tha^{-1} + Trico-compost (TC) @ 3 tha^{-1}; T_5=RDF + Trico-compost (TC) @ 3 tha^{-1} + Mustard Oil Cake (MOC) @ 0.5 tha^{-1}; T_6 =RDF + Farm Yard Manure (FYM) @ 5 tha^{-1}+ Mustard Oil Cake (MOC) @ 0.5 tha^{-1}; T_7= RDF + Trico-compost (TC) @ 3 tha^{-1}]

The maximum number of total tillers hill^{-1} (16.46) was obtained from T_4 (RDF + Farm Yard Manure @ 5 tha^{-1} + Trico-compost @ 3 tha^{-1}) while the lowest number of total tillers hill^{-1} (12.87) was obtained from T_1 (Control, Recommended Doses of Fertilizers, no amendment). The highest number of effective tillers hill^{-1} (14.93) was obtained from T_7 (RDF + Trico-compost (TC) @ 3 tha^{-1}) and the minimum number of effective tillers hill^{-1} (12.04) was obtained from T_1. Muhammad et al. (2012) and Hafiz et al. (2011) reported that application of organic amendments significantly

increased the number of total tillers and effective tillers hill^{-1}. Table 5 showed that the highest grain yield (4.69 tha^{-1}) was obtained from T_3 (Mustard Oil Cake @ 0.5 tha^{-1}) and the lowest grain yield (3.99 tha^{-1}) was obtained from T_5 (Trico-compost @ 3 tha^{-1}+ Mustard Oil Cake @ 0.5 tha^{-1}). The grain yield of T_3 increased 11.95% over control treatment (T_1). The highest straw yield (6.09 tha^{-1}) was obtained from T_5 (Trico-compost @ 3 tha^{-1} and Mustard Oil Cake @ 0.5 tha^{-1}) while the lowest straw yield (5.19 tha^{-1}) was obtained from T_1 (Control, Recommended Doses of Fertilizers). It was noted that straw yield of T_5 increased by 14.78% over control treatment (T_1). The highest biological yield (10.59 tha^{-1}) was obtained from T_4 (Farm Yard Manure @ 5 tha^{-1} + Trico-compost @ 3 tha^{-1}) while the lowest biological yield (9.33 tha^{-1}) was obtained from T_1 (Control, Recommended Doses of Fertilizers).

Table 5. Effect of organic amendments on grain and straw yield of BRRI dhan28 under dry direct seeded system of cultivation

Organic Amendment	Grain yield (tha^{-1})	Percent increase grain yield over control (%)	Straw yield (tha^{-1})	Percent increase grain yield over control (%)	Biological yield (tha^{-1})	Harvest index (%)
T_1	4.13bc	-	5.19d	-	9.33c	44.19a
T_2	4.31abc	4.18	5.63c	7.82	9.93b	43.30a
T_3	4.69a	11.95	5.74bc	9.58	10.42ab	45.00a
T_4	4.67a	11.56	5.92abc	12.33	10.59a	44.22a
T_5	3.98c	3.78	6.09a	14.78	10.08ab	39.19b
T_6	4.51ab	8.43	5.98ab	13.21	10.49a	39.19a
T_7	4.64a	10.99	5.57bc	6.82	10.38ab	44.68a
Level of significance	*	-	***	-	***	*
$LSD_{0.05}$	0.485		00.303		0.524	3.302
CV%	0.49	-	0.30	-	0.52	3.30

In a column, the figures with same letter (s) or without letter do not differ significantly, whereas figures with dissimilar letter (s) differ significantly; *= Significant at 5% level of probability; ***= Significant at 0.01% level of probability [T_1=Control, Recommended Doses of Fertilizers (RDF); T_2= RDF + Farm Yard Manure (FYM) @ 5 tha^{-1}; T_3 =RDF +Mustard Oil Cake (MOC) @ 0.5 tha^{-1}; T_4 =RDF + Farm Yard Manure (FYM) @ 5 tha^{-1} + Trico-compost (TC) @ 3 tha^{-1}; T_5=RDF + Trico-compost (TC) @ 3 tha^{-1} + Mustard Oil Cake (MOC) @ 0.5 tha^{-1}; T_6 =RDF + Farm Yard Manure (FYM) @ 5 tha^{-1}+ Mustard Oil Cake (MOC) @ 0.5 tha^{-1}; T_7= RDF + Trico-compost (TC) @ 3 tha^{-1}]

Harvest index was significantly influenced by application of different organic amendments. The maximum harvest index (45%) was obtained from T_3 (Mustard Oil Cake @ 0.5 t ha^{-1}) while the minimum harvest index (39.19%) was obtained from T_5

(Trico-compost @ 3 tha^{-1} + Mustard Oil Cake @ 0.5 tha^{-1}). Muhammad et al. (2012) and Hafiz et al. (2011) found that organic manure significantly increased grain and straw yield of rice. Mitran and Mani (2017) reported that the yield improvement in the organic amended plots could be related to the fact that the integrated application of inorganic and organic sources of nutrients enhances stomatal conductance and the photosynthetic rate which are the primary physiological processes responsible for plant dry matter production. Moreover, balanced fertilization facilitated the translocation of nutrients to the economic parts of the crop leading to enhanced crop yield (Mitran and Mani, 2017).

Table 6. Effect of interaction between rice straw mulching and organic amendments on growth and yield contributing characters of BRRI dhan28 under dry direct seeded system of cultivation

Mulch × Organic amendment	Plant height (cm)	No. of total tillers hill^{-1}	No. of effective tillers hill^{-1}	No. of non-effective tillers hill^{-1}	Panicle length (cm)	No. of filled grains panicle^{-1}	No. of unfilled Spikelet panicle^{-1}	1000-grain weight (g)
M_1T_1	94.50	12.50	11.83	0.67	23.57	104.20	15.40	19.97
M_1T_2	91.83	15.92	14.83	1.08	23.17	97.53	15.93	19.93
M_1T_3	95.17	16.67	14.50	2.17	23.60	100.33	15.93	20.30
M_1T_4	92.92	16.33	14.25	2.08	23.77	103.60	16.80	19.97
M_1T_5	90.33	15.83	14.00	1.83	23.70	106.53	14.73	19.73
M_1T_6	93.42	15.33	13.97	1.37	23.67	100.80	16.27	19.80
M_1T_7	96.42	15.67	114.58	1.08	24.13	100.33	15.60	20.00
M_2T_1	89.67	13.23	12.25	0.98	23.60	103.07	16.07	20.07
M_2T_2	94.42	16.17	15.00	1.17	23.40	111.67	15.87	20.03
M_2T_3	95.08	15.83	15.17	0.67	23.67	108.67	15.67	19.93
M_2T_4	95.50	16.58	14.85	1.73	22.47	103.20	14.27	20.10
M_2T_5	95.33	15.92	14.37	1.55	23.97	106.80	15.87	20.13
M_2T_6	96.75	15.58	14.53	1.05	23.87	106.80	15.87	20.07
M_2T_7	93.58	16.42	15.28	1.33	23.43	108.40	16.53	19.73
Level of significance	ns	ns	ns	ns	ns	Ns	ns	ns
$LSD_{0.05}$	10.047	2.566	2.758	1.853	1.849	11.362	3.512	0.5824
CV%	3.11	6.70	9.23	76.54	3.96	5.11	8.71	1.77

In a column, the figures with same letter (s) or without letter do not differ significantly, whereas figures with dissimilar letter (s) differ significantly; ns= Not significant [T_1=Control, Recommended Doses of Fertilizers (RDF); T_2= RDF + Farm Yard Manure (FYM) @ 5 tha^{-1}; T_3 =RDF +Mustard Oil Cake (MOC) @ 0.5 tha^{-1}; T_4 =RDF + Farm Yard Manure (FYM) @ 5 tha^{-1} + Trico-compost (TC) @ 3 tha^{-1}; T_5=RDF + Trico-compost (TC) @ 3 tha^{-1} + Mustard Oil Cake (MOC) @ 0.5 t ha^{-1}; T_6 =RDF + Farm Yard Manure (FYM) @ 5 tha^{-1}+ Mustard Oil Cake (MOC) @ 0.5 t ha^{-1}; T_7= RDF + Trico-compost (TC) @ 3 tha^{-1}]

Interaction effect of mulching and organic amendment

There was no signification interaction effect of mulching and organic amendment on plant height, number of total tillers hill^{-1}, number of effective tillers hill^{-1}, number of non-effective tillershill^{-1}, panicle length, number of filled grains panicle^{-1}, number of unfilled grains panicle^{-1}, weight of 1000 grains, grain yield, straw yield, biological yield and harvest index (Table 6 and 7).

Table 7. Effect of interaction between rice straw mulching and organic amendments on grain and straw yield of BRRI dhan28 under dry direct seeded system of cultivation

Mulch × Organic amendment	Grain yield (t ha^{-1})	Percent increase yield over control (%)	Straw yield (t ha^{-1})	Percent increase yield over control (%)	Biological yield (t ha^{-1})	Harvest index (%)
M_1T_1	4.02	-	4.99	-	9.02	44.48
M_1T_2	4.32	6.94	5.52	9.60	9.84	43.84
M_1T_3	4.79	16.08	5.62	11.21	10.41	46.05
M_1T_4	4.97	19.11	5.73	12.91	10.69	46.45
M_1T_5	3.90	3.08	5.89	15.28	9.79	39.11
M_1T_6	4.34	7.37	5.91	15.57	10.25	42.12
M_1T_7	4.65	13.54	5.55	10.09	10.20	45.63
M_2T_1	4.24	-	5.39	-	9.64	43.91
M_2T_2	4.29	1.17	5.74	6.09	10.03	42.76
M_2T_3	4.58	7.42	5.85	7.86	10.44	43.95
M_2T_4	4.77	11.11	6.11	11.78	10.48	41.98
M_2T_5	4.07	4.18	6.29	14.31	10.37	39.27
M_2T_6	4.68	9.41	6.06	11.06	10.74	43.48
M_2T_7	4.62	8.22	5.94	9.25	10.56	43..72
Level of significance	ns	ns	ns	ns	Ns	ns
$LSD_{0.05}$	0.989		0.931		1.554	5.986
CV%	9.22	-	4.42	-	4.32	6.39

In a column, the figures with same letter (s) or without letter do not differ significantly, whereas figures with dissimilar letter (s) differ significantly; ns= Not significant; [T_1= Control, Recommended Doses of Fertilizers (RDF), T_2= RDF + Farm Yard Manure (FYM) @ 5 tha^{-1} T_3 = RDF +Mustard Oil Cake (MOC) @ 0.5 tha^{-1}, T_4 = RDF + Farm Yard Manure (FYM) @ 5 t ha^{-1} + Trico-compost (TC) @ 3 tha^{-1}, T_5= RDF + Trico-compost (TC) @ 3 tha^{-1} + Mustard Oil Cake (MOC) @ 0.5 tha^{-1}, T_6 = RDF + Farm Yard Manure (FYM) @ 5 tha^{-1}+ Mustard Oil Cake (MOC) @ 0.5 tha^{-1}, T_7= RDF + Trico-compost (TC) @ 3 tha^{-1}]

The non-significant interaction indicates that effect of organic amendment on different crop characters and yield does not depend on the mulching treatment.

CONCLUSION

Organic amendments had significant effect on no. of total tillers hill^{-1}, no. of effective tillers hill^{-1}, grain yield (tha^{-1}), straw yield (tha^{-1}), biological yield (tha^{-1}) and harvest index (%) of BRRI dhan28 under the dry direct seeded *Boro* rice production system. Application of Mustard Oil Cake @ 0.5 tha^{-1} with recommended doses of fertilizers (RDF) gave the highest grain yield while application of Farm Yard Manure @ 5 tha^{-1} + Trico-compost @ 3 tha^{-1} with RDF or Trico-compost (TC) @ 3 tha^{-1} with RDF also gave the similar high yields. Therefore, highest yield of *Boro* rice cv. BRRI dhan28 under dry direct seeded system could be obtained by using Trico-compost (TC) @ 3 tha^{-1} or Mustard Oil Cake @ 0.5 tha^{-1} or Farm Yard Manure @ 5 tha^{-1} + Trico-compost @ 3 tha^{-1} along with the recommended rate of fertilizers.

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