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Article

Effect of mulch and organic amendment on yield performance of dry direct seeded *BORO* rice

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Abstract: An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from February to June 2018 with a view to study the effect of mulch and organic amendments on growth and yield performance of BRRI dhan58 under dry direct seeded boro rice production system. The experiment included two set of treatments. A. Mulch (M_1=rice straw mulch @ 7 t ha^{-1} and M_2=No mulch) and B. Organic amendments (T_1=Trico-compost (TC) @ 5 t ha^{-1}, T_2 =Farm Yard Manure (FYM) @ 5 t ha^{-1}, T_3 =Mustard Oil Cake (MOC) @ 0.5 t ha-1, T_4= Trico-compost (TC) @ 5 t ha^{-1} + Mustard Oil Cake (MOC) @ 0.5 t ha-1, T_5 = Farm Yard Manure (FYM) @ 5 t ha^{-1} + Mustard Oil Cake (MOC) @ 0.5 t ha-1, T_6=Control). The experiment was laid out in a split-plot design with mulch in the main plot and organic amendments in the sub-plot. The treatments were replicated three times. The higher plant height (95.90 cm), no. of effective tillers hill^{-1} (11.48), 1000-grains weight (24.75 g), grain yield (5.34 t ha^{-1}), and straw yield (7.38 t ha^{-1}) were found from rice straw mulch plots. The highest plant height (103.40 cm), panicle length (23.24 cm), no. of grain panicle^{-1} (118.79), 1000-grain weight (25.23 g), grain yield (5.67 t ha^{-1}), straw yield (7.80 t ha^{-1}), biological yield (13.47 t ha^{-1}) and harvest index (42.06%) were found from treatment T_4 (Tricho compost+Muatard Oil Cake). The crop grown with recommended rate of fertilizers (T_6) gave the worst performance. The interaction between mulch and organic amendments were not significant for grain yield. Thus the study concludes that rice straw mulching gives better yield than no mulch plots and the organic amendment is better than recommended inorganic fertilizer application.

Keywords: rice straw mulch; organic amendment; yield performance; biological yield

1. Introduction

Rice (*Oryza sativa L.*) is the major food crop of Bangladesh. Rice also contributes 95% of food production in Bangladesh. About 74.85% of cropped area of Bangladesh is used for rice production (BBS, 2017). In Bangladesh *boro* rice is mainly cultivated in puddled transplanted system and requires full irrigation and it is about 1500 to 2000 mm. The scarcity of irrigation water due to decline of water table as well as lack of surface water causes *boro* rice crop failure. This conventional methods of rice production require large amounts of energy, water and labour, which were becoming increasingly scarce and expensive. Hence, it is important to find efficient and comprehensive strategies that support global food security. In this regard dry direct seeded *boro* rice cultivation system can be used as an alternative approach, which is an environment friendly technology that helps saving of 50-60% irrigation water. Dry direct seeded *boro* rice production system, a water saving *boro* rice production technology, has been developed through continuous research at Department of Agronomy, Bangladesh Agricultural University, Mymensingh which could be successfully used in the country to produce *boro* rice with less water in a sustainable way.

Direct seeding of rice refers to the process of establishing a rice crop from seeds sown in the field rather than by transplanting seedlings from the nursery. There were three principal methods of direct seeding of rice (DSR): dry seeding (sowing dry seeds into dry soil), wet seeding (sowing pre-germinated seeds on wet puddle soils) and water seeding (seeds sown into standing water). Dry seeding has been the principal method of rice establishment since the 1950s in developing countries (Pandey and Velasco, 2005). In the traditional transplanting system (TPR), puddling creates a hard pan below the plough-zone and reduces soil permeability. It leads to high losses of water through puddling, surface evaporation and percolation. Water resources, both surface and underground were shrinking and water has become a limiting factor in rice production (Farooq *et al.*, 2009). In recent years, there has been a shift from TPR to DSR cultivation in several countries of Southeast Asia. This shift was principally brought about by the expensive labor component for transplanting due to an acute farm labor shortage, which also delayed rice sowing (Chan and Nor, 1993). Among the rice growing countries, Bangladesh stands 4th in position following China, India, and Indonesia (FAO, 2008). The production of rice in the country was 9.77 million tons from 9.2 million hectares of land in 1971-72 which became 33.914 million tons from 11.53 million hectares in 2011-12 (BBS, 2012). The adoption of a direct-seeded method for lowland rice culture would significantly decrease costs of rice production. The labor requirement for transplanted rice (nursery and transplanting) is approximately 50 person day's ha^{-1} in comparison to 37 person day's ha^{-1} for drill or wet seeded rice (FAO, 2010). In comparison to transplanted rice direct seeded rice also minimizes the emissions of methane gas. With the development of resource conserving technologies, direct seeding is being emerged as a viable alternative to transplanted rice (Tripathi *et al.*, 2004). However, mulching practice along with organic amendment in dry direct seeded rice production system, can provide several benefits to crop production through improving soil moisture, heat energy and nutrient status in soil, preventing soil and water loss, soil salinity from flowing back to surface, and controlling weeds, thus incorporation of organic materials such as crop residues offers a sustainable and ecologically sound alternative for meeting the nutrient requirements of crops (Boyle *et al*., 1989). Thus, there is an enormous potential of recycling these residues in the crop production systems (Mandal *et al.*, 2004). As indicated by Mendoza and Samson (1999) the use of rice straw mulching for conserving soil moisture in different crops is possible. Hence, conservation of soil moisture coupled with yield enhancements by rice straw mulching and organic amendment would be beneficial in integrated plant management systems, while minimizing the impact of agrochemicals; which is an important concern in current agricultural activities. Since not much works have been done in this field, this research was designed to address the problem of making DSR popular among farmers with the objective of evaluating the effect of mulch and organic amendment on yield performance dry direct seeded *boro* rice. This study was undertaken to evaluate the effect of mulch on growth and yield performance of dry direct seeded *boro* rice; to find out the effect of organic amendments of BRRI dhan58 under dry direct seeded system of cultivation; and to observe the interaction effect of mulch and organic amendments, if any, on yield and yield attributes of BRRI dhan58 under dry direct seeded system of cultivation.

2. Materials and Methods

2.1. Description of experimental site

2.1.1. Location

This experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, located at 24°75′ N latitude and 90°50′ E longitude having an altitude of 18 m. The experimental site belongs to the Sonatala series of Old Brahmaputra Floodplain Agro ecological Zone (AEZ9) having non-calcareous dark grey floodplain soils.

2.1.2. Soil

The land was medium high with moderate drainage facilities and the soil was silt loam. The pH value was 6.40. Soil contained 2.27% organic matter, 0.123% total N, 5.60 ppm available P, 0.22 meq 100 g^{-1} exchangeable K and 15.007 ppm available S.

2.1.3. Climate

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 occurred during Rabi season (October to March).

2.2. Experimental treatments

The treatment and treatment contents are shown in Table 1.

Table 1. Treatments and contents.

Name of treatment	Contents
T_1	Trico-compost (TC) @ 5 ton ha^{-1}
T_2	Farm yard manure (FYM) @ 5 ton ha^{-1}
T_3	Mustard oil cake (MOC) @ 0.5 ton ha^{-1}
T_4	Trico-compost (TC) @ 5 ton ha^{-1} + Mustard oil cake (MOC) @ 0.5 ton ha^{-1}
T_5	Farm yard manure (FYM) @ 5 ton ha^{-1} + Mustard oil cake (MOC) @ 0.5 ton ha^{-1}
T_6	Control
M_1	Rice straw @ 7 ton ha^{-1},
M_2	No mulch

2.3. Experimental design and layout

The experiment was laid out in a split-plot design as mulch in the main plot and organic amendments in the sub-plot with three replications. The total numbers of unit plots were 36. The size of each unit plot was 10 m^2 (4.0 m × 2.5 m). The spaces between blocks and plots were 1 m and 0.75 m respectively.

2.4. Description of the rice cultivar

2.4.1. BRRI dhan58

BRRI dhan58 was developed by the scientist of BRRI (Bangladesh Rice Research Institute from BRRI dhan29-SC3-28-16-4-HR2 and it was officially released by National Seed Board of Bangladesh in 2012. It is a *boro* rice variety with photoperiod insensitivity, 7-10 days earliness than BRRI dhan29 with similar grain type. BRRI dhan58 requires 150-155 days to mature and average yield is 7-7.5 t ha^{-1}.

2.5. Crop husbandry

2.5.1. Collection of seed

Healthy seeds of BRRI dhan58 were collected from the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh.

2.5.2. Priming of seed

Healthy and vigorous seeds were selected for priming. Before sowing the seeds were primed following hydro priming technique by soaking in water for 24 hours at room temperature and then incubated for 30 hours at 35°C. The primed seeds were then sown directly in the field.

2.5.3. Land preparation

The land was first opened with a power tiller and subsequently leveled by laddering. Weeds and stubbles of the previous crop were collected and removed from the field. Before sowing, fields were prepared by ploughing and harrowing to obtain a smooth seedbed. The land was finally prepared on 18th February 2018.

2.5.4. Application of fertilizer and manures

The land was fertilized as per treatment specification. The experimental plots were fertilized with triple super phosphate (TSP), muriate of potash (MoP) and gypsum at the rate of 120, 120 and 80 kg ha^{-1} respectively, along with Trico-compost and Farm Yard Manure (FYM) at the rate of 5 t ha^{-1} respectively in different unit of plots at the time of final land preparation. The manures were thoroughly mixed with the soil. Urea was applied in three equal splits at 15, 30 and 45 days after sowing (DAS). Mustard oil cake (MOC) was applied 15 days after sowing (DAS).

2.5.5. Sowing of seed

Seed was sown in furrows with 4 seeds hill^{-1} on 19 February 2018 under dry direct seeded system.

2.5.6. Application of mulch

Mulch were applied in different unit of plots as per layout of the experiment at the rate of 7 t ha^{-1} respectively.

2.5.7. Intercultural operations

2.5.7.1. Weed management

Pendimethalin (Trade name: Panida 33EC) was applied for weed control @ 50 ml 10 L^{-1} of water as pre-emergence herbicide on 20 February, 2018. Crops were infested with different weeds. Weeding was done twice by hand pulling on 14 March and 2 April.

2.5.7.2. Irrigation

Irrigation was provided only to maintain the field at moist soil condition for successful crop growth and development. Irrigation was done twice on 15 March and 23 April, 2018.

2.6. Sampling, harvesting and processing

The crop was harvested at full 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. The crop was threshed by pedal thresher. Grains were sun dried and cleaned. Straw was also sun dried properly. Finally, grain yields was adjusted to 14% moisture and converted to ton per hectare.

2.7. Collection of data

Plant height, Number of total tiller hill^{-1}, Number of effective tiller hill^{-1}, Number of non-effective tiller hill^{-1}, Panicle length, Number of grains panicle^{-1}, Number of sterile grains panicle^{-1}, 1000-grain weight, Grain yield, Straw yield, Biological yield, and Harvest index yield and yield components were taken during study period

2.8. Procedure of recording data

2.8.1. Plant height

The plant height at maturity stage was measured from ground level to tip of the uppermost panicle. The average height of five hills considered as the height to the plant for each plot.

2.8.2. Number of total tillers, effective tillers and non-effective tillers hill^{-1}

Tillers, which had at least one visible leaf, were counted including both effective and non-effective tillers.

2.8.3. Panicle length

Length of panicles was measured from the first node to the tip of the panicle from each panicle and then average was expressed in cm. Each observation was an average of five hills.

2.8.4. Number of sterile grains panicle^{-1}

Presence of material in the spikelet was considered as grain and total number of filled and unfilled grains present on each panicle was counted.

2.8.5. 1000-grain weight

One thousand clean and dried grains were counted from the seed stock obtained from five sample hills of each plot and weighed using an electric balance. The weight was adjusted at a seed moisture content of 14%.

2.8.6. Grain yield

Grains obtained from central 4.5 m^2 area of each plot were sun dried and weighed carefully. The dry weight of grains was adjusted to 14% moisture content and finally converted to t per hectare.

2.8.7. Straw yield

Straws obtained from central 4.5 m^2 area of each plot were sun dried and weighed separately and finally converted to t per hectare.

2.8.8. Biological yield (%)

Grain yield and straw yield were altogether regarded as biological yield. Biological yield was calculated with the following formula:

Biological yield (t ha^{-1}) = Grain yield (t ha^{-1}) + Straw yield (t ha^{-1}).

2.8.9. Harvest index

Harvest index is the ratio of economic yield to biological yield expressed as percentage and was calculated with the following formula:

$$\text{Harvest index} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

2.9. 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 program STATISTIX10 and mean differences were adjudged by Least Significance Difference (LSD) test.

3. Results and Discussion

3.1. Plant height

3.1.1. Effect of mulching

Plant height was not significantly affected by mulching. However, the higher plant height (95.90cm) was obtained from M_1 and the lower plant height (91.91cm) was obtained from M_2.

3.1.2. Effect of organic amendments

Plant height was significantly influenced by organic amendments. The maximum plant height (103.80cm) was obtained from T_4 (5 ton trico-compost ha^{-1} and 0.5 t mustard oil cake ha^{-1}) while the lowest plant height (85.55cm) was obtained from T_6 (Table 2). According to Muhammad *et al.* (2012), application of organic amendments have significant effect on plant height. They have reported that plant height increased with the application of organic amendments.

Table 2. Effect of organic amendments on yield and yield attributes of BRRI dhan58 under dry direct seeded system of cultivation.

Treatment	Plant height (cm)	No. of total tillers $hill^{-1}$	No. effective tillers $hill^{-1}$	No. non effective tillers $hill^{-1}$	Panicle length (cm)	No. of grains $panicle^{-1}$
T_1	90.23cd	13.89d	10.56d	3.32c	22.51c	112.78bc
T_2	95.81b	15.02c	11.14c	3.88ab	22.81bc	113.86b
T_3	94.58bc	15.38bc	11.38bc	4.00a	22.91ab	110.04cd
T_4	103.80a	16.16a	12.31a	3.85ab	23.24a	118.79a
T_5	93.49bc	15.56b	11.63b	3.95ab	22.80bc	115.82ab
T_6	85.55d	13.48e	9.94e	3.53bc	21.74d	108.91d
Level of significant	**	**	**	**	**	**
CV%	4.90	2.06	3.35	10.30	1.25	2.29

*= Significant at 5% level of probability
** = Significant at 1% level of probability
***= Significant at 0.01% level of probability
NS= Not significant

3.1.3. Effect of interaction

Plant height was significantly influenced by the interaction effect of mulching and different level of organic amendments. The maximum plant height (104.71cm) was found from M_1T_4 while the lowest plant height (83.63cm) was found from M_2T_6 (Table 3).

Table 3. Effect of interaction between rice straw mulching and organic amendments on yield and yield attributes of BRRI dhan58 under dry direct seeded system of cultivation.

Interaction	Plant height (cm)	No. of total tillers hill^{-1}	No. effective tillers hill^{-1}	No. non effective tillers hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}
M_1T_1	92.50de	14.13e	10.81cd	3.32	22.65cd	114.39bc
M_1T_2	96.70bcd	15.28cd	11.40bc	3.88	23.03bc	116.84ab
M_1T_3	100.52abc	15.83b	11.82b	4.00	23.20ab	111.98cd
M_1T_4	104.71a	16.73a	12.74a	3.99	23.57a	120.10a
M_1T_5	93.56cde	16.05b	11.98b	4.07	23.17ab	117.77ab
M_1T_6	87.47ef	13.60f	10.18de	3.42	21.75e	110.12cd
M_2T_1	87.97def	13.65ef	10.34de	3.32	22.37d	111.17cd
M_2T_2	94.92cde	14.76d	10.88cd	3.88	22.60cd	110.87cd
M_2T_3	88.65def	14.94d	10.94cd	4.00	22.62cd	108.11d
M_2T_4	102.90ab	15.59bc	11.88b	3.71	22.92bc	117.49ab
M_2T_5	93.42cde	15.10cd	11.28bc	3.82	22.43d	113.87bc
M_2T_6	83.63f	13.35f	9.71e	3.64	21.73e	107.69d
Level of significant	**	**	**	NS	**	**
CV%	4.90	2.06	3.35	10.30	1.25	2.29

NS= Not significant
*= Significant at 5% level of probability
** = Significant at 1% level of probability
***= Significant at 0.01% level of probability

3.2. Number of total tillers hill^{-1}

3.2.1. Effect of mulching

Number of total tillers hill^{-1} was significantly influenced by mulching. The highest number of total tillers hill^{-1} (15.27) was obtained from M_1 and the lowest number of total tillers hill^{-1} (14.56) was obtained from M_2 (Table 4). Similar results on number of total tillers hill^{-1} due to application of rice straw mulch have been reported by Devasinghe *et al.* (2013). They found that number of total tillers hill^{-1} were increased with the application of rice straw mulch.

Table 4. Effect of rice straw mulching on yield and yield attributes of BRRI dhan58 under dry direct seeded system of cultivation.

Mulching	Plant height (cm)	No. of total tillers hill^{-1}	No. effective tillers hill^{-1}	No. non effective tillers hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}
M_1	95.90	15.27a	11.48a	3.78	22.89a	115.20a
M_2	91.91	14.56b	10.83b	3.72	22.44b	111.53b
Level of significant	NS	**	**	NS	**	**
CV%	4.36	1.19	3.61	11.91	0.95	1.59

*= Significant at 5% level of probability
** = Significant at 1% level of probability
***= Significant at 0.01% level of probability
NS= Not significant

3.2.2. Effect of organic amendments

Number of total tillers hill^{-1} was significantly influenced by organic amendments. The highest number total tillers hill^{-1} (16.16) was obtained from T_4 (5 ton trico-compost ha^{-1} and 0.5 t mustard oil cake ha^{-1}) while the lowest number of total tillers hill^{-1} (13.48) was obtained from T_6 (Table 2). According to Muhammad *et al.* (2012), application of organic amendments have significant effect on number of total tillers hill^{-1}, they have reported that number of total tillers hill^{-1} increased with the application of organic amendments.

3.2.3. Effect of interaction

Number of total tillers hill^{-1} was significantly influenced by the interaction of mulching and different level of organic amendments. The maximum number of total tillers hill^{-1} (16.73) was found from M_1T_4 while the lowest number of total tillers hill^{-1} (13.35) was found from M_2T_6 (Table 3).

3.3. Number of effective tillers hill^{-1}

3.3.1. Effect of mulching

Number of effective tillers hill^{-1} was significantly influenced by mulching. The highest number of effective tillers hill^{-1} (11.48) was obtained from M_1 and the lowest number of effective tillers hill-1 (10.83) was obtained from M_2 (Table 4).

3.3.2. Effect of organic amendments

Number of effective tillers hill^{-1} was significantly influenced by organic amendments. The highest number of effective tillers hill^{-1} (12.31) was obtained from T_4 while the lowest number of effective tillers hill^{-1} (9.94) was obtained from T_6 (Table 2). According to Hafiz *et al.* (2011), application of different organic amendments were significant effect on number of effective tillers hill^{-1} of wheat. They had reported that number of effective tillers hill^{-1} were increased with the application of different organic manures.

3.3.3. Effect of interaction

Number of effective tillers hill^{-1} was significantly influenced by the interaction effect of mulching and different level of organic amendments. The maximum number of effective tillers hill^{-1} (12.78) was found from M_1T_4 while the lowest number of effective tillers hill^{-1} (9.71) was found from M_2T_6 (Table 3).

3.4. Number of non-effective tillers hill^{-1}

3.4.1. Effect of mulching

Number of non-effective tillers hill^{-1} was not significantly influenced by mulching. However, he highest number of non-effective tillers hill^{-1} (3.78) was obtained from M_1 and the lowest number of non-effective tillers hill^{-1} (3.72) was obtained from M_2 (Table 4).

3.4.2. Effect of organic amendments

Number of non-effective tillers hill^{-1} was significantly influenced by organic amendments. The highest number of non-effective tillers hill^{-1} (4.00) was obtained from T_3 which was statistically similar with T_2, T_4 and T_5. The lowest number of non-effective tillers hill^{-1} (3.32) was obtained from T_1 (Table 2).

3.4.3. Effect of interaction

Number of non-effective tillers hill^{-1} was not significantly influenced by the interaction of mulching and different level of organic amendments. The maximum number of non-effective tillers hill^{-1} (4.07) was found from M_1T_5 while the lowest number of non-effective tillers hill^{-1} (3.32) was found from M_2T_1 (Table 3).

3.5. Panicle length

3.5.1. Effect of mulching

Panicle length was significantly influenced by mulching. The highest panicle length (22.89cm) was obtained from M_1 and the lowest panicle length (22.44cm) was obtained from M_2 (Table 4).Similar results on panicle length due to application of rice straw mulch have been reported by Devasinghe *et al.* (2013). They found that panicle length was increased with the application of rice straw mulch.

3.5.2. Effect of organic amendments

Panicle length was significantly influenced by organic amendments. The highest number of panicle length (23.24cm) was obtained from T_4 while the lowest panicle length (21.74cm) was obtained from T_6 (Table 2). According to Muhammad *et al.* (2012), application of organic amendments have significant effect on panicle length, they have reported that panicle length was increased with the application of organic amendments.

3.5.3. Effect of interaction

Panicle length was significantly influenced by the interaction effect of mulching and different level of organic amendments. The maximum panicle length (223.57cm) was found from M_1T_4 while the lowest panicle length (21.73cm) was found from M_2T_6 (Table 3).

3.6. Number of grains panicle^{-1}

3.6.1. Effect of mulching

Number of grains panicle^{-1} was significantly influenced by mulching. The highest number of grains panicle^{-1} (115.20) was obtained from M_1 and the lowest number of grains panicle^{-1} (111.53) was obtained from M_2 (Table

4). Similar results were reported by Devi *et al.* (1991), application of rice straw mulching have significant effect on soil moisture content and growth parameter of rice. They had found, number of grains panicle^{-1} were increased with the application of rice straw mulch.

3.6.2. Effect of organic amendments

Number of grains panicle^{-1} was significantly influenced by organic amendments. The highest number of grains panicle^{-1} (118.79) was obtained from T_4 while the lowest number of grains panicle^{-1} (108.91) was obtained from T_6 as shown in (Table 2). According to Hafiz *et al.* (2011), application of different organic amendments were significant effect on number of grains panicle^{-1}. They had reported that number of grains panicle^{-1} were increased with the application of different organic manures.

3.6.3. Effect of interaction

Number of grains panicle^{-1} was significantly influenced by the interaction effect of mulching and different level of organic amendments. The maximum number of grains panicle^{-1} (120.10) was found from M_1T_4 while the lowest number of grains panicle^{-1} (107.69) was found from M_2T_6 (Table 3).

3.7. Number of sterile spikelets panicle^{-1}

3.7.1. Effect of mulching

Number of sterile spikelets panicle^{-1} was significantly influenced by mulching. The highest number of sterile spikelets panicle^{-1} (23.62) was obtained from M_1 and the lowest number of grains panicle^{-1} (20.39) was obtained from M_2 (Table 5).

Table 5. Effect of rice straw mulching on yield and yield attributes of BRRI dhan58 under dry direct seeded system of cultivation.

Mulching	No. of sterile spikelets panicle^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Percent increase yield over no mulching (%)	Straw yield (t ha^{-1})	Percent increase yield over no mulching (%)	Biological yield (t ha^{-1})	Harvest index (%)
M_1	23.62a	24.75	5.34a	9.93	7.38a	8.13	12.73a	41.95
M_2	20.39b	24.72	4.81b	0.00	6.78b	0.00	11.60b	41.53
Level of significant	**	NS	**	-	**	-	**	NS
CV%	1.08	1.55	5.35	-	3.60	-	4.30	1.21

*= Significant at 5% level of probability
** = Significant at 1% level of probability
***= Significant at 0.01% level of probability
NS= Not significant

3.7.2. Effect of organic amendments

Number of sterile spikelets panicle^{-1} was significantly influenced by organic amendments. The highest number of sterile spikelets panicle^{-1} (23.77) was obtained from T_6 while the lowest number of sterile spikelets panicle^{-1} (20.81) was obtained from T_4 (Table 6).

Table 6. Effect of organic amendments on yield and yield attributes of BRRI dhan58 under dry direct seeded system of cultivation.

Treatment	No. of sterile spikelets panicle^{-1}	1000-grain weight (g)	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 (%)
T_1	21.52bc	25.07a	5.16b	14.53	7.16bc	13.55	12.32bc	41.88ab
T_2	21.52bc	24.42b	4.91c	10.18	6.87c	9.90	11.78c	41.70ab
T_3	22.64ab	24.38bc	5.09bc	13.36	7.16bc	13.55	12.25bc	41.55b
T_4	20.81c	25.23a	5.67a	22.22	7.80a	20.64	13.47a	42.06a
T_5	21.79bc	25.15a	5.24b	15.84	7.33b	15.55	12.57b	41.69b
T_6	23.77a	24.17c	4.41d	0.00	6.19d	0.00	10.61d	41.60b
Level of significant	**	**	**	-	**	-	**	**
CV%	4.51	0.74	4.05	-	4.34	-	4.17	0.73

*= Significant at 5% level of probability
** = Significant at 1% level of probability
***= Significant at 0.01% level of probability
NS= Not significant

3.7.3. Effect of interaction

Number of sterile spikelets panicle^{-1} was significantly influenced by the interaction effect of mulching and different level of organic amendments. The maximum number of sterile spikelets panicle^{-1} (24.97) was found from M_2T_6 while the lowest number of sterile spikelets panicle^{-1} (18.90) was found from M_1T_4 (Table 7).

Table 7. Effect of interaction between rice straw mulching and organic amendments on yield and yield attributes of BRRI dhan58 under dry direct seeded system of cultivation.

Interaction	No. of sterile spikelets panicle^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Percent increase yield over no mulching + control (%)	Straw yield (t ha^{-1})	Percent increase yield over no mulching + control (%)	Biological yield (t ha^{-1})	Harvest index (%)
M_1T_1	19.70de	25.07	5.44	21.51	7.50b	19.07	12.94b	42.07b
M_1T_2	19.84de	24.50	5.09	16.11	7.13bc	14.87	12.22bc	41.67b
M_1T_3	20.88d	24.37	5.45	21.65	7.59b	20.03	13.04b	41.77b
M_1T_4	18.907e	25.33	6.08	29.77	8.16a	25.61	14.24a	42.68a
M_1T_5	20.46de	25.20	5.45	21.65	7.62b	20.34	13.06b	41.69b
M_1T_6	22.57c	24.03	4.55	6.15	6.32de	3.96	10.87de	41.87b
M_2T_1	23.35abc	25.07	4.88	12.50	6.82cd	11.00	11.70cd	41.70b
M_2T_2	23.21bc	24.33	4.73	9.73	6.61cd	8.17	11.35cd	41.72b
M_2T_3	24.40ab	24.40	4.73	9.73	6.72cd	9.67	11.45cd	41.33b
M_2T_4	22.71bc	25.13	5.27	18.98	7.44b	18.41	12.71b	41.44b
M_2T_5	23.12bc	25.10	5.03	15.11	7.05bc	13.90	12.08bc	41.68b
M_2T_6	24.97a	24.30	4.27	0.00	6.07e	0.00	10.34e	41.33b
Level of significant	**	NS	NS	-	**	-	**	**
CV%	4.51	0.74	4.05	-	4.34	-	4.17	0.73

*= Significant at 5% level of probability
** = Significant at 1% level of probability
***= Significant at 0.01% level of probability

3.8. Weight of 1000-grains

3.8.1. Effect of mulching

Weight of 1000-grains was not significantly influenced by mulching. The maximum weight of 1000-grains (24.75 g) was obtained from M_1 and the lowest weight of 1000-grains (24.72 g) was obtained from M_2 (Table 5). Similar results due to application of rice straw mulch have been reported by Devasinghe *et al.* (2013). They found that weight of 1000-grains were increased with the application of rice straw mulch.

3.8.2. Effect of organic amendments

Weight of 1000-grains was significantly influenced by organic amendments. The highest weight of 1000-grains (25.23 g) was obtained from T_4 which is statistically similar with T_5 and T_1. The lowest weight of 1000-grains (24.17 g) was obtained from T_6 (Table 6).

3.8.3. Effect of interaction

Weight of 1000-grains was not significantly influenced by the interaction effect of mulching and different level of organic amendments. The maximum weight of 1000-grains (25.33 g) was found from M_1T_4 while the lowest weight of 1000-grains (24.30 g) was found from M_2T_6 (Table 7).

3.9. Grain yield

3.9.1. Effect of mulching

Grain yield was significantly influenced by mulching. The higher grain yield (5.34 t ha^{-1}) was obtained from M_1 and the lowest grain yield (4.81 t ha^{-1}) was obtained from M_2 (Table 5). From the table 5 it is also clear that about 9.93% grain yield was increased over no mulching. Similar results on grain yield due to application of rice straw mulch have been reported by Devasinghe *et al.* (2013). They found that grain yield was increased with the application of rice straw mulch.

3.9.2. Effect of organic amendments

Grain yield was significantly influenced by organic amendments. The maximum grain yield (5.68 t ha^{-1}) was obtained from T_4 while the lowest amount of grain yield **(**4.41 t ha^{-1}) was obtained from T_6 (Table 6). It is also noted that 22.22% grain yield was increased over control treatment (Table 6). According to Muhammad *et al.* (2012), organic amendments have significant effect on grain yield, they reported that grain yield was increased with the organic amendments.

3.9.3. Effect of interaction

Grain yield was not significantly influenced by the interaction effect of mulching and different level of organic amendments. The maximum grain yield (6.08 t ha^{-1}) was found from M_1T_4 while the lowest grain yield (4.27 t ha^{-1}) was found from M_2T_6. The maximum grain yield percent (29.77%) over no mulching + control were found from M_1T_4 (Table 7).

3.10. Straw yield

3.10.1. Effect of mulching

Straw yield was significantly influenced by mulching. The highest straw yield (7.38 t ha^{-1}) was obtained from M_1 and the lowest straw yield (6.78 t ha^{-1}) was obtained from M_2 (Table 5). From the table 5 it was found that straw yield were increased 8.13% due to rice straw mulching over no mulching. Similar results were reported by Devi *et al.* (1991), application of rice straw mulching have significant effect on soil moisture content and growth parameter of rice. They found that number of straw yield of rice were increased with the application of rice straw mulch.

3.10.2. Effect of organic amendments

Straw yield was significantly influenced by organic amendments. The highest straw yield (7.80 t ha^{-1}) was obtained from T_4 while the lowest straw yield (6.19 t ha^{-1}) was obtained from T_6 (Table 6). It was also noted that 20.64% straw yield was increased over control treatment (Table 6). According to Hafiz *et al.* (2011), application of different organic amendments were significant effect on straw yield. They have reported that straw yield were increased with the application of different organic manures.

3.10.3. Effect of interaction

Straw yield was significantly influenced by the interaction effect of mulching and different level of organic amendments. The maximum straw yield (8.16 t ha^{-1}) was found from M_1T_4 while the lowest straw yield (6.07) was found from M_2T_6 (Table 7). From the Table 7 it was also found that the highest increasing percent of yield 25.61% was obtained from M_1T_4.

3.11. Biological yield

3.11.1. Effect of mulching

Biological yield was significantly influenced by mulching. The highest biological yield (12.73 t ha^{-1}) was obtained from M_1 and the lowest biological yield (11.60 t ha^{-1}) was obtained from M_2 (Table 5).

3.11.2. Effect of organic amendments

Biological yield was significantly influenced by organic amendments. The highest biological yield (13.47 t ha^{-1}) was obtained from T_4 while the lowest biological yield (10.61 t ha^{-1}) was obtained from T_6 (Table 6).

3.11.3. Effect of interaction

Biological yield was significantly influenced by the interaction effect of mulching and different level of organic amendments. The maximum biological yield (14.24 t ha^{-1}) was found from M_1T_4 while the minimum biological yield (10.34 t ha^{-1}) was found from M_2T_6 (Table 7).

3.12. Harvest index

3.12.1. Effect of mulching

Harvest index was not significantly influenced by mulching. The maximum harvest index (41.95%) was obtained from M_1 and the minimum harvest index (41.53%) was obtained from M_2 (Table 5).

3.12.2. Effect of organic amendments

Harvest index was significantly influenced by organic amendments. The maximum harvest index (42.06%) was obtained from T_4 while the minimum harvest index (41.60%) was obtained from T_6 (Table 6).

3.12.3. Effect of interaction

Harvest index was significantly influenced by the interaction effect of mulching and different level of organic amendments. The maximum harvest index (42.68%) was found from M_1T_4 while the minimum harvest index (41.33%) was found from M_2T_6 (Table 7).

4. Conclusions

Based on the result of the present study it may be concluded that in combination with 7 ton rice straw mulch ha^{-1} along with 5 ton trico-compost ha^{-1} and 0.5 ton mustard oil cake (MOC) ha^{-1} with recemmended dose of other fertilizers was the best to obtain the highest grain yield of BRRI dhan58 in *boro* season under dry direct seeded system.

Conflict of interest

None to declare.

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