EFFECTS OF COWDUNG AND CHEMICAL FERTILIZERS ON GROWTH AND YIELD OF AROMATIC RICE BRRI dhan50

By

MD. NAJMUS SADAT RATNA
Registration No. 11-04704

A Thesis
Submitted to the Department of Agricultural Chemistry, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements
for the degree
of

MASTER OF SCIENCE (M.S.)
IN
AGRICULTURAL CHEMISTRY

Semester: July - December, 2013

Approved By

....
Dr. Md. Abdur Razzaque
(Supervisor)
Professor
Department of Agricultural Chemistry

....
Dr. Sheikh Shawkat Zamil
(Co-supervisor)
Assistant Professor
Department of Agricultural Chemistry

....
Dr. Md. Abdur Razzaque
Chairman
Examination Committee
&
~~Head~~
Department of Agricultural Chemistry
Sher-e-Bangla Agricultural University

December, 2013

Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka – 1207
PABX: 9110351 & 9144270-79

CERTIFICATE

This is to certify that the thesis entitled *"EFFECTS OF COWDUNG AND CHEMICAL FERTILIZERS ON GROWTH AND YIELD OF AROMATIC RICE BRRI dhan50"* submitted to the **DEPARTMENT OF AGRICULTURAL CHEMISTRY, Sher-e-Bangla Agricultural University, Dhaka** in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (M.S.)** in **AGRICULTURAL CHEMISTRY,** embodies the results of a piece of *bona fide* research work carried out by ***Md. Najmus Sadat Ratna,*** Registration. No. *11-04704,* under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma in any other institution.

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

Supervisor
Dr. Md. Abdur Razzaque
Professor
Department of Agricultural Chemistry
Sher-e-Bangla Agricultural University
Dhaka-1207

Dhaka, Bangladesh

Dedicated

To

My Beloved Parents

Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka - 1207
PABX: 9110351 & 9144270-79

CERTIFICATE

This is to certify that the thesis entitled *"EFFECTS OF COWDUNG AND CHEMICAL FERTILIZERS ON GROWTH AND YIELD OF AROMATIC RICE BRRI dhan50"* submitted to the **DEPARTMENT OF AGRICULTURAL CHEMISTRY, Sher-e-Bangla Agricultural University, Dhaka** in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (M.S.)** in **AGRICULTURAL CHEMISTRY,** embodies the results of a piece of *bona fide* research work carried out by ***Md. Najmus Sadat Ratna,*** Registration. No. *11-04704,* under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma in any other institution.

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

Supervisor
Dr. Md. Abdur Razzaque
Professor
Department of Agricultural Chemistry
Sher-e-Bangla Agricultural University
Dhaka-1207

Dhaka, Bangladesh

ACKNOWLEDGEMENT

The author, first desires to express all his devotion and reverence to Almighty Allah, who enabled the author to complete the research work and writing up the thesis successfully.

The author would like to express his heartfelt respect, deep sense of gratitude and deep appreciation to his honorable teacher and supervisor Dr. Md. Abdur Razzaque, Professor and Chairman, Department of Agricultural Chemistry, Sher-e-Bangla Agricultural University, Dhaka, for his worthy guidance, valuable suggestions, constructive criticism, encouragement and continuous supervision throughout the study work and preparation of the thesis manuscript.

Sincere thanks and profound gratitude are extended to his co-supervisor , Dr. Sheikh Shawkat Zamil, Assistant Professor, Department of Agricultural Chemistry, Sher-e-Bangla Agricultural University, Dhaka, for offering his help and valuable suggestions during the course of study, in conducting research work and preparing the thesis manuscript.

The author extends his gratefulness to all the teachers of the Department of Agricultural Chemistry, SAU, Dhaka, for their valuable advice, suggestions and constructive criticism. He also expresses his special thanks to the staffs of the Department of Agricultural Chemistry, SAU, Dhaka, for their extended and heartiest co-operation.

The author extends his gratefulness to the workers of the field laboratory, SAU, Dhaka. Special thanks are extended to the authority of Sher-e-Bangla Agricultural University Library, SAU, Dhaka, from where the author found valuable information to complete the study.

At last the author expresses his boundless gratitude to his parents as well as his brothers, sisters and relatives for their blessing and encouragement during this higher study, which can never be forgotten.

December, 2013 *The Author*

ABSTRACT

The experiment was conducted in the Agronomy field laboratory of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from December, 2012 to May, 2013 to study the effect of cowdung and chemical fertilizers on growth and yield of aromatic rice BRRI dhan50. Five different levels of fertilizers and cowdung as recommended by BRRI for BRRI dhsn50 were used as: T_1: 100% Inorganic fertilizer, T_2: 75 % Inorganic fertilizer + 25% Cowdung, T_3: 50 % Inorganic fertilizer + 50% Cowdung, T_4: 25 % Inorganic fertilizer + 75% Cowdung, T_5: 100% Cowdung. Significant variations were found in growth and yield parameters and nutrient content of rice due to the various combinations of organic and inorganic fertilizers. It seems from the results that 100% inorganic fertilizers (T_1) showed the best result during initial stage of plant height but in later stages combination of organic and inorganic fertilizers (T_2) showed best results (82.97cm and 91.87cm respectively). Leaf length, number of total tillers hill^{-1} and number of effective tillers hill^{-1} showed best result during different growth stages of rice plant by using chemical fertilizer only (T_1) and all of that cases it was followed by T_2. Panicle length (22.52 cm), filled grain panicle^{-1} (135.33), grain yield (4.07 t ha^{-1}), 1000 seed weight (20.84 g) and dry weight of straw (0.45 kg m^{-2}) always counted superior result for the treatment T_2: 75 % Inorganic fertilizers + 25% Cowdung. Percent unfilled grain (17.18) was highest in T_5 and harvest index (45.45) was superior for the treatment T_1. And all of the cases inferior results were given by T_5 treatment i.e 100% Cowdung only. Significant effect also found in different chemical composition of straw and grain by using different combinations of fertilizer doses. Significantly the highest N, P and K contents of grain and straw were recorded in T_1 (100% Inorganic fertilizers) and T_2 (75 % Inorganic fertilizers + 25% Cowdung). The lowest N, P and K content in grain and straw were found from the treatment using Cowdung (T_5) only.

CONTENTS

CONTENTS

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

%	Percent
@	At the rate of
°C	Degree Celsius
AEZ	Agro Ecological Zone
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics
BRRI	Bangladesh Rice Research Institute
CV	Co-efficient of Variations
cv.	Cultivar (s)
DAS	Days After Sowing
DAT	Days After Transplanting
DMRT	Duncan's Multiple Range Test
EC	Emulsifiable Concentrate
et al.	And Others
FAO	Food and Agriculture Organization
FYM	Farm Yard Manure
g	Gram
IRRI	International Rice Research Institute
kg	Kilo Gram
LSD	Least Significant Difference
MOP	Muriate of Potash
ppm	Parts per million
RCBD	Randomized Complete Block Design
SAU	Sher-e-Bangla Agricultural University
t/ha	Ton per Hectare
TSP	Triple Super Phosphate

CHAPTER I
INTRODUCTION

Rice (*Oryza sativa*) is the staple food for more than three billion people that is over half of the world's total population (FAO, 2004). In Bangladesh, about 80% of the total cultivable lands are used for rice cultivation. Rice contributes about 91.1% of the total grain production and covers 74% of the calories intake in the people of Bangladesh (MOA, 2001). Unfortunately, the yield of rice is low considering the other rice growing countries like South Korea and Japan where the average yield is 7.00 and 6.22 t ha^{-1}, respectively (FAO, 1999). On the other hand, the demand for increasing rice production is mounting up to feed the ever-increasing population.

Aromatic rice is an important commodity in international trade having small grain with pleasant aroma. Aromatic rice had 15 times more 2-acetyl-1-pyrroline content than non-aromatic rice as 0.14 and .009 ppm respectively (Singh *et al.,* 2000). The yield of aromatic rice is low but its high price with low cultivation cost generates higher profit (Islam *et al.,* 2008b). BRRI dhan50 is one of the important rice introduced by Bangladesh Rice Research Institute (BRRI). It is a high yielding aromatic rice variety with fine grain and pleasant aroma. BRRI dhan50 is also called Banglamoti/ Bashmoti and the cultivation are increasing all over the country. Most of aromatic rice is cultivated in Aman season but BRRI dhan50 (Banglamoti/ Bashmoti) is a rice variety of boro season.

Nitrogen is the most deficient nutrient element in Bangladesh soils due to sub-tropical humid climate accompanied with centuries of cultivation. The element accounts for about

75% of total nutrient applied and urea is mainly used as a source of N for crop production in this country. From the stand point of costly input and environmental degradation for the use of chemical fertilizers, combined application of chemical and organic fertilizers is important for sustained crop productivity and soil fertility (Rahman *et al.*, 2006). Excess amount of N application can result in lodging of plant and reduce of yield and similarly deficiency of N may affect rice yield, so judicious application of N is important for obtaining better yield.

Phosphorus is particularly important to the rice seedling for recovering from transplanting shock. Phosphorus greatly stimulates root development in the young plant, thus increasing its ability to absorb nutrients from the soil. Phosphorus is a major component in ATP, the molecule that provides "energy" to that plant for such processes as photosynthesis, protein synthesis, nutrient translocation, nutrient uptake and respiration. Phosphorus is also a component of other compounds necessary for protein synthesis and transfer of genetic material DNA, RNA. Phosphorus application to rice increased P accumulation but did not consistently increase rice yields because flooding decreased soil P sorption and increased P diffusion (Delong *et al.*, 2002).

Potassium is one of the most important nutrient for rice production after nitrogen and phosphorus. It strengthens cell walls, thus making the plant physically stronger and enabling it to withstand the adverse effects of bad weather. It increases plant's resistance to penetration by disease organisms and makes the plant resistance to diseases affecting panicles and grains; it also helps to increase the protein content of the grains, thus improving the quality of the crop.

Cowdung is a good source of organic matter and plays a vital role in soil fertility improvement and as well as supplying macro and micro nutrients for crop production. It also improves soil by maintaining a better physical health and also by increasing the activities of soil microbes. Composted cow manure also contains beneficial bacteria, which convert nutrients into easily accessible forms so they can be slowly released without burning tender plant roots. Composting cow manure also produces about a third less greenhouse gases, making it environmentally friendly.

A suitable combination of organic and inorganic sources of nutrients is necessary for sustainable agriculture that can ensure high quality food production. Nambiar (1991) views that integrated use of organic manures and chemical fertilizers would be quite promising not only in providing greater stability in production, but also in maintaining better soil fertility. The long-term research at BARI revealed that the application of cowdung @ 5 t/ha/year improved rice productivity as well as prevented the soil resources from degradation (Bhuiyan, 1994). Poultry manure is another good source of nutrients in soil. Meelu and Singh (1991) showed that 4 t/ha poultry manure along with 60 kg N/ha as urea produce grain yield of crop similar to that with 120 kg N/ha as urea alone.

The application of different fertilizers and manures influences the physical and chemical properties of soil and enhances the biological activities. It is also positively correlated with soil porosity and enzymatic activity. Organic fertilizer enhances soil porosity by increasing regular and irregular pores and causes a priming effect of native soil organic matter. Applications of both chemical and organic fertilizers need to be applied for the improvement of soil physical properties and supply of essential plant nutrients for higher yield. (Sarvanan *et al.*, 1987).

Soil organic matter improves the physicochemical properties of the soil and ultimately promotes crop production. Evidences from different AEZ of the country have shown a decrease in the content of organic matter by the range of 15 to 30% over the last 20 years (Miah, 1994). Therefore, it would not be wise to depend only on inherent potentials of soils for higher crop production. More recently, attention is focused on the global environmental problems; utilization of organic wastes, Cow dung, FYM, compost, vermicompost and poultry manures as the most effective measure for the purpose.

Cowdung is the most important source of organic matter in our country for its availability all over the country. It is also cheaper than other sources of organic matter. Traditional agricultural system in Bangladesh has a long term practice on cowdung application but judicial application with chemical fertilizers is not practiced yet.

Considering the above fact, the present research was undertaken with the following objectives:

- To examine the combined effect of N, P and K fertilizers along with cowdung on the growth, yield and yield contributing characters of aromatic rice BRRI dhan50
- To study the integrated effect of cowdung, N, P and K fertilizers on the nutrient contents of BRRI dhan50
- To find out the suitable combination dose of N, P, K fertilizers and cowdung

CHAPTER II
REVIEW OF LITERATURE

Yield and yield contributing characters of rice are considerably depends on manipulation of basic ingredients of agriculture. The basic ingredients are including variety, environment and agronomic practices (fertilizer application, irrigation, weeding etc). Among the above factors fertilizer application is the most important practice for growth and yield of rice. High Yielding Varieties (HYV) are more adaptive to appropriate fertilizer application and they produce higher yield with increasing fertilizer level up to a certain end. Soil organic manure and inorganic fertilizers are the essential factor for sustainable soil fertility and crop productivity because they are the store house of plant nutrients. Sole and combined use of cowdung, poultry manure, compost, and inorganic fertilizer acts as a source of essential plant nutrients. Experimental evidences in the use of cowdung, poultry manure, compost, and nitrogen, phosphorus, potassium and sulphur showed an intimate effect on the yield and yield attributes of rice.

The available relevant reviews of related to nitrogen, phosphorus and potassium management with manure in the recent past have been presented and discussed below:

2.1 Effect of chemical fertilizer on growth and yield of rice

Amin *et al.* (2004) conducted an experiment to evaluate the effect of increased plant density and fertilizer dose on yield of rice variety IR-6. They found that increased fertilizer dose of NPK increase plant height.

Haq *et al.* (2002) conducted an experiment with twelve treatments combination of N, P, K, S, Zn and Diazinon. They found that all the treatments significantly increased the grain and straw yield of BRRI dhan30 rice over control. The treatment 90 kg N + 50 kg P_2O_5 + 40 kg K_2O + 10 kg S + 4 kg Zn ha^{-1} + diazinon gave the highest grain and straw yield.

Asif *et al.* (2000) reported that NPK levels significantly increase the panicle length, number of primary and secondary branches $panicle^{-1}$ when NPK fertilizer applied in 180-90-90 kg/ha might be attributed to the adequate supply of NPK.

Islam *et al.* (2008a) conducted an experiment in 2001-2002, 2002-2003 and 2003-2004 to determine the response and the optimum rate of nutrients (NPK) for Chili- Fallow-T. *aman* cropping pattern. They found that grain yield influenced significantly due to application of different rates of nutrients and 60-19-36 kg/ha NPK maximized the yield of T. *aman* rice varieties in respect of yield and economics.

Maurya and Yadav (1987) studied the effect of N level (0, 50 and 100 kg N/ha) on grain yield and yield parameters using overaged seedlings of four transplanted rice varities- Mahsuri, Sarjoo 52, Ratna, and Saket 4. Each increment of N significantly increased leaf number, panicle number, panicle weight, plant height and grain yield but average N use efficiency was low.

Ndaeyo *et al.* (2008) conducted an experiment in Nigeria with five rice varieties (WAB340-8-8-2HI, WAB881-10-37-18-8-2-HI, WAB99-1-1, WAB224-8-HB, WAB189-B-B-B-8-HB) and four rates of NPK (15:15:15) fertilizer (0, 200, 400 and 600kg/ha). The results showed that 600kg/ha NPK (15:15:15) fertilizer rate significantly ($P < 0.05$) increased plant height, number of leaves and tillers per plant in both years. The 400kg/ha rate increased the number of panicles per plant, length of central panicle per plant and the overall grain yields, straw yield over other rates by 4-32% and 2-21% in 2005 and 2006, respectively.

Ahmed *et al.* (1989) conducted a greenhouse experiment to investigate the effect of nitrogen and residual sulphur on growth and yield of rice. The highest values of filled grain per panicle, filled grain percentage, 1000 grain weight, grain yield, straw yield and grain: straw ratio were observed with the treatment receiving 120 ppm N with 60 ppm S applied as gypsum at previous monsoon season.

Aruna and Reddy, (2011) found that 100% N applied through urea or 75% N applied through urea + 25% N applied through FYM is optimum in the improvement of the yield attributes, grain and straw yields and quality of aerobic rice.

Gupta *et al.*, (2007) found that application of inorganic fertilizers (60 kg N, 30 kg P and 30 kg K/ha) to rainy season rice (cv. MW 10) increased the grain yield. Winter crops (Indian mustard, lentil, barley and linseed) grown in sequence on plots receiving 12 ton FYM + 30 kg N/ha in rice during the rainy season showed significantly higher productivity of the system.

Saha *et al.* (2004) conducted an experiment in 2002-2003 to create and compare a suitable fertilizer recommendation model for lowland rice. Five different fertilizer recommendation models were tested and compared with one check plot. Results showed that the application of different packages estimated by different fertilizer models significantly influenced leaf number, panicle length, panicle numbers, spikelet number per panicle, total grains per panicle, number of filled grain and unfilled grain per panicle. The combination of NPK that gave the highest result (120-13-70-20 kg/ha NPKS).

Sarker *et al.* (2001) obtained the nitrogen responses of a Japonica (Yumelvitachi) and an Indica (Takanari) rice variety with different nitrogen levels viz. 0, 40, 80, and 120 kg N/ha. They observed that application of nitrogen increased grain and straw yields significantly but harvest index was not increased significantly.

Rasheed *et al.* (2003) reported that the effect of different NP levels i.e., 0-0, 25-0, 50-25, 75-50, 100-75 and 125-100 kg ha^{-1} on yield and yield attributes of rice Bas-385. Yield attributes (No. of effective tillers per hill, spikelet per panicle, normal kernels per panicle, 1000-grain weight) were improved linearly with increasing NP levels up to 100-75 kg/ha. The NP level of 100-75 kg/ ha resulted in the highest grain yield of 4.53 t/ha with minimum kernel abnormalities (Sterility, abortive kernels and opaque kernels) as against the minimum of 2.356 t/ha in the control (0-0) followed by 25-0 kg NP/ ha with maximum kernel abnormalities.

Singh *et al.* (2003) also reported that crop growth rate and relative growth rate such as total dry matter production was significantly influenced by NPK fertilizers. The tiller number, number of leaves and total dry matter production are closely correlated with yield depending on the rice cultivar which can be greatly enhanced by applying proper nutrient.

Kundu *et al.*, (2007) found that both soil puddling and K fertilizer application at 80 kg /ha significantly increased grain and straw yields of rice. On this aspect, 10 cm puddling was more effective than 20-cm puddling. The interaction effects of soil puddling and K fertilizer application on rice yield was significant. Puddling of the top 10 cm soil and application of 80 kg /ha produced maximum K uptake in rice.

Lu *et al.*, (2011) found that N : P : K at 50 : 37.5 : 30 kg/ha showed the maximum leaf area index (2.98), plant height at maturity (130.33cm), grain yield (3.82) and harvest index (46.5%). This treatment also produced the highest number of grains per panicle, 1000 grain weight and straw yield, which also similar to the results obtain with the use of the same N : P : K rate applied with FYM at 10 kg /ha.

Tishe *et al.*, (2006) found that in the red soil paddy fields with a total of 7500 kg /ha of rice straw incorporated into the field each year, the recommended N fertilizer application rate is

180 kg/ha year^{-1}, of which 30% is applied as basal dressing, 30% as sidedressing at the tillering stage and 40% as sidedressing at the booting stage showed the maximum leaf area index (2.98), plant height at maturity (130.33cm), grain yield (3.82) and harvest index (46.5%).

2. 2. Effect of organic fertilizer on growth and yield of rice

Belefant and Miller., (2007) reported that the application of either poultry manure or organic fertilizer to the soil increases tiller number, but the combination of Poultry manure and organic fertilizer results in a synergistic increase in early tillers. Tiller induction by poultry manure occurred in a number of rice cultivars which included high and low tillering varieties.

Deng *et al*., (2010) suggest that the slow release of nitrogen from poultry manure increased panical length and grains per panical in rice plants and enhance the lodging resistance capability of high quality rice to achieve the goal of high quality and high yield.

Guan *et al*., (2011) suggested that reducing N fertilizer by 20% and applying organic manure in the experimental areas could effectively increases production, lower the production costs and significantly improve soil fertility and biological properties.

Myint *et al*., (2010) found that organic matter provided comparatively higher nutrient accumulations which in turn enhanced the growth and yield of rice.

Ogbodo (2005) reported that organic manure application doses of over 20 ton/ha reduced plant growth and grain yield. Improvements in soil physical and chemical properties owing to organic manure application was observed to have led to comparable performance between the plants in plots treated with organic and inorganic manure .

Reddy *et al*., (2004) shows the effect of different organic manures on growth and yield of paddy under tank irrigation .Poultry manure and sewage study produced batter growth components like number of panicles per hill and panicle weight.

Sangeetha and Balakrisnan (2011) suggested that the application of enriched poultry manure compost on equal N basis (2.3 ton 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.

Taki *et al*., (2008) suggested that the slow release of nitrogen from poultry manure increased panicle length and grains per panicle in rice plants.

Virdia *et al*., (2011) reported that application of bio-compost @ 20 t/ha have significantly higher paddy grain yield (4591 kg/ha) which was 1.5 time higher than no organic application. Next effective treatment was in-situ green manuring with dhaincha followed by FYM @ 20 kg/ha. Applications of organics have positive effect on growth and yield of paddy and have residual effect on castor crop. Application of bio-compost @ 20 ton/ha have significantly higher paddy grain yield (4591 kg/ha) which was 1.5 time higher than no organic application.

Yadav *et al*., (2010) reported that organic N sources i.e., farm yard manure (FYM), green leaf manure (GLM), poultry manure increase the 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. Green leaf manure is more efficient than other organic sources at all the proportions of N.

2.3 Combined effect of chemical fertilizer and manure on growth and yield of rice

Channbasavana and Biradar (2001) reported that the application of poultry manure @ 3 t ha^{-1} gave 26% and 19% higher grain yield than that of the control during 1998 and 1999, respectively.

Eneji *et al.* (2001) observed that average across the soils, the level of extractable Fe increased by 5% in chicken manure and 71% in cattle manure; Mn by 61% in chicken manure and 172% in swine manure and Cu by 327% in chicken manure and 978% in swine manure. Mixing these manures before application reduce the level of extractable trace elements.

Singh *et al.* (2001) studied on the effect of poultry manure under irrigated condition with nitrogen in rice-wheat cropping system in an Alfisol of Bilapur, Madhya Pradesh, India. The treatment consisted of poultry manure alone and in combination with nitrogen fertilizer. Root and shoot biomass at different growth stages increased with the application of N and poultry manure alone and combination. Root and shoot biomass was higher in 100% N through poultry manure, followed by 75% N through poultry manure and 25% through urea.

Vanaja and Raju (2002) conducted a field experiment on integrated nutrient management practice in rice crop. Different combinations of chemical fertilizer with poultry manure (PM) 2 t ha^{-1} gave highest grain and straw yield.

Umanah *et al.* (2003) found out the effect of different rates of poultry manure on the growth, yield component and yield of upland rice cv. Faro 43 in Nigeria, during the 1997 and 1998 early crop production seasons. The treatments comprised 0, 10, 20 and 30 t/ha poultry manure. There were significant differences in plant height, internode length, tiller number, panicle number per stand, grain number/panicle, and dry grain yield. There was no significant difference among the treatments for 1000-grain weight.

Channabasavanna (2003) conducted a field experiment to evaluate the efficient utilization of poultry manure with inorganic fertilizers in wetland rice and found that the growth parameters and grain yield increased with each increment of poultry manure application and was maximuma at 3 t poultry manure/ha. Poultry manure at 2 ton /ha recorded significantly higher values for seed yield and its attributes. The study proved the superiority of poultry manure over farmyard manure (FYM). It was evident from the study that one ton of poultry manure was equivalent to 7 ton FYM which produced at per seed yields. Agronomic efficiency of N (AEN) at 75% NPK (112.5:56.3:56.3 kg NPK/ha) was equivalent to 2 t poultry manure/ha. The results showed that an increase in poultry manure and fertilizer increased rice seed yield. The AEN decreased with an increase in the application of poultry manure and NPK fertilizer.

Mahavisha *et al*. (2004) investigated a field study during the kharif season of 2001 in Andra Pradesh, India to investigate the effect of organic fertilizer sources on the growth and yield of rice. The crop growth and yield were higher with 125% recommended fertilizer + poultry manure and 100% RDF + poultry manure compared to the other treatments.

Miah *et al*. (2004) found 5.6-6 t/ha-grain yields with application of 2 t/ha poultry manure plus 120 kg N/ha in Boro season.

Reddy *et al*. (2005) carried out a field experiment on black clay soils in Gangavati, Karnakata, India, to evaluate the performance of poultry manure (PM) as a substitute for NPK in irrigated rice (cv. IR 64). The application of PM at 5 t/ha recorded a significantly higher grain yield (5.25 t/ha) than the control and FYM application at 7.5 t/ha, significantly improved the soil P and K status, and increased the N content of the soil.

Xu *et al.* (1997) observed that application of half inorganic fertilizer and half organic manure (swine manure) increase nutrient absorption, panicle number, yield of rice & also increased soil organic matter.

Asim and Reddy (2010) observed that the highest net return and yield was recorded in the treatment, which received 75% RDF of N through fertilizer and rest 25% of N through combined application of FYM, VC and PM. The treatments with 75% RDF of nitrogen and the combination or individual use of organic source produced better grain and straw yield with higher harvest index indicating better nutrient management technique for aerobic rice.

Aulakh (2010) found that the effects of integrated use of organics (farmyard manure, piggery manure, poultry manure, green manures and crop residues) with chemical fertilizers, and impacts of long-term use of INM on enhancing crop productivity were studied. The results clearly demonstrated that INM enhances the yield potential of crops over and above achievable yield with recommended fertilizers.

Banik and Sharma (2008) found that application of inorganic fertilizers (60 kg N, 30 kg P and 30 kg K/ha) to rainy season rice (cv. MW 10) increased the grain yield. Winter crops (Indian mustard, lentil, barley and linseed) grown in sequence on plots receiving 12 ton FYM + 30 kg N/ha in rice during the rainy season showed significantly higher productivity of the system.

Bhabesh and Barua (2010) found that application of 50% recommended dose of fertilizers (RDF) along with 50% N through farmyard manure significantly increased yield-attributing parameters, such as effective tiller numbers/m^2, panicle length, filled grains/panicle and test weight of seeds of rice and plant height, branches/plant, plants/m^2, capitulums/plant, seeds/capitulum and test weight of seeds of niger, besides maximizing the straw (7.1 ton/ha) and grain (4.1 ton/ha) yield of kharif rice and stover (2.0 ton/ha) and seed (0.28 ton/ha) yield of rabi niger as compared to RDF.

Chaudhary *et al.*, (2011) found that Rice 'Rajendra Suwasani' recorded significantly higher values of yield attributes (panicles/m^2, panicle length, grains/panicle, panicle weight, 1000-grains weight), yields and nutrient accumulation under integrated source of nutrients than inorganic fertilizer alone. Maximum grain yield (4.12 ton/ha) was with 75% recommended dose of nitrogen (RDN)+25% N from dhaincha (*Sesbania aculata* L.) and it was 14.8 and 26.1% higher over 100 and 75% RDN, respectively. There was significant reduction in yield attributes, yields and nutrient uptake due to delayed transplanting.

Dahiphale *et al.*, (2004) carried out an experiment about yield and yield parameters of scented rice as influenced by integrated nutrient management and found that the highest number of panicles, panicle length, grains per panicle, panicle weight, percentage of field grains, grain yield and straw yield was obtain with 75% recommended dose of NPK fertilizers + 8 ton FYM /ha + bio fertilizer recommended dose of 75: 50:50 kg NPK /ha gave the highest 1000 grain weight.

Islam *et al.*, (2007) observed that conventional spacing of 25 cm -15 cm in combination with 50% N, P, K, S, Zn and 5 tons of poultry manure appeared as the best practice for transplant Aman rice cultivation in SRI method because it not only reduced the production cost but also had a long term impact on the improvement of the soil properties.

Jha *et al.*, (2004) observed that 50 : 40 : 30 kg NPK /ha + 3 ton CD and urea mixture /ha produced significantly higher yield compared with application of inorganic fertilizer alone.

Kumar *et al.*, (2009) carried out an experiment about the effect of integrated nutrient management in transplanted rice genotypes, the recommended package of compost with full dose of inorganic fertilizers recorded the significantly highest yield (48.78 q/ha). Among the different varieties, Puttabatta yielded the significantly highest grain (42.44 q/ha) and straw (48.6 q/ha) yields.

Muhammad *et al*., (2004) found that N : P : K at 50 : 37.5 : 30 kg/ha + FYM at 20 ton /ha showed the maximum leaf area index (2.98), plant height at maturity (130.33cm), grain yield (3.82) and harvest index (46.5%). This treatment also produced the highest number of grains per panicle, 1000 grain weight and straw yield which also similar to the results obtain with the use of the same N : P : K rate applied with FYM at 20 kg /ha.

Pandey *et al*., (2007) found that of 100, 60 and 40 kg/ha N, 150, 75 and 60 kg/ha N, + FYM. The application of 60% K as basal and 40% at maximum tillering significantly increased the grain yield, uptake of N, P and K and the net return than its whole amount applied basal.

Sarker *et al*., (2007) reported that BRRI dhan 31 and BRRI dhan 32 performed the best respect of yield parameters in 5 ton / ha of poultry manure coupled with 75% N P K S Zn among different treatments. Thus transplant aman rice (BRRI dhan31 and BRRI dhan32) can be cultivated successfully with 25 % reduction of recommended fertilizers when poultry manure will be applied at 5ton/ha.

Singh *et al*., (2010) found that integrated nutrients management practices T10 (RDF50+GM50) produced significantly higher plant height, no. of tillers m2, leaf area index, dry matter accumulation (DMA), crop growth rate (CGR), yield attributes panicle length (24.47 cm), fertile grains/panicle (117), sterility % (7.89), 1000 grain weight (30.17), grain yield (61.06 q/ha), harvest index (44.78 %) and straw yield (63.94 q/ha) as compared to other treatment but at par with T_5, T_{11}, T_7, T_6 and T_{12} (Farmers' practices).

Surendra *et al*., (2006) found that application of soil test based N, P, K and S (80, 26, 25 and 20 kg ha^{-1}), FYM (5 ton ha^{-1}) and green manuring to upland rice produced significantly higher mean grain yield of 3.36 ton ha^{-1}.

Virdia and Mehta (2010) found that the rice grain and straw yield was significantly higher with integrated nutrient application (pressmud @ 20 ton/ha+RDF), which remained at par with pressmud @ 15 ton/ha+RDF or FYM @ 10 ton/ha+RDF.

Waseem *et al*., (2010) found that Application of FYM @ 20 tones ha^{-1} recorded significantly higher rice grain yield of 17.4 % and 25.0 % than 30 tones FYM ha^{-1} and 10 tones FYM ha^{-1} respectively. However straw and biological yields of rice were higher under 30 tones FYM ha^{-1} application. 100% NPK fertilization recorded 28.0%, 15.7% superiority in grain and straw yields to 75% NPK fertilization, respectively. Yield attributing characters and dry matter were also higher under 100% NPK fertilization.

Yogananda and Reddy (2004) conducted an experiment and the results showed that combined application of either 8.5 tones of urban compost + 50:50:50 kg or 4.25 tones urban compost + 100 : 50 : 50 kg NPK/ha to hybrid rice was better than NPK fertilizer alone.

The literature review discussed above indicates that organic manure can supply a good amount of plant nutrients and thus can contribute to crop yields. The integrated approach by using the organic and inorganic sources of nutrients helps improve the efficiency of nutrients. Hence, an effort was undertaken to investigate the effects of integrated nutrient management on rice productivity.

CHAPTER III
MATERIALS AND METHODS

The experiment was conducted at the Agronomy field laboratory of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh, during the period from December`12 to May 2013 to study the effect of manure and chemical fertilizers on growth and yield of aromatic rice BRRI dhan50. This chapter includes materials and methods that were used in conducting the experiment. The details are presented below under the following sub-headings–

3.1 Experimental site and soil

The experiment was conducted in typical rice growing silt loam soil at the Sher-e-Bangla Agricultural University Farm, Dhaka during the Robi season of 2012-13. The morphological, physical and chemical characteristics of the soil are shown in the Table 3.1 and 3.2.

Table 3.1 Morphological characteristics of the experimental field

Morphology	Characteristics
Location	SAU Farm, Dhaka.
Agro-ecological zone	Madhupur Tract (AEZ- 28)
General Soil Type	Deep Red Brown Terrace Soil
Parent material	Madhupur Clay
Topography	Fairly level
Drainage	Well drained
Flood level	Above flood level

3.2 Climate

The experimental area was under the sub-tropical climate that is characterized by modrate temperature, moderate humidity and occasionally low rainfall with occasional gusty winds in robi season (November-May).

Table 3.2 Initial physical and chemical characteristics of the soil

Characteristics	Value (%)
Mechanical fractions:	
Sand (2.0-0.05 mm)	22.30
Silt (0.05-0.002 mm)	56.90
Clay (<0.002 mm)	20.80
Textural class	Silt Loam
pH (1: 2.5 soil- water)	6.1
Organic matter (%)	1.09
Total N (%)	0.04
Available K (ppm)	15.62
Available P (ppm)	9.88
Available S (ppm)	8.06

3.3 Planting material

BRRI dhan50 was used as the test crop in this experiment. This variety was developed at the Bangladesh Rice Research Institute (BRRI). It is mainly recommended for cultivation in Boro season.

3.4 Land preparation

The land was first opened on 18 January, 2013 by a tractor and prepared thoroughly by ploughing and cross ploughing with a power tiller. Laddering helped breaking the clods and leveling the land followed by every ploughing. Before transplanting of rice seedlings each unit of plot was cleaned by removing the weeds, stubbles and crop residues. Finally each plot was prepared by puddling.

3.5 Experimental design and layout

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Each replication was divided into 5 plots. The total numbers of unit plots were 15. The plot size was 3.0 m x 2.5 m. The distances between plot to plot and block to block were 0.75 m and 1.00 m, respectively. The layout of the experimental plot has been shown in Appendix I.

3.6 Raising of seedlings

Seeds of BRRI dhan50 were collected from Bangladesh Rice Research Institute (BRRI). The seedlings were raised at the wet seed bed in SAU farm. The seeds were sprouted by soaking for 72 hours. The sprouted seeds were sown uniformly in the well-prepared seed bed in December 12, 2012.

3.7 Treatments

Five treatments were used in the experiment. Different combinations of cowdung and chemical fertilizers were used for different treatments. The doses of chemical fertilizers and cowdung used were as treatment recommended by BRRI.

T_1: 100% Inorganic fertilizer (full recommended dose)

T_2: 75 % Inorganic fertilizer + 25% cowdung

T_3: 50 % Inorganic fertilizer + 50% cowdung

T_4: 25 % Inorganic fertilizer + 75% cowdung

T_5: 100% cowdung

Table 3.3 Recommended dose of fertilizer for BRRI dhan50

Urea (kg/ha)	TSP (kg/ha)	MOP (kg/ha)	Gypsum (kg/ha)	Cow dung (t/ha)
260	150	120	110	15

(http//knowledgebankbrri.org/brridhan50.pdf)

3.8 Fertilizer application

The amount of N, P, K and Zn fertilizers required (Table 3.3 and Table 3.5) per plot were calculated as per the treatments. Full amounts of TSP, MOP and gypsum were applied as basal dose during final preparation of land. The levels of urea were applied in 3 equal splits: one third was applied as basal dose before transplanting, one third at active tillering stage (30 *DAT)* and the remaining one third before panicle initiation stage (55 DAT) as per treatments. Calculated amount of zinc sulphate was applied as basal dose before transplanting as per treatments.

Table 3.4 Doses applied for different treatment

Treatment	Urea (kg/ha)	TSP (kg/ha	MOP (kg/ha)	Gypsum (kg/ha)	Cow dung (t/ha)
T_1	260	150	120	110	0
T_2	195	113	90	110	4
T_3	130	75	60	110	7.5
T_4	65	38	30	110	11
T_5	0	0	0	110	15

3.9 Cowdung incorporation

Cowdung (CD) was used in this experiment. The rate of cowdung applied to the plot was determined according to the treatment. Cowdung was applied to the plot before four days of final land preparation. Chemical constituents of cowdung are shown in the Table 3.5.

Table 3.5 Chemical composition of used Cowdung for the experiment.

Organic manure	**Nutrients content**				
	C (%)	**N (%)**	**P (%)**	**K (%)**	**C:N**
Cow dung	3.6	1.2	0.45	0.5	2.4

3.10 Transplanting of seedlings

Forty day old seedlings of BRRI dhan-50 were carefully uprooted from the seed bed and transplanted on January 25, 2013 in well puddled plot. 2-3 seedlings per hill were used following a spacing of 20 cm (row to row) ×15 cm (plant to plant). After one week of transplanting all plots were checked for any missing hill, which was filled up with extra seedlings whenever required.

3.11 Intercultural operations

The following intercultural operations were done for ensuring the normal growth of the crop.

3. 11.1 Weed control

During plant growth stage hand weedings were done according to need.

3. 11.2 Irrigation and drainage

Irrigation water was applied keeping a standing water of about 2-3 cm during the whole growing period.

3. 11.3 Plant protection measure

During the growing period some plants were infested by rice stem borer (*Scirpophaga incertulus*) which was successfully controlled by applying Diazinon 60 EC @ 20 mL per 10 Liter of water for spraying. No prominent infestation of insect-pests and diseases were observed in the field.

3.12 Crop harvesting

The crops were harvested at the full maturity. Time of maturity was identified when 80-90% grains were matured (turned into straw color). The crop was harvested 124 days after transplanting (DAT) on 27 May, 2013. The crops were cut with sickle by hand. Plot wise crop of 7.5 m^2 (3×2.5) was then bundled separately and brought to the threshing floor for measuring yield contributing characters. The selected hills for different plot were uprooted and tagged separately for final data collection. Grain yield and straw yield were measured at 14% moisture level.

3.13 Data collection on growth and yield parameters

Five plant hills were selected randomly and tagged for data collection. Further data were collected from these hills.

3.13.1 Plant height

The height of plant was recorded in centimeter (cm) at 40, 80 DAT (Days After Transplanting) and at harvest. Data were recorded as the average of 10 plants selected at random from the inner rows of each plot. The height was measured from the ground level to the tip of leaf of the panicle.

3.13.2 *Total number of tillers*

The total number of tillers hill^{-1} was counted at 40, 80 DAT and at harvest. Data on total tillers hill^{-1} were counted from 10 selected hills and average value was recorded.

3.13.3 Total number of effective and non-effective tillers

The total number of effective and non-effective tiller hill^{-1} was counted as the number of panicle and non-panicle bearing plant hill^{-1} at harvest. Data on effective and non effective tillers hill^{-1} were counted from 10 randomly selected hills and average value was recorded.

3.13.4 Leaf length

The length of leaves were also recorded from the sample plants at 40, 80 DAT and at harvest. Collected data were then averaged for further application.

3.13.5 Length of panicle

The length of panicle was measured with a meter scale from 10 selected plants and the average value as per plant was recorded at harvest.

3.13.6 Number of filled and unfilled grains per panicle

The total numbers of filled and unfilled grains per panicle was calculated from selected 10 *panicles* of a plot.

3.13.7 Grain yield

Grain yield obtained from each unit plot was sun-dried and weighed carefully which was converted to t ha^{-1}.

3.13.8 Straw yield

Straw yield obtained from each unit plot was sun-dried and weighed carefully which was converted to kg m^{-2}.

3.13. 9 Harvest index

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

$$\mathbf{HI} = \frac{\textbf{Economic yield}}{\textbf{Biological yield}} \times \mathbf{100}$$

Here,

Economic yield represented as grain yield.

Biological yield represents as total yield (straw yield+ grain yield)

3.14 Chemical analysis of plant samples (grain and straw)

3.14.1 Collection and preparation of plant samples

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

3.14.2 Digestion of samples with sulphuric acid for N determination

For the determination of nitrogen an amount of 0.5 g oven dry, ground sample were taken in a micro Kjeldahl flask. 1.0 g catalyst mixture (K_2SO_4: $CuSO_4$. $5H_2O$: Se in the ratio of 100: 10: 1), and 10 mL conc. H_2SO_4 were added. The flasks were heated at 160^0 C and added 2 mL 30% H_2O_2 then heating was continued at 360^0 C until the digests became clear and colorless. After cooling, the content was taken into a 100 mL volumetric flask and the volume was made up to the mark with de-ionized water. A reagent blank was prepared in a similar manner. Nitrogen in the digest was determined by distilling the digest with 10 N NaOH followed by titration of the distillate trapped in H_3BO_3 indicator solution with 0.01N H_2SO_4 (Jackson, 1973).

3.14.3 Digestion of samples with nitric-perchloric acid for P and K estimation

A sub sample weighing 0.5 g was transferred into a dry, clean 100 mL digestion vessel. 10 mL of di-acid (HNO_3: $HClO_4$ in the ratio 2:1) mixture was added to the flask. After leaving for a while, the flasks were heated at a temperature slowly raised to 200^{0}C. Heating were stopped when the dense white fumes of $HClO_4$ apparent. The content of the flask were boiled until they were became clean and colorless. After cooling, the content was taken into a 50 mL volumetric flask and the volume was made up to the mark with de-ionized water. P and K were determined from this digest by using different standard methods.

3.14.4 Determination of N, P, K from grain and straw samples

3.14.4.1 Nitrogen

Nitrogen was determined by micro Kjeldahl method (Jackson, 1973).

3.14.4.2 Phosphorus

Phosphorus in the digest was determined by using 1 ml of grain sample from 100 mL extract was then determined by developing blue color with reduction of phosphomolybdate complex using ascorbic acid and the color intensity were measured colorimetrically at 660 ήm wavelength and readings were calibrated with the standard P curve (Page *et al.*, 1982).

3.14.4.3 Potassium

Five mL of digest sample was taken in a volumetric flask (50 mL) and diluted up to the mark to make desired concentration so that the flame photometer reading of samples were measured within the range of standard solutions. The concentrations were measured by using standard curves.

3.15 Statistical analysis

The data collected on different parameters were statistically analyzed to obtain the level of significance using the MSTAT-C (Russell, 1986) computer package program. Analysis of variance (ANOVA) was done by applying single factors randomized complete block design (RCBD). The mean differences among the treatments were compared by Duncan's Multiple Range Test (DMRT) test at 5% level of significance.

CHAPTER IV

RESULTS AND DISCUSSION

The results of different growth parameters, yield attributes, yield and nutrient concentrations in the straw and grains of rice are presented in this chapter.

4.1 Plant height

The data on plant height of rice at different growth stages as influenced by cowdung and other inorganic fertilizers under study are presented in Appendix III and Figure 4.1.

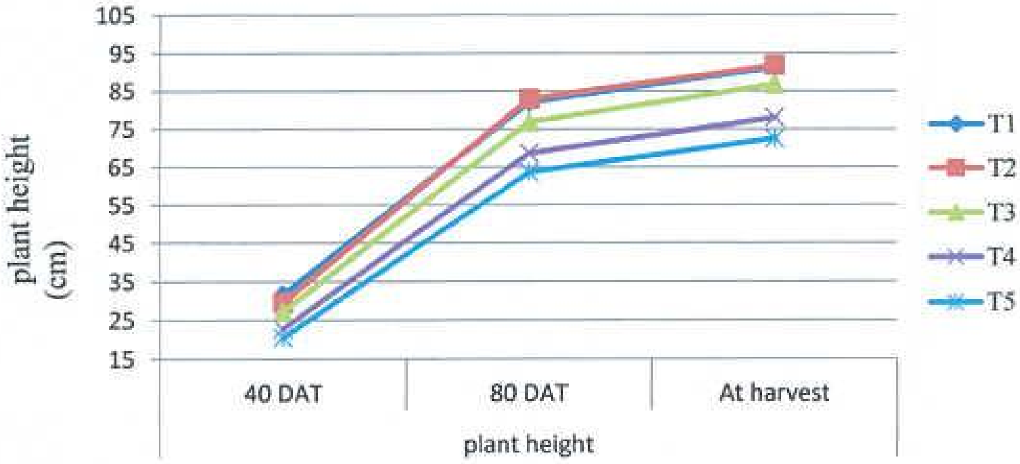
The plant height at 40 days after transplanting (DAT) differed significantly due to different treatments. Significantly higher plant height (31.60 cm) was recorded in T_1 (100% inorganic fertilizers + 0% cowdung and it was statistically similar with the application of T_2: 75 % inorganic fertilizers + 25% cowdung, (29.60 cm). The lowest plant height at 40 DAT (20.55 cm) was found from the treatment using sole manure (T_5: 100% cowdung).

The plant height at 80 days after transplanting (DAT) also differed significantly due to different treatments. The highest plant height (82.97 cm) was recorded in T_2 (75 % inorganic fertilizers + 25% cowdung) and it was closely related to T_1 (100% inorganic fertilizers) (82.13 cm). The lowest plant height at 80 DAT (63.60 cm) was found from the treatment using sole cow dung (T_5: 100% cowdung).

At harvest, the plant height also showed significant variation among the different combinations of organic and inorganic fertilizers. The highest plant height (91.87 cm) was recorded in T_2 (75 % inorganic fertilizers + 25% cowdung and it was statistically similar with the application of T_1: 100 % inorganic fertilizers + 0% cowdung), (91.39 cm). The lowest plant height at harvest (72.57 cm) was found from the treatment using only cowdung manure (T_5: 100% CD). It appears from the result that with increasing dose of cowdung and decrease in chemical fertilizers the plant height decrease which clearly indicated that chemical fertilizers influence the increase in plant height.

It seems from the results that 100% inorganic fertilizer shows the best result during initial stage of plant growth but combination of organic and inorganic fertilizers (T_2) shows best result at later stages than sole use of inorganic and organic fertilizers. Similar findings were found by many scientists while experimenting with various crops. Amin *et al.* (2004) found that increased fertilizer dose of NPK increase plant height. Combination of organic and inorganic fertilizers was found better by Umanah *et al.* (2003) in upland rice and Channabasavanna (2003) in wetland rice than only inorganic fertilizers.

Actually organic fertilizers help increase the organic matter content of soil, thus reducing the bulk density and decreasing compaction. Thus plants get a suitable growing environment which promotes better growth and development.



T_1: 100% Inorganic fertilizers (Recommended dose), T_2: 75 % Inorganic fertilizers + 25% cowdung, T_3: 50 % Inorganic fertilizers + 50% cowdung, T_4: 25 % Inorganic fertilizers + 75% cowdung, T_5: 100% cowdung

Figure 4.1 Effect of different combinations of cowdung and inorganic fertilizers on plant height of BRRI dhan50

4.2 Leaf length

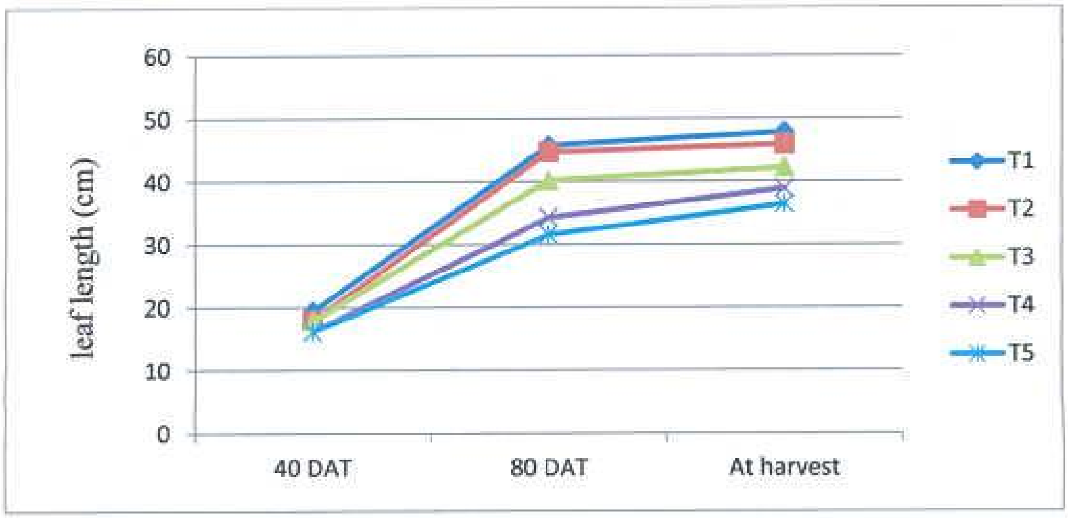
The data on average leaf length of rice at different growth stages as influenced by the different combinations of cowdung and inorganic fertilizers are presented in Appendix IV and Figure 4.2.

The leaf length at 40 DAT differed significantly due to different treatments. The highest leaf length (19.47 cm) was recorded in T_1 (100% inorganic fertilizers). The T_2 and T_3 treatments are statistically similar results on leaf length but lower than that of T_1. The lowest leaf length at 40 DAT (16.19 cm) was found from the treatment using only cowdung (T_5: 100% CD).

The leaf length at 80 DAT also differed significantly due to different treatments. The highest leaf length (45.80 cm) was recorded in T_1 (100% inorganic fertilizers) which was statistically similar to that of T_2 (75 % inorganic fertilizers + 25% cowdung) (44.77 cm) and T_3. The lowest leaf length at 80 DAT (31.60 cm) was found from the treatment using 100% cowdung (T_5).

At harvest, leaf length also showed significant variation among the different combinations of organic and inorganic fertilizers. The highest leaf length (47.90 cm) was recorded in T_1 (100% Inorganic fertilizers) and it was closely followed by T_2 (75 % Inorganic fertilizers + 25% cowdung) (45.97 cm). The lowest leaf length (36.43 cm) was found from the treatment using only cowdung (T_5) at harvest.

From the above results it can be presumed that combinations of organic and inorganic fertilizers significantly increased the leaf length than that of cowdung. Similar types of findings were found by many scientists while experimenting with various crops. Saha *et al.* (2004) found that different fertilizer recommendation models significantly influenced leaf growth.



T_1: 100% Inorganic fertilizers (Recommended dose), T_2: 75 % Inorganic fertilizers + 25% cowdung, T_3: 50 % Inorganic fertilizers + 50% cowdung, T_4: 25 % Inorganic fertilizers + 75% cowdung, T_5: 100% cowdung

Figure 4.2 Effect of different combinations of cowdung and inorganic fertilizers on leaf length of BRRI dhan50

4.3 Number of total tillers

The data on number of total tillers hill^{-1} of rice at different growth stages as influenced by cowdung and other inorganic fertilizers are presented in Appendix V and Figure 4.3.

The number of total tillers hill^{-1} at 40 days after transplanting (DAT) differed significantly due to different treatments. Significantly higher number of total tillers hill^{-1} (8.33) was recorded in T_1 (100% Inorganic fertilizers) which was closely followed by T_2 (75% Inorganic fertilizers + 25% cowdung) (7.40). The lowest number of total tillers hill^{-1} (4.83) at 40 DAT was found from the treatment using 100% cowdung application (T_5).

The number of total tillers hill^{-1} at 80 days after transplanting (DAT) also differed significantly due to different treatments. The highest number of total tillers hill^{-1} (14.53) was recorded in T_1 (100% Inorganic fertilizers) and it was closely followed by T_2 (75% Inorganic fertilizers + 25% cowdung) (13.47). The lowest number of total tillers hill^{-1} (8.07) at 80 DAT was found from the treatment using 100% cowdung application (T_5).

At harvest, the number of total tillers hill^{-1} also showed significant variation among the different combinations of organic and inorganic fertilizers. The highest number of total tillers hill^{-1} (16.82) was recorded in T_1 (100% Inorganic fertilizers). The lowest number of total tillers hill^{-1} (8.82) at harvest was found from the treatment using only 100% cowdung (T_5).

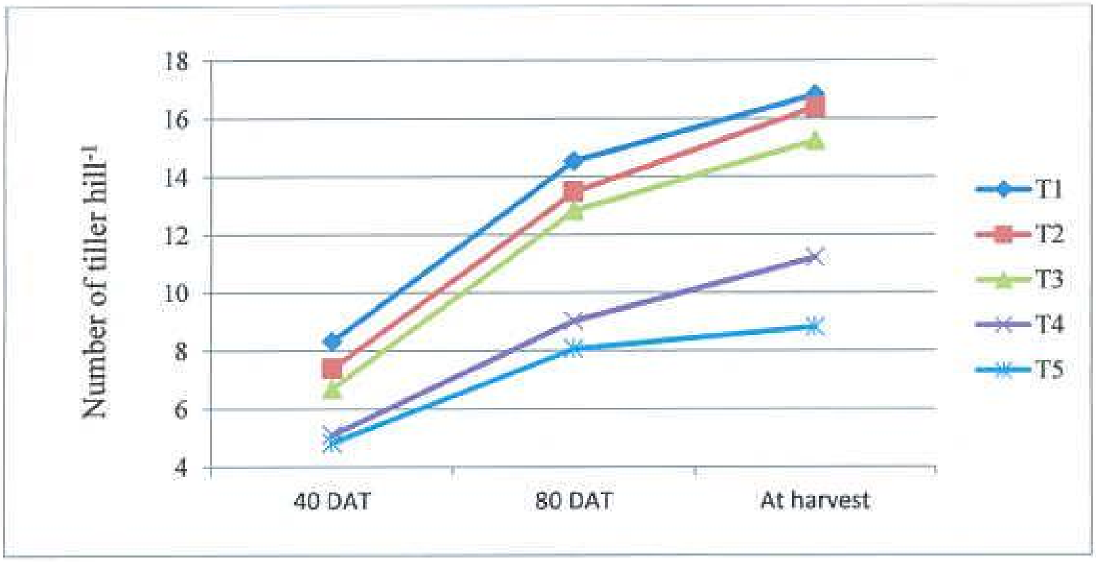


Figure 4.3 Effect of different combinations of cowdung and inorganic fertilizers on number of total tillers hill^{-1} of BRRI dhan50

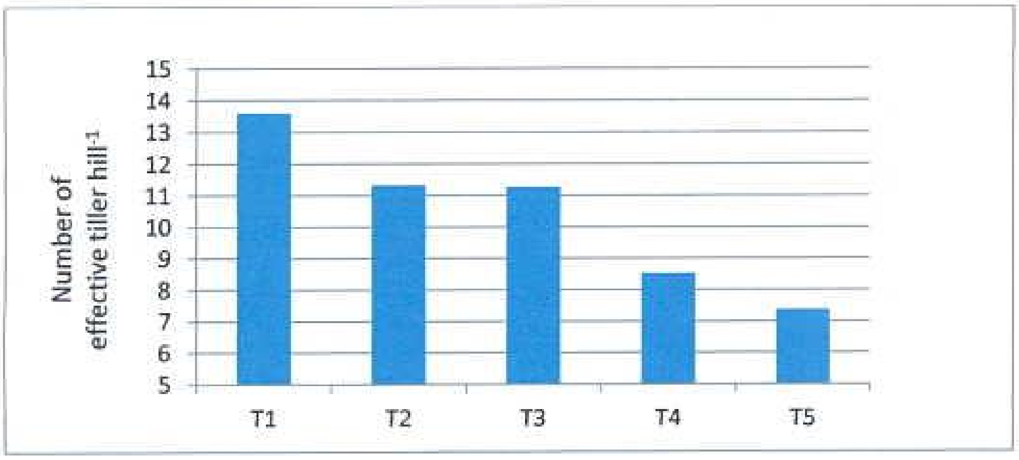
Among the different combination of cowdung and inorganic fertilizers 100 % inorganic fertilizers significantly increased the number of total tillers hill^{-1} than that of sole use of cowdung. Similar sort of findings were found by many scientists while experimenting with various crops. Sadaphal *et al.* (1981) found that increased fertilizer dose of NPK increase number of total tillers plant^{-1}. Ahmed *et al.* (1989) found that application of 120 ppm N with 60 ppm S applied as gypsum had a significant positive effect on number of total tillers plant^{-1}.

4.4 Number of effective tillers

The data on number of effective tillers hill^{-1} of rice at harvest as influenced by organic and inorganic fertilizers are presented in Figure 4.4 and Appendix VI.

The number of effective tillers $hill^{-1}$ at harvest differed significantly due to different treatments. . The highest number of tillers $hill^{-1}$ (13.6) was recorded in T_1 (100% Inorganic fertilizers) followed by T_2 (75% Inorganic fertilizers + 25% cowdung) (11.33) and T_3 (50 % Inorganic fertilizers + 50% CD) (11.27). The lowest number of total tillers $hill^{-1}$ (7.37) was found from the treatment using only 100% cow dung (T_5).

Combinations of organic and inorganic fertilizers and also only 100 % inorganic fertilizers significantly increased the number of effective tillers $plant^{-1}$ than sole use of cowdung. Similar sort of findings were found by many scientists while experimenting with various crops. Amin *et al.* (2004) found that increased fertilizer dose of NPK increase number of total tillers $plant^{-1}$. The combination of organic and inorganic fertilizers was found better for number of effective tillers by Umanah *et al.* (2003) in upland rice and by Channabasavanna (2003) in wetland rice than only inorganic fertilizers.

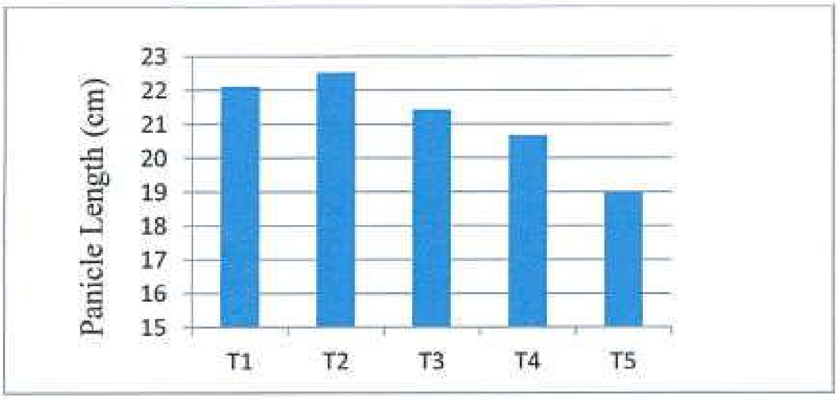


T_1: 100% Inorganic fertilizers (Recommended dose), T_2: 75 % Inorganic fertilizers + 25% cowdung, T_3: 50 % Inorganic fertilizers + 50% cowdung, T_4: 25 % Inorganic fertilizers + 75% cowdung, T_5: 100% cowdung

Figure 4.4 Effect of different combinations of cowdung and inorganic fertilizers on number of effective tillers $hill^{-1}$ of BRRI dhan50

4.5 Panicle length

The panicle length differed significantly due to different treatments (Figure 4.5 and Appendix VI). Significantly higher panicle length (22.52 cm) was recorded in T_2 (75% Inorganic fertilizer + 25% manure) which was statistically similar with T_1 (100% Inorganic fertilizer) (22.12 cm) and T_3 (50 % Inorganic fertilizers + 50% cowdung). T_5 (100% cowdung) (18.99 cm) recorded the lowest panicle length.



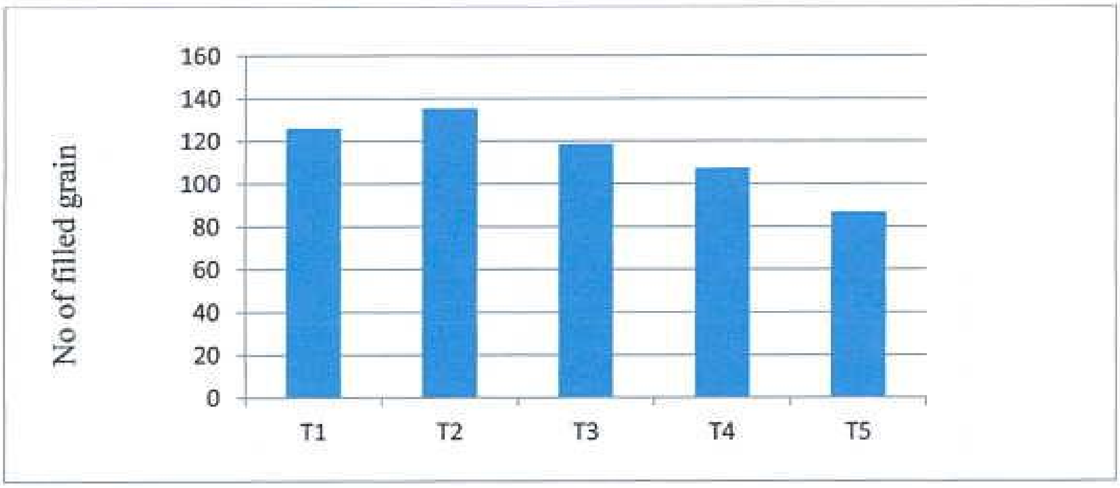
T_1: 100% Inorganic fertilizers (Recommended dose), T_2: 75 % Inorganic fertilizers + 25% cowdung, T_3: 50 % Inorganic fertilizers + 50% cowdung, T_4: 25 % Inorganic fertilizers + 75% cowdung, T_5: 100% cowdung

Figure 4.5 Effect of different combinations of cowdung and inorganic fertilizers on panicle length of BRRI dhan50

Sadaphal *et al.* (1981) showed that length of panicle under 80 and 120 kg N/ha were at par and were significantly superior to the attributes recorded at 40 kg N/ha.

4.6 Filled grain

The filled grain panicle^{-1} differed significantly due to different combinations of organic and inorganic fertilizer (Figure 4.6 and Appendix VII). Significantly higher number of filled grain panicle $^{-1}$ (135.33) was recorded in T_2 (75% Inorganic fertilizers + 25% cowdung) and followed by T_1 (100% Inorganic fertilizer) (126.07) and T_3 (118.67). The lowest number of filled grain panicle $^{-1}$ (86.8) was found from the treatment using cowdung (T_5) only.



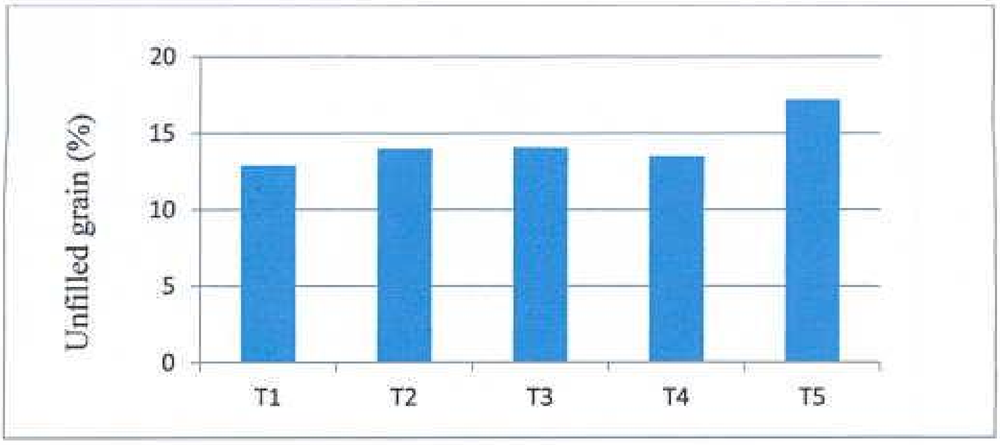
T_1: 100% Inorganic fertilizers (Recommended dose), T_2: 75 % Inorganic fertilizers + 25% cowdung, T_3: 50 % Inorganic fertilizers + 50% cowdung, T_4: 25 % Inorganic fertilizers + 75% cowdung, T_5: 100% cowdung

Figure 4.6 Effect of different combinations of cowdung and inorganic fertilizers on number of filled grain panicle $^{-1}$ of BRRI dhan50

Bhuvaneswari *et al.* (2007) found that number of filled grains per panicle increased with S levels and highest grain (5750 kg per ha) and straw (7300 kg per ha) yield was noticed with 40 kg S per ha plus FYM at the rate of 12.5 t per ha and decreased thereafter with further increase in sulphur level.

4.7 Unfilled grain

Percent unfilled grain panicle^{-1} showed no significant result among the different combinations of organic and inorganic fertilizer (Figure 4.7 and Appendix VII). The lowest percentage of unfilled grain panicle^{-1} (12.91 %) was recorded in T_1 (100% inorganic fertilizers). The highest percentage of unfilled grain panicle^{-1} (17.18 %) was found from the treatment using sole cowdung (T_5).

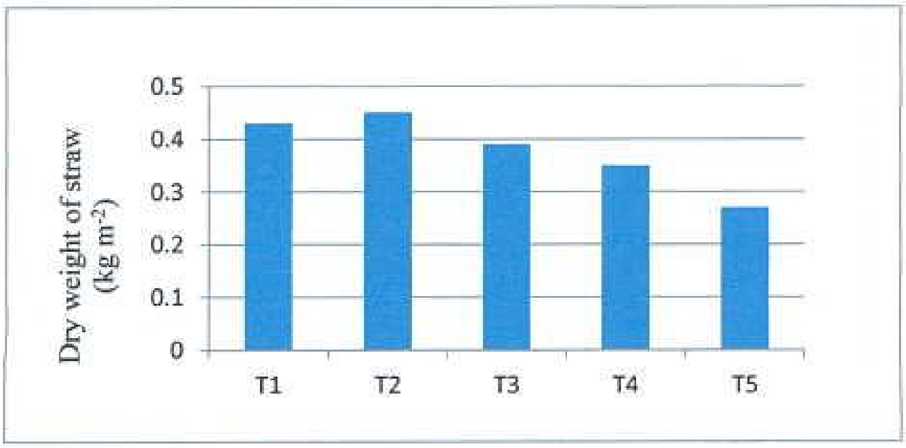


T_1: 100% Inorganic fertilizers (Recommended dose), T_2: 75 % Inorganic fertilizers + 25% cowdung, T_3: 50 % Inorganic fertilizers + 50% cowdung, T_4: 25 % Inorganic fertilizers + 75% cowdung, T_5: 100% cowdung

Figure 4.7 Effect of different combinations of cowdung and inorganic fertilizers on unfilled grain (%) hill^{-1} of BRRI dhan50

4.8 Dry weight of straw

Dry weight of straw (kg m^{-2}) differed significantly among the different combinations of organic and inorganic fertilizers (Figure 4.8 and Appendix VIII). Significantly highest dry weight of straw (0.45 kg m^{-2}) was recorded in T_2 (75% inorganic fertilizers + 25 % cowdung) and it was followed by T_1 (100% Inorganic fertilizers) and T_3 (50 % Inorganic fertilizers + 50% cowdung). Among the treatments, the lowest dry weight of straw (0.27 kg m^{-2}) was found from the treatment using only cowdung (T_5).

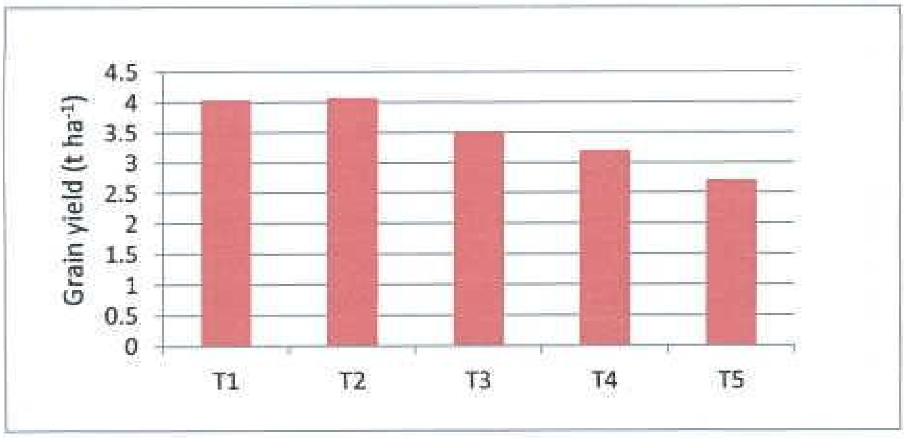


T_1: 100% Inorganic fertilizers (Recommended dose), T_2: 75 % Inorganic fertilizers + 25% cowdung, T_3: 50 % Inorganic fertilizers + 50% cowdung, T_4: 25 % Inorganic fertilizers + 75% cowdung, T_5: 100% cowdung

Figure 4.8 Effect of different combinations of cowdung and inorganic fertilizers on dry weight of straw of BRRI dhan50

4.9 Grain yield

Grain yield (t ha^{-1}) differed significantly among the different combination of organic and inorganic fertilizers (Figure 4.9 and Appendix VIII). Significantly higher grain yield (4.07 t ha^{-1}) was recorded in T_2 (75% Inorganic fertilizers + 25% CD) which was statistically similar with T_1 (100% Inorganic fertilizers) (4.04 t ha^{-1}). The lowest grain yield (2.71 t ha^{-1}) was found from the treatment using sole cowdung (T_5).



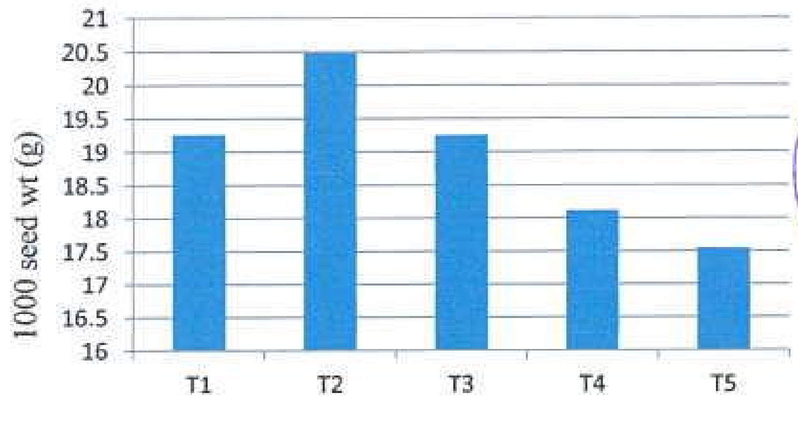
T_1: 100% Inorganic fertilizers (Recommended dose), T_2: 75 % Inorganic fertilizers + 25% cowdung, T_3: 50 % Inorganic fertilizers + 50% cowdung, T_4: 25 % Inorganic fertilizers + 75% cowdung, T_5: 100% cowdung

Figure 4.9 Effect of different combinations of cowdung and inorganic fertilizers on grain yield (t ha^{-1}) of BRRI dhan50

Sarker *et al.* (2001) observed that application of nitrogen increased grain and straw yields significantly. Islam *et al.* (2008) found that grain yield influenced significantly due to application of different rates of nutrients and 60-19-36 kg/ha NPK maximized the yield of T. *aman* rice varieties. Vanaja and Raju (2002) found that combinations of chemical fertilizer with poultry manure (PM) 2 t/ ha gave highest grain and straw yield. Channabasavanna *(2003)* found that grain yield increased with each increment of poultry manure application and was maximuma at 3 t poultry manure/ha.

4.10 Thousand Seed weight

1000 seed weight (g) of BRRI Dhan 50 showed no significant differences among the different combinations of cowdung and inorganic fertilizers (Figure 4.10 and Appendix VIII). The highest weight of 1000 grain (20.48) was recorded in T_2 (75% Inorganic fertilizers +25 % CD). Among the treatments, the lowest weight of 1000 seed (17.54 g) was found from the treatment using sole cowdung (T_5).



T_1: 100% Inorganic fertilizers (Recommended dose), T_2: 75 % Inorganic fertilizers + 25% cowdung, T_3: 50 % Inorganic fertilizers + 50% cowdung, T_4: 25 % Inorganic fertilizers + 75% cowdung, T_5: 100% cowdung

Figure 4.10 Effect of different combinations of cowdung and inorganic fertilizers on 1000 seed weight (g) of BRRI dhan50

4.11 Harvest index

Harvest index showed significant result among different combinations of organic and inorganic fertilizer (Appendix VII). The highest harvest index (45.45 %) was recorded in T_1 (100% inorganic fertilizers). The lowest harvest index (42.72 %) was found from the treatment using 50% Inorganic fertilizer +50 % cowdung (T_3).

4.12 Nutrient content in grain

4.12.1 N content in grain

N content in grain (%) differed significantly among the different combinations of organic and inorganic fertilizers (Table 4.1). Significantly highest N content in grain (1.353%) was recorded in T_1 (100% Inorganic fertilizers) which was closely followed by T_2 (75 % Inorganic fertilizers + 25% cowdung) and T_3 (1.32%). The lowest N content in grain (0.967%) was found from the treatment using cowdung only (T_5). Bari *et al.* (2013) found that nutrient content in grain increased while organic manure combined with inorganic fertilizers. Sharma and Mitra (1991) reported a significant increase in N, P and K content and also the nutritional status of soil with 5 t ha^{-1} of FYM of rice based cropping system.

4.12.2 P content in grain

P content in grain (%) differed significantly among the different combinations of organic and inorganic fertilizer (Table 4.1). The highest P content (0.363%) was recorded in T_1 (100% Inorganic fertilizers). The lowest P content (0.247%) was found from the treatment using cowdung manure only. These results agree with the results of Bari *et al.* (2013). Sharma and Mitra (1991) reported a significant increase in N, P and K content and also the nutritional status of soil with 5 t ha^{-1} of FYM of rice based cropping system.

4.12.3 K content in grain

K content in grain (%) differed significantly among the different combinations of organic and inorganic fertilizer (Table 4.1). Significantly higher K content (1.1221%) was recorded in T_1

(100% inorganic fertilizers) which was statistically identical with T_2 (75% Inorganic fertilizers + 25% cowdung). The lowest K content (0.833%) was found from the treatment using cow dung manure only. These results have the conformity with the results of Bari *et al.* (2013). Sharma and Mitra (1991) also reported a significant increase in N, P and K content and also the nutritional status of soil with 5 t ha^{-1} of FYM of rice based cropping system.

Table 4.1 Effect of different combinations of cowdung and inorganic fertilizers on N, P and K content in grain (%) of BRRI dhan50

Treatment	% in Grain		
	N	P	K
T_1	**1.353 a**	**0.363 a**	**1.221 a**
T_2	1.320 a	0.350 b	1.221 a
T_3	1.303 a	0.313 c	1.137 a
T_4	1.100 b	0.257 d	0.843 b
T_5	0.967 c	0.247 e	0.833 b
$LSD_{0.05}$	0.08664	0.0087	0.1225
CV %	2.41	4.6	3.93
Significance level	**	**	**

* - Significant at 5 % level, ** - Significant at 1 % level, ns- non-significant

4.13 Nutrient content in straw

4.13.1 N content in straw

N content in straw (%) differed significantly among the different combinations of organic and inorganic fertilizer (Table 4.2). Significantly higher N content (0.327%) was recorded in T_2 (75% Inorganic fertilizers + 25% cowdung) which was closely followed by T_1 (100% Inorganic fertilizers) (0.322%). The lowest N content (0.269%) was found from the treatment using cowdung only (T_5). These results have the conformity with the results of Bari *et al.* (2013). Sharma and Mitra (1991) also reported a significant increase in N, P and K content and also the nutritional status of soil with 5 t ha^{-1} of FYM of rice based cropping system.

4.13.2 P content in straw

P content in straw (%) differed significantly among the different combinations of organic and inorganic fertilizers (Table 4.2). Though higher P content (0.239%) was recorded in T_1 (100%

inorganic fertilizers) which was closely followed by T_2 (75% Inorganic fertilizers + 25% cowdung) (0.233%). The lowest P content (0.182%) was found from the treatment using T_4 (25% Inorganic fertilizers + 75% cowdung) which was statistically similar with T_5 (100% cowdung). These results agree with the results of Bari *et al.* (2013). Sharma and Mitra (1991) also reported a significant increase in N, P and K content and also the nutritional status of soil with 5 t ha^{-1} of FYM of rice based cropping system.

4.13.3 K content in straw

K content (%) in straw differed significantly among the different combinations of organic and inorganic fertilizers (Table 4.2). Significantly higher K content (1.313%) was recorded in T_2 (75% Inorganic fertilizers + 25% cowdung) which was statistically identical with T_1 (100% Inorganic fertilizers) (1.309%). The lowest K content (1.001%) was found from the treatment using cowdung manure only (T_5). These results have the conformity with the results of Bari *et al.* (2013). Sharma and Mitra (1991) also reported a significant increase in N, P and K content and also the nutritional status of soil with 5 t ha^{-1} of FYM of rice based cropping system.

Table 4.2 Effect of different combinations of cowdung and inorganic fertilizers on N, P and K content in straw (%) of BRRI dhan50

Treatment	% in Straw		
	N	P	K
T_1	0.32 a	**0.239 a**	1.309 a
T_2	**0.327 a**	0.233 a	**1.313 a**
T_3	0.304 b	0.195 b	1.177 b
T_4	0.281 c	**0.182 c**	1.069 bc
T_5	**0.269 d**	0.184 c	**1.001 c**
$LSD_{0.05}$	0.005995	0.008664	0.1225
CV %	6.83	5.67	3.98
Significance level	*	**	**

* - Significant at 5 % level, ** - Significant at 1 % level, ns- non-significant

CHAPTER V

SUMARRY AND CONCLUTION

The experiment was conducted at the Agronomy field laboratory of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from December'12 to May 2013 to study the effect of cowdung and chemical fertilizers on growth and yield of aromatic rice BRRI Dhan 50. The seeds of rice (BRRI dhan50) was collected from Bangladesh Rice Research Institute (BRRI), Gazipur. Five different fertilizer levels T_1: 100% Inorganic fertilizers (Recommended dose), T_2: 75 % Inorganic fertilizers + 25% cowdung, T_3: 50 % Inorganic fertilizers + 50% cowdung, T_4: 25 % Inorganic fertilizers + 75% cowdung, T_5: 100% cowdung were used as treatments in the experiment. The experiment was designed with 5 treatments, laid out in a randomized complete block design (RCBD) with 3 replications. Each plot size was 3 m x 2.5 m.

The seeds were sown at December 11, 2012 in seedbed. Forty five days old seedlings of BRRI dhan50 were carefully uprooted from the seedling nursery and transplanted on January 25, 2013 in well puddled plot. All recommended cultural practices were followed to grow the crop.

Frequent samplings were done at 40 (February 5, 2013) and 80 (April 15, 2013) days after transplanting (DAS) and at harvest (May 27, 2013) for counting plant height, number of leaves plant^{-1} and number of tiller hill^{-1}. The crop was harvested at maturity on 27 May, 2013. Grain yields were recorded at 14% moisture content. The plant samples were chemically analyzed for N, P and K content. All the data were statistically analyzed by MSTAT-C programme and the differences between treatments means were adjudged by Duncan's Multiple Range Test (DMRT).

Significant variation was found in growth and yield parameters and nutrient content of rice due to the various combinations of organic and inorganic fertilizers. At 40 DAT, the highest plant height (31.60 cm) was recorded in T_1 (100% Inorganic fertilizer + 0% cowdung. At 80 DAT, the highest plant height (82.97 cm) was recorded in T_2 (75 % Inorganic fertilizer + 25% cowdung and it was closely followed by T_1 (82.13 cm). At harvest, the highest plant height (91.87 cm) was recorded in T_2. The lowest plant height was found all of the stages by the treatment using sole cowdung manure (T_5: 100% cowdung). At 40 DAT, higher leaf length (19.47 cm) was recorded in T_1 (100% Inorganic fertilizers). At 80 DAT, the highest leaf length (45.80 cm) was recorded in T_1 which was statistically identical with T_2 (44.77 cm). At harvest the highest leaf length (47.90 cm) was recorded in T_1 and it was closely followed by T_2 (45.97 cm). The lowest leaf length all of the growing stages was found from the treatment using only cowdung (T_5).

At 40 DAT, the highest numbers of total tillers hill^{-1} (8.33) was recorded in T_1 (100% Inorganic fertilizers). At 80 DAT, the highest numbers of total tillers plant^{-1} (14.53) was recorded in T_1. At harvest highest number of total tillers hill^{-1} (16.82) was recorded in T_1 and it was closely followed by T_2 (16.38) and T_3 (15.24). T_5 showed inferior result all of the cases. The highest panicle length (22.52 cm) was recorded in T_2 and it was statistically similar with T_1 (22.12 cm). T_5 (18.99 cm) recorded the lowest panicle length.

Significantly higher number of filled grain panicle^{-1} (135.33) was recorded in T_2 (75% Inorganic fertilizers + 25% cowdung) and it was closely followed by T_1 (100% Inorganic fertilizers) (126.07). The lowest number of filled grain panicle^{-1} (86.8) was found from the treatment using sole cow dung manure (T_5). Percent unfilled filled grain panicle^{-1} showed no significant result. The lowest percentage of unfilled grain panicle^{-1} (12.91 %) was recorded in T_1 (100% inorganic fertilizers). The highest percentage of unfilled grain panicle^{-1} (17.18 %) was found from the treatment using sole cow dung manure (T_5).

Significantly the highest dry weight of straw (0.45 kg m^{-2}) was recorded in T_2 (75% Inorganic fertilizers + 25 % cowdung). Among the treatments, the lowest dry weight of straw (0.27 kg m^{-2}) was found from the treatment using only cowdung (T_5). Significantly highest grain yield (4.07 t ha^{-1}) was recorded in T_2 (75% Inorganic fertilizers + 25% cowdung) which was statistically similar with T_1 (4.04 t ha^{-1}). The lowest grain yield (2.71 t ha^{-1}) was found from the treatment using sole cowdung (T_5). 1000 seed weight (g) of BRRI dhan50 showed no significant differences. The highest weight of 1000 filled grain (20.48 g) was recorded in T_2 and the lowest weight of 1000 seed (17.54 g) was found by using T_5.

Significantly higher N, P and K content (1.353%, 0.363% and 1.1221% respectively) in grain was recorded in T_1 (100% Inorganic fertilizers) which was statistically similar with T_2 and T_3. The lowest value of N, P and K content in grain (0.967%, 0.247% and 0.833% respectably) was found from the treatment using cowdung only (T_5). Significantly higher N and K content of straw (0.327% and 1.313%) was recorded in T_2 (75% Inorganic fertilizers + 25% cowdung) which was statistically similar with T_1. The lowest N and K content (0.269% and 1.001%) was found from the treatment using cowdung only (T_5). Though higher P content (0.239%) was recorded in T_1 (100% Inorganic fertilizer), the lowest P content (0.182%) was found from the treatment using T_4 (25% Inorganic fertilizers + 75% cowdung).

From the above results it can be concluded that combination of cowdung and inorganic fertilizer is more productive compare to sole use of organic manure or inorganic fertilizers. Most of the cases of growth parameters recorded it was observed that 100% inorganic fertilizer showed best results over organic fertilizer or combination of organic and inorganic fertilizer. But superior results were found by using combination of cowdung (25%) and inorganic fertilizers (75%) (T_2) for different yield parameters than sole use of cowdung.

It is true that sustainable production of crops cannot be maintained by using only chemical fertilizers and similarly it is also not possible to obtain higher crop yield by using organic manure alone. So use of organic manure in integration with inorganic fertilizers is very important in improving soil fertility and crop productivity. By combining the both, we may be able to reduce the doses of inorganic fertilizers. It is evident from the results that, in case of BRRI dhan50, 75% inorganic fertilizer + 25% cowdung gave statistically similar growth, yield contributing characters, yield and nutrient content with 100% inorganic fertilizers. So, if we use 25% or 4-5 ton/ha CD manure +75% inorganic fertilizers, it will allow us to lessen 25% inorganic fertilizer at least.

Suggestion for further research

- Studies with different doses of other organic manure (poultry manure, green manure, leaf litter, FYM, compost etc) should be performed
- Research works may be initiated on the long term effects of organic and their residual effect on succeeding crop
- Other improved rice cultivars may be tested under such fertilizer combinations

CHAPTER VI

REFERENCES

Ahmed, I. U., Faiz, S. M. A., Rahman, S., Anwar Hussain, A. K. M., and Bhuiyan, N. I., 1989. Effect of nitrogen and residual sulphur on the growth, yield and N-S composition of rice. *J. Indian. Soc. Soil Sci.*, 37: 323-327.

Amin, M., Khan, M. A., Khan, E. A. and Ramzan, M. 2004. Effect of Increased Plant Density and Fertilizer Dose on the Yield of Rice Variety IR-6. *J. Res. Sci.*, 2004, 15(1), 09-16.

Aruna, P. and Reddy, G. P. 2011. Integrated nitrogen management in aerobic rice (*Oryza sativa* L.). *J. Res. ANGRAU*. 39(1/2): 69-71.

Asif, M., Aslam, M., Jabbar, A., Rafique, K., Babar, M.R. and Ehsanullah. 2000. Panicle Structure, Kernel Quality and Yield of Fine Rice as Influenced by NPK Rates and Split Nitrogen application. *Int. J. Agri. Biol.*, 2 (4): 306-308.

Asim, B. and Reddy, P.R. 2010. Effect of integrated nutrient management on soil available nutrient, plant nutrient uptake, and yield of aerobic paddy (Oryza sativa L.). *J. Interacade*. 14(4): 463-469.

Aulakh, M. S. 2010. Integrated nutrient management for sustainable crop production, improving crop quality and soil health, and minimizing environmental pollution. *Scienti. Agril. Sinica*. 44(12): 2484-2494 .

Banik, P. and Sharma, R.C. 2008. Effects of integrated nutrient management with mulching on rice (Oryza sativa) based cropping systems in rain fed eastern plateau area. *Indian J. Agril. Sci.* 78(3): 240-243.

Bari, A.S.M.F., Khan M A., Sultana S., Hasanuzzaman M., Sultana N.. 2013. Effect Of Various Inorganic Fertilizer And Manure With Different Water Managements On Yield And Yield Attributes Of Boro Rice. *J. Expt. Biosci*. 4 (2): 1-6.

Belefant and Miller. 2007. Poultry litter induces tillering in rice. *J. Sustain. Agil*. 31(1): 151-160.

Bhabesh, G., Barua, N. G. 2010. Effect of integrated nutrient management on growth, yield of crops and availability of nutrients in inceptisol under rainfed rice (Oryza sativa) at Asom. *Indian J. Agril. Sci*. 80(9): 824-828.

Bhuiyan, N. I. 1994. Crop production trends and need of sustainability in agriculture. Paper presented at the workshop. Integrated Nutrient Management for Sustainable Agriculture held at SRDI, Dhaka, Bangladesh in June 26-28. 1994.

Bhuvaneswari, R., Sriramachandrasekharan and Ravichandran, M., 2007, Integrated use of farmyard manure and sulfur for the growth and yield rice. *Oryza,* 44(2) : 169-171.

Brady, N. C. 1999. The nature and properties of soils. Prentice Hall of India Pvt. Ltd. Delhi.

Channabasavanna, A. S. 2003. Efficient utilization of poultry manure with inorganic fertilizer in wet land rice. J. *Maharashtra Agric. Univer*. 27(3): 237-238.

Channbasavana, A. S. and Biradar, D. P. 2001. Response of irrigated rice to the application of poultry manure and inorganic fertilizers N, P and K in Karnataka, India. *Int. Rice Res. Newsl*. 26(2): 64-65.

Chaudhary, S. K., Singh, J. P. and Jha, S. 2011. Effect of integrated nitrogen management on yield, quality and nutrient uptake of rice (Oryza sativa) under different dates of planting. *Indian J. Agron*. 56(3): 228-231.

Dahipale, A. V., Thakre, G. V. and Kubde, K.J. 2004. Yield and yield parameters of scented rice as influenced by integrated nutrient management. *Annals Plant Physiol*. 18 (2): 207 – 208.

Delog R.E., Slaton N.A., Anders M.M., and Johnson J.R.W.F., 2002. Phosphorus fertilization and previous crop effects nutrient uptake and grain yield of wheat. Arkansas soil Fertility Studies.1:28-3

Deng, W; Qing, X. G. and Yang,Y. 2010. Effects of applying organic fertilizer on rice lodging resistance and yield. *Agri. Sci. Tech. Hunan*. 11(2): 98-101.

Eneji, A. E., Honna, T. and Yamamoto, S. 2001. Manuring effect on rice grain yield and extractable trace elements in soils. *J. Plant Nutrition*. 24 (7): 967-977.

FAO (Food and Agricultural Organization) 1999. Yearbook of Production, FAO Statistics Division. Pp. 605-607.

FAO (Food and Agriculture Organization), 2004. Selected indicators of FAO in Asia-pacific region corporate document repository. Pp. 87- 91.

Guan, G., Tu, S. X., Yang, J. C., Zhang, J. F. and Yang, L. 2011. A field study on effects of nitrogen fertilization modes on nutrient uptake, crop yield and soil biological properties in rice-wheat rotation system. *Agril. Sci. China*. 10(8): 1254-1261.

Gupta, R. K., Yadvinder, S., Ladha, J. K; Bijay, S., Jagmohan, S., Gurpreet, Singh. and Pathak. 2007. Yield and phosphorus transformations in a rice-wheat system with crop residue and phosphorus management. *Soil Sci. Soci. Ameri J.* 71(5): 1500-1507.

Haq, M.T., Sattar, M.A., Hossain, M.M. and Hasan, M.M. 2002. Effects of Fertilizers and Pesticides on Growth and yield of Rice. *Online J. Biolo. Sci.* 2(2): 84-88.

http://knowledgebankbrri.org/Rice_Production_Training_Manual/Day_1 Module _2 / BoroFactsheet13-BRRIdhan50.pdf. Accessed on 08/12/2013.

Islam M. S., Howlader M. I. A., Rafiquzzaman S., Bashar H. M. K. and Al-Mamun M. H. 2008a. Yield Response of Chili and T. Aman Rice to NPK Fertilizers in Ganges Tidal Floodplain. *J. Soil. Nature*. 2(1): 07-13.

Islam, A. K. M. M., Sarkar, M. A. R. and Islam, N. 2007. Effect of spacing and nutrient managementbin SRI method on the yield components and yield of transplanted aman rice. *Balgladesh J. Crop Sci.* 18(1): 1-6.

Islam, M.S., Hossain, M.A., Choudhury, M.A.H., and Hannan, M.A. 2008b. Effect of nitrogen and transplanting date on yield and yield components of aromatic rice. *J. Bangladesh Agril. Univ.* 6(2): 291-296.

Jackson, M L. 1973. Soil chemical analysis. Prentice-Hall of India, Pvt. Ltd.. pp. 326-338.

Jha, S. K., Tripthi, R. S., Sanidiv. and Malaiya. 2004. Influence of interigrated nutrient management practices on growth and yield of scented rice (Oryza sativa). *World J. Agril. Sci.* 7(3): 351-358.

Kumar, M. D., Anwarulla, M.S. and Shadakshari, Y. G. 2009. Integrated nutrient management in transplanted rice genotypes. Ecology. 27(3): 1002-1005.

Kundu, D. K., Chaudhari, S. K. and Ravender, S. 2007. Effect of soil puddling and potassium application on rice in a Canal Irrigation Command of Orissa. *J. Indian Socie. Soil Sci.* 55(1): 84-85.

Lim, Y. C., Yoon, S. H., Jung, M. W., Kim, W. H., Kim, J. G., Lee, J. Ky., Park, N. G. and Yook,W. B. 2007. Effect of livestock manure application on the productivity of whole crop rice, feed value and soil fertility. *J. Korean Socie. Grassland Sci.* 27(4): 287-29.

Lu, X., Yang, Z. X., Xu, B. and Zhu, Y. Y. 2011. Effects of different nitrogen fertilizer use level on yield component and grain yield in rice. *J. Yunnan Agril. Univ.* 26(3): 376-381, 388.

Mahavisha, K. Reddy, A. S. and Rekha, K. B. 2004. Effect of organic sources of plant nutrients in conjunction with chemical fertilizers on growth, yield and quality of rice. *Resear. Crops.* 5 (2/3): 159-161.

Maurya, D.M. and Yadav, M.P.1987. Performace of overage seedlings at different N levels. *Inter. Rice Res. Newslet.* 12 (2): 9 p.

Meelu, O. P. and Singh, Y. 1991. Integrated use of fertilizers and organic manure for higher returns. *Prog. Fmg. Punjab Agric. Univ.* 27: 3-4.

Miah, M.A.M., Ishaque, M. and Saha, P.K. 2006. Integrated nutrient management for improving soil health and rice production. Proc. of Twenty First BRRI-DAE joint workshops on bridging the rice yield gap for food security. BRRI, Gazipur, Bangladesh, 19-21 September, paper 11: 1-15.

Miah, M. A. M., Shah, A. L. and Ishaque, M. 2004. Nutrient management for different rice ecosystem. Proc. of the workshop on modern rice cultivation in Bangladesh. BRRI, Gazipur, Bangladesh. 19-21. April. 159: 179-199.

Miah, M. M. U. 1994. Prospects and problems of organic farming in Bangladesh. Paper presented at the workshop on Integrated Nutrient Management for Sustainable Agriculture. Soil Resource Dev. Inst., Dhaka, June 26-28, 1994.

MOA (Ministry of Agriculture), 2001. Bangladesh Food and Agriculture. World Food Summit., 13-17 Nov. Rome, Italy.

Muhammad, U., Ehsan, U., Warriach, E. A., Muhammad, F. and Amir, L. 2004. Effect of organic and inorganic manures on growth and yield of rice variety 'Basmati 2000". *Intl. J. Agri. Biol.* 5(4): 481-483.

Myint., Yamakawa., Kajihara. and Zenmyo. 2010. Application of different organic and mineral fertilizers on the growth, yield and nutrient accumulation of rice in a japanese ordinary paddy field. *Sci. World J.* Vol 5 (No 2).

Nambiar, K.K.M. 1991. Long-term fertility effects on wheat productivity. In wheat for the Non-traditional Warm areas, Saunders D.A. ed., CIMMYT. p 516-521.

Ndaeyo, N.U., Iboko, K.U., Harry, G. I. and Edem, S. O. 2008. Growth and yield performances of some upland rice (*oryza sativa* l.) cultivars as influenced by varied rates of NPK (15:15:15) fertilizer on an ultisol. *J. Trop. Agric. Food. Env. Ext.* 7 (3): 249 – 255.

Ogbodo, E. N. 2005. Response of rice (Oriza sativa) to organic and inorganic manures in an ultisol, in Abakaliki, Ebonyi State, Nigeria. *J. Agri. Forestry and Soc.Sci.* 3(1): 9-14.

Page, A. L., Miller, R. H. and Keeney, D. R. (ed). 1982. Methods of analysis part 2, Chemical and Microbiological Properties, Second Edition American Society of Agronomy, Inc., Soil Science Society of American Inc. Madson, Wisconsin, USA. p p. 403-430.

Pandey, N., Verma, A. K., Anurag. and Tripathi, R. S. 2007. Integrated nutrient management in transplanted hybrid rice (Oryza sativa). *Indian J. Agron.* 52(1): 40-42.

Rahman, H.M., Hashem, M.A. and Haque, M.A., 2006. Reduction of urea fertilizer using poultry manure and raintree leaf litter in rice production. *J. Bangladesh Agril. Univ.* 4(1): 57-60.

Rasheed, M., Asif, M. and Ghafoor, A. 2003. Yield and yield attributes of fine rice BAS-385 as affected by different NP levels on farmer's field. *Pak. J. Agric. Sci.* Vol 40 (1-2).

Raun, W. R. and Johnson. G.V. 1991. Improving nitrogen use efficiency for cereal production. *Ind. J. Agron.* 91(3): 357.

Reddy, A. S., Mahavishnan, K. and Rekha, K. B. 2004. Effect of organic sources of plants nutrients in conjunction with fertilizers on growth, yield and quality of rice. Res.Crops. 5(2/3): 159-161.

Reddy, B. G. M., Pattar, P. S. and Kuchanur, P. H. 2005. Response of rice to poultry manure and graded levels of NPK under irrigated conditions. Oryza-. 2005; 42(2): 109-111.

Russell D.F. 1986. MSTAT-C Pakage Programme. Crop and Soil Science Department, Michigan University, USA.

Sadaphal, M. N., Dayanand A. and Singh. T. 1981. relative efficieny of different grades of urea and nitrogen rates for rice. *Indian J. Agron.* 26 (4): 428-431.

Saha, P.K., Saleque, M.A., Panaullah, G.M. and Miah, M.A.M. 2004. Comparison of the fertilizer recommendation Models for low land rice. *Bangladesh J. Soil Sci.* 30 (1-2): 31-37.

Sangeetha, S P. and Balakrishnan, A. 2011. Effect of organically supplemented N on yield of rice (Oryza sativa L.) *J. of Crop Weed.* 7(1): 86-88.

Sarkar, M. A. R., Rahman, M. H. and Islam, A. K. M. M. 2007. Effect of combination of poultry manure and inorganic fertilizer on yield and yield contributing characters of transplant aman rice. *Bangladesh J. Crop. sci.* 18(1): 7-12.

Sarker, A. B. S., Kojims, N. and Amano, Y. 2001. Effect of nitrogen rates on Japonica and Indica rice under irrigated Ecosystem. *Bangladesh J. Sci. Tech.* 3 (1): 49-58.

Sarvanan, A., Velu V. and Ramanath, K.M. 1987. Effect of combined application of bioorganic and chemical fertilizers on physical properties, nitrogen transformation and yield of rice in submerged soils. *Oryza:* 1-6.

Sharma, M.K. and Mitra, C. 1991. Nutrient content and also the nutritional status of soil with FYM of rice based cropping system. *Indian J. Agron.* 36 (3): 132-136.

Singh, M.K., Thakur, R., Verma, U.N., Upasani, R.R. and Pal, S.K., 2000. Effect of planting time and nitrogen on production potential of Basmati rice cultivation in Bhiar Plateau. *Indian J. Agron.* 45(2), pp. 300-303.

Singh, R. Singh, S. and Prasad, K. 2001. Effect of fertilizer, FYM and row spacing on transplanted rice. *Crop Res. (Hisar).* 22 (2): 296-299.

Singh, S. K., Sabhajeet., Ram, U. S. and Urkurkar, J. S. 2010. Effect of chemical fertilizers and integrated nutrient management practices on growth and yield of rice (Oryza sativa L.) in Inceptisol. *Environ. Ecol.* 28(4): 2235-2237.

Singh, V.K., Dwivedi, B.S., Shukla, A.K. and Yadav, R.L. 2003. Effects of nitrogen and phosphorus fertilization on the growth and yield of rice (*Oryza sativa*) and wheat

(*Triticum aestivum*) as influenced by the inclusion of forage cowpea (*Vigna unguiculata*) in rice-wheat system. *Indian J. Agril. Sci.* 73 (9): 482-489.

Surendra, S., Singh, R. N., Janardan, P. and Singh, B. P. 2006. Effect of integrated nutrient management on yield and uptake of nutrients by rice and soil fertility in rainfed uplands. *J Indian Socie. Soil Sci*. 54(3): 327-330.

Taki, N., Asano, M., Kumagai, C., Hatanaka, A. and Saito, K. 2008. Organic fertilizer application increases panicle length and number of grains per panicle in rice. *Japanese J. Soil Sci. Plant Nutri*. 79(2): 147-154.

Tishe, D. L., Wang, K. R., Xie, X. L. and Yin, C.M. 2006. Effects of application of N fertilizer and incorporation of rice straw on soil nitrogen supply and rice yield. *J. Ecol. Rur. Environ*. 22(2): 16-20.

Umanah, E. E., Ekpe, E. O., Ndon, B. A. , Etim, M. E. and Agbogu, M. S. 2003. Effect of poultry manure on growth characteristics, Yield and Yield components of upland rice in South Eastern Nigeria. *J. Sustain. Agric. Envir*. 5 (1): 105-110.

Vanaja, M. and Raju, A. S. 2002. Integrated nutrient management performance in rice crop. *Abbakas Agric. Res*. 2391: 177-182.

Virdia, H. M. and Mehta, H. D. 2010. Integrated nutrient management in transplanted rice (Oryza sativa L.). *Int. J. Agril. Sci*. 6(1): 295-299.

Virdia, H. M., Mehta, H. D. and Parmar, V. N. P.Y. 2011. Effect of organic on paddy-castor cropping system. *Int. J. Agril. Sci*. 7(2): 300-305.

Waseem, R., Khanday and Ansar 2010. Integrated Nutrient Management in Rice (Oryza sativa L.). *Research J. Agril. Sci.* 1(2): 150-152.

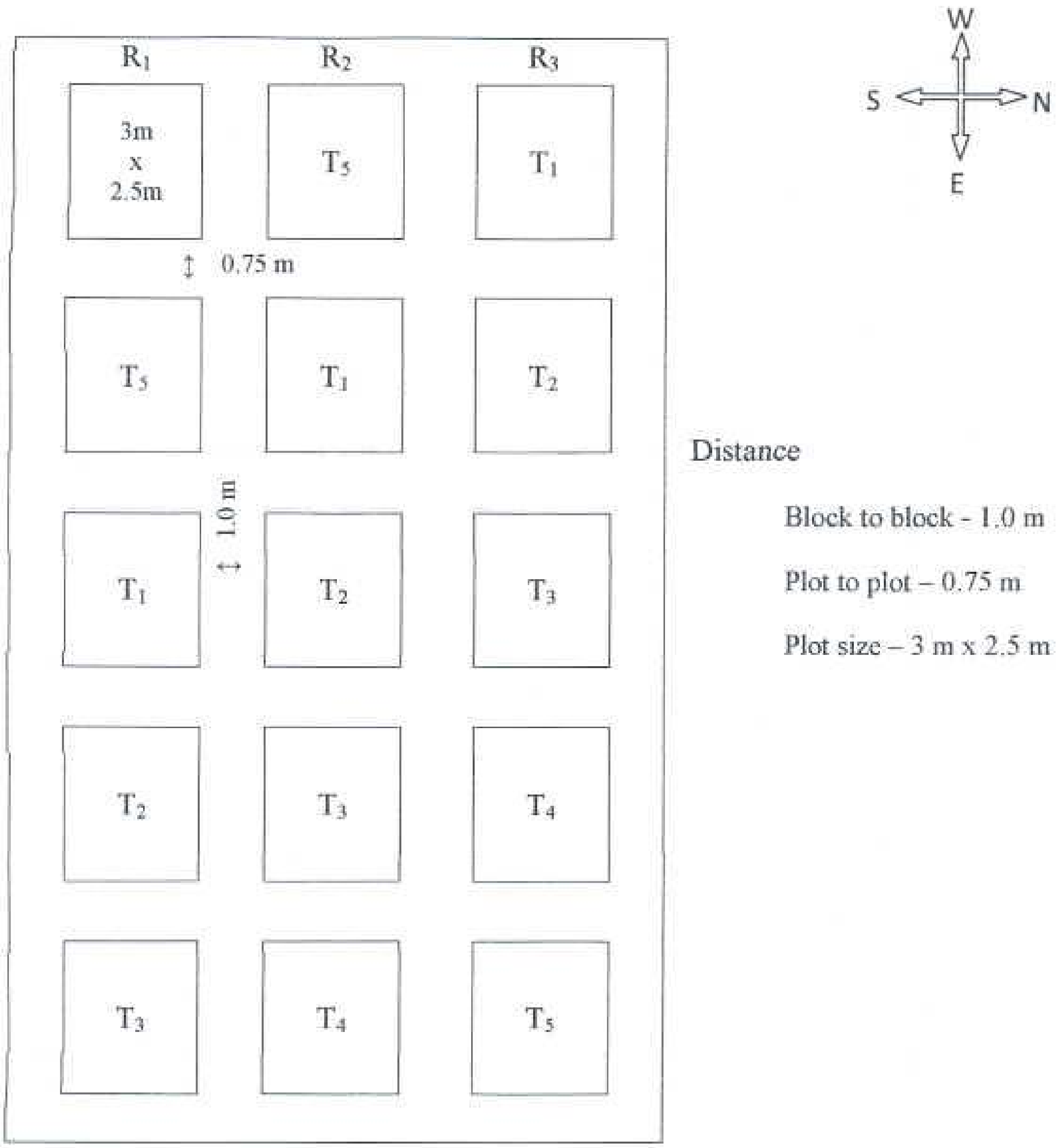
Xu, Y., Wang, Z., Li, Z., Guo, Y. and Wang, B. J. 1997. Methane productivity of two rice soils as affected by application of fertilizer. *Acta Agron. Sinica.* 232(2): 137-143.

Yadav, S. K., Panwar, N. R. and Ramana, S. 2010. Effect of organic nitrogen on yield and nutrient composition of rice (Oryza sativa L.) *Indian J. Plant Physiol.* 15(1): 77-79.

Yogananda, S. B and Reddy, V. C., 2004. Growth and sustainability of rice varieties as influenced by urban compost and inorganic fertilizers. *J. Ecobiol.* 16(4): 279-285.

APPENDICES

Appendix I : Layout of the experiment



Distance

Block to block - 1.0 m

Plot to plot – 0.75 m

Plot size – 3 m x 2.5 m

Appendix II : Analysis of variance (ANOVA) tables

Variable 3: Plant height at 40 DAT

A N A L Y S I S   O F   V A R I A N C E   T A B L E

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	6.643	3.321	5.1758	0.0361
2	Factor A	4	254.363	63.591	99.0922	0.0000
-3	Error	8	5.134	0.642		
	Total	14	266.140			

Variable 4: Plant height at 80 DAT

ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	17.649	8.825	3.4588	0.0827
2	Factor A	4	862.953	215.738	84.5591	0.0000
-3	Error	8	20.411	2.551		
	Total	14	901.013			

Variable 5: Plant height at harvest

ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	26.588	13.294	4.8727	0.0413
2	Factor A	4	869.491	217.373	79.6732	0.0000
-3	Error	8	21.826	2.728		
	Total	14	917.906			

Variable 6: Tiller/hill at 40 DAT

ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.485	0.243	1.1106	0.3753
2	Factor A	4	26.836	6.709	30.7048	0.0001
-3	Error	8	1.748	0.218		
	Total	14	29.069			

Variable 7: Tiller/hill at 80 DAT

ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.009	0.005	0.0227	
2	Factor A	4	98.044	24.511	119.2749	0.0000
-3	Error	8	1.644	0.206		
	Total	14	99.697			

Variable 8: Tiller/hill at harvest

ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.112	0.056	0.1650	
2	Factor A	4	73.637	18.409	54.2515	0.0000
-3	Error	8	2.715	0.339		
	Total	14	76.464			

Variable 9: Leaf length at 40 DAT

A N A L Y S I S   O F   V A R I A N C E   T A B L E

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.104	0.052	0.0565	
2	Factor A	4	23.003	5.751	6.2713	0.0138
-3	Error	8	7.336	0.917		
	Total	14	30.443			

Variable 10: Leaf length at 80 DAT

A N A L Y S I S   O F   V A R I A N C E   T A B L E

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	10.961	5.481	0.9429	
2	Factor A	4	480.289	120.072	20.6582	0.0003
-3	Error	8	46.499	5.812		
	Total	14	537.749			

Variable 11: Leaf length at harvest

A N A L Y S I S   O F   V A R I A N C E   T A B L E

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.796	0.398	0.0548	
2	Factor A	4	271.673	67.918	9.3502	0.0041
-3	Error	8	58.111	7.264		
	Total	14	330.580			

Variable 12: Panicle length

A N A L Y S I S   O F   V A R I A N C E   T A B L E

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	2.371	1.185	3.2801	0.0911
2	Factor A	4	23.415	5.854	16.1982	0.0007
-3	Error	8	2.891	0.361		
	Total	14	28.677			

Variable 13: No of filled grain/plant

A N A L Y S I S   O F   V A R I A N C E   T A B L E

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	71.557	35.779	0.6890	
2	Factor A	4	4206.758	1051.689	20.2539	0.0003
-3	Error	8	415.403	51.925		
	Total	14	4693.717			

Variable 14: % unfilled grain

ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	9.834	4.917	1.3031	0.3237
2	Factor A	4	32.960	8.240	2.1838	0.1613
-3	Error	8	30.187	3.773		
	Total	14	72.981			

Variable 15: Grain yield

ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.092	0.046	0.6879	
2	Factor A	4	4.002	1.000	14.9265	0.0009
-3	Error	8	0.536	0.067		
	Total	14	4.630			

Variable 16: 1000 seed weight

ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	3.570	1.785	1.1109	0.3752
2	Factor A	4	15.600	3.900	2.4270	0.1330
-3	Error	8	12.855	1.607		
	Total	14	32.025			

Variable 17: Dry weight of straw

ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.001	0.001	0.3118	
2	Factor A	4	0.061	0.015	6.4017	0.0130
-3	Error	8	0.019	0.002		
	Total	14	0.081			

Variable 18: % N in grain

ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.001	0.001	0.5972	
2	Factor A	4	0.338	0.084	99.5992	0.0000
-3	Error	8	0.007	0.001		
	Total	14	0.346			

Variable 19: % P in grain

ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.006	0.003	15.8319	0.0017
2	Factor A	4	0.034	0.008	42.4706	0.0000
-3	Error	8	0.002	0.000		
	Total	14	0.042			

Variable 20: % K in grain

ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.011	0.005	3.1680	0.0970
2	Factor A	4	0.468	0.117	68.5996	0.0000
-3	Error	8	0.014	0.002		
	Total	14	0.493			

Variable 21: % N in straw

ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.003	0.002	3.5691	0.0780
2	Factor A	4	0.008	0.002	4.6245	0.0315
-3	Error	8	0.003	0.000		
	Total	14	0.014			

Variable 22: % P in straw

ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.001	0.001	5.3584	0.0334
2	Factor A	4	0.009	0.002	16.1888	0.0007
-3	Error	8	0.001	0.000		
	Total	14	0.011			

Variable 23: % K in straw

ANALYSIS OF VARIANCE TABLE

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
1	Replication	2	0.026	0.013	6.0213	0.0254
2	Factor A	4	0.234	0.059	26.8602	0.0001
-3	Error	8	0.017	0.002		
	Total	14	0.278			

Appendix III Effect of different combinations of organic and inorganic fertilizer on plant height of BRRI dhan-50

Treatment	**Plant height (cm)**		
	40 DAT	**80 DAT**	**At harvest**
T_1	**31.60 a**	82.13 a	91.39 a
T_2	29.60 a	**82.97 a**	**91.87 a**
T_3	27.23 b	76.93 b	86.71 b
T_4	22.85 c	68.70 c	78.05 c
T_5	**20.55 d**	**63.60 d**	**72.57 d**
$LSD_{0.05}$	2.195	4.376	4.525
CV %	3.04	2.13	1.96
Significance level	**	**	**

* - Significant at 5 % level, ** - Significant at 1 % level, ns- non-significant

Appendix IV Effect of different combinations of cowdung and inorganic fertilizers on leaf length of BRRI dhan50

Treatment	Leaf length		
	40 DAT	80 DAT	At harvest
T_1	**19.47 a**	**45.80 a**	**47.90 a**
T_2	17.97 ab	44.77 a	45.97 ab
T_3	17.92 ab	40.27 ab	42.27 abc
T_4	16.20 b	34.30 bc	38.93 bc
T_5	**16.19 b**	**31.60 c**	**36.43 c**
$LSD_{0.05}$	1.803	6.605	7.387
CV %	5.46	6.14	6.37
Significance level	*	**	**

* - Significant at 5 % level, ** - Significant at 1 % level, ns- non-significant

Appendix V Effect of different combinations of cowdung and inorganic fertilizers on number of tiller $hill^{-1}$ of BRRI dhan50

Treatment	**Tiller/hill**		
	40 DAT	**80 DAT**	**At harvest**
T_1	**8.33 a**	**14.53 a**	**16.82 a**
T_2	7.40 ab	13.47 ab	16.38 ab
T_3	6.70 b	12.83 b	15.24 b
T_4	5.10 c	9.03 c	11.22 c
T_5	**4.83 c**	**8.07 c**	**8.82 d**
$LSD_{0.05}$	1.279	1.243	1.595
CV %	7.22	3.91	5.59
Significance level	**	**	**

* - Significant at 5 % level, ** - Significant at 1 % level, ns- non-significant

Appendix VI Effect of different combinations of cowdung and inorganic fertilizers on number of effective tiller $hill^{-1}$ and panicle length of BRRI dhan50

Treatment	Number of effective tiller	Panicle length (cm)
T_1	**13.6 a**	22.12 ab
T_2	11.33 b	**22.52 a**
T_3	11.27 b	21.43 ab
T_4	8.53 c	20.67 b
T_5	**7.37 c**	**18.99 c**
$LSD_{0.05}$	1.595	1.646
CV %	5.59	2.84
Significance level	**	**

* - Significant at 5 % level, ** - Significant at 1 % level, ns- non-significant

Appendix VII Effect of different combinations of cowdung and inorganic fertilizers on filled grain/panicle, unfilled grain (%) and harvest index (%) of BRRI dhan50

Treatment	Filled grain/panicle	Unfilled grain (%)	Harvest index (%)
T_1	126.07 ab	**12.91**	45.45 a
T_2	**135.33 a**	13.99	43.66 b
T_3	118.67 ab	14.07	42.72 c
T_4	107.40 b	13.52	44.12 ab
T_5	**86.80 c**	**17.18**	44.68 a
$LSD_{0.05}$	19.74		3.542
CV %	6.27	13.55	5.46
Significance level	**	ns	**

* - Significant at 5 % level, ** - Significant at 1 % level, ns- non-significant

Appendix VIII Effect of different combinations of cowdung and inorganic fertilizers on 1000 seed wt, grain yield and straw yield of BRRI dhan50

Treatment	1000 seed wt (g)	Grain yield (t/ha)	Straw yield ($kg\ m^{-2}$)
T_1	19.26	4.04 a	0.43 ab
T_2	**20.48**	**4.07 a**	**0.45 a**
T_3	19.25	3.52 ab	0.39 ab
T_4	18.12	3.20 bc	0.35 bc
T_5	**17.54**	**2.71 c**	**0.27 c**
$LSD_{0.05}$		0.7091	0.0842
CV %	6.70	7.38	12.89
Significance level	ns	**	*

* - Significant at 5 % level, ** - Significant at 1 % level, ns- non-significant