INFLUENCE OF INTEGRATED FERTILIZER MANAGEMENT ON THE GROWTH AND YIELD OF AUS RICE

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INFLUENCE OF INTEGRATED FERTILIZER MANAGEMENT ON THE GROWTH AND YIELD OF AUS RICE

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CERTIFICATE

This is to certify that the thesis entitled ***"INFLUENCE OF INTEGRATED FERTILIZER MANAGEMENT ON THE GROWTH AND YIELD OF AUS RICE"*** *submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE (MS)*** *in* ***AGRONOMY,*** *embodies the results of a piece of bona fide research work carried out by* ***NAYEMUL ISLAM,*** *Registration. No.* ***13-05674*** *under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information as has been availed of during the course of this investigation has duly been acknowledged.

Dated:

Dhaka, Bangladesh

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DEDICATED TO

MY

BELOVED PARENTS

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ABSTRACT

A field experiment was conducted at the Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during March, 2019 to July, 2019 in aus rice season with a view to study the growth and yield variations in aus rice as influenced by integrated fertilization. The treatments consist of two rice varieties namely V_1= BRRI dhan48 and V_2= BRRI dhan82 and seven fertilization levels as T_1= 100% RDF (Recommended dose of fertilizers) (148 kg N ha^{-1} + 52 kg P ha^{-1} + 74 kg K ha^{-1}), T_2= Poultry manure (10 t ha^{-1}), T_3= Vermicompost (4 t ha^{-1}), T_4= Compost (5 t ha^{-1}), T_5= Poultry manure @ 10 t ha^{-1} + 50% RDF, T_6= Vermicompost @ 4 t ha^{-1} + 50% RDF, T_7 = Compost @ 5 t ha^{-1} + 50% RDF. The experiment was carried out in split plot design with three replications. Results revealed that BRRI dhan48 was superior to BRRI dhan82 in respect of different parameters. Treatment T_5 gave significantly highest grain yield. In case of combined effect, BRRI dhan48 with V_1T_5 registered significantly maximum total tillers $hill^{-1}$ (21.04), leaves $hill^{-1}$ (95.57), above ground weight $plant^{-1}$ (48.11 g), effective tillers $hill^{-1}$ (20.00), longest panicle (27.94 cm), highest filled grains $panicle^{-1}$ (139.67), 1000 grain weight (26.37 g), grain yield (4.88 t ha^{-1}), straw yield (5.93 t ha^{-1}) and biological yield (10.81 t ha^{-1}). In respect of grain yield V_1T_1 was (4.61 t ha^{-1}). It may be advocated that Poultry manure @ 10 t ha^{-1} + 50% RDF was found to be the best for achieving maximum yield from variety BRRI dhan48.

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ABBREVIATIONS AND ACRONYMS

AEZ = Agro-Ecological Zone
Anon. = Anonymous
Atm. = Atmosphere
BARI = Bangladesh Agricultural Research Institute
BBS = Bangladesh Bureau of Statistics
BRRI = Bangladesh Rice Research Institute
cm = Centi-meter
CV % = Percent Coefficient of Variance
cv. = Cultivar (s)
DADPW = Day after Disappearance of Ponded Water
DAT = Days after Transplanting
et al. = And others
etc. = Etcetera
FAO = Food and Agriculture Organization
G = Gram (s)
HI = Harvest Index
hr = hour(s)
K_2O = Potassium Oxide
kg = Kilogram (s)
LSD = Least Significant Difference
MoP = Muriate of Potash
N = Nitrogen
No. = Number
NS = Non significant
P_2O_5 = Phosphorus Penta Oxide

CHAPTER I
INTRODUCTION

Rice (*Oryza sativa* L.) is the most important staple food for billions of people in the world. To assure food security in the rice-consuming countries of the world, farmers must produce more rice of better quality to meet the demands of consumers in coming years (Peng and Yang, 2003). Rice is the staple food of about 135 million people in Bangladesh. Rice provides 20% of the world's dietary energy supply, it provides about two-third of total calorie supply and about one-half of the total protein intake of an average person in Bangladesh during the year 2017-18. Rice covered an area of 11614 thousand ha with a production of 36279 thousand metric tons where aus rice (early summer) covers 1075 thousand ha with a production of 2710 thousand metric tons (BBS, 2018). Bangladesh ranked 3rd position in producing world rice statistic (BARC, 2012).

Unfortunately, the yield of rice in this country is low (average 3.4 t/ha) compared to other rice growing countries like South Korea and Japan where the average yield is 6.00 and 5.6 t/ha, respectively (FAO, 2003).

There are many reasons behind the lower yield of rice in general and aus rice is particular. (Uddin *et al.*, 2018).

Excessive or inappropriate use of chemical fertilizers (CFs) is a major cause of nutrient imbalance in soil, leading to high losses, particularly of N from the fertilizer, low N recovery (30%) (Krupnik *et al*, 2004) and low N use efficiency (about 35%) in rice (*Cao et al,* 2013) which may be a backdrop of rice production.

Organic matter is a key factor for maintaining soil fertility, soil health and sustainable crop productivity. An ideal soil should contain 5% organic matter but most of the cultivated soil in Bangladesh has only less than 1.5%. Evidences from different AEZ of the country have shown a decrease in the content of organic matter by the range of 15 to 30% over the last 20 years (Miah, 1994). In fact, organic manure alone might not meet the plant's requirements due to the relatively low nutrient contents and the slow release of plant nutrients (Miah, 1994).Thus, there has been a growing interest in the use of organic fertilizers along with chemical fertilizer for production (Nambiar, 1991). The integrated use of chemical and organic fertilizers improves plant growth and increases rice yield and quality (Masarirambi *et al.,* 2012; Reganold *et al.*, 1990).

Rate of N mineralization from poultry manure is faster than from FYM because it contains high amount of uric acid and urea substances which readily release NH_4. In a laboratory study, about 45% of total in poultry manure was mineralized in 4 weeks as compared to 12% from farmyard manure. In a rice–wheat cropping system, (Yadav *et al.,* 2009) observed that application of poultry manure at 5 t ha^{-1} along with 40 kg N ha^{-1} increased rice yield and nutrient uptake similar to *what* was obtained with the recommended fertilizer N level of 120 kg ha^{-1}.

Vermicompost is the product or process of composting using various worms usually it is a heterogeneous mixture of decomposing vegetable or food waste, bedding materials etc. During this process elements like N, P, K and Ca present in the waste are released and converted through microbial activity into forms more soluble and available to plant than those present in the organic waste. Application of vermicompost might increase the availability of N, P and K to plant. Composting of organic manures increases the nutrient content, reduces the bulk to be handled per unit of nutrients, and offers a potential for the utilization of low solubility materials such as phosphate rocks (Mostafa *et al.,* 2010). Prepared P-enriched phosphor compost from crop residues, animal feed wastes, grasses, weeds, tree leaves cattle dung, biogas slurr and phosphate.

Soil fertility deterioration is a major constraint for higher crop production in Bangladesh. The increasing land use intensity without adequate and balanced use of chemical fertilizers and with little or no use of organic manure have caused severe fertility deterioration of our soils resulting in stagnating or even declining of crop productivity.

Thus, it is necessary to use fertilizer and manure in an integrated way in order to obtain sustainable crop yield without affecting soil fertility. Based on the soil fertility problem as discussed above, the present study was undertaken to investigate the effect of combined use of chemical fertilizers and organic manures in a rice-rice cropping system with the following objectives.

1. To compare between aus varieties in terms of growth and yield performance.
2. To study the influence of fertilizer management on yield of aus rice.
3. To determine the combine effect of variety and fertilizer management on the growth and yield of aus rice.

CHAPTER II
REVIEW OF LITERATURE

2.1 Influence of integrated fertilizer management in rice crop

Subehia *et al*. (2013) conducted a research initiated in 1991 kharif season (April–October) on an acidic soil in the Western Himalayas of India, 25% and 50% of the recommended doses of nitrogen were substituted through different organics, *viz*. farmyard manure (FYM), wheat cut straw and *Sesbania aculeata* (as green manure) in rice, followed by use of chemical fertilizers in wheat each year. Application of 50% N through FYM plus 50% NPK through chemical fertilizers to rice followed by 100% NPK through chemical fertilizers to wheat maintained the highest productivity of rice and wheat at about 3.4 t ha^{-1} and 3.3 t ha^{-1}, respectively, as found from the pooled grain yield over the years. The highest values of organic carbon, cation exchange capacity and available N, P, K were also recorded under this treatment.

Haque *et al*. (2012) conducted a research to evaluate the integrated management of organic and inorganic fertilizers to reduce CH_4 emission and increase rice productivity (rice cultivar BRRI dhan 28) in Boro season during the period of January to May 2012 at the experimental field, Department of Environmental Science, Bangladesh Agricultural University, Mymensingh. Six different treatments such as, urea only (no organic amendments), urea + rice straw compost, urea + charcoal, urea + $CaSiO_3$, urea + rice straw compost + $CaSiO_3$, urea + charcoal + $CaSiO_3$ were applied in different plots in this experiment. The highest seasonal CH_4 flux 25.54 mg ha^{-1} was found from the urea + rice straw compost treatment and lowest seasonal CH_4 flux 17.47 mg ha^{-1} was produced in urea only (no organic amendments).

Rahman *et al*. (2000) conducted a research on integrated nutrient management in the Bush bean−T. Aus −T. Arnan cropping pattern during 2000-02. Different packages of chemical fertilizers in combination with organic materials (cowdung and rice straw/bush bean stover) were evaluated to find out a suitable combination for obtaining higher yield of crops. There was a positive effect of crop residue recycling and residual effect of cowdung on the yield. Both the soil test-based fertilizer and the cowdung with IPNS basis fertilizer treatments gave higher yield. For T. Aus rice, the highest yield was obtained with the treatment where bush bean stover was used along with IPNS based chemical fertilizer. The highest yield of T. Aman rice was observed in the residual effect of cowdung with reduced amount of fertilizer.

Yaduvanshi (2001) studied the effect of NPK fertilizers with and without organic and green manures (*Sesbania aculeata)* on rice-wheat cropping pattern in an experiment. They observed that application of NPK along with green manure and/or FYM increased the rice and wheat yields significantly.

Kakraliya *et al*. (2017) conducted a field experiment during rabi season of 2011-12 and 2012-13 at C.S. Azad University of Agriculture and Technology, Kanpur to find out the combined effect of organic and inorganic fertilizers on grain yield, fertilizer use efficiency and grain quality of wheat crop. The treatments were - Control (T_1), RDF (150:60:40 NPK Kg/ha) (T_2),125% RDF (T_3), RDF + Vermicompost (VC) at 2.5 t ha^{-1} (T_4), RDF + VC at 5 t ha^{-1} (T_5), RDF + FYM at 5 t ha^{-1} (T_6), RDF + FYM at 10 t ha^{-1} (T_7), RDF + VC at 2.5 t ha^{-1} + Azotobacter (T_8), RDF + FYM at 5 t ha^{-1} + Azotobacter (T_9), and RDF + VC at 2.5 t ha^{-1} + FYM at 5 t ha^{-1} + Azotobacter (T_{10}). Result showed that the treatment T_{10} produced higher grain yield than the other treatments. All the fertilizer use efficiency was maximum in treatment T_{10} followed by treatment T_9 and the minimum value was quantified in T_3, T_2, T_1 (control). The highest grain protein content was obtained from the application of organic and inorganic fertilizer along with azotobacter and lowest from control as well as NPK fertilizer alone.

Nyalemegbe *et al*. (2010) conducted an experiment to find solution to the problem of low rice yields on the Vertisols of the Accra Plains. Rice yields from continuously cropped fields have been observed to decline with time, even with the application of recommended levels of inorganic fertilizers. The decline in yield has been attributed to low inherent soil fertility, which is partly the result of low levels of soil organic matter (OM). As part of the study, cow dung (CD) and poultry manure (PM) were separately applied to the soil at 20 t ha^{-1} solely and also 5, 10 and 15 t ha^{-1}, in combination with urea fertilizer at 90, 60 and 30 kg N ha^{-1}, respectively. Other treatments included a control and urea fertilizer at 30, 60, 90 and 120 kg N ha^{-1}. There was a basal application of phosphorus and potassium to all plots at 45 kg P_2O_5 ha^{-1} and 35 kg K_2O ha^{-1}, respectively, based on the recommended fertilizer rate of 90 kg N ha^{-1}, 45 kg P_2O_5 ha^{-1} and 35 kg K_2O ha^{-1}, on the Vertisols of the Accra Plains. The application of 10 t ha^{-1} CD and urea fertilizer (at 45 kg N ha^{-1}) and 10 t ha^{-1} PM and urea (at 60 kg N ha^{-1}) both gave paddy yields of 4.7 t ha^{-1}, which did not differ significantly from the yield of 5.3 t ha^{-1}, obtained under the recommended inorganic nitrogen fertilizer application of 90 kg N ha^{-1}. This indicates a synergistic effect of OM and urea on soil fertility.

Satyanarayana *et al*. (2002) conducted a research to study the influence of application of farmyard manure in combination with three levels of chemical fertilizers [80: 40: 30, 120: 60: 45 and 160: 80: 60 kg N, P_2O_5 and K_2O ha^{-1}, respectively] on yield and yield components of irrigated lowland rice. The results showed that application of farmyard manure at 10 t ha^{-1} increased grain yield of rice by 25% compared to no farmyard manure control. The highest grain yield of rice was obtained with the application of farmyard manure at 10 t ha^{-1} and inorganic fertilizer at 120: 60: 45 kg N, P_2O_5 and K_2O ha^{-1}. The increased grain yield was due mainly to increased nutrient uptake and number of tillers, filled grains per panicle and 1000-grain weight.

Jana *et al. (*2008) carried out a field experiment to study the effect of integrated management of organic manure and inorganic N fertilizer on rice (*Oryza sativa* L.) and its residual effect on utera crop linseed (*Unum usitatissimum* L.) and fertilit buildup of soil. The yield, yield attributes, N content and N uptake of rice (cv. IR-36) were significantly higher under 75% recommended dose of nitrogen (RON) along with 2 ton poultry manure than all other treatments on pooled data basis, but remained on a par with 75% RON + 4 ton Sesbania green-leaf manure and 75 % RDN + 5 ton FYM. The per cent increase in grain yield with 75% RDN

+ 2 ton poultry manure, 75% RDN + 4 ton green manure and 75% RON + 5 ton FYM/ha over 100% RDN (60 kg/ha) alone were 27.7, 25 and 22.8% respectively. The nitrogen use-efficiency parameters revealed that agronomic efficiency and recovery efficiency were highest with 75% RON+ 2 ton poultry manure, followed by 75% RON + 4 ton green manure and 75% RDN + 5 ton FYM.

Saleque *et al.* (2004) conducted a research, to determine the effect of different doses of chemical fertilizers alone or in combination with cow dung (CD) and rice husk ash (ash) on yield of lowland rice. Six treatments-absolute control (T_1), one-third of recommended fertilizer doses (T_2), two-thirds of recommended fertilizer doses (T_3), full doses of recommended fertilizers (T_4), T_2 + 5 t CD and 2.5 t ash ha^{-1} (T_5) and T_3+ 5 t CD and 2.5 t ash ha^{-1} (T_6) were compared. The CD and ash were applied on dry season rice only. The 10 years mean grain yield of rice with T_1 was 5.33 t ha^{-1} year^{-1}, while the yield with T_2 was 6.86 t ha^{-1} year^{-1}. Increased fertilizer doses with T_3 increased the grain yield to 8.07 t ha^{-1} year^{-1}, while the application of recommended chemical fertilizer doses (T_4) gave 8.87 t ha^{-1} year^{-1}. The application of CD and ash (T_5 and T_6) increased rice yield by about 1 t ha^{-1} year^{-1} over chemical fertilizer alone (T_2 and T_3, respectively).

Ghosh *et al*. (2014) carried out a field experiment on integrated use of chemical and organic fertilizers. It can help in sustainable and environmentally sound nutrient management of soils. A study was conducted in the farmer’s field of Godaghari, Rajshahi from February to May 2012 to investigate the effect of integrated nutrient management on nutrient uptake by rice cv. NERICA 10 and economization of inputs. Six treatments viz. T_1 = Control, T_2 = RFD for MYG + cow dung @ 5 t ha^{-1}, T_3 = RFD for HYG, T_4 = RFD for HYG + cow dung @ 5 t ha^{-1}, T_5 = RFD for HYG + cow dung @ 5 t ha^{-1} based on IPNS, and T_6 = RFD for HYG + 10% excess fertilizer of HYG were used. The highest nutrient uptake was recorded from the treatment T_5 and the lowest value was obtained from control. Combined application of cow dung @ 5 t ha^{-1} along with recommended chemical fertilizers based on IPNS was more economic compared to other treatments because maximum benefit cost ratio was calculated from this treatment.

Mamun *et al*. (2018) conducted a field experiment to evaluate the effects of organic and inorganic sources of nitrogen on the post-harvest fertility status and yield of BRRI dhan29. Incorporation of recommended dose of nitrogen (RDN) @ 150 kg ha^{-1} from cow dung as organic nitrogen source and urea as inorganic nitrogen source along with a control was performed. All the treatments under study also received P20, K65, S18, Zn1.3 through inorganic sources of fertilizers. The grain and straw yields as well as the yield contributing characteristics like plant height, number of tillers $hill^{-1}$, number of effective tillers $hill^{-1}$, panicle length, number of grains $panicle^{-1}$ and number of filled grains $panicle^{-1}$ were significantly influenced by the different treatments. Significantly highest grain (5.89 t ha^{-1}) and straw (6.14 t ha^{-1}) yields were recorded from the treatment T_1 where 100% RDN provided from urea that was closely followed by the treatment T_6 (80% RDN from urea + 20% RDN from cowdung). Considering the results, treatment T_6 (80% RDN from urea + 20% RDN from cowdung) may be suggested for adequate substitute in reducing the chemical nitrogen usage for sustained boro rice cultivation.

Babu *et al*. (2001) conducted a field experiment during *kharif* seasons of 1998 at Annamalai University experimental farm,Tamil Nadu to study the effect of organic and inorganic manures on growth and yield of rice (*Oryza sativa* L.) variety ADT 38. Individual and combined application of organic manures (FYM, Green manure and Press mud) along with inorganic fertilizers (100% and 75% recommended dose of fertilizer) had significant influence on plant growth and yield characters and grain yield of rice. Application of FYM @12.5 t ha^{-1} along with 100 per cent recommended dose of fertilizer combination exhibited the highest growth and yield characters than other combinations.

Jinjala *et al. (*2016) conducted a field experiment during rabi season of 2011-12 on heavy black soil to study the effect of integrated nutrient management on growth and yield of baby corn. The treatments comprising all possible combinations of five levels of nitrogen (chemical and vermin compost fertilizer) with and without bio-fertilizer (Azotobacter and PSB). These were significantly higher with application of 100% RDN from chemical fertilizer with bio-fertilizer over 100% RDN from vermin compost. The cob and fodder yield significantly differed with different integrated nutrient management treatment. Significantly the higher growth and yield attributes yield and fodder yield were recorded with the application of 100% RDF from chemical fertilizer with bio-fertilizer.

Krishnakumar *et al.* (2005) conducted an experiment to optimize the NPK fertilizers requirements with hybrid rice and graded levels of NPK. The results indicated that application of 150:75:50 kg N: P_2O_5: K_2O ha^{-1} had registered the higher grain yield of hybrid rice due to plant had greater total Phosphorus and K uptake.

Ali *et al*. (2009) conducted a field experiment during 2003-2004 at Bangladesh Agricultural University farm, Mymensingh to evaluate the suitability of different sources of organic materials for integrated use with chemical fertilizers for the Boro-Fallow-T. Aman rice cropping pattern. The treatment combinations are T_1 :control, T_2 :70% NPKS, T_3: 100% NPKS, T_4: 70% NPKS + rice straw (RS) @ 5 t/ha, T_5: 70% NPKS + dhaincha (DH) @15 t/ha, T_6: 70% NPKS + mungbean residue (MBR) @ 10 t/ha, T_7: 70% NPKS + cowdung (CD) @ 5 t/ha and T_8: 70% NPKS + poultry manure (PM) @ 3 t/ha. Organic manure or crop residue was applied to T. Aman rice. The integrated use of fertilizers and manure resulted in considerable improvement in soil health by increasing organic matter, available P, and S contents of soils. The overall findings of the study indicate that the integrated use of chemical fertilizer and manure is important for sustainable crop yield in a rice-rice cropping pattern.

Kumar *et al.* (2012) conducted an experiment to assess the possibility of improving productivity of rice under two levels of fertilizer N and P applications i.e.,75% recommended NP (90 kg N + 19.5 kg P ha^{-1}) and 100% recommended

NP (120 kg N + 26 kg P ha^{-1}) with and without organic manures i.e., 10 t ha^{-1} farmyard manure (FYM), 10 t ha^{-1} sulphitation press mud (SPM), in situ green manuring (GM) as *Sesbania aculeata* and 2.5 t ha^{-1} wheat residue (WR). Application of N, P and organic sources significantly increased the no. of tillers, plant height and yield of rice over control. The maximum yield of rice was obtained in 100% NP+GM (6.42 t ha^{-1}) than 100% NP (5.31 t ha^{-1}) and 100% NP + wheat residue (6.02 t ha^{-1}) treatment. The 100% recommended NP with organic sources (FYM, PM, GM, and WR) recorded higher N uptake by 29.2, 29.4, 37.3 and 18.4%, respectively as compared to 100% recommended NP.

Baishya *et al*. (2015) conducted a field experiment at Nagaland Centre, Medziphema during Kharif season of 2010 and 2011 to study the effect of integrated nutrient management on rice productivity, profitability and soil fertility in eastern Himalayan region on a sandy loam soil. Among the organic sources, poultry manure (2.5 t ha^{-1}) was found to be most profitable in terms of productivity, profitability and sustaining soil fertility. The crop receiving 2.5 t poultry manure ha^{-1} along with 75 kg N + 16.5 kg P + 31.3 kg K ha^{-1} improved yield attributes and yield (6.03 t ha^{-1}) as well as nutrient uptake. The same treatment recorded significant improvement in soil organic carbon, nitrogen, phosphorus and potassium status of soil after harvest of the crop.

Wolie *et al. (2016)* conducted a field experiment on Rice (*Oryza sativa* L.). Exploiting the production potential of high yielding rice varieties through agronomic management is one of the alternatives to feed the ever-growing population. For this, fertilizers from different sources have contributed substantially to the spectacular increase in rice yield and to improve soil properties. The objective of this paper is to comprehensively review the literatures and recommend the best proportion different source of fertilizers for sustainable rice production and soil properties improvement. Rice yield and yield contributing traits significantly increased with the use of compost, vermi compost, sasbania, green manure and FYM in combination with chemical fertilizer than individual sources in most of the findings. Higher total nutrient uptake by rice crop was also recorded under integrated nutrient source. Moreover, integrated application of inorganic and organic fertilizers helped in increasing the availability of nutrients and improves major physical and chemical characteristics of the soil. In conclusion, application of 50 % fertilizers from organic sources and 50 % from inorganic sources is the best combination and reported by many scientists for rice yield and soil properties improvement.

Sarkar *et al.* (2016) conducted a field experiments at Water Management Research Station, Begopara, Nadia, WB, India, during the rabi seasons of 2008–2009 and 2009–2010 to find out the integrated effect of nitrogen (N), phosphorus (P), potassium (K), farmyard manure (FYM) and zinc (Zn) under the system of rice intensification (SRI) techniques using eight treatments on the fertility changes in soil. The results revealed that the amounts of organic carbon and available N content in soil were found to maintain the highest fertility status with the highest yield in T_6 (NPK + FYM 10 t ha^{-1} + Zn 5 kg ha^{-1}) and gave the highest N uptake (55.98 kg ha^{-1}). The availability of P decreased with the increased level of Zn application and gave the highest P uptake (23.52 kg ha^{-1}) in the treatment T_5 (NPK + FYM 10 t ha^{-1}). The highest Zn content (4.71 mg ha^{-1}) was recorded in the treatment T_7 (NPK + FYM 10 t ha^{-1}+ Zn 10 kg ha^{-1}).

Mondal *et al. (*2016) conducted a field experiment during the two consecutive *kharif* seasons of 2011 and 2012 on sandy-loam lateritic soil of Indian subtropics to investigate the impact of integrated nutrient management (INM) on crop productivity, nutrient use efficiency of applied nutrients and soil fertility in restoring sustainability with hybrid rice cultivation. Application of 50% recommended dose of fertilizer (RDF) + 50% recommended dose of nitrogen (RDN) through mustard oil cake (MOC) or 75% RDF + 25% RDN through MOC + biofertilizer recorded significantly higher grain and biomass yields, greater NPK removal and higher partial factor productivity of applied nutrient (PFPN) than those of the crop having 100% RDF, 100% RDN through MOC and 25% RDF + 75% RDN through MOC, which showed very poor performance. Results of study suggested integrated use of 50% RDF + 50% RDN through MOC or

75% RDF + 25% RDN through MOC + biofertilizer for increasing hybrid rice productivity, PFPN and improving soil fertility for sustainability.

Saha *et al.* (2007) conducted a 7-year-long field trial on integrated nutrient management for a dry season rice (Boro)–green manure (GM)–wet season rice (T. Aman) cropping system at the Bangladesh Rice Research Institute Farm, Gazipur during 1993–1999. Five packages of inorganic fertilizers, cow dung (CD), and GM dhaincha (*Sesbania aculeata*) were evaluated for immediate and residual effect on crop productivity, nutrient uptake, soil-nutrient balance sheet, and soil-fertility status. Plant height, active tiller production, and grain and straw yields were significantly increased as a result of the application of inorganic fertilizer and organic manure. Application of CD at the rate of 5 t ha^{-1} (oven-dry basis) once a year at the time of Boro transplanting supplemented 50% of the fertilizer nutrients other than nitrogen (N) in the subsequent crop of the cropping pattern. A positive effect of GM on the yield of T. Aman rice was observed. The application of CD and dhaincha GM along with chemical fertilizers not only increased organic C, total N, available P, and available S but also increased exchangeable K, available Zn, available iron (Fe), and available manganese (Mn) in soil.

Singh *et al.* (2018) conducted a field experiment on "Effect of integrated nutrient management on growth and yield of rice (*Oryza sativa L)* at Research Farm, Bihar Agricultural College, Bihar Agricultural University, Sabour during Kharif season 2014 to evaluate the impact of continuous use of inorganic fertilizers and organic nutrients on productivity, economics and soil fertility status. Growth attributes such as plant height (96.8 cm), number of tiller m^{-2} (332), LAI (4.22) and dry matter accumulation (1285.7 gm) were found highest with the treatment T_5 (50 % RDF + 50 % N through FYM) but remained at par with all the treatment where either 25 or 50 % N was substituted through organic sources (T_6 toT_{10}).The differences in growth attributes were statistically alike between 100 % RDF and treatments supplicated either 25 or 50 % N through organic sources (T_6 toT_{10}). Maximum number of days taken to 50 % flowering (98.7 days) and maturity (136.5 days) were recorded with T_5 (50 % RDF+50 % N as FYM) but remained at par with all the treatment where either 25 or 50 % N was substituted through organic sources (T_6 toT_{10}) and also with 100 % inorganic source only.

Sravan *et al.* (2019) conducted two years study to determine the effect of integrated nutrient management on yield and quality of basmati rice varieties in non-traditional area. Variety HUBR 10-9 produced 18.8% higher mean grain yield and superior quality parameters than HUBR 2-1. Addition of 75% recommended dose of fertilizers with 25% recommended dose of nitrogen as farmyard manure produced higher mean values by 3.1%, 4.2% and 4.0% for hulling, milling and head rice recovery respectively over 100% recommended dose applied as inorganic sources. Combined use of bio-inoculants (blue green algae plus Azospirillum) exhibited higher values for yield and quality parameters. HUBR 10-9 be grown using 75% recommended dose of fertilizers with 25% nitrogen as farmyard manure and blue green algae plus Azospirillum for enhancement in yield and quality in non-traditional areas of eastern Uttar Pradesh.

Puli *et al*. (2017) conducted a field experiment for two consecutive years (2011-2012 and 2012-2013) as doctoral research on fine texture soils of Agricultural College Farm, Bapatla to find out the effect of different sources of nutrients on NPK uptake by rice at various growth periods. The experiment was conducted with four treatments. The treatments consisted of M_1 (RDF -Control), M_2 (10 t FYM ha^{-1} + RDF), M_3 (1.5 t vermicompost ha^{-1} + RDF), M_4 (Green manuring + RDF). The NPK uptake by rice at various growth periods was significantly increased with the application of 100% NPK in combination with FYM @ 10t ha^{-1}.

Imade *et al*. (2017) conducted a field experiment during kharif season of 2012 and 2013 at Instructional Farm, Navsari Agricultural University, Navsari (Gujarat) to study the effect of organic manures in combination with inorganic fertilizers on transplanted rice under rice–green gram cropping sequence under south Gujarat condition. Pooled data of two years revealed that the application of general RDF (RDF:100-30-00 kg N-P-K/ha+ FYM @ 10 t/ha) recorded significantly higher growth attributes viz., plant height, total number of tillers per hill, leaf area index, dry matter accumulation per hill over control. Significantly higher yield attributes viz., number of panicles per m^2, number of filled grains per panicle, panicle length, test weight, seed and straw yields per hill and seed and straw yields per hectare as well as quality parameters, protein content and protein yield recorded under general RDF (RDF:100-30-00 kg N-P-K/ha+ FYM @ 10 t/ha) over control.

Tomar *et al.* (2018) conducted a field experiments at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (Utter Pradesh) during Kharif 2014. The treatment consisted of four planting methods (S_1- transplanting, S_2-SRI, S_3-drum seeded and S_4- direct seeded) and three integrated nutrient management (F_1- 100% NPK, F_2- 75% NPK+25% FYM and F_3- 50% NPK+ 50% FYM) in this way. The values of growth contributing characters viz. plant height (cm), number of tillers m^{-2}, dry matter accumulation (g m^{-2}), leaf area index, and yield attributes like number of panicles m^{-2}, length of panicle (cm), number of panicle^{-1}, grain weight panicle^{-1}, test weight (g), grain and straw yield (q ha^{-1}) and nutrient uptake of rice were increasing significantly with SRI method (S_2) followed by transplanting method (S_1) and significantly superior over rest of the treatments. In case of integrated nutrient management, the growth characters like plant height (cm), number of tillers m^{-2}, dry matter accumulation (g), LAI, yield attributes' number of panicle m^{-2}, length of panicle, grain weight panicle^{-1}, test weight (g), nutrient uptake, grain and straw yield (q ha^{-1}) of rice were maximum under F_2 (75% NPK+25% FYM) which was at par with F_1 100% NPK during course of investigation.

Borah *et al.* (2015) conducted an experiment on Weed infestation on rice. Weed infestation in upland direct sown rice is one of the most serious problems that may pose threat to the upland rice cultivation. Weed infestation increased with increasing the dose of FYM application and the highest weed infestation (both weed density and weed dry weight) was noticed in crop with 100% RDN through FYM among all other treatments. Integrated nutrient management (INM) with 75% RDN through VC + 25% RDF and 75% RDN through FYM + 25% RDF produced the highest grain and straw yields and paid maximum gross and net returns from rainfed upland rice among all other treatments though the crop with 75% RDN through FYM + 25% RDF faced greater weed infestation than other treatments except 100% RDN through FYM. The results indicate INM with 75% RDN through VC + 25% RDF or 75% RDN through well decomposed FYM(in which viability of weed seeds lost during decomposition)+ 25% RDF for reducing weed infestation and increasing productivity of rainfed upland rice.

Arif *et al*. (2014) conducted an experiment on integrated use of organic and inorganic manures on the yield of rice was evaluated in a field experiment at Chakkanwali Reclamation Research Station, District Gujranwala, Pakistan during kharif 2012. The organic sources used were farmyard manure, poultry manure, rice straw, sesbania, compost and mungbean residues alone and in combinations with 50% of recommended dose of fertilizer (RDF). Recommended dose of fertilizer (150-90-60 kg NPK/ha) and control treatments were also included in the experiment. The results showed that organic and inorganic manures in combination increased the plant height, fertile tillers per hill, number of grains per panicle, panicle length, number of panicles per hill, 1000-grain weight, biological yield, grain yield and harvest index. Maximum number of fertile tillers per plant (16.79), number of panicles per hill (8.41), 1000- grain weight (21.12 g), biological yield (10.19 t/ha), grain yield (4.47 t/ha) and harvest index (43.76%) were recorded from the plots receiving poultry manure @ 10 t/ha in combination with 50% of RDF. This was followed by 100% RDF. It is evident that yield of rice can be increase significantly with the combined use of organic manure with chemical fertilizers.

Tadesse *et al*. (2013) conducted an experiment on the effect of integrated farmyard manure (FYM) and inorganic nitrogen (N) and phosphorous (P) fertilizers on growth, yield, and terminal moisture stress tolerance of rain-fed lowland rice was assessed in a field experiment carried out at Fogera plains, in north-western Ethiopia during the main cropping seasons of 2010 and 2011. Treatments were factorial combinations of three rates of FYM (0, 7.5, and 15 t ha^{-1}), three rates of nitrogen (0, 60, 120 kg N ha^{-1}) and three rates of phosphorus (0, 50, and 100 kg P_2O_5 ha^{-1}). Economic analysis was performed by estimating costs of alternative uses of FYM and inorganic fertilizers as well as grain and straw prices. Analysis of the results revealed that applying FYM at 15 t ha^{-1} combined with 120 kg N ha^{-1} and 100 kg P_2O_5 ha^{-1} increased grain yield by 123% and 38% compared to the negative (0-0-0 kg ha^{-1} FYM-N- P_2O_5) and positive (0-120-100 kg ha^{-1} FYM-N- P_2O_5) controls, respectively. It was observed that 15 t ha^{-1} FYM combined with 120 kg N ha^{-1} and 100 kg P_2O_5 ha^{-1} resulted in the maximum grain yield, grain protein content, and terminal moisture stress escape.

Naher and Paul (2017) conducted an experiment to evaluate the effect of integrated nutrient management (INM) on T.Aman rice (cv. BRRI dhan40). Application of 70 % NPKS fertilizers + 4 t ha^{-1} dhaincha (*Sesbania rostrata*) produced the highest grain yield (5.90 t ha^{-1}), the second highest yield (5.85 t ha^{-1}) was obtained from 80% NPKS + 2 t ha^{-1} dhaincha .

2.2 Effect of variety on growth and yield of rice

Sarkar *et al*. (2004) conducted a field experiment at the Agronomy Field laboratory, Bangladesh Agricultural University, Mymensingh to study the effect of integrated management of green manures and nitrogen fertilizer on the growth of transplant aman rice (cv. BRRI dhan32). The experiment comprised of three green manures viz., *Sesbania rostrata, Sesbania aculeata* and *Crotalaria juncea* and 5 nitrogen (N) levels viz., 0, 20, 40, 60 and 80 kg ha^{-1}. Absolute control and recommended dose of nitrogen (i.e., 80 kg N ha^{-1}) and @ 20 t ha^{-1} of well-decomposed cow dung were also included. Growth attributes showed higher values with the incorporation of green manures in combination with higher levels of nitrogen. All green manuring crops in combination with 40 kg N ha^{-1} produced the highest grain yield in transplant aman rice.

Farid *et al.* (2011) conducted a field experiment to study the combined effect of cowdung, poultry manure, dhaincha and chemical fertilizers on the yield and nutrient uptake of BRRI dhan41. The maximum grain yield was 4.49 t ha^{-1} recorded in 70% NPKS + Poultry manure @ 5 t ha^{-1} and minimum grain yield of 2.69 t ha^{-1} in control. The dhaincha or cowdung along with 70% NPKS increase the grain yield significantly over 70% NPKS application. The relative performances of organic manures were in the order of PM>DH>CD.

Hussain *et al.* (2010) conducted a field experiment to observe different organic manures and nitrogenous fertilizer and its effect on the growth and yield of rice. Higher Plant height, dry matter production, yield attributes and grain yield was observed with application of 75% N as inorganic fertilizer and 25% N as poultry manure (7160 kg/ha) comparable with 25% N as vermicompost (6920 kg/ha) and was followed 25% N as green leaf manure (6710 kg/ha). Higher physiological efficiency was attained when substituting 25% N as poultry manure and was followed by the same proportion of vermicompost. The highest net return with B: C ratio of 3.12 was attained by 25% N substitution as poultry manure while green leaf manure fetched highest B: C ratio of 3.26. From the above results, it could be indoctrinated that application of 75% of recommended N as inorganic fertilizer and substitution of 25% N either as poultry manure or green leaf manure is the desirable integrated nutrient management practice for achieving higher productivity and profitability under transplanted condition.

Aasif *et al.* (2018) conducted field experiment at Agricultural Research Station, Thirupathisaram during rabi 2017-18 to study the effect of integrated nutrient management practices on rice under system of rice intensification. Biometrics such as number of panicles m^{-2}, number of grains $panicle^{-1}$, panicle length, grain yield, straw yield and nutrient uptake were recorded. Integrated Nutrient management significantly influenced the yield and nutrient uptake of rice. Application of 100% RDF + Poultry manure (3 t ha^{-1}) + 3% Panchakavya foliar spray @ AT, PI & 50% flowering significantly influenced the yield and nutrient uptake of rice under system of rice intensification. The lowest yield characters, yield and nutrient uptake were recorded under 75% RDF alone.

Patel (2014). conducted a field experiment to evaluate the effect of integrated nutrient management on soil quality and its management. It was carried out with the objective to study the response of integrated nutrient management on short grain aromatic rice varieties for optimization of yield and quality. The experiment having four varieties namely (V_1) Dubraj, (V_2) Badshah Bhog, (V_3) Vishnu Bhog and (V_4) Bisni and six nutrient management treatments i.e. (N_1) 60:40:30 Kg N:P_2O_5:K_2O ha^{-1} (Inorganic), (N_2) 80:50:40 Kg N:P_2O_5 :K_2O ha^{-1}(Inorganic),(N_3) 60:40:30 Kg N:P_2O_5 :K_2O ha^{-1} (50% Inorganic+ 50% Organic), (N_4) 80:50:40 Kg N: P_2O_5: K_2O ha^{-1} (50% Inorganic + 50% Organic), (N_5) 60:30:60 Kg N: P_2O_5: K_2O ha^{-1} (Organic-FYM) and (N_6) 80:40:80 Kg N: P_2O_5: K_2O ha^{-1} (Organic-FYM). The application of 80:40:80 kg N: P_2O_5: K_2O ha^{-1} (Organic-FYM) obtained the highest gain of available nitrogen, phosphorus and potassium in soil. While in case of available nitrogen in soil, application of 80:40:80 kg N:P_2O_5 :K_2O ha^{-1} (Organic-FYM) found at par with the application of 80:50:40 kg N:P_2O_5 :K_2O ha^{-1} (50% Inorganic+ 50% Organic). Chemical fertilizers applications reduce the postharvest soil nutrients as compared to organic manures application.

Gill *et al.* (2018) investicated a field experiment entitled NPK uptake influenced by integrated nitrogen management in basmati rice was conducted at Punjab Agricultural University, Ludhiana during kharif 2010. The highest grain yield (34.9±0.54q ha^{-1}) was obtained with combined application of FYM and 50 per cent of recommended nitrogen (RN) followed by GM+FYM+OP (33.7q ha^{-1}) and GM+FYM (33.4±0.99q ha^{-1}). Straw yield (63.1 q ha^{-1}) increased significantly ($P<0.01$) in treatment where FYM combined with 50 per cent of RN was applied. Among different nitrogen management treatments, the maximum N, P and K uptake in grain and straw were observed under treatment T_8 (FYM +50 per cent of RN) viz. integrated nitrogen treatment followed by T_{11} (GM+FYM+OP) and T_9 (GM+FYM). Thus, combined application of FYM @

19.76 t ha^{-1} with reduced fertilizer dose (50 % of RN) increased the yield and NPK uptake in basmati rice.

Apon *et al*. (2018) conducted an investigation to assess the integrated nutrient management in local rice. Cultivars under rainfed upland condition of Nagaland" was carried out at School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema, Nagaland, during kharifseason of 2015. This experimentation was carried out with 10 treatments. The factors comprised of two local rice cultivars viz. Nyakmok (V1) and Jamaghu (V2) and five fertilizer doses. The results revealed that, the application of 100% RDF + 5 t ha^{-1} poultry manure enhanced the growth and yield of both the local rice cultivars. The application of 100% RDF + 5 t ha^{-1} PM recorded highest number of panicles m^{-2} (120), length of panicle (28.93 cm), test weight (30.55 g), grain yield (3.14 t ha^{-1}) and straw yield (8.89 t ha-1). Combination of cultivar 'Nyakmok' with the application of 100% RDF resulted in significantly highest harvest index (32.68 %), uptake of P (19.93 kg ha^{-1}) and K (56.83 kg ha^{-1}). It is concluded from the study that Cultivar 'Nyakmok' was more suitable with 100% RDF + 5 t ha^{-1} PM under rainfed upland condition.

Mithun *et al*. (2007) studied the effect of integrated nutrient management on aromatic rice var. basmati-370 was studied. Treatments included 100% recommended dose of fertilizer (RDF:80:40:40 NPK), 75% RDF, and 75% RDF in combination with pelleted form of organic manure (0.4 t ha^{-1}), organic manure rich with humus (0.1 t ha^{-1}), Karanja (*Pongamia pinna*) cake (0.6 t ha^{-1}), neem seed powder (0.8 t ha^{-1}), FYM (4.0 t ha^{-1}) and crop residue (3.8 t ha^{-1}). Supply of inorganic sources of nutrient in conjunction with organic sources significantly increased grain yield (21.2–76.8%) over sole inorganic application. The highest grain yield of rice (2.83 t ha^{-1}) registered under integrated use of 75% RDF + pelleted form of organic manure. It was closely followed by the grain yield (2.56 t ha^{-1}) obtained with the application of 75% RDF + neem seed powder. However, sole chemical fertilizer addition produced lower grain yield (1.6 t ha^{-1}) compared to combined use of organic and inorganic sources.

Kumar *et al.* (2016) conducted a field experiment for quality rice production of scented rice variety Pusa Basmati and NDR-Lalmati. It was conducted on Students Instructional Farm, Narendra Deva university of Agriculture and Technology, Faizabad during Kharif season of 2013 and 2014. The treatment were included inorganic and organic combinations viz., T_1: RDF NPK (100:50:50) × V_1, T_2: RDF NPK + 5 tons FYM/ha × V_1, T_3: 75 per cent RDF NPK+25 per cent N with FYM × V_1, T_4: 75 per cent RDF NPK+25 per cent N with green manure × V_1, T_5 : 50 per cent RDF +25 per cent FYM-N+25 per cent GM-N × V_1, T_6 : 20 tons FYM/ha × V_1, T_7 : RDF NPK (100:50:50) × V_2, T_8 : RDF NPK + 5 tons FYM/ha × V_2, T_9 : 75 per cent RDF NPK+25 per cent N with FYM × V_2, T_{10}: 75 per cent RDF NPK+25 per cent N with green manure × V_2, T_{11} : 50 per cent RDF +25 per cent FYM-N+25 per cent GM-N × V_2, T_{12} : 20 tons FYM/ha × V_2. The variety Pusa Basmati recorded higher grain and straw yield as compared to NDR-Lalmati in both year of investigation. Maximum grain and straw yield of aromatic rice was recorded under integrated nutrient management of 100 per cent NPK + 5 t FYM followed by treatment T_1 and T_4 in both the years of investigation.

Roy *et al.* (2016) conducted a field experiment to find out the effect of integrated nutrient management in boro rice cv. BRRI dhan29 cultivation. Results of the experiment showed that integrated nutrient management had significant effect on yield contributing characters and yield of BRRI dhan29. The tallest plant (93.33 cm) was found in T_2 treatment (recommended dose of prilled urea and PKSZn), the highest number of total tillers hill^{-1}(16.85) and effective tillers hill^{-1} (15.90) were obtained in T_{11} treatment (USG (2.7g) + poultry manure 5 t ha^{-1}). The highest 1000-grain weight (22.40g), grain yield (7.19 t ha^{-1}) and straw yield (8.08 t ha^{-1}) were recorded in T_{10} treatment (full dose of USG (2.7g) + cowdung 10 t ha^{-1}) and the lowest grain yield (4.43 t ha^{-1}) and straw yield (5.21 t ha^{-1}) were obtained in T_7 treatment (cowdung 10 t ha^{-1}).

Moe *et al.* (2019) investigated the effects of integrated organic and inorganic fertilizers on the growth and yield of *indica* rice variety Manawthukha and *japonica* rice variety Genkitsukushi. In a split-plot design, the two rice varieties were assigned as main plot factors, and the integrated treatments were the subplot factors, including no-N fertilizer (N_0), 50% chemical fertilizer (CF) (CF_{50}), 100% CF (CF_{100}), 50% CF + 50% poultry manure (PM) ($CF_{50}PM_{50}$), 50% CF + 50% cow manure (CM) ($CF_{50}CM_{50}$), and 50% CF + 50% compost (CP) ($CF_{50}CP_{50}$). CF_{100} was equivalent to N at 85 kg/hm^2. Manawthukha rice plants were taller with higher tiller number and dry matter content. At the same N level, $CF_{50}PM_{50}$ application in both rice varieties resulted in higher SPAD values, plant height and tiller number than CF_{100}. $CF_{50}PM_{50}$ containing total N more than 4% supplied synchronized N for the demands of the rice plants, resulting in maximum dry matter, yield and yield components. $CF_{50}CM_{50}$ and $CF_{50}CP_{50}$ treatments containing total N less than 4% resulted in lower yields which were similar to CF_{100}. These results indicated that integrating organic and inorganic fertilizers enhanced growth parameters and yields of Manawthukha and Genkitsukushi, while reducing the dose of chemical fertilizer.

Sarker *et al.* (2017) conducted a research to evaluate the impact of organic and inorganic sources of nitrogen (N) on growth dynamics, yield, N content, N uptake and agronomic efficiency (AE) of irrigated rice. Four high yielding Boro (dry season irrigated) rice cultivars viz. BRRI dhan29, BRRI dhan59 Binadhan-8 and Binadhan-10 along with six N management combinations viz. Control (no N application), 140 kg N ha^{-1} from Prilled Urea (PU), 83 kg N ha^{-1} from Urea Super Granule (USG), 105 kg N ha^{-1} from PU + 3 t ha^{-1} Poultry manure, 112 kg N ha^{-1} from PU + 5 t ha^{-1} Cowdung and 77 kg N ha^{-1} from PU+4 t ha^{-1} vermicompost were used in the study. The cultivar Binadhan-8 had a higher yield than all other cultivars. AE were highest with 105 kg N ha^{-1} from PU + 3 t ha^{-1} Poultry manure application. The highest N uptake in grain and straw (120.1 kg ha^{-1} and 96.14 kg ha^{-1}, respectively) was shown by rice cultivar Binadhan-8. Therefore, the combined application of N sources in the form of PU + Poultry manure can produce good performances in terms of growth and yield of HYV rice under irrigated condition.

Hossaen *et al.* (2011) conducted a research to evaluate the efficacy of different organic manure and inorganic fertilizer on the yield and yield attributes of boro rice. At 30, 50, 70, 90 DAT and at harvest stage the tallest plant (24.18, 31.34, 44.67, 67.05 and 89.00 cm) and the greatest number of total tillers per hill (5.43, 11.64, 21.01 and 17.90) at same DAT was recorded from 70% NPKS + 2.4 t poultry manure ha^{-1} and the lowest was observed from control in every aspect. Although the highest biological yield was recorded from 70% NPKS +2.4 t poultry manure ha^{-1} treatment but statistically similar result was found from 70% NPKS + 3 t cowdung ha^{-1}, 50% NPKS + 4 t poultry manure ha^{-1} and 70% NPKS + 3 t vermicompost ha^{-1}. The highest harvest index also recorded for 70% NPKS + 2.4 t poultry manure ha^{-1}. It was obvious that yield of rice can be increased substantially with the judicious application of organic manure with chemical fertilizer.

Islam *et al.* (2013) conducted a field experiment in the Sher-e-Bangla Agricultural University research farm to study the effect of fertilizer and manure with different water management on the growth, yield and nutrient concentration of BRRI dhan28. 50% RDCF + 4 ton poultry manure/ha showed the highest effective tillers/hill, plant height, panicle length, 1000 grain wt., grain yield (5.92 kg/plot) and straw yield (5.91 kg/plot). The higher grain and straw yields were obtained organic manure plus inorganic fertilizers than full dose of chemical fertilizer and manure.

Ali *et al*. (2018) conducted a field experiment to investigate the influence of plant nutrient management on the yield performance of transplant Aman rice varieties. The experiment comprised four varieties viz., BRRI dhan70, BRRI dhan71, BRRI dhan72 and BRRI dhan73 and six nutrient managements viz. poultry manure 5 t ha^{-1}, recommended dose of prilled urea, P, K, S, Zn (160, 65, 90, 70, 10 kg ha^{-1} of urea, TSP, MoP, Gypsum and Zinc sulphate, respectively), 75% of recommended dose of prilled urea and P, K, S, Zn + poultry manure 2.5 t ha^{-1} , 50% of recommended dose of prilled urea and P, K, S, Zn + poultry manure 5 t ha^{-1}, USG 1.8 g/4 hills and P, K, S, Zn recommended dose, USG 1.8 g/4 hills and P, K, S, Zn + poultry manure 2.5 t ha^{-1}.Number of total tillers ha^{-1} (10.25), number of effective tillers ha^{-1} (8.85), grains panicle^{-1} (94.23), 1000-grain weight (27.81), grain yield (5.88 t ha^{-1}) and straw yield (8.83 t ha^{-1}) were found to be the highest in BRRI dhan72. Among the nutrient management, USG 1.8 g/4 hills and P, K, S, Zn + poultry manure 2.5 t ha^{-1} exhibited its superiority to other treatments in terms of plant height (131.0 cm), number of total tillers hill^{-1} (10.67), number of effective tillers hill^{-1} (9.13), grains panicle^{-1} (92.71), 1000-grain weight (26.82), grain yield (6.0 t ha^{-1}) and straw yield (8.35 t ha^{-1}). The highest grain yield (6.45 t ha^{-1}) was found in BRRI dhan72 combined with USG 1.8 g/4 hills and P, K, S, Zn + poultry manure 2.5 t ha^{-1} and the lowest grain yield (4.85 t ha^{-1}) was found in BRRI dhan71 fertilized with poultry manure 5 t ha^{-1}.

2.3 Effect of integrated nutrient management in aus rice varieties

Niru *et al.* (2009) conducted a field experiment to identify suitable organic nutrient management in scented rice for higher productivity, nutrient utilization and soil health. Scented rice (Basmati) grown with recommended inorganic fertilizer produced 20.09% higher grain yield when compared with the best organic source combination of green manuring (GM) @ 5 t/ha + FYM @ 10 t/ha (3.3 t/ha). The yield attributing characters also followed the trend of grain yield.

Bhowmick *et al*. (2011) conducted a field experiment to evaluate an integrated nutrient management (INM) practices for enhancing grain yield of aromatic rice varieties in West Bengal. Experimental results revealed that the variety Kalijeera recorded significantly the highest grain yield (2.72 t ha^{-1}). Among the nutrient levels, application of 50% RFD + 50% FYM (2.92 t ha^{-1}) and 100% RFD (2.86 t ha^{-1}) were found equally effective in producing significantly higher grain yields.

CHAPTER III

MATERIALS AND METHODS

The trial materials and strategies were taken in this investigation are displayed here. The trial time frame was March to July (Kharif season) of 2019.

3.1 Experimental site

The experiment was done at Sher-e-Bangla Agricultural University (SAU) farm, Dhaka. The site was located at 23°77' North Latitude and 90^0 30' East Longitude. The elevation of the experimental site is 8.0 m above the sea level. The AEZ of this site was AEZ-28 (Madhupur Tract). The geological Location of the site is presented on the map in (Appendix I).

3.1.1 Climate of the Experimental site

Subtropical, wet and humid climate was found in experimental site. The climate is characterized into 3 distinct seasons the winter season from November to February and the pre-monsoon or hot season from March to April and the monsoon period from May to October. Details of the meteorological data of air temperature, relative humidity, rainfall and sunshine hour during study period has been presented in (Appendix III).

3.1.2 Characteristic of Soil

The experiment was conducted on the soil that was shallow red brown terrace soil. The selected plot was medium high land and the soil series was 'Tejgaon'. The experimental area having available irrigation and drainage system and situated above flood level. The soil having a texture of silty clay composed of 26% sand, 43% silt and 31% clay. Details of the recorded of soil characteristics are presented in (Appendix II).

3.2 Experimental details

3.2.1 Treatment of the experiment

Factor A: Variety (2)

V_1 = BRRI dhan48

V_2 = BRRI dhan82

Factor B: Fertilizer management (7)

T_1= 100% RDF (148-52-74 NPK kg ha^{-1})

T_2= Poultry manure @ 10 t ha^{-1}

T_3= Vermicompost @ 4 t ha^{-1}

T_4= Compost @ 5 t ha^{-1}

T_5= Poultry manure @ 10 t ha^{-1} + 50% RDF

T_6= Vermicompost @ 4 t ha^{-1} + 50% RDF

T_7= Compost @ 5 t ha^{-1} + 50% RDF

There were in total 14 (2×7) treatment combinations such as V_1T_1, V_1T_2, V_1T_3, V_1T_4, V_1T_5, V_1T_6, V_1T_7, V_2T_1, V_2T_2, V_2T_3, V_2T_4, V_2T_5, V_2T_6 and V_2T_7. This combination was applied in my experimental field for getting best possible treatment for aus variety.

3.2.2 Design and layout

A split-plot design was laid out with three replications. The two rice varieties were cultivated as main plot factors and fertilization in the subplot. Each plot was measured 3m × 2m. The total number of plots was 42 (14×3). Block to block distance was 1 m and plot to plot distance was 1 m. The layout of the experiment has been shown in Appendix IV.

3.2.3 Description of rice varieties

BRRI dhan48

Among the aus rice cultivars BRRI dhan48 was developed by Bangladesh Rice Research Institute (BRRI) and released in the year 2008. It is recommended for aus seasons and growth duration is about 110 days, On an average it produced yield of 5.5 t ha^{-1} and plant height is about 105 cm. Its grain is coarse, white.

BRRI dhan82

BRRI dhan82 is an aus variety which was developed by BRRI through hybridization and released in the year 2017. It is recommended for aus season. Average plant height of the variety is around 110 cm at the ripening stage. The grains are medium coarse and free from stickiness, 1000 grain weight 23.8 g and crop duration 100-105 days with an average grain yield of around 4.5-5.5 t ha^{-1}.

3.3 Growing of crops

3.3.1 Seed collection and sprouting

Seeds were collected from BRRI just 20 days ahead of the sowing of seeds in seed bed. For seedling raising clean seeds was immersed in water in a bucket for 24 hours. The wet seeds were then taken out of water and kept in gunny bags. The seeds started sprouting after 48 hours which was suitable for sowing in 72 hours.

3.3.2 Raising of seedlings

The nursery bed was prepared by puddling with repeated ploughing followed by laddering. The sprouted seeds were sown on beds as uniformly as possible. Irrigation was gently provided to the bed and when needed to bring favorable condition for seedling growth. No fertilizer was used in the nursery bed. Seeds were sawn at 9th March, 2019 in the seed beds.

3.3.3 Land preparation

The plot selected for conducting the experiment was ploughed in the 14th March 2019 with a power tiller, and left exposed to the sun for a week. After three days the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain good puddle condition. Weeds and stubbles were removed.

3.3.4 Fertilizers incorporation

According to BRRI recommended dose of fertilizer for BRRI dhan48 and BRRI dhan82 is NPKSZn – 123, 43, 62, 31,4 (kg ha^{-1}) respectively. The entire amount of TSP, 1/3 Urea, ½ MP, gypsum and zinc sulphate was applied during the final preparation of experimental plot. Urea was applied in three equal installments at final land preparation, 15 DAT and 30 DAT, respectively and ½ MP was applied during last installment of urea.

3.3.5 Organic manure incorporation

Poultry manure, Vermicompost and compost were used at 10 t ha^{-1}, 4 t ha^{-1} and 5 t ha^{-1} respectively and they were applied before two days of final land preparation following treatment variables. Chemical compositions of the manures used have been presented in Table 1.

Table 1. Chemical compositions of the compost and poultry manure & vermicompost (oven dry basis)

		Nutrient content		
Manure	N (%)	P (%)	K (%)	S (%)
Compost	1.46	0.29	0.74	0.24
Poultry manure	2.2	1.99	0.82	0.29
Vermicompost	2.1	1.50	0.60	0.25

Source: Soil Research Development Institute and Fab Lab,SAU

3.3.6 Transplanting of seedling

21 days old seedlings were carefully uprooted from the seedling nursery and transplanted on 1 April, 2019 in well puddled plot. Two seedlings were transplanted in each hill. After one week of transplanting all plots was checked for any missing hill, which was filled up with extra seedlings of the same source.

3.3.7 Intercultural operations

Intercultural operations were done to ensure normal growth of the crop. Plant protection measures were followed as and when necessary. The following intercultural operations were done.

3.3.7.1 Irrigation and drainage

In the early stages to establishment of the seedlings irrigation was provided to maintain a constant level of standing water up to 5 cm. No water stress was encountered in reproductive and ripening phase. The plot was finally dried out at 15 days before harvesting due to prevent any lodging of rice plant.

3.3.7.2 Weeding

Weeding was done to keep the plots free from weeds, which ultimately ensured better growth and development. Weed may cause 80% of yield loss. So weeding done frequently in primary stages of rice plant growth.

3.3.7.3 Insect and pest control

There was no infection of diseases in the field but leaf roller (*Chaphalocrosis medinalis*) was found in the field and used Malathion @ 1.12 L ha^{-1} at 30 DAT with using a hand sprayer.

3.4 Harvesting, threshing and cleaning

The crop was harvested at full maturity based on variety when 80-90% of the grains were turned into straw colored. The harvested crop was bundled separately, properly tagged and brought to threshing floor. Enough care was taken during threshing and cleaning period of rice grain. Fresh weight of rice grain and straw was recorded plot wise. The grains was dried, cleaned and weighed for individual plot. The weight was adjusted to a moisture content of 14%.This fixed moisture helps rice to keep its quality for a long time. Yields of rice grain and straw was recorded from each plot and converted and expressed as t ha^{-1}.

3.5 Data collection

3.5.1 Plant height (cm)

The height of plant was recorded in centimeter (cm) at 20, 40, 60 DAT and at harvest. Data was recorded as the average of 10 plants selected at random from the inner rows of each plot. The height was measured from the ground level to the tip of the panicle or flag leaf.

3.5.2 Tillers $hill^{-1}$ (No.)

Number of tillers $hill^{-1}$ was recorded at 20, 40, 60 DAT and harvest. Data was recorded as the average of 10 plants selected at random from the inner rows of each plot.

3.5.3 Leaves hill^{-1} (No.)

Number of leaves hill^{-1} was recorded at 20, 40, 60 DAT and harvest. Data was recorded as the average of 10 plants selected at random from the inner rows of each plot.

3.5.4 Above ground weight plant^{-1} (g)

Dry weight plant^{-1} was recorded at 20, 40, 60 DAT and harvest. Data was recorded as the average of 10 plants selected at random from the inner rows of each plot.

3.5.5 Effective tillers hill^{-1} (No.)

The total number of effective tillers hill^{-1} was counted as the number of panicle bearing tiller during harvesting. Data on effective tillers hill^{-1} was counted from 5 selected hills and average value was recorded.

3.5.6 Panicle length (cm)

The length of panicle was measured with a meter scale from 5 selected panicles and the average length was recorded as per panicle in cm.

3.5.7 Filled grains panicle^{-1} (No.)

The total numbers of filled grain was collected randomly from selected 5 panicle of a plot on the basis of grain in the spikelet and then average numbers of filled grains panicle^{-1} was recorded.

3.5.8 Unfilled grains panicle^{-1} (No.)

The total numbers of unfilled grain was collected randomly from selected 5 plants of a plot on the basis of not grain in the spikelet and then average numbers of unfilled grains panicle^{-1} was recorded.

3.5.9 1000-grain weight (g)

One thousand grains were counted randomly from the total cleaned harvested grains and then weighed in grams and recorded and expressed in gram.

3.5.10 Grain yield

Grains obtained from each portion of unit plot ($1m^2$) were sun-dried and weighed carefully. The dry weight of grains of each plot was taken the final grain yield $plot^{-1}$ and finally converted to ton $hectare^{-1}$ ($t\ ha^{-1}$).

3.5.11 Straw yield

Straw obtained from each portion of unit plot ($1m^2$) was sun-dried and weighed carefully. The dry weight of straw from each plot and finally converted to ton $hectare^{-1}$ ($t\ ha^{-1}$).

3.5.12 Biological yield

Grain yield and straw yield together was regarded as biological yield. The biological yield was calculated with the following formula:

Biological yield = Grain yield + Straw yield.

3.5.13 Harvest index

Harvest index was calculated from the grain and straw yield of rice for each plot and expressed in percentage.

HI = {Economic yield (grain weight) / Biological yield (total dry weight)} × 100

3.6 Statistical analysis

The data obtained for different characters was statistically analyzed following STATISTIX 10 software. The significance difference among the means values was adjudged by the Least Significant Difference (LSD) test at 5% level of probability.

CHAPTER IV
RESULTS AND DISCUSSSION

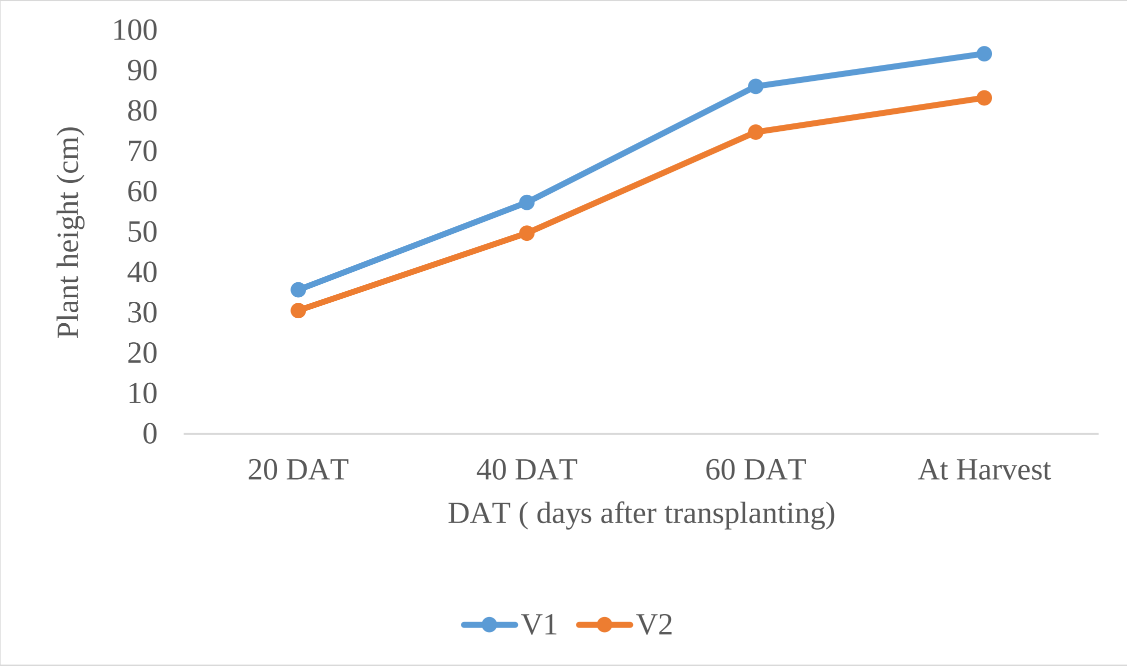
Results found from the present study concerning the effect of cultivar and various treatment combinations of organic and inorganic fertilizers on growth, yield and yield attributes of aus rice are presented and discussed in this chapter. The analyses of variance (ANOVA) of the data on growth and yield contributing characters of aus rice are presented in Appendix V-XI. The results have been presented and discussed under discrete heads and sub-heads as follows:

4.1 Growth characters of aus rice

4.1.1 Plant height

4.1.1.1 Effect of variety

Plant height is one of the most effective characters for better yield of rice which was also directly allied to straw yield. Plant height was recorded at 20, 40, 60 DAT (days after transplanting) and at harvest showed statistically significant variations due to varietal differences (Fig. 1). At 20, 40, 60 DAT and harvest, the tallest plant (35.68, 57.32, 86.11 and 94.22 cm, respectively) was observed in variety V_1 (BRRI dhan48) variety and the shortest plant height (30.57, 49.74, 74.75 and 83.28 cm respectively) was found in V_2 (BRRI dhan82). Plant height may be increased in BRRI dhan48 due to more cell elongation, it may founding more soluable nutrient in root zone than other variety. Similar results were found by Islam *et al*. (2013) who observed significant and genetic variation between the varieties concerning height of plant.

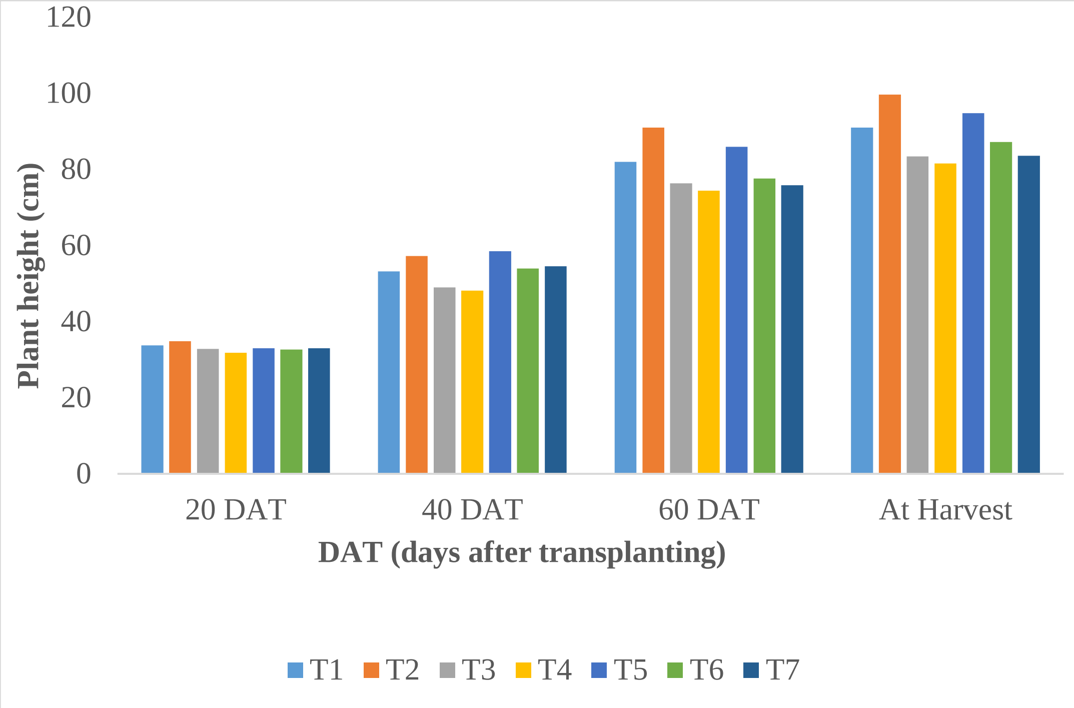


V_1= BRRI dhan48; V_2= BRRI dhan82

Figure 1. Effect of variety on plant height of aus rice at 20, 40, 60 DAT and harvest ($LSD_{0.05}$= 4.55, 5.39, 5.57 and 10.22, respectively).

4.1.1.2 Effect of fertilizer management

Plant height vary significantly due to different fertilizer management. It was observed at 20 DAT, the highest plant height was observed from T_2 (Poultry manure @ 10 t ha^{-1}) (34.84 cm) which was statistically similar to T_1, T_5, T_7, T_3 and T_6 and value was (33.72, 33.02, 32.96, 32.86 and 32.62 cm, respectively), whereas lowest value was found from T_4 (Compost @ 5 t ha^{-1}) (31.83cm). At 40 DAT, the highest plant height was observed from T_5 (Poultry manure @10 t ha^{-1} + 100% RDF) (58.54 cm) which was statistically similar to T_2 and T_7 and values were 57.28 and 54.53 cm, respectively, whereas lowest value was found from T_4 (Compost @5 t ha^{-1}) (48.16 cm) which was followed by T_3 (48.99).At 60 DAT ,the highest plant height was observed from T_2 (Poultry manure @ 10 t ha^{-1}) (90.98) which was statistically similar to T_5 and value was (85.92 cm), whereas lowest value was found from T_4 (Compost @ 5 t ha^{-1}) (74.38 cm) which was followed by T_7, T_3 and T_6 (75.82, 76.34 and 77.58 cm, respectively). At harvest the highest plant height was observed from T_2 (Poultry manure @ 10 t ha^{-1}) (99.65 cm) which was statistically similar to T_5 and value was (94.75 cm), whereas lowest value was found from T_4 (Compost) (81.55 cm) that was statistically similar with T_3, T_7 and T_6 (83.46, 83.58 and 87.24 cm, respectively). Ali *et al*. (2018) opined that the combination of integrated fertilizer affect plant height significantly.



T_1= 100% RDF (148-52-74NPK kg ha^{-1}); T_2= Poultry manure @ 10 t ha^{-1}; T_3= Vermicompost @ 4 t ha^{-1}; T_4= Compost @ 5 t ha^{-1}; T_5= Poultry manure @ 10 t ha^{-1} + 50% RDF; T_6= Vermicompost @ 4 t ha^{-1}+50% RDF; T_7=Compost @ 5 t ha^{-1} + 50% RDF

Figure 2. Effect of fertilizer management on plant height of aus rice at 20, 40, 60 DAT and harvest (LSD $_{0.05}$= 2.26, 4.20, 5.76 and 6.30, respectively).

4.1.1.3 Combined effect of variety and fertilizer management

Combined effect of variety and different fertilizer management had significantly influence on plant height at different growth stages of aus rice (Table 2). Data revealed that the highest plant height (37.87, 64.25, 98.61 and 105.86 cm at 20, 40, 60 DAT and at harvest, respectively) was scored by V_1T_2 which was statistically similar with V_1T_5 (36.61 cm), V_1T_4 (35.99 cm), V_1T_1 (35.37 cm), V_1T_3 (34.70 cm) and V_1T_6 (34.69 cm) at 20 DAT; with V_1T_5 (63.58 cm) at 40 DAT; with V_1T_5 (95.52 cm) at 60 DAT and with V_1T_5 (102.32 cm) and V_1T_1 (97.30 cm) at harvest. The lowest plant height (27.67, 44.00, 25.73 and 72.50

cm) at 20, 40, 60 DAT and harvest respectively) were found from treatment combination V_2T_4 which was statistically similar with V_2T_5 (29.44 cm) and V_2T_6 (30.54 cm) at 20 DAT; with V_2T_3 (46.41 cm) and V_2T_1 (49.37 cm) at 40 DAT; with V_2T_3 (71.76 cm), V_2T_7 (73.18 cm), V_2T_6 (74.57 cm), V_2T_1 (75.56 cm) and V_2T_5 (76.32 cm) at 60 DAT; with V_2T_3 (80.27 cm) at harvest. This increase in plant height in response to RDF might be primarily due to the improved vegetative growth and supplementary contribution of nitrogen. The variations in plant height of rice varieties may be attributable to differences in the genetic makeup of the varieties and their differences in the utilization ability of the different rates of soil amendments applied. Hussain *et al.* (2010) found that variety and integrated fertilizer management affect plant height significantly.

Table 2. Combined effect of variety and fertilizer management on plant height of aus rice at different days.

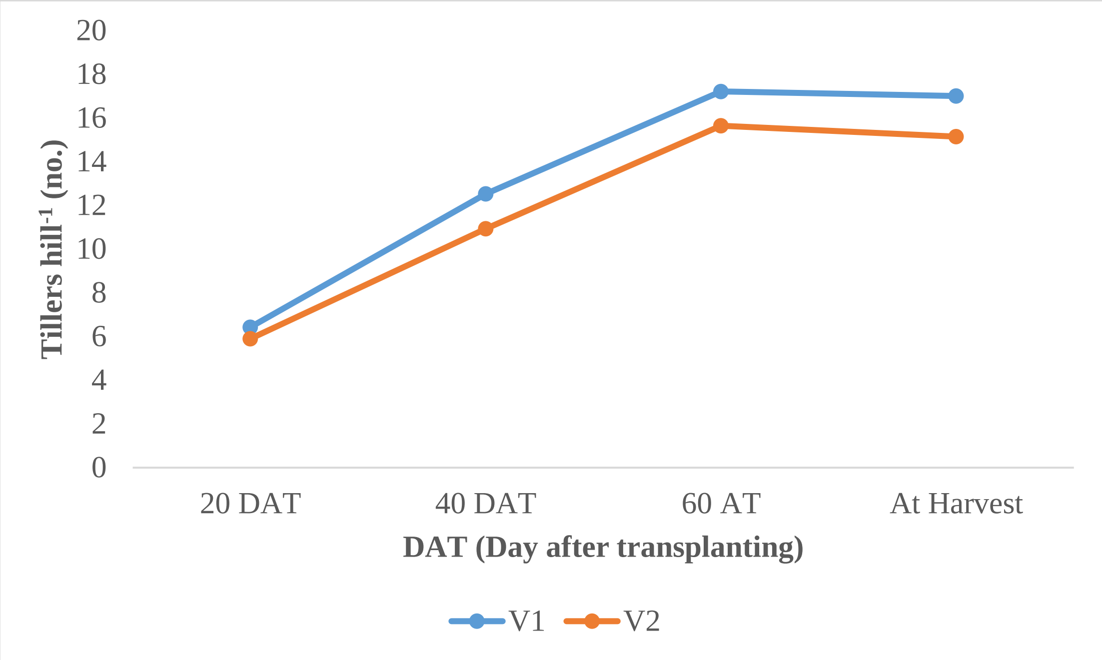
Treatments	Plant height (cm)			
	20 DAT	40 DAT	60 DAT	At harvest
V_1T_1	35.37 ab	57.08 b	88.44 bc	97.30 a-c
V_1T_2	37.87 a	64.25 a	98.61 a	105.86 a
V_1T_3	34.70 a-c	51.58 b-e	80.91 c-e	86.65 d-g
V_1T_4	35.99 ab	52.33 b-e	80.27 de	90.60 c-f
V_1T_5	36.61 ab	63.58 a	95.52 ab	102.32 ab
V_1T_6	34.69 a-c	56.21 bc	80.59 c-e	91.54 c-e
V_1T_7	34.52 b-d	56.22 bc	78.43 d-f	85.25 d-g
V_2T_1	32.07 c-e	49.37 d-f	75.56 d-g	84.75 d-g
V_2T_2	31.80 c-e	50.31 c-e	83.36 cd	93.43 b-d
V_2T_3	31.03 e	46.41 ef	71.76 fg	80.27 gh
V_2T_4	27.67 f	44 f	68.5 g	72.5 h
V_2T_5	29.44 ef	53.50 b-d	76.32 d-g	87.18 d-g
V_2T_6	30.54 ef	51.73 b-e	74.57 e-g	82.93 e-g
V_2T_7	31.40 de	52.83 b-d	73.20 e-g	81.92 fg
$LSD_{(0.05)}$	3.20	5.94	8.14	8.91
CV (%)	5.73	6.59	6.01	5.96

T_1= 100% RDF (148-52-74NPK kg ha^{-1}); T_2= Poultry manure @ 10 t ha^{-1}; T_3= Vermicompost @ 4 t ha^{-1}; T_4= Compost @ 5 t ha^{-1}**;** T_5= Poultry manure @ 10 t ha^{-1} + 50% RDF**;** T_6= Vermicompost @ 4 t ha^{-1}+50% RDF; T_7=Compost @ 5 t ha^{-1} + 50% RDF

4.1.2 Tillers hill^{-1}

4.1.2.1 Effect of variety

A significant variation in number of tillers hill^{-1} were observed due to variation in variety at 20, 40, 60 DAT and at harvest (Fig.3). At 20, 40, 60 DAT and harvest, the highest no. of tillers (6.43, 12.53, 17.22 and 17.01 respectively) was observed in V_1 (BRRI dhan48) and lowest no. of tillers (5.90, 10.93, 15.65 and 15.15 respectively) was observed in V_2 (BRRI dhan82). Fukushima (2019) also observed that tiller no. can vary due to varietal differences.



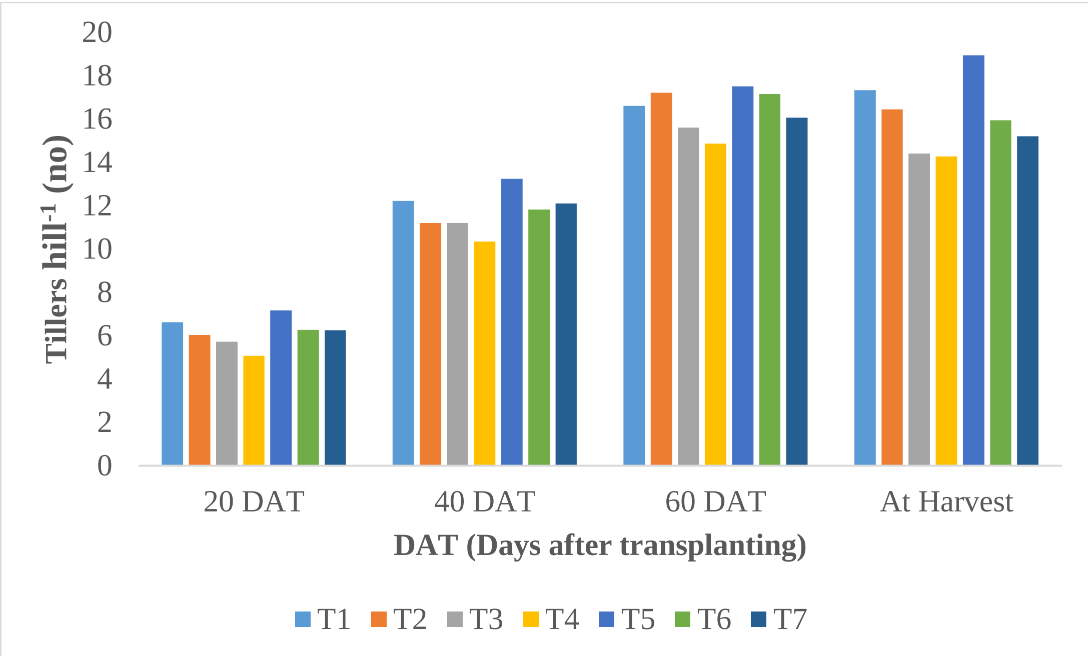
V_1= BRRI dhan48; V_2= BRRI dhan82

Figure 3. Effect of variety on tillers hill^{-1} of aus rice at 20, 40, 60 DAT and harvest (LSD $_{0.05}$=0.48, 1.54, 0.88 and 1.68, respectively).

4.1.2.2 Effect of fertilizer management

Different fertilizer management showed different no. of tillers hill^{-1} which varied significantly (Fig. 4). It was observed at 20 DAT, the highest no. of tillers was observed from T_5 (Poultry manure @ 10 t ha^{-1} + 50% RDF) (7.17) which was statistically similar to T_1 (6.63), whereas lowest value was found from T_4 (Compost @5 t ha^{-1}) (5.08), which was followed by T_3 (5.73). It was found at 40

DAT the highest no. of tillers was observed from T_5 (Poultry manure @10 t ha^{-1} + 100% RDF) (13.24).whereas lowest value was found from T_4 (Compost @5 t ha^{-1})(10.33). It was observed at 60 DAT the highest no. of tillers was observed from T_5 (Poultry manure @10 t ha^{-1} + 50% RDF) (17.51) which was statistically similar to T_2, T_6, T_1 and T_7 and value was (17.22, 17.16, 16.61 and 16.07) respectively, whereas lowest value was found from T_4 (Compost @5 t ha^{-1}) (14.87) which was followed by T_3 (15.61) and T_7 (16.07).It was revealed at harvest the highest no. of tillers was observed from T_5 (Poultry manure@ 10 t ha^{-1} + 50% RDF) (18.94). Whereas the lowest value was found from T_4 (Compost @ 5 t ha^{-1}) (14.28) that was statistically similar with T_3 (14.41) and T_7 (15.21). Roy *et al.* (2016) reported that integrated fertilizer management effect the no. of tillers hill^{-1}.



T_1= 100% RDF (148-52-74NPK kg ha^{-1}); T_2= Poultry manure @ 10 t ha^{-1}; T_3= Vermicompost @ 4 t ha^{-1}; T_4= Compost @ 5 t ha^{-1}**;** T_5= Poultry manure @ 10 t ha^{-1} + 50% RDF**;** T_6= Vermicompost @ 4 t ha^{-1}+50% RDF; T_7=Compost @ 5 t ha^{-1} + 50% RDF

Figure 4. Effect of fertilizer management on tillers hill^{-1} of aus rice at 20, 40, 60 DAT and at harvest ($LSD_{0.05}$= 0.73, 0.78, 1.65 and 1.29, respectively).

4.1.2.3 Combined effect of variety and fertilizer management

Combined effect of variety and fertilizer management showed significant differences in tillers number hill^{-1} (Table 3). Data revealed that the highest tillers number hill^{-1} (8.01, 14.89, 20.06 and 21.04) at 20, 40, 60 DAT and at harvest, respectively) was scored by V_1T_5 (BRRI dhan48 and Poultry manure + 50% RDF) which was statistically similar with V_1T_1 (18.22) at 60 DAT. The lowest tillers number hill^{-1} (4.60, 14.89, 13.93 and 12.78) at 20, 40, 60 DAT and harvest respectively) were found from treatment combination V_2T_4 (BRRI dhan82 and Compost @ 5 t ha^{-1}), which was statistically similar with V_1T_4 (5.56) at 20 DAT; with V_2T_2 (9.85) at 40 DAT; with V_2T_5 (14.96), V_2T_1 (14.99),V_2T_3 (15.04), V_1T_7 (15.74) , V_1T_4 (15.82) and V_1T_3 (16.18), respectively at 60 DAT; with V_1T_7 (14.00), V_2T_3 (14.05), V_2T_2 (14.11) and V_1T_3 (14.78) at harvest. Hossaen *et al.* (2011) observed that tillers number hill^{-1} is affected due to combined effect of variety and different dose of integrated fertilizer management. This might be due to optimum accessibility of the required nutrients (Brahmachari *et al.*, 2011). Furthermore, fertile tillering also depends primarily upon soil physical conditions that were superior due to addition of poultry manure.

Table 3. Combined effect of varieties and fertilizer management on tillers hill^{-1} (No.) of Aus rice at 20, 40, 60 DAT and at harvest.

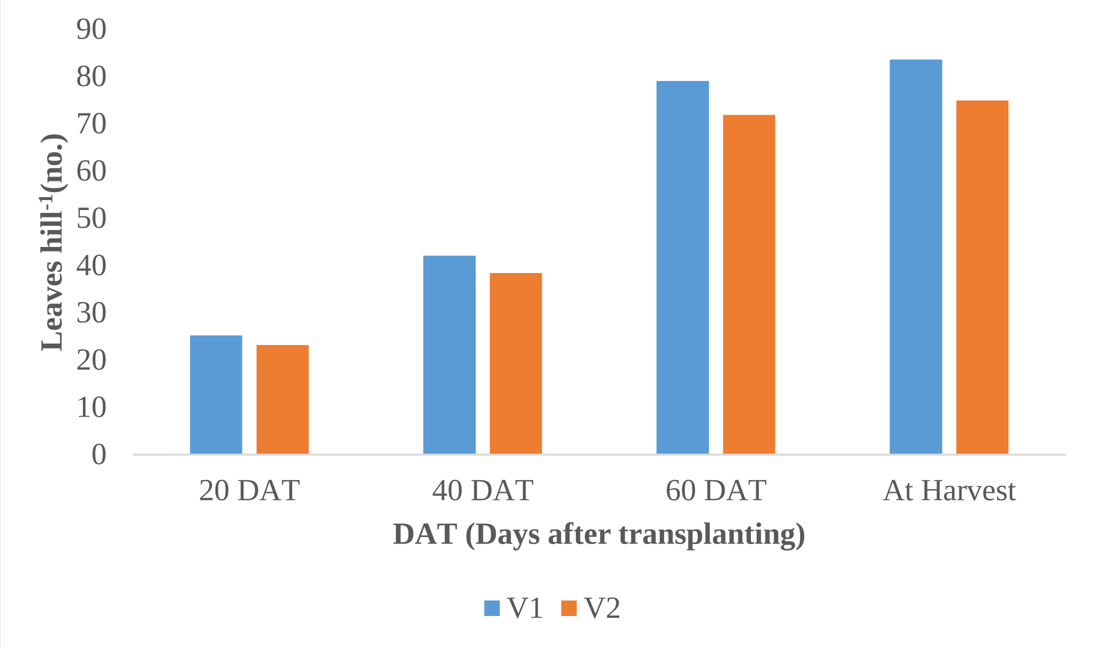
Treatments	Tillers hill^{-1} (No.)			
	20DAT	40DAT	60DAT	At harvest
V_1T_1	6.82 b	12.78 b	18.22 ab	19.11 b
V_1T_2	6.08 bc	12.54 bc	17.04 b-d	18.78 b
V_1T_3	5.82 bc	11.82 bc	16.18 b-e	14.78 de
V_1T_4	5.56 cd	11.92 bc	15.82 c-e	15.78 c-e
V_1T_5	8.01 a	14.89 a	20.06 a	21.04 a
V_1T_6	6.33 bc	11.56 cd	17.47 bc	15.55 c-e
V_1T_7	6.42 bc	12.22 bc	15.74 c-e	14 ef
V_2T_1	6.44 bc	11.67 cd	14.99 de	15.56 c-e
V_2T_2	5.99 bc	9.85 ef	17.40 bc	14.11 ef
V_2T_3	5.64 c	10.57 de	15.04 de	14.05 ef
V_2T_4	4.60 d	8.75 f	13.92 e	12.78 f
V_2T_5	6.33 bc	11.59 cd	14.96 de	16.83 c
V_2T_6	6.20 bc	12.11 bc	16.84 b-d	16.34 cd
V_2T_7	6.11 bc	12.00 bc	16.40 b-d	16.41 cd
$LSD_{(0.05)}$	1.03	1.10	2.34	1.82
CV(%)	9.88	5.56	8.44	6.72

V_1= BRRI dhan48, V_2= BRRI dhan82; T_1= 100% RDF (148-52-74NPK kg ha^{-1}); T_2= Poultry manure @ 10 t ha^{-1}; T_3= Vermicompost @ 4 t ha^{-1}; T_4= Compost @ 5 t ha^{-1}; T_5= Poultry manure @ 10 t ha^{-1} + 50% RDF; T_6= Vermicompost @ 4 t ha^{-1}+50% RDF; T_7=Compost @ 5 t ha^{-1} + 50% RDF

4.1.3 Leaves hill^{-1}

4.1.3.1 Effect of variety

Significant variations were observed in number of leaves hill^{-1} study as influenced due to variety of aus rice (Figure 5). Results showed that at 20, 40, 60 DAT and harvest, the highest no. of leaves (25.22, 42.09, 79.06 and 83.61 respectively) was observed in V_1 (BRRI dhan48) and lowest no. of leaves (23.23, 38.46, 71.93 and 74.92, respectively) was observed in V_2 (BRRI dhan82). The production of higher number of leaves per hill may be caused due to its genetical characters. Sultana *et al.* (2018) observed the significant variation in leaf numbers due to varietal differences.



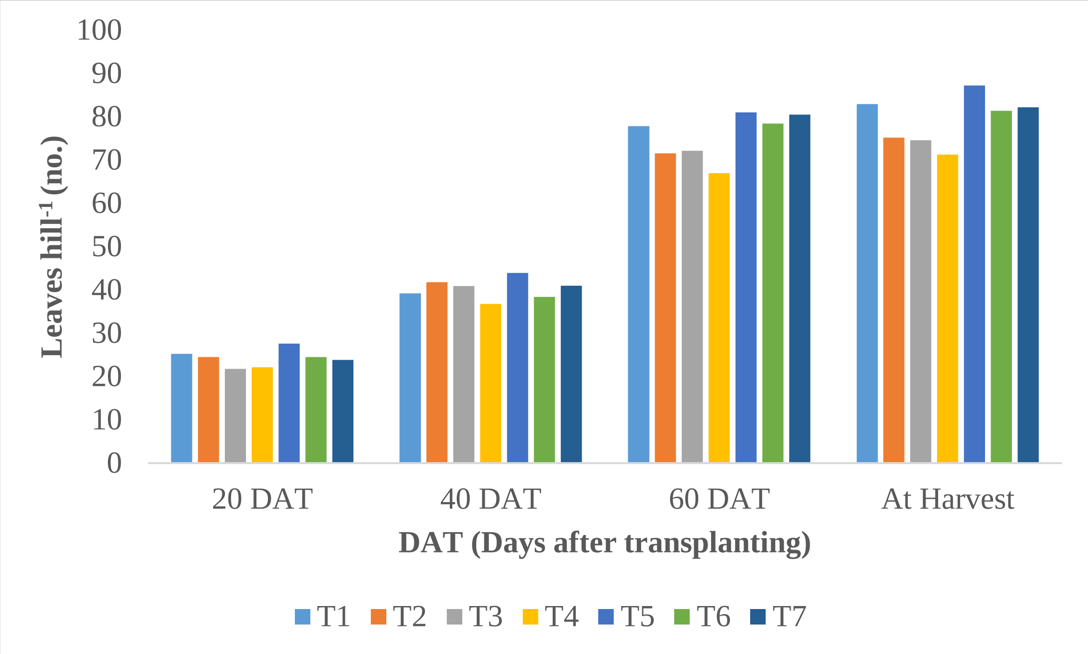
V_1= BRRI dhan48; V_2= BRRI dhan82

Figure 5. Effect of variety on leaves hill^{-1} of aus rice at 20, 40, 60 DAT and harvest ($LSD_{0.05}$= 1.64, 3.47, 10.17 and 12.78, respectively).

4.1.3.2 Effect of fertilizer management

Leaves hill^{-1} as influenced by different fertilizer management of aus rice was significant at different growth stages after transplantation (Figure 6). It was observed at 20 DAT, the highest number of leaves hill^{-1} was observed from T_5 (Poultry manure@10 t ha^{-1} + 50% RDF) (27.60), whereas the lowest value was found from T_3 (Vermicompost @4 t ha^{-1}) (21.77), which was followed by T_4 (22.14). It was found at 40 DAT the highest number of leaves hill^{-1} was observed from T_5 (Poultry manure@ 10 t ha^{-1} + 50% RDF) (43.93), which was statistically similar to T_2 (41.78), T_7 (40.97) and T_3 (40.89). Whereas the lowest value was found from T_4 (Compost @ 5 t ha^{-1}) (36.76), which was followed by T_6 (38.40) and T_1 (39.18). It was observed at 60 DAT the highest number of leaves hill^{-1} was observed from T_5 (Poultry manure + 50% RDF) (81.03) which was statistically similar to T_7 (80.50), T_6 (78.43) and T_1 (77.87) respectively. Whereas lowest value was found from T_4 (Compost) (66.96) which was followed by T_2

(71.57) and T_3 (72.12). It was revealed at harvest the highest number of leaves hill^{-1} was observed from T_5 (Poultry manure + 50% RDF) (87.23) which was statistically similar to T_1 (82.94), T_7 (82.20) and T_6 (81.39) respectively. Whereas the lowest value was found from T_4 (Compost @5 t ha^{-1}) (71.27) that was statistically similar with T_3 (74.62) and T_2 (75.20). Apon *et al.* (2018) also observed the variation in leaves no. due to integrated fertilizer management.



T_1= 100% RDF (148-52-74NPK kg ha^{-1}); T_2= Poultry manure @ 10 t ha^{-1}; T_3= Vermicompost @ 4 t ha^{-1}; T_4= Compost @ 5 t ha^{-1}; T_5= Poultry manure @ 10 t ha^{-1} + 50% RDF; T_6= Vermicompost @ 4 t ha^{-1}+50% RDF; T_7=Compost @ 5 t ha^{-1} + 50% RDF

Figure 6. Effect of fertilizer management on leaves hill^{-1} of aus rice at 20, 40, 60 DAT and harvest ($LSD_{0.05}$= 2.04, 3.13, 6.10 and 5.90, respectively).

4.1.3.3. Combined effect of variety and fertilizer management

Combined effect of variety and different fertilizer management had significantly influence on number of leaves hill^{-1} at different growth stages of aus rice (Table 4). Data revealed that the highest number of leaves hill^{-1} (29.89, 46.51, 87.27 and 95.57 at 20, 40, 60 DAT and at harvest, respectively) was scored by V_1T_5 (BRRI dhan48 and Poultry manure @10 t ha^{-1} + 50% RDF) which was statistically similar with V_1T_3 (42.55), V_1T_2 (42.47) and V_1T_7 (42.38) at 40 DAT; with V_1T_1 (82.20), V_1T_7 (80.80), V_2T_7 (80.20) and V_2T_6

(78.77) at 60 DAT. The lowest number of leaves hill^{-1} (20.62, 34.12, 60.46 and 63.78 at 20, 40, 60 DAT and at harvest respectively were found from treatment combination V_2T_4 (BRRI dhan82 and Compost @5 t ha^{-1}), which was statistically similar with V_2T_3 (21.44), V_1T_3 (22.10) and V_1T_7 (23.33) at 20 DAT; with V_2T_6 (35.25) at 40 DAT; with V_2T_3 (67.50), and V_2T_2 (68.27) at 60 DAT; with V_2T_3 (70.80) at harvest.

Table 4. Combined effect of variety and fertilizer management on leaves hill^{-1} of aus rice at 20, 40, 60 DAT and harvest.

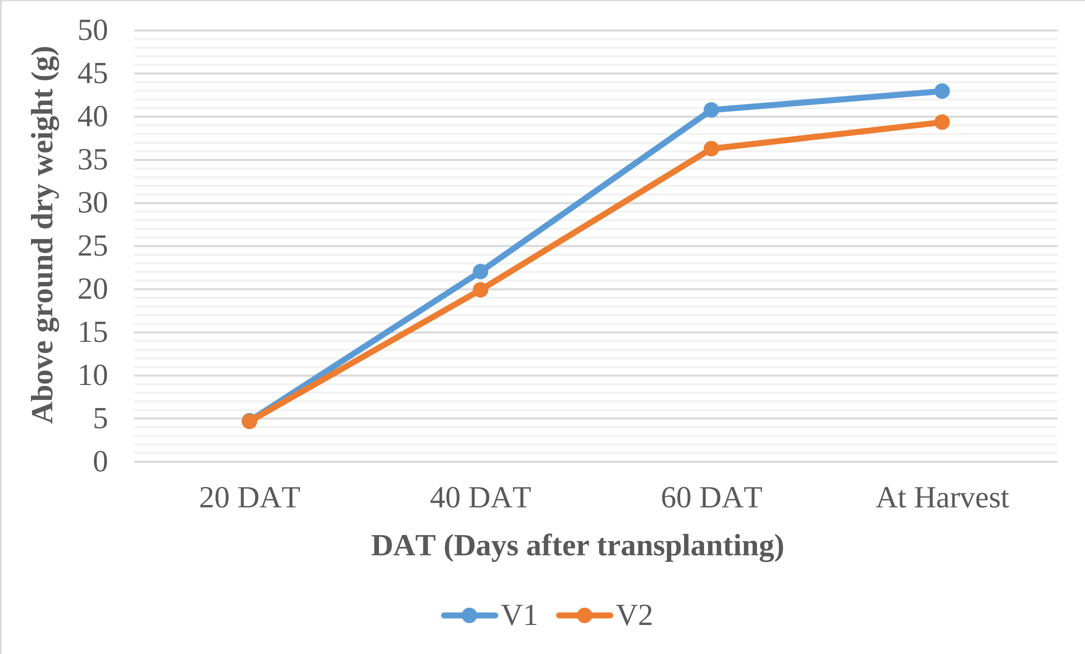
Treatments	Leaves hill^{-1} (No.)			
	20DAT	**40DAT**	**60DAT**	**At harvest**
V_1T_1	26.88 b	39.73 b	82.20 ab	85.83 b
V_1T_2	25.52 bc	42.47 ab	74.87 b-e	77.8 b-e
V_1T_3	22.10 d-f	42.55 ab	76.73 b-d	78.43 b-e
V_1T_4	23.65 c-e	39.40 bc	73.47 c-e	78.78 b-e
V_1T_5	29.89 a	46.51 a	87.27 a	95.57 a
V_1T_6	25.18 bc	41.56 b	78.10 bc	85.54 bc
V_1T_7	23.33 c-f	42.38 ab	80.80 a-c	83.32 bc
V_2T_1	23.54 c-e	38.63 bc	73.53 c-e	80.05 b-d
V_2T_2	23.50 c-f	41.10 b	68.27 d-f	72.60 de
V_2T_3	21.44 ef	39.22 bc	67.50 ef	70.80 ef
V_2T_4	20.62 f	34.12 d	60.46 f	63.77 f
V_2T_5	25.30 bc	41.36 b	74.80 b-e	78.90 b-e
V_2T_6	23.84 c-e	35.25 cd	78.77 a-c	77.24 c-e
V_2T_7	24.33 b-d	39.56 bc	80.20 a-c	81.08 bc
$LSD_{(0.05)}$	2.88	4.42	8.63	8.34
CV(%)	7.05	6.52	6.78	6.24

V_1= BRRI dhan48, V_2= BRRI dhan82; T_1= 100% RDF (148-52-74NPK kg ha^{-1}); T_2= Poultry manure @ 10 t ha^{-1}; T_3= Vermicompost @ 4 t ha^{-1}; T_4= Compost @ 5 t ha^{-1}**;** T_5= Poultry manure @ 10 t ha^{-1} + 50% RDF**;** T_6= Vermicompost @ 4 t ha^{-1}+50% RDF; T_7=Compost @ 5 t ha^{-1} + 50% RDF

4.1.4 Above ground dry weight (AGDW) plant^{-1}

4.1.4.1 Effect of variety

The Significant variations were observed in 40, 60 DAT and at harvest in above ground dry weight plant^{-1} (g) of this study as influenced due to variety of aus rice (Fig. 7). Results showed that at 20, 40, 60 DAT and harvest, the highest above ground dry weight (4.74, 22.04, 40.77 and 42.21g, respectively) was observed in V_1 (BRRI dhan48) and lowest above ground dry weight (4.68, 19.91, 36.29 and 39.36g, respectively) was observed in V_2 (BRRI dhan82).



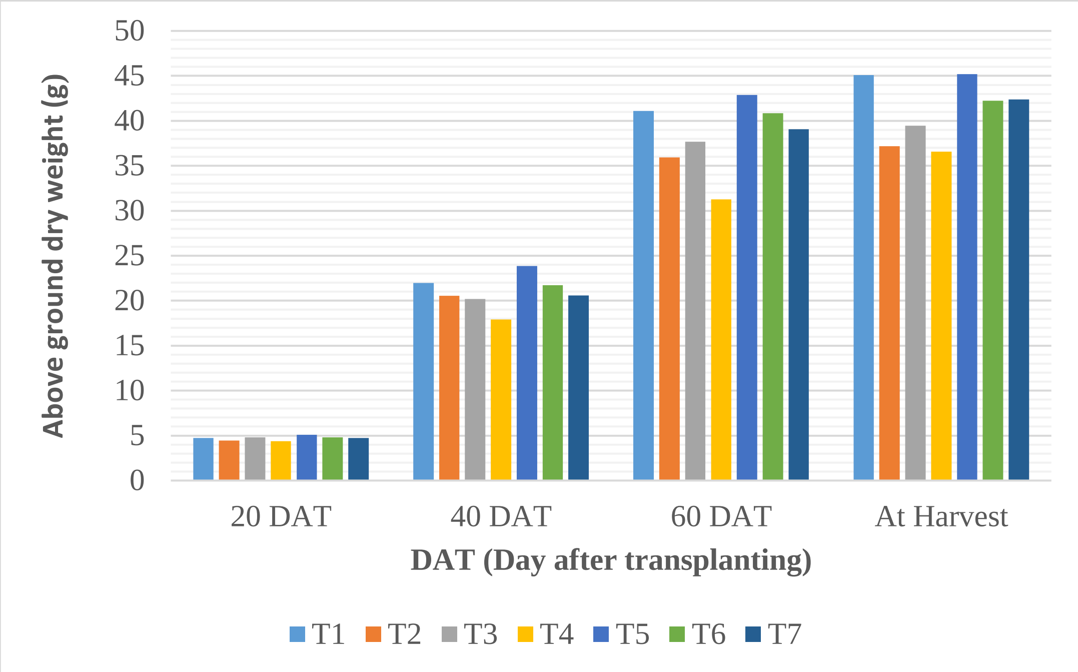
V_1= BRRI dhan48; V_2= BRRI dhan82

Figure 7. Effect of variety on dry weight plant^{-1} of aus rice at 20, 40, 60 DAT and at harvest ($LSD_{0.05}$= 0.61, 1.88, 3.64 and 3.33, respectively).

4.1.4.2 Effect of fertilizer management

Above ground dry weight plant^{-1} vary significantly due to different fertilizer management (Fig. 8).It was observed at 20 DAT the highest above ground dry weight was observed from T_5 (Poultry manure @10 t ha^{-1} + 50% RDF) (5.08g) which was statistically similar to T_3, T_6, T_1, T_7 and value was (4.81g, 4.79g, 4.75g, 4.73g) respectively whereas lowest value was found from T_4 (Compost @ 5 t ha^{-1}) (4.37g).It was found at 40 DAT the highest above ground dry matter weight was observed from T_5 (Poultry manure @10 t ha^{-1} + 50% RDF) (23.87g) which was statistically similar to T_1 and value was (21.98g) respectively whereas lowest value was found from T_4 (Compost @ 5 t ha^{-1}) (17.90 g). It was observed at 60 DAT the highest dry matter weight was observed from T_5 (Poultry manure @10 t ha^{-1}+ 50% RDF) (42.87g) which was statistically similar to T_1 and value was (41.10g) respectively whereas lowest value was found from T_4 (Compost @

5 t ha^{-1}) (31.27 g).It was revealed at harvest the highest above ground dry matter weight was observed from T_5 (Poultry manure @10 t ha^{-1} + 50% RDF) (45.20g) which was statistically similar to T_1 and value was (45.08g) respectively whereas lowest value was found from T_4 (Compost @ 5 t ha^{-1}) (36.56 g) that was statistically similar with T_2.



T_1= 100% RDF (148-52-74NPK kg ha^{-1}); T_2= Poultry manure @ 10 t ha^{-1}; T_3= Vermicompost @ 4 t ha^{-1}; T_4= Compost @ 5 t ha^{-1}; T_5= Poultry manure @ 10 t ha^{-1} + 50% RDF; T_6= Vermicompost @ 4 t ha^{-1}+50% RDF; T_7=Compost @ 5 t ha^{-1} + 50% RDF

Figure 8. Effect of fertilizer management on above ground dry weight plant^{-1} of aus rice at 20, 40, 60 DAT and harvest ($LSD_{0.05}$= 0.55, 2.12, 3.70 and 4.00, respectively).

4.1.4.3 Combined effect of variety and fertilizer management

Combined effect of variety and different fertilizer management had significantly influence on above ground dry weight plant^{-1} at different growth stages of aus rice (Table 5). Data revealed that the maximum above ground dry weight plant^{-1} (5.33, 26.18, 45.7 and 48.11g at 20, 40, 60 DAT and at harvest) respectively was scored by V_1T_5 (BRRI dhan48 and Poultry manure @ 10 t ha^{-1} + 50% RDF) which was statistically similar withV_1T_1, V_1T_3, V_1T_6, V_1T_7, V_2T_1, V_2T_3, V_2T_5, V_2T_6 and V_2T_7 at 20 DAT; with V_1T_1 at 40 DAT; with V_1T_1, V_1T_6, V_1T_7 and

V_2T_1 and V_2T_5 at 60 DAT and with V_1T_1 V_1T_6, V_1T_7 and V_2T_1 at harvest. The minimum above ground dry matter weight plant^{-1} (4.34, 15.92, 25.73 and 33.69g at 20, 40, 60 DAT and harvest respectively) were found from treatment combination V_2T_4 (BRRI dhan82 and compost @5 t ha^{-1}) which was statistically similar with V_1T_2, V_1T_4 and V_2T_2 at 20 DAT; with V_1T_2, V_1T_4, V_2T_2 and V_2T_3 at harvest.

Organic manures are slow releasing N source found beneficial during subsequent stages of crop, which might have resulted in increasing the total dry matter. Similar results were reported by Usman *et al.* (2003).

Table 5. Combined effect of varieties and fertilizer management on above ground dry weight plant^{-1} of aus rice at 20, 40, 60 DAT and at harvest.

Treatments	Above ground dry weight plant^{-1} (g)			
	20 DAT	**40 DAT**	**60 DAT**	**At harvest**
V_1T_1	4.84 ab	23.69 ab	43.23 ab	46.47 ab
V_1T_2	4.50 b	20.75 bc	37.54 c-e	38.80 c-f
V_1T_3	4.63 ab	20.72 bc	38.77 b-e	41.34 b-d
V_1T_4	4.39 b	19.87 c	36.80 de	39.43 c-f
V_1T_5	5.33 a	26.18 a	45.70 a	48.10 a
V_1T_6	4.77 ab	21.60 bc	42.39 a-c	43.94 a-c
V_1T_7	4.72 ab	21.47 bc	40.94 a-d	42.60 a-d
V_2T_1	4.66 ab	20.27 c	40.76 a-d	43.70 a-c
V_2T_2	4.39 b	20.32 c	34.37 e	35.53 ef
V_2T_3	4.99 ab	19.68 c	36.60 de	37.60 d-f
V_2T_4	4.34 b	15.92 d	25.73 f	33.69 f
V_2T_5	4.82 ab	21.55 bc	40.04 b-d	42.29 b-d
V_2T_6	4.81 ab	21.87 bc	39.30 b-e	40.52 c-e
V_2T_7	4.75 ab	19.73 c	37.20 c-e	42.17 b-d
$LSD_{(0.05)}$	0.78	2.99	5.23	5.66
CV (%)	9.87	8.46	8.05	8.16

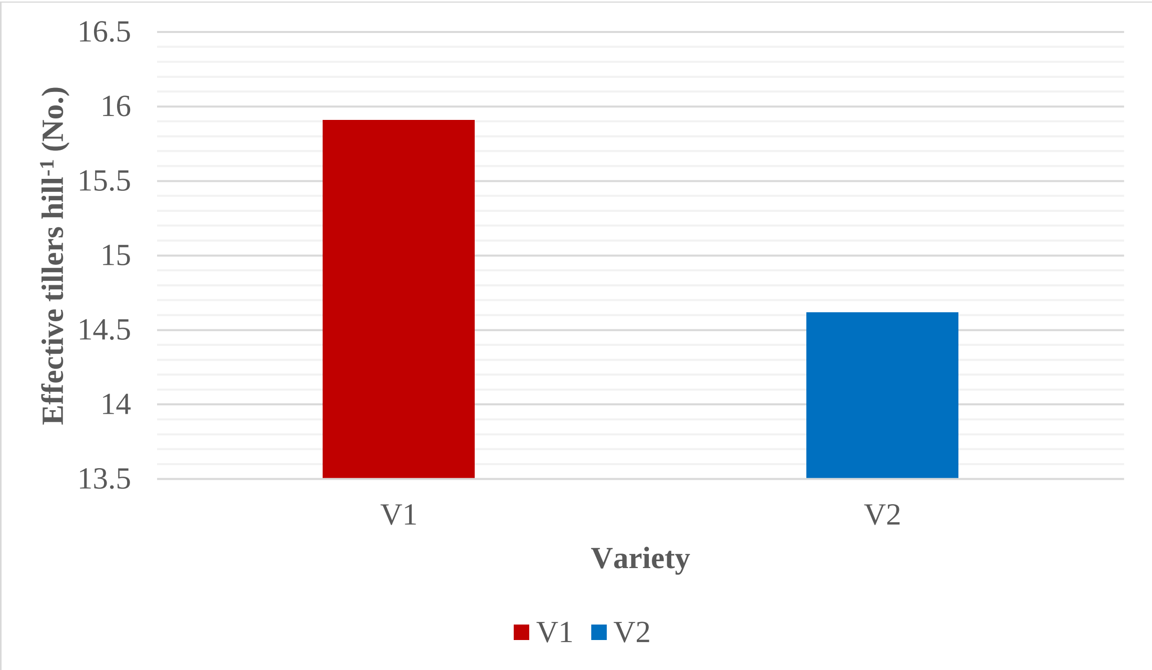
V_1= BRRI dhan48, V_2= BRRI dhan82; T_1= 100% RDF (148-52-74NPK kg ha^{-1}); T_2= Poultry manure @ 10 t ha^{-1}; T_3= Vermicompost @ 4 t ha^{-1}; T_4= Compost @ 5 t ha^{-1}; T_5= Poultry manure @ 10 t ha^{-1} + 50% RDF; T_6= Vermicompost @ 4 t ha^{-1}+50% RDF; T_7=Compost @ 5 t ha^{-1} + 50% RDF

4.2 Yield characters of Aus Rice

4.2.1 Effective tillers hill^{-1}

4.2.1.1 Effect of variety

Number of effective tillers hill^{-1} of aus rice varied significantly due to variation of different rice varieties (Fig. 9). The highest number of effective tillers hill^{-1} (15.91) was found from V_1 (BRRI dhan48), whereas the lowest number (14.62) was observed from V_2 (BRRI dhan82). Ali *et al*. (2018) observed the effect of variety on effective tillers of rice.



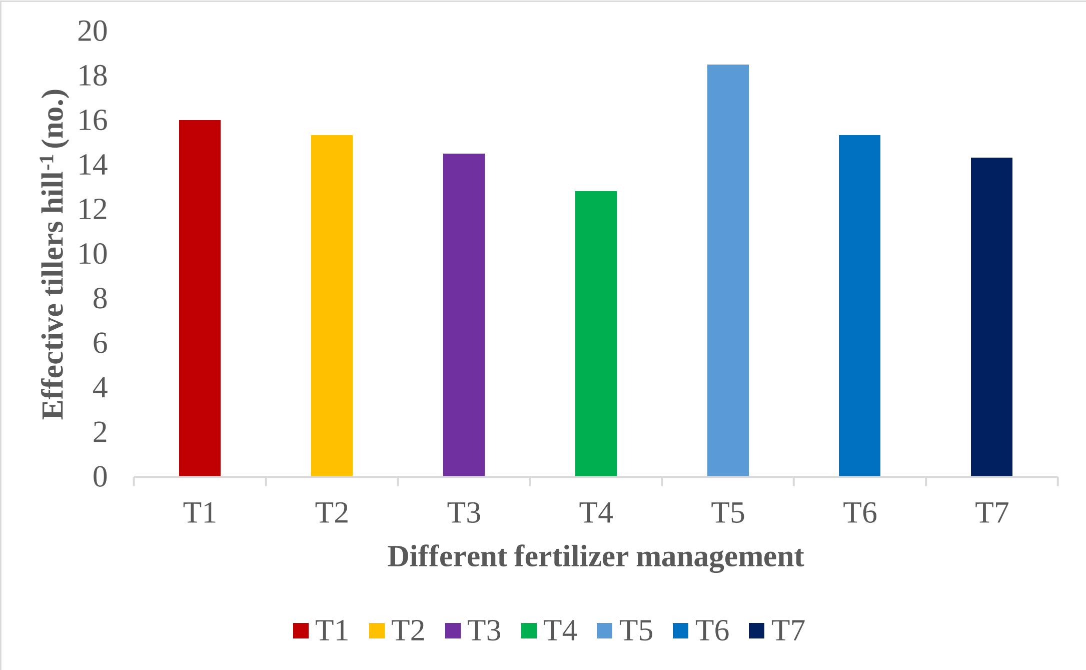
V_1= BRRI dhan48; V_2= BRRI dhan82

Figure 9. Effect of variety on Effective tillers hill^{-1} at harvest ($LSD_{0.05}$= 1.06).

4.2.1.2 Effect of fertilizer management

Different levels of integrated fertilizer management showed significant variations in terms of effective tillers hill^{-1} of aus rice (Fig. 10). The highest number of effective tillers hill^{-1} (16.26) was recorded from T_5 (Poultry manure @10 t ha^{-1} + 50% RDF), while the lowest number recorded (12.83) from T_4

(Compost @ 5 t ha^{-1}). Hossaen *et al.* (2011) observed the significant variations in effective tillers number with fertilizer managements.



T_1= 100% RDF (148-52-74NPK kg ha^{-1}); T_2= Poultry manure @ 10 t ha^{-1}; T_3= Vermicompost @ 4 t ha^{-1}; T_4= Compost @ 5 t ha^{-1}**;** T_5= Poultry manure @ 10 t ha^{-1} + 50% RDF**;** T_6= Vermicompost @ 4 t ha^{-1}+50% RDF; T_7=Compost @ 5 t ha^{-1} + 50% RDF

Figure 10. Effect of fertilizer management on Effective tillers hill^{-1} of aus rice at harvest ($LSD_{0.05}$= 1.05).

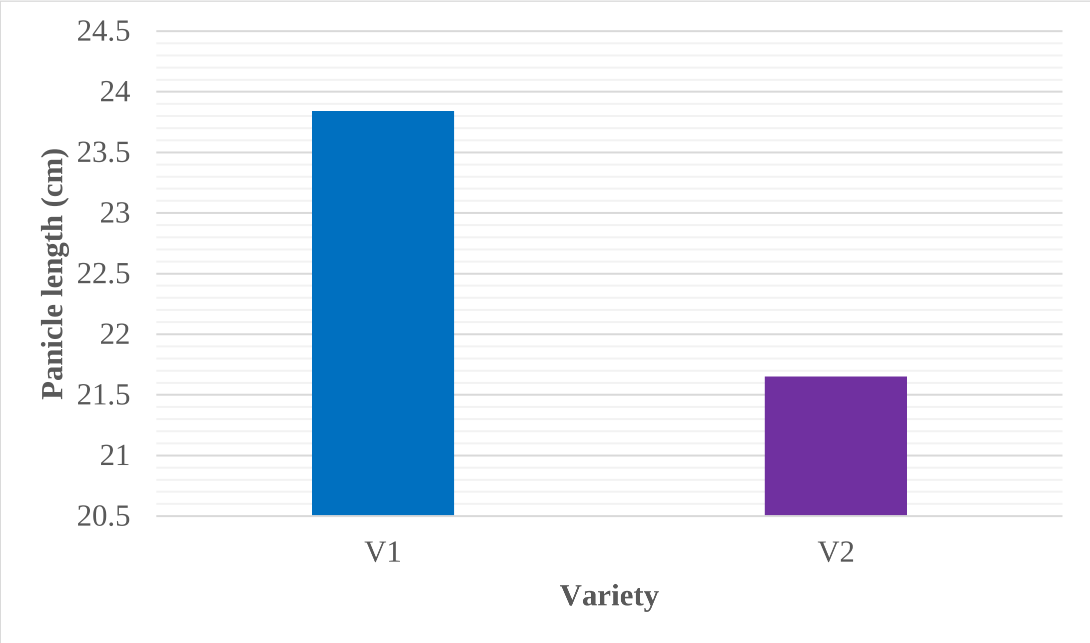
4.2.1.3 Combined effect of variety and fertilizer management

Statistically significant variation was recorded on number of effective tillers hill^{-1} of aus rice due to the combined effect of rice varieties and different levels of integrated fertilizer management (Table 6). The highest number of effective tillers hill^{-1} (20.00) was found from V_1T_5 (BRRI dhan48 and Poultry manure @10 t ha^{-1} + 50 % RDF) and the lowest number (9.78) was found from V_2T_4 (BRRI dhan82 and Compost @ 5 t ha^{-1}). This might be due to optimum accessibility of the required nutrients. Furthermore, effective tillering also depends primarily upon soil physical conditions that were superior due to addition of poultry manure (Usman *et al.*, 2003).

4.2.2 Panicle length

4.2.2.1 Effect of variety

Panicle length of aus rice varied significantly due to different rice varieties (Fig. 11). The longest panicle (23.84 cm) was recorded from V_1 (BRRI dhan48), whereas the shortest panicle (21.65 cm) was found from V_2 (BRRI dhan82). Arif *et al*. (2014) also observed the effect of variety on panicle length of rice.

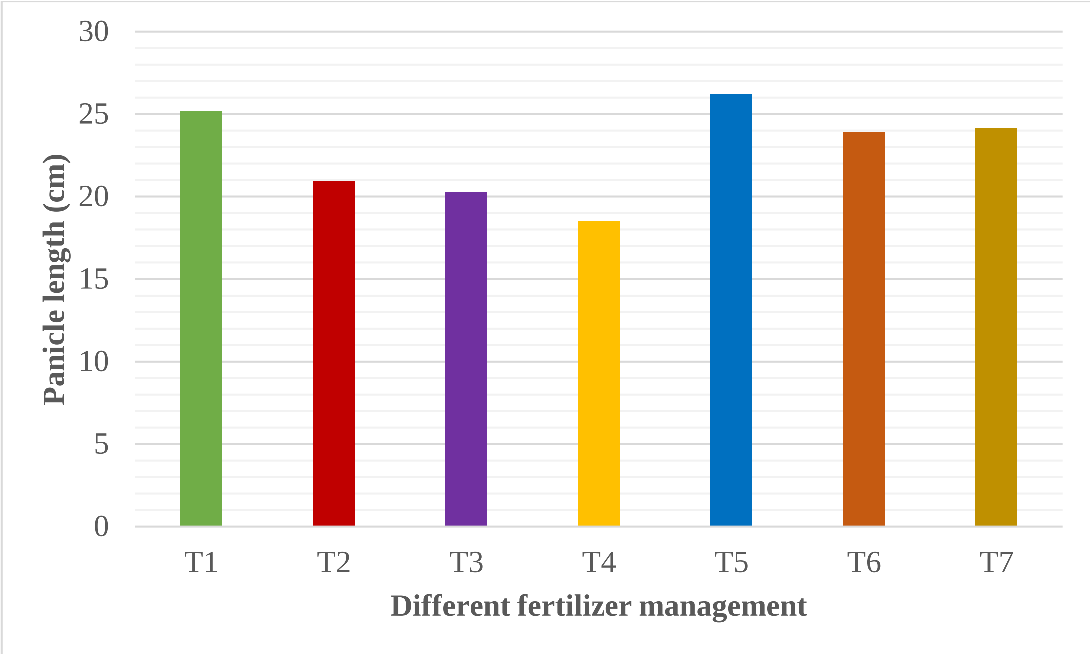


V_1= BRRI dhan48; V_2= BRRI dhan82

Figure 11. Effect of variety on panicle length at harvest ($LSD_{0.05}$= 2.17).

4.2.2.2 Effect of fertilizer management

Different levels of integrated fertilizer management showed statistically significant differences in terms of panicle length of scented rice (Fig. 12). The longest panicle (26.23 cm) was observed from T_5 (Poultry manure @10 t ha^{-1} + 50% RDF) that was followed by panicle length (25.18 cm) from T_1. The shortest panicle (18.54 cm) was found from T_4 (Compost @ 5 t ha^{-1}). Islam *et al.* (2013) found variation in panicle length for different fertilizer management.



T_1= 100% RDF (148-52-74NPK kg ha^{-1}); T_2= Poultry manure @ 10 t ha^{-1}; T_3= Vermicompost @ 4 t ha^{-1}; T_4= Compost @ 5 t ha^{-1}**;** T_5= Poultry manure @ 10 t ha^{-1} + 50% RDF**;** T_6= Vermicompost @ 4 t ha^{-1}+50% RDF; T_7=Compost @ 5 t ha^{-1} + 50% RDF

Figure 12. Effect of fertilizer management on panicle length (cm) of Aus rice at harvest (LSD$_{0.05}$= 1.45).

4.2.2.3 Combined effect of variety and fertilizer management

Statistically significant variation was recorded on panicle length of aus rice due to the combined effect of rice varieties and different levels of integrated fertilizer management (Table 6). The longest panicle (27.94 cm) was observed from V_1T_5 (BRRI dhan48 and Poultry manure @10 t ha^{-1} + 50% RDF) and the lowest number (16.38 cm) was found from V_2T_4 (BRRI dhan82 and Compost @5 t ha^{-1}). Increase in panicle length in response to combined use of organic and inorganic fertilizers is might be due to more availability of macro as well as micro nutrients (Babu *et al.*, 2001).

Table 6. Combined effect of varieties and fertilizer management on effective tillers hill^{-1} and Panicle length of aus rice

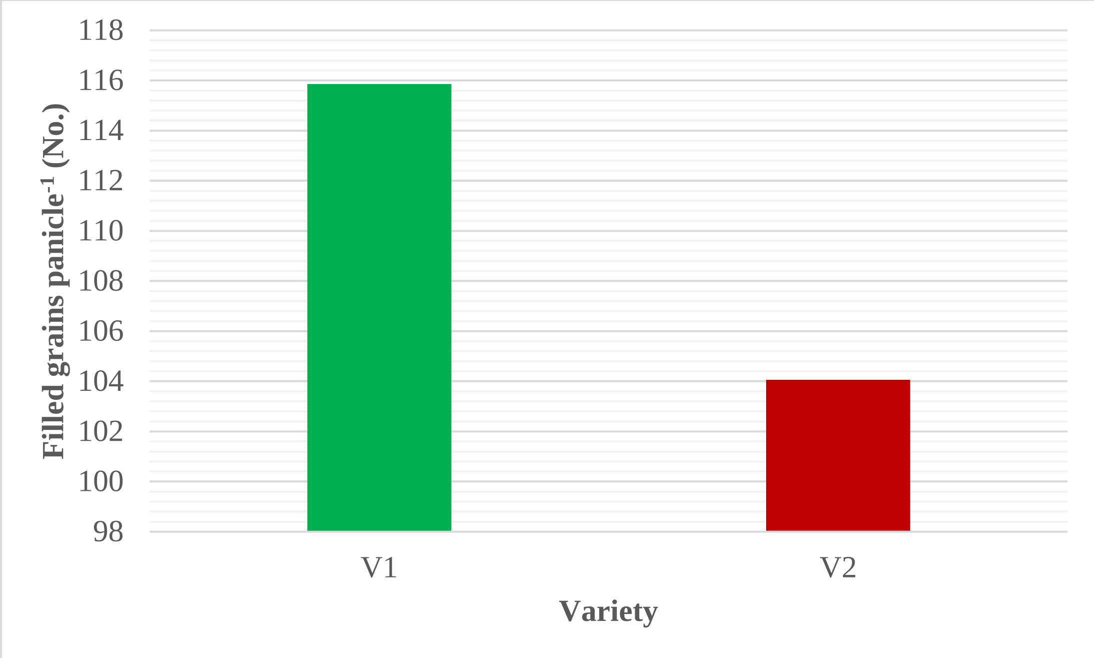
Treatments	Effective tillers hill^{-1} (No.)	Panicle length (cm)
V_1T_1	17.33 b	25.71 b
V_1T_2	15 cd	22.30 d-f
V_1T_3	13 e	21.57 e-g
V_1T_4	14.67 cd	20.70 f-h
V_1T_5	20 a	27.94 a
V_1T_6	15 cd	24.55 bc
V_1T_7	14.33 de	24.11 b-d
V_2T_1	14.67 cd	24.64 bc
V_2T_2	15.67 cd	19.56 gh
V_2T_3	16 bc	18.99 h
V_2T_4	11 f	16.38 i
V_2T_5	15 cd	24.51 bc
V_2T_6	15.67 cd	23.31 c-e
V_2T_7	14.33 de	24.17 b-d
$LSD_{(0.05)}$	1.49	2.05
CV (%)	5.79	5.36

V_1= BRRI dhan48, V_2= BRRI dhan82; T_1= 100% RDF (148-52-74NPK kg ha^{-1}); T_2= Poultry manure @ 10 t ha^{-1}; T_3= Vermicompost @ 4 t ha^{-1}; T_4= Compost @ 5 t ha^{-1}; T_5= Poultry manure @ 10 t ha^{-1} + 50% RDF; T_6= Vermicompost @ 4 t ha^{-1}+50% RDF; T_7=Compost @ 5 t ha^{-1} + 50% RDF

4.2.3 Filled grains panicle^{-1}

4.2.3.1 Effect of variety

Different rice varieties varied significantly in terms of filled grains panicle^{-1} of aus rice (Fig. 13). The highest number of filled grains panicle^{-1} (115.86) was observed from V_1 (BRRI dhan48), whereas the lowest number (104.05) was recorded from V_2 (BRRI dhan82). Hoque *et al.* (2003) also found the varietal effect on filled grains panicle^{-1}.

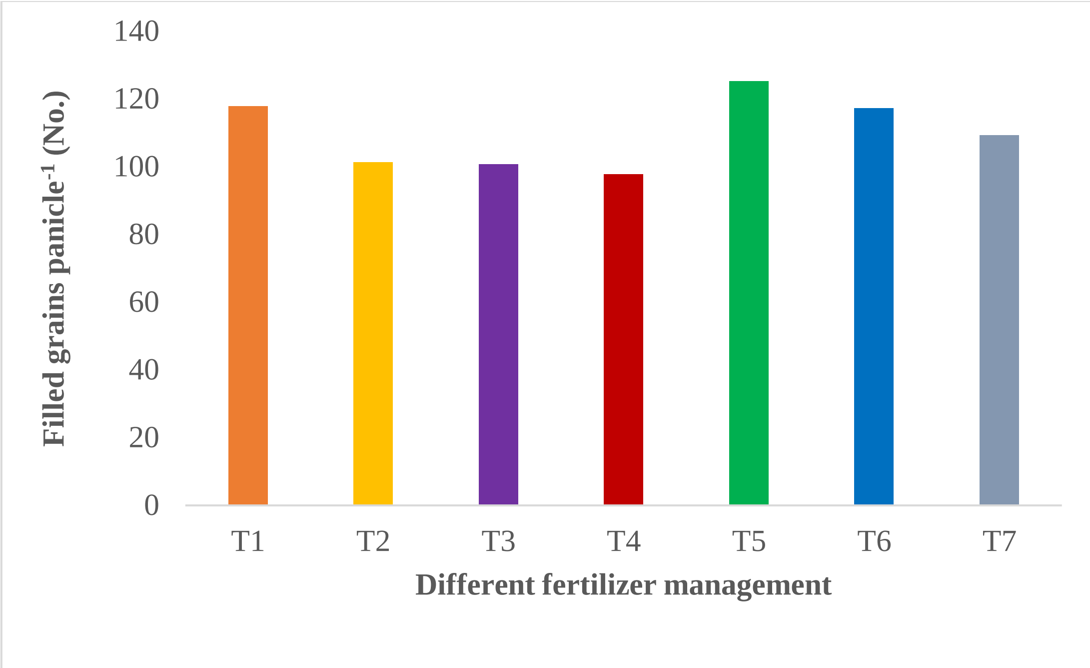


V_1= BRRI dhan48; V_2= BRRI dhan82

Figure 13. Effect of variety on filled grains panicle^{-1} at harvest ($LSD_{0.05}$= 8.92).

4.2.3.2 Effect of fertilizer management

Statistically significant variations was recorded in terms of filled grains panicle^{-1} of aus rice due to different levels of fertilizer management (Fig. 14). The highest number of filled grains panicle^{-1} (125.33) was found from T_5 (Poultry manure @10 t ha^{-1} + 50% RDF) which was followed by T_1 (117.83) and they were statistically similar, while the lowest number (97.83) was from T_4 (Compost @5 t ha^{-1}) which was followed by T_2 (Poultry manure) and T_3 (Vermicompost) (101.33 and 100.67 respectively). Arif *et al.* (2014) observed the effect of fertilizer management on filled grains panicle^{-1} in rice.



T_1= 100% RDF (148-52-74NPK kg ha^{-1}); T_2= Poultry manure @ 10 t ha^{-1}; T_3= Vermicompost @ 4 t ha^{-1}; T_4= Compost @ 5 t ha^{-1}; T_5= Poultry manure @ 10 t ha^{-1} + 50% RDF; T_6= Vermicompost @ 4 t ha^{-1}+50% RDF; T_7=Compost @ 5 t ha^{-1} + 50% RDF

Figure 14. Effect of fertilizer management on filled grains panicle^{-1} of Aus rice at harvest ($LSD_{0.05}$= 7.93).

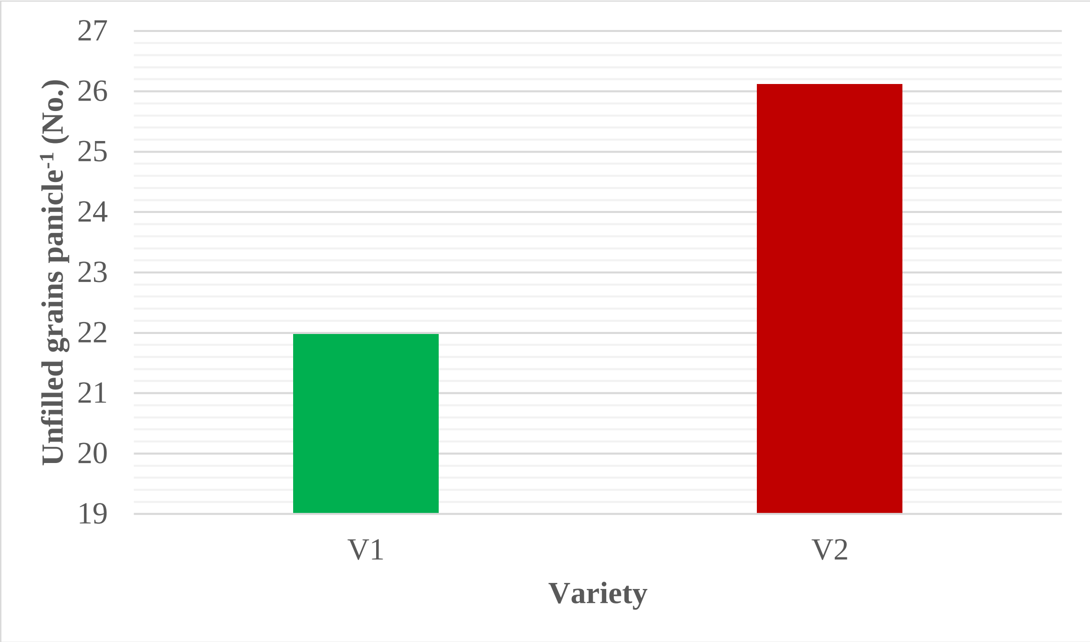
4.2.3.3 Combined effect of variety and fertilizer management

Filled grains panicle^{-1} of aus rice showed statistically significant differences due to the combined effect of rice varieties and different levels of fertilizer management (Table 7). The highest number of filled grains panicle^{-1} (139.67) was recorded from V_1T_5 (BRRI dhan48 and Poultry manure @10 t ha^{-1} + 50% RDF).The lowest number of filled grains panicle^{-1} (90.33) was found from V_2T_4 (BRRI dhan82 and compost @ 5 t ha^{-1}) that was followed by V_2T_2 and V_2T_3 (100.33 and 92.67, respectively).

4.2.4 Unfilled grains panicle^{-1}

4.2.4.1 Effect of variety

Different rice varieties varied significantly in terms of unfilled grains panicle^{-1} of aus rice (Fig. 15). The highest number of unfilled grains panicle^{-1} (26.12) was recorded from V_2 (BRRI dhan82), while the lowest number (21.98) was found from V_1 (BRRI dhan48). Hoque *et al.* (2003) also found the varietal effect on unfilled grains panicle^{-1}.

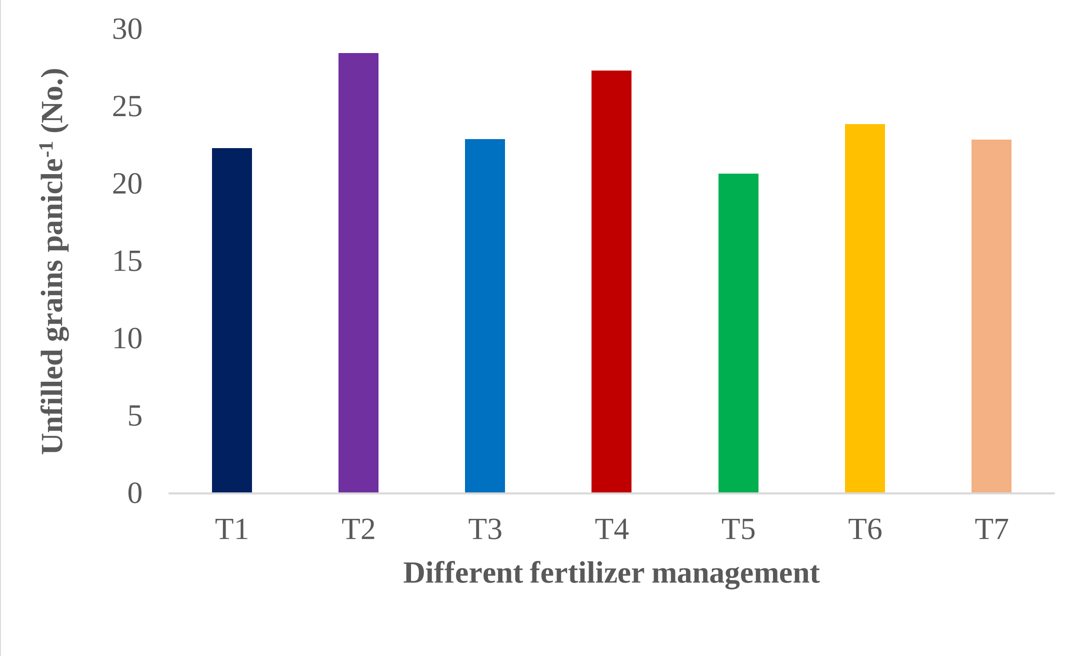


V_1= BRRI dhan48; V_2= BRRI dhan82

Figure 15. Effect of variety on unfilled grains panicle^{-1} of aus rice at harvest ($LSD_{0.05}$= 2.24).

4.2.4.2 Effect of fertilizer management

Unfilled grains panicle^{-1} of aus rice showed statistically significant variations due to different levels of fertilizer management (Fig. 16). The highest number of unfilled grains panicle^{-1} (28.45) was observed from T_2 (Poultry manure @10 t ha^{-1}) which was statistically similar (27.33) with T_4 (Compost @5 t ha^{-1}). On the other hand, the lowest number (20.66) was found from T_5 (Poultry manure@10 t ha^{-1} + 50% RDF) which was statistically similar with T_1 and T_7 (22.30 and 22.85, respectively).



T_1= 100% RDF (148-52-74NPK kg ha^{-1}); T_2= Poultry manure @ 10 t ha^{-1}; T_3= Vermicompost @ 4 t ha^{-1}; T_4= Compost @ 5 t ha^{-1}**;** T_5= Poultry manure @ 10 t ha^{-1} + 50% RDF**;** T_6= Vermicompost @ 4 t ha^{-1} + 50% RDF; T_7=Compost @ 5 t ha^{-1} + 50% RDF

Figure 16. Effect of fertilizer management on unfilled grains panicle^{-1} of aus rice at harvest ($LSD_{0.05}$= 2.24).

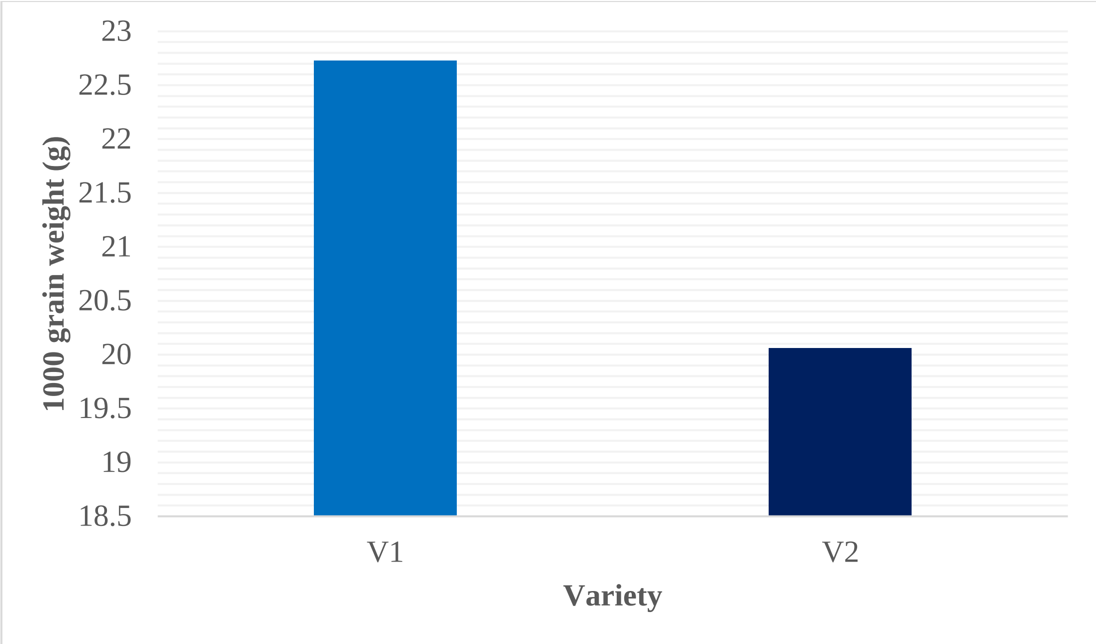
4.2.4.3 Combined effect of variety and fertilizer management

Statistically significant variation was recorded on unfilled grains panicle^{-1} of aus rice due to the combined effect of rice varieties and different levels of fertilizer management (Table 7). The highest number of unfilled grains panicle^{-1} (33.57) was observed from V_2T_4 (BRRI dhan82 and Compost @5 t ha^{-1}), whereas the lowest number (16.76) was found from V_1T_5 (BRRI dhan48 and Poultry manure @10 t ha^{-1} + 50% RDF) treatment combination that was followed by V_1T_7 and V_2T_3 (19.22 and 19.42, respectively).

4.2.5 1000-grain weight

4.2.5.1 Effect of variety

Different rice varieties varied significantly in terms of weight of 1000-grain (Fig. 17). The highest weight of 1000-grain of aus rice was recorded (22.73g) from V_1 (BRRI dhan48), whereas the lowest weight (20.96 g) from V_2 (BRRI dhan82).

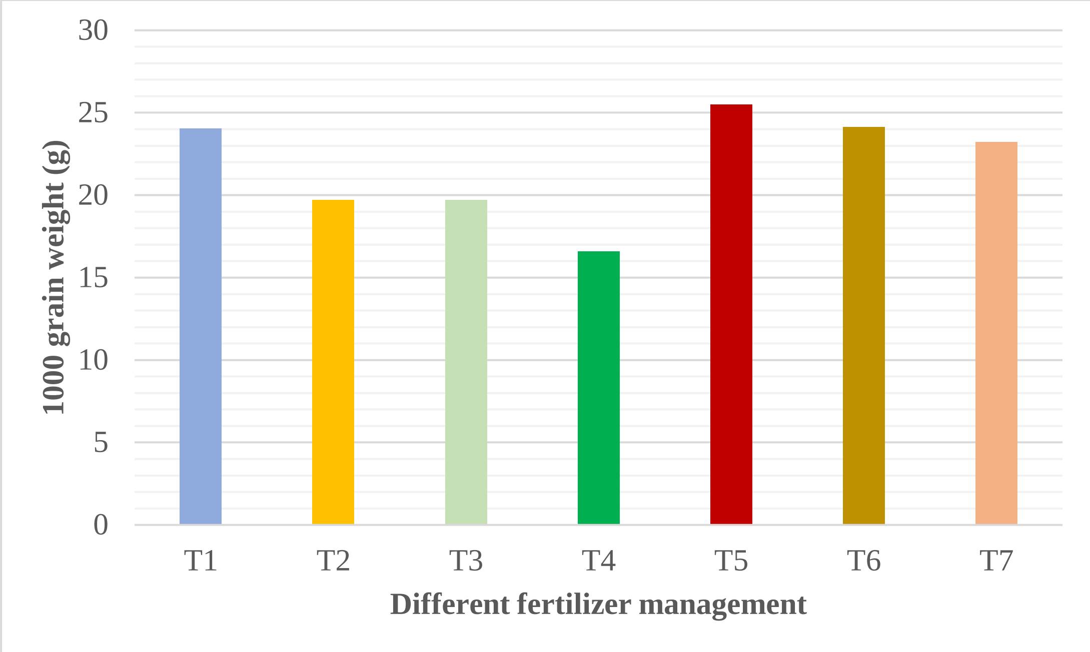


V_1= BRRI dhan48; V_2= BRRI dhan82

Figure 17. Effect of variety on 1000-grain weight at harvest ($LSD_{0.05}$= 1.75).

4.2.5.2 Effect of fertilizer management

Weight of 1000-grain of aus rice showed statistically significant variations due to different levels of fertilizer management (Fig. 18). The highest weight of 1000-grain (25.50 g) was observed from T_5 (Poultry manure @10 t ha^{-1} + 50% RDF) that was followed by T_6 and T_1 (24.13 g and 24.06 g respectively), whereas the lowest weight (16.57 g) was recorded from T_4 (Compost @5 t ha^{-1}). Islam *et al.* (2013) observed the effect of integrated fertilizer management on 1000-grains weight of rice.



T_1= 100% RDF (148-52-74NPK kg ha^{-1}); T_2= Poultry manure @ 10 t ha^{-1}; T_3= Vermicompost @ 4 t ha^{-1}; T_4= Compost @ 5 t ha^{-1}**;** T_5= Poultry manure @ 10 t ha^{-1} + 50% RDF**;** T_6= Vermicompost @ 4 t ha^{-1}+50% RDF; T_7=Compost @ 5 t ha^{-1} + 50% RDF

Figure 18. Effect of fertilizer management on 1000-grain weight of aus rice at harvest ($LSD_{0.05}$=2.26).

4.2.5.3 Combined effect of variety and fertilizer management

Statistically significant variation was recorded on weight of 1000-grain of aus rice due to the combined effect of rice varieties and different levels of fertilizer management (Table 7). The highest weight of 1000-grain (26.37 g) was observed from V_1T_5 (BRRI dhan48 and Poultry manure @10 t ha^{-1} + 50% RDF) that was statistically similar to V_1T_1, V_2T_5, V_1T_6, V_2T_6, V_2T_7 and V_2T_1 (24.81, 24.63, 24.52, 23.75, 23.43 and 23.30 respectively). The lowest weight of 1000 grain (15.12g) was found from V_2T_4 (BRRI dhan82 and Compost @ 5 t ha^{-1}) treatment combination that was followed by V_1T_4 and V_2T_2 (18.03 and 17.76 g, respectively).

Table 7. Combined effect of varieties and fertilizer management on Filled grains panicle^{-1}, Unfilled grains panicle^{-1} and 1000 grain weight of aus rice.

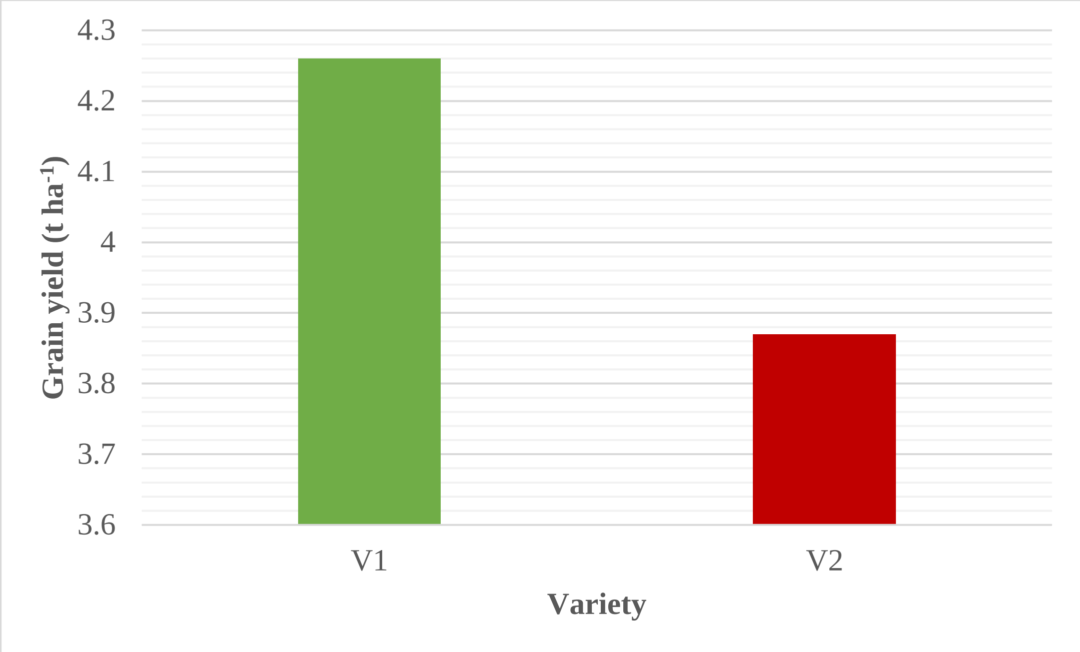
Treatments	Filled grains panicle^{-1} (No.)	Unfilled grains panicle^{-1} (No.)	1000 grain weight (g)
V_1T_1	125.33 b	20.35 f	24.81 ab
V_1T_2	102.33 ef	29.77 b	21.67 b-d
V_1T_3	108.67 c-e	26.37 cd	20.71 c-e
V_1T_4	105.33 de	21.10 ef	18.03 ef
V_1T_5	139.67 a	16.76 g	26.36 a
V_1T_6	119.00 bc	20.29 f	24.52 ab
V_1T_7	110.67 c-e	19.22 fg	23.03 bc
V_2T_1	110.33 c-e	24.25 de	23.30 a-c
V_2T_2	100.33 e-g	27.13 b-d	17.76 ef
V_2T_3	92.67 fg	19.42 fg	18.74 de
V_2T_4	90.33 g	33.57 a	15.12 f
V_2T_5	111.00 c-e	24.56 cd	24.63 ab
V_2T_6	115.67 b-d	27.44 bc	23.75 a-c
V_2T_7	108.00 c-e	26.47 c-d	23.43 a-c
$LSD_{(0.05)}$	11.21	3.17	3.2
CV (%)	6.05	7.83	8.69

V_1= BRRI dhan48, V_2= BRRI dhan82; T_1= 100% RDF (148-52-74NPK kg ha^{-1}); T_2= Poultry manure @ 10 t ha^{-1}; T_3= Vermicompost @ 4 t ha^{-1}; T_4= Compost @ 5 t ha^{-1}; T_5= Poultry manure @ 10 t ha^{-1} + 50% RDF; T_6= Vermicompost @ 4 t ha^{-1}+50% RDF; T_7=Compost @ 5 t ha^{-1} + 50% RDF

4.2.6 Grain yield

4.2.6.1 Effect of variety

Different rice varieties varied significantly in terms of grain yield of aus rice (Fig. 19). The highest grain yield (4.26 t ha^{-1}) was observed from V_1 (BRRI dhan48), while the lowest grain yield (3.87 t ha^{-1}) was recorded from V_2 (BRRI dhan48).

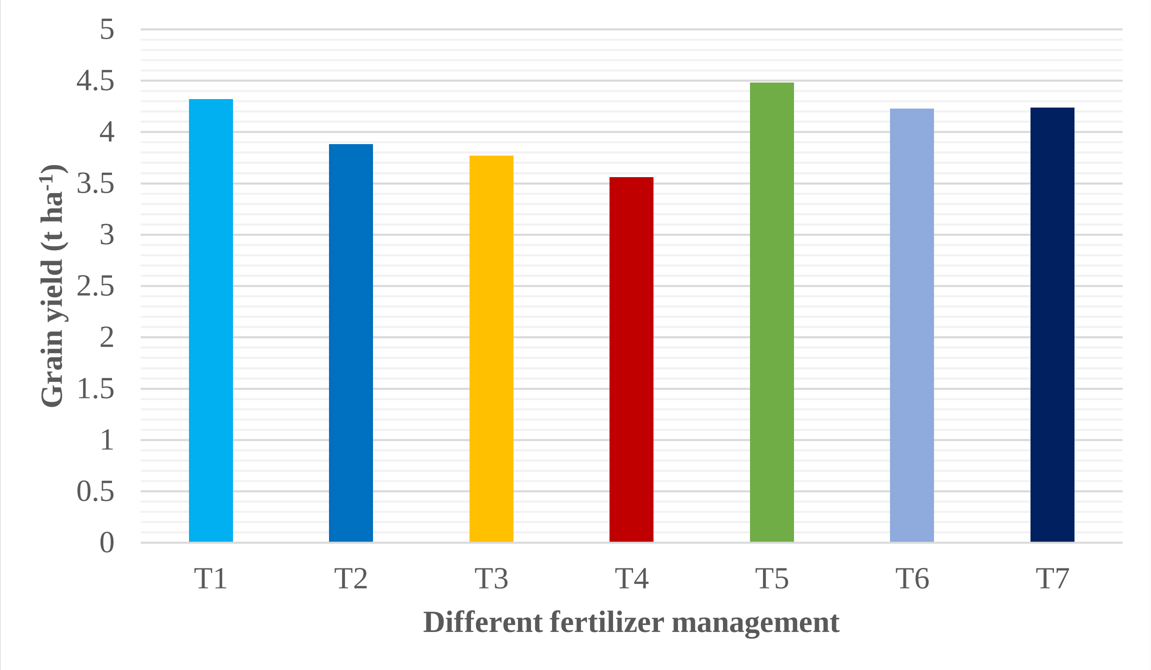


V_1= BRRI dhan48; V_2= BRRI dhan82

Figure 19. Effect of variety on grain yield of aus rice at harvest ($LSD_{0.05}$= 0.22).

4.2.6.2 Effect of fertilizer management

Statistically significant variation was recorded in terms of grain yield of aus rice due to different levels of fertilizer management (Fig. 20). The highest grain yield (4.48 t ha^{-1}) was found from T_5 (Poultry manure @10 t ha^{-1} + 50% RDF) that was followed by T_1, T7 and T_6 (4.32, 4.24 and 4.23 t ha^{-1} respectively), while the lowest grain yield (3.56 t ha^{-1}) was observed from T_4 (Compost @5 t ha^{-1}) which was statistically similar (3.77 t ha^{-1}) to T_3. Arif *et al.* (2014) also observed similar result in case of integrated fertilizer management in rice. Aasif *et al.* (2018) observed similar result in case of integrated fertilizer management where poultry manure shows better result in respect of others treatment combination in rice.



T_1= 100% RDF (148-52-74NPK kg ha^{-1}); T_2= Poultry manure @ 10 t ha^{-1}; T_3= Vermicompost @ 4 t ha^{-1}; T_4= Compost @ 5 t ha^{-1}**;** T_5= Poultry manure @ 10 t ha^{-1} + 50% RDF**;** T_6= Vermicompost @ 4 t ha^{-1}+50% RDF; T_7=Compost @ 5 t ha^{-1} + 50% RDF

Figure 20. Effect of fertilizer management on grain yield of aus rice at harvest ($LSD_{0.05}$=0.28).

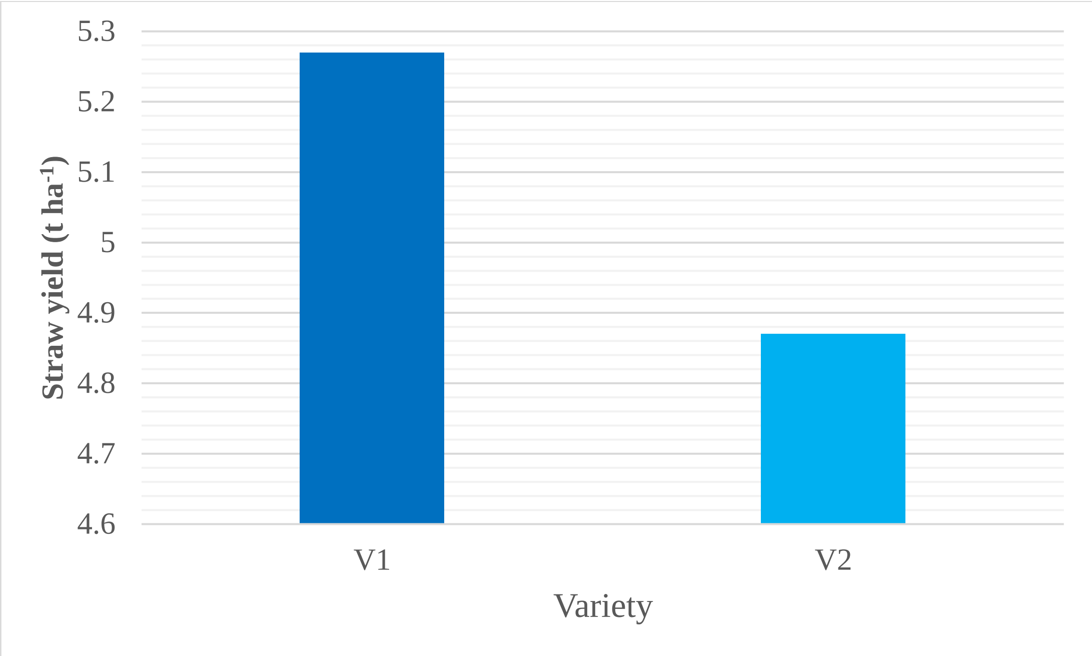
4.2.6.3 Combined effect of variety and fertilizer management

Grain yield of aus rice showed statistically significant differences due to the combined effect of aus rice varieties and different levels of fertilizer management (Table 8). The highest grain yield (4.88 t ha^{-1}) was found from V_1T_5 (BRRI dhan48 and Poultry manure @ 10 t ha^{-1} + 50% RDF) which was statistically similar to V_1T_1 (4.61 t ha^{-1}), whereas the lowest grain yield (3.35 t ha^{-1}) was recorded from V_2T_4 (BRRI dhan82 and Compost @5 t ha^{-1}) treatment combination which was statistically similar to V_2T_3 (3.70 t ha^{-1}).Organic matter provided the micro nutrients and increased the cation exchange capacity of soil thus improved nutrients availability which in combinations with inorganic fertilizers enhanced the growth and yield (Rani *et al.*, 2001). Farid *et al.* (2011) observed significant variation in grain yield for different fertilizer management in aus rice.

4.2.7 Straw yield

4.2.7.1 Effect of variety

Different rice varieties varied significantly in terms of straw yield of aus rice (Fig. 21). The highest straw yield (5.27 t ha^{-1}) was recorded from V_1 (BRRI dhan48), while the lowest straw yield (4.87 t ha^{-1}) was observed from V_2 (BRRI dhan82). Similar findings were also reported by Hassan *et al.* (2010).

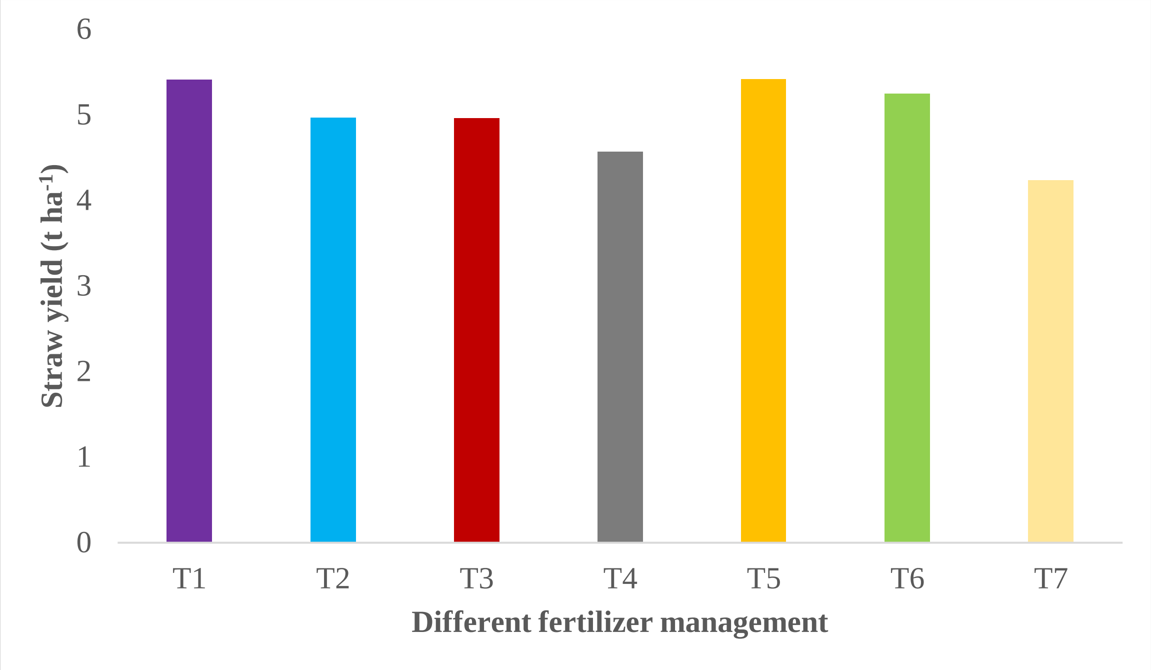


V_1= BRRI dhan48; V_2= BRRI dhan82

Figure 21. Effect of variety on straw yield of aus rice at harvest ($LSD_{0.05}$= 0.37).

4.2.7.2 Effect of fertilizer management

Straw yield of aus rice showed statistically significant variations due to different levels of integrated fertilizer management (Fig. 22). The highest straw yield (5.42 t ha^{-1}) was observed from T_5 (Poultry manure @10 t ha^{-1} + 50% RDF) which were statistically similar to T_1, T_6, T_2 and T_3 (5.41, 5.25, 4.97 and 4.96 t ha^{-1} respectively), whereas the lowest straw yield (4.57 t ha^{-1}) was recorded from T_4 (Compost) that was statistically similar to T_7, T_3 and T_2 (4.91, 4.96 and 4.97 t ha^{-1}, respectively).



T_1= 100% RDF (148-52-74NPK kg ha^{-1}); T_2= Poultry manure @ 10 t ha^{-1}; T_3= Vermicompost @ 4 t ha^{-1}; T_4= Compost @ 5 t ha^{-1}**;** T_5= Poultry manure @ 10 t ha^{-1} + 50% RDF**;** T_6= Vermicompost @ 4 t ha^{-1}+50% RDF; T_7=Compost @ 5 t ha^{-1} + 50% RDF

Figure 22. Effect of fertilizer management on straw yield of aus rice at harvest ($LSD_{0.05}$= 0.47).

4.2.7.3 Combined effect of variety and fertilizer management

Statistically significant variation was recorded on straw yield of aus rice due to the combined effect of rice varieties and different levels of integrated fertilizer management (Table 8). The highest straw yield (5.93 t ha^{-1}) was recorded from V_1T_5 (BRRI dhan48 and Poultry manure @10 t ha^{-1} + 50% RDF) which were statistically similar to V_1T_1 and V_1T_6 (5.82 t ha^{-1} and 5.55 t ha^{-1} respectively), whereas the lowest straw yield (4.19 t ha^{-1}) was observed from V_2T_4 (BRRI dhan82 and Compost @ 5 t ha^{-1}) treatment combination that was followed (4.76 t ha^{-1}) by V_1T_7.

Table 8. Combined effect of varieties and fertilizer management on grain yield, straw yield, biological yield and harvest index of aus rice

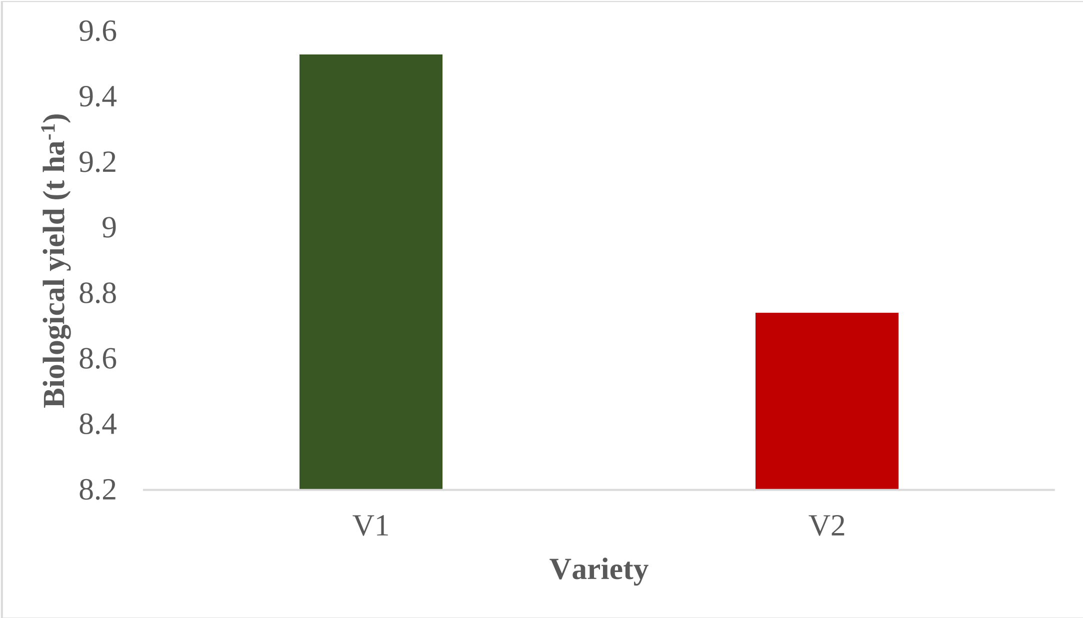
Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest Index (%)
V_1T_1	4.61 ab	5.82 a	10.43 a	44.18 bc
V_1T_2	3.96 d-f	4.95 bc	8.91 c	44.48 bc
V_1T_3	3.85 ef	4.94 bc	8.79 c	43.79 bc
V_1T_4	3.76 ef	4.95 bc	8.71 c	43.21 bc
V_1T_5	4.88 a	5.93 a	10.81 a	45.16 bc
V_1T_6	4.40 bc	5.55 ab	9.94 ab	44.24 bc
V_1T_7	4.35 b-d	4.76 cd	9.11 bc	47.87 a
V_2T_1	4.03 c-f	4.99 bc	9.02 bc	44.70 bc
V_2T_2	3.79 ef	5 bc	8.79 c	43.14 bc
V_2T_3	3.7 fg	4.98 bc	8.68 c	42.65 c
V_2T_4	3.35 g	4.19 d	7.54 d	44.47 bc
V_2T_5	4.07 c-f	4.90 bc	8.97 bc	45.39 ab
V_2T_6	4.06 c-f	4.95 bc	9.01 bc	45.08 bc
V_2T_7	4.13 c-e	5.05 bc	9.18 bc	45.02 bc
$LSD_{(0.05)}$	0.40	0.66	0.97	2.62
CV (%)	5.81	7.77	6.27	3.5

V_1= BRRI dhan48, V_2= BRRI dhan82; T_1= 100% RDF (148-52-74NPK kg ha^{-1}); T_2= Poultry manure @ 10 t ha^{-1}; T_3= Vermicompost @ 4 t ha^{-1}; T_4= Compost @ 5 t ha^{-1}**;** T_5= Poultry manure @ 10 t ha^{-1} + 50% RDF**;** T_6= Vermicompost @ 4 t ha^{-1}+50% RDF; T_7=Compost @ 5 t ha^{-1} + 50% RDF

4.2.8 Biological yield

4.2.8.1 Effect of variety

Biological yield of aus rice showed statistically significant differences due to different rice varieties (Fig. 23). The highest biological yield (9.53 t ha^{-1}) was recorded from V_1 (BRRI dhan48), while the lowest biological yield (8.74 t ha^{-1}) was found from $V_{2.}$ (BRRI dhan48).

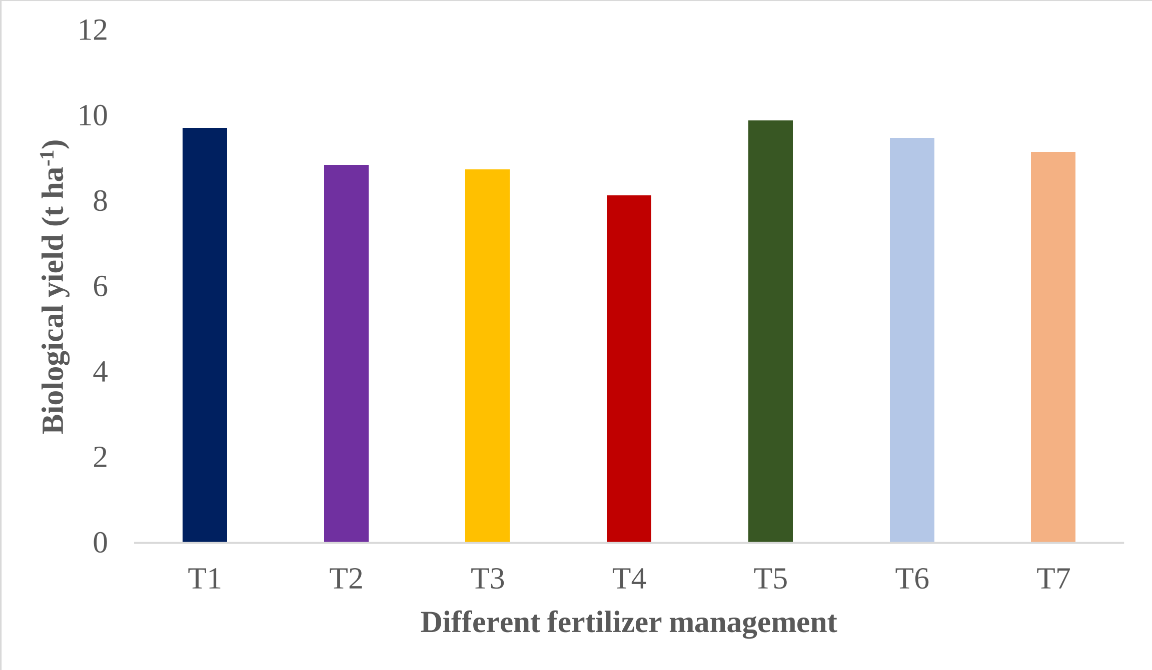


V_1= BRRI dhan48; V_2= BRRI dhan82

Figure 23. Effect of variety on biological yield of aus rice at harvest ($LSD_{0.05}$= 0.60).

4.2.8.2 Effect of fertilizer management

Different levels of fertilizer management showed statistically significant variations in terms of biological yield of aus rice (Fig. 24). The highest biological yield (9.89 t ha^{-1}) was found from T_5 (Poultry manure @10 t ha^{-1} + 50% RDF) which was followed by T_1 and T_6 (9.72 t ha^{-1} and 9.48 t ha^{-1}), while the lowest biological yield (8.13 t ha^{-1}) was observed from T_4 (Compost @5 t ha^{-1}) which was statistically similar (8.74 t ha^{-1}) to T_3.



T_1= 100% RDF (148-52-74NPK kg ha^{-1}); T_2= Poultry manure @ 10 t ha^{-1}; T_3= Vermicompost @ 4 t ha^{-1}; T_4= Compost @ 5 t ha^{-1}**;** T_5= Poultry manure @ 10 t ha^{-1} + 50% RDF**;** T_6= Vermicompost @ 4 t ha^{-1}+50% RDF; T_7= Compost @ 5 t ha^{-1} + 50% RDF

Figure 24. Effect of fertilizer management on biological yield of aus rice at harvest ($LSD_{0.05}$= 0.68).

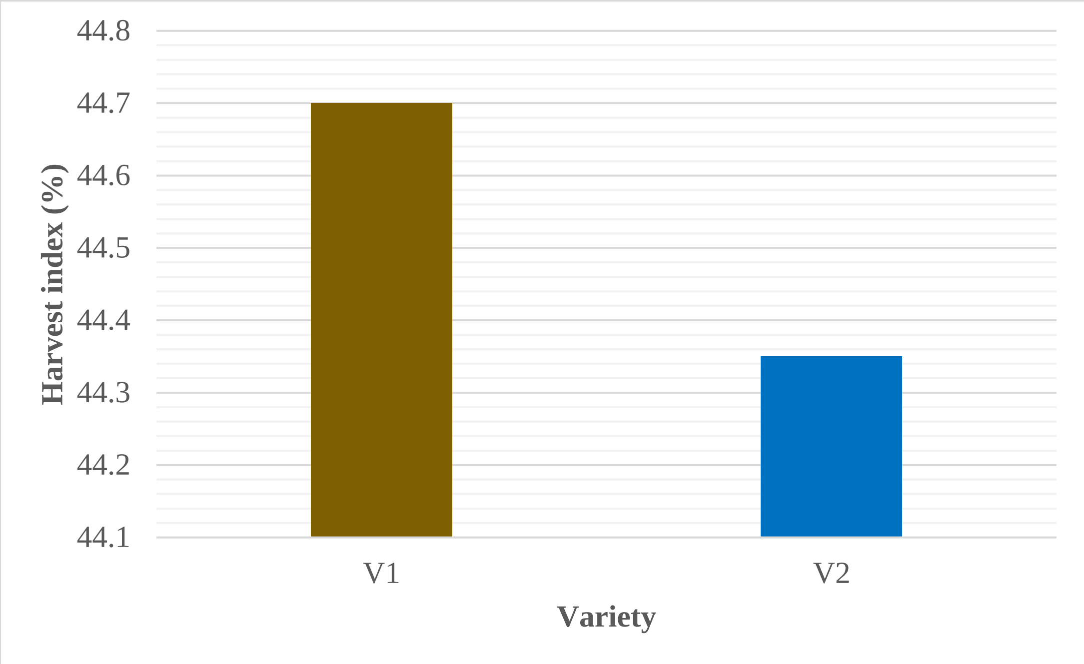
4.2.8.3 Combined effect of variety and fertilizer management

Statistically significant variation was recorded on biological yield of aus rice due to the combined effect of rice varieties and different levels of fertilizer management (Table 8). The highest biological yield (10.81 t ha^{-1}) was found from V_1T_5 (BRRI dhan48 and Poultry manure @10 t ha^{-1} + 50% RDF) which were followed to V_1T_1 and V_1T_6 (10.43 t ha^{-1}and 9.94 t ha^{-1} respectively) and the lowest biological yield (7.54 t ha^{-1}) was found from V_2T_4 (BRRI dhan82 and Compost @5 t ha^{-1}) treatment combination.

4.2.9 Harvest index

4.2.9.1 Effect of variety

There was no significant variation observed in terms of harvest index of aus rice (Fig. 25). The highest harvest index (44.70%) was recorded from V_1 (BRRI dhan48) which was followed by (44.35%) V_2 (BRRI dhan82).

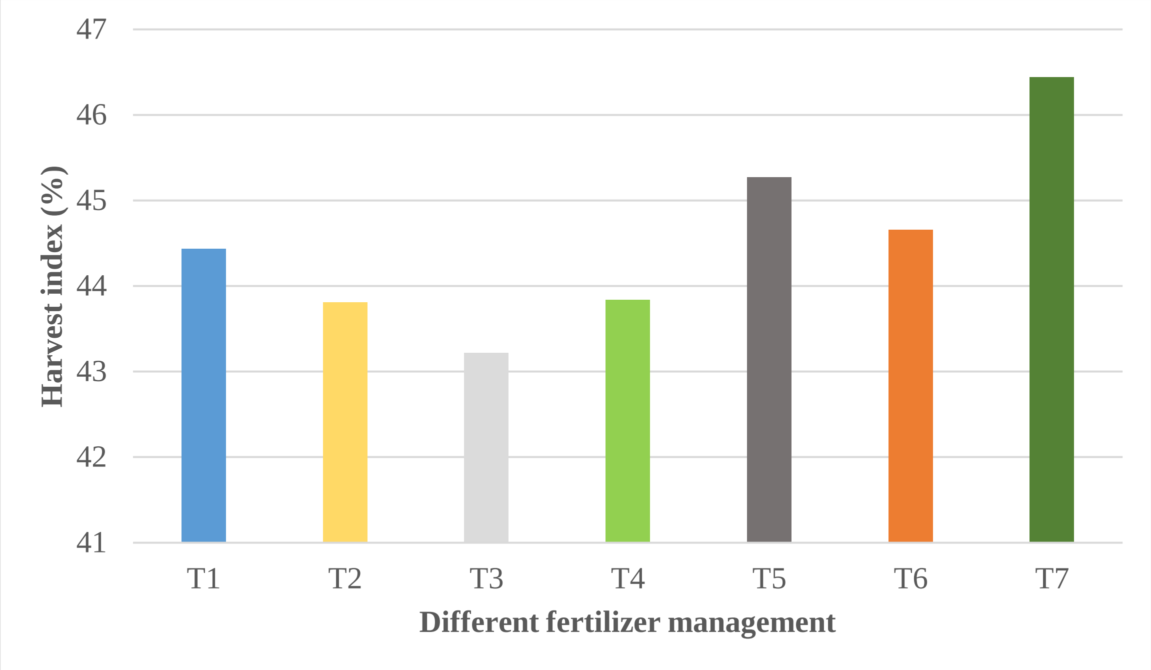


V_1= BRRI dhan48; V_2= BRRI dhan82

Figure 25. Effect of variety on harvest index of aus rice at harvest ($LSD_{0.05}$= 0.46).

4.2.9.2 Effect of fertilizer management

Harvest index of aus rice showed statistically significant variations due to different levels of fertilizer management (Fig. 26). The highest harvest index (46.44%) was found from T_7 (Compost @5 t ha^{-1} + 50% RDF) which were followed by T_5 and T_6 (45.27% and 44.66% respectively), whereas the lowest harvest index (43.22%) was recorded from T_3 (Vermicompost @ 4 t ha^{-1}) which was statistically similar to T_2, T_4, T_1 and T_6 (43.81%, 43.84%, 44.44% and 44.66%, respectively).



T_1= 100% RDF (148-52-74NPK kg ha^{-1}); T_2= Poultry manure @ 10 t ha^{-1}; T_3= Vermicompost @ 4 t ha^{-1}; T_4= Compost @ 5 t ha^{-1}**;** T_5= Poultry manure @ 10 t ha^{-1} + 50% RDF**;** T_6= Vermicompost @ 4 t ha^{-1}+50% RDF; T_7= Compost @ 5 t ha^{-1} + 50% RDF

Figure 26. Effect of fertilizer management on harvest index of aus rice at harvest ($LSD_{0.05}$= 1.86).

4.2.9.3 Combined effect of variety and fertilizer management

Statistically significant variation was recorded on harvest index of aus rice due to the combined effect of rice varieties and different levels of fertilizer management (Table 8). The highest harvest index (47.87%) was observed from V_1T_7 (BRRI dhan48 and Compost@ 5 t ha^{-1} +50 % RDF), which was statistically similar with V_2T_5 (45.39%) whereas the lowest harvest index (42.65 %) was found from V_2T_3 (BRRI dhan82 and Vermicompost @ 4 t ha^{-1}) treatment combination.

CHAPTER V
SUMMARY AND CONCLUSION

The present study was conducted at Sher-e-Bangla Agricultural University, Dhaka during the aus season of 2019 to evaluate the growth, yield, yield attributes of two varieties of aus rice as affected by different fertilizer managements. Two rice varieties namely BRRI dhan48 (V_1) and BRRI dhan82 (V_2) and seven fertilizer managements viz. T_1=100% RDF (148-52-74NPK kg/ha), T_2= Poultry manure @ 10 t/ha, T_3= Vermicompost @ 4 t/ha, T_4= Compost@ 5 t/ha, T_5= Poultry manure@ 10 t/ha + 50% RDF, T_6=Vermicompost @ 4 t/ha+50% RDF and T_7=Compost@ 5 t/ha + 50% RDF were considered as treatment variables.

The two factors experiment (Factor A: Variety and Factor B: Fertilizer Management) was laid out in Split plot design with three replications. In case of the effect of variety, plant height, tillers no. hill^{-1}, leaves no. hill^{-1}, number of effective tillers hill^{-1}, panicle length, filled grains panicle^{-1}, unfilled grains panicle^{-1}, 1000-grain weight, grain yield, straw yield and biological yield were significantly affected due to the main effect of variety. BRRI dhan48 variety out yielded BRRI dhan82 with tallest plant (94.22 cm). Maximum tillers no. hill^{-1} (17.01), leaves no. hill^{-1} (83.61), above ground dry weight plant^{-1} (42.21), effective tillers hill^{-1} (15.91), longest panicle (23.84 cm), filled grains panicle^{-1} (115.86), highest weight of 1000-grain (22.73 g), highest yield of grain and straw (4.26 t ha^{-1} and 5.27 t ha^{-1}, respectively), highest biological yield and harvest index (9.53 t ha^{-1} and 44.70%, respectively). In exactly fertilizer management T_5 (Poultry manure + 50% RDF) showed the best performance at all the characters except plant height. At harvest, the tallest plant (99.65 cm) were come from T_2, more tillers no. hill^{-1} (18.94), more leaves no. hill^{-1} (87.23), highest dry weight plant^{-1}(45.20g), more effective tillers hill^{-1} (16.26), longest panicle (26.23 cm), more filled grains panicle^{-1} (125.33), highest weight of 1000-grain (25.50 g), highest yield of grain and straw (4.48 t ha^{-1} and 5.42 t ha^{-1} respectively) , highest biological yield and harvest index (9.89 t ha^{-1}and 46.44% respectively), lowest unfilled grains (20.66) were obtained from T_5. Whereas the lowest plant height, tillers no. hill^{-1}, leaves no. hill^{-1}, dry weight plant^{-1}, effective tillers hill^{-1}, panicle length, filled grains panicle^{-1}, 1000-grain weight, grain yield, straw yield, biological yield (81.55 cm, 14.28, 71.27, 36.56g, 12.83, 18.54 cm, 97.83, 16.57 g, 3.56 t ha^{-1}, 4.57 t ha^{-1}, 8.13 t ha^{-1}) were observed in T_4. Besides the highest unfilled grain (28.45) and lowest harvest index (43.22%) were found in T_2 and T_3 respectively. In case of combined effect of variety and integrated fertilizer management plant height, tillers no. hill^{-1}, leaves no. hill^{-1}, dry weight plant^{-1}, effective tillers hill^{-1}, panicle length, filled grains panicle^{-1}, 1000-grain weight, grain yield, straw yield, biological yield and harvest index were significantly affected. Among the interactions, the variety V_1 (BRRI dhan48 and poultry manure @10 t ha^{-1}) (V_1T_2) produced significantly the tallest plant (105.86 cm). Again, maximum tillers hill^{-1} (21.04), leaves hill^{-1} (95.57), above ground dry weight plant^{-1}(48.11 g), effective tillers hill^{-1} (20.00), longest panicle (27.94 cm), more filled grains panicle^{-1} (139.67), highest weight of 1000-grain (26.37 g), highest yield of grain and straw (4.88 t ha^{-1} and 5.93 t ha^{-1} respectively), highest biological yield (10.81 t ha^{-1}) were obtained from variety, BRRI dhan48 and poultry manure @ 10 t ha^{-1} + 50% RDF (V_1T_5). The lowest plant height, tillers no. hill^{-1}, leaves no. hill^{-1}, dry weight plant^{-1}, effective tillers hill^{-1}, panicle length, filled grains panicle^{-1}, 1000-grain weight, grain yield, straw yield, biological yield, harvest index and highest unfilled grains (72.50 cm, 12.78, 63.78, 33.69 g, 9.78, 16.38 cm, 90.33, 15.12 g, 3.35 t ha^{-1}, 4.19 t ha^{-1}, 7.54 t ha^{-1}, and 33.57, respectively) were obtained from V_2T_4 and the lowest harvest index (42.65 %) from V_2T_3.

CONCLUSION

It is time demanding to use manure in soil to match favorable soil conditions with intensive crop cultivation for its sustainability even with 50% reduced chemical fertilizer. Here variety BRRI dhan48 showed comparatively better performance along with poultry manure @ 10 t ha^{-1} + 50% recommended dose fertilizer.

RECOMMENDATION

- Such study is needed to be repeated in different agro-ecological zones (AEZ) of Bangladesh for evaluation of regional adaptability.
- Other combination of organic manures and chemicals fertilizer may be tested for obtaining good agricultural practice for sustainable aus rice production in Bangladesh.

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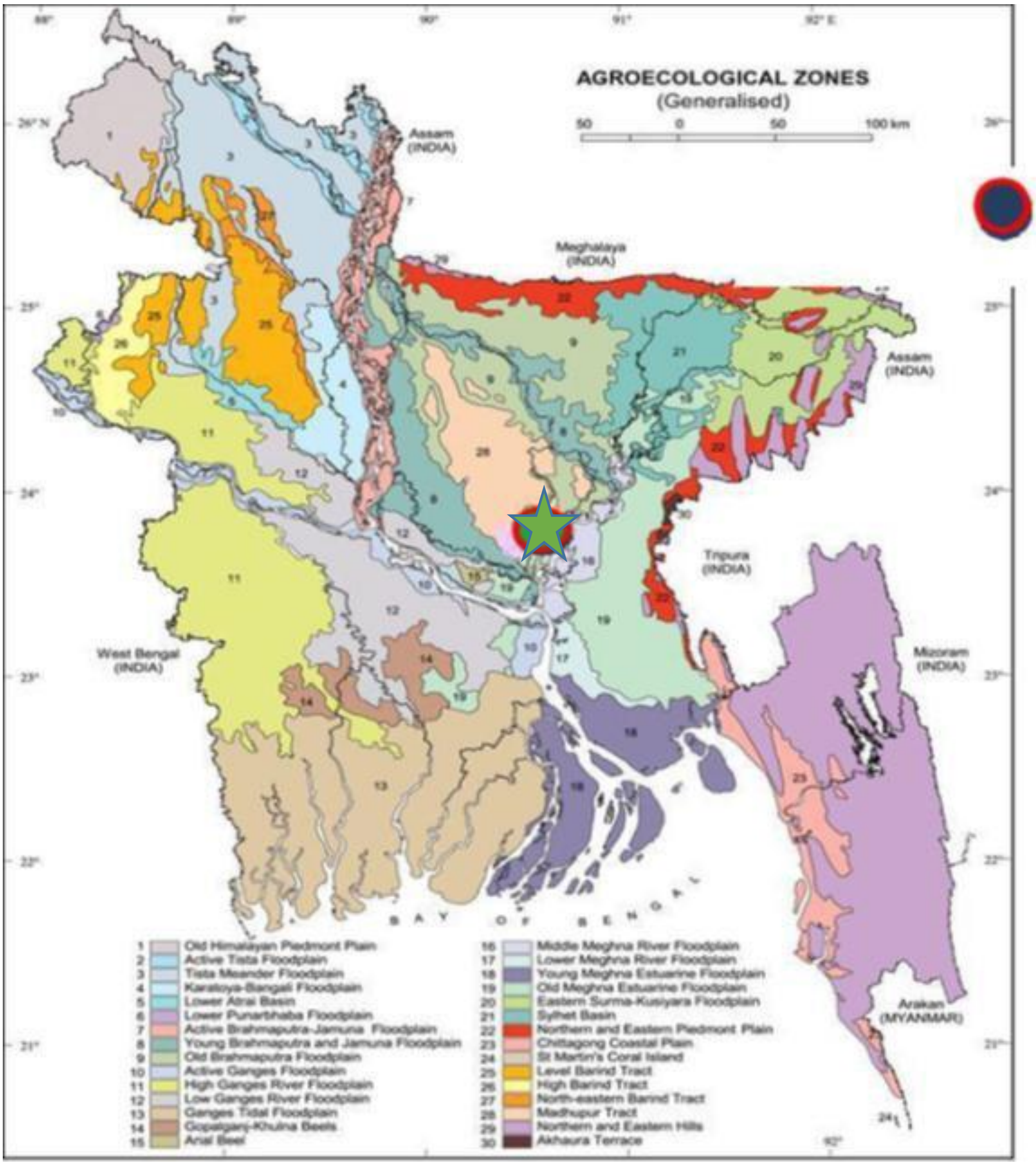
APPENDICES

Appendix I. The map of the experimental site



The experimental site under the study

Appendix II. Soil characteristics of experimental field as analyzed by Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

A. Morphological characteristics of the experimental field

Morphological features	**Characteristics**
Location	Experimental field, SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled

B. Physical and chemical properties of the initial soil

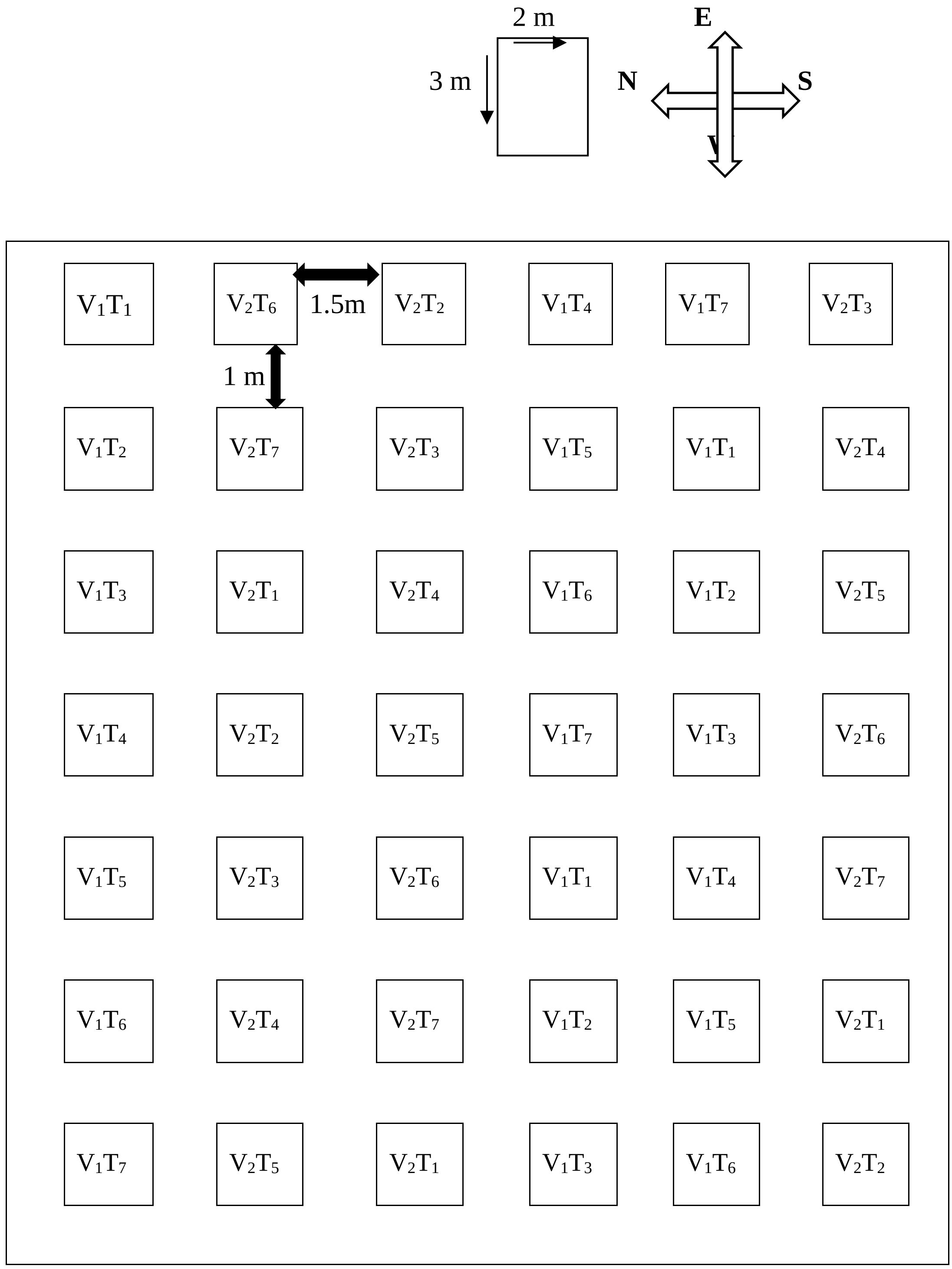
Characteristics	**Value**
% Sand	26
% Silt	43
% clay	31
Textural class	Silty clay
pH	5.9
Catayon exchange capacity	2.64 meq 100 g/soil
Organic matter (%)	1.15
Total N (%)	0.03
Available P(ppm)	20.00
Exchangeable K (me/100 g soil)	0.10
Available S (ppm)	45

Appendix III. Monthly record of air temperature, relative humidity, rainfall, and sunshine (average) of the experimental site during the period from March to July, 2019

Month (2019)	Air temperature (^0C)		Relative Humidity (%)	Total Rainfall (mm)	Sunshine (hr)
	Maximum	Minimum			
March	28.1	19.5	68	00	6.8
April	37.4	23.2	67	78	6.9
May	34.7	24.7	79	284	4.3
June	36.2	25.5	82	380	5.8
July	36.4	23.8	82	573	5.2

Source: Bangladesh Meteorological Department (Climate & weather division) Agargoan, Dhaka–1207

Appendix IV: Layout of the experiment



Appendix V. Analysis of variance of the data on plant height at different days after transplanting (DAT) and harvest as influenced by different aus rice varieties and fertilizer management

Source of variation	Degrees of freedom	Mean Square			
		Plant height			
		20 DAT	40 DAT	60 DAT	At Harvest
Replication	2	12.47	0.61	44.09	29.81
Variety	1	274.50*	603.62*	1354.57*	1255.80*
Error	2	11.72	16.47	17.58	59.21
Fertilizer	6	5.32*	89.86**	226.71**	268.61**
Variety × Fertilizer	6	6.41*	20.04*	37.49*	39.48*
Error	24	3.6	12.43	23.34	27.94

*Significant at 5% level of probability, ** Significant at 1% level of probability

Appendix VI. Analysis of variance of the data on Tillers hill^{-1} at different days after transplanting (DAT) and harvest as influenced by different aus rice varieties and fertilizer management

Source of variation	Degrees of freedom	Mean Square			
		Tillers hill^{-1}			
		20 DAT	40 DAT	60 DAT	At Harvest
Replication	2	0.28	1.06	5.44	2.41
Variety	1	2.98*	26.82*	25.83*	36.09*
Error	2	0.13	1.34	0.44	1.60
Fertilizer	6	2.63**	5.19**	5.57*	16.68**
Variety × Fertilizer	6	0.51	3.36**	6.28*	11.02**
Error	24	0.37	0.42	1.92	1.17

*Significant at 5% level of probability; ** Significant at 1% level of probability

Appendix VII. Analysis of variance of the data on Leaves hill^{-1} at different days after transplanting (DAT) and harvest as influenced by different aus rice varieties and fertilizer management

Source of variation	Degrees of freedom	Mean Square Leaves hill^{-1}			
		20 DAT	40 DAT	60 DAT	At Harvest
Replication	2	10.17	3.74	84.06	38.17
Variety	1	41.84*	137.80*	533.79	793.01
Error	2	1.52	6.84	58.69	92.67
Fertilizer	6	23.06**	33.57**	169.64**	192.16**
Variety × Fertilizer	6	5.19	6.12	43.39*	41.77
Error	24	8.82	6.89	26.21	24.48

*Significant at 5% level of probability; **Significant at 1% level of probability

Appendix VIII. Analysis of variance of the data on above ground dry weight plant^{-1} as influenced by different aus rice varieties and fertilizer management

Source of variation	Degrees of freedom	Mean Square Above ground dry weight plant^{-1}			
		20 DAT	40 DAT	60 DAT	At Harvest
Replication	2	0.03	2.92	3.36	0.04
Variety	1	0.04	47.81*	211.01*	136.04*
Error	2	0.21	2.01	7.53	6.28
Fertilizer	6	0.34	20.37**	96.59**	74.30**
Variety × Fertilizer	6	0.11	5.29	14.58	5.12
Error	24	0.22	3.15	9.62	11.28

*Significant at 5% level of probability; **Significant at 1% level of probability

Appendix IX. Analysis of variance of the data on effective tillers hill^{-1} and panicle length as influenced by different scented rice varieties and fertilizer management

Source of variation	Degrees of freedom	Mean square	
		Effective tillers hill^{-1}	Panicle length
Replication	2	14.31	0.51
Variety	1	17.36*	50.16*
Error	2	0.64	2.67
Fertilizer	6	18.38**	48.44**
Variety×Fertilizer	6	16.97**	3.44
Error	24	0.78	1.48

*Significant at 5% level of probability; **Significant at 1% level of probability

Appendix X. Analysis of variance of the data on filled grains panicle^{-1}, unfilled grains panicle^{-1} and 1000 grain weight as influenced by aus rice varieties and fertilizer management

Source of variation	Degrees of Freedom	Mean square		
		Filled grains panicle^{-1}	Unfilled grains panicle^{-1}	1000 grain weight
Replication	2	0.02	0.68	2.32
Variety	1	1464.38*	179.92*	32.97*
Error	2	45.17	2.86	1.74
Fertilizer	6	660.93**	47.49**	62.18**
Variety×Fertilizer	6	143.44*	67.66**	2.92*
Error	24	44.29	3.55	3.61

*Significant at 5% level of probability; **Significant at 1% level of probability

Appendix XI. Analysis of variance of the data on grain yield, straw yield, biological yield and harvest index as influenced by aus rice varieties and fertilizer management

Source of variation	Degrees of freedom	Mean square			
		Grain yield	Straw yield	Biological yield	Harvest index
Replication	2	0.11	0.47	0.96	5.33
Variety	1	1.55*	1.71*	6.51*	1.32
Error	2	0.03	0.08	0.20	0.12
Fertilizer	6	0.67**	0.56*	2.30**	6.94*
Variety×Fertilizer	6	0.09	0.40*	0.82*	3.25
Error	24	0.06	0.16	0.33	2.43

*Significant at 5% level of probability; **Significant at 1% level of probability

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Plate 2. Seedbed preparation

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