INFLUENCE OF THE INTEGRATED NUTRIENT MANAGEMENT ON THE GROWTH, YIELD AND NUTRIENT CONTENTS OF BINA DHAN 8

BY

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CERTIFICATE

This is to certify that the thesis entitled Influence of the **Integrated Nutrient Management on the Growth, Yield and Nutrient Contents of BINA Dhan 8** 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 Agricultural Chemistry**, embodies the result of a piece of bonafide research work carried out by **Mst. Tabreatus Salehin,** Registration number: **11-04709** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, received during the course of this investigation has duly been acknowledged.

Dated:
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Dedicated To

My Beloved Parent

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ABSTRACT

A field experiment was conducted at the research field of Sher-e-Bangla Agricultural University, Dhaka, during the period from November 2012 to May,2013 to study the effect of organic manures viz., Poultry manure, Mustard oil cake, sesame oil cake, vermicompost and inorganic fertilizers on yield and nutrient uptake by BINA dhan-8. There were altogether 11 treatments viz.T_0 (Control), T_1 (100% NPKSZn), T_2 (50% NPKSZn + Poultry manure@5t ha^{-1}), T_3 (75% NPKSZn + Poultry manure@5t ha^{-1}), T_4 (50% NPKSZn + Mustard oil cake@5t ha^{-1}), T_5 (75% NPKSZn + Mustard oil cake@5t ha^{-1}), T_6 (50% NPKSZn +Sesame oil cake@5t ha^{-1}), T_7 (75% NPKSZn + Sesame oil cake@5t ha^{-1}), T_8 (50% NPKSZn +Vermicompost@5t ha^{-1}), T_9 (75% NPKSZn + Vermicompost@5tha^{-1}) and T_{10} (Poultry manure@1.25t ha^{-1} + Mustard oil cake@1.25t ha^{-1} + Sesame oilcake @1.25t ha^{-1} + Vermicompost @1.25t ha^{-1}). The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. All the yield contributing characters were significantly influenced by the application of both organic manures and inorganic fertilizer combination. Highest plant height, leaves, panicle length,1000-seed weight grain yield , straw yield and biological yield were obtained when 75% of the recommended doses of N,P,K,S,Zn fertilizer along with 5 t ha^{-1} sesame oil cake was applied and the lowest values of all the parameters were obtained from the plants fertilized with neither organic manures and inorganic fertilizers. Nutrient contents of BINA dhan 8 were also significantly affected by different treatments. Highest N,P,K and S contents of both grain and straw were obtained from the same treatment . The lowest nutrient contents were obtained from the control treatment.The overall results suggest that farmers should be advised to use 75% of NPKSZn fertilizers along with 5 t ha^{-1} sesame oil cake for getting higher yield and quality in terms of nutrient contents of BINA dhan 8 under the agro-climatic condition of SAU.

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INTRODUCTION

INTRODUCTION

Bangladesh is an agro-based country and thus most of our economic activities are related to agriculture. More than 80% of the population is directly dependent on agriculture. In Bangladesh rice dominates over all other crops and covers 75% of the total cropped area and 92% peasants grow rice (Rekabder,2004).The total area and production of rice in Bangladesh about 10.53 million ha and 26.53 million metric tons, respectively (BBS, 2010). About 76.69% of total cultivable land in Bangladesh is used for rice production, which contributes 21.12% total agricultural production and engages about 48% of total agricultural forces. Bangladesh earns about 23.87% of its gross domestic product (GDP) from agriculture (Krishi Diary, 2011).

The climatic condition of Bangladesh is favourable for rice cultivation. More than 80% of the total cultivable land is used for rice cultivation. Rice is a particularly important food for a larger population of the world. It is cultivated in the countries of all continents (Except Antarctica) from 53^0N to 40^0S latitude (Lu and Chang, 1980).

The crop production in Bangladesh is dominated by intensive rice cropping and the most dominated cropping pattern is Boro-T.aman rice. Out of the total production in this country about 48%, 45% and 7% come from Boro, Aman and Aus, respectively. Although Bangladesh ranks 4^{th} in the world both in acreage and production of rice (FAO, 2000), it ranks 39^{th} in the yield (IRRI, 1995). Annual food grain deficit in Bangladesh is about 2.19 million tons per year (AIS, 1997) which could be minimize either by bringing more land under cultivation and by increasing the rice yield per unit area. The latter is the only possible means for minimizing food deficit the population pressure on agricultural land is increasing day by day. To ensure the food security for the present and future generation, the agricultural scientists and farmers are under pressure for producing more and more rice.

Integrated nutrient management approach could give higher yield in a suitable way. Fertilizers are indispensable for the crop production systems of modern agriculture.

Among the factors that affect crop production, fertilizer is the single most important factor that plays a crucial role in the yield increase and other factors are not limiting. Inorganic fertilizers today hold the key to the success of the crop production systems of Bangladesh agriculture, being responsible for about 50% of the total production.

Among the plant nutrients, nitrogen is the key element which can augment the production of rice to a great extent. Urea has been found to be effective nitrogenous fertilizer that gives good yield (BRRI, 1998). The low nitrogen use efficiency has always seen a problem due to a substantial loss of the applied fertilizer. Phosphorus is the second major nutrient for plant growth and plays a critical role in the life cycle of plants. Although phosphorus is widely deficient in Bangladesh soils, the farmers are not fully aware of using phosphatic fertilizers. As a result, phosphate supplies in most of the Bangladesh soils are generally in adequate for good crop yield. Potassium is one of the primary and third so called major food elements for plant growth. Its function appears to be catalytic in nature and its deficiencies may greatly reduce crop yield. Potassium is found in soils in varying amounts but the reaction of total potassium in the plant availability is very small. Sulphur is increasingly being recognized as the fourth major element for plant growth and plays a unique role in plant metabolism. In Bangladesh, sulphur deficiency in rice was first detected at BRRI farm, Joydebpur, Gazipur (Islam, 1978). Recently, the deficiency of this element has become alarming with the introduction of sulphur free fertilizer. Sulphur deficiency has been receiving increased attention as a major factor limiting wetland rice yields and proper plant growth. Zn increases the metabolic functions of plants. It is essential in formation of chlorophyll and carbohydrate by plants. Efficient fertilizer management gives higher yields of the crops and reduces fertilizer cost (Hossain and Islam, 1986).

Organic manure contains a wide range of nutrients. It is true that sustainable production of crops cannot be maintained by using only chemical fertilizer and similarly it is not possible to obtain high crop yield by using organic manure alone (Bair, 1990). Moreover, suitable combination of organic and inorganic sources of nutrients is necessary for sustainable agriculture that will provide food with good quality and maintain sound environment.

Green manure which is of organic origin offers the twin benefits of soil quality and fertility enhancement while meeting a part of nutrient need of crops. It provide regulated supply of N by releasing it slowly resulting in increased yield of rice and nutrient use efficiency (Sharma, 2002). Yields of rice can be increased about 50% by using green manures with chemical fertilizers (BRRI 1983 and 1984).

Oil cake has the potential for improving soil and water conservation sustaining soil productivity and enhancing crop yields. It also plays an important role in improving the nutrient supply capacity for achieving higher yield of aman rice. Under organic nutrient management and maintained soil health besides providing non-polluting environments.

High market price and uncertainty in supplies, limit the application of chemical fertilizers for crop production in Bangladesh. The use of organic manures and their proper management may reduce the need for chemical fertilizers thus allowing poor farmers to save in part the cost of the production. In addition, organic matter improves the physical, chemical and biological properties of soil and conserve the soil productivity.

In the light of the above discussion, the present study was under taken with the following objectives:

1.to study the effects of organic manure with inorganic fertilizers on the yield and yield attributes of BINA dhan 8 and

2. to evaluated the effect of organic and inorganic fertilizers on the nutrient content of BINA dhan 8.

CHAPTER 2
REVIEW OF LITERATURE

REVIEW OF LITERATURE

An attempt has been made to present a brief and pertinent review of literature in this chapter. While reviewing the works, emphasis has been given to the works done elsewhere in the world on the use of organic manures viz., poultry manure, mustard oil cake, sesame oil cake and vermicompost and inorganic fertilizer in rice

2.1 Effect of organic manures on rice

Babar and Dongale (2011) investigated the effect of integrated nutrient management on nutrient content and uptake in mustard - cowpea - rice cropping sequence in lateritic soil of Konkan. This experiment suggested that application of 50% recommended dose of N, P_2O_5 and K_2O should be applied through chemical fertilizers and the remaining 50% recommended dose should be applied through manure for each crop in the cropping sequence for soil fertility sustenance and saving of chemical fertilizers. For mustard and cowpea FYM be used as manure and for rice, glyricidia green leaf manuring be used.

Ji-ming *et al.* (2011) conducted a field experiment to study the effects of manure application on rice yield and soil nutrients in paddy soil. The results show that the long-term applications of green manure combined with chemical fertilizers (N, P, K, S) are in favour of stable and high yields of rice.

Sangeetha and Balakrishnan (2011) revealed the effect of organic sources of nutrients (enriched FYM compost, vermicompost, FYM+neem cake, enriched FYM compost+vermicompost+FYM, composted poultry manure and enriched poultry manure compost) and recommended NPK fertilizer on rice. The results revealed that the application of enriched poultry manure compost on equal N basis (2.3 t ha-1) recorded higher yield attributes and grain yield of 4675 kg ha-1 in 2007 and 4953 kg ha-1 in 2008, which was however comparable with composted poultry manure and better than other organic manure treatments and also inorganic source treatment The lower grain yield obtained with absolute control which did not receive organic manures and recommended NPK addition.

Wild *et al.* (2011) observed the nitrogen is the most limiting nutrient in irrigated rice (*Oryza sativa* L.) production, and growers continue to be faced with the challenge of meeting crop N demand, particularly in organic production systems. The main objective of this study was to determine how rice yield was affected by seasonal availability of N from organic sources under continuously and non-continuously flooded conditions. Laboratory and field experiments were conducted to determine the effectiveness of the commonly used poultry litter, pelletized organic fertilizers (blood, meat, and feather meal 13-0-0, feather meal 12-0-0, poultry litter plus feather meal 6-3-2), and $(NH_4)_2SO_4$, in synchronizing the supply of mineralized N with the demand of N by rice. The N mineralization of all organic fertilizers occurred primarily during the first 53 d after planting, results which were confirmed subsequently in a laboratory incubation study. In all fields, fertilizers increased grain yield and N uptake relative to a zero N control. Relative to poultry litter, the pelletized fertilizers resulted in higher yields (9980 vs. 9267 kg ha^{-1}), N uptake (140 vs. 114 kg ha^{-1}), and N recovery efficiency (35 vs. 20%) in all fields. It was concluded that pelletized fertilizers were significantly more effective than poultry litter in supplying N to the crop when fields were continuously flooded. In contrast all organic fertilizers were less effective in supplying N when fields were drained for weed control due to lower N recovery efficiency (26%) and N loss through denitrification, indicating that organic fertilizer application may not be economically viable under such circumstances.

Rajanna *et al.* (2011) studied during kharif of 2009. The initial status of available N, P_2O_5 and K_2O of the experimental site was 248.5, 26.8 and 202.8 kg ha, respectively. The variety used was Thanu (KMP-101). The results of the field experiment showed that application of vermicompost equivalent to 10 tonnes of FYM+100% N equivalent through jeevamrutha recorded significantly higher microbial population (24.23x106 CFU/g, 3.07x105 CFU/g, 6.12x105 CFU/g, 8.00x106 CFU/g and 5.90x106 CFU/g, of total bacteria, fungi, actinomycetes, nitrogen fixers and P solubilizers, respectively), which was on par with poultry manure equivalent to 10 t FYM+jeevamrutha at 100% N equivalent basis (21.50x106 CFU/g, 5.43x105 CFU/g, 7.53x106 CFU/g and 5.73x106 CFU/g, of total bacteria, actinomycetes, nitrogen fixers and P solubilizers, respectively). Application of recommended dose of fertilizers (100:50:50 kg N:P:K/ha) along with 10 tonnes of FYM/ha recorded significantly higher root volume (65.3 and 59.3 cc at 90 DAS and at harvest, respectively). Application of recommended dose of fertilizers (100:50:50 kg N:P:K/ha) along with 10 tonnes of FYM/ha recorded significantly higher root dry weight (6.51 and 6.03 g at 90 DAS and at harvest, respectively).

Li *et al.* (2011) observed in organic manure is beneficial fertilizer on soil quality and an excellent alternative resource of chemical fertilizer (CF). However, organic manure from intensive farms may have a negative impact on soil quality because of containing some harmful components, such as heavy metal and antibiotics. The aim of this study was to determine the influence of poultry litter (PL) and livestock manure (LM) from intensive farming on soil physical and biological indicators of soil quality. Results showed that PL and LM amendment increased soil macropore and mesopore volumes and decreased soil micropore volumes. Tensile strength in PL and LM treatment were lower than those in CF, while soil aggregate wet stability index were greater than those in CF. Compared with CF treatment, the microbial biomass C and N contents (89%, 74%), soil basal respiration rate (49%) and soil microbial quotient (45%) in PL and LM treatment were significantly greater. Significant linear correlations were found between soil organic carbon and most soil physical and biological properties ($P<0.01$). The results suggested that modern intensive farm manures can be alternate chemical fertilizers as a main fertilizer to improve soil physical and biological indicators in a rice-wheat system.

Islam *et al.* (2010) conducted and experiment in coastal soil (Barisal silt) of Bangladesh during July 2007 to May 2009 for determining the effect of organic manuring on soil organic matter and rice yield under tidal flooded ecosystem. Two rice crops of T. Aman (wet season; July-November) and Boro (dry season; December-May) were grown in the experimental fields in each year. Six treatments consisting of poultry liter application (2.0 t ha^{-1}) before Boro crop (T1), Sesbania incorporation before T. Aman (T_2), *Lathyrus* *sativas* (L) incorporation after T. Aman (T_3), red clover (*Melilotus alba,* L.) incorporation before T. Aman (T_4), Chemical fertilizers (T5=84-14-48-8 kg N, P, K & S ha-1) and absolute control (T_6) were compared in randomized complete block design. Each treatment was replicated for three times. Test rice varieties in T. Aman and Boro season were BRRI dhan44 and BRRI dhan29, respectively. The first T. Aman crop was damaged due to SIDR before harvest. The second T. Aman crop gave 3.96 to 4.39 t ha-1 grain yield across the treatments and their treatment effect was not significant (P>0.05). Boro crop in both the years showed consistently significant response to fertilizer and manure application. Means of two years results show that the absolute control plot yielded 3.66 t ha-1, which increased to 6.09 t ha-1 receiving chemical fertilizer alone (T_5). Application of organic residues increased rice yield compared with chemical fertilizer alone. The highest yield at the value of 6.71 t ha^{-1} was obtained with T_1 followed by 6.56 t ha^{-1} in T_3. After two years, soil analysis showed an insignificant increase in soil organic matter (SOM) due to the application of organic residues. However, long-term application of organic residues is expected to increase SOM in tidal flooded soil and which may contribute to soil health as well as rice yields.

Sangeetha *et al*. (2010) conducted a field experiment at Tamil Nadu Agricultural University, Coimbatore during rabi 2007 and 2008 to study the effect of organic sources of nutrients (enriched FYM compost, vermicompost, FYM + neem cake, enriched FYM compost + vermicompost + FYM, composted poultry manure and enriched poultry manure compost) and recommended NPK fertilizers on growth and yield of rice. The results revealed that the application of enriched poultry manure compost on equal N basis (2.3 t ha^{-1}) recorded higher growth parameters, yield attributes and grain yield of 4675 kg ha-1 in 2007 and 4953 kg ha^{-1} in 2008, which was however comparable with composted poultry manure.

Yadav *et al*. (2010) conducted to find the efficacy of substituting fertilizer N at different proportions (25%, 50% and 75% of total N) with organic N sources i.e., farm yard manure (FYM), green leaf manure (GLM), poultry manure and BGA on nutrient uptake (NPK) and yield of rice variety Sarju 52. In general the maximum uptake of the nutrients and grain yield were obtained with the application of 25% N through green manure +75% through inorganic urea. GLM is more efficient than other organic sources at all the proportions of N.

Ahmed *et al.* (2006) carried out an experiment to measure the ammonia volatilization loss following incorporation of organic and inorganic sources of N. It was observed that the highest available N (292 kg ha^{-1}) in surface soil was recorded with the incorporation of 40 kg N ha^{-1} as FYM followed by 40 kg N ha^{-1} as *S. aculeata*

Naik and yakadri (2005) studied an experiment in Hyderabad, Andhra Pradesh, India, during the 2001 wet season to study the effect of integrated nutrient management on the nutrient uptake and dry matter production of rice hybrid DRRH 1. The treatments comprised farmyard manure, ash (rice husk), geminicompost, vermicompost and in situ green manuring with *Sesbania rostrata*. The results showed a close relationship between nutrient uptake and dry matter production. In situ green manuring with *S. rostrata* along with 50% recommended N gave the best nutrient uptake and dry matter production.

Sairam and Reddy (2005) investigated that for three consequent years on clay soil (Vertisol) to investigate the effect of integrated nutrient management on nutrient uptake and soil properties in rice-mustard cropping system in Rudrur, Andhra Pradesh, India. This experiment suggested that substitution of 60 kg N ha^{-1} (50% or recommended N) through organic sources like Gliricidia or FYM to rice crop and 100% recommended NPK dose to mustard resulted in higher nutrient uptake with appreciable advantage on soil fertility status in rice-mustard cropping system.

Reddy *et al.* (2004) conducted a field study for two years (2001 and 2002) on the farmer's field in kolar district to study the effect of different organic manures on growth and yield of paddy under tank irrigation. Farm yard manure and sewedge produced better growth components, viz. plant height, number of tillers $hill^{-1}$, total dry matter production and yield components like number of panicles $hill^{-1}$, panicle length and 1000- grain weight.

Bhadoria and Prakash (2003) carried out field experiments in West Bengal, India to evaluate the relative efficiency of organic manures in combination with chemical fertilizers (CF) against application of only CF in improving the productivity of rice in a lateritic soil. The uptake of N, P and K by rice plants was significantly greater in treatments with organic manures in combination with chemical fertilizer .

Iftikhar and Qasim (2003) reported that using of farmyard manure, leaf mould and poultry manure as main sources and by making different combinations with sand, silt and saw dust. Potting media in different combinations were better than the sole factor of the soil itself because different combinations of potting media produced more growth and vigor of the plants and improved total available N and P among various growth responses and soil and NPK contents in plants.

Bijay *et al.* (2001) conducted a field experiment to observe the effect rice straw management in a rice-wheat rotation in northwest India. they reported that rice grain yield was not affected by the rice straw management practices

Channabasavanna and Birandar (2001) observed that grain yield increased with each increment of PM application and was maximum at 3 t PM ha^{-1} which was 26 and 19% higher than that of the control during 1998 and 1999, respectively and the significant increase was observed up to 2 t PM ha^{-1}.

Singh *et al.* (2001) reported that the application of FYM @ 10 t/ha produced 4.64% higher yield than the control.

Babu and Reddy (2000) conducted a field experiment on the effect of NPK fertilizer, FYM and poultry manure on rice. They were given 100:50:50 kg NPK/ha, 10t FYM/ha, 5t FYM/ha + 50 kg N/ha as top dressing or 3t/ha poultry manure, grain yield were the highest with 4t FYM + 50kg N/ha.

Hemalatha *et al.* (2000) studied on the influence of organic manure: dhaincha, sunhemp and FYM on rice productivity, quality and soil fertilizer. They reported that all the sources of organic manures improved the rice yield, quality and soil fertility.

Mannan *et al.* (2000) reported that manuring with cowdung upto 0t/ha in addition to recommended inorganic fertilizer with late N application improved grain and straw yield and quality of transplant aman rice over inorganic fertilizers alone.

Ram *et al.* (2000) reported that the use of 30 or 60 kg N/ha from organic sources in a total application of 120 kg N/ha increased grain and straw yields, N uptake and recovery, grain nutritive value, decreased soil pH and increased soil fertility and economic returns.

Sengar *et al.* (2000) stated that the application of chemical fertilizers in combination with manures sustained or improved the fertility status of the soil. They evaluated the efficiency of different fertilizers in rainfed low lands and found that the application of N fertilizer and manures significantly increased the yield and N, P, K uptake by rice compared with the control and P K treatment.

Subbiah and Kumaraswamy (2000) revealed that any one of the organic manures @ 5t/ha plus recommended levels of N, P_2O_5 , K_2O and gypsum gave significantly higher rice yield than the treatment that received N, P_20_5 and K_2 O alone.

Sharma (1999) reported that application of FYM 10 t/ha resulted in either same or significantly higher grain or straw yield than with 40 kg N/ha applied basally through urea fertilizer.

Thakur and patel (1998) conducted an experiment during kharif season of 1993 and 1994 to study the effect of split application of 60 or 80 kg N on growth and yield nitrogen content and uptake of rice with and without 5 tFYM and proposed that both N rates increased yield attributes, yield, plant N content and N uptake of rice compared with no N or application of FYM alone. N rates and use of split doses had no effect. The highest grain yield (3.84t/ha) was recorded with the application of 80 kgN/ha in 3 split doses with 5 t FYM/ha during both the year.

Jin *et al.* (1996) reported that heavy application of cattle manure resulted in increase of plant height, number of tiller and number of grain/panicle of rice.

Kant and Kumar (1994) reported that the increasing rates of amendments with FYM increased the number of effective tillers/hill significantly the number of grains/panicle, weight of 1000 grains also increased over the control. At the maximum level of FYM (30 t/ha) the increase of 48% tillers/hill, 14% number of grains/panicle and 4.5% weight of 1000 grains over the control were recorded. They also reported that higher rate of FYM (30 t/ha) resulted 22.0% increase in grain yield over the untreated plots.

2.2 Effect of inorganic fertilizers on rice

2.2.1 Effect of nitrogen on rice

Nitrogen is considered as an essential primary plant nutrient required in larger amounts for the growth and development of plant occurring in soils both in organicand inorganic forms. It is an important component of biologically important organic molecules in plants viz. proteins, nucleic acids, purines, pyrimidines, and coenzymes (vitamins), among many other compounds. Based on the redox conditions, plants absorb N mainly in the form of NH_4^+ and NO_3^-. Application of N to soil can bring a dramatic change in plant growth especially in the vegetative parts of plants. A sufficient supply of N also has its effects on stimulating the growth and development of plant roots, protein content of seed and foliage as well as the uptake of other nutrients. It is essential for carbohydrate use within the plants (Brady and Weil, 1996).

Singh *et al*. (2008) conducted field experiments in Patna, Bihar, India, from 2001-2002 to 2003-04, to study the effect of irrigation and nitrogen (N) fertilizers on yield, water use efficiency and nutrient balance in a rice based cropping system. Application of optimum levels of irrigation and N fertilizer increased the rice-equivalent yield by 8.40, 6.38 and 6.90% over the sub-optimum level in the cropping systems.

Xiao Fei *et al.* (2008) studied the effects of N rate on N metabolism in rice. The N rate had significant effects on nitrate reductive activity.

Liangjun *et al.* (2007) observed the effects of different N fertilizer application and the results indicated that yield was significantly influenced by the different N fertilizer application regimes. The regime with highest yield was at the basal to panicle application ratio of 58.34:41.66 and equal split panicle application at the fourth and second leaf age from the top. There were highly significant positive correlations between yield, total N uptake and agronomic N use efficiency.

Sharma and Sharma (2006) conducted a field study for 2 years (1995-96) at the Indian Agricultural Research Institute, New Delhi on a sandy clay loam soil and showed that the application of NP increased the total grain production of a rice wheat-mugbean cropping system by 0.5-0.6 t/ha, NK by 0.3-0.5tha-1 and NPK by 0.8-0.9 t/ha compared to N alone, indicating that the balanced use of primary nutrients was more advantageous than their imbalanced application. The application of farm yard manure along with NPK further increased the total productivity of the rice-wheat-mugbean cropping system by 0.3-0.6t ha-1, the organic C by 0.13%, the available N by 10.7 kg/ha, the available P by 4.7 kg/ha and the available K by 15 kg/ha compared to NPK after two crop cycles of the system. The results of the present study thus indicate that integrated nutrient management involving FYM and NPK fertilizer is must for the sustainability of a cropping system.

Gautam *et al.* (2005) conducted a field experiment in New Delhi, during kharif of 2002 and 2003 to study the influence of nitrogen and plant spacing on grain yield and quality of aromatic rice. Treatments comprised: 0, 80 and 160 kg/ha and PRH10, Pusa Sugandha 3, Pusa Basmati 1 cultivars. The results indicated that rice hybrid PRH 10 registered the significantly highest grain yield (51.5q/ha) than inbred aromatic rice, Pusa Sugandha 3 and Pusa Basmati 1. The highest grain (52.5q/ha) and straw yield (74.05q/ha) were recorded with application of 160 kgN/ha. Pusa Sugandha 3 and Pusa Basmati 1 were better at the plant spacing of 20x15 cm with 160 and 80kg N/ha.

Chopra and Chopra (2004) showed that nitrogen had significant effects on yield attributes such as plant height, panicle plant^{-1} and 1000-grain weight. Cumulative effect of yield attributing characters resulted in significant increase in seed yield at 120 kg N ha^{-1} over 60 N ha^{-1} and the control.

Bayan and Kandasamy (2002) noticed that the application of recommended doses of N in four splits at 10 days after sowing, active tillering, panicle initiation and at heading stages recorded significantly lower dry weight of weeds and increased crop growth viz., effective tillers/m^2. Number of effective tillers/hill increased with top dressing of N (Islam *et al.*, 1996). Effective tillers/hill was significantly affected by the level of N. The highest number of productive tillers/hill was obtained from the highest level (120 kg/ha) of nitrogen (BINA, 1996).

Ehsanullah *et al.* (2001) reported that the application of different levels (75 kg, 100 kg and 125 kg ha^{-1}) of N fertilizers in rice field, resulted the significantly increased 1000 grain weight and straw yield of 125 kg ha^{-1} N application

2.2.2 Effect of phosphorus on rice

Plant absorbs phosphorus in the form of H_2PO_4, HPO_4^{-2} and PO_4^{-3}. Adequate P nutrition enhances many aspects of plant physiology, including the fundamental processes of photosynthesis, N-fixation, flowering fruiting (including seed production) and maturation. It is an essential component of the organic compound often called the energy currency of living cell: adenosine tri phosphate (ATP) (Brady and Weil, 1996). Considerable amounts of works have been done on the effects of phosphorus on rice in different parts of the world. Some of them are cited below:

Zhar *et al.* (2005) conducted an experiment to study the effects of agricultural production on P losses from paddy soils. This implied that runoff P losses would be greatly increased in 10-20 years as a result of the accumulation of soil P if 50 kg P /ha is applied each year.

Xu-Da *et al*. (2005) conducted pot and field experiment to study the effects of N fertilizer application time and N,P,K fertilizer management on grain amylase content and RVA profile parameters in rice cultivars. Result showed that P fertilizer had influenced on the amylase content.

He-Yuan *et al.* (2004) carried out an experiment to study the effects of soil moisture content and phosphorus application on phosphorus nutrition of rice cultivated in different water regime systems. The P application rates had greater effect on the P nutrition of rice than the soil moisture content.

Iqbal (2004) carried out an experiment on interactions of N, P and water application and their combined effects on biomass and yield of rice. It was concluded that the yield of rice increased by 50-60% in response to the application of N and P interaction with H_2O.

Pheav *et al.* (2003) conducted an experiment and seen that freshly applied P increased rice grain yield by 95%. In the first and second crops using residual P fertilizer, yields increased by 62 and 33% relative to the nil-P plot. Grain yields in the third crop using residual P dropped to levels obtained in the nil-P soils.

Sharma and Prasad (2003) studied the effect of rock phosphate (RP) and TSP in three cycle of rice-wheat cropping systems. Application of TSP had significant effect on grain and straw yields and P uptake by rice and wheat. They found that the efficiency of RP+TSP was better than that of RP alone in rice wheat cropping system.

Kumar and Singh (2001) observed that the significant response of rice to P was observed only up to 26.2 kg ha^{-1} and application of P in all seasons recorded maximum rice equivalent yield (79.6 q ha^{-1}) which was as per with treatment receiving P in both year rabi (70.8 q ha^{-1}) and treatment receiving P in first *kharif* and *rabi* (70.8 ha^{-1}).

Sahrawat *et al.* (2001) reported that phosphorus deficiency has been identified as a major constant to crop production on highly weathered; low activity clay soils in the humid and sub humid zones of sub Saharan Africa. The main problem concerning is its fixation with soil complex with a very short period of application of inorganic P and relative increase in grain and straw yields.

Chitdeshwari and Savithri (2000) reported that the combined use of organic and inorganic phosphate fertilizer on yield and P status of rice. They obtained highest yield applying 100% of recommended P (SSP) and green manure @ 6.25 t ha^{-1}.

Chowdhury (1996) carried out an experiment in BAU farm to study the effect of different pesticides with recommended doses of NPK (100 kgN/ha, 60 kgP_2O_5/ha and 40 kg K_2O/ha) fertilizers on the growth, yield and mineral composition at tillering and harvesting stages of two varieties of transplanted Aman rice (BR 11 and Nizershall). He reported that nutrients like N,P,K were found to be in higher amount at tillering stage of plant and decreased with the age.

2.2.3 Effect of Potassium on rice

Dunn and Stevens (2005) found that pre plant and mid season K fertilizer application increased rice yields on soils where K fertilizer application was not previously expected to have that effect.

Arivazhagan *et al.* (2004) carried out a field experiment to investigate the effects of split application of different potassium fertilizers [muriate of potash (MOP) and sulfate of potash (SOP)] on the yield and nutrient uptake by rice (cv. PY). The highest mean grain yield was observed in MOP treated plots in both seasons.

Hong *et al.* (2004) conducted field experiments to investigate the potassium uptake distribution and use efficiency of hybrid and conventional rice under different low K stress conditions. The grain yield and total K uptake by rice increased.

BRRI (1994) reported that applying K rate upto 120 kg/ha that, it failed to increase the straw and grain yield significantly over 30 kg/ha.

Morok and Dhakiwak (1987) reported from replicated field trials enveloping graded doses of K showed that paddy response to the application of K in soils of low to medium K availability. A dose of 30 kg K_2O/ha was optimum that gave unit response of 4.90 kg grain with 1 kg of K_2O dose and also gave a net profit of Rupees 1.88 per Rupee invested on potassium fertilizer.

Purohit *et al.* (1986) conducted two years trails with three varieties of rice and four levels of K_2O (0, 40, 60 and 80 kg/ha) and observed that grain yield and net profit were the highest with 80 kg K_2O/ha.

Uexkull (1984) reported that in traditional rice culture, the negative K balance over a 5 years period was only 169 kg/ha, under intensive HYV culture it increased to about 1200 kg/ha.

2.2.4 Effect of sulphur on rice

Sulphur is a macronutrient occurring in soils both in organic and inorganic forms. Organic form provides the major source of sulphur in soils. The main sulphur bearing mineral is gypsum ($CaSO_4.2H_2O$). Plants absorb sulphur in the form of SO_4^{-2}. Sulphur carried out many functions for growth and development of plants. The element is involved in the synthesis of amino acids (cystine, cysteine and methionine), coenzymes biotine, Thiamine (Vit. B_1) and chlorophyll. It is vital part of ferrodoxins.

Bhuvaneswari *et al.* (2007) conducted field experiment in Tamil Nadu, India, during the 2001 *kharif* season to study the effect of sulphur (S) at varying rates, i.e. 0, 20, 40 and 60 kg ha^{-1} with different organic sources, i.e. green manure, farm yard manure, sulfitation press mud and lignite fly ash, each applied at 12.5 t ha^{-1} on yield, S use efficiency and S optimization of rice (cv. ADT 43). The results revealed that rice responded significantly to the application of S and organics compared to the control. The highest grain (5065 kg ha^{-1}) and straw yields (7524 kg ha^{-1}) was obtained with 40 kg K ha^{-1}.

Sarfraz *et al.* (2002) conducted a field experiment with different S fertilizers and NPK fertilizers on the yield and chemical composition of rice (cv. Shaheen Basmati). Result showed that the sulphur fertilizers increased S content and its uptake in straw compared to NPK treatment.

Raju and Reddy (2001) conducted field investigations at Agricultural Research Station, Maruteru, Andhra Pradesh, India to study the response of both hybrid and conventional rice to sulphur (at 20 kg ha^{-1}) and Zn (at 10 kg ha^{-1}) applications. Significant improved in grain yield was observed due to sulphur application..

Yang *et al.* (2001) studied the effects of sulphur fertilizer and nitrogen sulphur fertilizers with rice cv. Weiyou 63 in Fujian, China and found that in S fertilizer treated plots (6.9 mg available S/kg soil) fertilized with 20 and 40 kg N/ha, plants had a greater number of panicles and higher fertility than control plants without S fertilizer treatment. On the other hand in NS treated plots (receiving N rates of 0, 150 and 120 kg/ha, and S rates of 0, 30 and 60 kg/ha) the highest yield 8850 kg/ha was obtained with 150 kg N/ha + 60 kg S/ha. However, they further stated that the optimum ratio for NS fertilizer was 4:1.

Mandal *et al.* (2000) evaluated the effect of N and S fertilizers on nutrient content of rice grains (cv. HR 3) at various growth stages (tillering, flowering and harvesting). Nitrogen was applied as urea and S as gypsum at 0, 5, 10 and 20 kg S ha^{-1}. The combined application of these two elements gave better response than that of when nitrogen is applied only.

Sahu and Nanda (1997) conducted two field experiments, one in Black Soil (BS) another in Laterite soil (LS) to determine the response of rice cv. Jajati BS and Lalat, on LS to sulphur(0-60 kg/ha) in Orissa and found that mean grain yield increased with up to 40 kg S (5.06 t/ha) on BS and was highest 60 kg S (4.26 t/ha) on the LS.

Chowdhury *et al.* (1996) stated that application of Zn singly or in combination with S increased the straw and grain yields of rice. They further reported that the highest yield showing 33.60% increases over control which was obtained from the treatments $Zn_{12}S_{45}$, Zn_8S_{45} and $Zn_{12}S_{30}$. Straw yield ranged from 5.1 t/ha in Zn_0S_0 treatment to 6.6 t/ha $Zn_{12}S_{45}$ treatment.

Gupta *et al.* (1996) reported that application of gypsum at the rate of 18.75 kg/ha produced the highest grain yield of rice in Gobwala watershed in Punjab.

Chauhan(1995) observed that gypsum applied with pressmud gave the highest grain yield of 3.92 t/ha in 1991 and 4.53 in 1992,which produced 0.68 and 0.73 t/ha higher yield, respectively over control treatments.

Haque and Jahiruddin (1994) studied effects of single and multiple applications of S and Zn in a continuous rice cropping system and noted that crop yields were increased by S (20 kg/ha as gypsum.) and not generally by Zn. They also observed that although added gypsum had residual effect up to 3rd crop application in every crop produced comparatively higher grain yield of rice.

2.3 Combined effect of organic and inorganic fertilizer on rice

Kumar and Reddy (2010) conducted an experiment during three consecutive kharif seasons of 2000, 2001 and 2002 at Agricultural Research Station, Neliore in the southern Agro-climatic Zone of Andhra Pradesh to study the effect of organic and inorganic sources of nitrogen on soil fertility, productivity and profitability of lowland rice. Farmyard manure, poultry manure and neem cake were tried as organic sources of nitrogen substituting 25% and 50% of inorganic nitrogen in comparison to 100% inorganic nitrogen. The experiment was laid out in randomized block design, replicated thrice. The combination of 50% N through urea and 50% N through any of the organic sources viz., farmyard manure, poultry manure and neem cake produced significantly higher grain and straw yield, net returns and benefit cost ratio. Integrated supply of N at 50% each through fertilizer and organics recorded higher N uptake than all other combinations. Post harvest soil fertility status viz., organic carbon, available nitrogen, phosphorus and potassium was highest by substituting 50% N fertilizer with any of the organic source compared to recommended dose of N entirely through inorganic source. Lowest soil organic carbon and available nitrogen was registered with control while, lowest available phosphorus and potassium was with 100% N through urea.

Myint *et al.* (2010) conducted an experiment on rice cultivation at Kyushu University farm. Cow manure (CM), poultry manure (PM), rice straw + urea mix-application (SU), urea (UF) and M-coat, a slow released compound fertilizer (M-coat) were used as the N sources by comparing with no application (Control). Treatments were made with two levels application of each N source at 40 (level I) and 80 kg N ha-1 (level II) excluding

M-coat. In all urea treatments, three split applications were made. A study of soil incubation was conducted for 2 weeks to investigate the mineralized N of applied mineral and organic fertilizer. Plant growth characters, dry matter, yield and plant nutrient accumulations were higher in mineral fertilization than organic. Mineral fertilization was observed in correlation with the larger crop removal. PM-II as an organic matter provided comparatively higher nutrient accumulations which in turn enhanced the growth and yield of rice. CM and SU gave the lower plant growth, yield and nutrient accumulation. Mineralized N was higher in sole mineral N applications. Organic matter with high C/N ratio provided very low mineralized N and its net N mineralization percentage. Negative values of net N mineralization percentage were observed in SU due to N immobilization.

Nyalemegbe *et al.* (2010) studied at the Agricultural Research Centre, Kpong, of the University of Ghana, 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 P2O5 ha-1 and 35 kg K2O ha^{-1}, on the Vertisols of the Accra Plains. Studies were also conducted on the redox potential of CD, PM and rice straw (RS). 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. The redox potential studies showed that RS had greater propensity to bring about reduced soil condition in paddy fields than CD and PM, while PM brought about greater reduction than CD.

Yadav *et al.* (2009) studied at Kumarganj, Faizabad to assess the impact of organic manures on performance of (*Oryza sativa* L.)-wheat (*Triticum aestivum* (L.) Fiori & Paol.) system. Among different organic farming treatments, incorporation of crop residues in both the crops+green manuring+phosphorus solubilising microbes (PSM)+poultry manure (PM) 5 t/ha+neem cake 0.2 t/ha, resulted in highest values of growth and yield components, yield and net return. This treatment gave 16.1, 16.6, 13.1, 13.1 and 44.5% higher yield of rice and 19.7, 17.0, 14.5, 7.5 and 26.8% higher yield of wheat over T1, T2, T3, T4 (organics) and T6 (inorganics) respectively. Maximum amount of balance or un-utilized NPK was computed with inorganics treatment (T6). All the organic farming treatments improved soil health as evident by increased organic carbon and reduction in soil pH. Highest values of organic carbon (0.64%) after 5 years of experimentation was recorded with wheat residues+FYM 10 t/ha+0.2 t/ha neem cake in rice and rice residue+pressmud 10 t/ha in wheat (T3). Treatment with crop residue+green manuring+poultry manure 5 t/ha+PSM+neem-cake 0.2 t/ha also proved most remunerative and gave 15.46, 16.08, 14.17, 8.87 and 36.48x103 Rs/ha higher net return over T1, T2, T3, T4 and T6, respectively. Highest benefit: cost ratio (1.60) was also recorded with this treatment.

Reddy and Kumar (2007) conducted an experiment during 1999, 2000 and 2001 kharif seasons in Andhra Pradesh, India, to study the relative efficiency of organic and inorganics sources of N on the growth, yield and N uptake of lowland rice. The combination of 50 percent N through urea and 50 percent N through different organic sources (farmyard manure, poultry manure and neem cake) produced significantly taller plants, more number of tillers, higher quantity of dry matter, more number of panicles m-2, longer panicles, greater number of grains panicle-1 and higher test weight than all other combinations. The conjunctive use of 50 percent N fertilizer as urea alongwith 50 percent N as farmyard manure, poultry manure or neem cake produced significantly higher grain as well as straw yields of rice during all the three years. Integrated supply of N at 50 percent each through fertilizer and organics recorded higher N uptake than all the other combinations.

Mahavishnan *et al.* (2004) conducted a field study on the effect of nutrient management through organic and inorganic sources on the yield of rice. They found that the yield and yield contributing components were higher with the application of 125% recommended doses of fertilizer RDF + poultry manure (PM) compared to other treatments.

Singh *et al.*(2004) conducted a field experiment during boro and kharif seasons of 2001-2002 and 2002 respectively in a randomized block design in West Bengal, India with seven treatment combinations (T1=control, T2= 100% recommended dose of N through straight fertilizer, T3=100% N through IFFCO-NPK + urea, T4=25% of N as FYM _75%N as straight fertilizer, T5= 25% N as FYM + 75% N as IFFCO NPK + urea, T6= 50% of N as FYM + 50% N as straight fertilizer and T7=50% as FYM + 50% N as IFFCO-NPK+ urea) to study the effect of organic and inorganic manuring on growth and yield of high yielding rice cv. IET 1786 (shatabdi) grown under ricr-rice crop sequence. 100% recommended dose of N through IFFCO-NPK and urea produced higher number of panicle/m2, number of filled grains/panicle, 1000 grain weight and ultimately grain yield by 17.9, 4.6, 0.5 and 20.7% over the control treatment in boro season. This was closely followed by 100% recommended doses of N through straight fertilizer or 25% N through FYM + 75% N through IFFCO-NPK, while in kharif season all the yield components responded well with either 25% N as FYM + 75% N as IFFCO-NPK + urea of 100% recommended dose of N through IFFCO-NPK + urea. Under rice-rice cropping sequence maximum grain yield, total nutrient uptake, net return per rupee invested were recorded when the crop received 100% recommended doses of N through IFFCO-NPK + urea, fertility status of soil declined in all the treatment combination as compared to initial status after harvesting of the first and second season rice crop.

Rahman (2001) reported that in rice-rice cropping pattern, the highest grain yield of boro rice was recorded in the soil test basis (STB) NPKSZn fertilizers treatment while in T. Aman rice the 75% or 100% of NPKSZn (STB) fertilizers plus cowdung gave the highest or a comparable yield.

Sengar *et al.* (2000) stated that the application of chemical fertilizers in combination with manures improved the fertility status of the soil. They evaluated the efficiency of different fertilizers in rainfed lowlands at the Zonal Agricultural Research Station, Jagdalpur, Madhya Pradesh, India and found that application of N fertilizer and manure significantly increased the yield and NPK uptake by rice compared with the control and NPK treatment.

Liang *et al.* (1999) observed that the results from long term experiment in rice based cropping system where high crop yields were sustainable over period of 12-16 years through the continuous application of inorganic NPK fertilizers and yields were mainly restricted by insufficient N nutrient supplementing NPK fertilization with organic manure could further increase rice yield. Soil physical and chemical properties were either unaltered or improved soil physical condition.

Sarker and singh (1997) reported that soil pH was decreased to 6.5-6.6 by application of organic fertilizers alone compared with the pH 6.7. However a combination of organic plus inorganic fertilizers increased soil pH to 6.6-6.8. Organic fertilizers alone of in combination with inorganic fertilizers increased the level of organic carbon in the soil as the total N,P and K content of soil.

Sanzo *et al.* (1997) observed that application of standard rates of 200 kg N, 80 kgP and 90 kg K/ha or 15,30 or 45 cattle manure (t/ha) with or without 50% or 100% of the standard rate of application N. Yield generally increased with increasing rates of manures with better result in combination with NPK with 45 t manure there was no significant difference in yield between N rates.

Zhang and Peng (1996) showed that the content of soil organic matter and total N,P and K were raised, soil nutrients were activated, soil fertilizers were enhanced, nutrient absorption by rice was increased and rice yields were heightened by combined application of organic and inorganic fertilizers.

Jeony *et al.*(1996) observed that rice was given 110 kg N + 120 kg P+ 130 kg K/Ha(100% NPK) alone or with 5 t/ha rice straw or half these NPK rate (50% NPK) alone or 5 t rice straw, 20 t compost + 20 t fermented pig manure. Pig manure + compost, 3 t oil cake or 5 t/ha fermented chicken manure. Application of organic manure + 50% NPK gave grain yield of 9 to 17% lower than these were obtained with 100% NPK rate. Grain content alkali digestion value and gel consistency were unaffected by treatments. Amylase content of grain was lower in plant given straw, compost or compost + pig manure compared with 100% NPK treatment. In general, organic fertilizer did not improve rice cooking quality and tests.

Gupta (1995) conducted a field trial on different organic manure in India and reported that the application of field manure (10 t/ha) produced the highest grain yield (4.5 t/ha) followed by PM and FYM which produced yield of S.

Singh *et al.* (1995) reported that cattle manure significantly improves rice yield but was less efficient than urea. The combination of cattle manure and urea showed no positive interaction effects. Total N uptake by rice was also significantly higher from urea than manure. P and K up take by rice increased in response to N application from urea and cattle manures.

Ahmed and Rahman (1991) reported that the application of organic matter and chemical fertilizers increased tiller number, panicle length, grain and straw yields of rice.

From the literature cited above, it is evident that fertilizers and manure application have definite significant influence on growth parameters, yield components and yield of rice.

CHAPTER 3
MATERIALS AND METHODS

MATERIALS AND METHODS

In this chapter the details of different materials used and methodologies followed during the experimental period are presented under the following headings:

3.1 Experimental period

The experiment was conducted at the Agronomy Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the Boro season of November 2012 to February 2013. Detailed of materials and methods used in this experiment are given below.

3.2 Description of the experimental site

The experimental site is geographically situated at $23^0$41'N latitude and $90^0$22'E longitude at an altitude of 8.6 meter above sea level. The experimental was conducted in typical rice growing silt loam soil at the Sher-e-Bangla Agricultural University farm, Dhaka during the boro season of 2012-2013.

3.3 Climate

The experimental site under the sub-tropical climate that is characterized by cold temperature and minimum rainfall are the main features of the Rabi season. The weather conditions during experimentation such as monthly rainfall (mm), mean temperature (^{0}C), humidity (%) and rainfall (mm) are presented in Appendix I.

3.4 Soil

The soil of the experimental field belongs to the general soil type, Deep Red Brown Terrace Soils under Tejgaon Series under Agroecological Zone, Madhupur tract (AEZ - 28). The land was above flood level, well drained and sufficient sunshine was available during the experimental period. Soil samples from 0-15 cm depth were collected from the experimental field. The soil was collected and air dried , ground and passed through 2 mm sieve and analyzed for some important physiochemical properties (Table 1and 2).

Table 1: Morphological characteristics of the experimental field

Morphology	Characteristics
Location	SAU Farm,Dhaka
Agroecological Zone	Madhupur tract(AEZ -28)
General soil type	Deep Red Brown Terrace Soil
Parent material	Madhupur terrace
Topography	Fairly level
Drainage	Well drained
Flood level	Above flood level

Table2 : Initial physical and chemical characteristics of the experimental field

Physical properties

% Sand (2-0.02mm)	:	22.24
% Silt (0.02-0.002mm)	:	56.74
% Clay (>0.002mm)	:	20.75
Textural class	:	Silt loam

Chemical properties

pH (Soil: water = 1: 2.5)	:	5.7
Organic carbon (%)	:	0.69
Organic matter (%)		1.19
Total N (%)	:	0.08
Available P (mg kg^{-1})	:	18.75
Exchangeable K (c mol kg^{-1})	:	0.13
Available S (mg kg^{-1})	:	14.35

3.5 Description of the variety (BINA dhan 8)

Binadhan-8 is a salt tolerant high yielding rice variety which was released in 2010 by Bangladesh Institute of Nuclear Agriculture. It is semi dwarf, early maturing and medium bold grain rice variety. Binadhan-8 requires 130-135 days to mature. It is moderately resistant to bacterial leaf blight, sheath blight, brown plant hopper, stem borer and rice hispa. Under salt stress, maximum grain yield is 5.5 t ha^{-1} (average 4.5-5.5 t ha^{-1}) and in non saline area, maximum 9.0 t ha^{-1} (average 7.5-8.5 t ha^{-1}). This variety is most suitable in saline areas of Bangladesh and also other non saline areas.

3.6 Treatments

Four types of organic manure (poultry manure, mustard oil cake, sesame oil cake and vermicompost) were used in this experiment. The experiment consisted of 11 treatments. The treatments were as follows:

Treatments:

T_0= Control

T_1= 100% NPKSZn (Recommended dose)

T_2= 75% NPKSZn + Poultry manure @ 5 tha^{-1}

T_3= 50% NPKSZn + Poultry manure @ 5 tha^{-1}

T_4= 75% NPKSZn + Mustard oil cake @ 5 tha^{-1}

T_5= 50% NPKSZn + Mustard oil cake @ 5 tha^{-1}

T_6= 75% NPKSZn + Sesame oil cake @ 5 tha^{-1}

T_7= 50% NPKSZn + Sesame oil cake @ 5 tha^{-1}

T_8= 75% NPKSZn + Vermicompost @ 5 tha^{-1}

T_9= 50 % NPKSZn + Vermicompost @ 5 tha^{-1}

T_{10}= Poultry manure @ 1.25 tha^{-1}+ Mustard oil cake @ 1.25 tha^{-1} + Sesame oilcake @ 1.25tha^{-1} + Vermicompost @ 1.25 tha^{-1}

Here,

N=120 kg/ha, P=20kg/ha, K=80 kg/ha, S=16 kg/ha, Zn=2.1kg/ha

Source: Fertilizer recommendation guide, 2012

Plot size = 2 m×2 m
Plot to plot = 0.70m
Block to Block = 1.5m
No. of replication = 3
No. of plot in each replication = 11
Total plot; 3×11 = 33

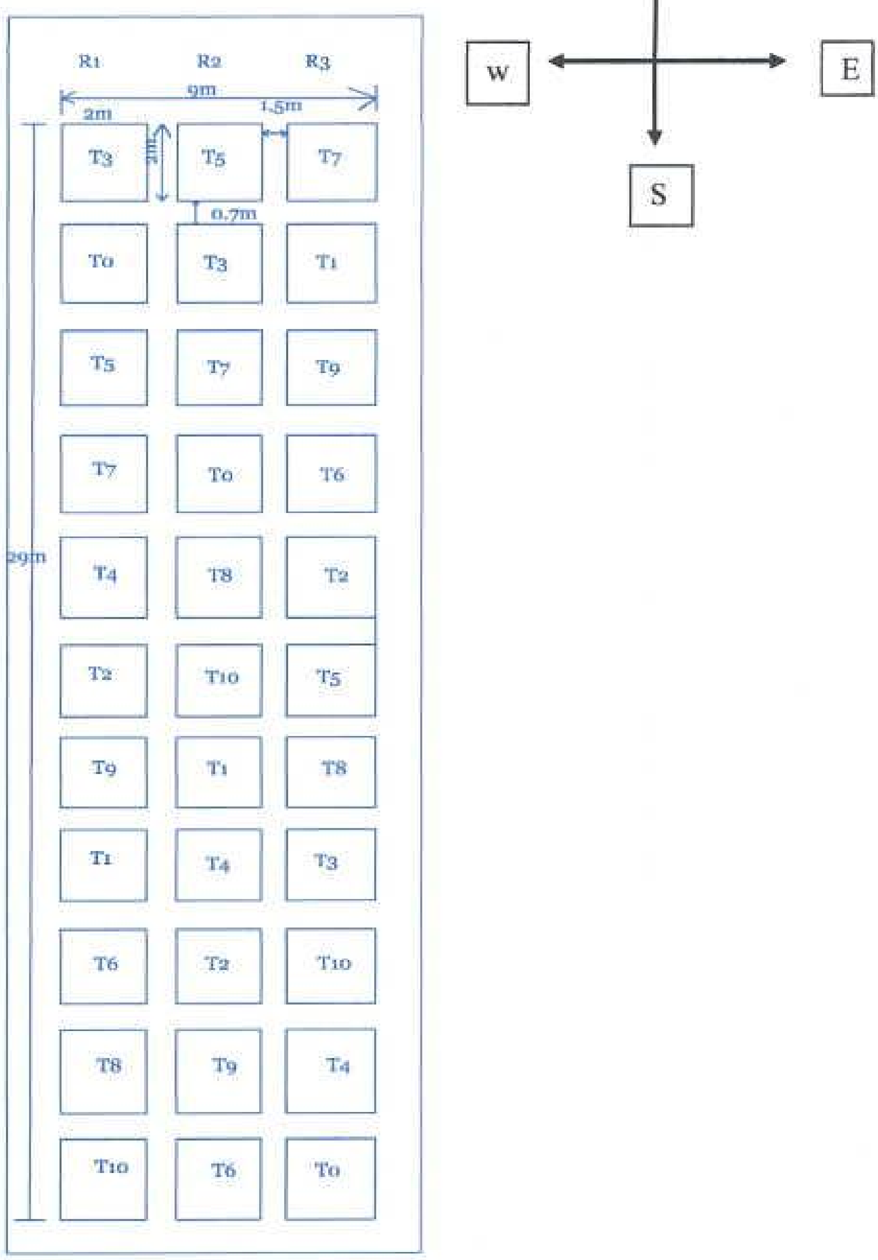

Fig.1. Lay out of the experiment

Table 3. Chemical composition of different organic manures

Source of organic manure	Nutrient content (%)		
	N	P_2O_5	K_2O
Poultry manure	1-1.8	1.4-1.8	0.8-0.9
Mustard oil cake	4.7	1.78	1.4
Sesame oil cake	6.2	2	1.2
Vermicompost	1.9-2.5	1.5-2.05	1.5-2

Source: □Hand book of Manures and Fertilizers", 1964

3.7 Planting material

The BINA dhan 8 collected from BINA, Mymensingh.

3.8 Preparation of the experimental field

The land was first opened on 10 December, 2012 and ploughed with power tiller followed by a country plough. Then the land was made saturated with water and prepared by successive ploughing and cross plough. The land was puddle thoroughly for ease of transplanting and water retention. All kinds of weeds, stubbles and crop residues were removed from the field and land was leveled by laddering. Finally each plot was prepared by puddling.

3.9 Experimental plot

The size of each plot was 4.0 m^2 (2m x 2m). Inter block and inter plot spacing were 1.5 m and 0.7 m, respectively.

3.10 Experimental design

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications where the experimental area was divided into 11 unit plots with raised bunds as per treatments. Thus the total number of unit plot was 33. The treatments were randomly distributed within the blocks.

3.11 Collection and preparation of initial soil sample

The initial soil sample was collected before land preparation from the plough depth layer (0-15 cm). The samples were taken by means of an augur from different spots covering the whole experimental plots and mixed thoroughly and sieve through a 20 mesh sieve and stored in a plastic bag for physical and chemical analysis.

3.12 Application of fertilizers

The recommended amounts of organic manures (Poultry manures, mustard oil cake oil cake, sesame oil cake, vermicompost and N,P,K,S and Zn required per plot were calculated as per the treatments. All organic manures were applied to soil two days before the final land preparation. Full amounts of TSP, MoP, gypsum and $ZnSO_4$ were applied as basal dose before transplanting of rice seedlings. Urea was applied in three equal splits, as top dressing first split 15 days after transplanting (DAT), second at active tillering stage at 30 days after transplanting (DAT) and third split at panicle initiation stage at 45 days after transplanting (DAT).

3.13 Raising of seedling

The seedlings of rice were raised by wet- bed method. Seeds (95% germination) @ 5 kg/ha were soaked and incubated for 48 hours and sown on a well prepared seedbed. During seedling growing no fertilizers are used. Proper water and pest management practices were followed whenever required.

3.14 Transplanting of seedling

The healthy of 40 days old seedlings were transplanted in the experimental plots on 28 January 2013. The seedlings were carefully uprooted from the seedbed before transplanting. Plant spacing was maintained 20cm x 15cm and three seedlings were transplanted $hill^{-1}$. The number of row and hill $plot^{-1}$ was equal in all plots. Gap filling was done 7 days after transplanting to make uniform plant population density in each unit plot.

3.15 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.

3.15.1 Weeding

The experimental plots were infested with some weeds, which were uprooted when necessary.

3.15.2 Irrigation

The plots were irrigated from deep tube-well as per need during the growing period of the crop.

3.15.3 Insect diseases and pest control

There was no infestation of plant diseases in the experimental field was infested by yellow rice leaf hoppers, stem borer and grass hoppers which were controlled by the application of Kurater 5G.

3.16 Harvesting, threshing, cleaning and processing

Maturity of crop was determined when about 90% of the seeds became golden yellow. Ten hills (excluding border hills) were selected randomly from each unit plot and uprooted before harvesting for recording necessary data. After sampling the whole plot (including boarder rows) was harvested at maturity. The crop was harvested on 17-05-13. The harvested crop of each plot was separately bundled, properly tagged and then brought to the threashing floor. The plant threshed and crop and straw was recorded plot wise. The grains were cleaned and sun dried, and straw were sun dried properly. Finally, grain and straw yield plot^{-1} were recorded and these were converted to t ha^{-1}.

3.17 Data recording

Ten hills were selected randomly from each plot before harvested and the data were recorded on the following characters:

3.17.1 Plant height

The height of the plants was measured in cm from the ground level to the top of the panicle from the selected plants of 10 hills from each plot and averaged.

3.17.2 Number of total tillers hill^{-1}

The number of tillers hill^{-1} was counted from the selected ten hills from each plot.

3.17.3 Number of leaves plant^{-1}

The number of leaves^{-1} was counted from the selected plants.

3.17.4 Panicle length

Measurement was taken from the basal node of the rachis to apex of each panicle. Each observation was a mean of 10 panicles.

3.17.5 Total number of grains panicle^{-1}

The number of total tillers hill^{-1} was counted from the selected ten hills from each plot.

3.17.6 Number of filled grains panicle^{-1}

The filled grains of each of the effective tillers for the individual plant and consequently those of all the selected ten plant were counted. The average of which gave the number of filled grains panicle^{-1}.

3.17.7 Number of unfilled grains panicle^{-1}

The number of unfilled grain was counted from the randomly selected ten plants, the average of which gave the number of unfilled grains panicle^{-1}.

3.17.8 1000-seed weight (g)

Thousand grains were taken from each plot and the weight of grains was measured after sun drying in an electric balance.

3.17.9 Grain yield (t ha^{-1})

Grains obtained from each unit plot were sun dried and weighed separately and carefully recorded. Grain yield was adjusted 14% moisture content. The dry weight of grains of 1 m^2 to the respective unit plot were recorded and finally converted to t ha^{-1}.

3.17.10 Straw yield (t ha^{-1})

After the separation of grain from rice plant, the straw were collected, sun dried , weighed and then recorded carefully. The dry weight of straw of 1 m^2 to the respective plot were recorded and finally converted to t ha^{-1}.

3.17.11 Biological yield (t ha^{-1})

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

Biological yield= Grain yield+ straw yield

3.18 Chemical analysis of grain and straw

3.18.1 Collection of samples

The plant samples (grain and straw) were collected after threshing.

3.18.2 Preparation of samples

The plant samples (grain and straw) were dried in an oven at 60^0 C for about 48 hours after sun drying and finely ground via a grinding machine. Then the ground samples were passed through a 20-mesh sieve and stored in paper bags and finally they were kept into desiccators. The grain and straw samples were analyzed for determination of N, P, K and S.

3.18.3 Digestion of plant samples for N determination

The total nitrogen was determined from the sample by macrokjeldahl method. The sample was digested by commercial H_2SO_4 in presence of catalyst mixture K_2SO_4, $CuSO_4.5H_20$ and selenium powder in the ratio of 100:10:1 and the flask was heated at 360-440^{0}C until the solution became clear. The flask was allowed to cool about 120 mL of distilled water was added and 5-6 glass bead put into the flask.

After digestion 125 mL of 40% NaOH was added in the kjeldahl flask. Then the flask was attached quickly to the distillation set and the flask was heated continuously.

The formed $(NH_4)_2SO_4$ was mixed with NaOH during distillation with the liberation of NH_3.The liberated NH_3 was received in 4% boric acid (H_3BO_3) solution and 5 drops of mixed indicator (of bromocresol and methylred) solution. Finally the distillate was titrated with standard H_2SO_4 (0.05N) until the color changed to pink (Jackson, 1973).

3.18.4 Digestion of plant samples with nitric-perchloric acid for P,K & S

A subsample weighing 0.5g was transferred into a dry, clean 100 mL digestion vessel.10 mL (HNO_3:$HClO_4$ in the ratio of 2:1) mixture was added to the flask. After leaving for a while, the flask was heated at a temperature slowly raised to 200^{0}C. Heating was stopped when the dense white fumes of $HClO_4$ occurred. The content of the flask were boiled until the solution became clear and colorless. After cooling the content was taken into a 100 mL volumetric flask and the volume was made upto mark with deionized water. P, K and S were determined from this extract.

3.18.5 Nitrogen determination

The N concentration was determined by macroKjeldahl method as described in section 3.18.3.

3.18.6 Determination of Phosphorus

P content in the extract of grain and straw were determined by adding ammonium molybdate and $SnCl_2$ solution and measuring the color with the help of spectrophotometer at 660 nm wavelength (Olsen *et al.,* 1995). Phosphorus in the digest was determined by using 1mL for grain determined and 2 mL for straw sample from 100 mL extract by developing blue color with reduction of phosphomolybdate complex and the color intensity were measured colorimetrically at 660 nm wavelength and readings were calibrated with the standard P curve.

3.18.7 Determination of Potassium

Potassium content in the extract of grain and straw was determined directly with the help of flame photometer (Black, 1965). 5 mL of the digest sample for grain and 10 mL for straw were taken and diluted to 50 mL volume to make the desired concentration. The samples were aspirated into a gas flame. The atmospheric pressure was fixed at 10 PSI. % emission was recorded .

3.18.8 Sulphur content

The sulphur content in the digest of grain and straw was determined by adding acid seed solution and precipitation with $BaCl_2$ crystal and measuring the turbidity with the help of spectrophotometer at 420 nm wavelength as outline by Page *et al.,* 1982.

3.19 Soil analysis

Soil samples were analyzed for both physical and chemical characteristics viz. organic matter, pH , total nitrogen content and available phosphorus ,potassium and sulphur contents. The soil samples were analyzed by following standard method:

3.19.1 Soil pH

Soil pH measured by using a glass electrode pH meter (corning pH meter 320). The soil-water ratio was maintained at 1:2.5 as described by Jackson,1973.

3.19.2 Organic C

Organic carbon of the soil samples was estimated by the wet oxidation method of Walkley and Black (1935). The underlying principle was used to oxidize the organic matter with an excess of 1N $K_2Cr_20_7$ solution in presence of concentric H_2SO_4 and conc. H_3PO_4 and to titrate the excess of $K_2Cr_2O_7$ solution with 1N $FeSO_4$. To obtain the content organic matter was calculated by multiplying the percent organic carbon by 1.73 (Van Bemmelen factor) and the results were expressed in perchantage (Page *et al.*, 1982).

3.19.3 Total nitrogen content

Total nitrogen content in soil was determined by macro-kjeldahl method. Digestion was made with conc. H_2SO_4 and catalyst mixture (K_2SO_4: $CuSO_4$. $5H_2O$: seed in the ratio of 100:10:1). The flasks were swirled and heated 200^0C and 3 mL H_2O_2 was added. Then it was heated at 360^0C until the digest was clear and colorless solution. After cooling the content was taken into a 100 mL volumetric flask and the volume was made upto mark with deionized water. A reagent blank was prepared in a similar manner. These digests were used for N determination following the method described by Page *et al.*, 1982.

3.19.4 Available phosphorus content

Available phosphorus was extracted from the soil by shaking with 0.5M $NaHCO_3$ solutions at pH 8.5 following Olsen method (Olsen et al., 1995). The extracted phosphorus was determined by developing blue color by $SnCl_2$ reduction of phosphomolybdate complex and measuring the intensity of color colorimetrically at 660 nm wave length and calibrating the reading to the standard P curve.

3.19.5 Exchangable potassium content

Exchangeable K was determined from 1N NH_4OAc (pH 7.0) extract of the soil by using flame photometer (Black, 1965)

3.19.6 Available sulphur content

Available S content was determined by extracting the soil with $CaCl_2$(0.15%) solution as described by Page *et al.*, (1982).The extractable S was determined by developing turbidity by adding acid seed solution (20 ppm S as K_2SO_4 in 6N HCl) and $BaCl_2$ crystals. The intensity of turbidity was measured by spectrophotometer at 420 nm wavelengths.

3.20 Statistical analysis

The collected data were analyzed statistically following the analysis of variance (ANOVA) technique using the MSTAT statistical Computer Package Programme in accordance with the principles of Randomized Complete Block Design (RCBD). Duncan's Multiple Range Test (DMRT) was used to compare variations among the treatments. (Gomez and Gomez, 1984).

CHAPTER 4
RESULTS AND DISCUSSION

RESULT AND DISCUSSION

The experiment was conducted to determine the effect of organic manure viz., poultry manure, sesame oil cake, mustard oil cake and vermicompost and inorganic fertilizers as well as their combination effects on growth, yield and nutrient concentrations of BINA dhan-8. Data recorded were on plant height, number of tillers hill^{-1}, leaves plant^{-1}, panicle length, total grain, effective grain, non-effective grain, 1000-grain weight, grain yield and straw yield while the nutrient contents of rice include nitrogen, phosphorus, potassium and sulphur.

4.1 Yield contributing characters and yield of BINA dhan-8

4.1.1 Plant height

Significant variation in plant height of BINA dhan-8 was observed due to application of organic manures and inorganic fertilizers along and in different combinations (Appendix III). From the result, it was evident that the maximum plant height (104.8 cm) was obtained from T_7 treatment (75% NPKSZn+ Sesame oilcake @5t ha^{-1}) followed by (98.18 cm) in T_5 treatment (75% NPKSZn+ Mustard oil cake @5t ha^{-1}) and lowest plant height (82.45 cm) was observed in control treatment followed by (82.87 cm) in T_1 treatment (100% NPKSZn) combination (Appendix II). From the Appendix III was revealed that all the treatments produced significantly taller plants compared to the control treatment. Jin *et al.* (1996) reported that heavy application of cattle manure increased plant height. The above results are in agreement with Awan *et al.* (1984) who reported that the application of nitrogen of different levels on rice increased plant height. Singh *et al.*, (2006) and Singh *et al.* (2004) reported that plant height increased with increasing rates of different potassic fertilizer.

4.1.2 Number of tillers hill^{-1}

Number of tillers hill^{-1}of the experiment was statistically significant by the application of organic manures and inorganic fertilizers (Appendix III). The highest number of tillers hill^{-1} (15.00) was achieved in T_7 treatment combination (75% NPKSZn+ Sesame oilcake @5t ha^{-1}) which was followed by T_5 (13.93) treatment combination (75% NPKSZn+

Mustard oil cake @5t ha^{-1}) and the lowest number of tillers hill^{-1} (8.26) in control treatment (Appendix II). Chauhan *et al.* (2010), Sangeetha *et al.* (2010)) reported that number of tillers hill^{-1} increased with the application of chemical fertilizers.

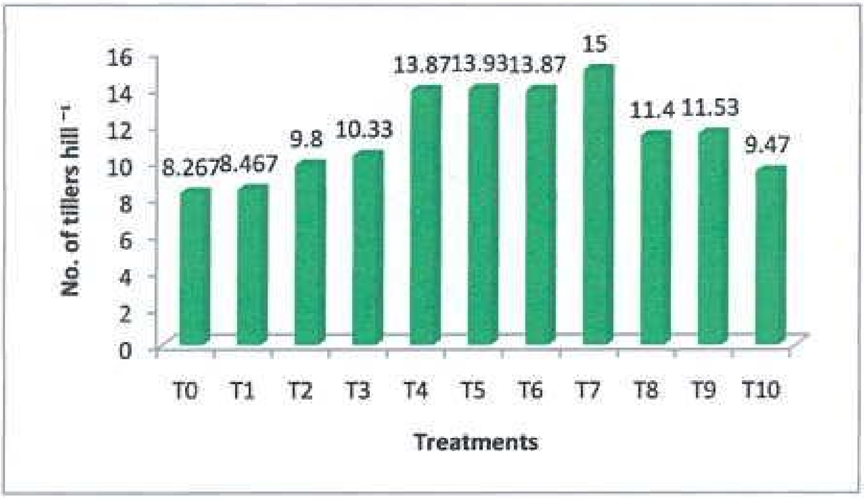

Figure 2.Effect of various organic manure and inorganic fertilizers on number of tillers hill^{-1}

Here,

T_0= Control, T_1= 100% NPKSZn (Recommended dose),
T_2= 50% NPKSZn + Poultry manure@5 tha^{-1} T_3= 75% NPKSZn + Poultry manure @ 5 tha^{-1}
T_4= 50% NPKSZn + Mustard oil cake @5 tha^{-1} T_5= 75% NPKSZn + Mustard oil cake @ 5 tha^{-1}
T_6= 50% NPKSZn + Sesame oil cake @ 5 tha^{-1} T_7= 75% NPKSZn + Sesame oil cake @ 5 tha^{-1}
T_8= 50% NPKSZn + Vermicompost @ 5 tha^{-1} T_9= 75 % NPKSZn + Vermicompost @ 5 tha^{-1}
T_{10}= Poultry manure @ 1.25 t ha^{-1}+ Mustard oil cake @ 1.25 t ha^{-1} + Sesame oilcake @ 1.25t ha^{-1} + Vermicompost @ 1.25 t ha^{-1}

4.1.3 Number of Leaves hill^{-1}

Significant variation was found due to the application of different organic manures and inorganic fertilizers in different combination (Appendix III). The highest leaves hill^{-1} (61.13) was observed in T_7 treatment (75% NPKSZn+ Mustard oilcake @5t ha^{-1}) followed by (57.87) in T_5 (75% NPKSZn+ Mustard oil cake @5t ha^{-1})) where the lowest leaves hill^{-1} (36.40) in control treatment which was followed by T_1 (37.47) treatment (100% NPKSZn) combination (Appendix II).

4.1.4 Panicle length

Panicle length of the experiment was statistically significant by the application of different combination of organic manures and inorganic fertilizers (Appendix III). The highest panicle length (20.63 cm) was observed in T_7 treatment (75% NPKSZn+ sesame oil cake @5 t ha^{-1}) followed by (19.87) in T_5 (75% NPKSZn+ Mustard oilcake @5t ha^{-1}) and the lowest panicle length (17.67 cm) in control treatment (Appendix II). Dixit and Singh (2000) observed that the increase panicle length due to application of increased rates of organic and inorganic fertilizers. Ahmed and Rahman (1991) reported that application of organic manure and chemical fertilizers increased the panicle length of rice.

4.1.5 Total number of grains panicle^{-1}

Total number of grains panicle^{-1} of the experiment was statistically significant by the application of different organic and inorganic fertilizer combination (Appendix V). The highest number of grains panicle^{-1} (100.5) was observed in T_7 treatment (75% NPKSZn+ Sesame oilcake @5t ha^{-1}) where the lowest total grain panicle^{-1} (84.13) in control treatment followed by (86.20) in T_1 treatment (100% NPKSZn) combination (Appendix IV & Figure 3). Kant and Kumar (1994) reported that the increasing rates of organic and inorganic fertilizer increased the number of grains per plant.

4.1.6 Filled grains panicle^{-1}

The effect of filled grain panicle^{-1} of BINA dhan 8 was significant due to the application of different organic and inorganic fertilizer combination (Appendix V). The highest filled grain per panicle (83.67) was observed in T_7 (75% NPKSZn+ sesame oil cake @ 5t ha^{-1}) followed by (82.87) in T_5 treatment (75% NPKSZn+ Mustard oil cake @5tha^{-1}) combination and the lowest filled grains panicle^{-1} (58.13) in control treatment followed by (68.27) inT_1 treatment (100% NPKSZn) combination (Appendix IV & Figure 3).

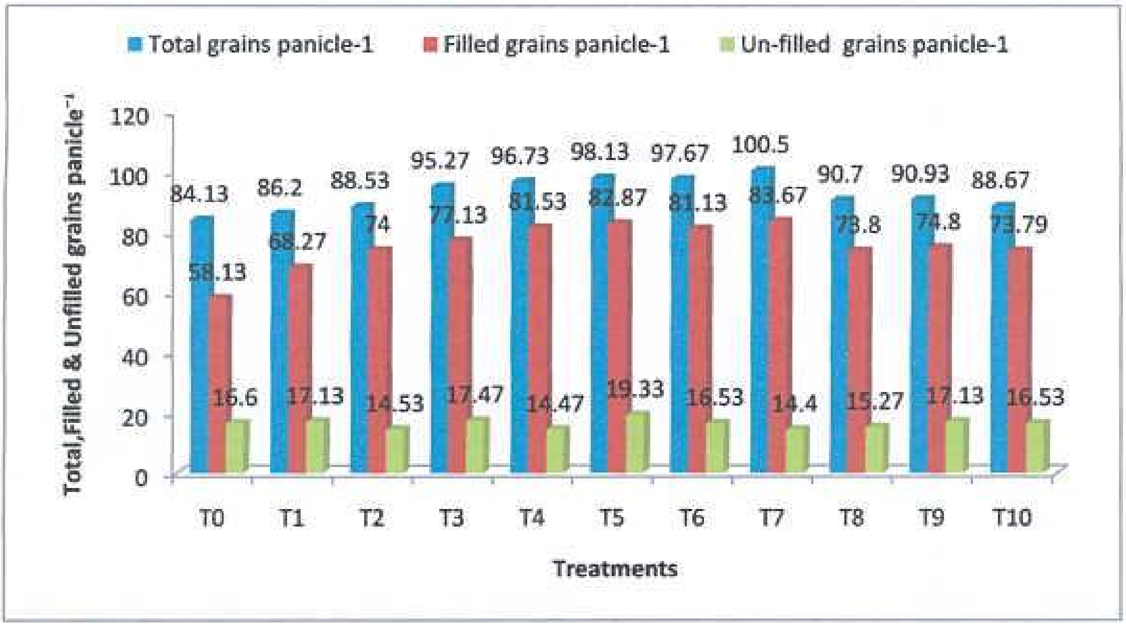

Figure 3.Effect of various organic manure and inorganic fertilizers on number of total, filled & unfilled grains panicle^{-1}

Here,

T_0= Control, T_1= 100% NPKSZn (Recommended dose),
T_2= 50% NPKSZn + Poultry manure@5 tha^{-1} T_3= 75% NPKSZn + Poultry manure @ 5 tha^{-1}
T_4= 50% NPKSZn + Mustard oil cake @5 tha^{-1} T_5= 75% NPKSZn + Mustard oil cake @ 5 tha^{-1}
T_6= 50% NPKSZn + Sesame oil cake @ 5 tha^{-1} T_7= 75% NPKSZn + Sesame oil cake @ 5 tha^{-1}
T_8= 50% NPKSZn + Vermicompost @ 5 tha^{-1} T_9= 75 % NPKSZn + Vermicompost @ 5 tha^{-1}
T_{10}= Poultry manure @ 1.25 t ha^{-1}+ Mustard oil cake @ 1.25 t ha^{-1} + Sesame oilcake @ 1.25t ha^{-1} + Vermicompost @ 1.25 t ha^{-1}

4.1.7 Unfilled grains panicle^{-1}

The effect of unfilled grains panicle^{-1} of BINA dhan-8 was significant due to the application of different organic manures and inorganic fertilizer combinations (Appendix IV). The highest unfilled grains panicle^{-1} (19.33) were observed in T_5 treatment (50% NPKSZn+ Mustard oil cake @5t ha^{-1}) NPKSZn+ poultry manure@5t ha^{-1}) and the lowest unfilled grains panicle^{-1} observed in control treatment.

4.1.8 1000-Seed weight

The results showed that the organic and inorganic fertilizers in different combinations were statistically significant (Appendix V). The lowest 1000-seed weight (23.83g) was noticed in control treatment followed by (26.2g) in T_1 treatment combination (100%NPKSZn) and the highest 1000-seed weight (40.53g) was noticed inT_7 treatment (75% NPKSZn+ Sesame oilcake @5t ha^{-1}) (Appendix IV). Islam *et al.* (1978) also reported that application of sulphur increased 1000-seed weight. Kant and Kumar (1994) reported that the increased rates of amendments with FYM increased the weight of 1000-grain. Haque (1994) also recorded that 1000-grain weight were increased by the application of organic manure.

4.1.9 Grain yield

Significant variation was found in grain yield due to the application of different organic manures and inorganic fertilizers in different combination(Appendix VII).The highest grain yield (6.43 t ha^{-1}) was observed in T_7 treatment (75% NPKSZn+ Sesame oil cake @) 5t ha^{-1}) followed by (6.14t ha^{-1}) in T_6 treatment (50% NPKSZn+ Sesame oil cake @ 5t ha^{-1}) where the lowest grain yield (1.40t ha^{-1}) in control treatment followed by (3.47t ha^{-1})inT_1treatment(100%NPKSZn) (Appendix VI and Figure 4).Devivedi and Thakur (2000) reported that the grain yield was significantly increased due to the application of organic manure and chemical fertilizers. This is also agreement with the findings of Rajni Rani *et al.*(2001),Haque *et al.* (2001),Ahmed and Rahman (1991).

4.1.10 Straw yield

Significant variation was found in straw yield due to the application of different organic manures and inorganic fertilizers in different combination (Appendix VII). The highest straw yield (7.97t ha^{-1}) in T_7 treatment (75% NPKSZn+ Sesame oil cake@)5t ha^{-1}) followed by (7.77t ha^{-1}) in T_6 treatment (50% NPKSZn+ Sesame oil cake @)5t ha^{-1}) combination where the lowest straw yield (2.70tha^{-1}) in control treatment followed by (4.47tha^{-1}) in T_1 treatment (100% NPKSZn) combination (Appendix VI and Figure 4). Islam *et al.* (2010) and Awan *et al.* (1984) reported that application of nitrogen with different levels organic manure increased straw and grain yield. Ahmed and Rahman (1991) reported that application of organic manures and chemical fertilizers increase the straw yield of rice. These findings are also found with the work of Islam (1996) and Khan (2007).

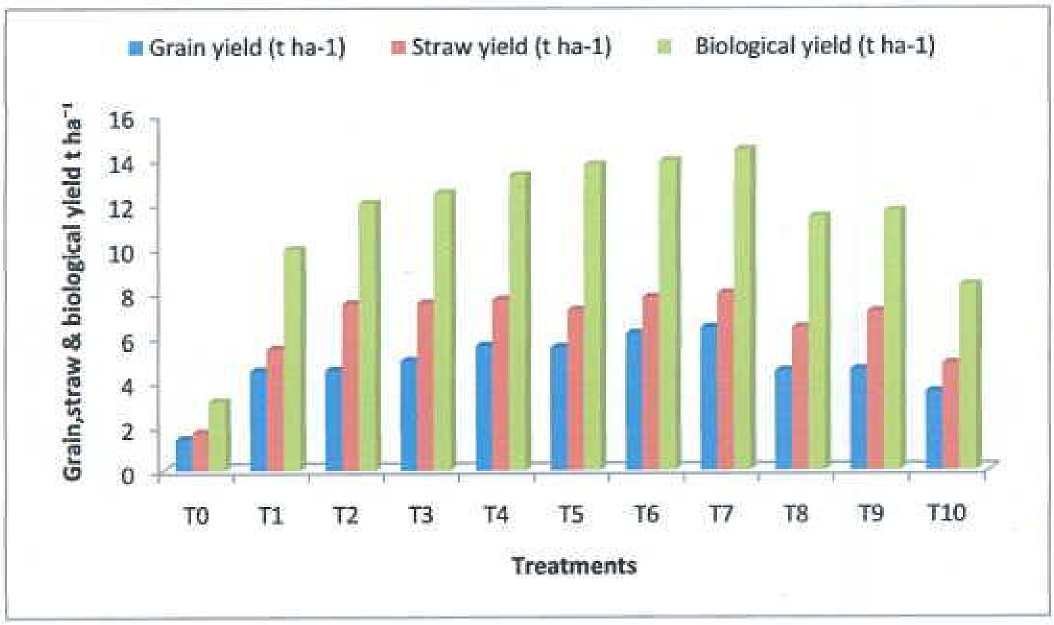

Figure 4 .Effect of various organic manure and inorganic fertilizers on grain,straw & biological yield of BINA dhan 8

Here,

T_0= Control, T_1= 100% NPKSZn (Recommended dose),
T_2= 50% NPKSZn + Poultry manure@5 tha^{-1} T_3= 75% NPKSZn + Poultry manure @ 5 tha^{-1}
T_4= 50% NPKSZn + Mustard oil cake @5 tha^{-1} T_5= 75% NPKSZn + Mustard oil cake @ 5 tha^{-1}
T_6= 50% NPKSZn + Sesame oil cake @ 5 tha^{-1} T_7= 75% NPKSZn + Sesame oil cake @ 5 tha^{-1}
T_8= 50% NPKSZn + Vermicompost @ 5 tha^{-1} T_9= 75 % NPKSZn + Vermicompost @ 5 tha^{-1}
T_{10}= Poultry manure @ 1.25 t ha^{-1}+ Mustard oil cake @ 1.25 t ha^{-1} + Sesame oilcake @ 1.25t ha^{-1} + Vermicompost @ 1.25 t ha^{-1}

4.1.11 Biological yield

Biological yield of BINA dhan-8 showed statistically significant variation due to the application of different organic manures and inorganic fertilizers in different combinations (Appendix VII).The The highest biological yield (15.90 t ha^{-1}) in T_7 treatment (75% NPKSZn+ Sesame oilcake @)5t ha^{-1}) followed by (15.60 t ha^{-1}) in T_6 treatment (50% NPKSZn+ Sesame oil cake @)5t ha^{-1}) combination where the lowest biological yield (4.10 t ha^{-1}) in control treatment followed by (7.94t ha^{-1}) in T_1 treatment (100% NPKSZn) combination (Appendix VI and Figure 4).

4.2 Effect of organic manure and inorganic fertilizers on nutrients content of BINA dhan-8

4.2.1 Nitrogen content

The effect of nitrogen content in grain as well as straw was statistically significant (Appendix IX). The highest N content in grain (2.10%) was obtained in T_7 treatment (75% NPKSZn+ Sesame oil cake @5t ha^{-1}) followed by (1.85%) T_6 (50% NPKSZn+ Sesame oil cake @5t ha^{-1}), and the lowest N content in grain (0.70%) was found in control treatment followed by T_1 (100% NPKSZn) (0.80%) treatment. In case of N content in straw, the highest N content in straw (0.69%) was obtain from T_7 treatment (75% NPKSZn+ Sesame oil cake @5t ha^{-1}) and it was lowest in straw (0.45%) in control treatment (Appendix VIII). Wild *et al.* (2011) and Kadu *et al.*, (1991) reported that nitrogen content in rice increased significantly with increased rates of urea application.

4.2.2 Phosphorus content

The effect of phosphorus content in grain as well as straw was statistically significant (Appendix IX). The highest P content in grain (0.29%) was obtained from T_7 treatment (75% NPKSZn+ Sesame oil cake @5t ha^{-1}) and the lowest phosphorus content (0.20%) found in control treatment followed by (0.21%) T_{10} treatment (Poultry manure @ 1.25 t ha^{-1}+ Mustard oil cake @ 1.25 t ha^{-1} + Sesame oilcake @ 1.25t ha^{-1} + Vermicompost @ 1.25 t ha^{-1}). In case of straw, P content was the highest (0.24%) in T_7 treatment(75% NPKSZn+ Sesame oil cake@5t ha^{-1})followed by (0.22%) T_5 treatment(75% NPKSZn+ Mustard oil cake @5tha^{-1}) combination and the lowest (0.12%) was found in control treatment (Appendix VIII). Zhar *et al.* (2005) and Kadu *et al.*, (1991) reported that grain

P and K were highest with NPK with organic manure in rice increased significantly with increasing rates of fertilizer application.

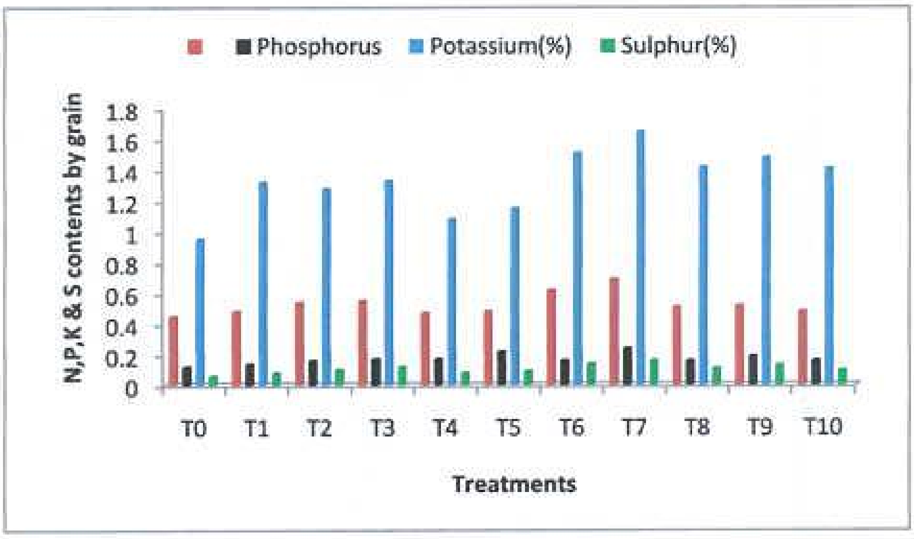

Figure 5 .Effect of various organic manure and inorganic fertilizers on N,P,K & S contents by grain of BINA dhan 8

Here,

T_0= Control, T_1= 100% NPKSZn (Recommended dose),
T_2= 50% NPKSZn + Poultry manure@5 tha^{-1} T_3= 75% NPKSZn + Poultry manure @ 5 tha^{-1}
T_4= 50% NPKSZn + Mustard oil cake @5 tha^{-1} T_5= 75% NPKSZn + Mustard oil cake @ 5 tha^{-1}
T_6= 50% NPKSZn + Sesame oil cake @ 5 tha^{-1} T_7= 75% NPKSZn + Sesame oil cake @ 5 tha^{-1}
T_8= 50% NPKSZn + Vermicompost @ 5 tha^{-1} T_9= 75 % NPKSZn + Vermicompost @ 5 tha^{-1}
T_{10}= Poultry manure @ 1.25 t ha^{-1}+ Mustard oil cake @ 1.25 t ha^{-1} + Sesame oilcake @ 1.25t ha^{-1} + Vermicompost @ 1.25 t ha^{-1}

4.2.3 Potassium content

The results of the K content in grain and straw of BINA dhan-8 have been significantly influenced by inorganic and organic manures (Appendix IX). The highest K content in grain (0.51%) was obtained from T_7 treatment(75% NPKSZn+ Sesame oil cake @5t ha^{-1}) followed by T_6 (0.48%) (50% NPKSZn+ Sesame oil cake @5t ha^{-1}) and the lowest K content in grain (0.33%) was obtained from control treatment. In case of K content in straw, the highest K content (1.65%) was obtained in T_7 treatment (75% NPKSZn+

Sesame oil cake @5t ha^{-1}) followed by T_6 (1.51%) (50% NPKSZn+ Sesame oil cake @5t ha^{-1}) and the lowest K content(0.95%) in control treatment (Appendix VIII). Rajanna *et al.* (2011) and Kadu *et al.*, (1991) reported that grain P and K were highest with NPK with organic manure in rice increased significantly with increasing rates of fertilizer application.

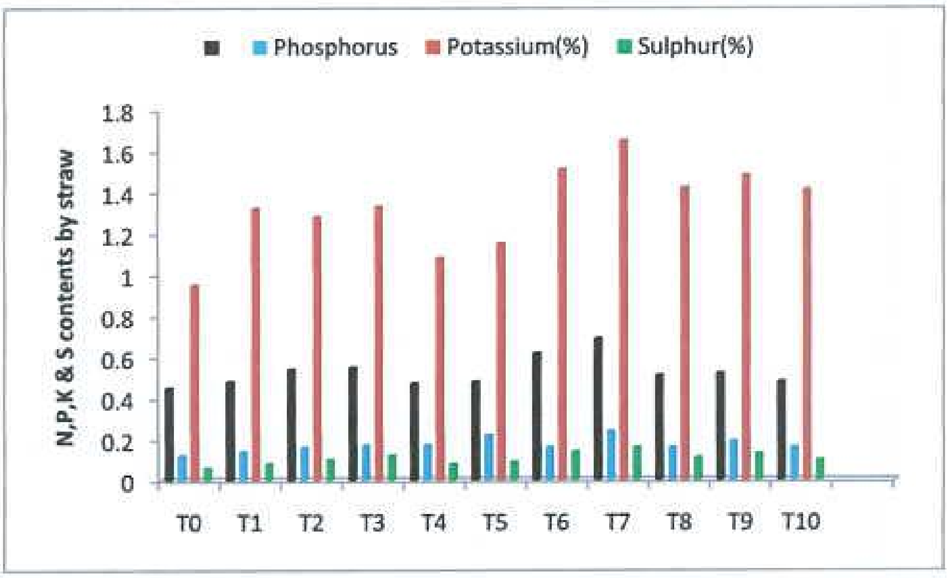

Figure 6 .Effect of various organic manure and inorganic fertilizers on N,P,K & S contents by straw of BINA dhan 8

Here,

T_0= Control, T_1= 100% NPKSZn (Recommended dose),
T_2= 50% NPKSZn + Poultry manure@5 tha^{-1} T_3= 75% NPKSZn + Poultry manure @ 5 tha^{-1}
T_4= 50% NPKSZn + Mustard oil cake @5 tha^{-1} T_5= 75% NPKSZn + Mustard oil cake @ 5 tha^{-1}
T_6= 50% NPKSZn + Sesame oil cake @ 5 tha^{-1} T_7= 75% NPKSZn + Sesame oil cake @ 5 tha^{-1}
T_8= 50% NPKSZn + Vermicompost @ 5 tha^{-1} T_9= 75 % NPKSZn + Vermicompost @ 5 tha^{-1}
T_{10}= Poultry manure @ 1.25 t ha^{-1}+ Mustard oil cake @ 1.25 t ha^{-1} + Sesame oilcake @ 1.25t ha^{-1} + Vermicompost @ 1.25 t ha^{-1}

4.2.4 Sulphur (S) content

The sulphur content in rice grain and straw was statistically significant (Appendix IX. The highest S content in grain (0.40%) was obtained in T_7 treatment (75% NPKSZn+

Sesame oil cake @5t ha^{-1}) T_6 (0.38%) (50% NPKSZn+ Sesame oil cake @5t ha^{-1}) and it was the lowest S content(0.22%) in control treatment .Sulphur content in straw was the highest (0.16%) in T_7 (75% NPKSZn+ Sesame oil cake @5t ha^{-1}) and the lowest S content (0.06%) was found in control treatment . Hossain *et al.* (1986) showed that S concentration of rice straw increased considerably due to addition of S supplied as gypsum. The levels of S in rice grain were improved in combined use of organic manures with NPKS.

CHAPTER 5
SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

A field experiment was conducted at the research field of Sher-e-Bangla Agricultural University, Dhaka, during the period from November 2012 to March 2013 to study the effect of organic manures viz., Poultry manure, Mustard oil cake, sesame oil cake, vermicompost and inorganic fertilizer on yield and nutrient uptake by BINA dhan-8. There were altogether 11 treatments viz.T_0 (Control), T_1 (100% NPKSZn), T_2 (50% NPKSZn + Poultry manure @ 5t ha^{-1}), T_3 (75% NPKSZn + Poultry manure @ 5t ha^{-1}), T_4 (50% NPKSZn + Mustard oil cake @ 5t ha^{-1}), T_5 (75% NPKSZn+ Mustard oil cake @ 5t ha^{-1}), T_6 (50% NPKSZn + Sesame oil cake @ 5t ha^{-1}), T_7 (75% NPKSZn fertilizer + Sesame oil cake @ 5t ha^{-1}), T_8 (50 %NPKSZn fertilizer + vermicompost @ 5t ha^{-1}), T_9 (75% NPKSZn + vermicompost @ 5t ha^{-1}) and T_{10} (Poultry manure @ 1.25t ha^{-1} + Mustard oil cake @ 1.25t ha^{-1} + Sesame oilcake @ 1.25t ha^{-1} + Vermicompost @ 1.25t ha^{-1}). The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The total number of unit plot was 33 and size of unit plot was 2m x 2m.

Recommended amount of organic manures was applied to soil two days before the final land preparation. Recommended amount of TSP, MOP, Gypsum, $ZnSO_4$ were applied to soil during the final land preparation. Urea was applied to soil during final land preparation. Urea was applied in three equal splits, as top dressing first split 15 days after transplanting (DAT), second at active tillering stage at 30 days after transplanting and third split at panicle initiation stage at 45 DAT. Thirty five days old seedlings were transplanted in the experimental plots with three seedlings per hill and plant spacing 15 cm x 20cm. The results revealed that the yield component such as plant height, number of tillers $hill^{-1}$, leaves $hill^{-1}$, panicle height, total grains $panicle^{-1}$, filled and unfilled grains $panicle^{-1}$, 1000-seed weight, grain yield, straw yield, biological yield, responded significantly by the application of both organic manures and inorganic fertilizer combinations along with the nutrient contents of rice include nitrogen, phosphorus, potassium and sulphur.

The tallest plant (104.80 cm) was obtained from T_7 treatment and the shortest plant height (82.45 cm) was recorded in control treatment. The highest number of tillers hill^{-1} (15.00) was observed in T_7 treatment and the lowest number of tillers hill^{-1} (8.26) in control treatment. The highest leaves hill^{-1} (61.13) was observed in T_7 treatment and the lowest leaves plant^{-1} (36.40) in control treatment. The highest panicle length (20.63 cm) was observed in T_7 treatment and the lowest panicle length (17.67 cm) in control treatment. The highest number of total grains panicle^{-1} (100.5) was obtained in T_7 treatment and the lowest total grain panicle^{-1} (84.13) in control treatment. The highest filled grain per panicle (83.67) was observed in T_7 treatment which was and the lowest filled grains per panicle (58.13) in control treatment. The highest unfilled grain per panicle (19.33) was observed in T_5 and the lowest unfilled grains per panicle (14.40) in T_7 treatment. The highest 1000-seed weight (40.53g) was observed in T_7 treatment and the lowest 1000-seed weight (23.83g) was observed in control treatment. The highest grain yield (6.93 t ha^{-1}) was observed in T_7 treatment where the lowest grain yield (2.40 t ha^{-1}) in control treatment. The highest straw yield (7.97 t ha^{-1}) was observed in T_7 treatment and the lowest straw yield (1.70 t ha^{-1}) in control treatment. The highest biological yield (15.90 t ha^{-1}) was observed in T_7 treatment and the lowest biological yield (4.10 t ha^{-1}) in control treatment. Nitrogen concentration of BINA dhan 8 was significantly influenced by application of organic manures and inorganic fertilizers. Treatment T_7 produced both maximum N content in grain (2.10%) and in straw (0.69%) while the minimum value of N content both grain (0.70%) and straw (0.45%) was recorded in control treatment. The highest P content in grain (0.29%) was obtained from T_7 treatment and the lowest phosphorus content (0.20%) found in control treatment and in straw, P content was the highest (0.24%) from T_7 treatment and the lowest (0.12%) was found in control treatment. The highest K content in grain (0.51%) was obtained from T_7 treatment and in straw, the highest K content (1.51%) was obtained in T_7 treatment and the lowest K content both grain and straw in control treatment. The highest S content in grain 0.40% was obtained in T_2 treatment and the lowest S content 0.22% in control treatment. Sulphur content in straw was the highest (0.16%) in T_7 treatment and the lowest S content (0.06%) was found in control treatment.

The overall results indicated that most of the nutrient concentrations by BINA dhan 8 were found to vary significantly at moderate doses of both organic manures and chemical fertilizers application than single application of organic manures and fertilizers or other combinations. In order to achieve higher yield and improved quality of rice, it is evident that T_7 treatment combination was the best under the experimental field condition and also reduce the use of chemical fertilizers upto 25% thus allowing small farmers to save in part the cost of the production.

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APPENDICES

Appendix I. Monthly average Temperature, Relative Humidity and Total rainfall of the experimental site during the period from December 2012 to March 2013

Year	Month	Air Temperature(°C)			Relative Humidity(%)	Rainfall(mm)
		Max.	Min.	Mean		
2012	Dec.	26	14	20	63	5
2013	Jan.	28	16	22	54	8
	Feb.	28	15	21	49	32
	Mar.	32	20	26	45	61

Appendix II. Effect of inorganic fertilizers and organic manures on plant height, number of tillers $hill^{-1}$, leaves $hill^{-1}$ and panicle length

Treatments	Plant height (cm)	No. of tillers $hill^{-1}$	Leaves $hill^{-1}$	Panicle length (cm)
T_0	82.45 e	8.267 c	36.40 e	17.67 bc
T_1	82.87 de	8.467 c	37.37 d	17.91 bc
T_2	87.37 bcde	9.8 bc	40.40 cd	19.17 abc
T_3	88.57 bcde	10.33 b	47.07 bc	19.54 abc
T_4	96.53 abc	13.87 a	53.93 ab	19.45 abc
T_5	98.18 ab	13.93 a	57.87 a	19.87 ab
T_6	94.59 abcd	13.87 a	55.60 a	19.70 abc
T_7	104.8 a	15.00 a	61.13 a	20.63 a
T_8	86.66 cde	11.40 b	47.07 bc	18.53 bc
T_9	91.20 bcde	11.53 b	47.47 d	18.88 abc
T_{10}	84.20 de	9.47 bc	37.47 bc	17.90 c
$LSD_{0.05}$	9.73	2.01	6.93	1.78
Level of significance	**	**	**	**
CV(%)	6.30	10.32	8.65	5.52

In a column means having similar letter(s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

T_0= Control, T_1= 100% NPKSZn (Recommended dose),
T_2= 50% NPKSZn + Poultry manure@5 t ha^{-1} T_3= 75% NPKSZn + Poultry manure @ 5 t ha^{-1}
T_4= 50% NPKSZn + Mustard oil cake @5 t ha^{-1} T_5= 75% NPKSZn + Mustard oil cake @ 5 t ha^{-1}
T_6= 50% NPKSZn + Sesame oil cake @ 5 t ha^{-1} T_7= 75% NPKSZn + Sesame oil cake @ 5 t ha^{-1}
T_8= 50% NPKSZn + Vermicompost @ 5 t ha^{-1} T_9= 75 % NPKSZn + Vermicompost @ 5 t ha^{-1}
T_{10}= Poultry manure @ 1.25 t ha^{-1}+ Mustard oil cake @ 1.25 t ha^{-1} + Sesame oilcake @ 1.25t ha^{-1} + Vermicompost @ 1.25 tha^{-1}

Appendix III. Analysis of variance (mean square) of the data for plant height, number of tillers hill^{-1}, leaves hill^{-1} panicle length

Source	Degree of freedom	Plant height (cm)	No.of tillers hill^{-1}	Leaves hill^{-1}	Panicle length
Replication	2	25.96	1.31	22.24	7.337
Treatment	10	152.05**	17.21**	233.39**	2.658**
Error	20	32.66	1.39	16.59	1.103

** = Significant at 1% level of probability

Appendix IV. Effect of inorganic fertilizers and organic manures on total number of grains panicle^{-1}, filled grains panicle^{-1}, unfilled grain panicle^{-1} &1000- seed wt (g).

Treatments	Total grains panicle^{-1}	Filled grain panicle^{-1}	Un-filled grains panicle^{-1}	1000 -seed wt (g)
T_0	84.13 d	58.13 e	16.60 bcd	23.83 d
T_1	86.20 d	68.27 e	17.13 bc	26.20 cd
T_2	88.53 cd	74.00 cde	14.53 def	31.80 bc
T_3	95.27 abc	77.13 abcd	17.47 ab	36.87 ab
T_4	96.73 ab	81.53 abc	14.47 ef	36.07 ab
T_5	98.13 a	82.87 de	19.33 a	37.33 ab
T_6	97.67 a	81.13 abcd	16.53 bcde	39.67 a
T_7	100.5 a	83.67 a	14.40 f	40.53 a
T_8	90.70 bcd	73.80 cde	15.27 cdef	36.60 ab
T_9	90.93 bcd	74.80 bcde	17.13 bc	37.00 ab
T_{10}	88.67 cd	73.79 de	16.53 bcde	28.07 cd
$LSD_{0.05}$	6.20	6.88	1.88	6.61
Level of significance	**	**	**	**
CV(%)	3.94	5.30	6.80	11.43

In a column means having similar letter(s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

T_0= Control, T_1= 100% NPKSZn (Recommended dose),
T_2= 50% NPKSZn + Poultry manure@5 t ha^{-1} T_3= 75% NPKSZn + Poultry manure @ 5 t ha^{-1}
T_4= 50% NPKSZn + Mustard oil cake @5 t ha^{-1} T_5= 75% NPKSZn + Mustard oil cake @ 5 t ha^{-1}
T_6= 50% NPKSZn + Sesame oil cake @ 5 t ha^{-1} T_7= 75% NPKSZn + Sesame oil cake @ 5 t ha^{-1}
T_8= 50% NPKSZn + Vermicompost @ 5 t ha^{-1} T_9= 75 % NPKSZn + Vermicompost @ 5 t ha^{-1}
T_{10}= Poultry manure @ 1.25 t ha^{-1}+ Mustard oil cake @ 1.25 t ha^{-1} + Sesame oilcake @ 1.25t ha^{-1} + Vermicompost @ 1.25 tha^{-1}

Appendix V. Analysis of variance (mean square) of the data for total number of grains panicle^{-1}, filled grains panicle^{-1}, unfilled grain panicle^{-1} & 1000 seed wt.

Source	Degree of freedom	Total grains panicle^{-1}	Filled grains panicle^{-1}	Unfilled grains panicle^{-1}	1000-seed wt.(g)
Replication	2	4.97	13.64	1.70	42.76
Treatment	10	88.14**	88.00**	6.99**	95.52**
Error	20	13.26	16.32	1.22	15.10

** = Significant at 1% level of probability

Appendix VI. Effect of inorganic fertilizers and organic manures on grain yield straw yield and biological yield

Treatmtents	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})
T_0	1.40 f	2.70 e	4.10 f
T_1	3.47 e	4.47 d	7.94 e
T_2	4.50 d	7.50 ab	12.00 c
T_3	4.93 c	7.53 b	12.46 c
T_4	5.53 b	7.20 b	13.27 b
T_5	5.60 b	7.67 b	13.73 b
T_6	6.14 a	7.77 ab	13.91 a
T_7	6.43 a	7.97 a	14.40 a
T_8	4.47 d	6.43 c	11.40c
T_9	4.53 d	7.13 b	11.66 d
T_{10}	3.53 e	4.80 d	8.33 e
$LSD_{0.05}$	0.410	0.570	1.20
Level of significance	**	**	**
CV(%)	4.77	5.24	6.14

In a column means having similar letter(s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

T_0= Control, T_1= 100% NPKSZn (Recommended dose),
T_2= 50% NPKSZn + Poultry manure@5 t ha^{-1} T_3= 75% NPKSZn + Poultry manure @ 5 t ha^{-1}
T_4= 50% NPKSZn + Mustard oil cake @5 t ha^{-1} T_5= 75% NPKSZn + Mustard oil cake @ 5 t ha^{-1}
T_6= 50% NPKSZn + Sesame oil cake @ 5 t ha^{-1} T_7= 75% NPKSZn + Sesame oil cake @ 5 t ha^{-1}
T_8= 50% NPKSZn + Vermicompost @ 5 t ha^{-1} T_9= 75 % NPKSZn + Vermicompost @ 5 t ha^{-1}
T_{10}= Poultry manure @ 1.25 t ha^{-1}+ Mustard oil cake @ 1.25 t ha^{-1} + Sesame oilcake @ 1.25t ha^{-1} + Vermicompost @ 1.25 tha^{-1}

Appendix VII. Analysis of variance (mean square) of the data for grain yield straw yield and biological yield

Source of variation	df	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})
Replication	2	0.122	0.155	0.982
Treatment	10	10.674**	11.395**	39.01**
Error	20	0.058	0.112	0.493

** = Significant at 1% level of probability

Appendix VIII. Effect of inorganic fertilizers and organic manures on N,P,K and S contents by grain & straw of BINA dhan 8

Treatments	Nitrogen (%)		Phosphorus (%)		Potassium (%)		Sulpher (%)	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_0	0.70 f	0.45 e	0.20 e	0.12 e	0.33 c	0.95 f	0.22 d	0.06 c
T_1	0.80 ef	0.48 d	0.22 de	0.14 de	0.42 b	1.32 cd	0.29 c	0.08 bc
T_2	1.20 de	0.54 c	0.23 cd	0.16 de	0.44 b	1.28 d	0.31 c	0.10 bc
T_3	1.40 c	0.55 c	0.24 c	0.17 cd	0.45 b	1.33 cd	0.32 c	0.12 bc
T_4	1.05 de	0.47 d	0.22 de	0.17 cd	0.43 b	1.08 e	0.33 bc	0.08 bc
T_5	1.75 b	0.48 d	0.22 de	0.22 ab	0.45 b	1.15 e	0.34 abc	0.09 bc
T_6	1.85 b	0.62 b	0.26 b	0.16 de	0.48 ab	1.51 b	0.38 ab	0.14 a
T_7	2.10 a	0.69 a	0.29 a	0.24 a	0.51 ab	1.65 a	0.40 a	0.16 a
T_8	1.10 de	0.51 bc	0.23 cde	0.16 de	0.45 b	1.48 b	0.32 c	0.13 bc
T_9	1.65 b	0.52 b	0.24 c	0.19 b	0.46 ab	1.48 b	0.36 abc	0.11 b
T_{10}	0.90 ef	0.48 d	0.21 de	0.16 de	0.43 b	1.41 bc	0.30 c	.0967 bc
$LSD_{0.05}$	0.214	0.053	0.016	0.016	0.053	0.119	0.053	0.053
Level of significance	**	**	**	**	**	**	**	**
CV(%)	9.43	6.04	4.34	10.37	4.98	5.35	6.63	9.46

In a column means having similar letter(s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability

T_0= Control, T_1= 100% NPKSZn (Recommended dose),
T_2= 50% NPKSZn + Poultry manure@5 t ha^{-1} T_3= 75% NPKSZn + Poultry manure @ 5 t ha^{-1}
T_4= 50% NPKSZn + Mustard oil cake @5 t ha^{-1} T_5= 75% NPKSZn + Mustard oil cake @ 5 t ha^{-1}
T_6= 50% NPKSZn + Sesame oil cake @ 5 t ha^{-1} T_7= 75% NPKSZn + Sesame oil cake @ 5 t ha^{-1}
T_8= 50% NPKSZn + Vermicompost @ 5 t ha^{-1} T_9= 75 % NPKSZn + Vermicompost @ 5 t ha^{-1}
T_{10}= Poultry manure @ 1.25 t ha^{-1}+ Mustard oil cake @ 1.25 t ha^{-1} + Sesame oilcake @ 1.25t ha^{-1} + Vermicompost @ 1.25 tha^{-1}

Appendix IX. Analysis of variance of the data on N, P, K and S concentration in grain and straw of BINA dhan 8 as influenced by organic manure and inorganic fertilizer

Source of variation	df	Nitrogen (%)		Phosphorus (%)		Potassium (%)		Sulpher (%)	
		Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Treatment	10	0.613**	0.015**	0.0022**	0.0020**	0.009**	0.126**	0.007**	0.005**
Error	22	0.016	0.001	0.0001	0.0001	0.001	0.005	0.001	0.001
Total	32								

** = Significant at 1% level of probability