RESPONSE OF BORO RICE TO NIMIN-COATED UREA AS A SLOW RELEASE NITROGEN FERTILIZER

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CERTIFICATE

This is to certify that the thesis entitled "**RESPONSE OF BORO RICE TO NIMN COATED UREA AS A SLOW RELEASE NITROGEN FERTILIZER** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE in Soil Science**, embodies the result of a piece of bonafide research work carried out by **Md. Tarikul Islam** Registration number: **02620** 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 been duly acknowledged.

Dated:

Place: Dhaka, Bangladesh

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ABSTRACT

A field experiment was conducted in the field of Soil Science Department of Sher-e-Bangla Agricultural University, Dhaka during the boro season from 3 December to 27 March, 2008, to observe the effect of Nimin coated nitrogen (N) fertilizer over prilled nitrogenous fertilizer on the yield and yield contributing characters of BRRI dhan 29. The soil of the experimental field belongs to the Modhupur tract under AEZ 28. The experiment was laid out in randomized block design with three replications. There were three levels of (N) (60, 90 and 120 kg N ha^{-1}) each from urea and nimin coated nitrogen fertilizer and one nitrogen control treatment. The unite plot size was 4 m × 3 m, with a spacing of 20 cm × 20 cm. Nimin coated nitrogen significantly increased plant height, tillers $hill^{-1}$, effective tillers $hill^{-1}$, grains $panicle^{-1}$, grain and straw yields of BRRI dhan-29. The highest plant height, number of effective tillers and straw yield were found in Nimin coated nitrogen @ 120 kg ha^{-1} which was statistically identical with Nimin coated nitrogen @ 90 kg ha^{-1}. The maximum yield (4.84 t ha^{-1}) and filled grain (146.1 $panical^{-1}$) were observed from Nimin coated nitrogen @ 90 kg ha^{-1} which was statistically similar with Nimin coated nitrogen @ 120 kg ha^{-1}.Therefore Nimin coated nitrogen @ 90 kg ha^{-1} is more economic and nitrogen use efficiency was higher than other treatments for boro dhan 29 cultivation. The different nitrogen levels significantly influenced uptake of nitrogen by BRRI dhan 29. Between the tow N sour as, the highest N uptake by BRRI dhan 29 was recorded in 120 kg Nimin coated ha^{-1}.

In all cases the uptakes of nitrogen i.e. from grain and from soil were affected by different nitrogen fertilizers, Nimin coated nitrogen @ 120 kg ha^{-1} performed the highest results.

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CHAPTER I

Introduction

Food is the Prime fundamental demand for human beings in the world. Its demand will continue to increase in the days to come. More than two third of the world population are presently living in the developing countries where agricultural production is not sufficient to meet the country. Bangladesh is a densely populated agro-based country where rice is the most extensively cultivated cereal crop .Bangladesh is the forth largest rice growing country of the world. Rice is the main food of Bangladesh. It has 8.65 million hectares of arable land of which 75% is devoted to rice cultivation. Rice based cropping system has been practical in Bangladesh since the beginning of modern agricultural practices.

Rice is the staple food for nearly 40% of the world's population. About 90% of the World's rice is grown and consume in Asia (De Datta 1981), the continent which absorbs the major share of the global population increase. Bangladesh is running with shortage of food. In order to attain self-sufficiency in food, efforts must be made to enhance the yield per unit area and improve the quality of the produce. According to one estimate, global rice production must reach to 800 million tons from the present 585 million tons in 2003 to meet the demand in 2025. Because irrigated rice contributes more than 75% of the total rice production, enhancing its yield potential would be key to meeting the global rice requirement for an additional 215 million tons. Tropical rice growing countries need an increased supply of rice because of their increasing populations and decreasing land and water resources.

During 2001-2002 agriculture contributes her gross domestic products (at current price) about 23.31%. Agriculture of Bangladesh is dominated by intensive rice production. In 2000-2001 rice covers about 26.7 million acres with production of 25.09 million tons and the average yield is 2.3 tons ha^{-1}. The total production of rice in Bangladesh is not sufficient to feed her people. Rice yield in unit area is very low as compared to other rice growing countries such as Japan, China, Korea, USA where yield ha^{-1} is 6.70, 6.23, 6.59, 7.04 t ha^{-1}, respectively . Moreover, total area under rice would be reduced gradually from 10.4 million hectare to 7.6 million hectare by year 2030.

Fertilizer nitrogen has played a key role in increasing rice production in Asia, yet it use efficiency is only 30-40% or even less, because about 30-50% of applied nitrogen is lost by runoff, leaching, volatilization and de-nitrification (Prasad 1998). Use of nitrification inhibitor along with nitrogenous fertilizers has been suggested to increase nitrogen use efficiency, and to most widely tested and marketed nitrification inhibitor is Neem oil. However, poor farmers in Asian countries who can not afford the fertilizer can hardly pay for NIs. Prasad *et al* (1998) reported that urea with neem oil is superior to prilled urea for increasing N use efficiency in rice field. As N from urea is responsible to pollute ground water to increase green house gas in atmosphere, therefore to increase the N use efficiency is a concern matter in rice field.

Rice crop yields largely depend upon the soil conditions (it's native nutrient status) and also on the supply of available nutrients (chemical fertilizer) like P, K, S and Zn. Most of the farmers of Bangladesh have a tendency to apply more amount of nitrogen to obtain higher yield. Our farmers mainly use urea as nitrogenous fertilizer which accounts for about 75% of the total fertilizer used in Bangladesh. Along with other management practices for increasing the efficiency of applied N fertilizer, the selection of N efficient rice genotypes or to increase the using efficiency of N may be a good option. Neem oil as a nitrification inhibitor is easily extractable in our country that will check the nitrogen loss in rice field. Neem oil would be a good option to minimize losses of N as well as to develop high yielding N utilization approach. Thus there is a need for seriously examining the potential of the use of nimin in Bangladesh agriculture as a coating material of urea which also ensures environmental safety to a great extent being environment-friendly. Therefore, an experiment was undertaken to increase the efficiency of applied nitrogenous fertilizer on boro rice with the following objective:

Objective (s):

1. To evaluate the performance of Nimin- coated nitrogenous fertilizer on rice and
2. To compare the effect of Nimin-coated nitrogenous fertilizer and prilled nitrogen fertilizer.

CHAPTER II

REVIEW OF LITERATURE

Nitrogenous fertilizer has a great impact and effect on the growth, yield and yield component of rice. Many experiments were conducted on rice with respect to different rates of nitrogen and also the nitrogen use efficiency in Bangladesh and in many other rice growing countries of the world. On the other hand, nimin-coated nitrogen is the new approach to increase nitrogen efficiency for low land crops. Nimin-coated nitrogen release elemental nitrogen slowly and can ensure nitrogen uptake by plans. Therefore, it would be a low cost and time saving approach to meet up the nitrogen requirement for rice. The findings of different workers on the use of nitrogen and nimin-coated nitrogen at different rates and their ultimate effects on the performance of rice have been summarized below:

2.1 Effect of Nitrogen on rice

2.1.1 Plant height

Rahman, *et al.* (1985) conducted a field experiment during the 2000 and 2001 rainy seasons in Port Blari, Andaman and Nicobar Island, India to study the effect of rice cv. Mansarovar cultivated under lowland conditions. The treatments comprised on nitrogen T_1; 30 kg N ha^{-1} at basal, 30 and 70 days after planting (dAP), T_2; 45 kg N ha^{-1} at 30 and 70 dAP, T_3; 32 kg N ha^{-1} at basal, 30 and 70 dAP and 25 kg N ha^{-1} at panicle initiation stage, T_4; 4.5% controlled release N at 60% of the recommended dose; and 6.0% controlled release N at 60% of the recommended dose. The highest plant height at harvest (106.0 cm) was obtained from 45 kg N ha^{-1} at 30 and 70 dAP application.

Lawal and Lawal (2002) disclosed that N (120 kg ha^{-1}) significantly increased plant height. A basal N application increased the plant height significantly (Sharma, 1995; Dahatonde, 1992).

Ebaid and Ghanem (2000) conducted a field experiment at the Rice Research and Training Center (Etai El-Baroud Agricultural Research Station Farm) in Egypt during the year of 1996-97 to find out the productivity and also the plant height of Giza 177 rice (*Oryza sativa*). Nitrogen fertilizer was applied to the rice crop at the rate of 0, 96 and 144 kg N ha^{-1} in urea form and they found that increasing nitrogen level upto 144 kg ha^{-1} significantly increased plant height.

Rajendra and Veeraputhiran (1999) conducted an experiment during the kharif season of 1996 and 1997 to study the effect of 4 nitrogen levels (0, 75, 150 and 225 kg ha^{-1}) and 3 sowing rates in the nursery (10, 20 and 3 g m^{-2}) on hybrid rice ADTRH1. Nitrogen was applied at 3 equal split namely, 7 days after transplanting, active tillering and panicle initiation stages. They found that the highest plant height and straw yield (13.1 t ha^{-1}) were observed in hybrids supplied with 225 kg N ha^{-1}.

Reddy *et al.* (1990) noticed positive effect of nitrogen on plant height in rice. Taller plants were produced by higher amount of nitrogen application.

Plant height decreased significantly with the reduction in the amount of nitrogen top dressings (Bhuiyan and Saleque, 1990).

Idris and Matin (1990) stated that plant height increased up to 120 kg N ha^{-1} compared to the control and thereafter it decreased at 140 kg N ha^{-1}. The longest plant was recorded from 80 kg N ha^{-1} and the lowest one from 0 kg N ha^{-1}.

2.1.2 Number of tillers $hill^{-1}$

Lawal and Lawal (2002) carried out 3 field experiments during the rainy season of 1996, 1997 and 1998 in Nigeria to evaluate the growth and yield response of low land rice to varying N rates and placement methods. The treatment consisted of 4 N rates (0, 40, 80 and 120 kg ha^{-1}) and 2 fertilizer placement method of (deep and surface placement). They found that application of 80 kg N ha^{-1} significantly increased the number of tiller $hill^{-1}$.

Prasad *et al* (1998) carried out a field experiment to find out the relative efficiency of prilled urea and neem coated urea on rice. As a slow release behavior of neem coated urea gave maximum number of tillers $hill^{-1}$ due to minimize the loss of nitrogen.

Mendhe *et al.* (2002) conducted a filed experiment at the National Agriculture Research Project, Navegaon Bardh, Maharshtra, India during the kharif season of 1998-2000 to evaluate the performance and nitrogen requirement of promising cultivars of transplanted paddy (Sye-92-27-11, Sye-116, 225-3-9-2 and surakshah). They found that nitrogen @ 125 kg ha^{-1} significantly increased the number of effective tiller $hill^{-1}$ (9.29) as compared to 75 and 100 kg N ha^{-1}.

Singh and Singh (2002) recorded that increasing levels of nitrogen significantly increased total tiller $hill^{-1}$.

Ehsanullah *et al.* (2001) carried out a field experiment to determine the effect of various methods of nitrogen application for increasing nitrogen use efficiency in fine rice (*Oryza sativa* L.) using cv. supper Basmati. They found that the application of 100 kg N ha^{-1} showed the maximum number of tillers $hill^{-1}$ and 75 kg N ha^{-1} showed minimum tillers $hill^{-1}$. Similarly application of nitrogen by incorporating in between hills wrapped tissue paper produced more tillers $hill^{-1}$ than other treatments and the differences were significant.

Devasenamma (2001) conducted a field experiment in Andhra Pradesh, India during the rabi season of 1996-97 to study the performance of rice hybrids (APHR-2, DRRH-1, MGR-1, TNRH-16 and NLR-33358) at various nitrogen fertilizer rates (0, 60, 120, 180 kg ha^{-1}). They found that the highest number of tillers (464 m^{-2}) and panicles (458 m^{-2}) were produced by ARHR-2.

Munnujan *et al.* (2001) conducted a field experiment at Gazipur in 1993 to determine the effects of nitrogen (N) fertilizer and planting density on growth and yield of long grain rice. Tiller per plant increased linearly with the increase in N fertilizer levels.

Sahrawat *et al.* (1999) also observed that nitrogen level significantly affected tillering in rice.

The number of tiller $hill^{-1}$ increased significantly with increased nitrogen level (Maske *et al.*, 1997).

Hari *et al.* (1997) carried out an experiment with rice hybrids PMS 2A/IR 30802 to study the effect of different levels of nitrogen and observed significant increase in productive tillers $hill^{-1}$ with increasing levels of nitrogen from 0 to 150 kg ha^{-1}.

BINA (1996) reported that the effect of different levels of nitrogen was significant for number of tillers $hill^{-1}$.

Chander and Pandey (1996) found that application of 120 kg N ha^{-1} resulted in significant increase in number of productive tillers $hill^{-1}$ compared to 60 kg N ha

Kumar *et al.* (1995) stated that an increase in N levels from 80 to 120 kg ha^{-1} significantly increased total tillers $hill^{-1}$.

Thakur (1993a) observed that increasing levels of N increased the productive tillers m^{-2}.

Ghosh *et al.* (1991) observed that application of N increased the number of productive tiller $hill^{-1}$.

Pandey *et al.* (1991) concluded that higher grain yield from the increase in nitrogen level might be attributable to increase in productive tiller $hill^{-1}$.

The application of 90 kg N ha^{-1} resulted in higher number of productive tiller $hill^{-1}$ (Dubey *et al.* 1991).

Idris and Matin (1990) noticed that the maximum tiller $hill^{-1}$ was produced with 140 kg N ha^{-1} which was statistically similar to those with 60, 80, 100 and 120 kg N ha^{-1}. The minimum tillers $hill^{-1}$ was obtained from the control treatment (0 kg ha^{-1}).

Mirza and Reddy (1989) concluded that increase in N levels significantly increased the total tiller $hill^{-1}$.

Kamal *et al.* (1988) concluded that the highest rate of nitrogen (120 kg ha^{-1}) fertilizer gave the maximum number of tiller $hill^{-1}$ which was significantly grater than all other treatments.

Nitrogen application from 0 to 120 kg ha^{-1} in three split dressings increased number of tillers (Reddy *et al.*, 1988).

Mondal *et al.* (1987) stated that increasing rate of N from 40 to 160 kg ha^{-1} increased the numbers of productive tillers $hill^{-1}$.

Nossai and Vargas (1982) stated that number of tillers $hill^{-1}$ and panicle length was increased linearly with increased N level.

Increasing rate of nitrogen application increased number of tillers $plant^{-1}$ (Dixit and Singh, 1980).

2.1.3 Panicle length

Sharma and Dadhich (2003) conducted a field experiment in Rajshthan, India during the rainy season of 1997 using rice cultivars Mahi Sugandha, Pusa Basmati-1 and Basmati-370 and supplied with 0, 40, 80 and 120 kg N ha^{-1}, to determine the effects of nitrogen on the yield of the crops. The Pusa Basmati-1 produced the maximum panicle length (25.1 cm).

Sarkar *et al.* (2001) conducted a field experiment during the kharif 1995 in West Bengal, India to evaluate the performance of 3 rice cultivars (IET 12199, IET 10664 and IET 15914) treated with 5 different nitrogen fertilizer levels (0, 40, 80, 120 and 160 kg ha^{-1}). IET 12199, treated with 80 kg N ha^{-1} gave the highest values for panicle length (25.77 cm); IET 10664 and IET 15914 also performed well.

Freitas *et al.* (2001) conducted a field experiment in Mococa, Sao, Paulo, Bazil during 1997-98 and 1998-99 to evaluate the response of three new rice cultivars (IAC-101, IAC-102 and IAC 104) grown under irrigated conditions N fertilizer was applied as urea (at the rate of 0, 50, 100 and 150 kg ha^{-1}) 33% at seedling transplantation, and 33% at 20 and 40 days. They found that panicle length of three cultivars was significantly affected by N treatments.

The panicle length increased significantly with the increasing level of nitrogen from 0 to 75 kg ha^{-1} (Azad *et al.*, 1995).

Panicle m^{-2}, panicle length increased due to application of 60 kg N ha^{-1} (Singh and Singh, 1993).

Idris and Matin (1990) concluded that the rate of nitrogen application influenced panicle length positively.

Increasing N levels increased panicle length significantly (Rafey *et al.*, 1989).

Sharma and Mishra (1986) found that the maximum length of panicle was recorded with higher nitrogen level.

The application of different levels of nitrogen on rice increased panicle length significantly (Awan *et al.*, 1984).

2.1.4 Number of grains panicle^{-1}

Subhendu *et al.* (2003) conducted an experiment to evaluate the effect of N split application (during transplanting, tillering and panicle initiation; transplanting, tillering, panicle initiation and 50% flowering and 10 days after transplanting, panicle initiation and botting) on the yield and yield components of rice cultivars BRT-5204, MTU-1010 and IR-64 in Rajendranagar, Hyderabad, Andhra Pradesh, India. They found that the application N (120 kg ha^{-1}) as urea in equal splits during transplanting, tillering, panicle initiation and 50% flowering resulted in the highest number of grains per panicle (89.8) in MTU-1010.

Mendhe *et al.* (2002) conducted a field experiment at the National Agriculture Research Project-Navegaon Bandh, Maharashtra, India, during the kharif season of 1998-2000 to study the performance and nitrogen requirement of promising cultivars of transplanted paddy (Sye-92-27-11, SK1-6-9-27, Sye-116, 225-5-9-2 and Suraksha). They found that 125 kg N ha^{-1} significantly increased the number of grains per panicle (130.09) in Suraksha compared to 100 kg N ha^{-1}.

Tunio *et al.* (2002) conducted a field experiment at Central Luzon State University Munoz, Nueva, Ecija, Philippines, during the wet season (June-October) of 1998-99 to evaluate the performance of two scented rice cultivars i.e. Kasturi, and Basmati-370 under different nitrogen rates (0, 30, 60, 90, 120 and 150 kg ha^{-1}). They found that Basmati-370 produce more filled grains per panicle. The nitrogen rates of 60 and 90 kg ha^{-1} proved to be the best among the rates evaluated in terms of filled grain per panicle.

Ehsanulla *et al.* (2001) pointed out that the nitrogen level of 125 kg ha^{-1} produced maximum number of grains panicle^{-1}.

The number of grains panicle^{-1} increased with increasing rate of nitrogen from 0 to 60 kg ha^{-1} (Rafey *et al.*, 1989).

Nitrogen significantly influenced the number of grin panicle^{-1} (Bhuiyan *et al.*, 1989).

Thomas and Martin (1999) conducted a field experiment to evaluate the integrated nitrogen management practice for wet seeded rice in Tamil Nadu, India during 1994-95. The different integrated nitrogen management practices used were

Sesbania rostrata as green manure (GM), Azolla (AZ) as biological fertilizer and prilled urea (PU) at different levels (0, 75, 100, 125 and 150 kg N ha^{-1}) as chemical fertilizer. They found that integrated use of green manures and biological fertilizer along with chemical fertilizers has a positive effect on the number of filled grains per panicle.

Maskina and Singh (1987) stated that nitrogen fertilizer application at 90, 120 and 150 kg ha^{-1} influenced number of grains $panicle^{-1}$ in rice.

Rahman *et al.* (1985) noted no significant influence of nitrogen of nitrogen on grains $panicle^{-1}$ of rice.

2.1.5 Panicles m^{-2}

Sharma and Dadhich (2003) conducted an experiment using rice cultivars Mahi Sugandha, Pusa Basmati-1 and Basmati-370 and the N rate was (0, 40, 80 or 120 kg N ha^{-1}) in Rajasthan, India during the rainy season of 1997 to determine the effects of N on the yield of the crops They found that Basmati-1 give highest number of panicles m^{-2} (336) than others. Yield attributes of the crop increased with increasing rates of N.

Tunio *et al.* (2002) conducted a field experiment at Central Luzon State University Munoz, Nueva, Ecija, Philippines, during the wet season (July-October) of 1998-99 with the aim to determine the performance of two scented rice cultivars i.e., Kasturi and Basmati 370 under different nitrogen rates (0, 30, 60, 90, 120 and 150 kg ha^{-1}). They found that among the N rates by receiving 60 and 90 kg ha^{-1} N, Basmati-370 produce maximum panicle m^{-2} among the other rates of nitrogen.

Thomass and Martin (1999) conducted a field experiment to develop a suitable integrated nitrogen management practice for wet seceded rice in Tamil Nadu, India during 1994-95. The different integrated nitrogen management practices used were *Sesbania rostrata* of green manure (GM), Azolla (AZ) as biological fertilizer and prilled urea (PU) at different levels (0, 75, 100, 125 and 150 kg ha^{-1}) as chemical fertilizer. They found that the integrated use of green manures and biological fertilizers along with chemical fertilizers has a positive effect on the number of panicle m^{-2}.

2.1.6 1000-grain weight

Lawal and Lawal (2002) conducted three field experiment during the rainy season of 1996, 1997 and 1998 in Nigeria to evaluate the growth and yield responses of lowland rice to varying N rates and placement methods. The treatment consisted of four N rates (0, 40, 80 and 120 kg ha^{-1}) and two fertilizer placement method (deep and surface placement). They found that the nitrogen rate upto 120 kg ha^{-1} has a positive effect on the 1000-grain weight.

Rodriguez *et al.* (2002) carried out an experiment in Araure, Portuguesa state (venezuela) during the rainy season of 1998 to evaluate the response of rice cultivars Fonaiap1 and Cimarron at two different rates of nitrogen (150 and 200 kg N ha^{-1}). They found that nitrogenous fertilizer supplied @ (150 and 200 kg ha^{-1}) has a positive effect on 1000-grain weight (28.979) of both cultivars.

Ehsanullah *et al.* (2001) conducted a field experiment a field experiment to evaluate the effect of split application of nitrogen at three different stages like sowing, tillering and panicle emergence @ 125 kg N ha^{-1}. They found that the split application of N fertilizer at different growth stages significantly affected the 1000 grain weight and also the grain and straw yields.

Devasenamma *et al.* (2001) conducted a field experiment in Andhra Pradesh, India during the rabi season of 1996-97 to study the performance of rice hybrids (APHR 2, DRRH 1, MGR 1, TNRH 16 and NLR 33358) at various N fertilizer rates (0, 60, 120 and 180 kg N ha^{-1}). They found that the TNRH 16 exhibits the highest 1000-grain weight (20.50 g) than others.

Bindra *et al.* (2000) conducted a field experiment in Malan, Himachal, Pradesh, India during the rainy season of 1996 and 1997 to determine the effect of 4 N rates (0, 30, 60 and 90 kg ha^{-1}) and 2 transplanting dates (7 and 14 July) on scented rice cv. Kasturi. They found that crop transplanted on 7 July give 2.26% higher 1000-grain weight, respectively than those that transplanted on 14 July. The higher N response was observed with 30 kg ha^{-1} during 7 July transplanting, followed by 60 kg ha^{-1}.

Sadeque *et al.* (1990) conducted an experiment with 50, 100 and 120 kg N ha^{-1} and reported that 50 kg N ha^{-1} gave the maximum 1000-grain weight.

Increasing levels of nitrogen significantly increased 1000-grain weight only up to 80 kg N ha^{-1} (Thakur, 1991).

There was an increased trend of 1000-grain weight with an increased level of nitrogen up to 80 kg ha^{-1} (Islam *et al.*, 1990).

Bhuiyan *et al.* (1990) reported that application of N at 0-60 kg ha^{-1} increased the weight of 1000-grain.

Increasing N levels from 40 to 160 kg ha^{-1} significantly increased the 1000-grain weight (Mondal *et al.*, 1987).

Rahman *et al.* (1985) concluded that nitrogen rate had significant influence on grains $panicle^{-1}$ and 1000-grain weight of rice.

Weight of 1000-grain was increased by the application of higher dose of nitrogen fertilizer (Awan *et al.*, 1984).

2.1.7 Grain and Straw yields

Sidhu *et al.* (2004) conducted field experiment from 1997 to 2001 in Indian Punjab, India to determine the optimum N requirement of Basmati rice in different cropping sequences i.e. fallow-Basmati rice-wheat, green manuring (GM; 50-days-old *Sesbania aculeata*), Basmati rice-wheat and GM-Basmati rice-sunflower. N fertilizer was applied at 0, 20, 40 and 60 kg ha^{-1}. Nitrogen fertilizers substantially increased the mean grain yield of Basmati up to 40 kg N ha^{-1} in the fallow Basmati-wheat sequence while 60 kg N ha^{-1} reduced Basmati yield.

Singh *et al.* (2004) conducted a field experiment during the rainy (kharif) season, in New Delhi India, to study the effect of nitrogen levels (0, 60, 120 and 180 kg ha^{-1}) on the yield nitrogen use efficiency (NUE) of the rice cultivars Pusa Basmati-1 (traditional high avidity aromatic rice) and Pusa rice hybrid-10 (aromatic hybrid rice). They found that Pusa rice hybrid -10 had than the significantly higher value for the yield attributes and nutrient accumulation than the non-hybrid Pusa Basmati-1. The maximum grain yield (5.87 t ha^{-1}) was recorded at the highest level of N nutrient (180 kg N ha^{-1}) and was 4.2, 15.5 and 39.3% higher than in the 120, 60 and 0 kg N ha^{-1} treatments respectively.

Jena *et al.* (2003) conducted field experiment on a Typic Haplaquept Orissa, India to evaluate the use efficiency of nitrogen and volatilization losses of amonia in rice by the following application of prilled urea (PU) and urea super granules (USG) at 76 and 114 kg N ha^{-1}. They found that deep placement of urea super-granules (USG) significantly improved grain and straw yield and nitrogen use efficiency of rice and reduced volatilization loss of amonia relative to the application of prilled urea.

Wopereis *et al.* (2002) stated that rice (cultivar IR 1529 and Jay in 1997 WS and IR 1324-108-2-2-3 in 1998) yields increased significantly as a result of an extra late N application on to of two N dressings (applied of the onset of tillering and at panicle initiation) with a total of approximately 120 kg N ha^{-1} in farmers field.

Choudhury and Khanif (2002) pointed out that yield of rice significantly increase with application of 120 kg N ha^{-1} over farmers practice (80 kg N ha^{-1}).

Fageria and Baligar (2001) conducted a field experiment during three consecutive years (1995-96, 1996-97 and 1997-98) in Goias, Central Part of Brazil on a Haplaquept inceptisol. The nitrogen levels used were 0, 30, 60, 90, 120, 150, 180 and 210 kg N ha^{-1}. They found that nitrogen fertilizer application significantly increased grain yield. Ninety percent of the maximum grain yield (6400 kg ha^{-1}) was obtained with the application of 120 kg N ha^{-1} in the first year and in the second and third years 90% of the maximum yields (6345 and 5203 kg ha^{-1}) were obtained at 90 and 78 kg N ha^{-1}, respectively.

Geethadevi *et al.* (2000) conducted an experiment during the summer season in Karnataka, India to determine the effects of split application of nitrogen and the timing of application on the growth and yield of rice cultivars KRH-1 and Rasi. Nitrogen was applied at 120 kg ha^{-1} in the form of urea, 50% was applied as basal rate to all treatments while the remaining 50% was applied in four splits at 21 days after transplanting, panicle initiation, boot leaf and 50% flowering. They found that higher grain yield (5950 kg ha^{-1}) was recorded from KRH-1 than Rasi (5181 kg ha^{-1}) and also found that among the split application treatments nitrogen applied at 60 : 20 : 20 : 20 : 0 recorded significantly higher grain yield (6004 kg ha^{-1}) than the recommended practice of 60 : 30 : 30.

Sudhakar *et al.* (2001) carried out an experiment to evaluate the effects of various rice cultivars and nitrogen levels on yield and economics of direct sown semidry rice during kharif 1996 and 97. They found that cultivar PMK-1 show the maximum grain and straw yield, net return and B:C ratio. There was a significant increase in grain yield, straw yield, net return and B:C ratio with each increment of nitrogen application upto 125 kg ha^{-1}.

Freitas *et al.* (2001) conducted a field experiment in Mococa Sao Paulo, Brazil during 1997-98 and 1998-99 to evaluate the response of three new rice cultivars (IAC-101, IAC-102 and IAC-104) grown under irrigation. The nitrogen fertilizer was applied as urea (at, 0, 50, 100 and 150 kg ha^{-1}) 33% at seedling transplantation and 33% at 20 and 40 days later. They found that cultivars responded significantly to N application and the average yield for three cultivars at higher N rates was more than 8 t ha^{-1}. The cultivars IAC-104 and IA-101 presented higher grain yield than an IAC -102.

Rajorathinam and Balasubramaniyan (1999) conducted a field experiment in Tamil Nadu, India during 1996-97 and 1997-98 to study the response of rice (*Oryza sativa*) hybrid CORH2 of different N levels (150, 200 and 250 kg ha^{-1}) under lowland conditions. They found that grain yield were highest (59.55 q ha^{-1}) with the 200 kg N ha^{-1} treatment and straw yield was highest (79.45 q ha^{-1}) upon treatment with 250 kg N ha^{-1}.

Sahrawat *et al.* (1999) found that N levels significantly affected the grain and straw yield.

Rajarathinam and Balasubramaniyan (1999b) reported that the higher grain yield of hybrid rice CoRH-2 was produced to the application of 200 kg N ha^{-1}. However, application of 250 kg N ha^{-1} reduced the grain yield significantly.

Rajarathinam and Balasubramaniyan (1999a) observed that there was no appreciable change in the yield due to application of higher dose of N above 150 kg ha^{-1}.

The influence of two N levels (90 an 150 kg ha^{-1}) on the productivity of two rice hybrids (TNH 1 and TNH 2) was evaluated in comparison with Rasi and Jaya as standard checks. The yield response to N application was significant up to 150 kg ha^{-1}. The interaction effects among the treatments were not significant. Jaya produced the highest grain yield (5.1 t ha^{-1}). The experimental results indicate that the higher N application (150 kg ha^{-1}) is required to achieve higher grain yields in hybrid rice (Singh *et al.*, 1998b).

Devaraju *et al.* (1998) reported that KHR2 out yielded to IR 20 at all levels of N application ranging from 0 to 100 kg ha^{-1}.

Singh *et al.* (1998a) studied the performance of three hybrids KHR 1, ProAgro 103 and MGR 1 using Jaya and Rasi as standard checks at four levels of N (0, 60, 120 and 180 kg ha^{-1}). They observed that the varieties responded linearly to the applied N levels up to 120 kg ha^{-1}.

Singh (1997) found that the grain yield increased with each increment of N up to 80 kg ha^{-1} which registered the maximum yield.

The performances of genotypes IET 5760, IET 5914 and IET 8002 were evaluated against national check Pankaj and local checks Radha and Rajshree at five levels of N (0, 40, 80, 120 and 160 kg ha^{-1}). It was observed that the genotype IET 8002 gave significantly higher grain and straw yields that did the other genotypes. Interaction effect of N levels and genotypes was significant for yield. At 0, 40 and 80 N kg ha^{-1}, rice genotypes Rajshree and IET 8002 were at par and significantly superior to other genotypes (Singh and Kumar, 1996).

Kumar *et al.* (1995) reported that an increase in N level from 80 to 120 kg ha^{-1} significantly increased the grain and straw yields, but decreased the sterility percent.

Hong *et al.* (1995) found that the yield increased by reducing basal application of N.

Hossain *et al.* (1995) reported that application of nitrogen up to 120 kg ha^{-1} increased the grain yield of rice. The increase in yields with 40, 80 and 120 N ha^{-1} over the control was 24, 33 and 33%, respectively. They noted significantly higher yields with 80 and 120 kg N ha^{-1} than 40 kg N ha^{-1}.

Thakur (1993a) stated that increasing levels of N increased the growth and yield attributes of rice significantly.

Thakur (1993b) concluded that most of the yield contributing characters particularly panicles m^{-2} and spikelets $panicle^{-1}$ increased with increase in N levels and followed this trend with the grain yield.

Thakur (1991) reported that increasing levels of N increased the yield and yield attributes of rice significantly.

Jha *et al.* (1991) observed that a variety responded up to 60 kg ha^{-1}, but another two varieties up to 40 kg N ha^{-1}, beyond which the grain yield declined.

Pandey *et al.* (1991) found significant increase in yield with increase in N levels. Dwarf varieties gave significantly more yield than tall ones (except straw yield). The interactions of N with varieties revealed significant improvement in yield up to 90 kg N ha^{-1}, for all the varieties except tall ones.

Kandasamy and Palaniappan (1990) concluded that grain yield and panicle m^{-2} increased with increasing N application.

Katayama *et al.* (1990) found that yield of Suweon 258 hybrid cultivar and IR 24 increased as N level increased.

Pandey *et al.* (1989) found that grain yield of rice increased with N application up to 90 kg ha^{-1}.

Singandhupe and Rajput (1989) from an experiment with four N levels (0, 50, 100 and 150 kg ha^{-1}) and two varieties of rice (PR 106 and PR 109) stated that application of nitrogen up to 150 kg ha^{-1} increased both the grain and straw yield significantly compared with the unfertilized control.

Mirza and Reddy (1989) concluded that increase in N level from 30 to 90 kg ha^{-1} significantly increased the grain and straw yields of rice.

Reddy and Reddy (1989) also reported similar result with up to120 kg N ha^{-1}.

Thakur (1989) reported that grain and straw yields were significantly increased with increasing levels of nitrogen application.

Hussain *et al.* (1989) carried out an experiment with rice cultivars Basmati 370 on sandy clay loam soil with 0, 30, 60, 90, 120 and 150 kg N ha^{-1} and found grain yield of 3.9 t ha^{-1} due to applied of 150 kg N ha^{-1}.

Subbiah *et al.* (1988) conducted an experiment with two rice cultivars (IR 50 and RI 20) each grown in two seasons and found that increasing N rates increased grain yield from 3.71 to 4.69 t ha^{-1} in IR 20 and from 4.14 to 6.58 t ha^{-1} in IR 50 when both cultivars were grown in the kharif season.

Milam *et al.* (1988) conducted a field experiment with two rice cultivars Lemont and Newbonnet found that grain yield for both cultivars increased from 4155 kg ha^{-1} without N to 6364 kg ha^{-1} with 168 kg N ha^{-1}.

Gill and Shahi (1987) concluded that the grain yield of rice increased significantly with an increase in N application from 60 to 150 kg ha^{-1} with significant difference between 60 and 120, 60 and 150 & 90 and 150 kg N ha^{-1}.

Katoch *et al.* (1987) also observed that the increasing N levels raised the grain yield in general with 0 to 60 kg ha^{-1} of N but the straw yield did not differ significantly.

Grain and straw yields increased significantly at each successive level of N application, due to increase in the number of panicles m^{-2}, length of panicle, spikelets $panicle^{-1}$ and 1000-grain weight (Dalai and Dixit, 1987).

Nitrogen application delayed flowering but the yield attributes were improved significantly. Grain and straw yields were also increased with every increase in N level by 20 kg ha^{-1} (Rao and Raju, 1987).

Budhar *et al.* (1987) reported that grain yield of rice was higher at 150 kg N ha^{-1} than that at 100 kg N ha^{-1}.

Grain yield of rice significantly increased with increase in the level of N up to 1000 kg ha^{-1}. The yield and yield attributes increased with increasing levels of N up to 100 kg ha^{-1} reflecting their effect on yield (Thakur and Singh, 1987).

Significant increase in grain yield (49%) was observed with increase in N from 0 to 20 kg ha^{-1}. There was no improvement in yield with further increase in up to 40 or 60 kg ha^{-1}. The effect of interaction between cultivars (CR 1016 and CR 1018) and N levels was significant in respect of grain yield (Ghosh *et al.*, 1987).

Kumar *et al.* (1986) stated that the grain yield and yield attributes of rice were significantly influenced by nitrogen. The maximum grain yield recorded 80 kg N ha^{-1}

was due to the highest number of panicles m^{-2}, increase in panicle length and filled grains $panicles^{-1}$ which was significantly superior to 40 kg N ha^{-1} and control.

Reddy and Reddy (1989) in a field experiment showed that grain yield of lowland rice (cv. Tella Hamsa) increased significantly with increasing doses of nitrogen up to 120 kg ha^{-1}. However, the rate of increase in grain yield from 80 to 120 kg N ha^{-1} was marginal.

Khole and Mitra (1985) reported from an experiment that higher levels of nitrogen were effective for significantly higher yield of rice.

Singh and Singh (1984) observed that the grain yield of rice increased significantly with each increment in the level of nitrogen producing higher panicles m^{-2}, panicle weight and 1000-grain weight.

Awan *et al.* (1984) studied the effect of different N levels (46.92 and 138 kg ha^{-1}) on rice (IR 6) and obtained the maximum grain yield (8.1 t ha^{-1}) with 138 kg N ha^{-1}. The grain yields from all the fertilizer treatments were significantly higher than that of control.

Awan *et al.* (1984) reported that application of different levels of nitrogen increased grain and straw yields of rice significantly.

An additive element trial with BR 3 and BR 4 rice was carried out at BAU farm and farmer's fields during 1980-82 by Eaqub and Mian (1984). Their experimental results showed that the application of N alone significantly increased the grain yield.

Thind *et al.* (1983) studied the influence of nitrogen application on grain yield of rice and observed that increasing rates of N application increased the yield significantly up to 180 kg N ha^{-1}.

Subbiah (1983) obtained significantly higher grain yield of rice with 120 kg N ha^{-1} than 40 kg N ha^{-1}.

Sadaphal *et al.* (1981) observed that the yield of grain increased with the increase in the rates of nitrogen.

Mahayan and Nagar (1981) reported from a field experiment that paddy yields of rice increased significantly by increasing of nitrogen rates from 50-150 kg N ha^{-1}.

In an experiment with three rice varieties (Saket 3, Ratna and CR 4.4-1) and five levels of nitrogen (0, 20, 40, 60 and 80 kg ha^{-1}), Kumar and Sharma (1980) observed significant increase in grain yield from each additional dose of nitrogen over control. The yield increased significantly up to 40 kg N ha^{-1}. The yield increased significantly up to 40 kg N ha^{-1}. However, the differences in the levels of nitrogen 40, 60 and 80 kg ha^{-1} were not significant.

Application of nitrogen significantly influenced the yield components of rice such as in number of tillers per plant, panicles $hill^{-1}$, panicle length, 1000-grain weight and grain yield of rice (Sharma and Prasad, 1980).

The maximum grain yield of rice was recorded with an application of 180 kg N ha^{-1}, which was followed by 120, 60 and control. The response per kg N application was 24.0, 14.2 and 15.2 kg of rice at 60, 120 and 180 kg N ha^{-1}, respectively (Singh and Paliwal, 1980).

Bindra *et al.* (2000) conducted a field experiment in Malan, Himachal Pradesh, India during the rainy season of 1996-97 to determine the effect of four N rates (0, 30, 60 and 90 kg ha^{-1}) in rice cv. Kastur. They found that increasing rates of N upto 60 kg ha^{-1} significantly increased the mean grain yield of Basmati rice.

Devaraju *et al.* (1998) in a study with F_1 hybrid rice cultivar KRH2 and IR 20 as a check variety having different levels of N from 0 to 200 kg ha^{-1} found that KRH2 out yielded IR20 at all levels of N. The increased grain yield of KRH2 was mainly attributed to the higher number of productive tillers, panicle, weight and number of filled grains $panicle^{-1}$.

Dwivedi (1997) in a field experiment found that scented genotypes, Kamini and Sugandha gave higher grain and straw yields than four other cultiver-RP615, Harban, Basmati and Kasturi with 60 kg N ha^{-1} under upland sandy-loam soil conditions of Agwanpur (Bihar).

Thind *et al.*, (2009) showed that neem coated urea (NCU) applied to rice can result in high N use efficiency as it contains nitrification inhibition properties. Field experiments were conducted for three years (2005–2007) at Ludhiana (sandy loam soil) and Gurdaspur (clay loam soil) for evaluating the relative performance of

NCU vis-à-vis ordinary urea as a source of N for transplanted wetland rice. Along with a no-N control, the two N sources were tried at three N levels—40, 80 and 100% of the recommended level of 120 kg N ha^{-1}. Different doses of N were applied in three equal split doses at transplanting, 21 and 42 days after transplanting (DAT). For need based site specific N management for improved N use efficiency, the two sources of N were applied using leaf colour chart (LCC). In this treatment a basal dose of N at the rate of 20 kg N ha^{-1} was applied after 7 DAT and LCC readings were recorded at weekly intervals starting 14 DAT. Whenever the intensity of green colour of the first fully opened leaf from the top was less than shade 4 of the LCC, N was applied at the rate of 30 kg N ha^{-1}. The application of N through NCU and ordinary urea increased the rice grain yield significantly with increasing levels of N at both the locations. The application of NCU at recommended rate (120 kg N ha^{-1}) produced significantly higher rice grain yield than the yield obtained with ordinary urea at Ludhiana. The differences were not significant at Gurdaspur. Need based N management using LCC revealed that rice required only 110 kg N ha^{-1} at Ludhiana and 80 kg N ha^{-1} at Gurdaspur, irrespective of the N sources. The application of NCU using LCC produced significantly higher (8.6%) rice grain yield than ordinary urea at Ludhiana but increase was not significant at Gurdaspur. The superiority of NCU over ordinary urea at Ludhiana was accompanied by spectacular increase in N uptake and nitrogen use efficiencies when applied on soil test basis or using of LCC.

Rao *et al.*,(2006) carried out A field experiment at Bangalore, Karnataka, during summer 1995 on alfisols to study the relative efficiency of nimin [neem]-coated and prilled urea for lowland rice under two irrigation regimes and found that grain and straw yields were significantly improved due to continuous submergence as compared to soil saturated to field capacity. Nimin-coated urea gave significantly higher grain yield (6237 kg/hectare) and increased the nitrogen use efficiency (94.93 kg grain/kg N) as compared to prilled urea (grain yield: 5203 kg/hectare; NUE; 79.88 kg grain/kg N). Yield decreased if N rate was reduced from the recommended rate.

Chaudhary *et al.*, (2006) conducted a field experiment was during 1998–2000 on silty-clay soil at University research farm, Pusa (Bihar), to evaluate the relative efficiency of few slow-release N fertilizers, viz. prilled urea (PU), Mussoorie rock phosphate-coated urea (MRPU), nimin-coated urea (NCU) and large granulated urea (LGU) with basal and split application in transplanted lowland rice (*Oryza sativa* L.) and their effect on succeeding wheat (*Triticum aestivum* L. emend. Fiori & Paol.). Modified urea fertilizers exhibited their superiority by recording significantly higher valueof all the yield-contributing characters, nitrogen uptake and significantly higher grain yield than prilled urea, irrespective of their methods of application. Maximum grain and straw yields of wheat were recorded under NCU which was significantly superior to the control and prilled urea and comparable with other sources of N.

CHAPTER III

MATERIALS AND METHODS

This chapter presents a brief description about the work which is related to the experiment. It represent a brief description about the experimental site, soil, climate, crops, treatments, experimental design followed, land preparation, seedling transplanting, intercultural operations, harvesting, data recording, collection and the methods for the chemical and statistical analysis.

3.1 Field trial

3.1.1 Experimental site and season

The experiment was laid out in the Non Calcareous Dark Grey Floodplain soil of Sher-e- Bangla Agricultural University, Sher-e- Bangla Nagar, Dhaka. This soil belongs to the Modhupur tract under AEZ 28. The site of the experimental plot was in the $23^{0}74'$ latitude and $90^{0}35'$ longitude with an elevation of 8.2 m above sea level (Anon, 1989)

3.1.2 Soil

The experimental soil was silt loam, a member of hyperthermic aeric haplaquept. The soil belongs to inceptisol order having only few horizons, developed under aquic moisture regime and variable temperature regime. A general characteristic of the soil is presented in Table 3.1. The selected plot was medium high land and the soil series was tejgaon series. The soil characteristics was silty loam in texture with pH value 6.5 and C:N ratio 8:1.

Table3.1. Morphological, physical and chemical characteristics of soil under study

A. Morphological characteristics

Characteristics	Experimental field
Location	Sher-e-Bangla Agricultural University farm, Dhaka.
AEZ	28
General soil type	Deep red Brown Terrace soil.
Drainage	erate
Topography	Medium high land
Flood level	Above flood level
Cropping pattern	Rice crop grown year round (rice-rice)

B. Physical characteristics

Characteristics	Experimental field
% Sand	36.92
% Silt	26.40
% Clay	36.68
Textural class	Clay loam

C. Chemical characteristics

Characteristics	Experimental field
pH (soil: water = 1:2.5)	5.70
Organic matter (%)	0.82
Total N (%)	0.05
Available P (ppm)	18.1
Available S ($\mu g\ g^{-1}$)	13.10
Exchangeable K (C mol kg^{-1} soil)	0.10
Cation Exchange Capacity (C mol kg^{-1} soil)	11.30

3.1.3 Climate

The climate of the experimental area is characterized by sub-tropical accompanied by bright sunshine, high rainfall associated with moderately high temperature during boro season from December to March, 2008.

3.1.4 Crop

BRRI Dhan 29 was the test crop. The life cycle of this variety ranges from 140-150 days. Seed of the variety was collected from Breeding Division of Bangladesh Rice Research Institute (BRRI).

3.1.5 Land preparation

Land preparation was started on 28 November 2007. The land was prepared by repeated ploughing and cross ploughing followed by laddering. After uniformly leaving and puddling, the experimental plots were laid out as per treatments and design of the experiment.

3.1.6 Raising of seedlings

A well puddled land was selected for seedling raising. The sprouted seeds were sown uniformly on 1 November and covered with a thin layer of fine earth. Proper care of the seedlings was taken in the nursery.

3.1.7 Experimental design

The experiment was laid out in a randomize block design. The size of the unit plot was 4.0 m × 3.0 m. There were seven treatments and three replications. The total numbers of plot were twenty one. There were 1 m drains between the blocks. The treatments were randomly distributed to each block.

3.1.8 Treatments

There were seven treatments including control are used in this study which were as follows-

i) Control of nitrogen fertilizer (N_0)
ii) Nitrogen fertilizer @ 60 N ha^{-1}
iii) Nitrogen fertilizer @ 90 N ha^{-1}
iv) Nitrogen fertilizer @ 120 N ha^{-1}
v) Nimin- coated nitrogen fertilizer @ 60 N ha^{-1}
vi) Nimin- coated nitrogen fertilizer @ 90 N ha^{-1}
vii) Nimin- coated nitrogen fertilizer @ 120 N ha^{-1}

Each plot received recommended doses of P, K, S, Zn and B fertilizers as basal dose. The rates and sources of nutrients used in the study are given in Table 3.2.

Table 3.2 Nutrients, their sources and rates used for the experiment

Nutrient element	Rate (kg ha^{-1})	Source
Nitrogen	0, 60, 90 and 120	Urea [$CO(NH_2)_2$] and Nimin-coated urea [$CO(NH_2)_2$]
Phosphorus	126	TSP [Ca (H_2PO_4)]
Potassium	130	MP [KCl]
Sulphur	60	Gypsum ($CaSO_4$, $2H_2O$)
Zinc	2	Zinc oxide (ZnO)
Boron	1	Boric acid ($Na_2B_4O_7$)

3.1.9 Nimin- coated preparation and fertilizer application

At first Nimin extract was applied to granular urea @ 250 g per 50 kg urea and then it was dried under room temperature. Recommended does of TSP, MP, Gypsum, Zinc sulphate and boric acid were applied to all plots as basal dose. Nimin coated urea was applied at the time of transplanting.

3.1.10 Transplanting of seedling

Thirty two days old seedlings of BRRI dhan 29 were uprooted carefully from the seedbed and transplanted in the experimental plots with a spacing of 20cm x 20cm on 3 December 2008. Three seedlings were transplanted in each hill.

3.1.11 Intercultural operations

Intercultural operations were done for ensuring and maintaining the normal growth of the crop. The following intercultural operations were done as and when required.

3.1.12 Irrigation

After transplanting 5-6 cm water was maintained in each plot through the growth period of the crop.

3.1.13 Weeding

The crop was infested with some common weeds, which were controlled by uprooting and remove them three times from the field during the period of experiment. Weeding was done after 15, 32 and 52 days of transplanting.

3.1.14 Disease and insect pest control

There were some incidence in insects specially grasshopper, rice stem borer, rice ear cutting caterpillar, thrips and rice bug which was controlled by spraying Curatter 5 G and Sumithion. Narrow brown spot of rice was controlled by spraying Tilt.

3.1.15 Harvesting and threshing

The crop was harvested plot wise at maturity from 15 May to 25 May 2008. The harvested crop of each plot was bundled separately and brought to the threshing floor. The harvested crops were threshed, cleaned and processed. Grain and straw yields were recorded plot-wise and moisture of grain and straw was calculated on oven dry basis. Grain and straw yields were converted into t ha^{-1}.

3.2 Data collection and recording

Six hills were selected randomly from each plot prior to harvest for recording data on crop parameters and the yield of grain and straw were taken plot wise. The following parameters were recorded at harvest;

i) Plant height (cm)

ii) Number of tillers hill^{-1}

iii) Number of effective tillers hill^{-1}

iv) Panicle length (cm)

v) Number of grains panicle^{-1}

vi) Panicle per m^{-2}

vii) Number of filled grains m^{-2}

viii) Weight of 1000 grain (g)

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

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

3.2.1 Data collection

3.2.1.1 Plant height

Plant height was measured from the base of the plant to the tip of the tallest panicle.

3.2.1.2 Number of tillers hill^{-1}

Tillers which had at least one leaf visible were counted. It includes both productive and unproductive tillers.

3.2.1.3 Number of effective tillers hill^{-1}

The panicles that had at least one grain were considered as bearing tillers.

3.2.1.4 Panicle length

Panicle length was measured from the basal node of rachis to the tip of the panicle.

3.2.1.5 Number of grains panicle^{-1}

Number of grains of all the fertile tillers was counted.

3.2.1.6 Number of panicles per m^{-2}

Panicles per m^{-2} were also counted.

3.2.1.7 Number of filled grains m^{-2}

Number of filled grain of all fertile tillers was counted.

3.2.1.8 Weight of 1000-grain

One thousand grain was counted from the seeds obtained from the samples and weighed by using an electric balance.

3.2.1.9 Grain and straw yields

After harvesting of the crop, grain yield of each plot was dried and weighted. The result was expressed as t ha^{-1} on 14% moisture basis. After harvesting of the crop, straw yields obtained from each plot were dried and weighed carefully. The results were expressed as t ha^{-1} and expressed on oven dry basis.

3.3 Statistical analysis

The data were analyzed statistically by F-test to examine whether treatment effects were significant (Gomez and Gomez, 1984). The mean comparisons for the treatments were evaluated by DMRT (Duncan's Multiple Range Test). The software package, MSTATC was followed for statistical analysis.

CHAPTER IV

RESULTS AND DISCUSSION

A field experiment was carried out with three levels of applied urea and nimin-coated urea on the performance of BRRI Dhan 29. The experiment was laid out in a randomized block design. The prilled nitrogen levels were 0, 60, 90 and 120 kg ha^{-1} (for high yield goal) and nimin coated nitrogen levels were 60, 90 and 120 kg ha^{-1}. Experimental results have been presented and discussed in this chapter.

4.1 Effect of different levels of Nitrogen on the yield and yield contributing characters of BRRI Dhan 29

4.1.1 Plant height

The application of different levels and forms of nitrogenous fertilizer significantly increased plant height of rice. The highest plant height (91.67 cm) was obtained in nimin coated N_{120} treated plots which was statistically identical with prilled N_{90}, N_{120}, nimin coated N_{90} treated plots. The lowest 55 cm plant height was recorded in N_0 treatments (Table 4.1). Nimin coated N_{120} gave highest plant height might be due to its slow release behavior and plant used maximum N during the growing season. Similar finding was reported by Lawal and Lawal (2002), who disclosed that plant height increased significantly due to nitrogen application. The increase in plant height due to application of nitrogen might be associated with stimulating effect of nitrogen on various physiological processes including cell division and cell elongation of the plant.

Table 4.1 Effect of different levels of Nitrogen on the yield and yield contributing characters of BRRI Dhan 29

N levels	Plant height (cm)	No. of tiller $hill^{-1}$	No. of effective tiller $hill^{-1}$
N_0	55.00 d	7.50c	4.50c
N_{60}	75.00 bc	10.0b	7.00b
N_{90}	84.67ab	10.13b	7.20b
N_{120}	88.00a	10.30b	7.30ab
Nimin coated N_{60}	72.33c	10.2 b	7.17b
Nimin coated N_{90}	85.67ab	11.24 a	8.00a
Nimin coated N_{120}	91.67a	11.30 a	7.73ab
SE	3.42	0.30	0.24
CV (%)	7.56	5.13	5.86

4.1.2 Number of total tillers $hill^{-1}$

The application of N significantly increased the tiller number of rice (Table 4.1). The highest tiller number (11.30) in nimin coated N_{120} treated plots which was statistically identical with nimin coated N_{90} treated plots (11.24) and the lowest tiller number (7.50) was obtained from N_0 treated plot. Prasad, *et al.* (1998) found that neem-coated urea increased nitrogen use efficiency as well as increase the total number of tillers per hill. The improvement in the formation of tillers with N application in the present experiment might be due to increase of nitrogen availability which enhanced tillering. Singh and Singh (2002) also found similar findings.

4.1.3 Number of effective tillers $hill^{-1}$

The number of effective tillers $hill^{-1}$ was significantly influenced by nitrogen application (Table 4.1). Maximum effective tillers $hill^{-1}$ (8.00) was obtained in nimin coated N_{120} treated plots which was statistically identical with nimin coated N_{90} treated plots (7.73) and the lowest tiller number (4.50) was found from N_0 treated plot. Adequacy of nitrogen probably favored the cellular activities during cell formation and development which lead to increase number of effective tillers $hill^{-1}$.

Table 4.2 Effect of different levels of Nitrogen on the yield and yield contributing characters of BRRI Dhan 29

N levels	Panicle m^{-2}	Panicle length (cm)	1000 grain wt (g)
N_0	113.0c	20.19 d	21.20e
N_{60}	197.1b	23.32 c	22.00d
N_{90}	265.5a	25.40 a	22.15d
N_{120}	246.3 a	25.17 a	23.50c
Nimin coated N_{60}	236.8ab	24.20 b	24.08b
Nimin coated N_{90}	276.1a	25.36 a	24.60a
Nimin coated N_{120}	271.8a	25.32 a	24.40ab
SE	13.75	0.27	0.11
CV (%)	10.37	1.96	0.83

4.1.4 Panicle m^{-2}

The number of panicles per square meter was significantly influenced by different levels of nitrogen application (Table 4.2). The highest number of panicle per square meter (276.1) was found in nimin coated N_{90} treatment which was statistically identical with nimin coated N_{120} plots (271.8) and the lowest panicle m^{-2} (113.0) was found from N_0 treated plot. Amberger (1986) found that neem oil soaked urea act as a potential nitrification inhibitor in modern nitrogen management for rice which is reflected in the number of panicle even panicle length of rice. Adequacy of nitrogen probably favored the cellular activities during cell formation and development which lead to increase number of panicle per square meter.

4.1.5 Panicle length

Different levels and forms of nitrogenous fertilizers influenced the panicle length significantly (Table 4.2). The highest panicle length (25.36 cm) was observed in nimin coated N_{90} treated plot which was statistically identical with nimin coated N_{90}, N_{120} and nimin coated N_{120} treated plots and the lowest (20.19 cm) in N_0 plot. Azad *et al.* (1995) observed that panicle length increased significantly with nitrogen application. Nitrogen plays an active role both in panicle formation and elongation. For this reason panicle length increased with increasing of nitrogen levels and N-use efficiency .Amberger (1986) found that neem oil soaked urea act as a potential nitrification inhibitor in modern nitrogen management for rice which increased the N-use efficacy and as a result increased panicle length of rice.

4.1.6 1000 grain weight

The application of different levels and forms of nitrogenous fertilizers had a significant effect on 1000 grain weight (Table 4.2). The 1000 grain weight was the highest in nimin coated N_{90} treated plots (24.60 g) which was statistically similar with nimin coated N_{120} treated plot. The lowest 1000 grain weight (21.20 g) was observed in N_0 plot. Prasad, *et al* (1998) reported that neem-coated urea increased N use efficiency has a response on grain filling and which reflected on grain weight of rice.

Table 4.3. Effect of different levels of Nitrogen on the yield and yield contributing characters of BRRI Dhan 29

N levels	Filled grains panicle^{-1}	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
N_0	81.20c	2.50d	3.47d
N_{60}	120.4b	4.00c	5.10c
N_{90}	125.6b	4.07c	6.38b
N_{120}	125.6b	4.20b	6.45b
Nimin coated N_{60}	123.2b	4.66a	6.80ab
Nimin coated N_{90}	146.1a	4.84a	6.95 ab
Nimin coated N_{120}	145.5a	4.80a	7.26 a
SE	2.80	0.56	0.20
CV (%)	1.92	6.47	5.78

4.1.7 Filled grains panicle^{-1}

Increased N-use efficiency significantly increased the number of grains panicle^{-1}. The highest number of grains panicle^{-1} (146.1) was found in nimin coated N_{90} treated plots which was statistically similar with nimin coated N_{120} plots (145.5) and the lowest grains panicle^{-1} (81.20) was found from N_0 plot (Fig. 1). Adequate supply of nitrogen contributed to grain formation that probably increased the number of filled grains $panicle^{-1}$. The present results explicitly confirm similar results obtained by Bhuiyan *et al.* (1989) who reported that filled grains $panicle^{-1}$ were increased significantly due to nitrogen application. Thomas and Prasad (1983) reported that neem coated urea has higher nitrogen use efficiency than prilled urea, therefore it enhanced grain formation of rice.

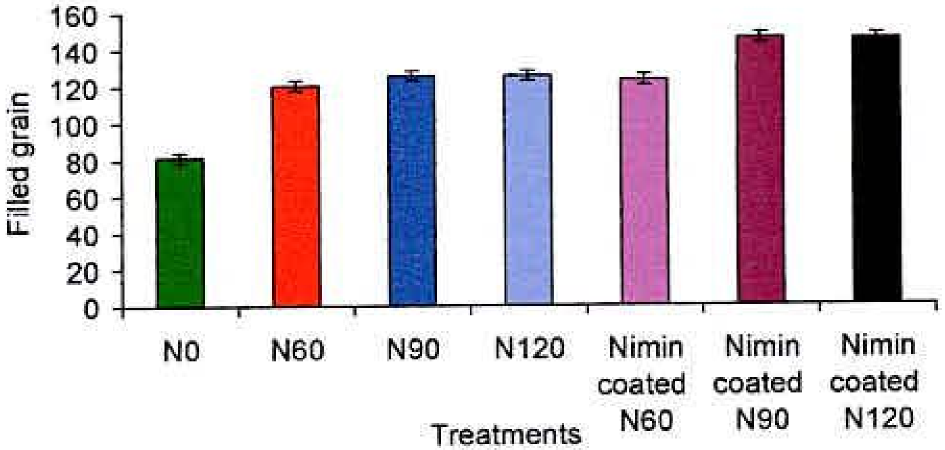

Fig. 1. Effect of different nitrogen on the filled grain of BRRI dhan 29

4.1.8 Grain yield

Increased N-use efficiency significantly increased the grain yield of rice (Fig.2). The highest grain yield was recorded from nimin coated N_{90} treated plots (4.84 t ha^{-1}) which was statistically identical with nimin coated N_{120} and prilled N_{120}. The lowest yield (2.50 t ha^{-1}) was found in N_0 plot. Rao *et al.* (1995) studied that nimin-coated urea gave significantly higher grain yield and increased the nitrogen use efficiency as compared to prilled urea. nimin coated like modified urea fertilizers exhibited its superiority by recording significantly higher value of all the yield-contributing characters, nitrogen uptake and significantly higher grain yield than prilled urea (Chaudhary *et al.*, 2004).

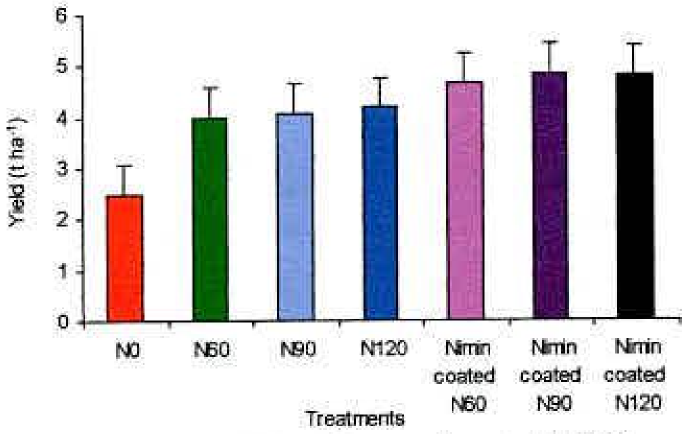

Fig. 2. Effect of different nitrogen on the grain yield of BRRI dhan 29

4.1.9 Straw yield

The application of different N levels and soures significantly increased the straw yield of rice (Fig.3). The maximum straw yield was recorded from nimin coated N_{120} treated plots (7.26 t ha^{-1}) which was statistically identical with nimin coated N_{90} plots (6.95 t ha^{-1}) along with nimin coated N_{60} treated plots (6.80 t ha^{-1}) and the lowest (3.47 t ha^{-1}) in N_0 plot. Nitrogen influenced vegetative growth in terms of plant height and number of tillers $hill^{-1}$ which increased straw yield. It might be due to the increased nitrogen use efficiency excess and application of nitrogen boosting vegetative growth. Rao *et al.* (1995) studied that nimin-coated urea gave significantly higher grain and straw yield and increased the nitrogen use efficiency as compared to prilled urea. Thind *et al.* (1983) also observed that the application of nitrogen through nimin coated urea increased the straw yield significantly with increasing levels of nitrogen.

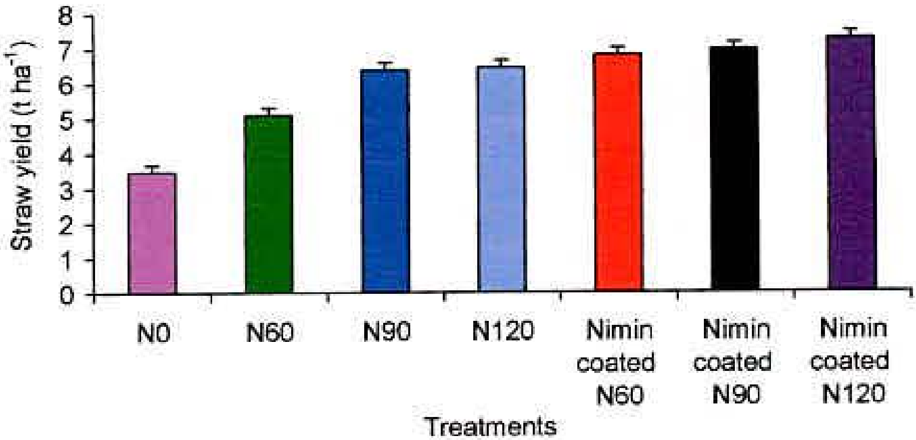

Fig. 3. Effect of different nitrogen on the straw yield of BRRi dhan 29

4.2. Effect of Nitrogen levels on uptake of nitrogen by grain in BRRI dhan 29

4.2.1 Effect of different levels of Nitrogen on nitrogen uptake by grain of BRRI dhan 29

Uptake of nitrogen by grain of BRRI dhan 29 was significantly influenced by the application levels and forms of nitrogenous fertilizer (Table 4.4). The highest grain N uptake (41.17 kg/ha) by grain was recorded in nimin-coated N_{120} treated plot which showed statistically similar result with N_{120} treatments but statistically different result with all other treatments. On the other hand, the lowest nitrogen uptake in BRRI dhan 29 (13.37 kg/ha) was recorded in N_0 treatment where no nitrogen fertilizer was applied.

Table 4.4 Effect of different levels of Nitrogen on nitrogen uptake by grain of BRRI Dhan 29

N levels	N Uptake by grain (kg/ha)
N_0	13.37d
N_{60}	17.40d
N_{90}	22.63c
N_{120}	38.03a
Nimin coated N_{60}	23.70c
Nimin coated N_{90}	31.75b
Nimin coated N_{120}	41.17a
LSD	4.317
CV (%)	5.99

4.2.2 Effect of different levels of Nitrogen on nitrogen uptake from soil in BRRI dhan 29

Uptake of nitrogen from soil by BRRI dhan 29 was significantly influenced by the application levels of N (Table 4.5). The highest nitrogen uptake (53.38 kg/ha) of BRRI dhan 29 was recorded in nimin-coated N_{120} which showed different result with all other treatments. On the other hand, the lowest nitrogen uptake in BRRI dhan 29 (21.20 kg/ha) was recorded in N_0 treatment where no nitrogen fertilizer was applied.

Table 4.5 Effect of different levels of Nitrogen on nitrogen uptake from soil in BRRI dhan 29

N levels	N Uptake from soil (kg/ha)
N_0	21.20c
N_{60}	38.37b
N_{90}	38.27d
N_{120}	35.10b
Nimin coated N_{60}	40.44b
Nimin coated N_{90}	40.20b
Nimin coated N_{120}	53.38a
LSD	7.99
CV (%)	6.33

4.3 Nutrient status of soil after harvest of BRRI dhan 29 as affected by different levels of nitrogen

4.3.1 Soil pH

Different levels of nitrogen showed significant effect in respect of soil pH after harvest of BRRI dhan 29 is presented in Table 4.6. Soil pH varied significantly at 5.50 to 5.89. The highest pH of the soil (5.89) was recorded in treatment urea @ 120 kg/ha and the lowest pH (5.50) was observed in control treatment (N_0).

4.3.2 Total nitrogen content

Total nitrogen content of soil after harvest of BRRI dhan29 was influenced by different levels of nitrogen which showed a statistically significant variation (Table 4.6). The highest N content (0.25%) was observed in case of treatment nimin coated urea @ 120 kg/ha and it was followed by the treatment N_{120} with the value of (0.21%). In contrast, the lowest N content (0.14%) was obtained in the N_0 treatment where no N fertilizer was applied.

4.3.3 Available phosphorous content

Different levels of nitrogen on the available phosphorous content of soil after harvest of BRRI dhan 29 showed significant variation (Table 4.6). It was revealed from the study that the performances of the most of the treatment differ significantly from each other. Among the different treatments, nimin coated urea @ 120 kg/ha showed the highest P content (23.26 ppm) after harvest of BRRI dhan 29. On the other hand, the lowest P content (15.30 ppm) was observed in the treatment N_0 receiving no fertilizer.

4.3.4 Potassium content

Different levels of nitrogen showed significant differences in respect of K content of soil after harvest of BRRI dhan 29 (Table 4.6). However, the lowest K content of crop-harvested soil (0.13 meq 100 g $soil^{-1}$) was recorded in the treatment N_0 (control) and the highest K content (0.24 meq 100 g $soil^{-1}$) was recorded with nimin coated urea @ 120 kg/ha. On the other hand, 0.21 meqk 100 g $soil^{-1}$ was obtained in both the treatments of nimin coated urea @ 90 kg/ha and nimin coated urea @ 60 kg/ha.

4.3.5 Sulphur content of soil (ppm)

Statistically significant difference was obtained in the sulphur content of soil after harvest of BRRI dhan 29. Application of showed 120 kg nimin coated urea/ha the highest S content (22.46 ppm) in soil. The next highest S content (21.50 ppm) was found in treatment nimin coated urea @ 60 kg/ha. On the contrary, the lowest S content (15.60 ppm) was observed in the N_0 treatment where no fertilizer was applied (Table 4.6).

4.3.6 Zinc content

No significant variation was observed in the different levels of applied nitrogen in respect of zinc content of post harvest soil. Among the treatments, nimin coated urea @ 120 kg/ha showed the highest Zn content (1.50 ppm) in the soil after harvest of BRRI dhan 29 when the lowest Zn content (1.01 ppm) was observed in control treatment (Table 4.6).

4.3.7 Boron content

No significant variation was observed in the different levels of nitrogen in respect of boron content of soil. Among the treatments, nimin coated urea @ 120 kg/ha showed the highest B content (0.20 ppm) in the soil after harvest of BRRI dhan 29 when the lowest B content (0.08 ppm) was observed in control treatment (Table 4.6).

Table 4.6. Effect of different N levels on the pH, OM, total N, available P, K, S and Zn in the soil after harvest of BRRIdhan29

N levels	pH	Total N	Available P	Available K	Available S	Available Zn	Available B
N_0	5.50	0.14	15.30	0.13	15.60	1.01	0.08
N_{60}	5.60	0.17	16.30	0.17	21.49	1.20	0.16
N_{90}	5.80	0.20	15.42	0.16	17.10	1.21	0.11
N_{120}	5.89	0.21	16.82	0.19	19.44	1.19	0.13
Nimin coated N_{60}	5.87	0.16	18.58	0.21	21.50	1.23	0.17
Nimin coated N_{90}	5.80	0.19	20.10	0.21	18.24	1.41	0.15
Nimin coated N_{120}	5.64	0.25	23.26	0.24	22.46	1.50	0.20
Level of sinificance	NS	**	**	**	*	NS	**
CV (%)	3.22	3.54	3.59	3.45	3.21	3.55	2.39

* = Significant at 5% level, ** = Significant at 1% level
NS = Non significant, CV= Co-efficient of variation

CHAPTER V

SUMMARY AND CONCLUSION

A field experiment was conducted at the Soil Science Department of Sher-e-Bangla Agricultural University, Dhaka during the boro season 2008, to observe the effect Nimin coated nitrogen fertilizer against prilled nitrogenous fertilizer on the yield and yield contributing characters of BRRI dhan 29. The soil of the experimental filed belongs to the Modhupur tract under AEZ 28. The selected plot was medium high land and the soil series was tejgaon series.

All management practices and intercultural operations such as weeding, irrigation and pest management were done as and when necessary. Five hills from each plot were selected randomly at harvest and tagged for recording data of plant height, number of total tiller hill^{-1}, number of effective tiller hill^{-1}, panicle m^{-2}, panicle length, filled grains panicle^{-1}, 1000 grain weight, grain yield and straw yield of BRRI dhan 29.

Grain yield was recorded from 25 hills (1m^2) and grain moisture was recorded and grain yield was expressed at 14% moisture. Straw yield was expressed on oven dry basis. The plant parameters grain and straw yield were statistically analyzed and the mean differences were adjudged by Duncan's Multiple Range Test (DMRT).

The N fertilizer treatments differed significantly on plant height, number of tillers hill^{-1}, number of effective tillers hill^{-1}, number of filled grains panicle^{-1} except panicle length. The highest plant height (91.67cm), total number of tiller per hill (11.30) and straw yield (7.26 t ha^{-1}) were found from Nimin coated urea @ 120 kgha^{-1}. The number of effective tillers per hill (8.00), panicle meter^{-2} (276.1), panicle length (25.36 cm), filled grain per panicle (146.1), 1000 seed weight (24.60g) and grain yield (4.84 t ha^{-1}) were found the highest in Nimin coated N_{90} treated plots.

However, considering all these treatment studied it is concluded that Nimin coated 90 kg N per hectare gave the highest grain yield and may be considered as best treatment which might be secure for optimum yield of BRRI dhan 29. On the basis of yield, the treatments N_{120}, Nimin coated N_{90} and Nimin coated N_{120} kg ha^{-1} gave identical yield but Nimin coated N_{90} is superior among all. Therefore, no need to apply higher dose of N. Moreover, Nimin coated N application at the rate of 90 kg ha^{-1} is the optimum dose of nitrogenous fertilizer for high yield goal. Application of this fertilizer at this dose will be economically viable and ensure maximum nitrogen use efficiency. It can be suggested to apply for rice cultivation.

The different nitrogen levels significantly influenced uptake of nitrogen of BRRIdhan29. In all cases the uptakes of nitrogen i.e. from grain and from soil were affected by different nitrogen fertilizers, Nimin coated nitrogen @ 120 kg ha^{-1} performed the highest uptake by BRRI dhan 29.

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APPENDICE

Appendix Table-1: Monthly average of temperature, relative humidity and sunshine hour of the experimental site during the period from 17 November 2008 to February 2009.

Month	Temperature (Maximum)	Temperature (Minimum)	Humidity (%)	Rainfall (mm)	Potential ET (mm day^{-1})	Solar radiation	Average sunshine (Hours)
October	32.51	23.13	85.00	168	3.612	16.61	172.0
November	30.20	20.13	83.30	31	2.966	15.364	193.6
December	26.60	13.5	81.00	9	2.43	14.089	208.6
January	25.40	12.93	78.00	7	2.387	14.766	213.2
February	25.30	14.2	73.68	7	2.37	14.866	247.6

Source: Bangladesh Meteorological Department (Climate Division), Dhaka.