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Influence of integrated nutrients management on growth and yield of BRRI dhan69

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ABSTRACT

The experiment was carried out to find out suitable integrated nutrient management options for growth and higher yield of BRRI dhan69. The treatment consists of T_1= Control, T_2= BRRI recommended fertilizer dose (N-P-K-S = 117-19-58-15 kg ha^{-1}), T_3= Soil Test Basis (STB) (N-P-K-S = 134-5-77-16 kg ha^{-1}), T_4= 75% STB, T_5= 75% STB + Decomposed poultry litter (DPL) (2.5 t ha^{-1}), T_6 = 75% STB + DPL (5 t ha^{-1}), T_7= 50% STB + DPL (5 t ha^{-1}) and T_8= DPL (5 t ha^{-1}). The experiment was laid out in RCB design with three replications. Results indicated that different integrated nutrient management had the significant effect on plant height, leaf area index (LAI), tillering pattern, productive tiller (%), tiller mortality (%), sterility (%), panicle m^{-2}, grains $panicle^{-1}$ and grain yield. 75% STB + Decomposed poultry litter (2.5 t ha^{-1}) showed highest tiller m^{-2}, panicle m^{-2}, grains $panicle^{-1}$ and ultimately grain yield. 75% STB + Decomposed poultry litter (2.5 t ha^{-1}) gave 11.4% and 18.8% higher grain yield than BRRI recommended dose and STB, respectively. All the treatments with integrated nutrient management gave the higher yield than STB. Treatment T_5 found much beneficial than T_3. Even the treatments T_4 and T_6 can be used in BRRI dhan69 cultivation to get more benefit.

Introduction

Rice (*Oryza sativa* L.) is one of the leading food crops of the world. In Bangladesh rice alone contributes 9.5 percent to the agricultural GDP (BBS, 2008). Rice cultivation requires about 10 million tons of N fertilizers every year worldwide (IRRI, 1996). Extensive use of chemical is under debate due to environmental concern and question raised regarding the consumers and soil health (Aditya et al., 2009). Soil organic matter is a key factor in maintaining long-term soil fertility since it is the reservoir of metabolic energy, which drives soil biological processes involved in nutrient availability. A good soil should have at least 2.5% organic matter, but in Bangladesh most of the soils have less than 1.5%, and some soils even less than 1% organic matter (BARC, 2005). So, it is necessary to use inorganic and organic fertilizers in an integrated way so as to obtain economically profitable crop yield, without incurring loss to soil fertility (Haque et al., 2001). Organic sources offer more balanced nutrition to the plants, especially, micro nutrients which positively affect number of tiller in plants (Miller, 2007). Sustainability in production could not achieve alone with chemical fertilizers or organic manures, but the integrated use of organic and inorganic fertilizer can sustain a highly intensive production system (Prasad, 1996). There has been increased interest in using poultry litter as fertilizer due to containing higher amount of all plant nutrients and it can contribute to reduce cost of fertilizer inputs in rice production. Poultry litter is very high in nitrogen and also contains a good amount of potassium and phosphorus. The poultry manure is relatively a cheap source of both macro nutrients (N, P, K, Ca, Mg, S) and micronutrients (Cu, Fe, Mn, B) and can increase soil carbon and N content, soil porosity and enhance soil microbial activity (Ghosh et al., 2004). The high nitrogen and balanced nutrients is the reason that poultry litter is a good kind of manure to use. So, this experiment was conducted to know the effect of integrated nutrients on low inputs rice variety, BRRI dhan69.

Materials and Methods

Experimental site

The experiment was carried out at Agronomy field of Bangladesh Rice Research Institute, Gazipur during the Boro season, 2015-16. The soil of BRRI farm was clay loam under Madhupur tract (AEZ 28).

Plant materials and planting method

Planting crop was BRRI dhan69. Forty-day-old seedling was transplanted using 1 seedling per hill at a spacing of 20 × 20 cm on 19th January, 2016.

Experimental design and application of manures and fertilizers

The experiment was laid out in RCB design with three replications. The treatments were; T_1= Control, T_2= BRRI recommended fertilizer dose

(N-P-K-S = 117-19-58-15 kg ha^{-1}), T_3= Soil Test Basis (STB) (N-P-K-S = 134-5-77-16 kg ha^{-1}), T_4= 75% STB, T_5= 75% STB + Decomposed poultry litter (DPL) (2.5 t ha^{-1}), T_6 = 75% STB + DPL (5 t ha^{-1}), T_7= 50% STB + DPL (5 t ha^{-1}) and T_8= DPL (5 t ha^{-1}). The full doses of PKS and poultry litter were applied during final land preparation and N was top dressed at 15, 30 and 45 DAT.

Data collection procedure and formulas

Tiller number was counted from 40 DAT and continued up to maturity at 15 days interval. Twelve hills from each plot were counted for tillering pattern. Productive tiller (%) and tiller mortality (%) was calculated by using following formulas.

$$\text{Productive tiller (\%)} = \times \frac{\text{Number of panicles per m}^2}{\text{Number of maximum tiller per m}^2} 100$$

$$\text{Tiller mortality (\%)} = \times \frac{\text{Maximum tiller number – Tiller number at maturity}}{\text{Maximum tiller number}} 100$$

Leaf area index (LAI) was taken at heading stage from one representative hill (selected from average of twelve hills). Plant height was measured from the base of the plant to tip of the panicle. At maturity, 5 m^2 area was harvested for grain yield and adjusted to 14% moisture content.

Statistical analysis

The data were statistically analyzed using Statistics 10 analytical software. The least significant difference (LSD) at 5% probability was used to compare means of the treatments.

Results and Discussion

Plant height

At maturity, plant height was differed significantly among the treatments (Figure 1). Treatment T_6 gave higher plant height (98 cm) but it was statistically similar with T_2, T_3, T_5 and T_7. The results showed that combination of organic and inorganic fertilizer significantly increased the plant height than sole use of inorganic fertilizer and similar result was found by Sarker et al. (2015).

Leaf area Index

There was significant difference in leaf area index (LAI) (Figure 2). Highest LAI (3.6) was found in T_3 (STB dose) which is statistically similar with treatment T_2 (BRRI recommended dose). Treatment T_5 (75% of STB + PL 2.5 t ha^{-1}) showed 20.9% higher LAI than T_4 (75% of STB). Ndaeyo et al. (2008) found that higher NPK fertilizer significantly increased the number of leaves and consequently higher LAI. The lowest LAI was found in T_1. Sarker et al. (2015) reported that lowest number of leaves $plant^{-1}$ was found from the treatment using only poultry manure and combination of organic and inorganic fertilizer significantly increased the number of leaves $plant^{-1}$ than chemical fertilizer.

Tillering pattern

There was significant difference among the treatments (Table 1). At 40 DAT, the treatments T_5, T_6 and T_7 produced higher number of tiller than other treatments. From 55 DAT-85 DAT, T_2 showed highest tiller number but at maturity T_5 gave highest tiller number. Miller (2007) reported that, tiller number is increased by poultry litter at early stage of rice growth. An increase in fertilizer levels increase the number of tillers and further increases in the amount of fertilizer does not further increase tillering, only with poultry litter combined with inorganic fertilizer increase tiller number. For the treatments T_1, T_4, T_7 and T_8 tiller number increased till 55 DAT. But the treatments T_2, T_3, T_5 and T_6 where the total amount of fertilizer was higher, tiller number increased till 70 DAT and the treatments T_3, T_5 and T_6 produced statistically similar tiller number from 55 DAT-maturity. Amin et al. (2004) reported that increased in fertilizer dose of NPK increase the number of total tiller $plant^{-1}$.

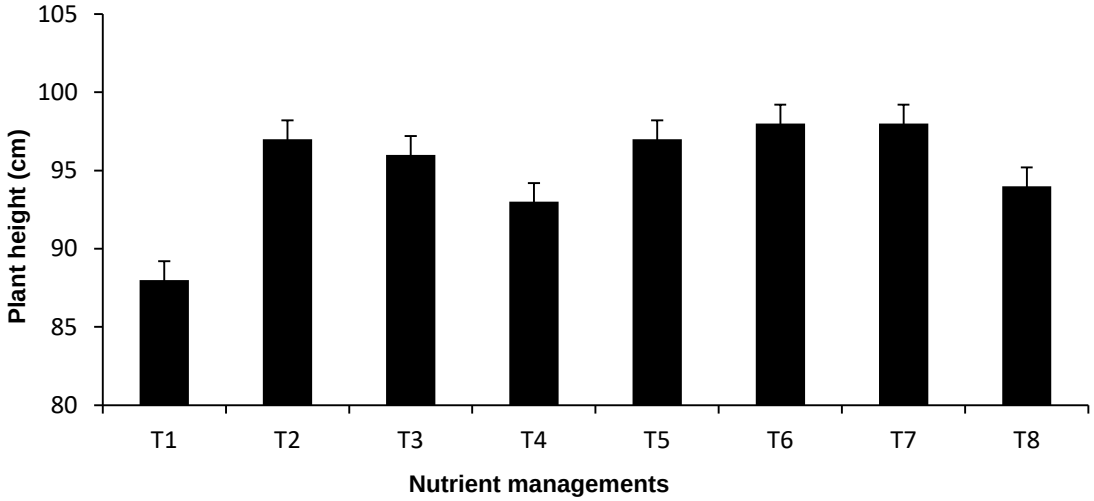

Figure 1. Effect of integrated nutrient on plant height of BRRI dhan69, Boro 2015-16, BRRI, Gazipur (small bar represents SE). T_1= Control, T_2= BRRI Rec. dose, T_3= STB, T_4= 75% of STB, T_5= 75% of STB + PL 2.5 t ha^{-1}, T_6= 75% of STB + PL 5.0 t ha^{-1}, T_7= 50% of STB + PL 5 t ha^{-1}, T_8= PL 5 t ha^{-1}

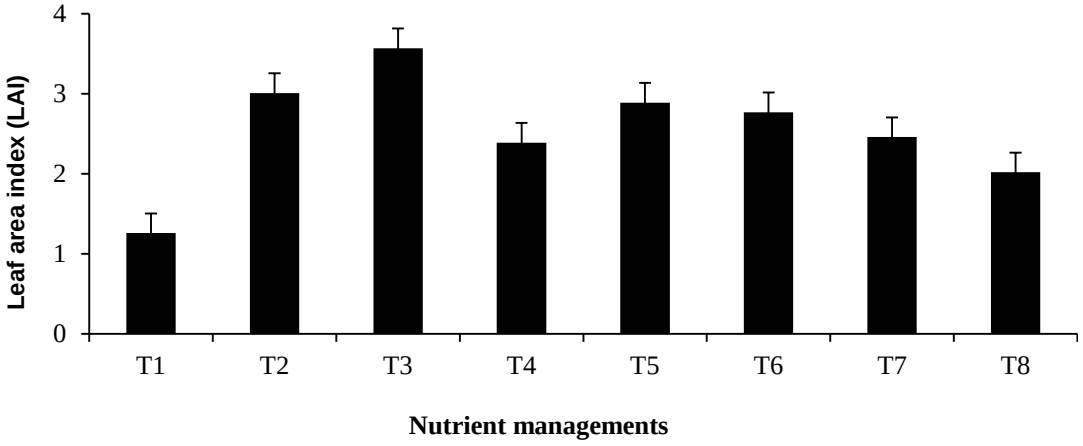

Figure 2. Effect of integrated nutrient on LAI of BRRI dhan69, Boro 2015-16, BRRI, Gazipur (small bar represents SE). T_1= Control, T_2= BRRI Rec. dose, T_3= STB, T_4= 75% of STB, T_5= 75% of STB + PL 2.5 t ha^{-1}, T_6= 75% of STB + PL 5.0 t ha^{-1}, T_7= 50% of STB + PL 5 t ha^{-1}, T_8= PL 5 t ha^{-1}

Table 1. Effect of integrated nutrient on tillering pattern of BRRI dhan69 in Boro 2015-16, BRRI, Gazipur

Nutrient managements	Tiller number (m^2) at different DAT				
	40 DAT	55 DAT	70 DAT	85 DAT	At maturity
T_1	133	144	140	138	132
T_2	175	229	241	225	201
T_3	183	224	238	214	199
T_4	163	204	202	201	186
T_5	195	221	223	220	205
T_6	187	218	220	217	194
T_7	202	220	210	208	189
T_8	179	190	180	174	161
CV%	2.64	2.95	3.40	3.40	3.61
$LSD_{(0.05)}$	8.18	10.88	12.40	12.05	11.79

T_1= Control, T_2= BRRI Rec. dose, T_3= STB, T_4= 75% of STB, T_5= 75% of STB + PL 2.5 t ha^{-1}, T_6= 75% of STB + PL 5.0 t ha^{-1}, T_7= 50% of STB + PL 5 t ha^{-1}, T_8= PL 5 t ha^{-1}

Productive tiller (%)

Highest productive tiller (%) was found in T_5 (92%) which is statistically similar with T_1, T_4 and T_6 (Figure 3). T_2 gave lowest productive tiller percentage (83%) which is similar with T_3. Combination of organic and inorganic fertilizers significantly increased the number of effective tillers and decreased the number of non-effective tillers plant^{-1} than sole use of inorganic fertilizer or organic fertilizer (Sarker et al., 2015).

Tiller mortality (%)

The tiller mortality was higher at T_2 (16.6%) which is similar with T_3 (Figure 4). Tiller mortality was found lower in the combination of organic and inorganic fertilizers and lowest was found in T_5 (8.1%). T_5 gave 51% and 50% lower tiller mortality (%) than T_2 and T_3 respectively.

Sterility (%)

In sterility percentage significant difference was found among the treatments (Figure 5). T_3 showed highest sterility percentage (32.6%) which is statistically similar with T_6. T_3 showed 93% higher sterility (%) than T_5. Lowest sterility (%) was found in the treatment T_8 (PL 5 t ha^{-1}).

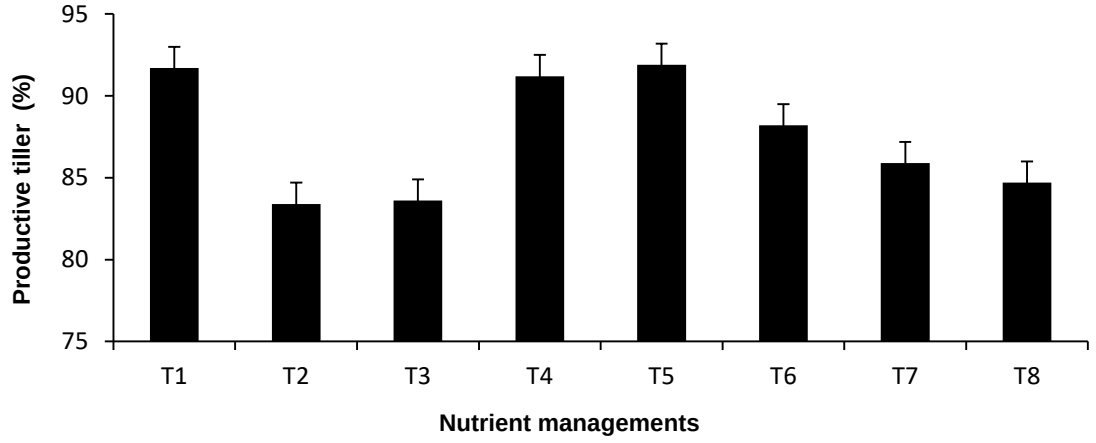

Figure 3. Effect of integrated nutrient on productive tiller (%) of BRRI dhan69, Boro 2015-16, BRRI, Gazipur (small bar represents SE). T_1= Control, T_2= BRRI Rec. dose, T_3= STB, T_4= 75% of STB, T_5= 75% of STB + PL 2.5 t ha^{-1}, T_6= 75% of STB + PL 5.0 t ha^{-1}, T_7= 50% of STB + PL 5 t ha^{-1}, T_8= PL 5 t ha^{-1}

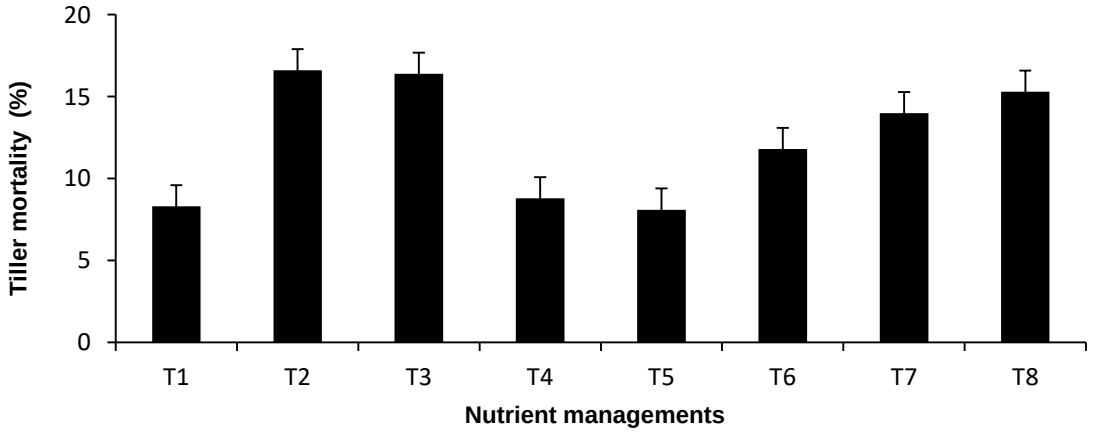

Figure 4. Effect of integrated nutrient on tiller mortality (%) of BRRI dhan69, Boro 2015-16, BRRI, Gazipur (small bar represents SE)**.** T_1= Control, T_2= BRRI Rec. dose, T_3= STB, T_4= 75% of STB, T_5= 75% of STB + PL 2.5 t ha^{-1}, T_6= 75% of STB + PL 5.0 t ha^{-1}, T_7= 50% of STB + PL 5 t ha^{-1}, T_8= PL 5 t ha^{-1}

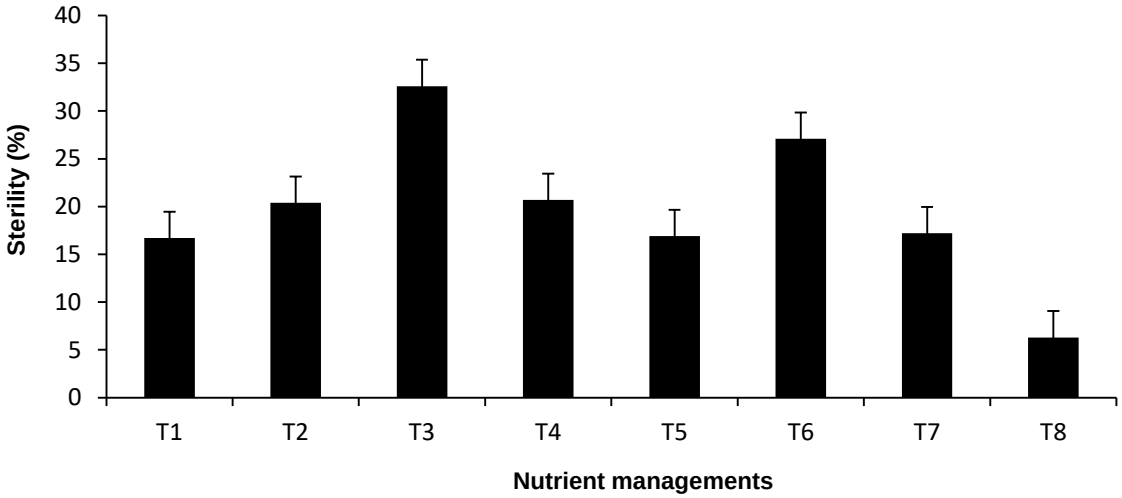

Figure 5. Effect of integrated nutrient on sterility (%) of BRRI dhan69, Boro 2015-16, BRRI, Gazipur (small bar represents SE). T_1= Control, T_2= BRRI Rec. dose, T_3= STB, T_4= 75% of STB, T_5= 75% of STB + PL 2.5 t ha^{-1}, T_6= 75% of STB + PL 5.0 t ha^{-1}, T_7= 50% of STB + PL 5 t ha^{-1}, T_8= PL 5 t ha^{-1}

Yield and yield components

In panicle m^{-2}, there was significant difference among the treatments and statistically similar number of panicle was observed for the treatment T_2, T_3, T_5 and T_6 (Table 2). Treatments T_5 gave highest panicle m^{-2}. In grains $panicle^{-1}$ treatments T_5, T_6, T_7 and T_8 showed similar result where the poultry litter used. T_5 gave 23.9% higher grains $panicle^{-1}$ than T_2 and T_3. In thousand grains weight there was no significant difference among the treatments. In grain yield there was significant difference among the treatments. T_5 gave highest grain yield which is 11.4% and 18.8% higher than T_2 and T_3 respectively.

Treatment T_4 gave 5% higher grain yield than T_3 because BRRI dhan69 is a low input variety. In Grey Terrace soils (AEZ 28), BRRI dhan69 could produce 5.08-5.60 t ha^{-1} grain yield with 20% less of recommended fertilizer dose (BRRI, 2014-15). This result also supported by Miah et al. (2006), who reported that application of 2 tons poultry litter per hectare in low organic matter containing soil in combination with moderate dose of N (30-60 kg ha^{-1}) gave better yield (5.5 to 6.5 t ha^{-1}) as compared to higher N levels (80-120 kg ha^{-1}). T_8 gave 40% higher grain yield than T_1 but 23.7% lower grain yield than T_5. For sustaining higher rice production, use of only chemical fertilizer or organic manure would not be a judicial approach. Hossain et al., (2010) reported that thirty days aged PL with 50% STB chemical fertilizer was superior and it may be recommended for better rice production.

Table 2. Effect of integrated nutrient on yield and yield contributing characters of BRRI dhan69 in Boro 2015-16, BRRI, Gazipur

Nutrient managements	Panicle m^{-2}	Grains $Panicle^{-1}$	1000 grain weight (g)	Grain yield (t ha^{-1})
T_1	132	111	25.0	3.61
T_2	201	113	24.4	5.62
T_3	199	113	24.6	5.27
T_4	188	122	24.5	5.53
T_5	205	140	24.3	6.26
T_6	194	130	24.5	5.75
T_7	189	138	24.8	5.52
T_8	161	135	24.6	5.06
CV%	3.61	6.99	1.64	2.67
$LSD_{(0.05)}$	11.79	15.98	NS	0.25

T_1= Control, T_2= BRRI Rec. dose, T_3= STB, T_4= 75% of STB, T_5= 75% of STB + PL 2.5 t ha^{-1}, T_6= 75% of STB + PL 5.0 t ha^{-1}, T_7= 50% of STB + PL 5 t ha^{-1}, T_8= PL 5 t ha^{-1}

Economic analysis

Economic value of the treatments should be under consideration. The current price rate of urea, TSP, MoP and gypsum are 16, 22, 15 and 10 tk kg^{-1} respectively. Decomposed poultry litter price is 2000 tk ton^{-1}. From those price rates of fertilizers, the individual treatments cost per hectare are given below:

T_1: 0 tk
T_2: Urea (254×16) + TSP (95×22) + MoP (116×15) + Gypsum (83×10) tk ha^{-1} = 8,724 tk ha^{-1}
T_3: Urea (291×16) + TSP (25×22) + MoP (154×15) + Gypsum (89×10) tk ha^{-1} = 8,406 tk ha^{-1}
T_4: Urea (218×16) + TSP (19×22) + MoP (116×15) + Gypsum (67×10) tk ha^{-1} = 6,316 tk ha^{-1}
T_5: Urea (218×16) + TSP (19×22) + MoP (116×15) + Gypsum (67×10) + DPL (2.5×2,000) tk ha^{-1} = 11,316 tk ha^{-1}
T_6: Urea (218×16) + TSP (19×22) + MoP (116×15) + Gypsum (67×10) + DPL (5×2,000) tk ha^{-1} = 16,316 tk ha^{-1}
T_7: Urea (146×16) + TSP (13×22) + MoP (77×15) + Gypsum (45×10) + DPL (5×2,000) tk ha^{-1} = 14,227 tk ha^{-1}
T_8: DPL (5×2,000) tk ha^{-1} = 10,000 tk ha^{-1}

For BRRI dhan69, if per ton rice price is 2000 tk than benefit comes from those treatments are given below:

T_1: (3.61×20,000) tk ha^{-1} = 72,200 tk ha^{-1}
T_2: (5.62×20,000) tk ha^{-1} = 112,400 tk ha^{-1}
T_3: (5.27×20,000) tk ha^{-1} = 105,400 tk ha^{-1}
T_4: (5.53×20,000) tk ha^{-1} = 110,600 tk ha^{-1}
T_5: (6.26×20,000) tk ha^{-1} = 125,200 tk ha^{-1}
T_6: (5.75×20,000) tk ha^{-1} = 115,000 tk ha^{-1}
T_7: (5.52×20,000) tk ha^{-1} = 110,400 tk ha^{-1}
T_8: (5.06×20,000) tk ha^{-1} = 101,200 tk ha^{-1}

From above calculation it can be said that treatment T_5 is best in the consideration of cost and benefit. Even T_4 is much cost effective and beneficial than T_3.

Conclusions

All the treatments with integrated nutrient showed better performance on the growth and yield of BRRI dhan69 than STB. Even the yield of BRRI dhan69 was higher in T_4 (75% of STB) than T_3 (STB). From economic and soil health point of view, treatment T_5 (75% STB + 2.5 t ha^{-1} Decomposed poultry litter), is better option for achieving higher yield of BRRI dhan69.

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