# EFFECT OF INORGANIC AND ORGANIC (VERMICOMPOST) MANAGEMENT ON THE GROWTH AND YIELD POTENTIAL OF BORO RICE


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**BY**


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# *CERTIFICATE*

*This is to certify that the thesis entitled,* ***"EFFECT OF INORGANIC AND ORGANIC (VERMICOMPOST) MANAGEMENT ON THE GROWTH AND YIELD POTENTIAL OF BORO 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*** *in* ***SOIL SCIENCE,*** *embodies the result of a piece of bona fide research work carried out by* ***SUDIP BISWAS****, Registration No.* ***10-04085*** *under my supervision and guidance. No part of the 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: June, 2016***

***Place: Dhaka, Bangladesh***

***(Prof. Dr. Alok Kumar Paul)***
***Supervisor***

**DEDICATED TO**

**MY BELOVED PARENTS**

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## ABSTRACT

The experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from October 2015 to April 2016 to study the effect of integrated use of urea and vermicompost on the growth and yield potential of boro rice(BRRI dhan24). The experimental treatments included $T_1$= No chemical fertilizer, no organic manure (Control), $T_2$=140 kg N ha$^{-1}$ from urea, $T_3$=120 kg N from urea + 20 kg N substituted by vermicompost, $T_4$=100 kg N from urea + 40 kg N substituted by vermicompost, $T_5$=80 kg N from urea + 60 kg N substituted by vermicompost, $T_6$=60 kg N from urea + 80 kg N substituted by vermicompost, $T_7$=40 kg N from urea + 100 kg N substituted by vermicompost, $T_8$=20 kg N from urea + 120 kg N substituted by vermicompost, $T_9$= 140 kg N substituted by vermicompost. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Results showed that different levels of nitrogen and vermicompost significantly increased contributing characters and yield of rice. The tallest plant (110.3 cm) was produced in 80 kg N from urea + 60 kg N substituted by vermicompost. The maximum total number of tiller and effective tiller hill$^{-1}$, Panicle length, number of filled grains panicle$^{-1}$ also recoeded from the same treatment . The highest grain yield (6.86 t ha$^{-1}$) was obtained from the same package. The minimum grain yield (2.35 t ha$^{-1}$) was produced from control treatment. The highest N, P, K and S concentration in grain was recorded from 80 kg N from urea + 60 kg N substituted by vermicompost treatment. The highest N, P, K and S concentration in straw was recorded from 80 kg N from urea + 60 kg N substituted by vermicompost treatment. . The highest N, P, K and S uptake by grain and straw of boro rice was recorded from same combination ($T_5$).Thus the treatmen package$T_5$(80kg N from urea+60kg N from vermicompost ) found as remunerative in augmending the yield of boro rice at the studied location (AEZ 28).

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| | | |
|---|---|---|
| AEZ | = | Agro- Ecological Zone |
| BARC | = | Bangladesh Agricultural Research Council |
| BBS | = | Bangladesh Bureau of Statistics |
| BINA | = | Bangladesh Institute of Nuclear Agriculture |
| BRRI | = | Bangladesh Rice Research Institute |
| cm | = | Centi-meter |
| cv. | = | Cultivar |
| DAT | = | Days after transplanting |
| $^{0}$ C | = | Degree Centigrade |
| DF | = | Degree of freedom |
| EC | = | Emulsifiable Concentrate |
| *et al.* | = | and others |
| etc. | = | Etcetera |
| FAO | = | Food and Agricultural Organization |
| g | = | Gram |
| HI | = | Harvest Index |
| HYV | = | High yielding variety |
| hr | = | hour |
| IRRI | = | International Rice Research Institute |
| Kg | = | kilogram |
| LV | = | Local variety |

| | | |
|---|---|---|
| LYV | = | Low yielding varieties |
| LSD | = | Least significant difference |
| m | = | Meter |
| $m^2$ | = | meter squares |
| MPCU | = | Mussorie phos-coated urea |
| MV | = | Modern variety |
| mm | = | Millimeter |
| *viz.* | = | namely |
| N | = | Nitrogen |
| ns | = | Non significant |
| % | = | Percent |
| CV % | = | Percentage of Coefficient of Variance |
| P | = | Phosphorus |
| K | = | Potassium |
| ppm | = | Parts per million |
| PU | = | Prilled urea |
| SAU | = | Sher-e- Bangla Agricultural University |
| S | = | Sulphur |
| SCU | = | Sulphur coated urea |
| t $ha^{-1}$ | = | Tons per hectare |
| UNDP | = | United Nations Development Program |
| USG | = | Urea supergranules |
| Zn | = | Zinc |

# Chapter I

# INTRODUCTION

Bangladesh is an agro-based country. Most of her economic activities mainly depend on agriculture. Geographical and climatic conditions of Bangladesh are favorable for rice (*Oryza sativa* L.) cultivation. Rice is the staple food of Bangladesh where its production has increased more than three times during the last 3 decades and reached more than 25 million tons in 2001-2002 (BBS, 2002). The population of Bangladesh will increase to 173 million in 2020 which is 31 percent higher than the present level (FAO, 1998). National Agricultural Commission says that to feed the increased population in 2020, 47 million tons of rice will be needed to produce in the country. For food security of the country, rice production is needed to be increased from 3 tons $ha^{-1}$ to 5 tons $ha^{-1}$ in next 20 years (Mahbub *et al*., 2001).

In Bangladesh total cultivable land is 90,98,460 hectare and near about 70 per cent of this land is occupied by Rice cultivation. In the year of 2011, total production of rice is 3,35,41,099 metric ton(BBS, 2011). Hybrid rice varieties is cultivated in 6,53,000 hectare of land and total production is 28,82,000 metric ton in the year of 2010-2011(BBS, 2011). On the other hand, HYV (High Yielding Variety) is cultivated in 40,67,000 hectare land and the total production of rice is 156,32,000 metric ton(BBS, 2011). The average rice production of hybrid varieties is 4.41 metric ton and HYV varieties are 3.84 metric ton in the year of 2010 – 2011(BBS, 2011).

Intensive cultivation of rice has caused considerable damage to the environment and natural resources including build up of salinity or alkalinity, water logging, water pollution, depletion of groundwater and health hazards due to excessive use of agro chemicals and pesticides and release of higher methane gas to the environment. For these reasons farmers, scientists and policy makers are now looking at the integrated approach to nutrient management for crops including rice to some extent.

Nitrogen nutrition due to the considerable impact on growth parameters and physiological traits of rice is important. The percentage of light penetration, photosynthesis active radiation, light use efficiency, dry matter partitioning to different parts are affected by the amount of nitrogen. Dry matter partitioning to the reproductive organs depends on number, capacity and activity of physiological sinks (Fageria and Baligar, 2001; Fageria and Baligar, 2005; Fageria, 2007). The cultivar of rice with higher physiological indices has better growth and higher yield (Esfahani *et al.,* 2006; Katsura, 2007; Mahdavi *et al.,* 2006). It can be concluded from the above studies that nitrogen is one of the important agronomic factors which has a significant impact on the growth indices and by selecting the appropriate amount of nitrogen, balanced complex of growth indices will be create in canopy which lead to yield improvement since the most indicators of growth are related to (LAI) in some way. LAI changing through alteration in nitrogen fertilizer levels is one of the most practical ways. In every region, (LAI) which produces the maximum yield is different and it should be obtained by the location specific research.

Organic agriculture is one among the broad spectrum of production methods that are supportive of the environment. The demand for organic food is gradually increasing both in developed and developing countries with an annual growth rate of 20–25 per cent (Ramesh *et al.,* 2005). Organic cultivation which is responsible for material circulation in agricultural ecosystem and enhanced crop production with a minimal environmental load in keeping ecological balance contains the holistic approach for production and management system for enhancing health of agricultural ecosystem. Organic systems avoid the use of synthetic fertilizers, pesticides and growth regulators. Instead they relay on crop residues, animal manures, legumes, green manures, off-farm wastes, mechanical cultivation and biological pest control to maintain soil health, supply of plant nutrients and minimize insects, weeds and other inputs. Organic culture helps in improvement of crop quality and reduces environment pollution. It brightens the prospects of export of organic food items. Now there are signs of change across the agriculture landscape of the country towards organic farming. Rice produced by organic farming had higher grain quality (Mendoza, 2004).

Vermicompost improves the physical, chemical and biological properties of soil. There is a good evidence that vermicompost promotes growth of plants and it has been found to have a favourable influence on all yield parameters of crops like, wheat, paddy, and sugarcane (Ismail., 1997; Ansari., 2007). Hidlago *et al*., (2006) reported that the incorporation of earthworm increased plant growth, leaf growth and root length. The suitability of vermicompost amended soil for sustaining plant growth and biological activity is a function of physical properties and the chemical properties which depend on soil organic matter. Soil plays a key role in completing the cycling of major demands required by biological systems decomposing organic wastes and detoxifying certain hazardous compounds.

Keeping all the points in mind mentioned above, the present piece of research work was under taken with the following objectives.

i) To evaluate the effect of integrated use of vermicompost and inorganic N management in soil for boro rice production.
ii) To study the potentiality of vermicompost as a supplement of nitrogen for boro rice production.
iii) To find out the appropriate combination of inorganic N with vermicompost for high yield of boro rice.

# CHAPTER II

# REVIEW OF LITERATURE

Yield and yield contributing characters of rice are considerably depend on manipulation of basic ingredients of crop production. The basic ingredients include variety, environment and agronomic practices (planting density, fertilizer, irrigation etc.). Among the factors nutrient management plays a key role for manipulation of the growth and yield of rice. High yielding varieties (HYV) are generally more adaptive to appropriate nutrient application. The available relevant reviews related to nutrient management in the recent past have been presented and discussed under the following headings:

## 2.1 Effect of nitrogen management

Among the factors that are responsible for growth, yield and yield contributing characters of rice, nitrogen management is very important for the production of modern varieties. Some information regarding effect of nitrogenous fertilizer and their application are reviewed under the following headings:

Haque and Haque (2016) conducted at Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh during the rainy season of 2014 to assess growth, yield and nitrogen use efficiency of a new rice variety. The new rice variety (BU dhan1) was treated with six levels of nitrogenous fertilizer in a randomized complete block design replicated three times. The nitrogen levels 0, 20, 40, 60, 80 and 100 kg N $ha^{-1}$ constituted the treatment variables. Results revealed that growth of the new rice variety favored at higher levels of applied nitrogen although it flattened at 80 and 100 kg N $ha^{-1}$. Preanthesis assimilates reserves contributed to sustaining the yield of the variety which indicated that current photosynthesis was insufficient to support the present yield level. The assimilate remobilization varied from 109.21 to 232.93 $g \cdot m^{-2}$ between the nitrogen levels where the maximum amount of remobilization was observed at 60 kg N $ha^{-1}$. The highest grain yield (5.36 $t \cdot ha^{-1}$) was found when the variety was fertilized with 60 kg N $ha^{-1}$. Application of 60 kg N $ha^{-1}$also showed the highest nitrogen use efficiency (344.50 kg grain/kg N applied) of the variety.

Azarpour *et al.* (2014) studied the effects level of nitrogen fertilizer on yield and physiological traits of rice cultivars (*Oryza sativa L.*), an experiment was conducted during 2009 year in the Rice Research Institute, Iran, Rasht, central of Guilan and Rudsar, East of Guilan. Factors were cultivar (Khazar, Ali Kazemi and Hashemi), and nitrogen fertilizer levels (0, 30, 60, and 90 Kg N/ha). Characters measured were: leaf area index (LAI), total of dry weight (TDW), leaf dry weight (LDW), Crop growth rate (CGR), relative growth rate (RGR), net assimilation rate (NAR), leaf area duration (LAD), leaf area ratio (LAR), leaf weight rate (LWR), specific leaf area (SLA), grain yield. Growth parameters were calculated during six growth stages by harvesting samples from leaf area index, leaf dry and total weight dry weight in all treatments. The comparison of calculated and measured amounts of growth indexes with use determination of regression coefficients (R2). Results of growth analysis indicated that, nitrogen increasing rates of fertilizer caused the increment of growth indexes. Khazar and Ali Kazemi Hashemi showed higher growth indices rather than Hashemi. Results indicated that cultivar and nitrogen fertilizer significantly contributed to grain yield. Khazar and Ali Kazemi gave the highest grain yield among the cultivars. Also, results indicated that with increasing nitrogen fertilizer application, grain yield increased significantly (17,13 and 57 %).

Rao *et al.* (2014) conducted during three consecutive kharif seasons of 2009-10, 2010-11 and 2011-12 at Agricultural Research Station, Seethampeta, Andhra Pradesh on sandy clay loam soil with three varieties (RGL 2537, RGL 2332 and MTU 7029) and four nitrogen levels (60, 80,100 and 120 kg/ ha) with an objective to find out suitable variety with optimum nitrogen level for high altitude areas of Andhra Pradesh. Tiller production, days to 50 per cent flowering, dry matter production at harvest, yield attributes, yields and harvest index, gross returns, net returns and rupee per rupee invested, protein content of grain, soil organic carbon and available nitrogen were progressively augmented by incremental levels of N. Nutrient response in terms of partial factor productivity was progressively decreased with incremental levels of N from 60 kg to the highest dose tried. Post soil fertility status revealed that the status was progressively increased with incremental levels of N up to the highest dose that increased significantly by elevated levels of N.

Pramanik and Bera (2013) conducted during kharif season of 2010 and 2011 to investigate the optimization of nitrogen levels under different age of seedlings transplanted on growth, chlorophyll content, yield and economics of hybrid rice. Fifteen treatment combinations consisted of three levels of seedlings age (10, 20 and 30 days) and five levels of nitrogen viz. N0, N50, N100, N150 and N200 kg ha-1. Seedlings age had marked effect on all the growth, chlorophyll content and yield attributing traits. Transplanting of 10 days seedlings showed significantly highest grain yield of 5575 and 5946 kg $ha^{-1}$ in 2010 and 2011, respectively. The percentage of grain yields an increase of 10.7 and 21.3 per cent in first year and 10.6 and 21 per cent in second year over 20 and 30 days seedlings respectively. Among the nitrogen levels N200 kg $ha^{-1}$ gave significant higher plant height, panicle initiation, number of tillers $hill^{-1}$, total chlorophyll content, panicle length and straw yield and nitrogen levels N150 kg $ha^{-1}$ gave significant higher Number of effective $tillers^{-1}$, effective tiller index, panicle weight, filled grain $panicle^{-1}$, 1000 grain weight, grain yield, and harvest index as compared to N0, N50, N100 during both years. N150 kg $ha^{-1}$ produced significantly highest grain yield of 6286 and 6652 kg $ha^{-1}$in 2010 and 2011, respectively. The percentage of grain yields an increase of 72.5, 44.4, 23.8 and 5.1 per cent in first year and 69.9, 44.1, 22.1 and 3.5 per cent in second year over N0, N50, N100 and N200 kg $ha^{-1}$ respectively.

The effects of different nitrogen application levels on nutrient uptake and ammonia volatilization were studied with the rice cultivar Zheyou 12 as a material by YU Qiao-gang, *et al*. (2013). The accumulative amounts of nitrogen, phosphorus and potassium in rice plants across all growth stages showed a trend to increase with increasing nitrogen application levels from 0 to 270 kg/m$^2$, but decreased at nitrogen application levels exceeding 270 kg/m$^2$. Moreover, the accumulative uptake of nitrogen, phosphorus and potassium by the rice plants was increased by application of organic manure in combination with 150 kg/m2 nitrogen. The nitrogen uptake was high during the jointing to heading stages. Correlation analysis showed that rice yield was positively correlated with the accumulative uptake of nitrogen, phosphorus and potassium by the rice plants. The highest correlation coefficient observed was between the amount of nitrogen uptake and rice yield. The rate and accumulative amounts of ammonia volatilization increased with increasing nitrogen fertilizer application level. Compared with other stages, the rate and accumulative amount of ammonia volatilization were higher after base fertilizer application. The ammonia volatilization rates in response to the nitrogen application levels of 270 kg/m$^2$ and 330 kg/hm$^2$ were much higher than those in the other treatments. The loss of nitrogen through ammonia volatilization accounted for 23.9% of the total applied nitrogen at the nitrogen application level of 330 kg/hm$^2$.

Tayefe *et al.* 92011) studied the effects of nitrogen fertilizer on nitrogen use efficiency, yield and characteristics of nitrogen uptake during two years (2008-2009) in paddy soil in Guilan province, Iran. In this experiment, four treatments including: $N_1$-control (no N fertilizer); $N_2$- 30 kg ha$^{-1}$ N (at transplanting time); $N_3$- 60 kg ha$^{-1}$ N (at transplanting, and tillering times); $N_4$- 90 kg ha$^{-1}$ N were compared. Results showed that total N uptake, physiological nitrogen use efficiency (PNUE), apparent nitrogen recovery efficiency (ANRE) and agronomic nitrogen use efficiency (ANUE) was varied in different cultivars significantly and Khazar variety had the highest contents. Total N uptake, physiological N use efficiency (PNUE), agronomic nitrogen use efficiency (ANUE) was varied significantly with the increasing of the amount of nitrogen applied. As total N uptake increased with increasing in N fertilizing contents but physiological N use efficiency (PNUE), agronomic nitrogen use efficiency

(ANUE) decreased. There were significant differences in the effects of applying nitrogen fertilizer on nitrogen use efficiency and characteristics of nitrogen uptake.

Xie *et al.* (2007) reported that increased split application of nitrogen from control to 140 kg $ha^{-1}$ increased dry matter accumulation (DMA) of different growth stages of Jinzao22 and Shanyou63 rice varieties and after that dose the DMA reduced due to the losses of nitrogen by volatilization.

Singh and Modgal (2005) noted that dry-matter accumulation (DMA) and concentration and uptake of nitrogen increased with increasing level of nitrogen at all the stages of crop growth. Split application of nitrogen with its heavier fractions (1/3+1/3+1/3) at tillering and panicle initiation stages resulted in higher dry-matter accumulation, and higher nitrogen concentration of rice. They also noted that the rice plants accumulated nearly 15% of the total absorbed nitrogen, up to tillering, 50% up to panicle initiation and 85–90% up to heading.

Bowen *et al.* (2005) conducted 531 on-farm trials during the *Boro* and *aman* seasons in 7 districts of Bangladesh from 2000-2004. The results showed that UDP (Deep placement of urea super granule) increased grain yield by 1120 kg $ha^{-1}$ and 890 kg ha-1 during the *Boro* season and *aman* season, respectively.

Rahman (2003) worked out an experiment at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, during the aman season with three levels of USG viz. one, two and three USG/4 hills providing 40, 80 and 120 kg N $ha^{-1}$. He found that two USG/4 hills produced the higher grain and straw yield (5.22 and 6.09 t $ha^{-1}$, respectively).

Subhendu *et al.* (2003) conducted a field experiment during *kharif* season at Hyderabad, India. They found that the application of nitrogen (120 kg N $ha^{-1}$) as urea in equal splits during transplanting, tillering, panicle initiation and 50% flowering resulted in the highest 1000 grain weight (22.57 g).

Mondal and Swamy (2003) found that application of N (120 kg ha$^{-1}$) as urea in equal split during transplanting, tillering, panicle initiation and flowering resulted in the highest number of panicles, number of filled grain panicle$^{-1}$,1000-grain weight, straw yield and harvest index.

Ikeda *et al*. (2003) stated the efficiency of the non-split fertilizer application to the rice variety 'Koshihikari' was evaluated in order to dispense with top dressing and improve the recovery rate of fertilizer in pneumatic direct sowing culture of rice on a submerged paddy field in Aichi Prefecture, Japan. The fertilizer used in this study, which was a combination of a linear-type coated urea and a sigmoidal-type coated urea, was found effective in this cultivation system. Results also showed that nitrogen recovery rate, yield rate and quality were improved with this system. The accumulative nitrogen release rates of the combined fertilizer were 40% at panicle formation stage, 80% at heading stage and 95% at maturity stage. Furthermore, the nitrogen release pattern was adapted for the growth phase of this cultivation system.

Bayan and Kandasamy (2002) noticed that the application of recommended rates of N in four splits at 10 days after sowing, active tillering, and panicle initiation and at heading stages effective tillers m$^{-2}$. Islam *et al*. (1996) reported that number of effective tillers hill$^{-1}$ increased with increasing nitrogen level and split application was more effective compare to basal application during transplanting.

Jaiswal and Singh (2001) conducted an experiment with USG and PU both at 60 and 120 kg ha-1 under different planting methods. They found that transplanting method with urea super granules proved to be the best for maximum grain yield (4.53 t ha$^{-1}$).

Ehsanullah *et al*. (2001) when work with split application of nitrogenous fertilizer and reported that nitrogen as split application at different growth stages significantly influenced grain yield and straw yield .

Angayarkanni and Ravichandran (2001) conducted a field experiment at Tamill Naru from July to October, 1997 and found that split application of nitrogen for rice cv. IR20, treatment applying 16.66% of the recommended N as basal, followed by 33.33% N at 10 DAT, 25% N at 20 DAT and 25% N at 40 DAT recorded the highest grain yield e.g. 6189.4 kg $ha^{-1}$.

Geethadevi *et al*. (2000) showed that four split applications of 150 kg $Nha^{-1}$ nitrogen in KRH-1 recorded the maximum yield, as well as increased growth and yield components. The higher number of tillers, filled grains $panicle^{-1}$ and higher grain weight $hill^{-1}$ for split application of nitrogenous fertilizer at 120 kg N $ha^{-1}$.

Ahmed *et al*. (2000) revealed that USG was more efficient than PU at all respective levels of nitrogen in producing all yield components and in turn, grain and straw yields. Placement of USG @ 160 kg N $ha^{-1}$ produced the highest grain yield (4.32 t $ha^{-1}$) which was statistically identical to that obtained from 120 kg N $ha^{-1}$ as USG and significantly superior to that obtained from any other level and source of nitrogen.

Mishra *et al*. (2000) carried out a field experiment in 1994-95 in Bhubaneswar, Orissa, India, and reported that rice cv. Lalate was given 76 kg N $ha^{-1}$ as USG at 0, 7, 14 for 21 days after transplanting (DAT), and these treated control. N increased plant height, panicle length, N up take and consequently the grain and straw yields of lowland rice.

Surekha *et al*. (1999) found that N application in four equal splits, the last at flowering improved the grain yield as well as nutrient uptake.

Asif *et al*. (1999) noticed that application of 60 : 67 : 67 or 180 : 90 : 90 kg NPK $ha^{-1}$, with N at transplanting and early tillering or a third each at transplanting, early tillering and panicle initiation resulted in higher grain yield with the higher NPK rates. Split application of N gave higher yields than a single application.

Prasad *et al.* (1999) conducted an experiment on growth of rice plants as influenced by the method of seeding, seed rate and split application of nitrogen and reported that plants were generally tallest with N applied 25% at 15 days after sowing, 50% at active tillering and 25% at panicle initiation stages.

Thakur and Patel (1998) reported that the highest grain yield (3.84 t $ha^{-1}$) was recorded with the application of 80 kg N $ha^{-1}$ in three split rates with 5 t FYM $ha^{-1}$ and 60 kg N $ha^{-1}$ in three split rates with 5 t FYM gave 3.81 t $ha^{-1}$.

Faraji and Mirlohi (1998) reported that plant height, number of tillers per unit area and days to heading and maturity increased with the increase of rate of N fertilizer application at 60, 90, 120 or 150 kg N $ha^{-1}$, were given before transplanting or in 2 or 3 splits while grain yield and panicle number increased with up to 120 kg N $ha^{-1}$ but decreased were decreased with increasing N.

Rao *et al.* (1997) showed that nitrogen application at 50 kg $ha^{-1}$ at tillering, 25 kg $ha^{-1}$ at panicle initiation and 25 kg $ha^{-1}$ at booting stage produced the longest panicle.

Vijaya and Subbaiah (1997) showed that plant height, number of tillers, number and weight of panicles, N and P uptake, dry matter and grain yield of rice increased with the increasing USG size and were greater with the deep placement method of application both N and P compared with broadcasting.

Kapre *et al.* (1996) reported that USG has favourable effects on rice. They also observed from a study with 8 slow releasing fertilizers that grain yield, straw production, panicle $hill^{-1}$, grains $panicle^{-1}$ and 1000-grain weight increase significantly with USG and sulphur coated urea (SCU).

Islam *et al.* (1996) reported that number of effective tillers $hill^{-1}$ increased with increasing nitrogen level upto 150 kg $Nha^{-1}$ and split application was more effective compare to basal application during transplanting.

Vaiyapuri *et al*. (1995) stated that application of 100 kg N $ha^{-1}$ in three splits 25% basal + 50% tillering stage +25% panicle initiation gave the highest yield (5.88 t $ha^{-1}$).

Surendra *et al.* (1995) conducted an experiment during rainy season with nitrogen level @ 0, 40, 80, 120 kg $ha^{-1}$ and sources, of nitrogen, USG and urea dicyandiamide @ 80 kg ha-$^{1}$. They showed that USG and urea dicyandiamide produced more panicle $hill^{-1}$, filled grains $panicle^{-1}$, panicle weight and grain yield than PU @ 80 kg N $ha^{-1}$. Nassem et al. (1995) indicated that percent grains remained unchanged in response to different levels but a significantly lower 1000-grain weight was recorded in the control treatment than in the plots received nitrogen fertilizer.

Sharma (1995) reported in an experiment that split application of nitrogenous fertilizer increased the plant height significantly compare to the basal nitrogen application.

Panda and Mphanty (1995) observed that grain yield was the highest with 60 $kgha^{-1}$ applied 30 kg at transplanting and 15 kg each at 21 and 75 days after transplanting.

Patel and Mishra (1994) carried out an experiment with rice cv. IR36 and was given 0, 30, 60 or 90 kg N $ha^{-1}$ as Muossorie rock phosphate-coated urea, neem cake-coated urea, gypsum coated urea, USG or PU. The coated materials as incorporated before transplanting and USG as placed 5-10 deep a week after transplanting and urea as applied in 3 split doses. They showed that N rate had no significant effect on panicle lenght, percent sterility and harvest index.

Das and Singh (1994) reported that grain yield and N use efficiency by rice were greater for deep placed USG than for USG broadcast and incorporated or three split applications of PU.

Channabasavanan and Setty (1994) found that rice yield was the highest when N was applied in different splits between sowing, tillering, panicle initiation and panicle emergence.

Rabinson (1992) reported that among 12 different split application treatments, grain yield ranged 4.2-5.9 t $ha^{-1}$ and was the highest with application of three equal splits (Basal application, panicle initiation stages and heading stages).

Nair and Gautam (1992) found that grain yield was higher when 60 kg N was applied at initiation, or 50% at transplanting + at tillering + 25% at panicle initiation stages than when all was applied at transplanting or at tillering.

Mongia (1992) reported that grain yield was the highest with 60 kg N $ha^{-1}$ with the application in three split application (50% basal + 25% at flowering + 25% at the flag leaf stage).

Ali *et al.* (1992) reported from their earlier findings that 1000 grain weight was the highest when 100 kg N $ha^{-1}$ was applied in three equal splits at basal, 30 and 60 days after transplanting.

Thakur (1991) reported that total spikelets $panicle^{-1}$ was the highest when 40%, 30% and 20% nitrogen was applied as basal, at maximum tillering and panicle initiation stages, respectively. He also studied the influence of levels, forms of urea and method of application of nitrogen in rice during *Kharif* season. He observed that yield attributes attributes and grain yield differed significantly due to the levels and sources of nitrogen applied. Placement of nitrogen at 60 kg $ha^{-1}$ through USG produced the highest number of panicle $unit^{-1}$.

Tantawi *et al.* (1991) stated that split application of nitrogen markedly increased yield and the highest yield obtained from the triple splits. They also observed that split application resulted in greater number of panicles, heavier grains and more grains $panicle^{-1}$.

Kamal *et al.* (1991) conducted a field experiment in *Kharif:* season of 1985 and 1986 on rice cv. Joya with different forms of urea and level of nitrogen @ 29.58, 87 kg $ha^{-1}$. They reported that total tiller varied significantly due to forms in 1995, but during 1996 there was no significant variation. PU was significantly inferior to the other forms. The highest number of tillers was produced in treatment where USG was applied.

Sen and Pandey (1990) reported that the application of USG or PU @ 38.32 kg N $ha^{-1}$ gave higher yield than broadcast PU and there were no significant differences in panicle length.

Reddy *et al.* (1990) reported a significant effect of nitrogen on plant height in rice with 120 kg N $ha^{-1}$ in three split dressings at tillering, panicle initiation and booting stages.

**2.2 Effect of Vermicompost (VC)**

The importance of composts as a source of humus and nutrients to increase the fertility of soil and growth of plant has been well recognized in the present study. Vermicompost and chemical fertilizer were taken first for chemical analysis and then to find the effect of these composts on the growth of SRI Rice Cultivation. It was found that the vermicompost was rich in nutrients like Potassium, Nitrate, Sodium, Calcium, Magnesium, and Chloride and have the potential for improving plant growth than Fertilizer. The optimal growth of SRI Rice in our study conducted for a period of four month. The study also showed distinct differences between vermicompost and chemical fertilizer in terms of their nutrient content and their effect on SRI Rice plant growth (Kandan and Subbulakshmi, 2015)

Kumar *et al.* (2014) carried out during kharif season of 2011 to study the effect of organic and inorganic sources of nutrient on yield, yield attributes and nutrient uptake of rice cv. PRH-10. Application of organic and inorganic sources of nutrient in combination remarkably increased yield, yield attributes and nutrient uptake of rice than alone. 125% RDF + 5 t/ha vermicompost recorded significantly higher yield, yield attributes and nutrient uptake in comparison to other treatments and this was followed by 100% RDF + 5 t/ha vermicompost. 125% RDF + 5 t/ha vermicompost was increased the number of panicles (20.50%), panicle length (23.12%), panicle wt. (13.02%), 1000 grain wt. (12.90%), grain yield (31.15%), straw yield (37.12%), protein content (18.77%), N uptake in grain (36.81%) and straw (42.81%), P uptake in grain (32.62%) and straw (31.56%) and K uptake in grain (35.46%) and straw (25.39%) over control. The lower yield, yield attributes, gross return and nutrient uptake was recorded in control.

Tharmaraj *et al.* (2011) studied the effect of vermicompost on soil chemical and physical properties was evaluated during samba rice cultivation studies. The experiments were arranged in a completely randomized block design manner with three replications. The soil sampling and plant growth measurements were carried out for two months, ie., during initial and final stages. The study was carried out to know the impact of various vermiproduct such as vemicompost, vermiwash and mixture of vermicompost and vermiwash on soil physico-chemical properties during the pot culture studies with samba rice. The physical properties such as, electrical conductivity (EC), porosity, moisture content, water holding capacity and chemical properties like nitrogen, phosphorous, potassium, calcium and magnesium were found distinctly enhanced in vermicompost treated soil, where as the corresponding physicochemical values in control were minimum. The soil treated with vermicompost had significantly more electrical conductivity in comparison to unamended pots. The addition of vermicompost in soil resulted in decrease of soil pH. The physical properties such as water holding capacity, moisture content and porosity in soil amended with vermicompost were improved. The vermiproduct treated plants exhibit faster and higher growth rate and productivity than the control plants. Among the treated group, the growth rate was high in the mixture of vermicompost and vermiwash treated plants, than the vermicompost and vermiwash un-treated plants. The maximum range of some plant parameter's like number of leaves, leaf length, height of the plants and root length of plant, were recorded in the mixture of vermicompost and vermiwash. The results of this experiment revealed that addition of vemicompost had significant positive effects on the soil physical, chemical properties and plant growth parameters.

Conjuctive use of vermicompost @ 2 t/ha along with 50 per cent N/ha enabled hybrid rice to produce grain yield at par that obtained by application of recommended dose of fertilizer along (Upendrarao and Srinivasulureddy, 2004).

A field experiment was carried out during wet season of 1997 to study the response of scented rice (cv. Pusa basmati1) to levels of NPK, vermicompost and growth regulator at ARS, Siraguppa. The results revealed that application of 150:75:75 NPK kg ha-1 has recorded significantly higher growth, yield attributes and yield (5261 kg ha-1) as compared to lower levels of NPK. Scented rice Pusa Basmati-1 responded significantly to the organic manure. Application of vermicompost @ 5 t $ha^{-1}$ resulted in significantly higher yield (4889 kg $ha^{-1}$) as compared to no vermicompost application. Significantly response was observed from spraying of triacontanol (GR) @ 500 ml ha-1 with respect to growth, yield attributes and yield (4861 kg $ha^{-1}$) as compared to spraying @ 250 ml $ha^{-1}$ and water spray (Murali and Setty, 2004).

Vermicomposting is the bioconversion of organic waste materials into nutritious compost by earthworm activity and is an important component of organic farming package. Meena (2003) reported multifarious effects of vermicompost on growth and yield of crops.

In a recent field experiment conducted at Kerala Agricultural University, vermicompost @ 6 t/ha was tried as an organic manure for short duration rice variety in Kanchana. It was found that vermicompost addition had a positive influence on growth and yield attributes of rice to result in a better grain yield of 4.54 t/ha and straw yield of 5.15 t/ha along with the NPK dose of 105: 52.5: 52.5 kg/ha supplied through inorganic sources. Apart from the improvement in fertilizer use efficiency, vermicompost ensured a steady supply of secondary nutrients like Mg as well as micronutrients throughout the growth period, which improved the chlorophyll content of leaves and reduced the chaff percentage.

Unlike other organic manures, vermicompost addition has got the added advantage of quick nutrient absorption by plants, to result in better dry matter accumulation. The increase in panicle number per $m^2$ noted in the study was due to the promotion of tiller production with the supply of vermicompost (Sudha and Chandini, 2003).

Application of vermicompost improved the chemical and physical structures of the soil. (Anitha and Prema, 2003). Application of vermicompost increased the infiltration and reduced run-off and thus increased soil water availability for plant growth (Longsdon and Linden, 1992). Vasanthi and Kumaraswamy (1999) found that the soil organic carbon content increased with the treatment receiving vermicompost over the control. Availability of nitrogen increased in earthworm cast application as compared to non-ingested soil.

Earthworms can live in decaying organic wastes and can degrade it into fine particulate materials, which are rich in nutrients. Vermicomposting is the application of earthworm in producing vermin-fertilizer, which helps in the maintenance of better environment and results in sustainable agriculture, earthworm make the soil porous and help in better aeration and water infiltration. Vermicompost can be prepared from different organic materials like sugarcane trash, coir pith, pressmud, weeds, cattle dung, bio digested slurry etc. Increased availability of nutrients in vermicompost compared to non-ingested soil resulted in significantly better growth and yield of rice has been reported by several workers (Sudhakar, *et al*., 2002).

Application of vermicompost with fertilizer N and bio-fertilizer increased the rice yield by 16 per cent over the application of fertilizer N alone. Vermicompost applied with FYM recorded higher grain and straw yield of rice (Jeyabal and Kuppuswamy, 2001).

Ravi and Srivastava (1997) reported that combined application of vermicompost and inorganic fertilizers recorded significantly higher plant height, effective tillers per hill, seed and straw yield of rice, compared to application of inorganic fertilizer alone.

Gopal Reddy (1997) reported that vermicompost contains 1.98 per cent nitrogen 1.23 per cent phosphorus. 1.59 per cent potassium and 132, 70.5, 1440.2 and 317.5 mg per kg of total Zn, Cu, Fe and Mn, respectively.

Vasanthi and Kumaraswany (1996) reported that the seed yield of rice was significantly higher in the treatment that received vermicompost 5 t ha-1, along with recommended NPK application.

Vasanthi *et al*. (1995) reported that vermicompost application along with inorganic fertilizers increased the organic carbon content and available nitrogen status of soil by 87.7 and 42.9 per cent, respectively. In another study it was indicated that vermicomposting significantly increased the organic carbon by 17.88 per cent, available nitrogen by 20.93 per cent, available phosphorus by 6.82 per cent and available potassium by 15.93 per cent (Bangar and Jatgar, 1995).

Laboratory analysis showed that vermicompost contains 3.0 per cent nitrogen, 1.0 per cent phosphorus and 1.5 per cent potash. Jambhekar (1994) reported that vermicompost contains 2.0 to 2.5 per cent available nitrogen, 1.0 to 1.5 per cent available phosphorus and 1.0 to 1.5 per cent available potassium and also secondary nutrients like Ca, Mg and micronutrients like Fe, Cu, Zn, Mn and Mo in sample quantities. Further, it contains ezymes like phosphatases, invertase, chitinase etc. and also growth harmones like indole acetic acid and gibberellic acid. Microbial analysis confirms that vermicompost is rich in microbes *viz*., bacteria like *Azotobacter* and *Azospirillum* besides number of actinomycetes.

Jadhav *et al*. (1993) reported that the water holding capacity and electrical conductivity of the soil were increased in the plots supplied with 5.0 t vermicompost per ha compared to control plots.

Hapse (1993) noticed that the organic carbon content of the soil increased by 0.27 per cent due to application of vermicompost compared to application of chemical fertilizer alone.

Vermicompost is rich in both macronutrients (0.56% N, 1.48% $P_2O_5$ and 0.36% $K_2O$) and micronutrients (Shinde *et al*., 1992), besides having plant growth promoting substances, humus forming microbes and nitrogen fixers (Bano and

Kale, 1987) observed more available phosphorus, total nitrogen and nitrate nitrogen in worm cast than surrounding soil.

The vermicompost is an aerobically degraded organic matter which has undergone chemical disintegration by the enzymic activity in the gut of earthworms and so also enzymes of the associated microbial population. It has been found that use of vermicompost in field crops, vegetables, flowering plants and fruit crops has increased the yield and improved the quality with less disease and pest incidence (Baphna, 1992).

Kale *et al*. (1992) opined that vermicompost was like any other organic manure depending on the nature of wastes used as feed for worms. The nitrogen content varied between 0.5 to 2.0 per cent. Similar variation in respect of phosphorus and potassium content was also been reported. In the vermicompost production, the complex organic residues are bio-degraded by symbiotic association between earthworms and microbes. In the process of vermicompost, it helps to increase the density of microbes and also provides sufficient energy to remain active. Vermicasting will provide the vital macro nutrients *viz*., N, P, K, Ca, Mg, and micronutrients such as Fe, Mo, Zn, Cu etc. Apart from these, it also contains plant growth promoting substances like NAA, cytokinins, gibberellins etc. the chemical analysis of vermicompost produced at Dharwad revealed the availability of N, P, and K content at 0.8, 1.1 and 0.5 per cent, respectively (Giraddi, 1993).

Kale *et al*. (1991) reported that application of vermicompost to summer paddy increased the uptake of nutrients and also increased the nitrogen and phosphorus contents of the soil. The application of vermicompost has long range influence on soil in improving chemical and biological properties.

Kale and Bano (1988) opined that fifty per cent of recommended NPK fertilizer could be saved with the application of 2.5 t ha-1 of vermicompost in upland and transplanted paddy. Studies conducted at Agricultural Research Station, Mugad under upland conditions have revealed that vermicompost application @ 2.5 t $ha^{-1}$was as good as application of 10 t $ha^{-1}$ FYM and these could substitute 50% of recommended dose of fertilizer in rice (Anon., 1993).

In a field study, Kale and Bano (1986) observed that the vegetative parameters like shoot weight, root weight, root and shoot length in IR -20 rice variety were positively correlated with the application of wormcast than with chemical fertilizer alone. This was due to higher availability of nitrogen for plant growth. The improved growth was also attributed to the release of plant growth promoting compounds from wormcast. Although there was no significant difference in grain yield of rice between wormcast and chemical fertilizer treatment, it was felt that application of wormcast might be beneficial in long run due to its favourable influence on soil structure and on colonization of useful microbes such as N-fixers and actinomycetes.

Senapathi *et al*. (1985) reported that paddy crop applied with vermicompost resulted in highest grain and straw production.

Das and Patra (1979) reported that vermicast contained 0.47% N compared to 0.35% N in the surrounding soil. Nitrogen contribution from mucus, dead earthworm tissue and wormcasts amounted to 180 kg $ha^{-1}$ $year^{-1}$.

## 2.3 Effect of nitrogen and vermicompost

Sudhakar (2016) conducted at Annamalai University, Experimental Farm, Annamalainagar, Chidambaram during two seasons to identify and evaluate different sources of vermicomposts on productivity enhancement, nutrient uptake and nitrogen use efficiency in low land rice under SRI method of cultivation The experiment comprised of eight treatments which includes recommend dose of fertilizer alone and in combination with vermicomposts prepared from various organic wastes namely Paddy straw, Coirpith, sewage sludge, Sugarcane trash, Pressmud and Crop residues @ 5t ha–1. These were laid out in randomized block design and replicated thrice. Rice cultivar ADT 36 was used as the test variety. The results revealed that crop raised with pressmud based vermicompost registered higher grain, straw yield and harvest index. The vermicompost treatments had significant influence on the nutrient uptake, Nitrogen use efficiency (NUE) and Economic nitrogen use efficiency (ENUE) over control and recommended dose of fertilizer by the crop at harvest. Among the different organic source of vermicompost, pressmud based vermicompost registered the highest N, P, K uptake, nitrogen use efficiency (NUE) and economic nitrogen use efficiency (ENUE) values at harvest. From the above experimental results, it could be concluded that with application of pressmud based vermicompost @ 5.0 t $ha^{-1}$ not only resulted in higher yields but also superior in respect of nutrient uptake and nitrogen economy under SRI method of rice cultivation.

Mahmud et *al*. (2016) studied the combined effect of vermicompost and chemical fertilizers on the nutrient content in grain, straw and post harvest soil of boro rice cv. BRRI dhan29, a field experiment was conducted in December, 2013 to June, 2014 at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. Sixteen combinations of 4 vermicompost level @ 0, 1, 2, 4 t ha 1 and 4 NPKS levels i.e. 0-0-0-0, 50-8-33-6, 100-16-66-12, 150-24-99-18 kg ha 1, respectively were applied in a Randomized Complete Block Design (RCBD) with three replications. Results showed that the highest dose of vermicompost and chemical fertilizer increased the concentration of P, K and S by rice grain and straw significantly at the harvesting stage. Combined application of vermicompost and chemical fertilizer failed to increase the total N content of post-harvest soil. Combination of vermicompost and chemical fertilizers also increased the organic matter, P, K and S status of post harvest soil significantly.

Sultana *et al.* (2015) conducted in Sher-e-Bangla Agricultural University Farm, Dhaka, Bangladesh during December, 2011 to April, 2012 to assess the effect of integrated use of vermicompost, pressmud and urea on the nutrient status of grain and straw of rice (Hybrid Dhan Hira 2). Ten treatments coded from T1 to T10 were used in this experiment. The highest amount of nitrogen (1.092%), phosphorus (0.297 %), potassium (0.374 %) in grain and the highest amount of potassium (1.213%), sulfur (0.091%) in straw were observed in T3 treatment receiving 90 kg N/ha from urea along with 30 kg N/ha from vermicompost. The highest sulfur (0.124 %) content in grain and the highest nitrogen (0.742%), the highest phosphorus (0.182 %) in straw was recorded in treatment T2 receiving 120 kg N/ha from urea. The highest amount of nitrogen (93.81 kg/ha), phosphorus (26.07 kg/ha), potassium (32.82 kg/ha) and sulfur (10.79 kg/ha) uptake by grains and the highest amount of nitrogen (55.70 kg/ha), phosphorus (13.79 kg/ha), potassium (92.43 kg/ha) and sulfur (6.91 kg/ha) uptake by straw of rice were observed in T3 treatment. On the other hand the lowest values of these parameters were obtained from control treatment T1.

Dekhane, *et al.* 2014) conducted a trial with three replications and six treatments was laid out in Randomized Block Design to assess the performance of different organic and inorganic fertilizer on growth and yield of paddy crop (Variety GR 11) during *Kharif* season. Different doses of fertilizers were applied to all the plots except untreated control. Application of 50 % N through RDF + 50% N through vermicompost recorded higher growth attributes like plant height was 42.2 cm and 118.1 cm, no. of tillers per plant was 8.7 and 12.1 at 45 DAT and at harvest time respectively, panicle length (22.3 cm), grains per panicle (128.0), 1000-grain weight (19.7 g) and grain yield (4.97 t/ha.) and straw yield (5.77 t/ha.) of rice variety GR 11. The data clearly revealed that the yield obtained with treatment T5 (50% RDF + 50% N through vermicompost) was recorded significantly higher growth as well as yield attributes than all other treatments.

# CHAPTER III

# MATERIALS AND METHODS

The experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from October 2015 to April 2016 to study effect of inorganic and organic (vermicompost) management on the growth and yield potential of boro rice. The details of the materials and methods have been presented below:

## 3.1 Description of the experimental site

### 3.1.1 Location

The present piece of research work was conducted at the experimental field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka. The location of the site is $23^{0}74^{/}$N latitude and $90^{0}35^{/}$E longitude with an elevation of 8.4 meter from sea level.

### 3.1.2 Soil

The soil belongs to “The Modhupur Tract”, AEZ – 28 (FAO, 1988). Top soil was silty clay loam in texture, olive-gray with common fine to medium distinct dark yellowish brown mottles. Soil pH was 6.2 and organic carbon content was 0.84%. The experimental area was flat having available irrigation and drainage system. The selected plot was medium high land. The details of experimental plot soil have been presented in Appendix-I.

### 3.1.3 Climate

The geographical location of the experimental site was under the subtropical climate, characterized by three distinct seasons, winter season from November to February and the pre-monsoon period or hot season from March to April and monsoon period from May to October. Details of the meteorological data of air temperature, relative humidity, rainfall and sunshine hour during the period of the experiment was collected from the Weather Station of Bangladesh, Sher-e Bangla Nagar, Dhaka and have been presented in Appendix II.

### 3.2 Test crop

BRRI dhan29 was used as the test crop in this experiment. The grains are medium fine and white.

### 3.3 Experimental details

#### 3.3.1 Treatments

Treatment combinations:

$T_1$= No chemical fertilizer, no organic manure (Control)

$T_2$=140 kg N ha$^{-1}$ from urea

$T_3$=120 kg N from urea + 20 kg N substituted by vermicompost

$T_4$=100 kg N from urea + 40 kg N substituted by vermicompost

$T_5$=80 kg N from urea + 60 kg N substituted by vermicompost

$T_6$=60 kg N from urea + 80 kg N substituted by vermicompost

$T_7$=40 kg N from urea + 100 kg N substituted by vermicompost

$T_8$=20 kg N from urea + 120 kg N substituted by vermicompost

$T_9$= 140 kg N substituted by vermicompost

#### 3.3.2 Experimental design and layout

The experiment was laid out in one factors Randomized Complete Block Design with three replications. The layout of the experiment was prepared for distributing the combination of different combination of nutrient levels. Thus there were 27 unit plots each of 4 m × 3 m size. The 9 treatments of the experiment were assigned at random in 9 plots of each block, representing a replication.

### 3.4 Growing of crops

### 3.4.1 Raising seedlings

#### 3.4.1.1 Seed collection

The seeds of the test crop i.e. BRRI dhan29 were collected from Bangladesh Rice Research Institute (BRRI), Joydevpur, Gazipur.

#### 3.4.1.2 Seed sprouting

Healthy seeds were selected by specific gravity method, the seeds were immersed in water bucket for 24 hours and then they were kept tightly in gunny bags. After taking the bucket seeds started sprouting after 48 hours and were sown after 72 hours.

### 3.4.2 Preparation of the main field

The plot selected for the experiment was opened in the first week of December 2015 with a power tiller, and was exposed to the sun for a week, after which the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain a good tilth. Weeds and stubble were removed, and finally obtained a desirable tilth of soil for transplanting of seedlings.

### 3.4.3 Fertilizers and manure application

The amounts of N, P, K, S and Zn fertilizers required per plot were calculated as per the treatments. Full amounts of TSP, $M_OP$, gypsum and zinc sulphate were applied as basal dose before transplanting of rice seedlings. Urea were applied in 3 equal splits: one third was applied at basal before transplanting, one third at active tillering stage (30 DAT) and the remaining one third was applied at 5 days before panicle initiation stage (55 DAT). Total amount of vermicompost as per calculated was applied during final land preparation.

### 3.4.4 Uprooting of seedlings

The nursery bed was made wet by application of water one day before uprooting of the seedlings. The seedlings were uprooted on December 17, 2015 for transplant on the date of 18 January without causing much mechanical injury to the roots.

### 3.4.5 Transplanting of seedlings in the field

On the scheduled dates as per experiment the rice seedlings were transplanted in lines each having a line to line distance of 30 cm and plant to plant distance 25 cm in the well prepared plots.

### 3.4.6 After care

After establishment of seedlings, various intercultural operations were accomplished for better growth and development of the rice seedlings.

#### 3.4.6.1 Irrigation and drainage

Flood irrigation was provided to maintain a constant level of standing water upto 6 cm in the early stages to enhance tillering and 10-12 cm in the later stage to discourage late tillering and weed growth. The field was finally dried out at 15 days before harvesting.

#### 3.4.6.2 Gap filling

First gap filling was done for all of the plots at 10 days after transplanting (DAT) by planting same aged seedlings.

#### 3.4.6.3 Weeding

Weedings were done to keep the plots free from weeds, which ultimately ensured better growth and development. The newly emerged weeds were uprooted carefully at tillering stage and at panicle initiation stage by mechanical means.

#### 3.4.6.4 Top dressing

After basal dose, the remaining doses of urea were top-dressed in 2 equal installments and were applied on both sides of seedlings rows in the soil.

#### 3.4.6.5 Plant protection

Furadan 57 EC was applied at the time of final land preparation and later on other insecticides were applied as and when necessary.

## 3.5 Harvesting, threshing and cleaning

The rice was harvested depending upon the maturity of plant and harvesting was done manually from each plot on 5th May, 2016. The harvested plants of each plot was bundled separately, properly tagged and brought to threshing floor. Enough care was taken during harvesting, threshing and cleaning of rice seed. Fresh weight of grain and straw were recorded plot wise. The grains were cleaned and finally the weight was adjusted to a moisture content of 14%. The straw was sun dried and the yields of grain and straw plot$^{-1}$ were recorded and converted to t ha$^{-1}$.

## 3.6 Data recording

### 3.6.1 Plant height

The height of the plant was recorded in centimeter (cm) at harvest. Data were recorded as the average of 5 plants selected at random from the inner rows of each plot. The height was measured from the ground level to the tip of the tiller.

### 3.6.6 Total tillers hill$^{-1}$

The total tillers hill$^{-1}$ was calculated by adding effective and non-effective tillers hill$^{-1}$ and average value was recorded.

### 3.6.6 Dry matter plant$^{-1}$

Total dry matter plant$^{-1}$ was recorded at harvest after oven drying of sample plants. Data were recorded as the average of 3 sample hill$^{-1}$ selected at random from the inner rows of each plot and expressed in gram

.

### 3.6.7 Length of panicle

The length of panicle was measured with a meter scale from 10 selected panicles and the average value was recorded.

### 3.6.8 Filled grain panicle$^{-1}$

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

### 3.6.9 Unfilled grains panicle$^{-1}$

The total number of unfilled grains was collected randomly from selected 5 plants of a plot on the basis of no grain in the spikelet and then average number of unfilled grains panicle$^{-1}$ was recorded.

### 3.6.12 Grain yield

Grains obtained from each unit plot were sun-dried and weighed carefully. The dry weight of grains of central 1 m$^2$ area and five sample plants were added to the respective grain yield m$^{-2}$ and converted to t ha$^{-1}$.

### 3.6.13 Straw yield

Straw obtained from each unit plot were sun-dried and weighed carefully. The dry weight of straw of central 1 m$^2$ area and five sample plants were added to the respective straw yield m$^{-2}$ and finally converted to t ha$^{-1}$.

### 3.6.14 Biological yield

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

Biological yield = Grain yield + Straw yield.

### 3.6.15 Harvest index

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

$$HI = \frac{\text{Economic yield (grain weight)}}{\text{Biological yield (Total dry weight)}} \times 100$$

## 3.7 Chemical analysis

### 3.7.1 Collection and preparation of plant samples

Grain and straw samples were collected after threshing for N, P, K and S analyses. The plant samples were dried in an oven at 70 $^{0}$C for 72 hours and then ground by a grinding machine (Wiley-mill) to pass through a 20-mesh sieve. The samples were stored in plastic vial for analyses of N, P, K and S. The grain and straw samples were analyzed for the determination of N, P, K and S concentrations. The methods used were as follows:

### 3.7.2 Digestion of plant samples with sulphuric acid for N

For the determination of nitrogen an amount of 0.5 g oven dried, ground sample was taken in a micro Kjeldahl flask. 1.1 g catalyst mixture ($K_2SO_4$: $CuSO_4$. $5H_2O$: Se in the ratio of 100: 10: 1), and 7 ml conc. $H_2SO_4$ were added. The flasks were heated at 160$^{0}$ C and 2 ml 30% $H_2O_2$ was added ,then heating was continued at 360$^{0}$ C until the digests become clear and colorless. After cooling, the content was taken into a 50 ml volumetric flask and the volume was made up to the mark with de-ionized water. A reagent blank was prepared in a similar manner. Nitrogen in the digest was estimated by distilling the digest with 10 N NaOH followed by titration of the distillate trapped in $H_3BO_3$ indicator solution with 0.01N $H_2SO_4$.

### 3.2.3 Digestion of plant samples with nitric-perchloric acid for P, K and S

A sub sample weighing 0.5 g was transferred into a dry, clean 100 ml digestion vessel. Ten ml of di-acid ($HNO_3$: $HClO_4$ in the ratio 2:1) mixture was added to the flask. After leaving for a while, the flasks were heated at a temperature slowly raised to $200^0$C. Heating were stopped when the dense white fumes of $HClO_4$ occurred. The content of the flask were boiled until they were became clean and colorless. After cooling, the content was taken into a 50 ml volumetric flask and the volume was made up to the mark with de-ionized water. P, K and S were determined from this digest by using different standard methods.

### 3.8 Statistical Analysis

The data obtained for different characters were statistically analyzed for ANOVA to observe the significant difference among the treatment means. The mean values of all the characters were calculated and analysis of variance was performed. The significant difference among the treatments means was estimated by the Duncan's Multiple Range Difference (DMRT) test at 5% level of probability (Gomez and Gomez, 1984).

# Chapter IV

## RESULTS AND DISCUSSION

The experiment was conducted to investigate the effects of integrated use of urea and vermicompost on the growth and yield potential of *Boro* rice. Data on different parameters were analyzed statistically. The result of the present study have been presented and discussed in this chapter under the following heading.

### 4.1. Plant height

The effects of nutrient management practices were evident at harvest recorded significantly influenced on plant height. The tallest plant (110.3 cm) was produced in $T_5$ (80 kg N from urea + 60 kg N substituted by vermicompost). The lowest plant height (93.01cm) was produced under control treatment. The increase in plant height due to application of increased level of fertilizer and manure might be associated with stimulating effect of nitrogen on various physiological processes including cell division and cell elongation of the plant. In general, plant height increased with the increasing level of nitrogen with organic matter. The results are in agreement with those of Singh and Singh (1986) who reported a positive effect of USG level on plant height.

**Table 1. Effect of integrated use of urea and vermicompost on plant height, number of tiller per hill and number of effective tiller per hill of rice**

| Treatment | **Plant Height (cm)** | | **No. of tiller per hill** | | **Effective tiller per hill** | |
|---|---|---|---|---|---|---|
| $T_1$ | 93.01 | c | 12.73 | d | 10.33 | c |
| $T_2$ | 109.30 | a | 19.20 | a | 17.20 | a |
| $T_3$ | 108.20 | ab | 16.20 | c | 15.13 | abc |
| $T_4$ | 97.54 | bc | 16.33 | bc | 14.73 | abc |
| $T_5$ | 110.30 | a | 20.07 | a | 18.44 | a |
| $T_6$ | 104.60 | ab | 16.67 | bc | 15.73 | ab |
| $T_7$ | 100.20 | abc | 18.40 | ab | 16.53 | ab |
| $T_8$ | 99.06 | abc | 15.73 | c | 14.93 | abc |
| $T_9$ | 93.31 | c | 13.00 | d | 12.00 | bc |
| LSD $_{(0.05)}$ | 10.17 | | 2.01 | | 4.60 | |
| CV (%) | 7.26 | | 10.44 | | 7.70 | |

$T_1$= No chemical fertilizer, no organic manure (Control)

$T_2$=140 kg N ha$^{-1}$ from urea

$T_3$=120 kg N from urea + 20 kg N substituted by vermicompost

$T_4$=100 kg N from urea + 40 kg N substituted by vermicompost

$T_5$=80 kg N from urea + 60 kg N substituted by vermicompost

$T_6$=60 kg N from urea + 80 kg N substituted by vermicompost

$T_7$=40 kg N from urea + 100 kg N substituted by vermicompost

$T_8$=20 kg N from urea + 120 kg N substituted by vermicompost

$T_9$= 140 kg N substituted by vermicompost

## 4.2 Number of total tiller hill$^{-1}$

Total number of tiller per hill was statistically influenced by nitrogen and vermicompost (Table 1). The maximum total number of tiller hill$^{-1}$ (20.07) was produced from $T_5$. Minimum total number of tiller hill$^{-1}$ 12.73) was produced form $T_1$ treatment. The progressive improvement in the formation of tillers with might be due to effect of fertilizer and manure. Mirzeo and Reddy (1989) and Singh and Singh (1986), also reported similar results.

## 4.3 Number of effective tiller hill$^{-1}$

Number of effective tiller per hill was statistically influenced by nitrogen and vermicompost (Table 1). The maximum total number of tiller hill$^{-1}$ (18.44) was produced from $T_5$, which was statistically similar with $T_2$ treatment. Minimum total number of tiller hill$^{-1}$ (10.33) was observed form $T_1$ treatment.

## 4.4 Panicle length

Panicle length was statistically affected by levels of nitrogen and vermicompost (Table 2). Longest (23.82 cm) panicle was produced from $T_5$ treatment. Lowest (21.6 cm) panicle length was produced form $N_o$ treatment, which was statistically similar with $T_2$, $T_4$, $T_7$ and $T_8$. A similar finding was reported by Hasan *et al.* (2002).

## 4.5 Number of filled grains panicle$^{-1}$

From the table 2 it was observed that there was a statistical variation in number of filled grains panicle$^{-1}$ due to nitrogen and vermicompost. Results showed that highest number of filled grains panicle$^{-1}$ was obtained (160.30) from $T_5$ treatment. The lowest number of filled grains panicle$^{-1}$ (134.90) was found from control treatment. Gradual adequate supply of nitrogen form vermicompost contributed to grain formation which probably increased number of grain panicle$^{-1}$ with increasing nitrogen level. Rama *et al.* (1989) found significantly higher filled grains panicle$^{-1}$ with 40, 80 or 120 kg N ha$^{-1}$. The present results supported those results.

### 4.6 Number of unfilled grains panicle$^{-1}$

Among the traits made, number of unfilled grains panicle$^{-1}$ plays a vital role in yield reduction. Number of unfilled grains panicle$^{-1}$ was statistically influenced from the different nitrogen and vermicompost combination levels (Table 2). The highest number of unfilled grains panicle$^{-1}$ was obtained (20.13) from control treatment. The lowest number of unfilled grains panicle$^{-1}$ (14.60) was found from $T_5$ (80 kg N from urea + 60 kg N substituted by equal portion of vermicompost) treatment. Hasan *et al.* (2002) also observed that unfilled grains panicle$^{-1}$ was unaffected by the application of higher doses of nitrogen fertilizer.

**Table 2. Effect of integrated use of urea and vermicompost on yield contributing character of rice**

| Treatment | Panicle length (cm) | Filled grains panicle$^{-1}$ | Unfilled grains panicle$^{-1}$ |
|---|---|---|---|
| $T_1$ | 22.12 b | 134.90 d | 20.13 a |
| $T_2$ | 22.18 b | 155.90 ab | 19.07 ab |
| $T_3$ | 22.93 ab | 152.40 abc | 18.33 ab |
| $T_4$ | 21.60 b | 138.00 cd | 16.13 ab |
| $T_5$ | 23.82 a | 160.30 a | 14.60 b |
| $T_6$ | 22.37 ab | 143.60 bcd | 17.33 Ab |
| $T_7$ | 21.93 b | 147.50 abcd | 15.27 Ab |
| $T_8$ | 21.94 b | 146.00 abcd | 19.67 A |
| $T_9$ | 22.61 ab | 145.90 abcd | 16.40 Ab |
| $LSD_{(0.05)}$ | 1.41 | 14.05 | 4.46 |
| CV (%) | 7.29 | 11.08 | 5.87 |

$T_1$= No chemical fertilizer, no organic manure (Control)

$T_2$=140 kg N ha$^{-1}$ from urea

$T_3$=120 kg N from urea + 20 kg N substituted by vermicompost

$T_4$=100 kg N from urea + 40 kg N substituted by vermicompost

$T_5$=80 kg N from urea + 60 kg N substituted by vermicompost

$T_6$=60 kg N from urea + 80 kg N substituted by vermicompost

$T_7$=40 kg N from urea + 100 kg N substituted by vermicompost

$T_8$=20 kg N from urea + 120 kg N substituted by vermicompost

$T_9$= 140 kg N substituted by vermicompost

### 4.7 Grain yield (t/ha)

Grain yield affected significantly due to the levels of different nitrogen and vermicompost combination levels (Table 3). The maximum grain yield (6.86 t $ha^{-1}$) was produced from $T_5$ treatment. The minimum grain yield 2.35 t $ha^{-1}$) was produced from control treatment. Similar results were reported by Mishra *et al.* (2000) and Raju *et al.* (1987) who observed that among all the levels of N recorded the highest grain yield and proved significantly superior to other sources. Adequate amount of nitrogen application probably favoured to yield components i.e. number of tillers $hill^{-1}$, panicle length, and number of grain which ultimately gave higher grain yield.

### 4.8 Straw yield

From the Table 3, it was found that straw yield was significantly affected due to the levels of different nitrogen and vermicompost combination levels. The maximum straw yield (6.92 t $ha^{-1}$) was produced from $T_5$ treatment. The minimum straw yield 2.99 t $ha^{-1}$) was observed from control treatment.

### 4.9 Biological yield

It was evident from the results (Table 3) that biological yield was significantly affected by the levels of nitrogen and vermicompost. The maximum biological yield (13.78 t $ha^{-1}$) was produced from $T_5$ treatment. The minimum biological yield (5.34 t $ha^{-1}$) was observed from control treatment.

**Table 3. Effect of integrated use of urea and vermicompost on yield and yield contributing character of rice**

| Treatment | Grain Yield (t ha$^{-1}$) | Straw yield (t ha$^{-1}$) | Biological Yield (t ha$^{-1}$) | Harvest Index (%) |
|---|---|---|---|---|
| $T_1$ | 2.35 e | 2.99 f | 5.34 g | 43.30 cd |
| $T_2$ | 4.50 bc | 5.48 b | 9.98 cd | 44.68 bcd |
| $T_3$ | 2.85 de | 4.90 c | 7.75 ef | 35.29 d |
| $T_4$ | 4.18 cd | 4.60 d | 8.78 de | 47.50 abc |
| $T_5$ | 6.86 a | 6.92 a | 13.78 a | 49.76 abc |
| $T_6$ | 5.81 ab | 5.45 b | 11.26 bc | 51.45 abc |
| $T_7$ | 6.57 a | 5.69 b | 12.26 ab | 53.59 ab |
| $T_8$ | 5.86 ab | 4.64 d | 10.50 c | 55.68 a |
| $T_9$ | 3.41 cde | 3.27 e | 6.68 fg | 50.98 abc |
| $LSD_{(0.05)}$ | 1.51 | 0.24 | 1.64 | 5.87 |
| CV (%) | 9.97 | 6.99 | 6.83 | 7.07 |

$T_1$= No chemical fertilizer, no organic manure (Control)

$T_2$=140 kg N ha$^{-1}$ from urea

$T_3$=120 kg N from urea + 20 kg N substituted by vermicompost

$T_4$=100 kg N from urea + 40 kg N substituted by vermicompost

$T_5$=80 kg N from urea + 60 kg N substituted by vermicompost

$T_6$=60 kg N from urea + 80 kg N substituted by vermicompost

$T_7$=40 kg N from urea + 100 kg N substituted by vermicompost

$T_8$=20 kg N from urea + 120 kg N substituted by vermicompost

$T_9$= 140 kg N substituted by vermicompost

### 4.10 Harvest Index

Levels of nitrogen fertilizer with vermicompost had exerted significant variation on harvest index (Table 3). The maximum harvest index (55.68%) was produced from $T_8$ treatment. The minimum harvest index (43.30 %) was produce from $T_3$ treatment. Ali (2005) was reported that N management strategy did not influence HI. On the other hand Miah *et al.* (2004) also reported that levels of nitrogen fertilizer had exerted very little variation on harvest index.

### 4.11 NPKS concentration in grain

#### 4.11.1 Effect of integrated use of urea and vermicompost on N concentration in grain

Nitrogen concentrations in grain of rice showed statistically significant variation due to the application of integrated use of urea and vermicompost are presented in Table 4. The nitrogen concentration in Boro rice grain significantly increased due to application of urea and vermicompost. The higher levels of grain N concentrations were recorded in the combined application of integrated use of urea and vermicompost compare to the chemical fertilizer alone. The highest N concentration in grain (1.002%) was recorded from $T_5$ treatment. On the other hand, the lowest N concentration in grain (0.5661%) was found from $T_0$ as control treatment which was closely followed by $T_3$ and $T_8$. A significant increase in N content in rice grain due to the application of organic manure and fertilizers have been reported by investigators (Azim, 1999 and Hoque, 1999).

**Table 4. Effect of integrated use of urea and vermicompost on NPKS concentration in grain**

| Treatment | Concentration (%) in grain | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **N** | | **P** | | **K** | | **S** | |
| $T_1$ | 0.5661 | f | 0.2000 | c | 0.3830 | d | 0.0711 | b |
| $T_2$ | 0.6991 | d | 0.2554 | ab | 0.4414 | bc | 0.1071 | ab |
| $T_3$ | 0.6801 | e | 0.2304 | bc | 0.4324 | c | 0.1051 | ab |
| $T_4$ | 0.7271 | c | 0.2724 | a | 0.4734 | ab | 0.1191 | a |
| $T_5$ | 1.0020 | a | 0.2857 | a | 0.4867 | a | 0.1291 | a |
| $T_6$ | 0.9068 | b | 0.2794 | a | 0.4824 | a | 0.1251 | a |
| $T_7$ | 0.6691 | e | 0.2107 | c | 0.4277 | c | 0.1031 | ab |
| $T_8$ | 0.7081 | d | 0.2724 | a | 0.4544 | abc | 0.1121 | ab |
| $T_9$ | 0.5731 | f | 0.2014 | c | 0.3874 | d | 0.0731 | b |
| $LSD_{(0.05)}$ | 0.0173 | | 0.0300 | | 0.0346 | | 0.0387 | |
| CV (%) | 5.35 | | 6.87 | | 7.54 | | 8.26 | |

$T_1$= No chemical fertilizer, no organic manure (Control)

$T_2$=140 kg N ha$^{-1}$ from urea

$T_3$=120 kg N from urea + 20 kg N substituted by vermicompost

$T_4$=100 kg N from urea + 40 kg N substituted by vermicompost

$T_5$=80 kg N from urea + 60 kg N substituted by vermicompost

$T_6$=60 kg N from urea + 80 kg N substituted by vermicompost

$T_7$=40 kg N from urea + 100 kg N substituted by vermicompost

$T_8$=20 kg N from urea + 120 kg N substituted by vermicompost

$T_9$= 140 kg N substituted by vermicompost

### 4.11.2 Effects of integrated use of urea and vermicompost on P concentration of boro rice grain

Phosphorous concentrations in grain of rice showed significant variation due to the application of integrated use of urea and vermicompost are presented in Table 4. The highest P concentration in grain (0.28%) was recorded from $T_5$ which was statistically similar with $T_4$, $T_6$ and $T_8$. On the other hand, the lowest P concentration in grain (0.200%) was found from $T_0$ as control treatment which was statistically similar with $T_9$. Significant increase in P content in rice straw due to the application of organic manure and fertilizers was reported by many investigators (Azim, 1999 and Hoque, 1999).

### 4.11.3 Effect of integrated use of urea and vermicompost on K concentration in boro rice grain

Potassium concentrations in grain of rice showed significant variation due to the application of integrated use of urea and vermicompost are presented in Table 4. The highest K concentration in grain (0.4867%) was recorded from $T_5$ treatment, which was statistically similar with $T_6$. On the other hand, the lowest K concentration in grain (0.383%) was found from $T_1$ as control treatment, which was statistically similar with $T_9$. Singh *et al.* (2001) revealed that Potassium content in grain was increased due to combined application of organic manure and chemical fertilizers.

### 4.11.4 Effects of integrated use of urea and vermicompost on S concentration in boro rice grain

Sulphur concentrations in grain of rice showed significant variation due to the application of integrated use of urea and vermicompost are presented in Table 4. The highest S concentration in grain (0.12%) was recorded from $T_{5,}$ which was statistically similar with $T_4$ and $T_{6.}$ On the other hand, the lowest S concentration in grain (0.05%) was found from $T_1$ as control treatment, which was statistically similar with $T_9$ treatment.

### 4.12.1 Effect of fertilizer on N concentration in boro rice straw

Nitrogen concentrations in straw of boro rice showed significant variation due to the application of integrated use of urea and vermicompost are presented in Table 5. The N concentration of boro rice straw significantly increased due to the application of integrated use of urea and vermicompost. The higher N concentrations were found in the treatments those received integrated use of urea and vermicompost combined. The highest N concentration in straw (0.57%) was recorded from $T_5$. On the other hand, the lowest N concentration in straw (0.32%) was found from $T_0$ as control treatment, which was statistically similar with $T_9$ treatment.

### 4.12.2 Effect of different doses of integrated use of urea and vermicompost on P concentration in straw

The application of different levels of integrated use of urea and vermicompost increased the P concentration of Boro rice. Phosphorous concentrations in straw of rice showed significant variation due to the application of integrated use of urea and vermicompost (Table 5). The highest P concentration in straw (0.08%) was recorded from $T_5$. On the other hand, the lowest P concentration in straw (0.05%) was found from $T_1$ as control treatment, which was statistically similar with $T_9$ treatment.

### 4.12.3 Effects different doses of integrated use of urea and vermicompost on K concentration in boro rice straw

Potassium concentrations in straw of rice showed significant variation due to the application of integrated use of urea and vermicompost (Table 5). The highest K concentration in straw (1.54%) was recorded from $T_{10,}$ which was statistically similar with $T_6$ treatment. On the other hand, the lowest K concentration in straw

(0.08%) was found from $T_0$ as control treatment. Singh *et al.* (2001) reported that Potassium content in grain was increased due to combined application of organic manure and chemical fertilizers.

### 4.12.4 Effect of integrated use of urea and vermicompost on S concentration in straw of boro rice

Sulphur concentrations in straw of rice showed insignificant variation due to the application of integrated use of urea and vermicompost (Table 5). The highest S concentration in straw (0.09%) was recorded from $T_5$, which was statistically similar with $T_6$ treatment. On the other hand, the lowest S concentration in straw (0.05%) was found from $T_0$ as control treatment. Azim (1999) and Hoque (1999) reported that application of sulphur from manure and fertilizers increased S content both in grain and straw.

**Table 5. Effect of integrated use of urea and vermicompost on NPKS concentration in straw**

| Treatment | Concentration (%) in grain | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | N | | P | | K | | S | |
| $T_1$ | 0.3390 | f | 0.0473 | D | 0.8334 | e | 0.0507 | cd |
| $T_2$ | 0.4534 | de | 0.0673 | abcd | 1.1770 | bc | 0.0621 | bcd |
| $T_3$ | 0.4164 | e | 0.0593 | bcd | 1.0940 | cd | 0.0641 | bcd |
| $T_4$ | 0.5134 | bc | 0.0783 | abc | 1.2030 | b | 0.0781 | ab |
| $T_5$ | 0.5717 | a | 0.0873 | a | 1.5380 | a | 0.0884 | a |
| $T_6$ | 0.5664 | ab | 0.0853 | ab | 1.4580 | a | 0.0881 | a |
| $T_7$ | 0.4087 | e | 0.0703 | abcd | 1.0440 | d | 0.0694 | bc |
| $T_8$ | 0.4914 | cd | 0.0553 | cd | 1.1840 | bc | 0.0591 | bcd |
| $T_9$ | 0.3434 | f | 0.0493 | d | 0.8717 | e | 0.0501 | d |
| $LSD_{(0.05)}$ | 0.0547 | | 0.0245 | | 0.0948 | | 0.0173 | |
| CV (%) | 6.25 | | 5.68 | | 7.32 | | 8.75 | |

$T_1$= No chemical fertilizer, no organic manure (Control)

$T_2$=140 kg N $ha^{-1}$ from urea

$T_3$=120 kg N from urea + 20 kg N substituted by vermicompost

$T_4$=100 kg N from urea + 40 kg N substituted by vermicompost

$T_5$=80 kg N from urea + 60 kg N substituted by vermicompost

$T_6$=60 kg N from urea + 80 kg N substituted by vermicompost

$T_7$=40 kg N from urea + 100 kg N substituted by vermicompost

$T_8$=20 kg N from urea + 120 kg N substituted by vermicompost

$T_9$= 140 kg N substituted by vermicompost.

Integrated use of urea-N and vermicompost(VC) significantly influenced the yield component and yield of boro rice.

# CHAPTER V

# SUMMERY AND CONCLUSIONS

The experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from October 2015 to April 2016 to study effect of inorganic and organic (vermicompost) management on the growth and yield potential of boro rice. The experimental treatments included $T_1$= No chemical fertilizer, no organic manure (Control), $T_2$=140 kg N ha$^{-1}$ from urea, $T_3$=120 kg N from urea + 20 kg N substituted by vermicompost, $T_4$=100 kg N from urea + 40 kg N substituted by vermicompost, $T_5$=80 kg N from urea + 60 kg N substituted by vermicompost, $T_6$=60 kg N from urea + 80 kg N substituted by vermicompost, $T_7$=40 kg N from urea + 100 kg N substituted by vermicompost, $T_8$=20 kg N from urea + 120 kg N substituted by vermicompost, $T_9$= 140 kg N substituted by vermicompost. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The entire field was divided into three blocks each containing 9 plots. In total, there were 27 plots. The treatments were randomly assigned to each unit plot. The size of unit plot was 4 m ×3 m.

The effects of nutrient management practices were evident at harvest recorded significantly influenced on plant height. The tallest plant (110.3 cm) was produced in $T_5$ (80 kg N from urea + 60 kg N substituted by vermicompost). Total number of tiller per hill was statistically influenced by nitrogen and vermicompost (Table 1). The maximum total number of tiller hill$^{-1}$ (20.07) was produced from $T_5$. Number of effective tiller per hill was statistically influenced by nitrogen and vermicompost. The maximum total number of tiller hill$^{-1}$ (18.44) was produced from $T_{5.}$ Longest (23.82 cm) panicle was produced from $T_5$ treatment. There was a statistical variation in number of filled grains panicle$^{-1}$. The highest number of filled grains panicle$^{-1}$ (160.30) was obtained from $T_5$ treatment. Number of unfilled grains panicle$^{-1}$ was statistically influenced from the different nitrogen and vermicompost combination levels .The highest number of unfilled grains panicle$^{-1}$ (20.13) was obtained from control treatment. Grain yield increased significantly due to nitrogen and vermicompost combinations at different levels. The maximum grain yield (6.86 t ha$^{-1}$) was produced from $T_5$ treatment. The minimum grain yield (2.35 t ha$^{-1}$) was produced from control treatment. The straw yield was significantly affected due to the levels of different nutrient management. The maximum straw yield (6.92 t ha$^{-1}$) was produced from $T_5$ treatment. The maximum biological yield (13.78 t ha$^{-1}$) was produced from $T_5$ treatment.. Levels of nitrogen fertilizer with vermicompost had exerted significant variation on harvest index. The maximum harvest index (55.68%) was produced from $T_8$ treatment. The minimum harvest index (43.30 %) was produce from $T_3$ treatment.

The highest N (1.02%), P (0.28%), K (0.48%) and S (0.13%) concentration in grain was recorded from $T_5$ (80 kg N from urea + 60 kg N substituted by vermicompost). The highest N (0.5717%), P (0.873%), K (1.538%) and S (0.0884%) concentration in straw was recorded from $T_5$ (80 kg N from urea + 60 kg N substituted by vermicompost).

It may be included that a package of 80 kg urea-N along with 6tha$^{-1}$ vermicompost (in aid of substituting 60kg N demand) appeared in remunerative in augmenting the boro rice yield for Deep Red Brown Terrace Soil under AEZ-28. However further research is suggestein achieving final conclusion and recommendation.

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# APPENDIES

**Appendix I**: **Soil characteristics of experimental farm of Sher-e-Bangla Agricultural University are analyzed by soil Resources Development Institute (SRDI), Farmgate, Dhaka.**

## A. Morphological characteristics of the experimental field

| Morphological features | Characteristics |
|---|---|
| Location | SAU farm, SAU, Dhaka |
| AEZ | Modhupur tract (28) |
| General soil type | Deep red brown terrace soil |
| Land type | High land |
| Soil series | Tejgaon |
| Topography | Fairly leveled |
| Flood level | Above flood level |
| Drainage | Well drained |
| Cropping pattern | **N/A** |

Source: SRDI

## B. Physical and chemical properties of the initial soil

| Characteristics | Value |
|---|---|
| Practical size analysis | |
| Sand (%) | 16 |
| Silt (%) | 56 |
| Clay (%) | 28 |
| Silt + Clay (%) | 84 |
| Textural class | Silty Clay Loam |
| pH | 6.2 |
| Total N (%) | 0.04 |
| Available P (µgm/gm soil) | 24.0 |
| Available K (me/100g soil) | 0.13 |
| Available S (µgm/gm soil) | 14.0 |

**Appendix II. Monthly air temperature, Rainfall and Relative humidity of the experimental site during the study period (October, 2015 to April, 2016)**

| Year | Month | Air temperature ($^0$C) | | | Rainfall** (mm) | * Relative humidity (%) |
|---|---|---|---|---|---|---|
| | | Max. | Min. | Mean | | |
| 2015 | October | 35.6 | 17.5 | 26.455 | 320 | 74.5 |
| | November | 29.8 | 16.8 | 24.3 | 14 | 68.0 |
| | December | 25.2 | 13.3 | 19.75 | 0.00 | 66.0 |
| 2016 | January | 28.0 | 12.8 | 20.40 | 0 | 17.5 |
| | February | 28.9 | 16.2 | 22.55 | 48 | 56 |
| | March | 35.4 | 24.3 | 29.85 | 22 | 59 |
| | April | 35.5 | 24.4 | 29.95 | 37 | 67 |

* Monthly average
** Monthly total
Source: The Meteorological Department (Weather division) of Bangladesh, Agargoan, Dhaka