INORGANIC FERTILIZERS USE EFFICIENCY COUPLED WITH ORGANIC MANURES UNDER RICE-RICE CROPPING PATTERN IN BANGLADESH

MST. UMME KULCHHUM

DEPARTMENT OF AGRICULTURAL CHEMISTRY
SHER-E-BANGLA AGRICULTURAL UNIVERSITY
DHAKA -1207

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Certificate of Approval

Prof. Dr. Md. Abdur Razzaque

Chairman

Advisory Committee

Prof. Dr. Rokeya Begum

Member

Advisory Committee

Prof. Dr. Md. Asaduzzaman Khan

Member

Advisory Committee

Prof. Dr. H.M.M. Tariq Hossain

Member

Advisory Committee

(Prof. Dr. Md. Abdur Razzaque)
Department of Agricultural Chemistry
Sher-e-Bangla Agricultural University,
Dhaka Bangladesh

CERTIFICATE

This is to certify that the thesis entitled "INORGANIC FERTILIZERS USE EFFICIENCY COUPLED WITH ORGANIC MANURES UNDER RICE-RICE CROPPING PATTERN IN BANGLADESH" submitted to the DEPARTMENT OF AGRICULTURAL CHEMISTRY, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of DOCTOR OF PHILOSOPHY (Ph.D.) in AGRICULTURAL CHEMISTRY, embodies the results of a piece of bonafide research work carried out by MST. UMME KULCHHUM, Registration. No. 13-05795, 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.

Dated : June, 2017

Dhaka, Bangladesh

(Prof. Dr. Md. Abdur Razzaque)
Supervisor and Chairman
Advisory Committee

Dedicated To

My Beloved Parents and Husband

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Dhaka, Bangladesh ***Dhaka,Bangladesh***

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ABSTRACT

A series of research works on the effects of different inorganic fertilizers and organic manures on growth, yield and nutrient content of Boro rice (BRRI dhan29) and T. aman rice (BRRI dhan49) were conducted at the farmers field of Shakhepur, Tangail and Shere Bangla Agricultural University (SAU) Farm, Dhaka, respectively during period from 2013-2016. The research works consisted of 4 levels (0, 50, 75 and 100% of recommended dose) of each organic manure such as compost (C), cowdung (CD) and poultry manure (PM) and 4 levels (0, 50, 75 and 100% of recommended dose) of inorganic fertilizers (Urea, TSP and MoP) which were laid out in a randomized complete block design (RCBD) taking sixteen treatments with three replications in both season. Aman rice (BRRI dhan49) was grown on the same plots after harvesting of boro (BRRI dhan29) rice. Combined application organic manure (compost, cowdung and poultry manure) and inorganic fertilizers (Urea, TSP and MoP) produced significantly higher yield over single application of inorganic fertilizers. The performance of poultry manure among the organic manure placed superior position than that of cowdung and compost. Application of 100% organic manure and 100% inorganic fertilizer gave higher results in most growth yield and yield related parameters. Statistically similar observation was found in treatment combination 100% organic manure and 75% inorganic fertilizer. In case of interaction, both BRRI dhan29 and BRRI dhan49 gave highest plant height, higher number of effective tillers hill^{-1}, longer panicle, higher 1000-grain weight, higher number of filled grains panicle^{-1}, higher grain yield, straw yield and BCR. After economic analysis full dose combination (100% organic manure and 100% inorganic fertilizer) and (100% organic manure and 75% inorganic fertilizer) shows better performances. Application of above mentioned two treatment combination contribute the highest grain yield in both boro and aman rice. The combined application of organic manure (compost, cowdung and poultry manure) and inorganic fertilizers (Urea, TSP and MoP) is might be the suitable management for increasing grain yield. The combination also highlights the significant effects on N, P and K contents by grain and straw of both season. The post harvest properties of soil of both BRRI dhan29 and BRRI dhan49 also varied significant positive effects under full dose treatment combination. The content of post harvest soil properties were increased due to application of above mentioned two combination of organic manure and inorganic fertilizer, compared to initial status, which refer to point out that soil fertility status in increase due to application of organic manure (compost, cowdung and poultry manure) and inorganic fertilizers (Urea, TSP and MoP). On the basis of economic analysis (benefit cost ratio) it can be summarized that above two treatment combination shows statistically similar results and considering inorganic fertilizer use efficiency comparatively low cost can be used for profitable cultivaiton of both boro rice (BRRI dhan29) and aman rice (BRRI dhan49). So treatment combination (100% Organic Manure +75% Inorganic Fertilizer) used best for both boro and aman season.

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AEZ	Agro- Ecological Zone	K_2O	Potassium Oxide
@	At the rate	Kg	Kilogram (s)
B	Boron	LSD	Least Significant Difference
BARI	Bangladesh Agricultural Research Institute	m	Meter
BAU	Bangladesh Agricultural University	m^2	Meter squares
BBS	Bangladesh Bureau of Statistics	mm	Millimeter
BINA	Bangladesh Institute of Nuclear Agriculture	MoP	Muriate of Potash
BRRI	Bangladesh Rice Research Institute	N	Nitrogen
cm	Centi-meter	No.	Number
CV	Coefficient of Variance	NS	Non significant
cv.	Cultivar (s)	%	Percentage
DAT	Days After Transplanting	P_2O_5	Phosphorus Penta Oxide
^0C	Degree Centigrade	pH	Negative Logarithm of Hydrogen ion
et al.	And others	S	Sulphur
e.g.	Exempli gratia	SAU	Sher-e- Bangla Agricultural University
FAO	Food and Agriculture Organization	t ha^{-1}	Ton per hectare
g	Gram (s)	TSP	Triple Super Phosphate
DMRT	Duncan's Multiple Range Test	var.	Variety
IRRI	International Rice Research Institute	Viz.	Namely
hr	Hour(s)	Wt.	Weight
H_2SO_4	Sulfuric acid	Zn	Zinc

CHAPTER I

INTRODUCTION

The major cropping pattern in Bangladesh agriculture mostly consist of rice based cereal crops (Haque, 1998). It provides 700 calories per person, mostly residing in developing countries (Barai *et al*., 2009) which contributes 60% of the world's population and one of the most potential grain crops that could responsible to the efforts for the realization of food security (Gebrekidan and Seyoum, 2006). Bangladesh is now essentially self-sufficient in rice, its basic cereal (USAD, 2006). In the self sufficiency of rice, the dominant cropping pattern t. aman (wet season rice) – fallow boro (dry season rice) plays an important role which covers about 1.8 million hectare (about 22% of the total land) of land (Elahi *et al.*, 1999). Fertilizer Use Efficiency is a critically important concept for evaluating crop production systems and can be greatly impacted by inorganic fertilizer management as well as soil and plant-water relationships. It indicates the potential for nutrient losses to the environment from cropping systems as managers strive to meet the increasing societal demand for food, fiber and fuel (Fixen *et al*., 2015). The objective of inorganic fertilizer use is to increase the overall performance of cropping pattern by providing economically optimum nourishment to the crop while minimizing nutrient losses from the field and supporting agricultural system sustainability through contributions to soil fertility or other soil quality components. The most valuable fertilizer use efficiency improvements are those contributing most to overall cropping pattern performance. According to International Rice Research Institute (IRRI) 800 million tons of rice will be required in 2025 (Kubo and Purevdorj, 2004). More than 60% of the total cropped area covered by Boro-T. aman rice cropping pattern in Bangladesh (Fertilizer Recommendation Guide, 1997). Rice is unquestionably the main cereal food for the people of Bangladesh. It occupies 74.77% of total cropped area (BBS, 2009) supplies 92% of cereal food requirements, 75% of caloric intake and

55% of protein in average daily diet of the people (Bhuiyan *et al*., 2004). It is the grain with the second-highest worldwide production, after corn and Bangladesh is the fourth highest rice (*Oryza sativa* L.) producing country in the world (FAO, 2013). About 76.71% of the total cropped area is planted to rice in the year 2012-13. (Mondal and Choudhury, 2014). Due to adoption of high production technology followed by high cropping intensity the soils of Bangladesh are depleted of many essential plant nutrients. The most important causes of soil degradation are depletion of nutrients resources of soil through crop removal, leaching, and decline in organic matter content. Besides the continuous and imbalanced use of inorganic fertilizers accelerates depletion of soil organic matter and impairs physical and chemical properties of soil. Repeated use of inorganic fertilizer Urea, TSP, MOP and gypsum are principal sources alone fails to sustain desire yield, impairs the physical condition and organic matter content of soils (Rabindra *et al*., 1985). Soil organic manure and inorganic fertilizer is the essential factor for sustainable soil fertility and crop productivity because is the store house of plant nutrients. Sole and combined use of compost, cowdung and poultry manure inorganic fertilizer acts as a source of essential plant nutrients. Experimental evidences in the use of compost, cowdung, poultry manure, and Urea, TSP and MOP showed an intimate effect on the yield and yield contributing characters of rice. Yield and yield contributing characters of rice are considerably influenced by different doses of NPKS and Zn fertilizer and cowdung, poultry manure & compost and their combined application. Organic matter content in Bangladesh soils is very low (<1.5%) and is being gradually depleted. Neither the inorganic fertilizers nor organic manure alone can help achieve sustainable crop production. Even with balanced use of only inorganic fertilizers, high yield level could not be maintained over the years because of deterioration in soil physical and biological environments. The integrated nutrient management is the best approach to restore/ maintain soil fertility and productivity on sustainable basis. In Bangladesh, fertilizer management practices of the homestead area is very poor where most of the farmers use only urea as a fertilizer which is sometimes recommended dose and not sufficiently aware of management practices and use of other fertilizers and organic manure. Possibly these are the main causes of poor yield and soil health deterioration (Ali *et al.* 1997 and Khan *et al.* 2008). Organic matter plays a vital role in maintaining fertility of soil and acts as reservoirs of plant nutrients and also prevents the leaching of the elements which are essential for plant growth. An organic material is supplementary sources of plant nutrients, improves the physical, chemical and microbiological properties of soils and helps to increase and conserve their productivity. Soil testing is essential in order to determine the soil's nutrient content and determine deficiencies that need to remedy, so that growth, development and yield may be high rise (Rashid and Rafique, 1998). Accumulation of nutrients in soils, particularly nitrogen, phosphorus and several micronutrients increases the potential for the degradation of surface and ground water resources, especially when organic manure application is nitrogen based fertilizer (Edwards and Daniel, 1992., and Hao *et al*, 2008) . It involves in improving the physical, chemical and biological properties of soil.

Composts (Household waste) refers to solid or semisolid, non soluble material (including gases and liquids in containers) such as agricultural refuse, demolition waste, industrial waste, mining residues, municipal garbage and sewerage sludge's. Household wastes products are the source of homestead, which is not widely practiced for crop production due to lack of sufficient information regarding this. Mixture of household waste especially kitchen waste, dining waste, domestic refuses residues from food processing are used as component of compost. The compost domestic wastes possesses a high nutritional value with high concentration of nitrogen, phosphorus and potassium improve soil physical properties while the contamination by heavy metals and other toxic substances is negligible (Hogland *et al.*, 2003). It delivers the microorganisms, provides the nutrients and food reserves needed by the microorganisms to survive and multiply and improves soil water holding capacity, which favors the beneficial microorganisms over disease causing organisms in the soil. Compost allows beneficial soil microorganisms to out compete disease-causing organisms in the soil. Highly mineralized soils that are low in organic matter may actually favor disease organisms in the soil (Travis *et al.,* 2004). The nutrient value of compost varies a lot and depends on what ingredients made from. The NPK ranges for composted materials as 0.75 – 1.5 % N, 0.25 – 0.5 % P_2O_5 and 0.5 – 1.0 % K_2O (Leonard, 1986). Aside from N, P and K, it supplies varying amounts of secondary nutrients and micronutrients. Preparation of compost is desirable to mix materials for composting in the proportions that give rapid, effective and complete decomposition to a stable product (Harris *et al.,* 2001). Application of organic manure generally aims at two major goals increased supply of nutrient elements to the crop and increased organic matter content in the soil, resulting in more favorable soil physical and chemical properties (Ridder and Keulen, 1990). These two goals are conflicting, as release of nutrient elements requires decomposition of the organic material, which is thus, lost for the formation of soil organic matter. However, farmers are now showing interest in organic farming because, they are more aware about the residual effect of inorganic fertilizer used in the crops field and environmental degradation. Besides, the excess application of inorganic fertilizer causes hazard to public health and to the environment. But the application of both organic manure and inorganic fertilizer combined, can increase the yield as well as keep the environment sound (Hsieh *et al.*, 1996). In the past, only three primary plant nutrients such as N, P and K along with S were commonly used by the farmers of Bangladesh. The importance of the use of micronutrients was mostly ignored, although they could be the limiting factors, recently used micronutrients for crop production. In Bangladesh, most of the cultivated soils have less than 1.5% organic matter, while a good agricultural soil should contain at least 2% organic matter.

Cowdung along with inorganic fertilizer indicating dominant sources of phosphorous and along with other fertilizer can modulate the yield of rice.

High content of N, K and fibrous materials rich in cowdung that favourably regulates soil moisture, temperature and even prevents multiplication effects of weeds on soil surfaces (Adetunji, 1991; Adeoye *et al.,* 2004). When cowdung were applied along with inorganic fertilizer for efficient growth of crop, decline in organic carbon is arrested and the gap between potential yield and actual yield is turned into low (Rabindra *et al.,* 1985). Cowdung contains the undigested portion of the feed eaten by animal, whereas urine contains only the soluble products and has higher nitrogen and potassium contents than dung and since these are in solution, they are quickly available to plant (Fagbenro *et al.,* 2001). By the application of mineral fertilizer associated with cow-dung increases the efficiency by improving properties of the soil (Vanlauwe *et al.,* 2001). Cow dung applied with inorganic nitrogen (N), increased soil pH and ameliorated acidity (Olayinka and Ailenubhi, 2001). Saleque *et.al.* (2004); has stated that Integrated Pest Management (IPM) and the use of cow dung and ash is effective on rice yield and soil fertility.

Poultry manure produced by properly handled live-stock is the most valuable manures of all organic manure. Now a day’s poultry farm of different sizes have been established all over the country and farm holders use concentrate feeds to feed their poultry animals. As a result the poultry excreta are rich in N, P, K, secondary and micronutrients. If the poultry excreta are not used as fuel, these can be the used as a good source of manure for different field crops (Farid *et al.,* 2011). Poultry manure is rich in nutrients and good sources of P, K and N that improves soil fertility and more uptakes of these nutrients in grain crops (Reddy *et al.,* 2005). Organic manures like poultry manure, farm yard manure, vermicompost and neemcake deserve priority for sustained production and better utilization in organic rice production (Dahiphale *et al.,* 2003). Composted poultry manure is a complete package (Travis *et al.,* 2004). The poultry manure contain 2.91% of phosphorous and 2.12% of potassium which is supirior than cowdung (Saha *et al.* 2003). Increasing organic matter contents in the soil and improving the soil texture, organic matter improves soil health and phyto-availability of the nutrients (Ibrahim *et al*. 1992; Alam *et al.* 2003*).* Animal manure is an organic fertilizer consisting of a partly decomposed mixture of dung and urine (Defoer and Budelman ,2000).

Therefore, integrated nutrient management in which both organic manures and inorganic fertilizers are used simultaneously is the most effective method to maintain a healthy and sustainably productive soil (Dejene and Lemlem, 2012). Emerging evidence indicated that integrated soil fertility management involving the judicious use of combined organic and inorganic resources is a feasible approach to overcome soil fertility constraints (Efthimiadou *et al.*, 2010*)*. But organic nutrients alone could not be a perfect substitute for inorganic fertilizers as these are not as much quick nutrient supplier as inorganic fertilizers, so integrated use of organic nutrients along with inorganic fertilizer has proved more beneficial (Nasir and Qureshi, 1999; Khanam *et al*., 2001; Alam *et al*., 2005). Integrated approach increases the crop yields but also sustains the agricultural productivity, helps in water use, improve plant growth and recover soil health. Beside this, a large amount of wastes material generated in cities, towns and villages of Bangladesh, polluting the environments badly. By using this material along with inorganic fertilizers not only reduces environmental pollution but also enhances soil fertility and crop productivity (Shah *et al.,* 2010). Developing a suitable nutrient management system that integrates use of these inorganic fertilizers may be a challenge to reach the goal of sustainable agriculture. The integrated nutrient management system is an alternative and is characterized by reduced input of inorganic fertilizers and combined use of inorganic fertilizers with organic manures such as composts (house hold wastes) (C), cowdung (CD), and poultry manure (PM). For sustainable crop production, integrated use of inorganic fertilizer and organic manures proved to be highly beneficial (Malliga and Subramanian, 2002). But application of only organic manures inefficiently improves the yield per unit area (Jobe, 2003 and Satyanarayana *et al*., 2002). According to Lamps (2000) the integrated management of plant nutrients can reduce the problem and suitable for any farming system and socio-economic circumstances. Sustainable production of crops cannot be maintained by using only inorganic fertilizer and similarly it is not possible to obtain higher crop yield by using organic manure alone (Bair, 1990). For sustainable crop production, integrated use of inorganic and organic fertilizer proved to be highly beneficial (Malliga and Subramanian, 2002).

The soils of Bangladesh are already depleted in many of essential plant nutrients mainly because of intensive cultivation having no return from organic recycling. Inorganic fertilizer application are indispensable for the production of crop systems of modern agriculture and today hold the key to the success of the crop production systems of Bangladesh agriculture, being responsible for about 50% of the total production. But, it is also true that maintaining the sustainable crop production is difficult by using inorganic fertilizer alone and similarly it is not possible to get higher crop yield by using organic manure (cowdung, poultry manure and composts) only.

In view of the continued need to increase crop yield per unit area proper use of inorganic fertilizers and organic manures are essential. It is also essential to look after immediate crop needs in order to build up soil fertility and to conserve good soil health for increasing crop production in future. The farmers of Bangladesh are so poor and illiterate. So it is rigid that they don’t know how to use properly secondary and micro nutrients adding from organic and inorganic sources. The intensive cropping with modern varieties, nutrients leaching with monsoon rains and light textured soil favorer emergence of secondary and micronutrient deficiency in those soils limiting secondary and micronutrients in properly inorganic fertilization and organic manures programmed should be taken into sequentially sustainable agricultural practices. In the light of these problems, it was planned to study the effect of inorganic fertilizers use efficiency coupled with organic manure such as composts (house hold wastes), cow dung and poultry manure under rice-rice cropping pattern in Bangladesh.

The piece of research work was undertaken to find the following objectives:

1. To assess the nutrient content of different organic manures like composts (house hold waste), cow dung and poultry manure.
2. To determine the use efficiency of different organic manures along with inorganic fertilizers using rice –rice cropping pattern.
3. To observe the nutrient content in grain, straw and the nutrient status of soil using of inorganic fertilizers and organic manures under rice-rice cropping system and
4. To optimize the combination inorganic fertilizers and organic manures for sustainable rice- rice cropping pattern in Bangladesh.

CHAPTER II

REVIEW OF LITERATURE

An attempt has been made in this chapter to present a brief review of the pertinent works on the inorganic fertilizers use efficiency combined with organic manure in rice done by different researchers in our country and elsewhere in the world. Since review of literature forms a bridge between the post and present research works related to problems which help an investigator to draw a satisfactory conclusion, so an effort was made to present some research works related to the present study in this section. Some literature related to the study are reviewed below-

2.1 Effects of Nitrogenous fertilizers for production of rice

Mashkar and Thorat (2005) conducted a field experiment during the 1994 kharif season in Konkan, Maharashtra, India, to study the effects of different nitrogen levels (0, 40, 80 and 120 kg N ha^{-1}) on the N, P and K uptake and grain yield of scented rice cultivars (Pula Basmati 1, Kasturi, Indrayani and Sugandha). The different levels of N had significant effect in augmenting the uptake of N, P and K nutrients and grains as well as straw yield of rice. Application of 120 kg N ha^{-1}recorded significantly higher N, P and K uptake in rice compared to the rest of the N levels. Every increment of 40 kg N $ha^{-1}$from 0 to 120 kg N ha^{-1} increased the total N uptake by 49.55, 34.30 and 27.17% total P uptake by 40.33, 27.06 and 20.32% and total K uptake by 32.43, 20.70 and 17.25%, respectively.

Pidwimy (2002) revealed that the soil, N found in decomposing organic matter may be converted into ammonium -N (NH_4^+) by soil microorganisms (bacteria and fungi) through mineralization.

Liu *et al.* (2012) observed that, comparing with applying inorganic fertilizers and combined application of organic & inorganic fertilizers decreased the soil microbial biomass carbon and nitrogen and soil mineral nitrogen contents before tillering stage, but increased them significantly from heading to filling stage. Under the combined fertilization, the dynamics of soil nitrogen supply matched best the dynamics of rice nitrogen uptake and utilization, which promoted the nitrogen accumulation in rice plant and the increase of rice yield and biomass, and increased the fertilizer nitrogen use efficiency of rice significantly. Combined application of inorganic and organic fertilizers also promoted the propagation of soil microbes, and consequently, more mineral nitrogen in soil was immobilized by the microbes at rice early growth stage, and the immobilized nitrogen was gradually released at the mid and late growth stages of rice, being able to better satisfy the nitrogen demand of rice in its various growth and development stages.

Chopra and Chopra (2000) reported that application of either 80 or 120 kg N ha^{-1} improved the entire yield attributes of rice compared to the control.

Brady and Weil (1996) found that Nitrogen is a primary macro nutrient occurring in soils both in organic and inorganic forms. Plants absorb N mainly in the form of NH_4^+ and $NO_{3.}$ It is an integral component of many essential plant compounds. Nitrogen dramatically stimulates plant growth, especially the above ground vegetative parts of plants. A good supply of nitrogen and protein content of seed and foliage as well as the uptake of other nutrients. It is essential for carbohydrate use within the plants. It is a major part of all amino acids, enzymes and nucleic acids.

The N-requirement of crops is comprehensively reviewed by Tisdale *et al.* (1993). Nitrogen is a vitally important plant nutrient, the supply of which can be controlled by man (Adediran and Banjoko, 1995; Shanti *et al*.1997).

Duhan and Singh (2002) reported that the rice yield and uptake of nutrients increased significantly with increasing N levels. Moreover, the application of N along with various green manures (GM) showed additive effects on the yield and uptake of micronutrients. Under all GM treatments, the yield and uptake were always higher with 120 kg N ha^{-1} than with lower level of nitrogen.

Lakshmanan *et al.* (2005) observed that current high yields of irrigated rice are associated with large applications of fertilizer and nitrogen as a fertilizer is normally a key factor in achieving optimum lowland rice grain yields and is a constituent of numerous important compounds found in living cells, including amino acids, proteins (enzymes), nucleic acids, and chlorophyll furthermore nitrogen increases the concentration and uptake of other nutrients by rice.

Singh and Shivay (2003) evaluated that the effective tillers $hill^{-1}$ was significantly affected by the level of nitrogen and increasing level of nitrogen significantly increased the number of effective tillers $hill^{-1}$.

Wang (2004) conducted a field experiment in Taiwan to investigate the effect of deep placement of fertilizer and nitrogen top dressing on rice yield and to develop a simple method for diagnosing the level of' nitrogen (N) top-dressing during panicle initiation stage. The deep placement of nitrogen fertilizer promoted nitrogen uptake, grain nitrogen content and nitrogen harvest index, resulted in a higher dry matter production, harvest index and a higher grain yield of rice plant compared with conventional nitrogen application. Similarly, top-dressing of nitrogen at panicle initiation stage also increased nitrogen uptake, dry matter production, nitrogen harvest index, harvest index and grain yield of rice plants.

Chaturvedi (2005) conducted a field trial at Agricultural Research Station, Bilaspur Chhattisgarh, India to determine the effect of different nitrogenous fertilizers on growth, yield and quality of hybrid rice variety “Proagro 6207”. The two years data revealed that all the growth characters, yield parameters and grain nitrogen (N) were increased significantly with an application of sulphur containing N- fertilizer.

2.2 Effects of Phosphorous fertilizers for production of rice

Potash and Phosphate Institute (2003) reported that there is however a strong competition between plants and soils for P in the solution, and the winner usually being soils, especially highly weathered soils like those in the tropics. Most soils in the tropics contain large amounts of iron and aluminum-oxides or amorphous alumino silicate clays, which tie up P firmly, making P virtually unavailable for plant uptake. It is estimated that as much as 90 % of added fertilizer phosphorus is fixed in these soils.

Tchienkoua and Zech (2003) evaluated that Phosphorus is one of the main limiting plant nutrients and its deficiency is a major constraint for better crop production in most tropical soils.

Kumar and Singh (2001) reported that the significant response of rice to P was observed only up to 26.2 kg P $ha^{-1}$and application of P in all seasons recorded maximum rice equivalent yield (79.8 q ha^{-1}) and treatment receiving P in first year kharif and rabi (70.8 q ha^{-1}).

Dongarwar *et al.* (2003) conducted an experiment in Bhandara, Maharashtra, India during Kharif 2000-2001 to investigate the requirement of phosphorus for rice (KJIRH-1) production. They observed that there was a significant increase in grain yield with successive increase in P fertilizer. The highest grain yield (53.05 q ha^{-1}) was obtained with the application of 75 kg P ha^{-1}.

Sahrawat *et al.* (2001) conducted a field experiment for six years (1993-1998) to determine the response of four promising upland rice cultivars with 0, 45, 90, 135, and 180 kg ha^{-1} as triple superphosphate (TSP). They stated that grain yields of the rice cultivars were significantly increased by fertilizer P in 1993 and by the fertilizer P residues in the subsequent years although the magnitude of response decreased rapidly with time since the fertilizer was applied.

2.3 Effects of Potassic fertilizers for production of rice

Wilson *et al.* (1996) conducted experiments with insufficient P and K and evaluated response of P and K fertilizers and found that grain yield significantly increased by P application (40 lb P_20_5acre^{-1}) where the soil available P was 11 lb acre^{-1}, but no response to K application.

Saleque *et al.* (1998) conducted 6 on-farm trials on K deficient Barind Soils of Bangladesh to evaluate the response of rice to K fertilizers and found that application of 30 kg K ha^{-1} significantly increased grain yield at all the test locations. Potassium application increased K content only in the straw but not in the grain.

Saha *et al.* (2011) observed that agronomic use efficiency of K decreased with increasing K levels. A narrower balance of K was observed when rice straw or a higher dose of inorganic K fertilizer was used.

Kundu *et al.* (2007) found that both soil puddling and K fertilizer application at 80 kg ha^{-1} 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^{-1} produced maximum K uptake in rice.

Motavalli *et al.* (1989) observed that manure N and P are present in organic and inorganic forms, and are not totally available to plants. The organic forms must be mineralized or converted into inorganic forms over time before they can be used by plants. The availability of K in manure is considered similar to that in commercial fertilizer since the majority of K in manure is in the inorganic form .

Jack and Sara (2001) found that optimum K requirement of rice were 1.8-2.6%, 1.4-2.0% and 1.5-2.0% in the tillering to panicle initiation stage, flowering stage and maturity stage respectively. Available K (ppm) for rice ranges with values 20-80 ppm and 82-246 ppm representing low and high available potassium, respectively

Meena *et al.* (2003) conducted a field experiment at the Indian Agricultural Research Institute, New Delhi, India to study the productivity and economics of rice (Oryza sativa L) as influenced by K application. The experiment was laid out in split plot design with 2 levels of potassium, viz. 62.5 and 125 kg K ha^{-1}. Significantly higher total number of tillers, dry matter accumulation, grain yield and straw yield were recorded with the application of 62.5 kg ha^{-1} applied in 2 equal splits (half at transplanting + half at maximum tillering).

Charles and James (1999) Phosphorus (P) and Potassium (K) fractions are considered to be about 75% as effective as commercial fertilizers during the first year of application. If poultry litter is applied at rates that will supply all N needed by the crop, P and K applications greater than those needed by the crop may occur. Under frequent manure applications, P wills buildup in soils to extremely high levels. Potassium may also build up unless large quantities of hay or forage are removed.

Mitra *et al*. (2001) conducted an experiment in the alluvial soils (Inceptisol) of Orissa, India for three consecutive years in a rice groundnut cropping sequence. There were consecutive years in a rice groundnut cropping sequence. There were four levels of K_2O (0, 30, 60, 90 for rice and 0, 40, 60, 80 for groundnut). The results showed a significant increase in yield of both rice and groundnut with increased levels of K. Averaged over three cropping cycles, application of 60 kg K_2O was found to be optimum dose for kharif rice.

Cong *et al.* (2001) found that K application improved yield of rice grown on a alluvial soil. Overall quality of crops was improved with K application though there is no generally accepted indicator according to which fertilizer effects on quality can be measured.

2.4 Effect of compost, cowdung and poultry manure on growth and yield of rice

Singh *et al.* (2000) stated that each increment dose of N significantly increased grain and straw yields of rice over its preceding dose. Consequently, the crop fertilized with 100 kg N ha^{-1} gave the maximum grain yield (2647 kg ha^{-1}).

Ogbodo *et al.* (2005) reported that organic manure application doses of over 20 ton ha^{-1} 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 .

According to Sarwar *et al*, (2007), the grain yield and yield components (plant height, number of fertile tillers and 1000 grain weight) of rice and wheat increased significantly with the application of different organic materials but compost proved the most superior in this regard. The combination of compost with chemical fertilizer further enhanced the biomass and grain yield of both crops (Sarwar *et al*. 2008).

Laxminarayana (2000) cited that application of 100%NPK + poultry manure @ 5 t ha^{-1} gave the highest grain yields among the treatments and the lowest grain yield was obtained with 100% N treated plot.

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^{-1}) 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.

Mannan *et al.* (2000) reported that manuring with cowdung up to 10 t ha^{-1} in addition to recommended inorganic fertilizers with the rate of N application improved grain and straw yields and quality of transplant aman rice over inorganic fertilizers alone.

Dahiphale *et al.* (2004) carried out an experiment about yield and yield parameters of scanted 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^{-1} + bio fertilizer recommended dose of 75: 50:50 kg NPK ha^{-1} gave the highest 1000 grain weight.

Rajput *et al*. (1992) reported that application of PM, FYM and cowdung with chemical fertilizers was found to produce higher grain yield than from chemical fertilizers alone.

Ahmed and Rahman (1991) who reported that the application of organic matter and chemical fertilizer increased straw and grain yields of rice also reported that the application of urea-N in combination with cowdung and poultry manure increased the straw yields of rice.

Bhuiyan (1994) observed that the long-term research of BRRI revealed that the application of cowdung 5 t ha^{-1} yr^{-1} improved rice productivity as well as prevented the soil resources from degradation. Thus, it is necessary to use fertilizer and manure in an integrated way in order to obtain sustainable crop yield without affecting soil fertility.

According to Ewulo *et al*. (2008) corn crop plants on cow dung mixed soil is a good source of different plant nutrients particularly N.P.K.S.

Use of organic manure especially cow dung and poultry droppings helps in improving physical condition of soil and serves as major contributor of plant nutrients Bagayoko (2012).

Solomon *et al*. (2012) found that cow dung is environmental friendly, is easily used and compared with chemical fertilizer which increases the environmental problems. Organic fertilizers are used easily from locality products and livestock wastes and cost effective than chemical fertilizer.

Tasnin *et al*. (2013) experimented that, Organic fertilizer such as cowdung may play a vital role in soil fertility improvement as well as supplying primary, secondary and micro nutrients for crop production. In addition, it can improve the physical, chemical and biological properties of soil and help increase and conserve the soil productivity.

Sarker *et al.* (2007) reported that BRRI Dhan31 BRRI dhan32 performed the best respect of yield and parameters in 5 ton ha^{-1} of poultry manure coupled with 75% N P K S Zn. Thus transplant Aman rice (CVs BRRI dhan 31 BRRI dhan 32) can be cultivated successfully with 25 % reduction of recommended fertilizers when poultry manure will be applied at 5ton ha^{-1}

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 panicles length and grains per panicles in rice plants and enhance the lodging resistance capability of high quality rice to achieve the goal of high quality and high yield.

According to (BRRI, 1998-1999) and (Egrinya *et al.* 2001) poultry litter (PL) has been proved to be a good source to supplement chemical fertilizers in the rice-rice cropping pattern This material contains not only N, but also other elements like P , K , S , Ca , Mg and micronutrients.

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

Poultry litter can be utilized for rice production (BRRI, 2002 and 2006). There are 72.71 million poultry in Bangladesh (BBS, 2003), a source of huge wastes, which creates environmental pollution in some locations. This waste contains various nutrients, which can be used successfully for crop production and ruminant feed (Jacob *et al.* 1997; Kunkle *et al.* 1997).

Jacob *et al.* (1997) reported that availability of fertilizer at the right time is one of the major constraints now days for rice production in Bangladesh. The cost of fertilizer is also high. So, poultry litter could be used under such conditions to supplement plant nutrients for rice production because it contains good amount of available nutrients.

Charles and James (1999) evaluated that the organic N fraction gradually becomes available for crop uptake as the manure decomposes (mineralizes). Mineralization rates can range from 40 to 90 percent depending on environmental conditions. For broiler litter in Alabama, assume that 60 percent of the organic N may be released during the first year following application. There-fore, around 70 percent of the total N in broiler litter will be available to the crop the first year after application Poultry Mortality Composts. A survey of 30 composters in Alabama found an average moisture of 36 percent. On a fresh weight basis, the average fertilizer grade of the secondary compost was 2.4-2.6-1.6 (48-52-32 pounds N-P_2O_5-K_2O ton^{-1})

Travis *et al.* (2004) stated that composted animal manure is a complete package and it delivers the microorganisms, provides the nutrients and food reserves needed by the microorganisms to survive and multiply and improves soil water holding capacity, which favors the beneficial microorganisms over disease causing organisms in the soil. Compost allows beneficial soil microorganisms to out compete disease-causing organisms in the soil. They finalized that highly mineralized soils that are low in organic matter may actually favor disease organisms in the soil.

Saha *et al.* (2013) stated that poultry manure is an excellent source of nutrients and can be incorporated into most fertilizer programs. Application of manures must be practiced sound soil fertility management to prevent nutrient imbalances and associated animal health risks as well as surface-water and groundwater contamination. Global environment pollution can also be reduced considerably by reducing the use of chemical fertilizers and increasing the use of cow dung, poultry manure, rice straw and others. Bangladesh agriculture has experienced multiple nutrient deficiencies over the years. For sustainable agriculture, a soil management strategy must be based on maintaining soil quality, which is only possible by utilization of high quality manures along with inorganic fertilizers.

Umanah *et al.* (2003) conducted a field experiment to study the effect of different rates of poultry manure on the growth, yield components 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 poultry manure ha^{-1}. There were significantly differences in plant height, internodes length, number of tillers $hill^{-1}$, panicle number $stand^{-1}$, number of grains $panicle^{-1}$, and dry grain yield. There was no significant variation among treatments for 1000 grain weight.

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

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 *et al.* (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.

Leonard (1986) stated that Animal manures are valuable sources of nutrients and the yield-increasing effect of manure is well established. Apart from the nutrients in manure, its effects on the improvement of soil organic matter, soil structure and the biological life of the soil are well recognized particularly at high rates of application in on-station trials. There is also some evidence that it may contain other growth-promoting substances like natural hormones and B vitamins .

Gaur and Verma (1991) stated that Indian municipal wastes contained 0.5 % N, 0.3 % P and 0.3 % K. Also, Leonard (1986) quoted 1.1 % N, 1.1 % P_2O_5 and 0.5 % K_2O for poultry manure at 70 % moisture content.

Sistani *et al.* (2008) found that poultry litter application, optimum rate of broiler litter as a primary fertilizer at 11 kg ha^{-1} applied in 4 consecutive years on a silt loam soil produced corn grain yields similar to chemical fertilizer under both no-till and conventional tillage systems and kept soil test P, Cu and Zn levels below values considered to be harmful to surface water quality or the crop.

According to Adhikari *et al.* (2008) *and* Bertoldi *et al.* (1987)**, c**omposting is generally defined as the biological oxidative decomposition of organic constituents in wastes under controlled conditions which allow development of aerobic micro- organisms that convert biodegradable organic matter into a final product sufficiently stable for storage and application without adverse environmental effects.

The soil application of co-composted manure has several advantages over fresh manure, such as reduced numbers of viable weed seeds, reduced volume and particle size, which facilitates land distribution, a better balanced nutrient composition, stabilized organic matter and a slower release of nutrients. This topic has recently been reviewed by Moral *et al.* (2009) and also the process destroys pathogens, converts nitrogen from unstable ammonia to stable organic forms and reduces the volume of waste. Similar opinion stated by Zhu (2007), Haug (1993) and Zhu (2007).

Guo *et al.* (2012) investigate that composting is an economical and effective way to treat animal manure for land application. This is because pathogens and weed seeds are destroyed and the heterogeneous solid-state organic matter is transformed to more stable humic substance by the activity of bacteria.

Legros and Petruzzelli (2001) reported that the application of compost to soil is of considerable interest as a means of maintaining a suitable soil structure, as well as a means of adding organic material to soil whose organic matter content has been reduced by the practice of intensive agriculture.

Wang *et al.* (2003) investigated the changes of soil quality attributes in field plots after 3-5 years of annual paddy-upland crop rotation with various fertilizations. Other than the amendments of green manure, compost, and peat, chemical fertilizer N in the amounts of 33% and 67% of established N rate were complemented. After rice harvest, the soil water tension was significantly greater in soils amended with peat and/or compost than that with chemical fertilizer and the check. The bulk density of surface soils of the field plots amended with organic materials was significantly lower than that of the check. The percentages of water stable aggregate in 1-2 and 0.5-1 mm particle size fractions of the soils, amended with peat and compost, were significantly higher than those amended with chemical fertilizer and the check.

Lopez-Real (1995) considered that the market wastes could be co-composted with sawdust waste. Compost that has been made from a variety of materials is likely to provide the best spectrum of nutrients. Thus the range and supply of different materials may need to be considered in a waste management strategy for soil amelioration.

Leonard (1986) reported NPK ranges for composted materials as 0.75 – 1.5%N, 0.25 – 0.5%P_2O_5 and 0.5 – 1.0%K_2O.

Tejada *et al.* (2009) conducted an experiment and reported that compost application is mostly concentrated on the improvement of soil physio-chemical parameters.

Wahba (2007) and Bastida *et al. (*2010) reported that compost has the unique ability to improve soil properties and the growing media physically, chemically and biologically.

Castillo *et al.* (2012) observed that the amount of straw to be incorporated and its respective N content are critical in SOM (soil organic matter) accumulation. Higher amount of straw incorporated resulted to higher SOM accumulation. Incorporation of 4-5 ton ha^{-1} straw, which is equivalent to one season straw biomass production per hectare, was not enough to significantly change the level of SOM, as well as the physical and chemical properties of the soil. Nevertheless, continuous recycling and incorporation of rice straw in soil during fallow period may lead to the improvement of soil properties over the long-term.

Harris *et al.* (2001) investigated that compost is also a slow-release fertilizer compared with fresh manure, its N is in a more stable form and not susceptible to loss as NH3 gas (Leonard, 1986). The nutrient value of compost varies a lot and depends on what it is made from. A side from N, P and K, it supplies varying amounts of secondary nutrients and micro-nutrients. In addition some compost contains other growth promoting substances such as B vitamins, natural hormones and organic acids. In the preparation of compost it is desirable to mix materials for composting in the proportions that give rapid, effective and complete decomposition to a stable product.

Tasseva and Krishkov (2007) conducted a field experiment to improve soil physical and chemical properties in organic agriculture. The incorporation of green manure crops, the application of compost and other organic fertilizers and amendments, combined with suitable soil cultivation practices are part of the practices, aimed at achieving this goal. The role of soil microorganisms in achieving optimal nutritional regime in organic agriculture was reviewed. Soil microbial flora control for the enhancement of the domination of the beneficial and effective microorganisms could prove to be a means for the improvement and maintenance of optimal physical and chemical soil properties in organic agriculture.

Rathi, (2006) investigated that waste is an unavoidable by-product of human activities and its production maintain positive relation with increasing population that are responsible for increasing the global pollution.

Mcintire *et al.* (1992) revealed that in an on-station research applied quantities of manure were approximately 2.5 to 20 tons ha^{-1}, whereas farmers' actual application levels ranged from 175 to 700 kg ha^{-1}

Mizanur (2010) observed that waste management is considered to be one of the most serious environmental problems confronting urban areas in Bangladesh. Conversely, upon its proper management waste may treat an important resource because it contains essential plant nutrients for crop production. Waste recycling is becoming an essential component of sustainable environment.

Hogland *et al.* (2003) investigated that household wastes products are the source of homestead, which is not widely practiced for crop production due to lack of sufficient information regarding this. Mixture of household waste especially kitchen waste, dining waste, domestic refuses residues from food processing are used as component of compost. The compost domestic wastes possesses a high nutritional value with high concentration of nitrogen, phosphorus and potassium improve soil physical properties while the contamination by heavy metals and other toxic substances is negligible

2.5 Combined use of organic manure and inorganic fertilizer

Rahman (2001) reported that in rice-rice cropping pattern, the highest grain yield of Boro rice was recorded in the soil test basis (STB) NPKSZn fertilizers treatment while m T. aman rice the 75% or 100% of NKSZn (STB) fertilizers plus Green manure (GM) with or without cowdung(CD) gave the highest or a comparable yield. The mean yearly N, P, K, S and Zn uptake by rice (Boro +T. aman) increased with increasing supply of nutrients. Application of cowdung along with NPKSZn (STB) resulted in markedly uptake of nutrient in Boro rice. In T. aman rice, application of NPKSZn (STB) with GM or CD showed higher N, P, K, S and Zn uptake than that with NPKS (FRG) and NPK (FP) treatments. The total N content and the available P, K, S and Zn status in soils increased slightly due to manuring. The whole results suggest that the integrated use of fertilizers with manure (viz, Sesbania, cowdung) can be efficient practice for ensuring higher crop yields without degradation of soil fertility.

Reganold *et al. (*1990) and Nambiar (1991) were reported that a suitable combination of organic and inorganic source of nutrients is necessary for sustainable agriculture that can ensure food production with high quality viewed that integrated use of organic manure and chemical fertilizers would be quite promising not only in providing greater stability in production, but also in maintaining better soil fertility.

Subbiah and Kumaraswamy (2000) revealed that any one of the organic manures @ 5t ha^{-1} plus recommended levels of N, P_2O_5, K_2O and gypsum gave significantly higher rice yield than the treatment that received N, P_2O_5, K_2O and alone.

Zaman *et al.* (2004) reported that chemical properties like organic matter content, CEC, total N, exchangeable K, available P and S were favorably influenced by the application of organic sources of nitrogen and potassium.

Yogananda *et al.* (2004) conducted an experiment and the results showed that combined application of either 8.5 tones of urban compost + 50:50 kg PK ha^{-1}or 4.25 tones urban compost + 100:50:50 kg NPKha^{-1} to hybrid rice was better than NPK fertilizer alone.

Bodruzzaman *et al.* (2010) reported that percent OM (organic matter) was reduced (13 to 19%) with inorganic fertilizers and increased (7 to 39%) with organic manures. Percent total N was unchanged in OM plots, but reduced in others. Available P increased dramatically in poultry manure (PM) plots and was reduced in control plots. Exchangeable K was reduced in control and inorganic fertilizer treatments, but was sustained for others. After 9 years, OM%, total N% and exchangeable K were reduced further in inorganic treatment and increased in OM treatments. The soil pH increased in PM receiving treatments.

Prasithikhet *et al.* (1993) used organic and mineral fertilizers in farmers' rice fields and recommended that a low rate of compost manure should be used with mineral fertilizer over a long period in order to promote high rice yields and good soil fertility.

Parvez *et al.* (2008) Poultry manure performed better in increasing plant height in combination with chemical fertilizers as compared to compost and cowdung. Compost when applied @ 5 t ha^{-1} with 75%RFD (T_4) produced taller plants compared to the application of cowdung @ 5 tha^{-1} with same doses of chemical fertilizers (T_2), also observed that the plant height was significantly influenced by the incorporation of organic manures and fertilizers.

Choudhary *et al.* (2009) found that application of organic and inorganic fertilizers also improved soil organic carbon, total N and available NPK content over initial status and over the years as studied at the end of first and second year of experimentation. The study revealed that integrated use of organic manures and inorganic fertilizers can play a key role in improving crop productivity, nutrient uptake and soil fertility in wheat-rice sequence besides substantial organic carbon and total N build up in wet temperate western Himalayan soils.

Mahavishnan *et al.* (2004) conducted a field experiment during the kharif season of 2000 in Andhra Pradesh, India to investigate the effects of organic fertilizer sources on the growth and yield of rice cv. BPT-5204. The experiment included N:P:K at 75, 100 and 125 % of the recommended rate (RDF, 120: 60: 40 $kgha^{-1}$), combine with farmyard manure (FYM) at 10 tha^{-1} ; poultry manure at 5 tha^{-1} and glyricidia (Gliricidia sp.) at 10 t/ha, alone with control and fertilizer application based on test crop response (N:P:K at 104: 52: 74 $kgha^{-1}$). The crop growth and yield were higher with 125% RDF –poultry manure and 100% RDF + poultry manure compared to the other treatments.

Jha *et al.* (2004) observed that 50:40:30 kg NPK ha^{-1} + 3 ton CD and urea mixture /ha produced significantly higher yield compared with application of inorganic fertilizer alone.

Ali *et al.* (2009) revealed that application of 3 tha^{-1} poultry manure (PM) once in a year with 70% NPKS can reduce the use of 30% NPKS as fertilizers. There were negative balances for N and K with the highest mining of K, while the balances for P and S were positive. The economic analysis reveals that most of the treatments produced BCR (benefit-cost ratio) of more than 3.0 showing that they all are economically viable. The integrated use of fertilizers and manure resulted in considerable improvement in soil health by increasing organic matter, available P, and S contents of soils.

Azad and Leharia (2002) conducted a field experiment during Kharif of 1995 and 1996 in Jammu, India to investigate the effect to NPK application with and without poultry manure (PM at 10 t ha^{-1}) and Zn (as $ZnSO_4$ at 20 kg ha^{-1}) on growth and yield of rice cv. PC-19. Results indicated that application of poultry manure in combination with different NPK levels exhibited a significant increase in effective tillers m^{-2} row and grain and straw yields over NPK, a significant increase in growth and yield and straw (13187 kg ha-1) yields were recorded from T_7 and the lowest from T_4.

Singh *et al.* (2001) studied the effect of poultry manure under irrigated condition with nitrogen in rice wheat cropping system in an Alfisols of Bilaspur, Madhya Pradesh, India. The treatments 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 along and in combination. Root and shoot biomass was higher in 100% N through poultry manure, followed by 75% N through poultry manure and 25% N through urea.

Jahan (2014) conducted an experiment on effect of Prilled Urea, Urea Super Granule, alone and in combination with Poultry Manure (PM) on the rice field water properties and yield of BR21. She found that the USG application generated available NH_4-N slowly rather spontaneously compared to PU over the entire growth period. The overall result indicate that application of USG with PM could be considered more effective in rice production for reducing N losses, conserving N and increasing the efficiency of applied N.

Islam *et al.* (2007) observed that conventional spacing of 25-15 cm in combination with 50% N, P, K, S, Zn fertilizers 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

Singh *et al.* (2006) conducted an experiment during kharif 2004, on an Inceptisol in Varanasi, Uttar Pradesh, India to evaluate the effects of chemical fertilizer (urea), cowdung and biofertilizer (Azospirillum) on the yield of rice and physicochemical properties of the soil. Application of chemical fertilizer, cowdung and Azospirilluni, individually or in combinations, significantly increased the yield attributes (plant height, number of tillers, panicle length, grain yield and straw yield) over the control. The treatment comprising 80 kg N ha^{-1} + Azospirillum + 2.5 t cowdung ha^{-1} was superior over all other treatments in terms of rice yield.

Qiao *et al.* (2011) found that inorganic-organic fertilizer incorporation could effectively promote the organic matter to be accumulated in the soil. After N, P and K entered rice cropping system and organic matter cycling of system had been maintained, the pools of total N, P and K could be strengthened.

Palm (1995) also obtained significant increase in crop yields when a combination of organic and mineral fertilizers was applied compared with sole application of organic or mineral fertilizer.

Mizanur (2010) revealed that different organic wastes are rich source of essential plant nutrients. They could be used to supplement nutrients to crops and improve soil physio-chemical properties. The present study revealed that application of 30% household waste produced the significantly higher grain yield (58.94 g pot-1) even over the recommended doses of N, P and K. The maximum sustainable yield index (SYI) 0.91 was found when 10% poultry manure and 30% cow dung were applied to soil, whereas the value was 0.67 when 30% HW was applied. However, before approaching to a conclusion on SYI, it demands long time field experiment using these organic wastes.

Namreen *et al.* (2013) investigate that efficient plant nutrition management enhances and sustains agricultural production and safeguards the environment. The use of organic and inorganic fertilizer has its advantages and disadvantages in terms of nutrient supply, soil quality and crop growth. Developing a suitable nutrient management system that integrates use of these fertilizers may be a challenge to reach the goal of sustainable agriculture.

Singh *et al.* (2010) found that integrated nutrients management practices T10 (RDF50+GM50) produced significantly higher plant height, number of tillers m^{-2}, 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.

Ali *et al.* (2009) found that integrated use of inorganic fertilizers and organic manure is necessary for crop production as well as maintaining soil fertility. The findings of the experiment revealed that 70% of recommended dose of inorganic fertilizers and 3 tons poultry manure per hectare performed better production. Therefore, 30% of inorganic fertilizer may be replenished by organic manure which is economically viable for the farmers.

Harris *et al.* (2001) reported that manure, when applied, will be mineralized gradually and nutrients become available. However, the nutrient content of manure varies, and the reason is that the fertilizer value of manure is greatly affected by diet, amount of bedding, storage and application method.

Cross and Strauss (1985) quoted the following for municipal wastes, 0.4 – 3.6 % N, 0.3 – 3.5 % P_2O_5, and 0.5 – 1.8 % K_2O.

Mannan *et al.* (2000) reported that manuring with cowdung up to 10 t ha^{-1} in addition to recommended inorganic fertilizers with the rate of N application improved grain and straw yields and quality of transplant aman rice over inorganic fertilizers alone.

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

Laxminarayana (2000) cited that application of 100%NPK + poultry manure(PM) @ 5 t ha^{-1}gave the highest grain yields of rice among the treatments and the lowest grain yield was obtained with 100% N treated plot. Application of 3 tha^{-1} PM once in a year with 70% NPKS can reduce the use of 30% NPKS fertilizers. There were negative balances for N and K with the highest mining of K, while the balances for P and S were positive. The economic analysis reveals that most of the treatments produced BCR (benefit-cost ratio) of more than 3.0 showing that they all are economically viable. The integrated use of fertilizers and manure resulted in considerable improvement in soil health by increasing organic matter, available P, and S contents of soils.

Rajni *et al.*(2001) conducted a pot experiment in a glasshouse of Varanasi, Uttar Pradesh, India during Kharif season to assess the response of rice to different combination of vermicompost (VC), poultry manure and nitrogen fertilizers. Results revealed that all integrated treatments significantly increased plant height, number of effective panicles pot-1and dry weight panicle-1over the having full N dose through urea.

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

Parvez *et al.* (2008) conducted an experiment at the soil science field laboratory, Bangladesh Agricultural University, Mymensingh during aman season of 2006 to evaluate the combined effects of poultry manure(PM), cowdung(CD), Dhaincha and fertilizers on the yield and nutrient uptake by BRRI dhan 30. The treatment receiving 80% recommended fertilizer dose (RDF) with 3t ha^{-1} poultry manure produced the higher grain yield of 4867 kg ha^{-1} and straw yield of 5797 kg ha^{-1}. The performance of manures may be ranked in order of PM> Dh> CD.

Rahman *et al.* (2009) conducted an experiment at the soil science field laboratory, Bangladesh Agricultural University, Mymensingh during boro season of 2007 to evaluate the effect of Urea-N in combination with poultry manure and cowdung on BRRI dhan 29. Application of manures and different doses of urea-N fertilizers significantly increased the yield components and grain and straw yields of BRRI dhan 29. The treatment receiving N 80kg ha^{-1} and PM 3t ha^{-1} produced the highest grain yield of 5567.29 kg ha^{-1} and straw yield of 6991.78 kg ha^{-1}.

Saitoh *et al.* (2001) conducted an experiment to evaluate the effect of organic fertilizers (cowdung and poultry manure) and pesticides on the growth and yield of rice and revealed that the yield of organic manure treated and pesticide free plots were 10% lower than that of chemical fertilizer and pesticide-treated plot due to a decrease in the number of panicle.

Venkatakrishnan *et al*. (2003) Field trials in different parts of the world have shown significant increase in grain yield of many rice varieties under integrated fertilization. Frequent crop cultivation using modern / high yielding varieties to meet the demand for increasing population has led to a depletion of soil fertility. Due to continuous exhaustion of plant nutrients from the soil, farming system has become unstable. No crop cultivation system will be sustained if the nutrients input and output in the soil is least balanced. The farmers use chemical fertilizers as a supplemental source of nutrients but they do not apply in balanced proportion (BARC, 2005).

2.6 Effects of organic manure and inorganic fertilizer on soil health

Ali *et al*. (2009) organic matter undergoes mineralization with the release of substantial quantities of N, P, and S and smaller amount of micro-nutrients. In Bangladesh, most of the cultivated soils have less than 1.5% organic matter, while a good agricultural soil should contain at least 2% organic matter. Moreover, this important component of soils is declining with time due to intensive cropping and use of higher doses of nitrogenous fertilizers with little or no addition of organic manure

Walker *et al.* (2007) conducted an experiment to evaluate the change in Lancaster extractable P, K, Ca, Mg, Na, Zn as well as soil pH and total N on Sharkey soils (very-fine, smectitic, thermic Chromic Epiaquert). Concentrations of total N and Lancaster P declined with soil profile depth on Sharkey clay and Sharkey silty clay soil. Soil pH significantly decreased at one of two locations. Rice grain yields decreased as the percentage of pre-flood (PF) N increased for 'Lemont.' Optimum yields for 'Priscilla' were obtained at 151 to 202 kg N

Kumar *et al.* (2010) observed that post-harvest soil fertility status viz., organic carbon, available nitrogen, phosphorus and potassium was highest by substituting 50% N fertilizer with any of the organic source compared to recommended dose of N entirely through inorganic source. Lowest soil organic carbon and available nitrogen was registered with control while, lowest available phosphorus and potassium was with 100% N through urea.

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

Jian *et al.* (2011) reported that high amount and the same ratio of organic manure combined with chemical fertilizers is the best to improve soil quality and decrease the accumulated amount of NO_3-N in soil, respectively. In consideration of soil quality and environmental protection, the ratio of organic manure combined with chemical fertilizers should be used in the region.

Hemalatha *et al.* (2000) revealed that green manure significantly improved the soil fertility status, organic carbon, available soil N, P and K at post-harvest soil.

Efthimiadou *et al.* (2010) investigate that emerging evidence indicated that integrated soil fertility management involving the judicious use of combined organic and inorganic resources is a feasible approach to overcome soil fertility constraints.

Silva *et al.* (2005) conducted a field experiment to evaluate the possibilities of increasing crop yields and soil nutrients by combined application of organic manure (straw, cattle manure, poultry manure and compost) and chemical fertilizers under rice crop rotation in 2004 yala and 2004/2005 maha seasons. Results of the experiment revealed that higher crop growth and yield can be obtained by combining organic manures and chemical fertilizers. Among the organic manure and chemical fertilizer combinations tested, poultry manure +

NPK showed the highest (493% in yala and 256% in maha) and rice straw + NPK combinations showed the lowest (361% in yala and 145% in maha) grain yields and increase of soil nutrient status, respectively. They concluded that the combined application of poultry manure and chemical fertilizer is better compared to the organic manure + NPK combinations in sustaining crop yield and soil nutrient (status).

It can be said that a stable compost when added to soil as an organic amendment improves the functionality of soil. An evidence to support this statement is a finding by Piccolo et al. (2004) regarding plant, growth and soil fertility can be improved when stable and mature compost is added to soil as an organic amendment. For a compost to be safely used in soil, it needs a high degree of stability and maturity which means stable organic matter content and the absence of phytotoxic compounds and plant or animal pathogen. One of the environmental advantages of compost as a soil amendment is the decreased mineralization rates may reduce the nitrate leaching potential by delaying the conversion of organic N to mobile nitrate (Evanylo *et al.* 2008).

Islam *et al.* (2010) observed that insignificant increase in soil organic matter (SOM) due to the application of organic residues. However, long-term application of organic residues is expected to increase SOM in tidal flooded soil and which may contribute to soil health as well as rice yields.

Azim (1999) reported that organic manuring slightly increased the organic matter content, total N, available P, exchangeable K and available S and CEC of soil where as a decreasing trend was noted with application of chemical fertilizers.

Hoque (1999) reported that organic manuring slightly increased the organic matter content, total N, available P, exchangeable K, available S and CEC in soil.

Nambiar *et al.* (1998) observed that long term fertilizer experiments established in India in 1970-71 have shown that continuous application of N fertilizer alone to soil had a deleterious effect on soil productivity was noticed in rice-rice system on tropaquepts (Hyderabad) associated mainly with the loss of inherent soil fertility. The nutrients removed by this cropping system for exceeded the nutrients applied.

Xu *et al.* (1997) observed that application of organic matters affected soil pH value as well as nutrient level.

Sarkar and Singh (1997) reported that soil pH was decreased to 6.5-6.6 by application of organic fertilizer alone compared with the initial pH of 6.7, however a combination of organic + inorganic fertilizerincreased soil pH from 6.6 to 6.8. Organic fertilizers alone or in combination with inorganic fertilizers increased the level of organic carbon in the soil as well as the total N, P and K content of soil.

Mathew and Nair (1997) reported that cattle manure when applied alone or in combination with chemical fertilizer of NPK increased the organic carbon content, total N, available P and K in rice soils.

Chaphale and Badole (1999) reported that incorporation of glyricidia leaf foliage increased organic C, total N, available NPK, water holding capacity and decreased the bulk density of soil.

Koppen and Eich (1993) noted that application of farmyard manure K and P deficiencies were reduced, and with rising pH values, the Mn content of the soil declined. The potential of manure, especially poultry manure, to neutralize soil acidity and raise soil pH is less well known. Long term field and greenhouse studies have demonstrated the liming effect of animal manure in acid and neutral soils.

2.7 Residual effects

Ramamurthy and Shivashankar (1996) conduct an experiment that residual effect of organic matter added to the soil by the manure refers to the carry-over benefit of the application on the succeeding crop.

Ginting *et al.* (2003) stated that residual effects of organic materials on soil properties can contribute to improvement in soil quality for several years after application ceases

Urkurkar *et al.* (2010) carried out an experiment in Inceptisols about the influence of long-term use of inorganic and organic manures on soil fertility and sustainable productivity of rice (Oryza sativa) and wheat (Triticum aestivum). Residual effect of green manure was significant also observed on the following wheat crop, 50% recommended dose of fertilizer + 50% N (green manure) also maintained the sustainability of the system.

Cooke (1970) carried out an experiment that the residual effect of a single dressing of phosphorus and potassium is usually much smaller than the direct effect the year before and may be too small to measure accurately in experiments. Only the cumulative residual effects of many annual dressings are large and may be sufficient for normal yields of crops with minute additions of fertilizer.

Roberts (2008) announced that fertilizer nutrients applied, but not taken up by the crop, are vulnerable to losses through leaching; erosion or they could be temporarily immobilized in soil organic matter, all of which impact nutrient use efficiency.

Hsieh *et al.* (1996) examined that farmers are now showing interest in organic farming because of, they are more aware about the residual effect of chemical substances used in the crops field and environmental degradation. On the other hand, the excess application of inorganic fertilizer causes hazard to public health and to the environment.

Motavalli *et al.* (1989) reported that residual effects of manure or compost application can maintain crop yield level for several years after manure or compost application ceases since only a fraction of the N and other nutrients in manure or compost become plant available in the first year after application.

Peng *et al.* (2002) conducted a field experiment where one hundred and sixteen soil samples were collected from cultivated soils in Southeast Fujian, China. Field experiments showed that there was a different yield increasing efficiency with application S at the doses of 20-60 kg ha^{-1} to rice plant.

From the above reviews combined application of inorganic fertilizers and organic manures (composts, cowdung and poultry manure) are essential to increase crop yield per unit area in both Boro (BRRI dhan29) and Aman (BRRI dhan49). It is also essential to look after immediate crop needs in order to build up soil fertility and to conserve good soil health for increasing crop production in future. Thus there may have enough scope investigating the effect of combined use of fertilizer and manures in favors of yield improvement of BRRI dhan29 and BRRI dhan49.

CHAPTER III

MATERIALS AND METHODS

This chapter presents a brief description about the work which was related to the experiment. It represents a brief description about the experimental site, soil, climate, crops, treatments combination, experimental design, land preparation, seedling transplanting, intercultural operations, harvesting, data recording, collection and the methods for the chemical, economical and statistical analysis. To fulfill the objectives of the experiment six research works were performed separately under two (Boro and Aman) seasons.

1. **Effects of different inorganic fertilizers and organic manures on growth, yield and nutrient content of Boro rice**

a) Effects of compost and different inorganic fertilizers on growth, yield and nutrient content in Boro rice (BRRI dhan29)

b) Effects of cowdung and different inorganic fertilizers on growth, yield and nutrient content in Boro rice (BRRI dhan29)

c) Effects of poultry manure and different inorganic fertilizers on growth, yield and nutrient content in Boro rice (BRRI dhan29) and another three research works under the experiment:

2. Effects of different inorganic fertilizers and organic manures on growth, yield and nutrient content of Aman rice

a) Effects of compost and different inorganic fertilizers on growth, yield and nutrient content in Aman rice (BRRI dhan49)

b) Effects of cowdung and different inorganic fertilizers on growth, yield and nutrient content in Aman rice (BRRI dhan49)

c) Effects of poultry manure and different inorganic fertilizers on growth, yield and nutrient content in Aman rice (BRRI dhan49).

Compost along with inorganic fertilizer in both season carried out in Shere Bangla Agricultural University (SAU) Farm, Dhaka and cowdung, poultry manure along with inorganic fertilizer in both season were conducted in the farmer fields of Shakhepur upazila under Tangail District respectively during the period from November 2013 to May 2016. In

case of Boro season 1. **Effects of different inorganic fertilizers and organic manures on growth, yield and nutrient content of Boro rice** above mentioned experiment includes three sub experiment has been decorated into a number of sub-heads and were presented below under the following headings–

3.1 Experimental site

The experiment was conducted at the Sher-e-Bangla Agricultural University farm (SAU Farm), Dhaka and Shakhepur, Tangail respectively during the boro season of 2013-2014. The site of the experiment (SAU Farm) is in the $23^{\circ}74$ N latitude and $90^{\circ}35$ E longitudes with an elevation of 8.2m above flood level.This soil belongs to the Modhupur tract under Agro-Ecolological Zone 28 (AEZ-28). The area Shakhepur, Tangail belong to the Old Brahmaputra Flood Plain (AEZ 9). The morphological, physical and chemical characteristics of the soil were presented in Table 2.

3.2 Climate

The climate of the experimental area is characterized by a scanty rainfall associated with moderately low temperature in the *rabi* season (October-March). Details of the meteorological data of air temperature, relative humidity, rainfall and sunshine hour during the period of the experiment was collected from the Weather Station of Bangladesh, Sher-e-Bangla Nagar, Dhaka and details has been presented in Appendix I.

3.3 Composting of Household waste

The raw materials such as non-edible foods, fruits and vegetable wastes products left after meal etc. were collected from different houses of the Sher-e-Bangla Agricultural University (SAU) campus and mixed well near the compost preparing shed which was laid out in the front part of the academic building adjacent to the wall of Sher-e-Bangla Agricultural University, Dhaka during July-October in 2013. The mixed materials were moistened and shredded to reduce the size and enhance the decomposition process. The shredded materials were piled at the height of 1-1.5 m under shed covered with plastics to increase the temperature, maintain moisture and minimize escape of gases to the atmosphere. The temperatures of the pile were monitored weekly. Then the piled were opened and turned thoroughly after two weeks to facilitate decomposition. The materials were keep rest to complete decomposition and produce mature compost that looked like soil. The composed materials were spreaded on a flat floor in drying area for at least a week. Sun drying was avoided. All organic matter eventually decomposes. Composting speeds the process by providing an ideal environment for bacteria and other decomposing microorganisms, and the final product looks like soil. Decomposing organisms consist of bacteria, fungi and larger organisms such as worms and numerous other bugs.

3.4 Composting of cowdung

The organic manures 'Cowdung' were collected from different cattle farms of Shakhepur upazila under Tangail District. These cowdung were decomposed properly near the experiment field site of Shakhepur upazila under Tangail District. A burrow was made for preparing the cowdung compost. The size of the burrows was made 6 feet long, 6 feet wide and 3 feet deep. Burrows may vary in size according to the availability of organic matter, but depth must never exceed 3 feet, otherwise the activity of microorganisms slows down, decelerating the process of decomposition. Two parallel burrows was dug and a dyke was built around them, so that rain water will not enter. Collected cowdung was arranged into burrows. After filling the burrow, it was covered with jute sac. To mix the compost evenly, the materials was transferred from the filled burrow to an empty one whenever needed. In order to ensure proper aeration, compost prepared with the burrow method needs to be mixed thoroughly on a regular basis. compost is thoroughly mixed occasionally, the decomposition will be homogeneous and rapid (Annonymous, 2008).

3.5 Composting of poultry manure

The 'Poultry Manures' were collected from different poultry farms of Shakhepur upazila under Tangail District. These poultry manure were decomposed properly near the experiment field site of Shakhepur upazila under Tangail District. The composting process of poultry manure was occurred by the participation of large number of aerobic micro-organisms (mainly mesophilic and thermophilic bacteria, protozoa, fungi, rotifer) that decompose organic material in order to maintain their proper growth and reproduction. Moisture and carbon-nitrogen ratio (C/N ratio) of the composting materials were also very important factor for the composting process. Moisture was be maintained within 55-65% in the composting pile. The decomposition of organic matter by microorganisms increases the temperature in the compost pile and it was the most important indicator of the efficiency of composting. Initially mesophilic organisms were responsible for the break down of the readily available organic matter and started to increase the temperature of the compost pile and reaches up to 40-45 °C temperature within 2-3 days. The initial low temperature period was called lag period, and this lag period is necessary for the development of the microbial population. Thermophilic organisms were active when the pile temperature reaches at 40-45 °C and then the temperature reaches up to 60-70 °C within a short period. High temperature period is called active composting period and maximum biodegradation is occurred at this period.

As the pile temperatures increase into the thermophilic stage, the pile becomes inhabited by a diverse population of micro-organisms operating at peak growth and efficiency. All odors were removed from the composting pile during active composting period. As a result, microbial population and their activity were starts to decrease. As microbial activity decreases, more heat was lost from the pile than is generated, and the compost pile begins to cool. Thermophilic stage ranges between 1 to 2 weeks depending on the nature of composting materials. Compost pile needs to turn over after every 3-4 days for proper aeration and mixing. Curing stage was started after active composting and was characterized by a lower level of microbial activity. When curing was reached its final stage, the compost is said to be stabilized. Proper management of moisture and oxygen was still required during the curing period to maintain microbial activity. Larger particle size were also converted into smaller parts during curing period. Curing was generally considered as complete when the pile temperature reaches to the ambient temperature. (Anonymus, 1979)

3.6 Calculation of Moisture%

Moisture 15% or more considered solid for pupose of the study, (Bruce *et. al.* 2003).

$$\% \text{ Moisture} = \frac{(\text{Weight undried sample+Container})-(\text{Weight dried sample+Container})\times 100}{(\text{Weight undried sample+Container}) - (\text{Weight of empty container})}$$

$$\% \text{ Dry matter} = \frac{(\text{Weight dried sample+Container}) - (\text{Weight of empty container })\times 100}{(\text{Weight undried sample+Container}) - (\text{Weight of empty container})}$$

Dry matter or moisture can be calculated from other as cmplement of 100% original content.

% Dry matter = 100- % Moisture

% Moisture = 100-% Dry matter

3.7 Chemical analysis of organic manures (composts, cowdung and poultry manure)

3.7.1 % Total Nitrogen

One gram of oven dry sample was taken into micro kjeldahl flask to which 1.1 g catalyst mixture (K_2SO_4: $CuSO_4.5H_20$: Se=100: 10: 1), 2mL 30%H_2O_2 and 5 mL H_2SO_4 were added. The flasks were swirled and allowed to stand for 10 minutes. Then heating (380°C) was continued until the digest was turned into clear and colorless. When the mixture was cooling, then it was taken into 100 mL volumetric flask and the volume was made up to the mark with distilled water. A blank reagent was prepared in a similar way. These digest was used for nitrogen determination. After completion of digestion, 40% NaOH was added with the digest for distillation. The evolved ammonia was trapped into 4% H_3BO_3 solution and 5 drops of mixed indicator of bromocressol green ($C_{21}H_{14}O_5Br_4S$) and methyl red ($C_{10}H_{10}N_3O_3$) solution. Finally the distillate was titrated with standard 0.01 N H_2SO_4 until the color changed from green into pink (Bremner and Mulvaney, 1982).

The amount of N was calculated using the following formula.

$\% N = (T-B)\times N\times 0.014\times 100/S$

Where, T= Sample titration value (ml) of standard H_2SO_4

B= Blank titration value (mL) of standard H_2SO_4

N = Strength of H_2SO_4

S= Sample weight (g)

N = Normality or strength of H_2SO_4,

1.4 = Conversion factor

3.7.2 % Phosphorus content

Available phosphorus was extracted from the samples by shaking with 0.5 M $NaHC0_3$ solution at pH 8.5 following Olsen method (Olsen *et al*. 1954). The extracted phosphorus was determined by developing blue color by $SnCl_2$ reduction of phosphomolybdate complex and measuring the intensity of color spectrophotometrically at 660 nm wavelength and the readings were calibrated to the standard P curve.

3.7.3 % Potassium content

Exchangeable potassium was extracted from the samples with 1.0 N NH_4OAc (pH 7) and K was determined from the extract by flame photometer (Black, 1965) and calibrated with a standard curve.

The N, P and K content in compost, cowdung and poultry manure shown below Table 1.

Table 1: Nutrient content of cowdung, poultry manure and compost

Organic manure	Nutrient Content (%)		
	N	P	K
Composts	0.98	0.65	0.78
Cowdung	1.18	0.45	0.47
Poultry manure	0.92	3.42	1.04

3.8 Collection of initial soil and analysis

The soil of the experimental site belongs to the general soil type, Deep Red Brown Terrace Soils under Tejgaon Series. Top soils were silty loam in texture, olive-gray with common fine to medium distinct dark yellowish brown mottles. The experimental area was flat having available irrigation and drainage system and above flood level. Soil samples from 0-15 cm depths were collected from experimental field. Soil samples were analyzed for both physical and chemical properties in the laboratory of the Soil Resource and Development Institute (SRDI), Farmgate, Dhaka. The initial soil samples were collected for analysis included particle size distribution, textural classes, soil pH, organic matter, total N (%), available P (ppm), exchangeable K (meq/100 g soil), available S (ppm), exchangeable Ca (meq/100 g soil), exchangeable Mg (meq/100 g soil) and available Zn (μg /g). The soil was analyzed following standard methods. Soil pH was measured with the help of a glass electrode pH meter using soil water suspension of 1:2.5. The morphological characteristics and initial physico- chemical properties of soils are presented in Table 2.

3.8.1 Textural classes

Particle size analysis of soil was done by hydrometer method (Black, 1965) and textural class was determined by plotting the value of % sand, % silt, % clay to Marshall's triangular coordinate following the USDA system.

3.8.2 Soil pH

The pH was measured with the help of glass electrod pH meter using soil water suspension of 1:25 as described by Jackson (1962). By using standard buffer solutions to standardize pH meter weighed 10 grams of soil into a 50 ml beaker. 10 ml of distilled water was added and stared thoroughly. Let stand for at least 30 minutes, stirred two or three times. A pH meter using a glass electrode was read.

3.8.3 Soil Organic Matter

Organic matter in soil was determined by methods of Walkley and Black's (1934) Wet Oxidation method. The principle is to oxidize the organic carbon with an excess of 1N $K_2Cr_2O_7$ in presence of conc. H_2SO_4 and to titrate the residual $K_2Cr_2O_7$ solution with 1N $FeSO_4$ solution. To obtain the organic matter content, the amount of organic carbon was multiplied by the Van Bemmelen factor, 1.73.

Calculate C (%) and organic matter (%)

a. Easily Oxidizable Organic C (%)

C (%) = (B-S) x M of Fe^{2+} x 12 x 100 g of soil x 4000

where: B = ml of Fe^{2+} solution used to titrate blank S = ml of Fe^{2+} solution used to titrate sample 12/4000 = equivalent weight of C in g.

To convert easily oxidizable organic C to total C, divide by 0.77 (or multiply by 1.30) or other experimentally determined correction factor. To convert total organic C to organic matter use the following equation:

b. Organic Matter (%)

OM (%) = Total C (%) x 1.73

3.8.4 Total Nitrogen

One gram of oven dry ground soil sample was taken into micro kjeldahl flask to which 1.1 g catalyst mixture (K_2SO_4:$CuSO_4.5H_20$: Se=100: 10: 1), 2mL 30%H_2O_2 and 5 mL H_2SO_4 were added. The flasks were swirled and allowed to stand for some minutes (about 10 minutes). Then heating (380°C) was continued until the digest was turned into clear and colorless. When the mixture was cooling, then it was taken into 100 ml volumetric flask and the volume was made up to the mark with distilled water. A blank reagent was prepared in a similar way. These digest was used for nitrogen determination. After completion of digestion, 40% NaOH was added with the digest for distillation. The evolved ammonia was trapped into 4% H_3BO_3 solution and 5 drops of mixed indicator of bromocressol green ($C_{21}H_{14}O_5Br_4S$) and methyl red ($C_{10}H_{10}N_3O_3$) solution. Finally the distillate was titrated with standard 0.01 N H_2SO_4until the color changed from green into pink. (Bremner and Mulvaney, 1982).

The amount of N was calculated using the following formula.

% N = (T-B)×N×0.014×100/S

Where, T= Sample titration value (mL) of standard H_2SO_4

B= Blank titration value (ml) of standard H_2SO_4

N = Strength of H_2SO_4

S= Sample weight (g)

N = Normality or strength of H_2SO_4,

1.4 = Conversion factor

3.8.5 Available Phosphorus

Available phosphorus was extracted from the soil samples by shaking with 0.5 M $NaHCO_3$ solution at pH 8.5 following Olsen method (Olsen *et al*. 1954). The extracted phosphorus was determined by developing blue color by $SnCl_2$ reduction of phosphomolybdate complex and measuring the intensity of color spectrophotometrically at 660 nm wavelength and the readings were calibrated to the standard P curve.

3.8.6 Exchangeable Potassium

Exchangeable potassium was extracted from the soil samples with 1.0 N NH_4OAc (pH 7) and K was determined from the extract by flame photometer (Black, 1965) and calibrated with a standard curve.

3.8.7 Available Sulphur

Available sulphur in the soil was determined by extracting the soil samples with $CaCl_2$ (0.15%) solution (Page *et al*., 1982). The sulphur in the soil was determined by spectrophotometer at 420 nm wave length.

3.8.8 Exchangeable calcium

Exchangeable calcium of soil was determined from 1 N ammonium acetate (pH 7.0) extract of soil by using flam photometer.

3.8.9 Exchangeable magnesium

Exchangeable magnesium of soil was determined from 1 N ammonium acetate (pH 7.0) extract of soil by using flam photometer.

3.8.10 Available zinc

1.5 g scoop of soil was transferred to a 125 ml Phillips beaker. Then 15 ml of extracting solution was added. The samples were sharked for 15 minutes on an oscillating shaker. Then the extract was filtered through Whitman No. 2 or equivalent filter paper into 10 ml funnel tubes. Zn was determined in the filtered extract via Atomic Absorption Spectrophotometer, using a bulk Zn standard containing 1.6 ppm Zn, which was diluted by the Atomic Absorption to make as many standards as the user specifies.

Calculations:

ppm Zn in soil = ppm Zn in solution x 10

Table 2 : The initial morphological, physical and chemical properties of soil in Boro season

Soil properties	Value (SAU farm Dhaka)	Value (Shakhepur,Tangail)
Locality	SAU farm Dhaka	Shakhepur, Tangail
Agro-ecological zone (AEZ)	Madhupur Tract (AEZ 28)	Old Brahmaputra Flood Plain (AEZ 9)
Topography	Fairly leveled	Fairly leveled
Drainage	Well drained	Well drained
Flood level	Above flood level	Above flood level
Mechanical fractions:		
Sand (%)	29	32
Silt (%)	52	57
Clay (%)	19	11
Texural class	Silty loam	Silty loam
pH	5	5.7
Organic matter (%)	2.22	2.15
Total N (%)	0.11	0.09
Available P (ppm)	11.08	10.96
Exchangeable K (meq/100g soil)	0.12	0.14
Available S (ppm)	9.11	9.98
Exchangeable Ca (meq/100 g soil)	10.30	13.95
Exchangeable Mg (meq/100 g soil)	0.91	1.04
Available Zn (μg /g)	5.83	5.51

3.9 Planting materials

BRRI dhan29, a high yielding variety of boro season was developed by the Bangladesh Rice Research Institute (BRRI), Joydevpur, Gazipur, Bangladesh. It takes about 155 to 160 days to mature bearing plant height of 95-100 cm. The grains are medium slender with light golden husks and kernels are white in color. The variety is resistant to damping off and moderately resistant to blast (*Pyricularia oryzae*) and bacterial blight (*Xanthomonas oryzae*).

3.10 Raising seedlings

Seeds of BRRI dhan29 was collected from BRRI (Bangladesh Rice Research Institute), Gazipur. 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 3 December, 2013. Irrigation was gently provided to the bed as and when needed

3.11 Design and Layout of the experiment

The experiment was laid in a RCBD factorial design with three replications to reduce the heterogenetic effect of soil. There were two factors used in this experiment. Factor A :Organic manures (Compost, Cowdung and Poultry manure)- 4 levels (0, 50, 75 and 100% level of treatments of the recommended doses of Urea, TSP and MoP). Factor B: Inorganic fertilizers (Urea, TSP and MoP) - 4 levels (0, 50, 75 and 100% level of treatments of the recommended doses of Urea, TSP and MoP). The total treatments combinations were 16 with 3 replications. The unit plot size was 1.5m x 2m and block was separated by 70 cm drains. Allocation of all the treatments was made at random in each block. Fertilizer recommendation guide, BARC, 2012

Factor A: Compost (C) 8 t ha^{-1}			Factor B: Inorganic fertilizer (F)		
1.	C_0	0 (Control)	1.	F_0	0 (Control)
2.	C_1	50%(4 ton ha^{-1} Compost)	2.	F_1	50%
3.	C_2	75% (6 ton ha^{-1} Compost)	3.	F_2	75%
4.	C_3	100% (Nutrient from Compost)	4.	F_3	100% (of RDIF)
Cowdung (CD) 5 t ha^{-1}			Inorganic fertilizer (F)		
1.	CD_0	0 (Control)	1.	F_0	0 (Control)
2.	CD_1	50% (2.5 t ha^{-1}cowdung)	2.	F_1	50%
3.	CD_2	75% (3.75 t ha^{-1}cowdung)	3.	F_2	75%
4.	CD_3	100% (Nutrient from Cowdung)	4.	F_3	100% (of RICF)
Poultry manure (PM) 4 t ha^{-1}			Inorganic fertilizer (F)		
1.	PM_0	0 (Control)	1.	F_0	0 (Control)
2.	PM_1	50% (2 t ha^{-1}poultry manure)	2.	F_1	50%
3.	PM_2	75% (3 t ha^{-1}poultry manure)	3.	F_2	75%
4.	PM_3	100% (Nutrient from Poultry manure)	4.	F_3	100% (of RDIF)

So, there were 16 treatment combinations were as follows in case of compost with inorganic fertilizers

1. C_0F_0	5. C_1F_0	9. C_2F_0	13. C_3F_0
2. C_0F_1	6. C_1F_2	10. C_2F_1	14. C_3F_1
3. C_0F_2	7. C_1F_2	11. C_2F_2	15. C_3F_2
4. C_0F_3	8. C_1F_3	12. C_2F_3	16. C_3F_3

16 treatment combinations in case of cowdung with inorganic fertilizers were as follows

1. CD_0F_0	5. CD_1F_0	9. CD_2F_0	13. CD_3F_0
2. CD_0F_1	6. CD_1F_2	10. CD_2F_1	14. CD_3F_1
3. CD_0F_2	7. CD_1F_2	11. CD_2F_2	15. CD_3F_2
4. CD_0F_3	8. CD_1F_3	12. CD_2F_3	16. CD_3F_3

16 treatment combinations were as follows in case of poultry manure with inorganic fertilizers

1. PM_0F_0	5. PM_1F_0	9. PM_2F_0	13. PM_3F_0
2. PM_0F_1	6. PM_1F_2	10. PM_2F_1	14. PM_3F_1
3. PM_0F_2	7. PM_1F_2	11. PM_2F_2	15. PM_3F_2
4. PM_0F_3	8. PM_1F_3	12. PM_2F_3	16. PM_3F_3

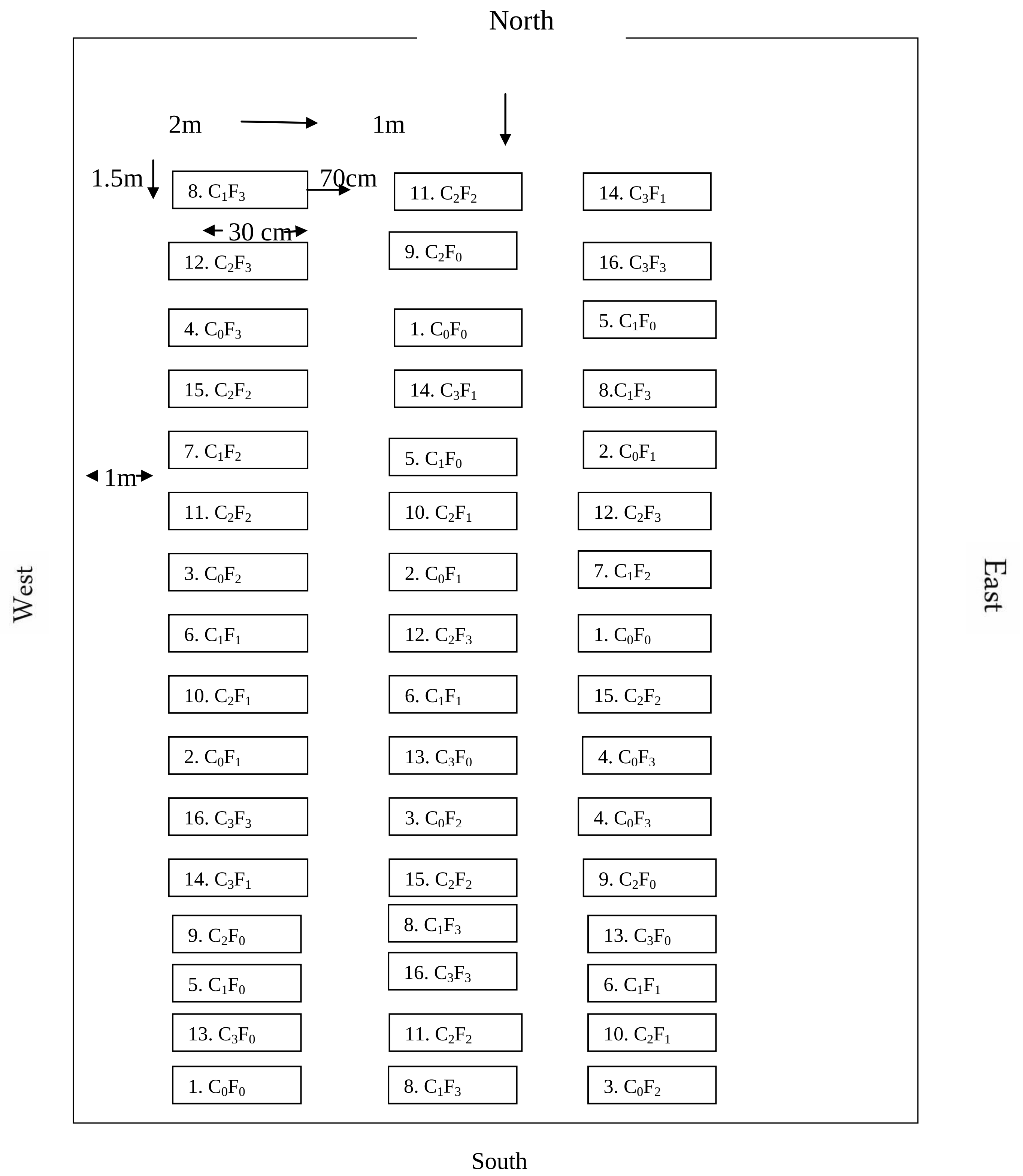


Figure 1. The layout of the experimental plot in case of compost with inorganic fertilizers

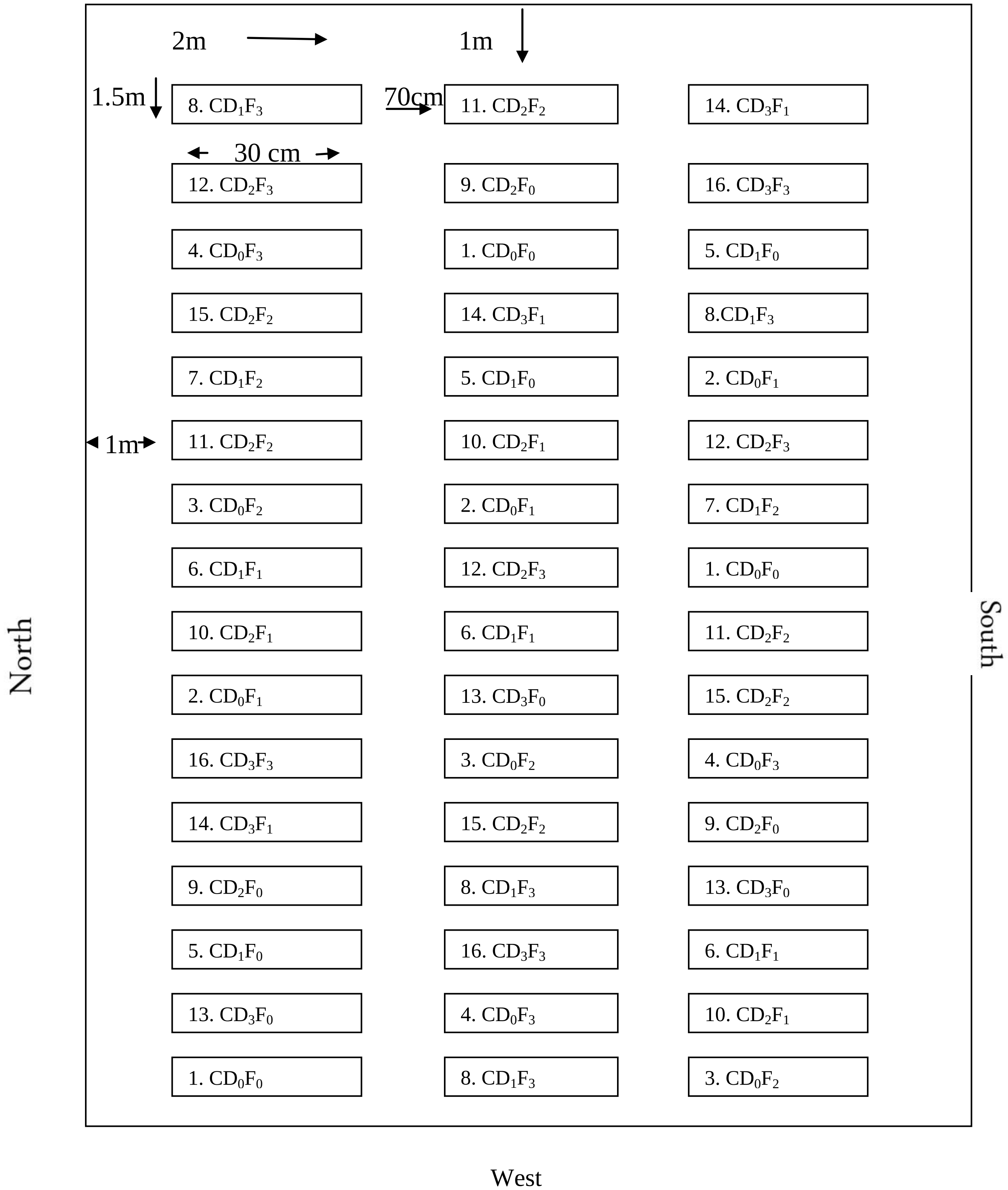


Figure 2. The layout of the experimental plot in case of cowdung with inorganic fertilizers.

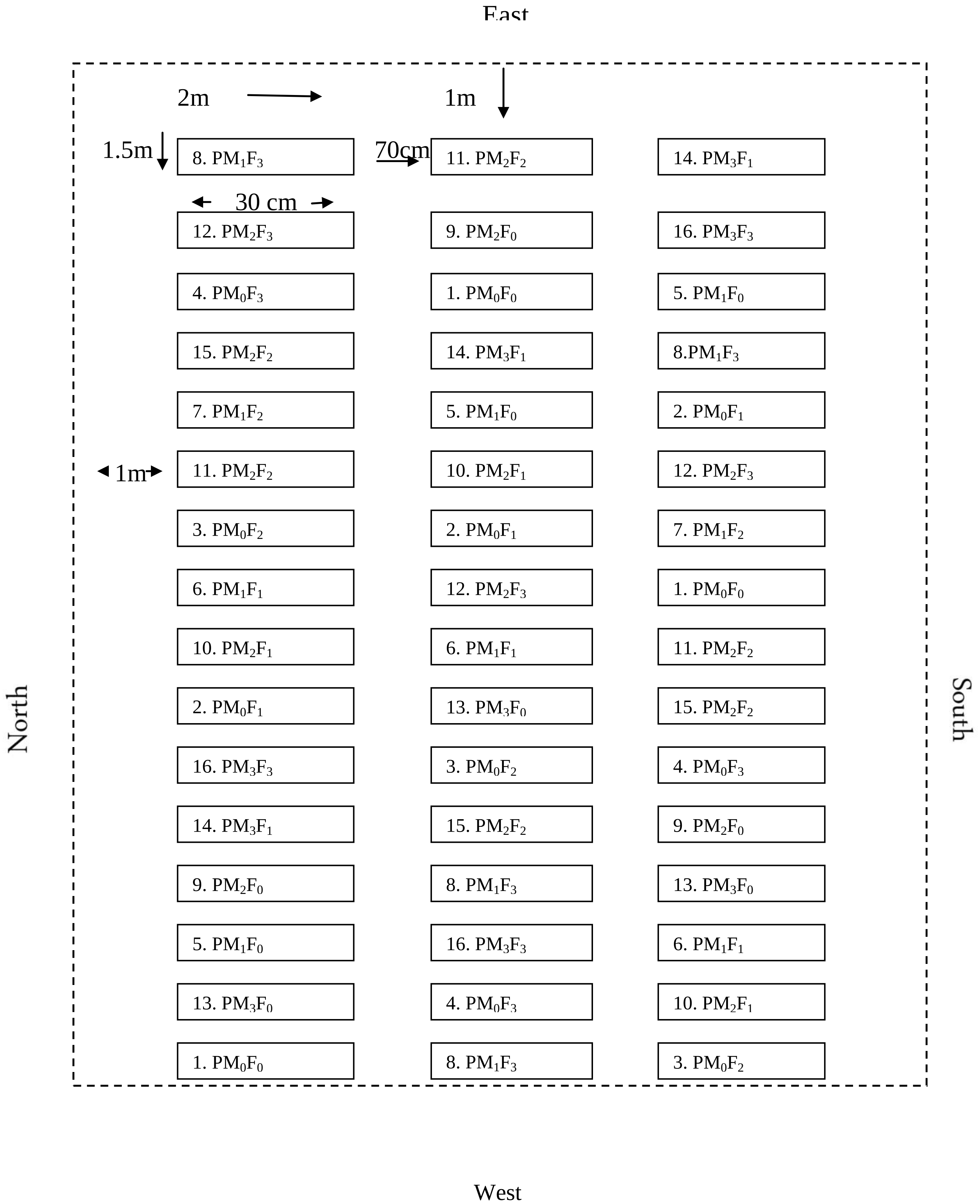


Figure 3. The layout of the experimental plot in case of poultry manure with inorganic fertilizers.

3.12 Land preparation

The field was opened with a power tiller and later on, the land was ploughed and cross-ploughed several times by country plough followed by laddering to obtain the desirable plain soil surface. The corners of the land were spaded. Weeds and stubbles were removed from the field and the land was made ready. The entire experimental land was divided into unit plots in accordance with the experimental design.

3.13 Organic manure and Inorganic Fertilizers

Organic Manures	**Inorganic Fertilizers**
Compost- 8 t ha^{-1}, Cow dung-5 t ha^{-1} and Poultry manure- 4 t ha^{-1}.	Urea 200 kg ha^{-1} TSP 100 kg ha^{-1} MOP 140 kg ha^{-1} Gypsum 80 kg ha^{-1} Borax- 10 kg ha^{-1} and $ZnSO_4$ 5 kg ha^{-1}

Inorganic fertilizers and organic manures were applied in each unit plot according to treatments. After planting the seedlings the urea was applied in three splits in equal ratios. At the time of first ploughing organic manure were applied Cow dung- 5 t ha^{-1} (Farid *et* al., 2011), Poultry manure- 4 t ha^{-1} (Fakhrul *et al.*, 2013) and Compost- 8 t ha^{-1}. The recommended dose of fertilizers were applied as per above description in both boro and aman season (Fertilizer recommendation guide, BARC, 2012).

3.14 Transplanting of seedlings

Five weeks old seedlings were transplanted in the plot on 25 January 2014. The line to line distances 20 cm and hill to hill 15 cm distances were maintained. Three seedlings per hill were transplanted. After one week of transplanting all plots were checked for any missing hill, which was filled up with extra seedlings whenever required.

3.15 Intercultural operations

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

3.15.1 Thinning and Gap Filling

After one month of transplanting, thinning was done to maintain the constant population number. Moreover gap filling was done when it was necessary.

3.15.2 Weed control

During plant growth stages, plots were infested with some common weeds, which were removed by hand according to needs.

3.15.3 Irrigation

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

3.16 Harvest and post-harvest operation

When 80-90% of the grains become golden yellow in color maturity of crop was determined. The harvesting of BRRI dhan 29 was done on May 10, 2014.

Five random selected hills per plot were collected, harvested and bundled, properly; tagged and then brought to the threshing floor for recording grain and straw yield. Threshing was done using pedal thresher. The grains were cleaned and sun dried to a moisture content of 12-13%. Straw was also sun dried properly. Finally grain (kg/plot) and straw yields (kg/plot) were determined and converted to ton ha^{-1}.

3.17 Collected data on yield components

Data collections from the experiment on different growth stages were done under the following heads as per experimental requirements.

3.17.1 Plant height

The plant heights (cm) of the randomly selected 5 hills were taken by measuring the distance from base of the plant to the tip of the flag leaf/ panicle. The collected data were finally averaged.

3.17.2 Number of effective, non-effective and total tillers $hill^{-1}$

Number of effective and non-effective tillers were counted from 5 selected hills after harvesting and finally averaged. The total tillers were counted by the total of effective and non-effective tillers $hill^{-1}$.

3.17.3 Panicle length

The panicle length (cm) was measured from 5 selected panicles and average value was recorded as per panicle.

3.17.4 1000-grain weight

One thousand grains of BRRI dhan29 were randomly counted and collected from different place of each plot and were sun dried and weighed (g) by an electronic balance.

3.17.5 Filled grains per panicle

Number of filled grains panicle^{-1} were counted from 5 panicles from each plot.

3.17.6 Grain yield

According the plot size rhe whole of BRRI dhan29 of rice of each plot were harvested. The grains were threshed, cleaned, dried and then weighed in kg/plot. Thereafter it was converted as ton per hectare (t ha^{-1}).

3.17.7 Straw yield

The straw obtained from the same area was sun dried and weighed in kg. Thereafter it was converted as ton per hectare (t ha^{-1}).

3.18 Post harvest Soil analysis

The post harvest samples were collected for analysis of soil pH, organic matter, total N (%), available P (ppm), and exchangeable K (meq/100 g soil).The analysis methods of above parameter were done as simillar as stated in in case of initial soil analysis.

3.19 Chemical analysis of grain and straw samples

3.19.1 Collection and preparation of grain and straw samples

Grain and straw samples were collected after threshing. The samples were finely ground by using a Wiley-Mill with stainless contact points to pass through a 60-mesh sieve. The samples were stored in plastic vial for analyses of N, P and K. The grain and straw samples were dried in an oven at 70^{0}C for 72 hours and then ground by a grinding machine to pass through a 20-mesh sieve. The grain and straw samples were analyzed for determination of N, P and K concentrations. The methods were as follows:

3.19.2 Digestion of plant samples with sulphuric acid for N

For the determination of nitrogen an amount of 0.2 g oven dry, ground sample were taken in a micro kjeldahl flask. 1.1 g catalyst mixture (K_2SO_4: $CuSO_4$. $5H_2O$: Se in the ratio of 100: 10: 1), and 5 ml conc. H_2SO_4 were added. The flasks were heating at 120^0C and added 2.5 ml 30% H_2O_2 then heated was continued at 180^0C 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 24 digest was estimated by distilling the digest with 10 N NaOH followed by titration of the distillate trapped in H_3BO_3 indicator solution with 0.01N H_2SO_4.

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

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

3.19.4 Determination of nutrients in the digest

Nitrogen and Phosphorus content in the digest was determined by the method as described in soil analysis. Potassium concentration of the digest was determined directly by flame photometer.

Expt. 2 Effects of different inorganic fertilizers and organic manures on growth, yield and nutrient content of Aman rice. To fulfill the objectives of the study 3 experiments were done in the following heads-

a) Effects of compost and different inorganic fertilizers on growth, yield and nutrient content in Aman rice (BRRI dhan49)

b) Effects of cowdung and different inorganic fertilizers on growth, yield and nutrient content in Aman rice (BRRI dhan49)

c) Effects of poultry manure and different inorganic fertilizers on growth, yield and nutrient content in Aman rice (BRRI dhan49).

Compost along with inorganic fertilizer carried out in Shere Bangla Agricultural University (SAU) Farm, Dhaka and cowdung, poultry manure along with inorganic fertilizer were conducted in the farmer fields of Shakhepur upazila under Tangail District respectively during the period from August 2014 to January 2015. This chapter has been divided into a number of sub-heads described as below-

3.20 Experimental site

The experiment was conducted at the Sher-e-Bangla Agricultural University farm, Dhaka and Shakhepur, Tangail respectively during the Aman season of 2014-2015. The site of the experimental plot is in the $23^{\circ}74$ N latitude and $90^{\circ}35$ E longitudes with an elevation of 8.2m above flood level.This soil belongs to the Modhupur tract under Agro-Ecolological Zone 28 (AEZ-28).The area Shakhepur, Tangail belong to the Old Brahmaputra Flood Plain (AEZ 9). The land was above flood level and sufficient sunshine was available during the experimental period. The morphological, physical and chemical characteristics of the soil were presented in Table 1.

3.21 Climate

The climate of the experimental area is characterized by high temperature, high humidity and medium rainfall with occasional gusty winds during the season and a scanty rainfall associated with moderately low temperature in the (October-January).

3.22 Collection of initial soil and analysis

The collection and analysis of initial soil procedure were as simillar as stated in experiment 1. The morphological characteristics and initial physico- chemical properties of soils are presented in Table 3.

3.22.1 Textural classes

Particle size analysis of soil was done by hydrometer method (Black, 1965) and textural class was determined by plotting the value of % sand, % silt, % clay to Marshall's triangular coordinate following the USDA system.

3.22.2 Soil pH

The pH was measured with the help of glass electrod pH meter using soil water suspension of 1:25 as described by Jackson (1962).

3.22.3 Soil Organic Matter

Organic matter in soil was determined by methods of Walkley and Black's (1934) Wet Oxidation method. The principle of the methods wre described in case of experiment 1.

Total nitrogen, available phosphorus, exchangeable potassium, available sulphur exchangeable calcium, exchangeable magnesium and available zinc in the soil were estimated and determined by using the procedure as described in the experiment 1.

3.23 Planting materials

The variety BRRI dhan49 is a high yielding variety and used as the test crop in this experiment. The variety BRRI dhan49 developed by Bangladesh Rice Research Institute (BRRI), Gazipur, Bangladesh. Main characteristics of the variety possess plant height 100 cm. Planting season and time Kharif II, Mid June-Mid July, approximate harvesting time is late October with yield 5.5t ha^{-1}

3.24 Raising seedlings

Seeds of BRRI Dhan49 were collected from BRRI (Bangladesh Rice Research Institute), Gazipur. 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 02 August 2014. Irrigation was gently provided to the bed as and when needed.

Table 3 : The initial morphological, physical and chemical properties of soil in Aman season

Soil properties	Value (SAU farm Dhaka)	Value (Shakhepur,Tangail)
Locality	SAU farm Dhaka	Shakhepur, Tangail
Agro-ecological zone (AEZ)	Madhupur Tract (AEZ 28)	Old Brahmaputra Flood Plain (AEZ 9)
Topography	Fairly leveled	Fairly leveled
Drainage	Well drained	Well drained
Flood level	Above flood level	Above flood level
Mechanical fractions:		
Sand (%)	29	32
Silt (%)	52	57
Clay (%)	19	11
Texural class	Silty loam	Silty loam
pH	5.45	5.21
Organic matter (%)	2.51	2.34
Total N (%)	0.09	0.14
Available P (ppm)	12.03	13.38
Exchangeable K (meq/100g soil)	0.11	0.16
Available S (ppm)	9.11	9.98
Exchangeable Ca (meq/100 g soil)	11.24	12.95
Exchangeable Mg (meq/100 g soil)	0.98	1.09
Available Zn (µg /g)	6.83	6.51

3.25 Design and Layout of the experiment

The Design, Layout and treatment combinations of the experiment of the experiment as simillar as experiment as 1.

3.26 Land preparation

The field was opened with a power tiller and later on, the land was ploughed and cross-ploughed several times by country plough followed by laddering to obtain the desirable plain soil surface. The corners of the land were spaded. Weeds and stubbles were removed from the field and the land was made ready. The entire experimental land was divided into unit plots in accordance with the experimental design.

3.27 Organic manures and Inorganic Fertilizers application

Organic Manures	**Inorganic Fertilizers**
Compost- 8 t ha^{-1}, Cow dung- 5 t ha^{-1} and Poultry manure- 4 t ha^{-1}.	Urea 140 kg ha^{-1} TSP 60 kg ha^{-1} MOP 100 kg ha^{-1} Gypsum 60 kg ha^{-1} Borax- 10 kg ha^{-1} and ZnSO4 4 kg ha^{-1}

Inorganic fertilizers and organic manures were applied in each unit plot according to treatments. After planting the seedlings the urea was applied in three splits in equal ratios. At the time of first ploughing organic manure were applied Cow dung- 5 t ha^{-1} (Farid *et* al., 2011), Poultry manure- 4 t ha^{-1} (Fakhrul *et al.,* 2013) and Compost- 8 t/ha. The recommended dose of fertilizers were applied as per above description in both boro and aman season

(Fertilizer recommendation guide, BARC, 2012). All the fertilizers except urea were incorporated with the soil one day before transplanting.

3.28 Seedling age and planting method

Five weeks old seedlings were transplanted in the plot on 7th September 2014 in Aman season. The line to line distances 20 cm and hill to hill distances 15 cm distances were maintained. Three seedlings per hill were transplanted. After one week of transplanting all plots were checked for any missing hill, which was filled up with extra seedlings whenever required.

3.29 Intercultural operations

Intercultural operations were done following the procedures as mentioned in the experiment 1.

3.30 Harvest and post-harvest operation

The crop was harvested after the grains attained maturity, stated as similar as expt. 3.1.

3.31 Collected data on yield components

Data collections from the experiment on different growth stages were done under the following heads as per experimental requirements.

Plant height, number of effective, non-effective and total tillers hill^{-1} , panicle length, 1000-grain weight, filled grains per panicles, grain yield and straw yield were as similler as stated in experiment 1

3.32 Harvest and post-harvest operation

The crop was harvested after the grains attained maturity, stated as similar as expt. 3.1.

3.33 Post harvest soil analysis

The post harvest samples were collected for analysis of soil pH, organic matter, total N (%), available P (ppm), and exchangeable K (meq/100 g soil).

The analysis methods of above parameter were done as simillar as stated in in case of initial soil analysis.

3.34 Chemical analysis of grain and straw

Determination of total N, P and K were estimated in grain and straw as following as experiment 1.

3.35 Economic analysis

A partial budget was estimated. It is useful to analyze relatively small changes in the farm business (Kay, 1981). Yield and added benefit of crop due to different treatments were calculated. Input cost of different parameter like weeding, irrigation, top dressing of urea and variable cost of manures and fertilizers were considered for calculation of the cost of cultivation. Besides, the gross return was calculated on the basis of farm prices of rice grain and straw prevailed during the harvesting period. Benefit Cost Ratios has been calculated for finding the most profitable combination in terms of total and net revenue. More specifically the Benefit Cost Ratio (BCR) for each variety was:

BCR = VNR / TC Where, VNR = Variety net revenue and TC = Total cost of the variety. More and more the value of Benefit Cost Ratio more will be the net return.

3.6 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 was done following two factors randomized complete block design. The mean differences among the treatments were compared by Duncan’s Multiple Range Test (DMRT) at 5% level of significance.

CHAPTER IV

RESULTS AND DISCUSSION

The present research study was conducted to determine effects of cowdung and different inorganic fertilizers on growth, yield and nutrient content in Boro rice (BRRI dhan29). The analyses of variance (ANOVA) of the data on different components are given in Appendix III-XX The recorded and collected results and discussion of different parameter were presented and possible interpretations given under the following headings:

4.1 1a) EXPERIMENT: EFFECTS OF COMPOST (HOUSEHOLD WASTE) AND DIFFERENT INORGANIC FERTILIZERS ON GROWTH, YIELD AND NUTRIENT CONTENT OF BORO RICE (BRRI dhan29)

4.1.1 Effect of compost (household waste) and inorganic fertilizers on plant height, number of effective tiller, non effective and total tiller per hill of BRRI dhan29

4.1.1.1 Plant height

The plant height is an important growth character directly linked with the productive potential of the plants. Effects of compost (household waste) and inorganic fertilizers differed significantly in respect of plant height of BRRI dhan29 (Table 1). The highest plant height was recorded in 100% compost i.e. C_3 (90.28 cm) which is statically similar with 75% compost (C_2). On the other hand, the highest plant height was recorded when 100% inorganic fertilizers application (93.25 cm) which also closely followed by $F_{2.}$ The lowest plant height was observed by control treatment having no household waste or fertilizer. Rahman *et al.* (2007); found that application of S fertilizer had a significant positive effect on plant height.

4.1.1.2 Number of effective, non-effective and total tillers per hill

The effect of compost and inorganic fertilizers on effective, non-effective and total tillers per hill were significantly differed (Table 1) where produced higher number of effective and total tillers per hill over control treatment. The highest numbers of effective and total tillers per hill were observed at 100% compost i.e C_3 (21.83) and 100% inorganic fertilizers i.e F_3 (24.17) respectively where 100% inorganic fertilizers (F_3) statistically similar with 75% inorganic fertilizers application (F_2) separately or along with 100% compost (C_3) (Table 01). The lowest numbers of effective and total tillers per hill were observed at control *i.e.* C_0 and F_0 respectively. On the other hand, the non-effective tillers per hill were (3.25) and (4.41) higher at 0% compost (C_0) and 0% inorganic fertilizers (F_0) respectively. Sadaphal *et al*. (1981) investigate that increased fertilizers dose of NPK increase number of total tillers plant$^{-1.}$

4.1.2 Interaction effect of compost and inorganic fertilizers on plant height, number of effective tiller, non effective and total tiller per hill of BRRI dhan29

4.1.2.1 Plant height

The interaction effects of different levels of compost and inorganic fertilizers application significantly differed the plant height of BRRI dhan29 (Table 2), where the maximum plant height was found in C_3F_3 (97.30 cm) combination and the minimum plant height (79.60 cm) in control treatment (C_0F_0). and C_0F_0 treatments (Table 2).

4.1.2.2 Number of effective tiller, non effective and total tiller per hill

The interaction effects of different doses of compost and inorganic fertilizers application significantly differed the number of effective tiller, non effective and total tiller per hill of BRRI dhan29 (Table 2), where the maximum number of effective tiller and total tiller per hill were found both in C_3F_3 (24.00 and 25.67) combination and the minimum number of effective tiller and total tiller per hill both in control treatment (C_0F_0) (Table 2). On the other hand the non effective tiller per hill was found maximum in C_0F_0 and C_1F_0 and minimum non effective tiller per hill was found in C_3F_3.

Table 1. Effects of compost and inorganic fertilizers on different characteristics of BRRI dhan29

Compost	**Plant height (cm)**	**Effective tiller hill^{-1} (No.)**	**Non- effective tiller hill^{-1} (No.)**	**Total tiller hill^{-1} (No.)**
C_0	84.14 b	11.58 d	3.25 a	14.83 d
C_1	88.40 ab	14.75 c	3.25 a	18.00 c
C_2	89.67 a	16.50 b	2.91 a	19.42 b
C_3	90.28 a	21.83 a	2.33 b	24.17 a
LSD $_{0.05}$	4.41	0.96	0.43	1.01
CV%	6.01	6.16	17.76	6.34
Fertilizer				
F_0	81.24 c	11.92 c	4.41 a	16.33 c
F_1	88.23 b	16.08 b	2.75 b	18.83 b
F_2	89.76 ab	17.92 a	2.41 bc	20.33 a
F_3	93.25 a	18.75 a	2.16 c	20.92 a
LSD $_{0.05}$	4.41	0.96	0.43	1.01
CV%	6.01	6.16	17.76	6.34

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Compost(C) (Household wastes) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose

CV=Co-efficient of Variance

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

Table 2. Interaction effects of compost and inorganic fertilizers on different characteristics of BRRI dhan29

Interaction		Plant height (cm)	Effective tiller hill^{-1} (No.)	Non-effective tiller hill^{-1} (No.)	Total tiller hill^{-1} (No.)
Compost	**Fertilizer**				
C_0	F_0	79.60 e	7.33 f	5.333 a	12.67 g
	F_1	86.97 a-d	10.67 e	2.667 cd	13.33 fg
	F_2	84.90 c-e	14.33 d	2.333 cd	16.67 de
	F_3	88.50 a-e	14.00 d	2.667 cd	16.67 de
C_1	F_0	80.67 de	10.33 e	5.333 a	15.67 de
	F_1	87.67 a-e	14.67 d	3.000 c	17.67 d
	F_2	89.07 a-e	15.67 d	2.000 cd	17.67 d
	F_3	96.20 ab	18.33 c	2.667 cd	21.00 c
C_2	F_0	86.10 bd	11.00 e	4.000 b	15.00 ef
	F_1	90.80 a-d	17.67 c	3.000 c	20.67 c
	F_2	90.77 a-d	18.67 c	3.000 c	21.67 bc
	F_3	91.00 a-d	18.67 c	1.667 d	20.33 c
C_3	F_0	82.00 de	19.00 c	3.000 c	22.00 bc
	F_1	87.50 a-d	21.33 b	2.333 cd	23.67 ab
	F_2	94.30 a-c	23.00 ab	2.333 cd	25.33 a
	F_3	97.30 a	24.00 a	1.667 d	25.67 a
$LSD_{0.05}$		8.83	1.93	0.86	2.02
CV%		6.01	6.16	17.76	6.34

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Compost(C) (Household wastes) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose.

CV=Co-efficient of Variance

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability**.**

4.1.3 Effect of compost and inorganic fertilizers on panicle length, 1000 grain weight and filled grains/panicles of BRRI dhan29

4.1.3.1 Panicle length

In case of compost (household waste) (Table 3) the tallest panicle length was noted in 100% compost i.e.C_3 (27.97 cm) treatment which was statistically similar with C_2 and C_1 treatments and the lowest panicle length was produced by 0 % compost i.e. C_0 (26.13 cm) treatment. In case of inorganic fertilizers application, the highest panicle length was found in F_3 (100% inorganic fertilizers) (28.24 cm) treatment which is statistically similar with F_2 and F_1 treatments and the lowest panicle length found in F_0 (26.29 cm).

4.1.3.2 1000-grain weight

1000 grains weight of BRRI dhan29varied significantly due to the effects of compost and inorganic fertilizers application separately (Table 3). The maximum weights of 1000 grain were observed in the treatments C_3 (27.11g) and F_3 (27.16 g) respectively. Combined application of organic manure and inorganic fertilizers increased the 1000-grain weight of rice written by (Abedin *et al*., 1999).

4.1.3.3 Filled grains/panicle

Number of grains per panicle is special type of crop characters which contributes to the economic yield. The effect of compost and inorganic fertilizers application on filled grains/panicles differed significantly (Table 3). The highest filled grains/panicles (114.6 and 103.6) was recorded in 100% cowdung (C_3) and 100% inorganic fertilizers F_3 respectively. These results are also in agreement with (Hoque, 1999).

Table 3. Effects of compost and inorganic fertilizers on panicle length (cm), 1000 grain wt.(g) and filled grains/panicle of BRRI dhan29

Compost	Panicle length(cm)	1000 grain wt.(g)	Filled grains/panicle (No.)
C_0	26.13 b	23.95 c	70.17 d
C_1	27.43 a	25.37 bc	99.92 c
C_2	27.83 a	26.31 ab	106.1 b
C_3	27.97 a	27.11 a	114.6 a
LSD $_{0.05}$	1.03	1.46	3.33
CV%	4.52	6.82	4.09
Fertilizer			
F_0	26.29 b	24.13 c	91.58 c
F_1	27.23 ab	25.49 bc	97.58 b
F_2	27.59 a	25.97 ab	98 b
F_3	28.24 a	27.16 a	103.6 a
LSD $_{0.05}$	1.03	1.46	3.33
CV%	4.52	6.82	4.09

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Compost(C) (Household wastes) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose.

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

4.1.4 Interaction effect of compost and inorganic fertilizers on panicle length, 1000 grain weight and filled grains/panicles of BRRI dhan29

4.1.4.1 Panicle length

The interaction effects of compost and inorganic fertilizers significantly increased the panicle length with increasing the level of organic and inorganic fertilizers application. It was observed that the maximum panicle length found in 100% compost and 100% inorganic fertilizers C_3F_3 (28.67 cm) treatment which is statistically similar with C_2F_3 and lowest results was found in C_0F_0 (Table 4).

4.1.4.2 1000 grain weight

In case of interaction effects of compost and inorganic fertilizers application , the highest weight of 1000-grain was obtained in 100% compost and 100% inorganic fertilizers (C_3F_3) combination, which is statistically identical with C_2F_3 and C_1F_3 combinations of compost and inorganic fertilizers (Table 4). On the other hand, the lowest results were found at 0 % compost and inorganic fertilizers separately or combined treatments (C_0, F_0 or C_0F_0).

4.1.4.3 Filled grains/panicle

The interaction effects of compost and inorganic fertilizers on filled grains/panicles differed significantly. It was observed that the maximum filled grains/panicles was found in 100% compost and 100% inorganic fertilizers i.e C_3F_3 (119) treatment statically identical with C_3F_1 treatments and the lowest filled grains/panicle (61.67) was found in C_0F_0 treatment having no use of inorganic fertilizers and compost.

4.1.5 Effect of compost and inorganic fertilizers on grain yield, straw yield and benefit cost ratio of BRRI dhan29

4.1.5.1 Grain and straw yield

The effect of compost and inorganic fertilizers application on grain and straw yields of BRRI dhan29 differed significantly by using compost and inorganic fertilizers individually (Figure 1 and 2 and appendices III). The highest grain and straw yields and the lowest grain and straw yields were observed in 100% compost (5.82 and 6.54 t ha^{-1}) and 0% compost (C_0) (3.88 and 4.55 t ha^{-1}) treatment, respectively.

Table 4. Interaction effects of compost and inorganic fertilizers on panicle length (cm), 1000 grain wt.(g)and filled grains/panicles of BRRI dhan29

Interaction		Panicle length(cm)	1000 grain wt.(g)	Filled grains/panicle (No.)
Compost	**Fertilizer**			
Co	F_0	25.30 d	21.98 d	61.67 g
	F_1	26.00 cd	23.97 bd	64.67 g
	F_2	25.40 d	24.93 a-d	73.00 f
	F_3	27.80 a-c	24.93 a-d	81.33 e
C_1	F_0	27.20 a-d	22.27 cd	90.33 d
	F_1	27.33 a-d	25.37 a-c	98.00 c
	F_2	27.03 a-d	25.78 ab	104.7 bc
	F_3	28.17 a-c	28.07 a	106.7 b
C_2	F_0	26.13 bd	26.01 ab	104.3 bc
	F_1	28.03 a-c	25.42 a-c	109.3 b
	F_2	28.43 ab	26.40 ab	103.3 bc
	F_3	28.57 a	27.42 a	107.3 b
C_3	F_0	26.53 a-d	26.27 ab	110.0 b
	F_1	28.33 a-c	27.19 ab	118.3 a
	F_2	28.47 ab	26.78 ab	111.0 b
	F_3	28.67 a	28.20 a	119.0 a
$LSD_{0.05}$		2.05	2.92	6.68
CV%		4.52	6.82	4.09

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Compost(C) (Household wastes) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose.

letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

In case of inorganic fertilizers application, the highest grain and straw yields were obtained in 100% inorganic fertilizers F_3 (5.58 and 5.91 t ha^{-1}) respectively, which are statistically similar to 75% inorganic fertilizers (F_2) treatment and the lowest grain straw yields (4.14 and 4.90 t ha^{-1}) were noted in 0% inorganic fertilizers (F_0) (control) respectively. Thus, the results indicated that the combined application of organic and inorganic fertilizers increased both straw and grain yields of rice. A report published by Azim (1999) that the beneficial effects of organic manures in combination with inorganic fertilizers on effective tillers $hill^{-1}$ as a result the yield of grain must be increased.

4.1.5.2 Benefit cost ratio

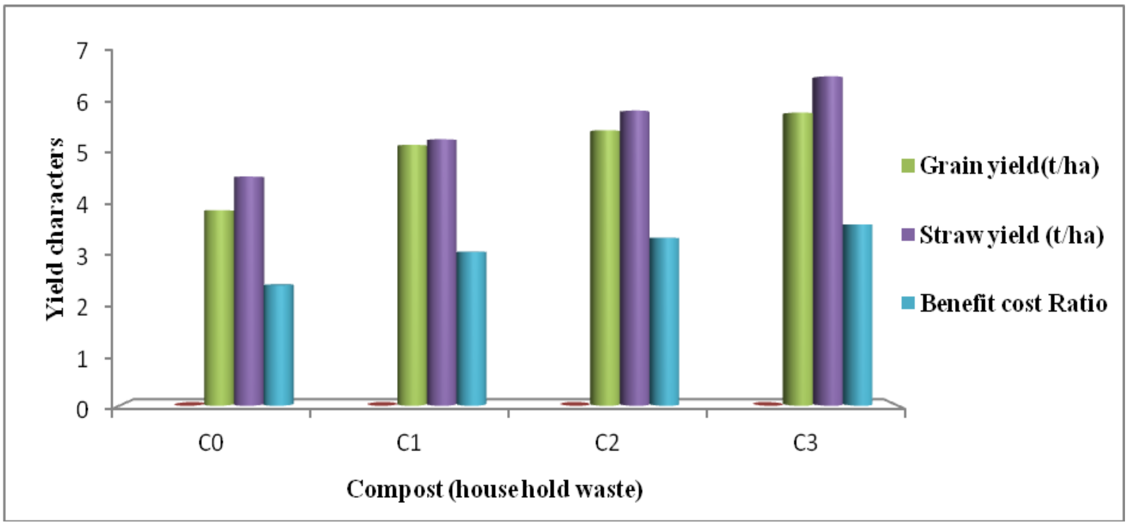
The economic performance of different treatments was evaluated through economic analysis. The effect of compost and inorganic fertilizers application on benefit cost ratio differed significantly (Figure 1, 2 and appendices III). The highest benefit cost ratio were recorded in 100% compost i.e.C_3 (3.60) and 100% inorganic fertilizers F_3 (3.32).The lowest benefit cost ratio were recorded in 0% compost C_0 and 0% inorganic fertilizers F_0. Similar results were reported by Alam *et al*. (2004), who observed that higher profit was obtained when inorganic fertilizers was combined with organic manures.

4.1.6 Interaction effect of compost and inorganic fertilizers on grain yield, straw yield and Benefit cost ratio of BRRI dhan29

4.1.6.1 Grain and straw yield

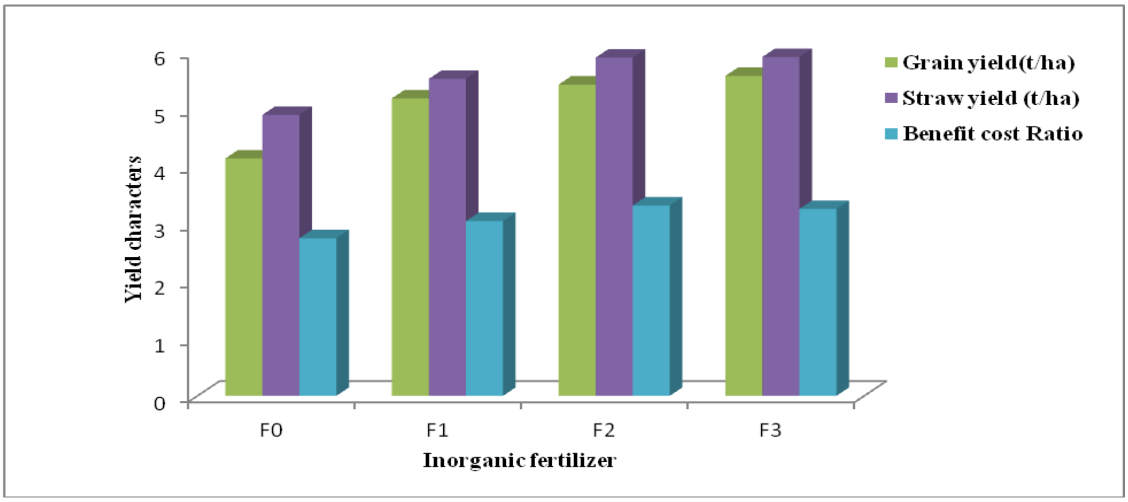
The interaction effects of compost (household waste) and inorganic fertilizers application varied significantly on grain and straw yields of BRRI dhan29, where the maximum grain and straw yields (6.52 and 7.16 t ha^{-1}) were found in 100% compost and 100% inorganic fertilizers combination (C_3F_3) and C_3F2 treatment respectively which are statistically similar to 100% compost and 75% inorganic fertilizers combination (C_3F_2) C_3F_3 treatment, respectively (Table 5).

The minimum grain and straw yields (3.28 and 3.85 t ha^{-1}) were obtained in the combination 0% compost and 0% inorganic fertilizers (C_0F_0) treatment.



Compost(C) (Household wastes) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose

Figure 1: Effects of compost on different yield components of BRRI dhan29.



Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Figure 2: Effects inorganic fertilizers on different yield components of BRRI dhan29.

Table 5. Interaction effects of compost and inorganic fertilizers on different yield and yield components of BRRI dhan29

Interaction		Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Benefit cost ratio
Compost	**Fertilizer**			
C_0	**F_0**	3.28 g	3.85 i	1.85 i
	F_1	3.77 fg	3.53 hi	2.19 h
	F_2	4.03 ef	5.00 f-h	2.95 f
	F_3	4.43 e	4.82 gh	2.59 g
C_1	**F_0**	4.10 ef	4.77 gh	2.52 g
	F_1	5.55 cd	5.40 e-g	3.24 def
	F_2	5.43 d	5.55 d-g	3.18 ef
	F_3	5.64 bd	5.44 e-g	3.29 cde
C_2	**F_0**	4.61 e	5.20 f-h	3.24 def
	F_1	5.48 cd	5.77 c-f	3.20 ef
	F_2	6.05 a-c	6.29 bd	3.53 a-d
	F_3	5.74 bd	6.17 b-e	3.39 b-e
C_3	**F_0**	4.56 e	5.77 c-f	3.35 b-e
	F_1	5.98 a-d	6.40 bc	3.59 abc
	F_2	6.20 ab	7.16 a	3.62 ab
	F_3	6.52 a	6.81 ab	3.82 a
LSD $_{0.05}$		0.53	0.70	0.27
CV%		6.32	7.58	5.36

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Compost(C) (Household wastes) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose.

CV=Co-efficient of Variance . In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

4.1.6.2 Benefit cost ratio

The interaction effects (Table 5) of compost and inorganic fertilizers application on benefit cost ratio differed significantly. It was observed that the maximum benefit cost ratio (3.82) was found in 100% compost and 100% inorganic fertilizers (C_3F_3) combination which was statistically similar with C_3F_2, C_3F_1 respectively and the lowest result (1.85) was found in C_0F_0 treatment having no use of inorganic fertilizers and compost.

4.1.7 Effect of compost and inorganic fertilizers on Nitrogen, Phosphorus and Potassium content in grain of BRRI dhan29

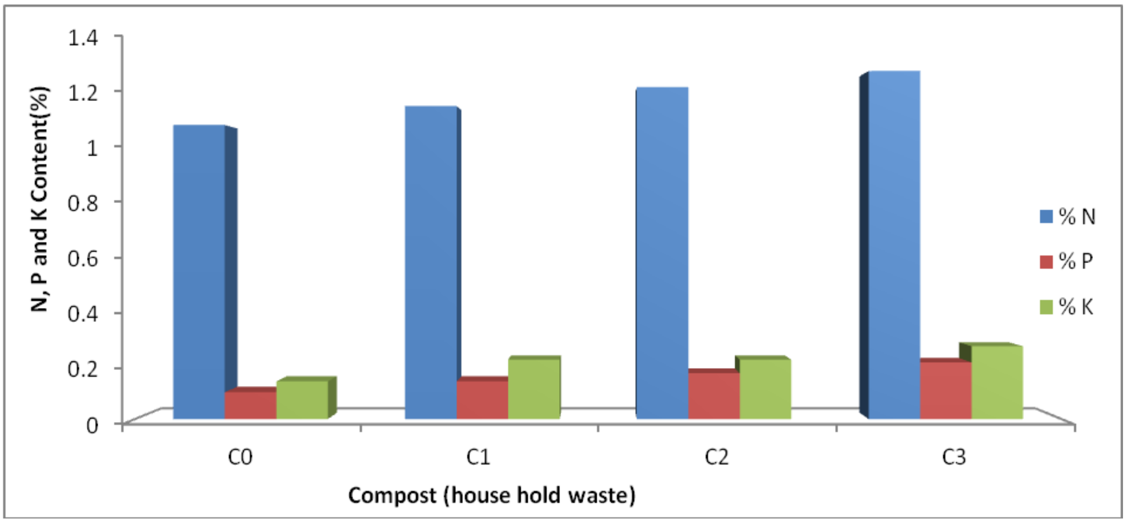
4.1.7.1 N, P and K content in grain

The data shows on N, P and K content in grain in rice at differed significantly and influenced by compost (household waste) and inorganic fertilizers application were presented in (Figure 3, 4 and appendix IV) the maximum N, P, and K content in grain (1.29%, 0.208% and 0.272%) were noted in 100% compost C_3 treatment and In case of inorganic fertilizers application, the highest N, P, and K content in grain (1.24%, 0.16% and 0.23%) were found in F_3 (100% inorganic fertilizers) respectively and it is statistically similar with F_2 treatments and in both cases the lowest N, P, and K content in grain (1.09%, 0.104% and 0.137%) were produced by 0 % compost in C_0 treatment and (1.16%, 0.138% and 0.186%) found in F_0 respectively. Lower available nitrogen in inorganic fertilizers plots might be due to higher grain and straw yields of crop, which resulted in extraction of most of the soil nutrients. These results are in assembling with that of (Siddaram *et al.,* 2011).

4.1.8 Interaction effect of compost and inorganic fertilizers on Nitrogen, Phosphorus and Potassium content in grain of BRRI dhan29

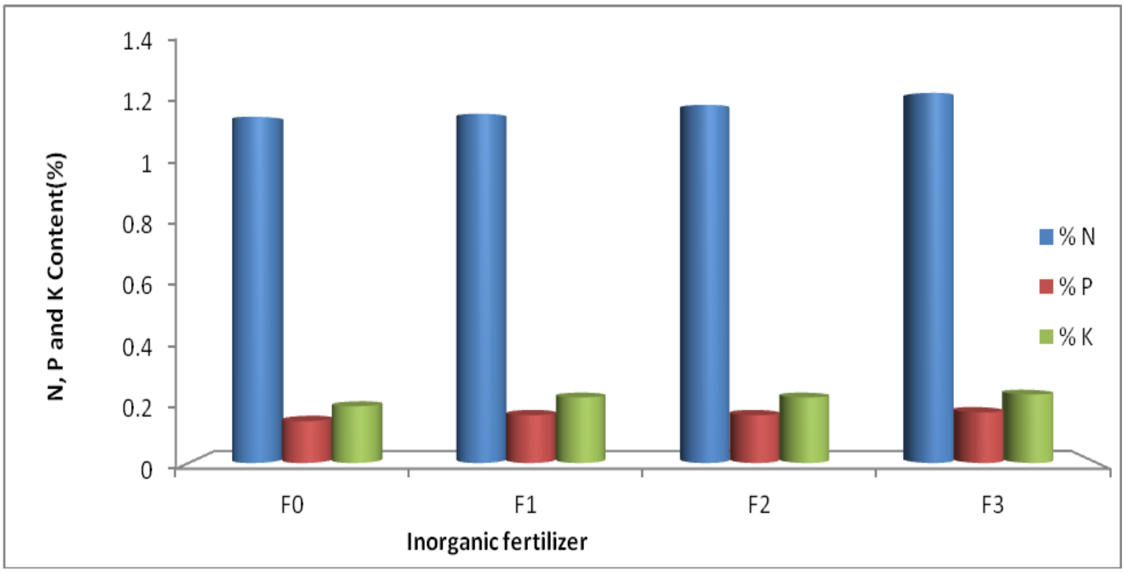
4.1.8.1 N, P and K content in grain

The interaction effects of compost and inorganic fertilizers application significantly increased the N, P and K content in grain with increasing the level of compost and inorganic fertilizers. It was observed that the maximum N, P, and K content in grain (1.34%, 0.226% and 0.313%) found in 100% compost and 100% inorganic fertilizer (C_3F_3) treatment which is statistically similar with several treatments minimum data recorded in C_0F_0 (Table 6).



Compost(C) (Household wastes) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose

Figure 4. Effects of compost with NPK content in grain in BRRI dhan29.



Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Figure 5. Effects of inorganic fertilizers with NPK content in grain in BRRI dhan29.

Table 6. Interaction effects of compost and inorganic fertilizers of NPK content in grain of BRRI dhan29

Interaction		**% N**	**% P**	**%K**
Compost(Household waste)	**Fertilizer**			
C_0	F_0	1.06 f	0.095 g	0.126 g
	F_1	1.06 f	0.097 g	0.151 f
	F_2	1.12 ef	0.097 g	0.139 fg
	F_3	1.14 def	0.126 f	0.133 g
C_1	F_0	1.12 ef	0.124 f	0.188 e
	F_1	1.15 def	0.147 e	0.210 d
	F_2	1.16 c-f	0.158 de	0.230 cd
	F_3	1.23 bcd	0.147 e	0.244 c
C_2	F_0	1.22 b-e	0.144 e	0.199 e
	F_1	1.20 b-e	0.173 cd	0.224 d
	F_2	1.23 bcd	0.188 c	0.219 d
	F_3	1.26 abc	0.176 cd	0.243 c
C_3	F_0	1.26 ab	0.189 c	0.229 cd
	F_1	1.27 ab	0.206 b	0.268 b
	F_2	1.30 ab	0.201 ab	0.279 b
	F_3	1.34 a	0.226 a	0.313 a
$LSD_{0.05}$		0.09	0.01	0.016
CV%		4.43	5.83	7.11

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Compost(C) (Household wastes) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose.

CV=Co-efficient of Variance

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

4.1.9 Effect of compost and inorganic fertilizers on Nitrogen, Phosphorus and Potassium content in straw of BRRI dhan29

4.1.9.1 % N content in straw

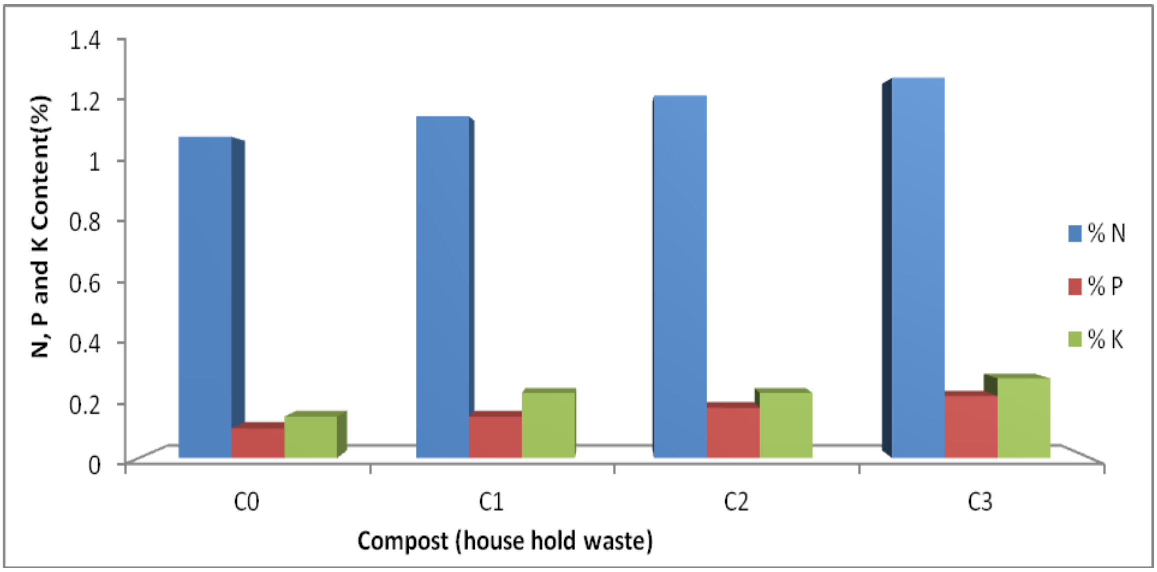
The N content in straw of BRRI dhan29 has been significantly increased due to the application of inorganic fertilizers associate with compost. There were numerical variations in N content among the treatments (Figure 5, 6 and appendix v). The maximum proportions of N (0.484% and 0.451%) were observed in the treatments C_3 and F_3, respectively. The minimum proportions of N (0.330% and 0.373%) were observed in the treatments C_0 and F_0, respectively.

4.1.9.2 % P content in straw

The P content in straw of BRRI dhan29 has been significantly increased due to the application of inorganic fertilizers associate with compost. There were numerical variations in P content among the treatments (Figure 5, 6 and appendix v). The maximum proportions of P (0.064% and 0.053%) were observed in the treatments C_3 and F_3, respectively. The minimum proportions of P (0.33% and 0.37%) were observed in the treatments C_0 and F_0, respectively. Subbian *et al*. (1989); reported that total P level increase in both grain and straw with increasing level of P.

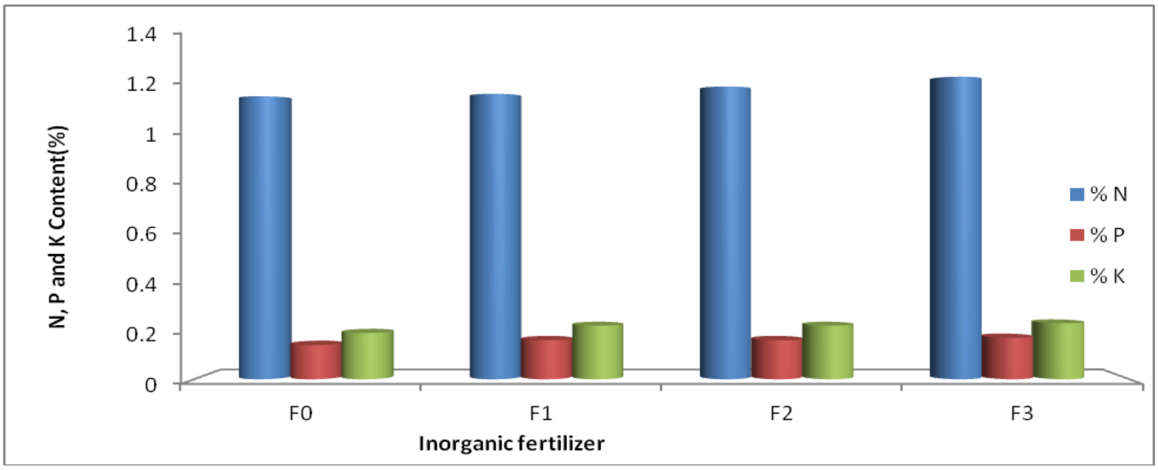
4.1.9.3 K content in straw (%)

The P content in straw of BRRI dhan29 has been significantly increased due to the application of inorganic fertilizers associate with compost. There were numerical variations in K content among the treatments (Figure 5, 6 and appendices v). The maximum proportion of K (1.28% and 1.35%) were observed in the treatments C_3 and F_3, respectively which was closely followed by C_2, C_1 and F_2, F_1.. Rice straw contains most of the K that is absorbed by the rice crop illustrated by (Javier *et al.*, 2003).



Compost(C) (Household wastes) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose

Figure 5. Individual effects of compost with NPK content in straw in BRRI dhan29.



Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Figure 6. Effects of inorganic fertilizers with NPK content in straw in BRRI dhan29.

4.1.10 Interaction effect of compost and inorganic fertilizers on Nitrozen, Phosphorus and Potassium content in straw of BRRI dhan29

4.1.10.1 % N content in straw

In case of interaction effects of compost and inorganic fertilizers application, the highest percentage of **N** was obtained in 100% compost and 100% inorganic fertilizers (0.516%) (C_3F_3) combination, which is statistically identical with C_2F_3 and C_1F_3 combinations of compost and inorganic fertilizers (Table 7). On the other hand, the lowest results were found at 0 % compost and inorganic fertilizers separately or combined treatments 0.279% (C_0, F_0 or C_0F_0).

4.1.10.2 % P content in straw

In case of interaction effects of compost and inorganic fertilizer application, the highest percentage was obtained in 100% compost and 100% inorganic fertilizer C_3F_3 (0.071%) combination, which is statistically identical with C_3F_2 and C_3F_1 combinations of compost and inorganic fertilizers (Table 7). On the other hand, the lowest results were found at 0 % compost and 0% inorganic fertilizers combined treatments 0.037% (C_0F_0) which was closely followed by $C_0F_{1,}$ C_0F_2 and $C_0F_{3.}$

4.1.10.3 % K content in straw

In case of interaction effects of compost and inorganic fertilizers, the highest percentage was obtained in 100% compost and 100% inorganic fertilizer (1.400%) (C_3F_3) combination, which is statistically identical with C_3F_2 combinations of compost and inorganic fertilizers (Table 7). On the other hand, the lowest results were found at 0 % compost and 0% inorganic fertilizers combined treatments 1.10% (C_0F_0) which was closely followed by $C_0F_{1.}$

Table 7. Interaction Effects of different levels of compost and inorganic fertilizers in straw in BRRI dhan29

Interaction		% N	% P	%K
Compost(Household waste)	**Fertilizer**			
C_0	F_0	0.279 i	0.037 c	1.10 e
	F_1	0.324 hi	0.039 c	1.13 de
	F_2	0.343 h	0.041 c	1.27 c
	F_3	0.376 f-h	0.042 c	1.30 bc
C_1	F_0	0.370 gh	0.040 c	1.10 de
	F_1	0.421 d-g	0.046 bc	1.13 de
	F_2	0.458 a-e	0.047 bc	1.34 a-c
	F_3	0.471 a-d	0.046 bc	1.33 a-c
C_2	F_0	0.411 e-g	0.047 bc	1.13 de
	F_1	0.486 a-c	0.054 a-c	1.13 de
	F_2	0.505 a	0.056 a-c	1.33 a-c
	F_3	0.443 b-e	0.054 a-c	1.36 ab
C_3	F_0	0.432 c-f	0.054 a-c	1.15 de
	F_1	0.490 a-c	0.0630 ab	1.18 d
	F_2	0.498 ab	0.0693 a	1.38 ab
	F_3	0.516 a	0.071 a	1.40 a
$LSD_{0.05}$		0.052	0.016	0.074
CV%		5.57	5.29	3.41

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Compost(C) (Household wastes) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose.

CV=Co-efficient of Variance

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

4.1.11 Effects of compost and inorganic fertilizers on post harvest soil properties of BRRI dhan29

4.1.11.1 Soil pH

The effect of compost and inorganic fertilizers application on post harvest soil pH differed significantly by using compost and inorganic fertilizers application separately (Table 8). The highest soil pH values (5.53 and 5.48) were found 100% compost (C_3) and 100% fertilizers (F_3), respectively and the lowest soil pH values (5.18 and 5.10) were observed in 0% compost (C_0) and 0% fertilizers (F_0) treatments, respectively (Lap, 1990) reported that the soil with pH<6.6 is the best condition for growing rice, and it can produce higher yield than neutral or alkaline soil.

4.1.11.2 Organic matter content

The effect of different levels of compost (from household waste) and chemical fertilizers on organic matter content of post harvest soil differed significantly due to individual or combined application of organic and inorganic fertilizers (Table 8). In case of compost, the maximum organic matter content was found in 75% compost C_2 (2.75%) treatment and the minimum organic matter content found in C_0 (1.969%) treatment. In case of inorganic fertilizers, the maximum organic matter content (2.527%) was found in F_3 treatment and the lowest amount (1.994%) found in F_0. The organic matter content of post harvest soils increased due to application of manures and fertilizers. Myint *et al.* (2010) found that organic matter provided comparatively higher nutrient accumulations which in turn enhanced the growth and yield of rice.

4.1.11.3 Total nitrogen

The effect of compost and inorganic fertilizers application separately or combined on N content of post harvest soil was differed significantly (Table 8). The highest amounts of N (0.085 and 0.076%) were observed at 100% compost (C_3) and 100% inorganic fertilizers (F_3) treatments which are statistically identical with 75% compost (C_2) and 75% chemical fertilizers (F_2) treatment, respectively and the lowest amount N (0.053 and 0.063%) found in 0% compost and 0% fertilizer, respectively. The application of N fertilizer along with organic fertilizer significantly increased the yield and NPK uptake by rice over control and PK only observed by (Sengar *et al.*, 2000).

4.1.11.4 Available phosphorus

The effect of compost and inorganic fertilizers application on available P content of post harvest soil was differed significantly (Table 8). The highest amounts of P (13.61 ppm and 12.16 ppm) were observed at 100% compost (C_3) and 100% inorganic fertilizers (F_3) treatments, respectively and the lowest amount P (7.98 ppm and 9.47 ppm) found in 0% compost and 0% fertilizer, respectively. Bhuiyan and Saha (1992), marked similar findings that available soil P content increased substantially due to application of organic and chemical fertilizers in each crop.

4.1.11.5 Exchangeable potassium

Data presented in Table 8 indicate that K content in post harvest soil varied significantly of BRRI dhan29 by different combination of treatments. The effect of different levels of compost (from household waste) and chemical fertilizers on exchangeable K content of post harvest soil differed significantly due to separate or combined application of organic and inorganic fertilizers. In case of compost, the maximum exchangeable K (0.174 meq/100 g soil) was found in 75% compost (C_2) treatment and the minimum exchangeable K (0.109 meq/100 g soil) found in C_0 treatment. In case of chemical fertilizers, the highest exchangeable K (0.152) was found in F_3 treatment and the lowest amount (0.128 meq/100 g soil) found in $F_{0.}$ Soil available potassium (K) content increased on average by 26%, as compared with control, in 5-year compost treatments derived from organic household wastes and yard trimmings (Hartl *et al*,. 2003). Illustrared by Tiwari *et al.* (2002); that the inclusion of manure in the fertilization schedule improved the organic carbon status and available N, P, K and S in soil, sustaining soil health

Table 8. Effects of compost and fertilizer on post-harvest soil properties in BRRI dhan29

Compost	**Soil pH**	**% Organic matter**	**% N**	**P (ppm)**	**K(meq/100 g soil)**
C_0	5.18 c	1.96 d	0.053 c	7.98 d	0.109 d
C_1	5.35 b	2.17 c	0.067 b	9.83 c	0.128 c
C_2	5.40 b	2.75 a	0.077 a	12.44 b	0.174 a
C_3	5.53 a	2.37 b	0.085 a	13.61 a	0.140 b
$LSD_{0.05}$	0.095	0.108	0.008	0.444	0.008
CV%	2.15	5.65	6.8	4.86	10.4
Fertilizer					
F_0	5.10 b	1.994 c	0.063 b	9.47 d	0.128 c
F_1	5.41 a	2.338 b	0.070 ab	10.87 c	0.133 bc
F_2	5.47 a	2.412 b	0.072 a	11.37 b	0.137 b
F_3	5.48 a	2.527 a	0.076 a	12.16 a	0.152 a
$LSD_{0.05}$	0.19	0.108	0.008	0.444	0.008
CV%	2.15	5.65	6.8	4.86	10.4

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Compost(C) (Household wastes) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose.

CV=Co-efficient of Variance

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

4.1.12 Interaction effect of compost and inorganic fertilizer on post harvest soil properties of BRRI dhan29

4.1.12.1 Soil pH

The interaction effects of compost and inorganic fertilizer application varied significantly on post harvest soil pH, where the maximum soil pH (5.77) was found in 100% compost and inorganic fertilizers combination (C_3F_3) treatment, which is statistically similar to 100% compost and 75% inorganic fertilizers combination (C_3F_2) treatment, respectively (Table 9). The minimum soil pH (5.02) was obtained in the combination 0% compost and 0% inorganic fertilizers C_0F_0) treatment.

4.1.12.2 Organic matter content

The interaction effects of compost and inorganic fertilizers significantly increased the organic matter content with increasing the level of organic and inorganic fertilizers. It was observed that the maximum organic matter content (3.047%) found in C_3F_3 treatment which is statistically similar with C_3F_2 treatment and the minimum organic matter content (1.770%) obtained C_0F_0 treatment (Table 9).

4.1.12.3 Total nitrogen

In case of interaction of compost and inorganic fertilizer, the highest amounts of N (0.090%) was obtained at 100% compost and 100% inorganic fertilizers combination(C_3F_3), which is statistically similar to 100% compost with 75% inorganic fertilizers combination (C_3F_2). The lowest amount of N (0.048%) was found in C_0F_0 treatment.

4.1.12.4 Available phosphorus

The interaction effect of compost and inorganic fertilizer application on available P content of post harvest soil was varied significantly (Table 9). The highest amount of P (14.57 ppm) was obtained at C_3F_3 treatment, which is statistically similar to C_3F_2, C_2F_3 and C_3F_1 treatments and the lowest amount of P (7.34 ppm) was found in C_0F_0 treatment, which is statistically similar to C_0F_1 treatment (Table 9).

4.1.12.5 Exchangeable potassium

The interaction effects of composts and inorganic fertilizer significantly increased the exchangeable K content with increasing the levels of compost and inorganic fertilizer application. The maximum exchangeable K (0.197 meq/100 g soil) was found in C_2F_3 treatment and the minimum exchangeable K (0.091 meq/100 g soil) obtained in C_0F_0 treatment (Table 9). The release of exchangeable K from the decomposition of organic manures and inorganic fertilizer application might be the cause of higher values of K in post harvest soils treated with these manures and chemical fertilizer. Where 8 ton cowdung ha $^{-1}$ and 100% RDCF were applied.

Table 9. Interaction effects of compost and inorganic fertilizer on post harvest soil properties on BRRI dhan29

Interaction		Soil pH	Organic matter %	% N	P (ppm)	K(meq/ 100 g soil)
Compost	**Fertilizer**					
C_0	**F_0**	5.02 g	1.77 h	0.04 e	7.34 i	0.09 h
	F_1	5.26 d-f	1.85 gh	0.05 de	7.49 i	0.11 g
	F_2	5.24 d-f	1.92 gh	0.05 e	8.09 hi	0.11 g
	F_3	5.20 e-g	2.32 e	0.05 de	9.00 gh	0.12 e-g
C_1	**F_0**	5.09 fg	1.867gh	0.06 c-e	8.79 gh	0.12 d-g
	F_1	5.42 b-d	2.30 e	0.06 b-e	9.42 fg	0.11 fg
	F_2	5.28 d-f	2.23 ef	0.06 b-e	10.09 ef	0.12 fg
	F_3	5.60 ab	2.28 e	0.07 a-d	11.05 cd	0.14 cd
C_2	**F_0**	5.11 fg	2.03 fg	0.06 b-e	10.38 de	0.14 c-e
	F_1	5.53 bc	2.41 de	0.07 a-c	12.50 b	0.13 d-f
	F_2	5.58 a-c	2.60 cd	0.08 ab	12.72 b	0.13 c-e
	F_3	5.37 c-e	2.44 de	0.08 ab	14.18 a	0.14 cd
C_3	**F_0**	5.17 e-g	2.30 e	0.07 a-c	11.38 c	0.15 c
	F_1	5.43 bd	2.77 bc	0.08 ab	14.08 a	0.17 b
	F_2	5.74 a	2.88 ab	0.08 a	14.40 a	0.17 b
	F_3	5.77 a	3.04 a	0.09 a	14.57 a	0.19 a
$LSD_{0.05}$		0.19	0.217	0.016	0.888	0.016
CV%		2.15	5.65	6.8	4.86	10.4

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Compost(C) (Household wastes) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose.

CV=Co-efficient of Variance

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

4.2 EXP No. 1b): EFFECTS OF COWDUNG AND DIFFERENT INORGANIC FERTILIZERS ON GROWTH YIELD AND NUTRIENT CONTENT OF BORO RICE (BRRI dhan29)

4.2.1 Effect of cowdung and inorganic fertilizer on plant height, number of effective tiller, non effective and total tiller per hill of BRRI dhan29

4.2.1.1 Plant height

Plant height of rice is one of the most important growth and development parameter. The effect of cowdung and inorganic fertilizers on plant height (cm) differed significantly Table 1). The highest plant height (89.37 cm) was recorded in 100% cowdung (CD_3) which was statistically similar with 75% cowdung (CD_2). In case of inorganic fertilizers, the highest plant height (92.73 cm) was recorded in 100% inorganic fertilizers (F_3). Plant height recorded either with single or combined application of fertilizer and manure was higher than that of control treatment. However the lowest plant height (83.25 and 78.47cm) were observed by control treatment having no cowdung and inorganic fertilizers, respectively. The plant height of BRRI dhan29 was increased by the application of farm wastes (Budhar *et al*., 1991). Hoque (1999) proved that plant height significantly increased with the application of cowdung associate with chemical fertilizer.

4.2.1.2 Number of effective tiller, non-effective and total tillers per hill

Combined use of cowdung, and inorganic fertilizers were significantly influenced the number of effective, non-effective and total tillers per hill of BRRI dhan29 (Table 1). All the treatments significantly produced higher number of effective tillers per hill over control treatment. The highest number of effective and total tillers per hill were recorded in CD_3 treatment in 100% cowdung application (15.52 and 16.90 respectively) in and F_3 in 100% fertilizers application (16.30 and 17.80 respectively) which were statistically identical with 75% cowdung (CD_2) and 75% fertilizers (F_2) respectively (Table

1). In case of nin effective tiller per hill both use cowdung an fertilizer highest results was found in CD_0 and Fo respectively. Cowdung along with inorganic fertilizer plays vital effect on the tillers per hill of BRRI dhan29. Nayak *et al*. (2007) observed a significant increase in effective tillers/hill due to application of inorganic fertilizer with organic manure.

Table 1. Effects of cowdung and inorganic fertilizer on different crop characters of BRRI dhan29

Cowdung	**Plant height (cm)**	**Effective tiller hill^{-1} (No.)**	**Non- effective tiller hill^{-1} (No.)**	**Total tiller hill^{-1} (No.)**
CD_0	83.25 b	13.72 b	1.750 a	15.47 b
CD_1	86.50 ab	14.80 ab	1.700 a	16.50 ab
CD_2	88.42 a	15.23 a	1.650 a	16.88 a
CD_3	89.37 a	15.52 a	1.383 b	1 6.90 a
$LSD_{0.05}$	3.31	1.224	0.142	1.235
CV%	4.58	9.91	10.6	9.01
Fertilizer				
F_0	78.47 c	13.08 c	1.700 a	14.78 c
F_1	86.98 b	14.77 b	1.650 a	16.42 b
F_2	89.35 b	15.12 ab	1.633 ab	16.75 ab
F_3	92.73 a	16.30 a	1.500 b	17.80 a
$LSD_{0.05}$	3.31	1.224	0.142	1.235
CV%	4.58	9.91	10.6	9.01

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Cowdung (CD) → CD_0 =0, CD_2 = 50%, CD_2 = 75% and CD_3 =100% of the recommended dose.

CV=Co-efficient of Variance

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

4.2.2 Interaction effect of cowdung and inorganic fertilizer on plant height, number of effective tiller, non effective and total tiller per hill of BRRI dhan29

4.2.2.1 Plant height

The interaction effect of different doses of cowdung and inorganic fertilizers on plant height of BRRI dhan29 differed significantly (Table 2). The highest plant height (96.13 cm) was observed in 100% cowdung and 100% inorganic fertilizers (CD_3F_3) and the lowest plant height (73.93 cm) was obtained in 0% cowdung and 0% inorganic fertilizers (CD_0F_0). Combination of organic and inorganic fertilizers was found better result in upland rice (Umanah *et al*., 2003) and Channabasavanna (2003) in wetland rice than only inorganic fertilizers application.

4.2.2.2 Number of effective tiller, non effective and total tiller per hill

The interaction effects of cowdung and inorganic fertilizers were on effective and total tillers per hill of BRRI dhan29 were significantly differed (Table 2), where the highest effective tiller (17.67) and total tiller per hill (18.93) were obtained in the combined effect of 100% cowdung and 100% inorganic fertilizer application (CD_3F_3). However the lowest number of effective (12.00) and total tillers per hill were (14.00) found in the combined effect of 0% cowdung and 0% inorganic fertilizer application (CD_0F_0) respectively. The interaction effects of cowdung and inorganic fertilizer application on non-effective tiller per hill were found higher (2.00) in 0% cowdung and 0% inorganic fertilizer in (CD_0F_0) and lower in (1.26) respectively.

Table 2. Interaction effects of cowdung and inorganic fertilizer on different crop characters of BRRI dhan29

Interaction		Plant height (cm)	Effective tiller hill^{-1} (No.)	Non-effective tiller hill^{-1} (No.)	Total tiller hill^{-1} (No.)
Cowdung	Fertilizer				
CD_0	F_0	73.93 g	12 f	2.00 a	14.00 f
	F_1	83.86 c-f	13.8 c-f	1.8 a-c	15.60 c-f
	F_2	86.00 c-f	13.8 c-f	1.66 b-e	15.47 c-f
	F_3	89.20 a-c	15.27 a-e	1.40 ef	17.00 a-d
CD_1	F_0	78.80 fg	12.73 ef	1.73 a-d	14.00 ef
	F_1	86.46 c-e	15.07 a-e	1.53 c-f	16.60 b-f
	F_2	89.86 a-c	14.87 a-e	1.33 f	16.20 b-f
	F_3	90.86 a-c	16.53 a-e	1.40 ef	17.93 a-c
CD_2	F_0	79.8 e-g	14.07 b-f	1.66 b-e	15.73 c-f
	F_1	89.2 a-c	14.13 b-f	1.66 b-e	15.69 c-f
	F_2	89.93 a-c	15.07 a-e	1.53 c-f	16.65 b-f
	F_3	94.73 ab	15.73 a-d	1.46 d-f	17.19 a-d
CD_3	F_0	81.33 d-f	13.53 d-f	1.93 ab	15.46 d-f
	F_1	88.80 bd	16.07 a-e	1.8 a-c	17.87 a-c
	F_2	91.6 a-c	16.73 ab	1.53 c-f	18.26 ab
	F_3	96.13 a	17.67 a	1.267 f	18.93 a
$LSD_{0.05}$		6.63	2.447	0.284	2.47
CV%		4.58	9.91	10.6	9.01

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Cowdung (CD) → CD_0 =0, CD_2 = 50%, CD_2 = 75% and CD_3 =100% of the recommended dose.

CV=Co-efficient of Variance

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

4.2.3 Effect of cowdung and inorganic fertilizer on panicle length, 1000 grain weight and filled grains/panicles of BRRI dhan29

4.2.3.1 Panicle length

Panicle length is an important phenotypic plant character of rice. The panicle length of BRRI dhan29 responded positively due to application of cowdung and inorganic fertilizer, (Table 3). All the treatments gave significantly higher panicle length compared to the control treatment (CD_0 and Fo). The highest panicle lengths observed in CD_3 in 100% cowdung (21.93) and 22.18 cm 100% inorganic fertilizer application (F_3) respectively, which were statistically similar with $CD_{2,}$ CD_1 and $F_{2,}$ F_1 treatments. The lowest panicle lengths found at CD_0 in 0% cowdung (21.02) and (F_0) at 0% inorganic fertilizer application (20.45 cm) which were (no organic and inorganic fertilizer) treatments respectively. Haque (1998) stated that a significant increase in panicle length due to the application of combined treatments that are organic manure and chemical fertilizers.

4.2.3.2 1000-grain weight

The effect of cowdung on 1000-grain weight (g) of BRRI dhan29 was differed significantly but the effect of inorganic fertilizers was non-significant (Table 3). The highest 1000-grain weight was found in 100% cowdung (26.00). Yang *et al*. (2004) recorded that 1000-grain weight was increased by the application of chemical fertilizer along with organic manure.

4.2.3.3 Filled grains/panicle

The total number of filled grains per panicle contributes materially towards the final yield of rice. The effect of cowdung and inorganic fertilizers on filled grains/panicles was differed significantly shown in (Table 3 and 4). The highest filled grains/panicles was recorded in (CD_3) in 100% cowdung (102.9) and F_3 in 100% inorganic fertilizer application (92.00). More number of panicles per hill might be due to more availability of macro as well as micro plant nutrients with the addition of organic matter in to soil investigated by (Siavoshi *et al*., 2011).

Table 3. Effects of cowdung and inorganic fertilizer on panicle length (cm), 1000 grain wt.(g) and filled grains/panicles of BRRI dhan29

Cowdung	Panicle length(cm)	1000 grain wt.(g)	Filled grains/panicles
CD_0	21.02 b	22.97 b	68.25 d
CD_1	21.67 a	22.93 b	84.00 b
CD_2	21.80 a	24.16 b	89.83 b
CD_3	21.93 a	26.00 a	102.9 a
$LSD_{0.05}$	0.648	1.38	2.47
CV%	3.6	6.89	3.43
Fertilizer			
F_0	20.45 b	23.63	83 c
F_1	21.83 a	24.21	82.33 c
F_2	21.95 a	23.73	87.67 b
F_3	22.18 a	24.49	92.00 a
$LSD_{0.05}$	0.648	$1.38^{(NS)}$	2.47
CV%	3.6	6.89	3.43

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Cowdung (CD) → CD_0 =0, CD_2 = 50%, CD_2 = 75% and CD_3 =100% of the recommended dose.

CV=Co-efficient of Variance NS=Non significant.

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

4.2.4 Interaction effect of cowdung and inorganic fertilizer on panicle length, 1000 grain weight and filled grains/panicles of BRRI dhan29

4.2.4.1 Panicle length

The combined effects of cowdung and inorganic fertilizer on panicle length of BRRI dhan29 were differed significantly (Table 4). It was observed that the highest panicle length (22.60 cm) was found in CD_3 in 100% cowdung and

Table 4. Interaction effects of cowdung and inorganic fertilizers on fertilizer on panicle length(cm), 1000 grain wt.(g)and filled grains/panicle of BRRI dhan29

Interaction		Panicle length(cm)	1000 grain wt.(g)	Filled grains/panicle (No.)
Cowdung	**Fertilizer**			
CDo	F_0	20.27 d	20.73 e	64.33 i
	F_1	21.60 a-d	23.67 a-e	65.67 i
	F_2	20.87 bd	24.13 a-d	69.33 hi
	F_3	21.33 a-d	23.33 b-e	73.67 h
CD_1	F_0	20.80 bd	21.77 de	79.33 g
	F_1	21.80 a-c	23.87 a-e	81.67 g
	F_2	21.67 a-d	22.67 c-e	83.33 g
	F_3	22.40 a	23.42 a-e	91.67 ef
CD_2	F_0	20.47 cd	23.55 a-e	89.33 f
	F_1	22.13 ab	23.54 a-e	81.33 g
	F_2	22.40 a	24.97 a-d	93.67 ef
	F_3	22.53 a	24.60 a-d	95.00 de
CD_3	F_0	20.27 d	25.07 a-c	99.00 cd
	F_1	22.27 ab	25.77 a-c	100.7 bc
	F_2	22.27 ab	26.54 ab	104.3 ab
	F_3	22.60 a	26.62 a	107.7 a
$LSD_{0.05}$		1.29	2.761	6.66
CV%		3.6	6.89	3.43

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Cowdung (CD) → CD_0 =0, CD_2 = 50%, CD_2 = 75% and CD_3 =100% of the recommended dose.

CV=Co-efficient of Variance

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

100% inorganic fertilizer application ($CD_3F_{3)}$ treatment which was statistically identical with CD_2F_3, CD_2F_2 and CD_1F_3 treatments. The lowest panicle length (20.27 cm) was noted in 0% cowdung in CD_3 and 0% inorganic fertilizer application CD_0F_0 followed by CD_3F_0 treatments.

4.2.4.2 1000 grain weight

The interaction effects of cowdung and inorganic fertilizers on 1000-grain weight was differed significantly. It was observed that the maximum weight of 1000 grain (26.62 g) was found in 100% cowdung and 100% inorganic fertilizer (CD_3F_3) treatment and the lowest weight was found in CD_0F_0 (20.73 g) having no use of fertilizer and cowdung.

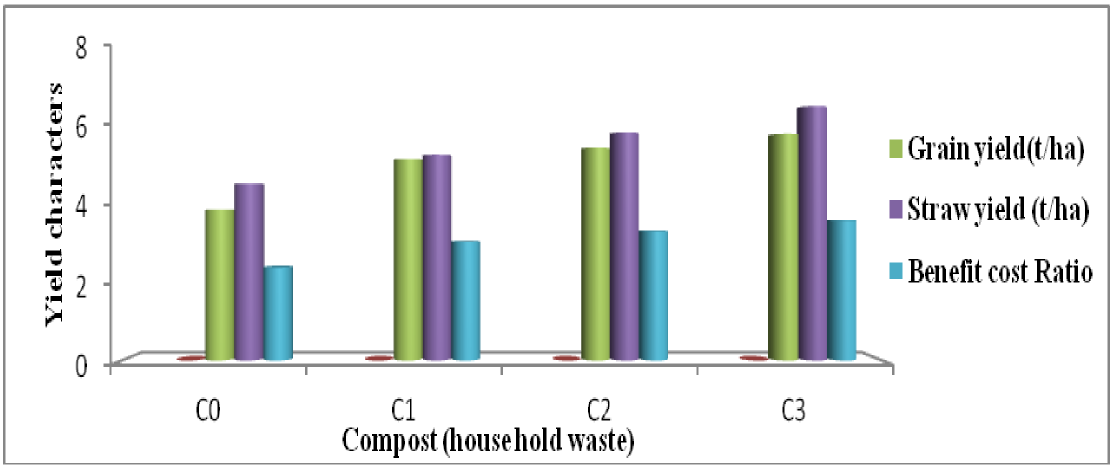
4.2.4.3 Filled grains/panicle

The interaction effects of cowdung and inorganic fertilizers on filled grains/panicle was differed significantly. It was observed that the maximum filled grains/panicle was found in 100% cowdung and 100% inorganic fertilizer CD_3F_3 (107.7) treatment and the lowest filled grains/panicles was found in CD_0F_0 (64.33) treatment having no use of fertilizer and cowdung

4.2.5 Effect of cowdung and inorganic fertilizer on grain yield, straw yield and benefit cost ratio of BRRI dhan29

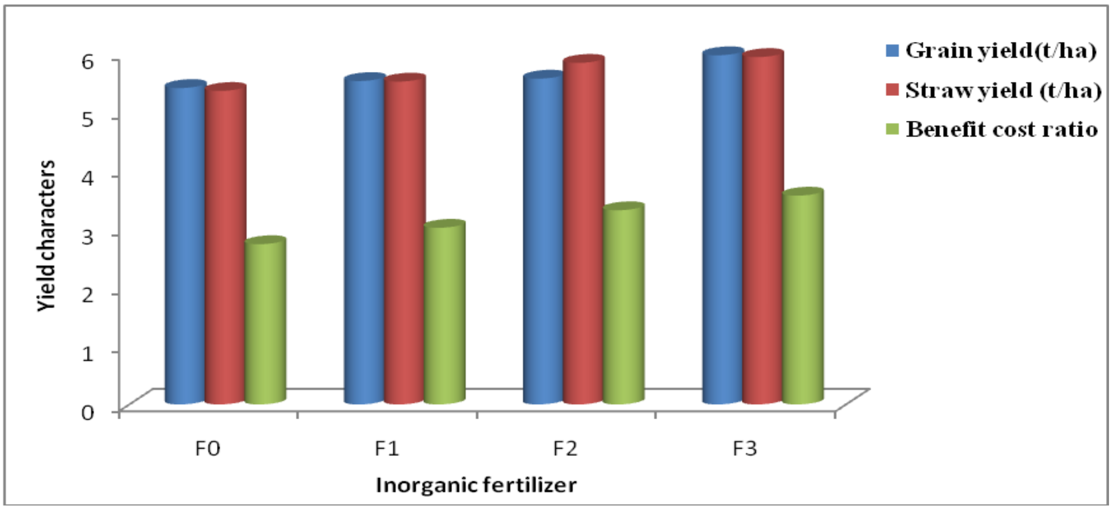
4.2.5.1 Grain and straw yield

Grain yield is the additive result act as an important yield contributing characters of rice. The ultimate goal of raising crop is to increase the grain yield. Application of cowdung along with inorganic fertilizer showed a positive effect on grain yield of BRRI dhan29 (Figure 1 and 2 appendix vi). The grain and straw yield of BRRI dhan29 has been significantly increased due to the application of inorganic fertilizer associate with cowdung. There were numerical variations in grain and straw yield among the treatments. The highest grain (6.402 t ha^{-1}) and straw yields (6.572 t ha^{-1}) were observed in CD_3 in 100% cowdung respectively and the lowest grain (4.763) and straw yields (4.734 t ha^{-1}) were obtained in 0% cowdung (CD_0) (control) respectively. In use of inorganic fertilizer application the highest grain and straw yields were found in F_3 in 100% fertilizers (5.968 and 5.935 t ha^{-1}) respectively and the



Cowdung (CD) → CD_0 = 0%, CD_1 = 50%, CD_2 =75% and CD_3 = 100% of the recommended dose

Figure 1. Effects of cowdung on different yield components of BRRI dhan29.



Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Figure 2. Effects inorganic fertilizer on different yield components of BRRI dhan29.

lowest grain and straw yields (5.410 and 5.363 t ha^{-1}) in 0% fertilizers (F_0) respectively. Ahmed and Rahman (1991), accomplished that the application of organic manure and chemical fertilizers increased the straw and grain yields of rice.

4.2.5.2 Benefit cost ratio

Economic yields and added benefits influenced by combined use of inorganic fertilizer and cowdung on rice. The effect of cowdung and inorganic fertilizer on benefit cost ratio was differed significantly (Figure 1 and 2 and appendix vi). The highest benefit cost ratio was recorded CD_3 in 100% cowdung application (3.57) and F_3 100% inorganic fertilizer application (3.57). Similar results were reported by Yaduvanshi (2003), who observed that higher profit was obtained when inorganic fertilizer was combined with organic manures.

4.2.6 Interaction effect of cowdung and inorganic fertilizer on grain yield, straw yield and Benefit cost ratio of BRRI dhan29

4.2.6.1 Grain and straw yield

The interaction effects of cowdung and inorganic fertilizer, the maximum grain yield was found in CD_3F_3 in 100% cowdung and 100% inorganic fertilizers combination (6.77 t ha^{-1}) and straw yield (6.84 t ha^{-1}) found in same treatment in CD_3F_3 in 100% cowdung and 100% inorganic fertilizer combination, which were statistically similar (6.60 and 6.81 t ha^{-1}) with CD_3F_2 treatment, respectively (Table 5). The minimum grain and straw yields were noted in CD_0F_0 in 0% cowdung and 0% inorganic fertilizer combination (4.48 and 4.37 t ha^{-1}), respectively.

4.2.6.2 Benefit cost ratio

The interaction effects (Table 5) of cowdung and inorganic fertilizer on benefit cost ratio was differed significantly. It was observed that the maximum benefit cost ratio (3.81) was found CD_3F_3 in 100% cowdung and 100% inorganic fertilizer treatment which was statistically similar with CD_3F_2 and the lowest result was found in CD_0F_0 (1.85) having no use of inorganic fertilizer and cowdung.

Table 5. Interaction effects of cowdung and inorganic fertilizer on different yield and yield components of BRRI dhan29

Interaction		Grain yield ($t\ ha^{-1}$)	Straw yield ($t\ ha^{-1}$)	Benefit cost ratio
Cowdung	**Fertilizer**			
CDo	F_0	4.48 d	4.370 g	1.85 h
	F_1	4.57 d	4.601 fg	2.19 g
	F_2	4.60 d	5.07e-g	2.35 fg
	F_3	5.39 c	4.88 e-g	2.58 f
CD_1	F_0	5.65 c	5.21 d-g	2.52 f
	F_1	5.63 c	5.28 c-g	3.23 de
	F_2	5.49 c	5.55 b-f	3.16 e
	F_3	5.93 a-c	5.44 b-f	3.28 c-e
CD_2	F_0	5.54 c	5.64 b-e	3.24 de
	F_1	5.64 c	5.77 b-e	3.20 e
	F_2	5.55 c	6.29 ab	3.52 bc
	F_3	5.76 bc	6.17 a-d	3.34 c-e
CD_3	F_0	5.96 a-c	6.22 a-c	3.38 b-e
	F_1	6.26 a-c	6.4 ab	3.48 b-d
	F_2	6.60 ab	6.81 a	3.61 ab
	F_3	6.77 a	6.84 a	3.81 a
$LSD_{0.05}$		0.775	0.85	0.23
CV%		8.27	9.01	4.69

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Cowdung (CD) → CD_0 =0, CD_2 = 50%, CD_2 = 75% and CD_3 =100% of the recommended dose.

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

4.2.7 Effect of cowdung and inorganic fertilizer on Nitrogen, Phosphorus and Potassium content in grain of BRRI dhan29

4.2.7.1 N, P and K content in grain

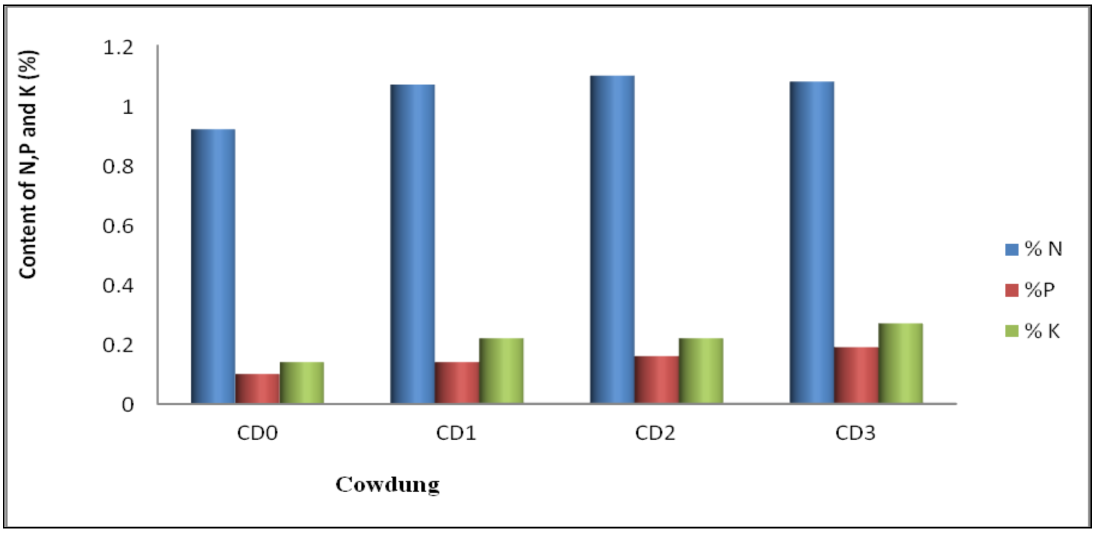
The data showed on N, P and K content in grain in rice differed significantly and influenced by cowdung and inorganic fertilizer application were presented in (Figure 3, 4 and appendices Vll). The highest N content in grain found (1.10%) was recorded in 75% cowdung (CD_2), P content in grain found higher (0.19%) in 100% cowdung (CD_3), and K content in grain was higher (0.27%) in 100% cowdung (CD_3) respectively, and lowest N, P and K content in grain were found in 0% cowdung CD_0 (0.92%,0.10% and 0.13%) respectively.

From the using inorganic fertilizer the highest N content in grain observed higher (1.10%, 0.16% and 0.23%) were recorded in F_3 in 100% inorganic fertilizer application respectively. The lowest amount of N, P and K content in grain (0.98%, 0.13% and 0.19%) was observed by treatment 0% fertilizer (F_0)

4.2.8 Interaction effect of cowdung and inorganic fertilizer on Nitrogen, Phosphorus and Potassium content in grain of BRRI dhan29

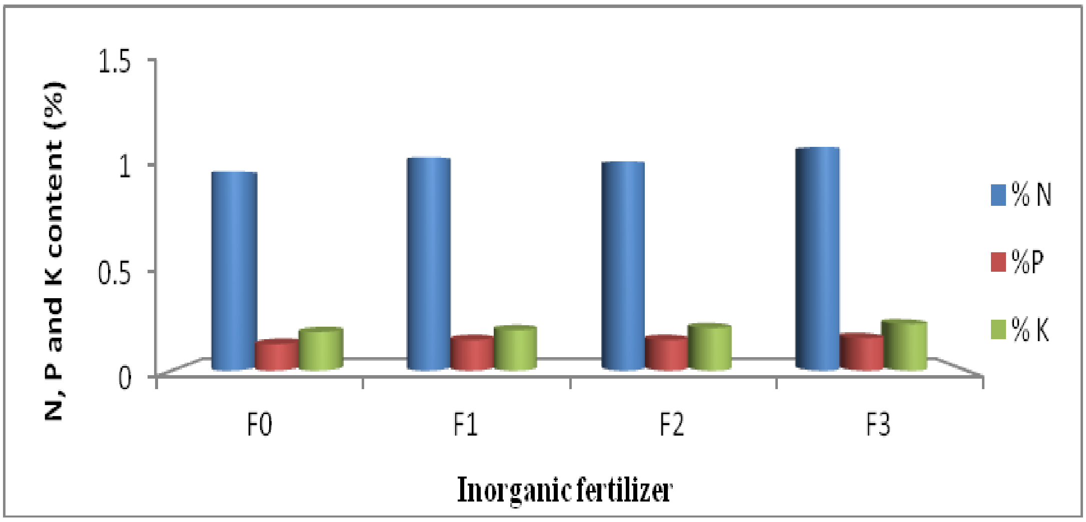
4.2.8.1 N, P and K content in grain

The interaction effect of different doses of cowdung and inorganic fertilizer of BRRI dhan29 significantly higher in N content in grain CD_2F_1 (50% cowdung and 0% Inorganic fertilizer) (1.14%), P content in grain observed higher CD_3F_3 (0.20%) and K content in grain observed higher (0.30%) was recorded in CD_3F_3 respectively., which were closely followed by CD_2F_3 , CD_3F_2 and CD_3F_3 in N content and CD_3F_2 (100 % Inorganic fertilizer + 75% cowdung t/ha) was both in P and K content respectively (Table 6). The lowest value in these three)



Cowdung (CD) → CD_0 = 0%, CD_1 = 50%, CD_2 =75% and CD_3 = 100% of the recommended dose

Figure 3. Effects of cowdung with NPK content in grain in BRRI dhan29.



Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Figure 4. Effects of inorganic fertilizer with NPK content in grain in BRRI dhan29.

cases (0% inorganic fertilizer + 0% cowdung t/ha) $CD_0F_{0.}$ (0.82%, 0.08% and 0.12%) respectively. N content of BRRI dhan29 was increased by the application of farm wastes (Budhar *et al*., 1991, and Hoque 1999) proved that N content significantly increased with the application of cowdung along with inorganic fertilizer.

Table 6. Interaction effects of cowdung and inorganic fertilizer of NPK content in grain of BRRI dhan29

Interaction		**% N**	**% P**	**% K**
Cowdung	**Fertilizer**			
CD_0	F_0	0.82 e	0.08 f	0.12 f
	F_1	0.95 d	0.09 f	0.14 ef
	F_2	0.87 e	0.09 f	0.12 f
	F_3	1.05 bc	0.12 e	0.15 d-f
CD_1	F_0	1.05 bc	0.12 e	0.19 c-e
	F_1	1.09 abc	0.15 d	0.20 cd
	F_2	1.05 bc	0.15 d	0.23 bc
	F_3	1.08 abc	0.15 d	0.25 a-c
CD_2	F_0	1.01 cd	0.14 d	0.21 bc
	F_1	1.14 a	0.17 c	0.21 c
	F_2	1.11 ab	0.17 bc	0.22 bc
	F_3	1.14 a	0.17 c	0.22 bc
CD_3	F_0	1.06 abc	0.18 bc	0.25 a-c
	F_1	1.03 bc	0.18 bc	0.25 a-c
	F_2	1.10 ab	0.19 ab	0.27 ab
	F_3	1.11 ab	0.20 a	0.30 a
$LSD_{0.05}$		0.07	0.016	0.052
CV%		4.76	7.49	13.45

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Cowdung (CD) → CD_0 =0, CD_2 = 50%, CD_2 = 75% and CD_3 =100% of the recommended dose.

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

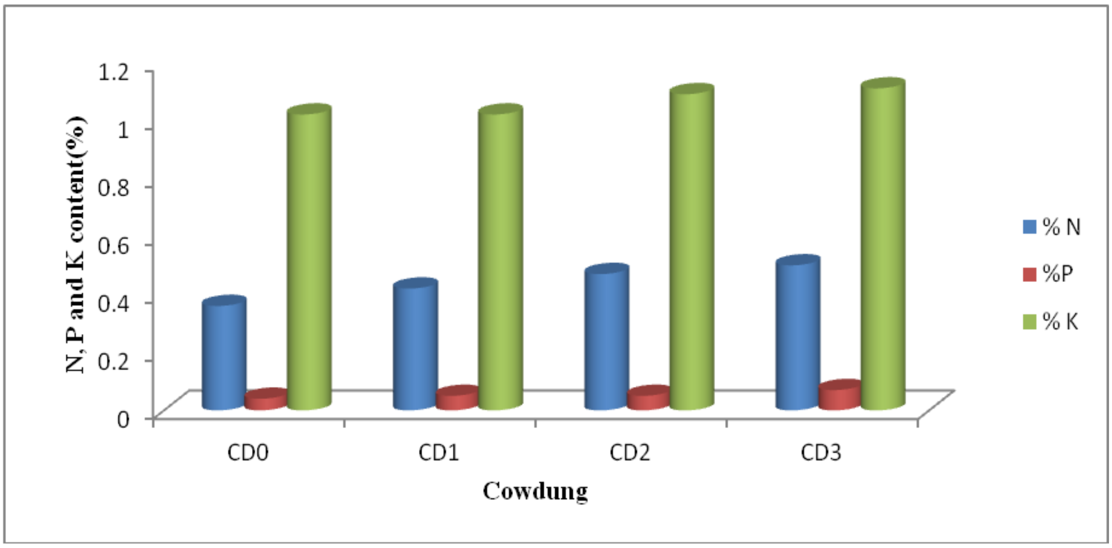
4.2.9 Effect of cowdung and inorganic fertilizer on Nitrozen, Phosphorus and Potassium content in straw of BRRI dhan29

4.2.9.1 N content in straw (%)

Due to application of inorganic fertilizer coupled with cowdung, the N content in straw of BRRI dhan29 was increased to a significant extent (Figure 5, 6 and appendix Vlll). and differed significantly among the different combinations of cowdung and inorganic fertilizer. The highest N content in straw was recorded in CD_3 (0.49%) in cowdung which was statistically similar with CD_2 and lowest observation was found in CD_0 (0.36%). From the Figure 6 by the application of inorganic fertilizer the highest N content was recorded in F_3 (0.46%) and the lowest amount of N content (0.42%) was observed by treatment F_0 which was statistically similar with F_1 and $F_{2.}$ N content recorded either with single or combined application of fertilizer and cowdung was higher than that of control treatment. Bari *et al.* (2013) shows similar results

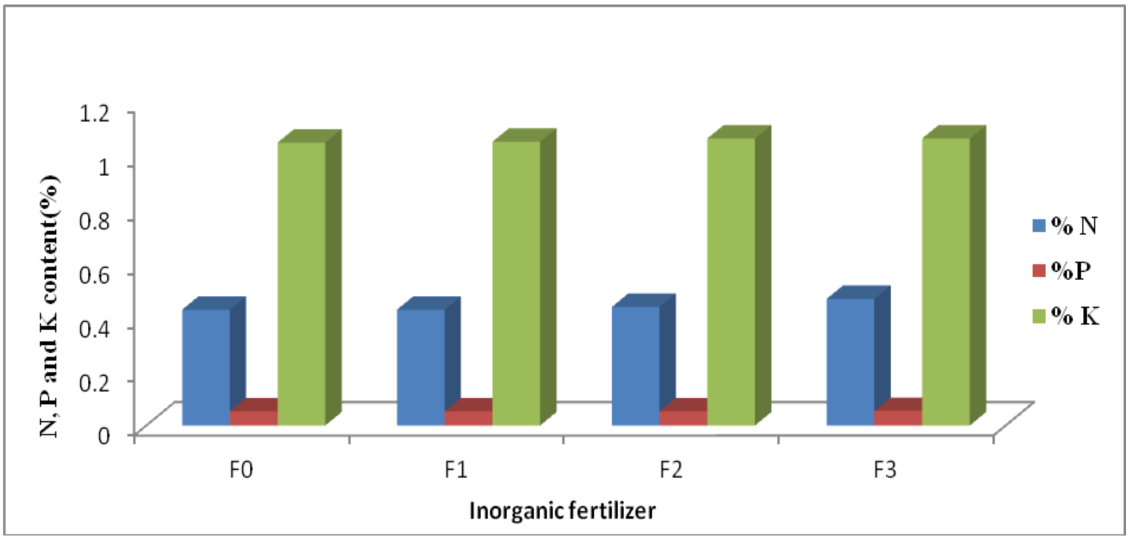
4.2.9.2 % P and % K content in straw

P and K content in straw (%) for BRRI dhan29 responded positively due to application of different doses of inorganic fertilizer and cowdung. Different interaction and single effects of cow dung and inorganic fertilizer differed significantly in respect of P and K content (Figure 5, 6 and appendix VIII). The maximum P and K content in straw were recorded in CD_3 (0.06% and 1.11%) in using cowdung and minimum observation was found in CD_0 (0.03 and 1.01%). From the figure 8 in application of in organic fertilizer there is no significant observation found in both P and K content in straw.. Uptake of K was much higher than straw (Ali *et al.*, 2007).



Cowdung (CD) → CD_0 = 0%, CD_1 = 50%, CD_2 =75% and CD_3 = 100% of the recommended dose

Figure 5. Effects of cowdung with NPK content in straw in BRRI dhan29.



Inorganic Fertilizer (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Figure 6. Effects of inorganic fertilizer with NPK content in straw in BRRI dhan29

Table 7. Interaction effects of cowdung and inorganic fertilizer of NPK content in straw of BRRI dhan29

Interaction		% N	% P	% K
Cowdung	**Fertilizer**			
CD_0	F_0	0.34 f	0.03 c	1.01 b-d
	F_1	0.33 f	0.03 c	1.01 b-d
	F_2	0.35 f	0.03 c	1.02 b-d
	F_3	0.41 e	0.03 c	1.02 b-d
CD_1	F_0	0.41 e	0.03 c	0.98 d
	F_1	0.42 de	0.04 bc	1.00 cd
	F_2	0.42 de	0.05 a-c	1.04 a-d
	F_3	0.43 c-e	0.05 a-c	1.043 a-d
CD_2	F_0	0.48 a-d	0.05 a-c	1.11 ab
	F_1	0.47 a-d	0.05 a-c	1.09 a-d
	F_2	0.46 b-e	0.05 a-c	1.05 a-d
	F_3	0.49 a-c	0.05 a-c	1.07 a-d
CD_3	F_0	0.47 a-e	0.05 a-c	1.09 a-d
	F_1	0.48 a-d	0.06 a	1.10 a-c
	F_2	0.51 ab	0.06 ab	1.137 a
	F_3	0.53 a	0.06 a	1.11 ab
$LSD_{0.05}$		0.052	0.016	0.091
CV%		5.42	9.14	4.97

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Cowdung (CD) → CD_0 =0, CD_2 = 50%, CD_2 = 75% and CD_3 =100% of the recommended dose.

CV=Co-efficient of Variance

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

4.2.10 Interaction effect of cowdung and inorganic fertilizer on Nitrozen, Phosphorus and Potassium content in straw of BRRI dhan29

4.2.10.1 % N content in straw

Interaction effect of different doses of cowdung and inorganic fertilizer of BRRI dhan29 significantly higher N content in straw (0.53%) was recorded in

CD_3F_3 (100% Inorganic fertilizer +100% cowdung t/ha) which was closely followed by CD_3F_2 (75 % Inorganic fertilizer + 100% cowdung t/ha) (Table 7).

4.2.10.2 % P and % K content in straw

The interaction effect of different doses of cowdung and inorganic fertilizer in BRRI dhan29 significantly influenced the straw P and K concentration and the highest straw P and K content (0.068% and 1.13%) was recorded in CD_3F_3 (100 % Inorganic fertilizer + 100% cowdung t/ha) and CD_3F2 respectively which were closely followed by CD_3F_2 and CD_3F_3 respectively (Table 7). The lowest observation were found in both CD_0F_0 (0.038% and 1.01%) which were accurately simillar with $CD_0F_{1,}$ CD_0F_2 and $CD_0F_{2.}$

4.2.11 Effects of cowdung and inorganic fertilizer on post harvest soil properties of BRRI dhan29

4.2.11.1 Soil pH

There is no significant relationship was exists on using cowdung and inorganic fertilizer application. Even using both of cowdung and inorganic fertilizer application i.e. interaction effects there is no significant relation exists on (Table 8 and 9).

4.2.11.2 Organic matter content

Organic matter is the most additive result of the post-harvest characters of soil in rice. The ultimate goal of raising crop is to increase the organic matter incorporation in soil. The effect of different levels of cowdung and inorganic fertilizer on organic matter content of post- harvest soil differed significantly (Table 8), where the maximum organic matter content was 2.888% obtained in 100% cowdung (CD_3) and 2.803% was 100% inorganic fertilizer (F_3), respectively. The lowest organic matter content was obvious in CD_0 (2.152%) and F_0 (using no cowdung and inorganic fertilizer) 2.285% was found respectively. Increase rate of organic matter content in soil due to increase combined application of organic manures and chemical fertilizers examined by (Haque *et al.,* 2001).

4.2.11.3 Total nitrogen

The significant effect was found on total nitrogen (N) content of post-harvest soil of BRRI dhan29 due to cowdung and inorganic fertilizer application (Table 8). All the treatments significantly influence on higher N content over control one. The highest N content of post-harvest soil was recorded in CD_3 in 100% cowdung (0.165%) and the lowest N content of post-harvest soil was found in CD_0 in 0% cowdung (0.098%). In case of inorganic fertilizer, the highest amount of N (0.143%) was found in 100% fertilizers (F_3) treatment which is statistically identical with 75% fertilizers (F_2) treatment (Table 8).

4.2.11.4 Available phosphorus

Available phosphorus (P) content of the post-harvest soils was significantly influenced by the application of cowdung and inorganic fertilizer (Table 8 and 9). The highest amount of available P content (14.94 ppm) of the post-harvest soils was found in 100% cowdung (CD_3) and the lowest value (10.64 ppm) was observed in 0% cowdung (CD_0) treatment. In case of inorganic fertilizer, the highest amount of available P (14.32 ppm) was recorded in 100% fertilizers (F_3) treatment and the lowest amount available P (11.44 ppm) was observed by treatment 0% fertilizers (F_0).

4.2.11.5 Exchangeable potassium

Data presented in (Table 8) indicate that K content in post-harvest soil in rice of BRRI dhan29 varied significantly by using different treatments**.** The exchangeable K content of the initial soil was 0.14 meq/100 g soil. The highest exchangeable K content of post-harvest soil was recorded in 100% cowdung in CD_3 (0.208 meq/100 g soil) and the lowest exchangeable K content (0.120 meq/100 g soil) of post-harvest soil was found in 0% cowdung (CD_0)

treatment. In case of inorganic fertilizer, the highest amount of exchangeable K was recorded 100% fertilizers F_3 (0.177 meq/100 g soil) which is statistically similar with 75% fertilizers (F_2).

4.2.12 Interaction effect of cowdung and inorganic fertilizer on post harvest soil properties of BRRI dhan29

4.2.12.1 Soil pH

There is no significant relationship was exists on using cowdung and inorganic fertilizer. Even using both of cowdung and inorganic fertilizer i.e. interaction effects there is no significant relation was exists on.

Table 8. Effects of different levels of cowdung and inorganic fertilizer on post harvest soil

Cowdung	Soil pH	% Organic matter	% N	P (ppm)	K (meq/100 g soil)
CD_0	5.108	2.15 d	0.09 d	10.64 d	0.120 c
CD_1	5.193	2.49 c	0.13 c	12.82 c	0.16 b
CD_2	5.238	2.72 b	0.14 b	13.35 b	0.16 b
CD_3	5.297	2.88 a	0.16 a	14.94 a	0.20 a
$LSD_{0.05}$	0.19	0.095	0.008	0.399	0.008
CV%	4.47	4.50	4.26	3.71	12.35
Fertilizer					
F_0	5.163	2.28 c	0.12 b	11.44 d	0.15 c
F_1	5.185	2.59 b	0.12 b	12.87 c	0.16 b
F_2	5.233	2.57 b	0.13 a	13.22 b	0.17 ab
F_3	5.254	2.80 a	0.14 a	14.32 a	0.17 a
$LSD_{0.05}$	0.19 $^{(NS)}$	0.190	0.008	0.399	0.008
CV%	4.47	4.50	4.26	3.71	12.35

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Cowdung (CD) → CD_0 =0, CD_2 = 50%, CD_2 = 75% and CD_3 =100% of the recommended dose.

CV=Co-efficient of Variance NS=Non significant.

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

4.2.12.2 Organic matter

The interaction effects of cowdung and inorganic fertilizers on organic matter content also differed significantly (Table 9). It was observed that the highest organic matter content was found in CD_3F_3 (3.137%) which was statistically identical with CD_3F_2 combination. The lowest organic matter (2.057%) noted in CD_0F_0 treatment.

4.2.12.3 Total Nitrogen

The interaction effects of cowdung and inorganic fertilizer of BRRI dhan29 on N content of post-harvest soil differed significantly (Table 9), where the highest N content (0.178%) obtained at the combination of 100% cowdung (CD_3) and 100% inorganic fertilizers (F_3) i.e. CD_3F_3 treatment, which is statistically similar with CD_3F_2 combination. The lowest amount of N content was found in the combination of 0% cowdung (0.083%) and 0% fertilizers (CD_0F_0) treatment, which is statistically identical with CD_0F_1 and CD_0F_2 treatments (Table 9). Mathew and Nair (1997) revealed that the application of organic manure increased the total N content in soil. Several workers also found that organic matters had a positive effect on total and available N content of soil.

4.2.12.4 Available phosphorus

The interaction effect of different doses of cowdung and chemical fertilizers on available phosphorus (P) content of post-harvest soil differed significantly (Table 9). The maximum available P was recorded in CD_3F_3 in 100% cowdung + 100 % Inorganic fertilizer (16.33 ppm) which was closely followed by CD_3F_2 treatment. The lowest amount available P (8.14 ppm) was observed in the treatment 0% cowdung and 0% chemical fertilizers (F_0) combination, which is statistically identical with CD_0F_1 treatment. Tchienkoua and Zech (2003) examined that the

Table 9. Interaction effects of cowdung and fertilizer on post-harvest soil properties in BRRI dhan29

Interaction		Soil pH	% Organic matter	% N	P (ppm)	K (meq/100 g soil)
Cowdung	**Fertilizer**					
CD_0	**F_0**	5.040	2.057 f	0.083 g	8.14 h	0.096 L
	F_1	5.137	2.110 ef	0.084 g	8.87 h	0.122 k
	F_2	5.120	2.120 ef	0.099 g	10.18 g	0.129 jk
	F_3	5.137	2.313 d-e	0.117 f	15.39 b	0.135 i-k
CD_1	**F_0**	5.220	2.180 ef	0.121 ef	11.69 f	0.146 h-j
	F_1	5.220	2.473 d	0.13 d-f	13.23 de	0.167 e-g
	F_2	5.233	2.443 d	0.142 cd	13.68 d	0.186 cd
	F_3	5.097	2.867 bc	0.143 cd	12.69 e	0.179 c-e
CD_2	**F_0**	5.180	2.387 d	0.148 cd	13.05 de	0.172 d-f
	F_1	5.193	2.790 c	0.148 cd	14.52 c	0.157 f-h
	F_2	5.270	2.840 bc	0.148 cd	12.97 de	0.151 g-i
	F_3	5.307	2.893 bc	0.137 de	12.87 de	0.183 c-e
CD_3	**F_0**	5.213	2.517 d	0.158 bc	12.89 de	0.196 bc
	F_1	5.190	2.880 bc	0.157 bc	14.50 c	0.209 ab
	F_2	5.310	3.202 ab	0.169 ab	16.06 ab	0.210 ab
	F_3	5.477	3.137 a	0.178 a	16.33 a	0.216 a
$LSD_{0.05}$		0.38 ns	0.190	0.01668	0.799	0.016
CV%		4.47	4.50	4.26	3.71	12.35

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Cowdung (CD) → CD_0 =0, CD_2 = 50%, CD_2 = 75% and CD_3 =100% of the recommended dose.

CV=Co-efficient of Variance NS=Non significant.

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

deficiency of P is a major constraint for better crop production in most tropical soils.

4.2.12.5 Exchangeable potassium

The interaction effects of cowdung and inorganic fertilizers on exchangeable K content of post-harvest soil differed significantly (Table 9), where the highest K content CD_3 obtained at the combination of 100% cowdung (0.216 meq/100 g soil) and 100% inorganic fertilizer applicatin (F_3) i.e. CD_3F_3 treatment combination, which is statistically similar with CD_3F_2 and CD_3F_1 combination. Where 8 ton cowdung ha $^{-1}$ and 100% RDCF were applied. The lowest amount of exchangeable K was found in CD_0F_0 the combination of 0% cowdung and 0% fertilizers (0.096 meq/100 g soil).

4.3 EXPERIMENT TITLE: EFFECTS OF POULTRY MANURE AND DIFFERENT INORGANIC FERTILIZERS ON GROWTH YIELD AND NUTRIENT CONTENT OF BORO RICE (BRRI dhan29)

4.3 Effect of poultry manure and inorganic fertilizers on plant height, number of effective tiller, non effective and total tiller per hill of BRRI dhan29

4.3.1 Plant height

Use of poultry manure and inorganic fertilizers significantly differed in effect of the plant height of BRRI dhan29 (Table 1). The highest plant height (92.49 cm) was recorded in PM_3 in 100% poultry manure, which is statistically similar with 75% poultry manure (PM_2). In case of inorganic fertilizers, the tallest plant (95.53 cm) was recorded in F_3 in 100% inorganic fertilizers. The lowest plant height (87.98 and 83.62 cm) were observed by 0% poultry manure and 0% inorganic fertilizers *i.e* no poultry manure or inorganic fertilizer application Maximum plant height was noted in BRRI dhan29 due to the application of poultry manure at the rate of 3 t ha^{-1} along with 50% soil test basis fertilizer in boro season (Anonymous, 2008). Plant height might be increased due to greater availability of nutrients.

4.3.2 Number of effective, non-effective and total tillers per hill

Significant relationships were found by using poultry manure and inorganic fertilizers on effective, non-effective and total tillers per hill of BRRI dhan29 (Table 1). The highest numbers of effective (17.67) and total tillers per hill (19.95) were PM_3 in 100% poultry manure and F_3 in 100% inorganic fertilizer application separately. Azim (1999) also reported beneficial effects of organic manures in combination with inorganic fertilizer on effective tillers $hill^{-1}$

Table 1. Effects of poultry manure and inorganic fertilizer on different characteristics of BRRI dhan29

Poultry manure	Plant height (cm)	Effective tiller $hill^{-1}$ (No.)	Non- effective tiller $hill^{-1}$ (No.)	Total tiller $hill^{-1}$ (No.)
PM_0	87.98 b	12.90 c	3.383 a	16.28 c
PM_1	89.64 ab	14.53 b	3.192 a	17.73 b
PM_2	91.24 a	15.12 b	2.883 b	18.00 b
PM_3	92.49 a	17.67 a	2.283 c	19.95 a
$LSD_{0.05}$	3.035	0.8796	0.2912	0.9152
CV%	4.03	7.01	11.88	6.10
Fertilizer				
F_0	83.62 c	11.38 c	3.883 a	15.27 c
F_1	89.97 b	14.85 b	3.208 b	18.06 b
F_2	92.24 b	16.60 a	2.675 c	19.27 a
F_3	95.53 a	17.38 a	1.975 d	19.36 a
$LSD_{0.05}$	3.035	0.8796	0.2912	0.9152
CV%	4.03	7.01	11.88	6.10

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Poultry manure (PM) → PM_0 =0, PM_2 = 50%, PM_2 = 75% and PM_3 =100% of the recommended dose.

CV=Co-efficient of Variance

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

4.3.2 Interaction effect of poultry manure and inorganic fertilizer on plant height, number of effective tiller, non effective and total tiller per hill of BRRI dhan29

4.3.2.1 Plant height

The interaction effects of different doses of poultry manure and inorganic fertilizer application on plant height of BRRI dhan29 differed significantly (Table 2). The tallest plant (97.10 cm) was found in PM_3F_3 (100% poultry manure and 100% inorganic fertilizers) and the lowest value (80.87 cm) observed in PM_0F_0 (0% poultry manure and 0% inorganic fertilizer application).

4.3.2.2 Number of effective tiller, non effective and total tiller per hill

In interaction effect of poultry manure and inorganic fertilizer application plays vital rule on the effective and total tillers per hill, where 100% poultry manure (PM_3) and 100% inorganic fertilizers (F_3) statistically identical with (20.80) and (22.37) ie 100% poultry manure and 75% inorganic fertilizer application (PM_3F_2). The lowest numbers of effective and total tillers per hill were found by 0% poultry manure (PM_0) and 0% fertilizers (F_0) combinedly. In case of non-effective tillers per hill, the highest and the lowest results were observed in 0% poultry manure (PM_0) & 0% inorganic fertilizer (F_0) and 100% poultry manure (PM_3) and 100% inorganic fertilizer (F_3) respectively as their combined of poultry manure and inorganic fertilizer.

4.3.3 Effect of poultry manure and inorganic fertilizer on panicle length, 1000 grain weight and filled grain/panicles of BRRI dhan29

4.3.3.1 Panicle length

Panicle length is an important plant character for contributing yield performance of rice. The effect of different doses of poultry manure and inorganic fertilizer on panicle length were differed significantly (Table 3). The highest panicle length (29.45 cm) was noted in (PM_3) treatment 100% poultry manure and the statistically similar result was found in (PM_2). The lowest panicle length was produced by 0 % poultry manure PM_0 in (27.10 cm) treatment. In case of inorganic fertilizer application, the highest (30.48 cm) and lowest (26.53 cm) panicle length were noted in 100% inorganic fertilizers F_3 and (F_0) 0% inorganic fertilizer application respectively (Table 3).

Table 2. Interaction effects of poultry manure and inorganic fertilizer on different characteristics of BRRI dhan29

Interaction		Plant height (cm)	Effective tiller hill^{-1} (No.)	Non- effective tiller hill^{-1} (No.)	Total tiller hill^{-1} (No.)
Poultry manure	**Fertilizer**				
PM$_0$	F_0	80.87 e	10.47 h	4.46 a	14.93 g
	F_1	87.47 c-e	12.60 fg	3.60 cd	16.20 e-g
	F_2	90.27 a-d	13.80 ef	3.20 c-e	17.00 d-g
	F_3	93.33 a-c	14.73 de	2.26 f-h	17.00 d-g
PM$_1$	F_0	82.33 e	11.40 gh	4.26 ab	15.67 fg
	F_1	89.53 bd	15.00 de	3.56 cd	18.57 bd
	F_2	90.57 a-d	16.67 c-e	2.86 ef	18.53 bd
	F_3	96.13 ab	16.07 bd	2.06 gi	18.13 b-e
PM$_2$	F_0	84.07 d-e	11.27 gh	3.80 bc	15.07 g
	F_1	92.03 a-c	14.67 de	3.00 de	17.67 c-f
	F_2	93.33 a-c	16.60 bd	2.73 ef	19.33 bc
	F_3	95.53 ab	17.93 b	2.00 hi	19.93 b
PM$_3$	F_0	87.20 c-e	12.40 fg	3.00 de	15.40 g
	F_1	90.87 a-d	17.13 bc	2.66 e-g	19.80 b
	F_2	94.80 ab	20.33 a	1.90 hi	22.23 a
	F_3	97.10 a	20.80 a	1.567 i	22.37 a
LSD $_{0.05}$		3.035	0.8796	0.2912	0.9152
CV%		4.03	7.01	11.88	6.10

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Poultry manure (PM) → PM_0 =0, PM_2 = 50%, PM_2 = 75% and PM_3 =100% of the recommended dose.

CV=Co-efficient of Variance

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

Increase in panicle length in response to combined use of organic and inorganic fertilizers is might be due to more availability of macro as well as micro nutrients (Babu *et al.,*. 2001 and Awan *et al.,* 2011).

4.3.3.2 1000-grain weight

The 1000-grain weight of BRRI dhan29 was significantly differed due to the effects of poultry manure combination with inorganic fertilizer (Table 3). The maximum weight of 1000-grain (25.59 g) was observed in the treatment 100% poultry manure (PM_3) and the lowest weight (22.27 g) of 1000- grain was found in 0% poultry manure (PM_0). But the effect of inorganic fertilizer application on 1000-grain weight of BRRI dhan29 was non-significant (Table 3). Record keeping by Hoque (1999) was that 1000-grain weights were increased by the application of organic manure. The data proved that the application of organic manures (PM) was better performing in producing 1000-grain weights. Similar findings were obtained by (Kant and Kumar, 1994).

4.3.3.3 Filled grains/panicle

The effect of poultry manure and inorganic fertilizers application on filled grains/panicle differed significantly which display in (Table 3). The highest filled grains/panicles (114.9 and 101.3) was recorded in 100% poultry manure (PM_3) and 100% inorganic fertilizer F_3. However the lowest one is both found in PM_0 and F_0 respectively. Grains/panicle significantly increased due to the application of organic manures and inorganic fertilizers cited by (Razzaque, 1996)

4.3.4 Interaction effect of poultry manure and inorganic fertilizer on panicle length, 1000 grain weight and filled grains/panicles of BRRI dhan29

4.3.4.1 Panicle length

In case of interaction effects of different doses of poultry manure and inorganic fertilizers application on panicle length of BRRI dhan29, the highest panicle length (31.27 cm) was found in 100% inorganic fertilizers and 100 % poultry manure PM_3F_3, which is statistically similar with PM_3F_2, PM_0F_3, PM_1F_3, PM_2F_3 and PM_2F_2 treatments (Table 4). The lowest result (24.53 cm) noted in PM_0F_0 treatment.

Table 3. Effects of poultry manure and inorganic fertilizer on panicle length(cm), 1000 grain wt.(g) and filled grains/panicles of BRRI dhan29

Poultry manure	Panicle length(cm)	1000 grain wt.(g)	Filled grains/panicle (No.)
PM_0	27.10 b	22.27 c	74.83 d
PM_1	28.28 ab	23.15 bc	95.75 c
P_2	28.76 a	24.35 ab	104.0 b
PM_3	29.45 a	25.59 a	114.9 a
$LSD_{0.05}$	1.495	6.45	3.81
CV%	6.31	1.282	4.69
Fertilizer			
F_0	26.53 c	23.25	93.67 b
F_1	27.70 bc	23.87	95.08 b
F_2	28.88 b	23.95	99.50 a
F_3	30.48 a	24.30	101.3 a
$LSD_{0.05}$	1.495	1.282 (NS)	3.81
CV%	6.31	6.45	4.69

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Poultry manure (PM) → PM_0 =0, PM_2 = 50%, PM_2 = 75% and PM_3 =100% of the recommended dose.

CV=Co-efficient of Variance NS=Non significant.

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

4.3.4.2 1000 grain weight

All the treatments of inorganic fertilizer with the association of poultry manure performed better on 1000-grain weight over control treatment (PM_0F_0), where the

Table 4. Interaction effects of poultry manure and inorganic fertilizers on panicle length (cm), 1000 grain wt.(g) and filled grains/panicle of BRRI dhan29

Interaction		Panicle length(cm)	1000 grain wt.(g)	Filled grains/panicle (No.)
Poultry manure	**Fertilizer**			
PMo	F_0	24.53 d	21.76 d	68.67 h
	F_1	25.80 cd	22.67 cd	70.67 h
	F_2	27.67 bd	22.46 cd	76.00 h
	F_3	30.40 ab	22.18 cd	84.00 g
PM_1	F_0	27.13 bd	22.56 cd	90.67 fg
	F_1	27.73 bd	23.44 bd	96.67 ef
	F_2	28.00 a-c	22.48 cd	99.00 def
	F_3	30.27 ab	24.13 a-d	96.67 ef
PM_2	F_0	27.07 bd	23.99 a-d	102.7 cde
	F_1	28.53 a-c	24.43 a-d	98.67 ef
	F_2	29.47 ab	24.77 a-d	107.7 bc
	F_3	29.97 ab	24.22 a-d	107.0 bcd
PM_3	F_0	27.40 bd	24.67 a-d	112.7 ab
	F_1	28.73 a-c	24.95 a-c	114.3 ab
	F_2	30.40 ab	26.07 ab	115.3 ab
	F_3	31.27 a	26.67 a	117.3 a
$LSD_{0.05}$		2.99	2.563	7.62
CV%		6.31	6.45	4.69

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Poultry manure (PM) → PM_0 =0, PM_2 = 50%, PM_2 = 75% and PM_3 =100% of the recommended dose.

CV=Co-efficient of Variance

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

highest (26.67 g) and the lowest (21.76 g) weight was found in PM_3F_3 and PM_0F_0 treatments respectively (Table 4).

4.3.4.3 Filled grains/panicle

The interaction effects of poultry manure and inorganic fertilizer on filled grains/panicle differed significantly. It was observed that the maximum filled grains/panicle (117.3) was found in 100% poultry manure and 100% inorganic fertilizer (PM_3F_3) treatment statically identical with several treatments and the lowest result (68.67) was found in PM_0F_0 treatment having no use of inorganic fertilizer and poultry manure.

4.3.5 Effect of poultry manure and inorganic fertilizers on grain yield, straw yield and benefit cost ratio of BRRI dhan29

4.3.5.1 Grain and straw yield

Grain yield or economic yield is an important characteristic and the ultimate output of rice. In case of poultry manure and inorganic fertilizer, the grain and straw yields varied significantly due to the application of poultry manure and inorganic fertilizer separately or their combined treatments (Figure 1 and 2 and appendix ix). The highest grain and straw yields (6.144 and 7.081 t ha^{-1}) were observed both in 100% poultry manure (PM_3) respectively. The lowest grain and straw yields (4.005 and 4.879 t ha^{-1}) were found in 0% poultry manure (PM_0) treatment, which were statistically identical with 50% poultry manure (PM_1) treatment, respectively. In case of inorganic fertilizer application, the highest grain and straw yields (5.622 and 6.221 t ha^{-1}) and the lowest grain and straw yields (4.617 and 5.380 t ha^{-1}) were found in 100% inorganic fertilizer application (F_3) and 0% chemical fertilizers (F_0) treatments, respectively. Illustrated by Vanaja and Raju (2002) that the combinations of chemical fertilizer with poultry manure (PM) 2 t/ ha gave highest grain and straw yield. Grain yield increased with each increment of poultry manure application and was maximum at 3 t ha^{-1}given by (Channabasavanna, 2003).

4.3.5.2 Benefit cost ratio

The economic performances of different treatments were evaluated through estimation of benefit and cost analysis. The effect of poultry manure and inorganic fertilizers on benefit cost ratio differed significantly found (Figure 1 and 2 and appendix ix). The highest benefit cost ratio (3.69 and 3.40) was recorded in 100% poultry manure (PM_3) and 100% inorganic fertilizer application ($F_{3)}$. Similar results were reported by Alam *et al*. (2005), who observed that higher profit was obtained when inorganic fertilizer was combined with poultry manure.

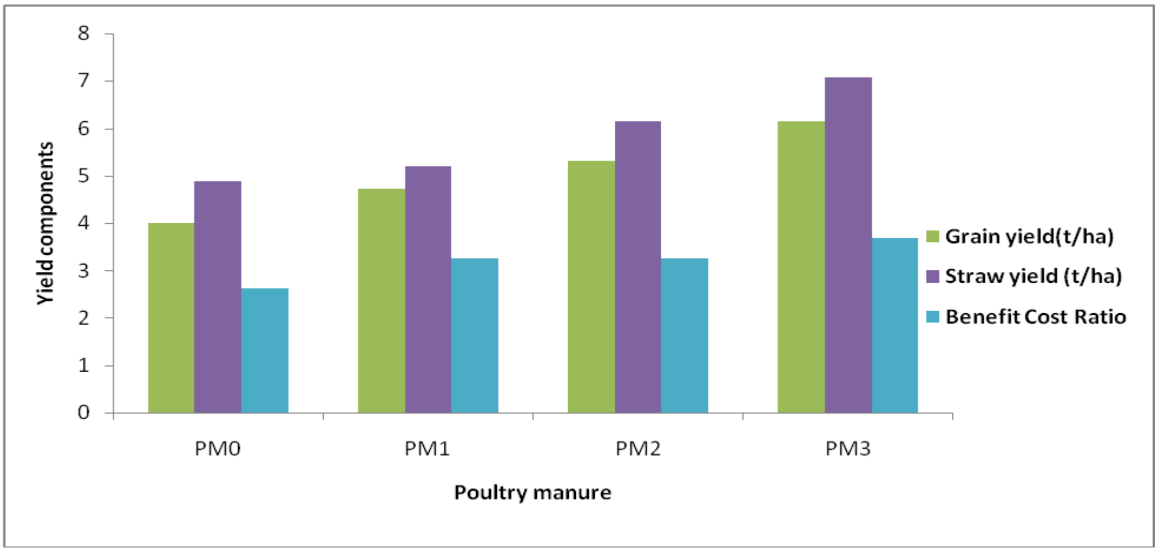
4.3.6 Interaction effect of poultry manure and inorganic fertilizer on grain yield, straw yield and Benefit cost ratio of BRRI dhan29

4.3.6.1 Grain and straw yield

The interaction effects of poultry manure and inorganic fertilizer application, the maximum grain and straw yields (6.838 and 7.630 t/ha) were observed in 100% poultry manure and 100% inorganic fertilizer combination (PM_3F_3), which are statistically similar with PM_3F_2 treatment, respectively (Table 5). The minimum grain and straw yields (3.023 and 4.556 t/ha) were found in 0% poultry manure and 0% inorganic fertilizer combination (PM_0F_0), which are statistically similar with PM_0F_1 treatment.

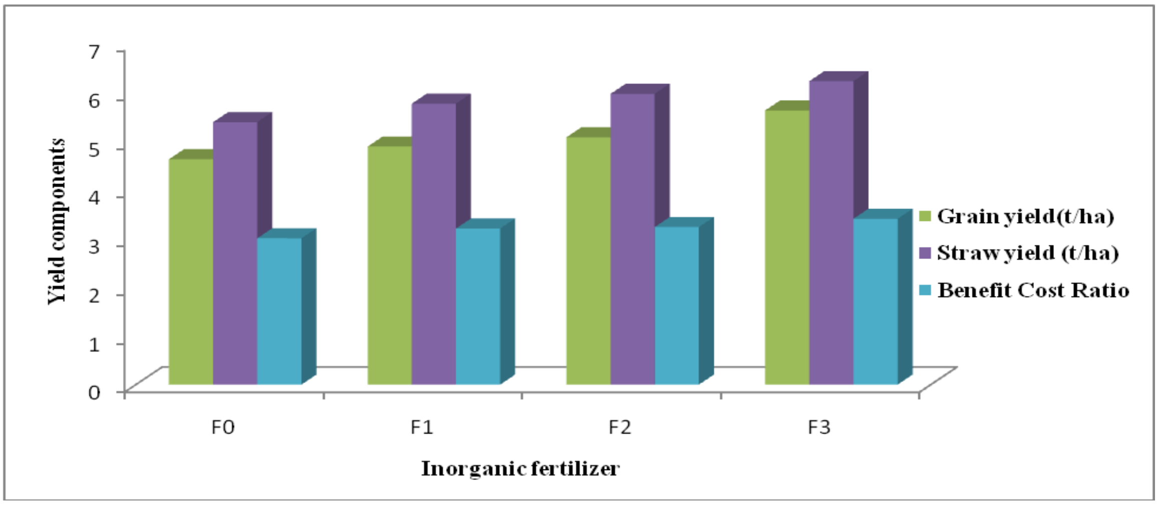
4.3.6.2 Benefit cost ratio

The interaction effects (Table 5) of poultry manure and inorganic fertilizer application on benefit cost ratio differed significantly. It was observed that the maximum benefit cost ratio (3.84) was found in 100% poultry manure and 100% inorganic fertilizer (PM_3F_3) treatment which was statistically similar with PM_3F_2 and the lowest result (2.02) was found in PM_0F_0 treatment having no use of inorganic fertilizer and poultry manure.



Poultry manure (PM) → PM_0 = 0%, PM_1 = 50%, PM_2 =75% and PM_3 = 100% of the recommended dose

Figure 1. Effects of poultry manure on different yield components of BRRI dhan29.



Inorganic Fertilizer (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Figure 2. Effects inorganic fertilizer on different yield components of BRRI dhan29.

Table 5. Interaction effects of poultry manure and inorganic fertilizer on different yield and yield components of BRRI dhan29

Interaction		Grain yield ($t\ ha^{-1}$)	Straw yield ($t\ ha^{-1}$)	Benefit cost ratio
Cowdung	**Fertilizer**			
PMo	F_0	3.023 h	4.556 f	2.02 f
	F_1	3.270 h	4.823 ef	2.66 e
	F_2	4.586 e-g	4.990 d-f	2.68 e
	F_3	5.142 d-g	5.148 d-f	3.14 d
PM_1	F_0	4.525 fg	5.037 d-f	3.29 cd
	F_1	4.720 d-g	5.398 c-f	3.27 cd
	F_2	4.381 g	4.963 d-f	3.20 d
	F_3	5.245 c-g	5.400 c-f	3.27 cd
PM_2	F_0	5.553 b-d	5.645 c-e	3.24 cd
	F_1	5.419 c-e	5.963 bd	3.23 cd
	F_2	5.049 d-g	6.296 bc	3.23 cd
	F_3	5.265 c-f	6.708 ab	3.36 cd
PM_3	F_0	5.368 c-f	6.281 bc	3.47 bc
	F_1	6.098 a-c	6.844 ab	3.65 ab
	F_2	6.273 ab	7.570 a	3.83 a
	F_3	6.838 a	7.630 a	3.84 a
$LSD_{0.05}$		0.8824	0.762	0.22
CV%		9.08	9.05	4.21

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Poultry manure (PM) → PM_0 =0, PM_2 = 50%, PM_2 = 75% and PM_3 =100% of the recommended dose.

CV=Co-efficient of Variance

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

4.3.7 Effect of poultry manure and inorganic fertilizer on Nitrogen, Phosphorus and Potassium content in grain of BRRI dhan29

4.3.7.1 N content in grain:

The N content in grain significantly differed due to the effects of poultry manure and combined with inorganic fertilizer application (Figure 3, 4 and appendix X).

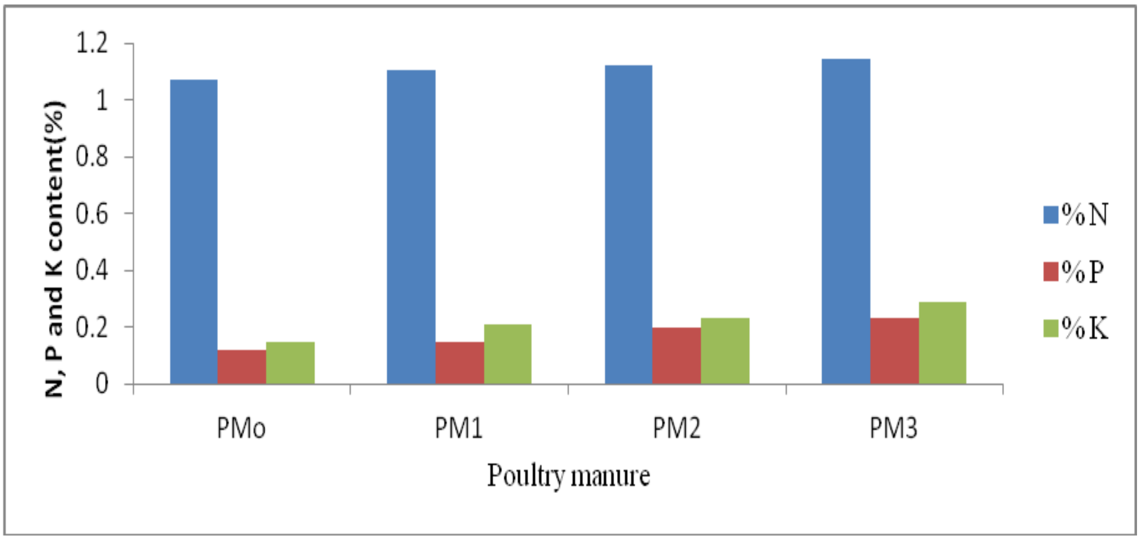
The maximum amount of N (1.142%) was observed in the treatment 100% poultry manure (PM_3) and the minimum amount (1.070%) was found in 0% poultry manure (PM_0). The effect of inorganic fertilizers on N content of BRRI dhan29 shows non-significant relationship. Bari *et al.* (2013); found that nutrient content in grain increased while organic manure combined with inorganic fertilizers. Application of 100% NPK + poultry manure @ 5 t ha^{-1} gave the highest grain yields among the treatments and the lowest grain yield was obtained with 100% N treated plot approved by (Laxminarayana, 2000).

4.3.7.2 Phosphorus content

The P content significantly differed due to the effects of poultry manure and combined with inorganic fertilizer (Figure 3, 4 and appendix X). The maximum P content was observed in the treatment 100% poultry manure (PM_3) and the lowest content (0.12%) of P was found in 0% poultry manure (PM_0) in (0.229%). The effects of fertilizer show that best performer treatments is F_3 and negligence performance observed in F_0. Datta and Gupta (1984) reported that total P level increase in both grain and straw with increasing level of P.

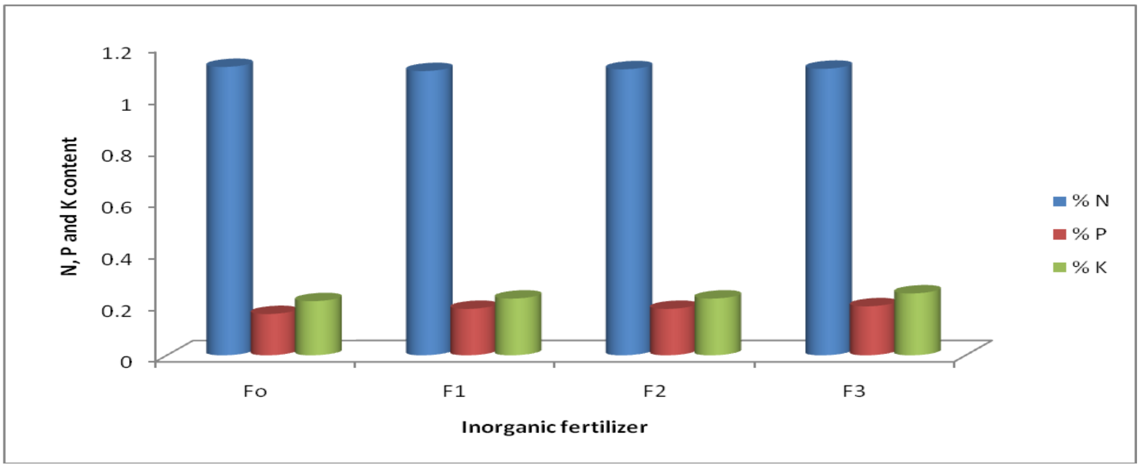
4.3.7.3 Potassium content

The K content significantly differed due to the effects of poultry manure and combined with chemical fertilizers (Figure 3, 4 and appendix X). The maximum amount of K (0.291) was observed in the treatment 100% poultry manure (PM_3) and the minimum amount is (0.152%) was found in 0% poultry manure (PM_0). The effect of inorganic fertilizers on K content of BRRI dhan29 was peak percentage was in F_3 (0.235%) lower amount was found in F_0 (0.208%). Uptake of K was much higher than straw supported by (Ali *et al.*, 2007).



Poultry manure (PM) → PM_0 = 0%, PM_1 = 50%, PM_2 =75% and PM_3 = 100% of the recommended dose

Figure 3. Effects of poultry manure with NPK content in grain in BRRI dhan29.



Inorganic Fertilizer (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Figure 4. Effects of inorganic fertilizer with NPK content in grain in BRRI dhan29.

4.3.8 Interaction effect of poultry manure and inorganic fertilizer on Nitrogen, Phosphorus and Potassium content in grain of BRRI dhan29

4.3.8.1 N content in grain

All the treatments of inorganic fertilizer association with poultry manure performed better on N content over control treatment (PM_0F_0), where the highest (1.157%) and the lowest (1.090%) amount found in PM_3F_2 and PM_0F_0 combination respectively (Table 6).

4.3.8.2 P content in grain

All the treatments of inorganic fertilizer with the association of poultry manure performed better on P content over control treatment (PM_0F_0), where the highest (0.244%) and the lowest (0.105%) content found in PM_3F_3 and PM_0F_0 combination respectively (Table 6).

4.3.8.3 K content in grain

All the treatments of inorganic fertilizer with the association of poultry manure performed better on K content over control treatment (PM_0F_0), where the highest (0.320%) and the lowest (0.138%) amount found in PM_3F_3 and PM_0F_0 combination respectively (Table 6).

4.3.9 Effect of poultry manure and inorganic fertilizer on Nitrogen, Phosphorus and Potassium content in straw of BRRI dhan29

4.3.9.1 % N content in straw

The N content significantly differed due to the effects of poultry manure and combined with inorganic fertilizer (Figure 5, 6 and appendix XI).

Table 6. Interaction effects of poultry manure and inorganic fertilizer of NPK content in grain of BRRI dhan29

Interaction				
Poultry manure	**Fertilizer**	**% N**	**% P**	**% K**
PMo	F_0	1.090 b-e	0.105 g	0.138 i
	F_1	1.020 f	0.116 f-g	0.164 h
	F_2	1.070 d-f	0.130 e-f	0.142 i
	F_3	1.100 a-e	0.137 d-e	0.164 h
PM1	F_0	1.107 a-e	0.140 d-e	0.179 h
	F_1	1.127 a-d	0.154 c-d	0.208 g
	F_2	1.130 a-d	0.158 c	0.213 g
	F_3	1.053 e-f	0.163 c	0.236 d-f
PM2	F_0	1.137 a-c	0.196 b	0.226 e-g
	F_1	1.133 a-c	0.199 b	0.240 d-e
	F_2	1.080 c-e	0.206 b	0.252 d
	F_3	1.147 a-b	0.209 b	0.220 f-g
PM3	F_0	1.137 a-c	0.211 b	0.288 b
	F_1	1.130 a-d	0.235 a	0.272 c
	F_2	1.157 a	0.228 a	0.288 b
	F_3	1.143 a-b	0.244 a	0.320 a
LSD (0.05)		3.38	7.73	9.51
CV%		0.052	0.016	0.016

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Poultry manure (PM) → PM_0 =0, PM_2 = 50%, PM_2 = 75% and PM_3 =100% of the recommended dose.

CV=Co-efficient of Variance

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

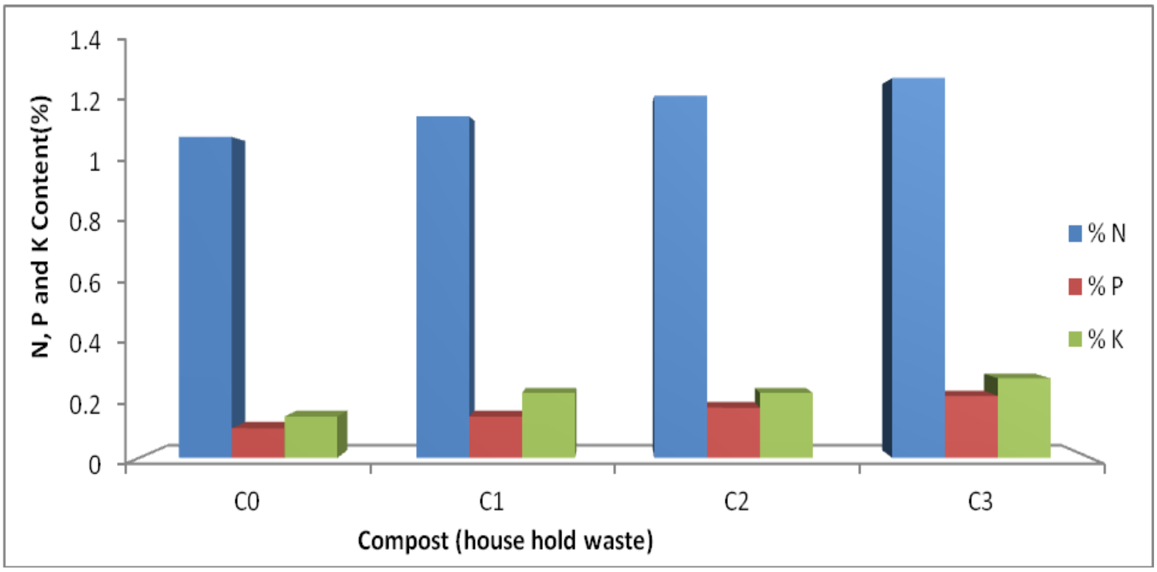
The maximum amount of N, PM_3 was observed in the treatment 100% poultry manure (0.485) closely related to (PM_2) and the minimum amount is (0.344%) was found in 0% poultry manure (PM_0). From the (Figure 6) the peak amount of N found in (0.454%) 100% fertilizer (F_3) closely related to (F_2) and the minimum amount is (0.415%) was found in 0% poultry manure (F_0). Saleque *et al.* (1998); proved that Potassium application increased N content only in the straw but not in the grain.

4.3.9.2 % P content in straw (%)

The P content significantly differed due to the effects of poultry manure and combined with inorganic fertilizer (Figure 5, 6 and appendix XI). The maximum amount of P (0.050%) was observed in the treatment 100% poultry manure (PM_3) and the minimum amount is (0.036%) was found in 0% poultry manure (PM_0). The effect of inorganic fertilizers on P content of BRRI dhan29 shows no significant data. Datta and Gupta (1984) reported that total P level increase in both grain and straw with increasing level of P.

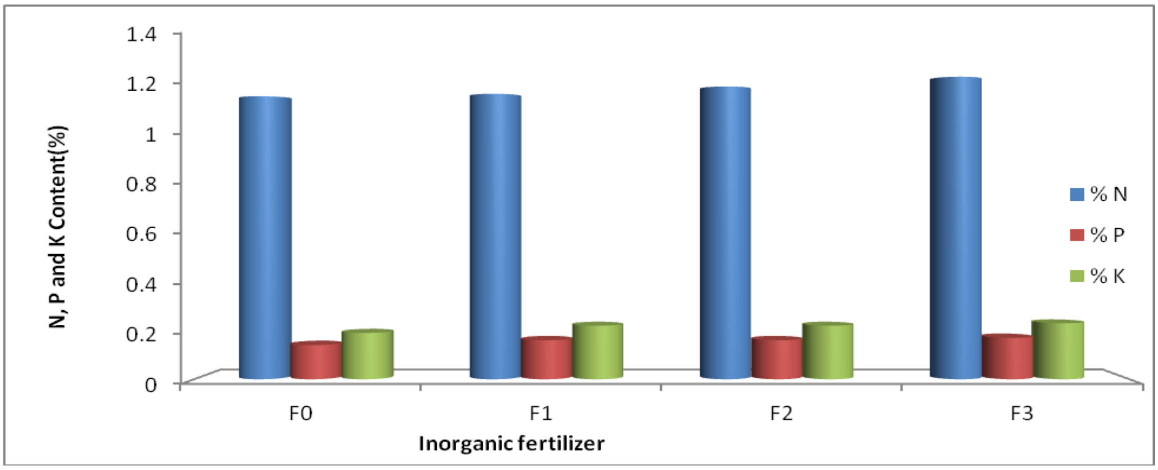
4.3.9.3 % K content in straw (%)

The effect of different doses of poultry manure and inorganic fertilizer application on K content differed significantly (Figure 5, 6 and appendix XI). The highest K content was noted in PM_3 treatment 100% poultry manure in (0.842%) and the statistically similar result was found in ($PM_{2.}$).The lowest K content (0.683%) was produced by 0 % poultry manure (PM_0) treatment. In case of inorganic fertilizers, the highest (0.815%) and lowest (0.760%) N content were noted in 0% inorganic fertilizer application $F_{1.}$



Poultry manure (PM) → PM_0 = 0%, PM_1 = 50%, PM_2 =75% and PM_3 = 100% of the recommended dose

Figure 5. Effects of poultry manure with NPK content in straw in BRRI dhan29.



Inorganic Fertilizer (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Figure 6. Effects of inorganic fertilizer with NPK content in straw in BRRI dhan29.

4.3.10 Interaction effect of poultry manure and inorganic fertilizer on Nitrogen, Phosphorus and Potassium content in straw of BRRI dhan29

4.3.10.1 %N content in straw

All the treatments of inorganic fertilizer with the association of poultry manure performed better on N content over control treatment (PM_0F_0), but the data shows the interaction effect of inorganic fertilizer and poultry manure on N content of BRRI dhan29 shows highest proportion (0.506%) found in 100% poultry manure and 100% fertilizer (PM_3F_3) (Table 7).

4.3.10.2 % P content in straw

All the treatments of inorganic fertilizer with the association of poultry manure performed better on P content over control treatment (PM_0F_0), but the data shows the interaction effect of poultry manure and inorganic fertilizer application on P content of BRRI dhan29 shows non-significant result (Table 7).

4.3.10.3 % K content in straw

In case of combined effects of different levels of poultry manure and inorganic **f**ertilizer application on K content of BRRI dhan29, the highest K content (0.866%) was found in PM_3F_3 in 100% inorganic fertilizer application and 100 % poultry manure, which is statistically similar with most of the treatments (Table 7). The lowest K in straw was (0.647%) noted in PM_0F_0 treatment..

Table 7. Interaction Effects of different levels of poultry manure and inorganic fertilizer in straw in BRRI dhan29

Interaction		% N	% P	%K
Poultry manure	**Fertilizer**			
PM_0	**F_0**	0.031 e	0.034	0.647 d
	F_1	0.035 e	0.036	0.658 c-d
	F_2	0.343 e	0.036	0.703 b-c
	F_3	0.407 d	0.037	0.724 b
PM_1	**F_0**	0.419 c-d	0.034	0.743 b
	F_1	0.433 b-d	0.038	0.820 a
	F_2	0.458 a-d	0.042	0.830 a
	F_3	0.433 b-d	0.044	0.824 a
PM_2	**F_0**	0.477 a-c	0.044	0.817 a
	F_1	0.473 a-c	0.042	0.833 a
	F_2	0.468 a-c	0.048	0.820 a
	F_3	0.470 a-c	0.049	0.846 a
PM_3	**F_0**	0.464 a-d	0.049	0.834 a
	F_1	0.479 a-c	0.051	0.830 a
	F_2	0.493 a-b	0.05	0.840 a
	F_3	0.506 a	0.052	0.866 a
$LSD_{0.05}$		5.37	6.15 $^{(NS)}$	4.36
CV%		0.052	0.016	0.052

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Poultry manure (PM) → PM_0 =0, PM_2 = 50%, PM_2 = 75% and PM_3 =100% of the recommended dose.

CV=Co-efficient of Variance NS=Non significant. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

4.3.11 Effects of poultry manure and inorganic fertilizer on post harvest soil properties of BRRI dhan29

4.3.11.1 Soil pH

The effect of different levels of poultry manure and fertilizers on soil pH of BRRI dhan29 the data was not differed significantly (Table 8). There is no significant relationship exists on using poultry manure and inorganic fertilizer, even using both of poultry manure and inorganic fertilizer i.e. interaction effects there is no significant relation exists on.

4.3.11.2 Organic matter content

The effect of different levels of poultry manure and inorganic fertilizer on organic matter content of post harvest soil significantly differed (Table 8). The highest organic matter content (2.675%) was obtained in 100% poultry manure (PM_3) treatment. The lowest organic matter content of post harvest soil (2.205%) was found by 0% poultry manure (PM_0) treatment. In case of inorganic fertilizer, the highest organic matter content of post harvest soil (2.533%) was found in 100% inorganic fertilizer treatment (F_3), which is statistically identical with F_2 treatment and the lowest organic matter content of post harvest soil (2.34%) was noted in F_0 treatment.

4.3.11.3 Total nitrogen

Application of poultry manure in combination with N showed more pronounced effect in increasing N content in post harvest soil in rice. Significant relationships were found on N content of post harvest soil by the application of poultry manure and inorganic fertilizer (Table 8). The highest N content of post harvest soil (0.153% and 0.130%) were found at 100% poultry manure (PM_3) and (F_3) respectively. On the other hand the lowest value of N content in soil was found in (PM_0) and (F_0) respectively.

4.3.11.4 Available phosphorus

Poultry manure exerted pronounced effect in increasing the P uptake by rice grain and straw compared to cowdung and compost. Significant influences were observed on available P content of post harvest soil due to the application of poultry manure and inorganic fertilizer individually (Table 08). The highest amounts of available P content in post harvest soil (16.32 and 15.33 ppm) were found at 100% poultry manure (PM_3) and 100% inorganic fertilizers (F_3), respectively and the lowest values of P content in post harvest soil (10.85 and 12.68 ppm) were obtained at 0% poultry manure (PM_0) and 0% inorganic fertilizer application (F_0) respectively. Chicken manure increases phosphorus in the soils, although their accumulated concentration in the soil is still lower than the critical level (0.20 m.e/100) required by the rice plants to complete its growth and grain production examined by (Javier *et al.*, 2003).

4.3.11.5 Exchangeable potassium

The effect of different levels of poultry manure and inorganic fertilizer on exchangeable K content of post harvest soil differed significantly (Table 8). The highest amount exchangeable K was observed in PM_3 in 100% poultry manure (0.241 meq/100 g soil) treatment and the lowest exchangeable K content (0.123 meq/100 g soil) of post harvest soil was found in 0% poultry manure (PM_0) treatment. In case of inorganic fertilizer application, the highest exchangeable K content of post harvest soil (0.201 meq/100 g soil) was found in 100% inorganic fertilizer application (F_3), which is statistically identical with F_2 treatment and the lowest exchangeable K (0.174 meq/100 g soil) of post harvest soil was noted in F_0 treatment. This finding evaluated by (Iftikhar and Qasim , 2003) who showed that poultry manure increased total available N, P and K contents.

Table 8. Effects of different levels of poultry manure and inorganic fertilizer on post harvest soil properties of BRRI dhan29

Poultry manure	Soil pH	% Organic matter	% N	P (ppm)	K (meq/100 g soil)
PM_0	5.124	2.205 d	0.092 c	10.85 c	0.123 d
PM_1	5.193	2.501 b	0.126 b	13.61 b	0.177 c
PM_2	5.298	2.417 c	0.131 b	14.19 b	0.219 b
PM_3	5.310	2.675 a	0.153 a	16.32 a	0.241 a
$LSD_{0.05}$	0.188 (NS)	0.052	0.001	0.757	0.008
CV%	4.34	2.66	5.37	6.61	9.31
Fertilizer					
F_0	5.186	2.342 c	0.122 c	12.68 c	0.174 c
F_1	5.213	2.429 b	0.123 b	13.16 b-c	0.187 b
F_2	5.266	2.493 a	0.125 b	13.81 b	0.198 a
F_3	5.260	2.533 a	0.130 a	15.33 a	0.201 a
$LSD_{0.05}$	0.376 (NS)	0.052	0.001	0.757	0.008
CV%	4.34	2.66	5.37	6.61	9.31

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Poultry manure (PM) → PM_0 =0, PM_2 = 50%, PM_2 = 75% and PM_3 =100% of the recommended dose.

CV=Co-efficient of Variance NS=Non significant. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

4.3.12 Interaction effect of cowdung and inorganic fertilizer on post harvest soil properties of BRRI dhan29

4.3.12.1 Soil pH

There is no significant relationship exists on using poultry manure and inorganic fertilizer application. Even using both of poultry manure and inorganic fertilizer i.e. interaction effects there is no significant relation exists on.

4.3.12.2 Organic matter

In case of interaction effects of different doses of poultry manure and inorganic fertilizer application on organic matter content of post harvest soil, the maximum organic matter content (2.760%) was found in PM_3F_2, which is statistically similar with PM_3F_3 treatment (Table 09). The lowest result (2.093%) was noted in PM_0F_0 treatment, which is statistically similar with $PM_0F_{1.}$ Organic matter provided the micro nutrients elaborated by (Rani *et al.* 2001) also said an increased the cation exchange capacity of soil thus improved nutrients availability which in combinations with inorganic fertilizers enhanced the growth and yield.

4.3.12.3 Total Nitrozen

In case of interaction effects of different levels of poultry manure and inorganic fertilizer on total nitrozen content of post harvest soil, the maximum total nitrozen content (0.163%) was found in PM_3F_3, which is statistically similar with PM_3F_2 treatment (Table 9). The lowest result (0.08%) was noted in PM_0F_0 treatment, which is statistically similar with $PM_0F_{1.}$ Wopereis *et al.* (2002); stated that rice yields increased significantly as a result of N application on two N dressing (applied of the onset of tillering and at panicle initiation) with a total of approximately 120 kg N ha^{-1} in farmer's field.

4.3.12.4 Available phosphorus

In case of interaction effects of different doses of poultry manure and inorganic fertilizer, the maximum available P (18.15 ppm) was found in PM_3F_2 treatment, which is statistically similar with PM_3F_3 treatment and the minimum available P (7.34 ppm) found in PM_0F_0 treatment (Table 9).

Table 9. Interaction effects of poultry manure and fertilizer on post-harvest soil properties in BRRI dhan29

Interaction		Soil PH	%Organic matter	% N	P (ppm)	K(meq/100 g soil)
Poultry manure	Fertilizer					
PM_0	F_0	5.063	2.093 g	0.085 g	7.34 h	0.102 g
	F_1	5.080	2.097 g	0.086 g	10.26 g	0.134 f
	F_2	5.160	2.330 d-f	0.091 fg	11.61 fg	0.121 f
	F_3	5.193	2.300 ef	0.10 ef	14.18 c-e	0.137 f
PM_1	F_0	5.150	2.430 cd	0.118 de	13.31 de	0.161 e
	F_1	5.157	2.537 bc	0.127 d	12.57 ef	0.179 d
	F_2	5.237	2.510 bc	0.131 cd	14.03 c-e	0.183 d
	F_3	5.227	2.527 bc	0.127 d	14.55 cd	0.186 d
PM_2	F_0	5.263	2.223 f	0.137 bd	15.65 bc	0.193 d
	F_1	5.323	2.513 bc	0.133 bd	14.17 c-e	0.216 c
	F_2	5.300	2.547 bc	0.128 d	12.52 ef	0.239 ab
	F_3	5.307	2.383 de	0.125 d	14.43 cd	0.227 bc
PM_3	F_0	5.267	2.623 b	0.151 ab	14.40 cd	0.242 ab
	F_1	5.293	2.570 b	0.147 a-c	15.63 bc	0.220 c
	F_2	5.367	2.767 a	0.151 ab	18.15 a	0.255 a
	F_3	5.313	2.740 a	0.163 a	17.09 ab	0.246a
$LSD_{0.05}$		0.376 (NS)	0.105	0.016	1.151	0.016
CV%		4.34	2.66	5.37	6.61	9.31

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Poultry manure (PM) → PM_0 =0, PM_2 = 50%, PM_2 = 75% and PM_3 =100% of the recommended dose.

CV=Co-efficient of Variance NS=Non significant. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

4.3.12.5 Exchangeable potassium

The interaction effects of poultry manure and inorganic fertilizer application on exchangeable K content of post harvest soil varied significantly (Table 9). The maximum exchangeable K (0.255 meq/100 g soil) was observed in PM_3F_2 treatment, which is statistically identical with PM_3F_3 treatment (Table 9). The lowest amount exchangeable K (0.102 meq/100 g soil) was found in PM_0F_0 treatment.

4.4 EXPERIMENT TITLE: EFFECTS OF COMPOST (HOUSE HOLD WASTES) AND DIFFERENT INORGANIC FERTILIZERS ON GROWTH YIELD AND NUTRIENT CONTENT OF OF AMAN RICE (BRRI dhan49)

Results and discussion of different growth parameter yield and chemical analysis of soil were recorded. The results have been presented and possible interpretations given under the following headings:

4.4.1 Effect of compost (household waste) and inorganic fertilizers on plant height, number of effective tiller, non effective and total tiller per hill of BRRI dhan49

4.4.1.1 Plant height

Effects of compost (household waste) and inorganic fertilizer differed significantly in respect of plant height of BRRI dhan49 (Table 1). There is no significant relationship exists in the treatments using only composts. On the other hand, the tallest plant height (92.50 cm) was recorded when 100% inorganic fertilizer application F_3. The lowest plant height was observed by control treatment having no household waste or inorganic fertilizer. These data are quite similar with the findings of (Bhabesh *et al.*, 2010).

4.4.1.2 Number of effective, non-effective and total tillers per hill

Significant relationships were found by using compost (household waste) and inorganic fertilizer application on effective, non effective and total tillers per hill of BRRI dhan49 individually (Table 01). The highest numbers of effective and total tillers per hill were recorded at 100% composts (C_3) and non significant relation exists on using inorganic fertilizer application. In case of non effective tillers per hill, non significant relation exists on using household waste & 0% fertilizers (F_0) shows highest observation and 75% household waste (C_3) and

Table 1. Effects of compost and inorganic fertilizer on different crop characters of BRRI dhan49

Compost	**Plant height (cm)**	**Effective tiller hill^{-1} (No.)**	**Non- effective tiller hill^{-1} (No.)**	**Total tiller hill^{-1} (No.)**
C_0	88.08	10.25 b	2.833	13.08
C_1	87.75	11.67 a	2.08	13.75
C_2	89.33	10.41 b	2.667	13.08
C_3	89.25	12.33 a	2.00	14.33
LSD $_{0.05}$	1.714 $^{(NS)}$	1.250	0.857 $^{(NS)}$	1.332$^{(NS)}$
CV%	2.32	13.30	42.91	11.78
Fertilizer				
F_0	85.50 c	9.833 b	3.000 a	12.83 c
F_1	87.58 b	11.08 a	2.333 ab	13.41 bc
F_2	88.83 b	12.25 a	1.833 b	14.08 ab
F_3	92.50 a	11.92 a	2.417 ab	14.33 a
LSD $_{0.05}$	1.714	1.250	0.8572	1.332
CV%	2.32	13.30	42.91	11.78

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Compost (C) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose.

CV=Co-efficient of Variance NS=Non significant. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

100% fertilizers (F_3) respectively as individually. These findings are similar with the findings of (Akhtar, 1990).

4.4.2 Interaction effect of compost and inorganic fertilizer on plant height, number of effective tiller, non effective and total tiller per hill of BRRI dhan49

4.4.2.1 Plant height

The interaction effects of different doses of compost and fertilizers significantly differed the plant height of BRRI dhan49 (Table 1), where the maximum plant height (94.67 cm) was found in C_3F_3 combination and the lowest value (83.67cm) in control treatment (C_0F_0).

4.4.2.2 Number of effective tiller, non effective and total tiller per hill

In combine effect of household waste and inorganic fertilizers plays vital rule on the effective and total tillers per hill, where 100% household waste (C_3) and 100% inorganic fertilizers (F_3) statistically identical with 75% household waste and 75% inorganic fertilizers (C_3F_2). The lowest numbers of effective and total tillers per hill were found by 0% household waste (C_0) and 0% fertilizers (F_0) separately or their combinedly. However the non effective tillers per hill are combined use of household waste and inorganic fertilizer found highest observation C_0F_1 and C_2F_0 which is statically simillar with most of the treatments (Table 2).

4.4.3 Effect of compost and inorganic fertilizer on panicle length, 1000 grain weight and filled grains/panicles of BRRI dhan49

4.4.3.1 Panicle length

In case of compost (household waste) and using inorganic fertilizer (Table 3), either individual effects or combined effects there exist on non- significant relations.

Table 2. Interaction effects of compost and inorganic fertilizer on different crop characters of BRRI dhan49

Interaction		Plant height (cm)	Effective tiller $hill^{-1}$ (No.)	Non-effective tiller $hill^{-1}$ (No.)	Total tiller $hill^{-1}$ (No.)
Compost	**Fertilizer**				
C_0	F_0	83.67 de	8.333 d	3.33 ab	11.67
	F_1	86.00 cd	10.67 b-d	3.67 a	13.67 a-c
	F_2	91.33 ab	11.67 a-c	1.67 ab	13.33 a-c
	F_3	91.33 ab	11.00 b-d	2.67 ab	13.67 a-c
C_1	F_0	88.33 bc	10.33 b-d	2.33 ab	12.67 a-c
	F_1	82.00 e	12.33 ab	1.67 ab	13.00 a-c
	F_2	88.00 bc	12.33 ab	2.00 ab	14.33 a-c
	F_3	92.67 a	12.33 ab	2.33 ab	15.00 ab
C_2	F_0	86.33 cd	9.000 cd	3.67 a	12.00 bc
	F_1	83.67 de	11.00 b-d	1.33 b	12.33 a-c
	F_2	88.33 bc	11.00 b-d	2.33 ab	13.33 a-c
	F_3	91.33 ab	11.33 a-c	3.33 ab	14.67 a-c
C_3	F_0	83.67 de	11.67 a-c	2.67 ab	14.33 a-c
	F_1	91.00 ab	10.33 b-d	2.67 ab	13.00 a-c
	F_2	87.67 bc	14.00 a	1.33 b	15.33 a
	F_3	94.67 a	13.00 ab	1.33 b	14.67 a-c
$LSD_{0.05}$		3.42	2.49	1.71	2.66
CV%		2.32	13.30	42.91	11.78

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Compost (C) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose.

CV=Co-efficient of Variance In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

4.4.3.2 1000 grain weight

Thousand grains weight of BRRI dhan49 varied significantly due to the effects of compost and inorganic fertilizer (Table 3). The maximum weights of 1000 grain (22.90 g) were observed in the treatments C_3 and non-significant relationship exists on using inorganic fertilizer respectively. Similar results have also been reported by Zeidan and Kramany (2001) who reported that the higher 1000 grain weight with the use of organic manure and mineral N.

4.4.3.3 Filled grains/panicle

The effect of compost and inorganic fertilizers on filled grains/panicles differed significantly shown in (Table 3). The highest filled grains/panicles (112.5 and 111.1) were recorded in 100% compost (C_3) and 100% inorganic fertilizers F_3, they were statistically identical with C_2 and F_2 respectively. Similar result was reported by Pandey *et al.* (1999) they published that all the sources of organic manures improve the soil fertility, yield and quality of rice.

4.4.4 Interaction effect of cowdung and inorganic fertilizers on panicle length, 1000 grain weight and filled grains/panicles of BRRI dhan49

4.4.4.1 Panicle length

In case of compost (household waste) and using inorganic fertilizers (Table 4), either individual effects or interaction effects there exists on non- significant relations.

4.4.4.2 1000 grain weight

The interaction effects of compost and inorganic fertilizers application, the highest weight of 1000-grain was obtained in C_2F_2 combination, which is statistically identical with most of the treatment combination of compost and inorganic fertilizers (Table 04). On the other hand, the lowest results were found at 0 % compost and inorganic fertilizer combined treatments (C_0F_0).

4.4.4.3 Filled grains/panicle

The interaction effects of compost and inorganic fertilizers on filled grains/panicle differed significantly. It was observed that the maximum filled

Table 3. Effects of compost and inorganic fertilizer on panicle length (cm), 1000 grain wt.(g) and filled grains/panicle of BRRI dhan49

Compost	Panicle length(cm)	1000 grain wt.(g)	Filled grains/panicle
C_0	22.33	20.50 b	98.58 c
C_1	22.63	21.26 ab	106.5 b
C_2	22.75	22.02 ab	108.9 ab
C_3	22.63	22.90 a	112.5 a
LSD $_{0.05}$	1.265$^{(NS)}$	1.742	3.82
CV%	6.72	9.64	4.09
Fertilizer			
F_0	22.25	20.85	100.4 c
F_1	22.38	21.31	106.7 b
F_2	22.46	22.59	108.3 ab
F_3	23.25	21.94	111.1 a
LSD $_{0.05}$	1.265$^{(NS)}$	1.742$^{(NS)}$	3.82
CV%	6.72	9.64	4.09

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Compost (C) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose.

CV=Co-efficient of Variance NS=Non significant. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

grains/panicle (121.00) was found in 100% compost and 100% inorganic fertilizer (C_3F_3) treatment statically identical with C_3F_1 treatments and the lowest result (85.33) was found in C_0F_0 treatment having no use of fertilizer and compost.

4.4.5 Effect of compost and inorganic fertilizer on grain yield, straw yield and benefit cost ratio of BRRI dhan49

4.4.5.1 Grain and straw yield

The effect of compost and inorganic fertilizer on grain and straw yields of BRRI dhan49 differed significantly by using compost and inorganic fertilizers separately (figure 1 and 2 and appendix XII). The highest grain and straw yields (4.329 and 5.03 t ha^{-1}) and the lowest grain and straw yields (3.258 and 4.507 t ha^{-1}) were observed in 100% compost (C_3), 75% compost (C_2) and 0% compost (C_0) treatments in both case respectively. The effect of different levels of composts (Household waste) and fertilizers of BRRI dhan49 differed significantly. There is no significant relationship exists on using inorganic fertilizer. Application of nitrogen up to 90 kg ha^{-1} enhanced the growth and yield of rice crop and application of phosphorus @ 40 kg P_2O_5 ha^{-1} resulted in higher growth and yield of rice crops. Myint *et al.* (2010); found that organic matter provided comparatively higher nutrient accumulations which in turn enhanced the growth and yield of rice.

4.4.5.2 Benefit cost ratio

The effect of compost and inorganic fertilizers on benefit cost ratio differed significantly shown in (figure 1 and 2 appendix XII). The highest benefit cost ratio (2.60 and 2.45) were recorded in 100% compost (C_1) and 100% inorganic fertilizers F_2. Which were closely followed by C_3 and F_3. The lowest benefit cost ratio were recorded in 0% compost C_0 and 0% inorganic fertilizer F_0. Alam *et al*. (2004); cited that higher profit was obtained when inorganic fertilizer was combined with organic manures.

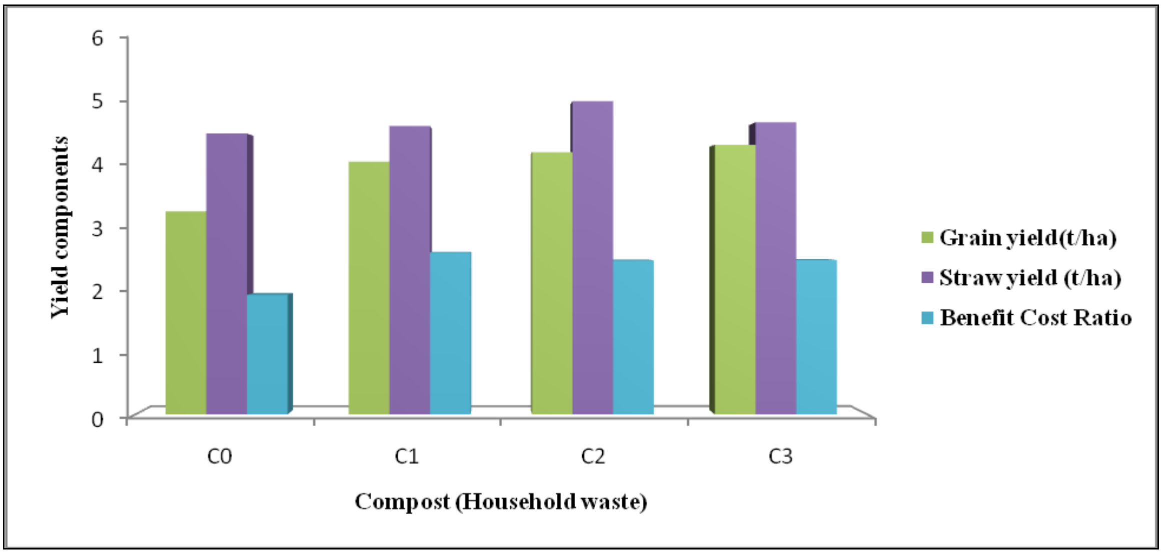
Table 4. Interaction effects of cowdung and inorganic fertilizers on fertilizer on panicle length (cm), 1000 grain wt.(g)and filled grains/panicle of BRRI dhan49

Interaction		Panicle length(cm)	1000 grain wt.(g)	Filled grains/panicle
Compost	Fertilizer			
C_0	Fo	22.50	19.73 b	85.33 g
	F_1	21.67	20.51 ab	97.00 f
	F_2	21.67	20.76 ab	107.7 b-e
	F_3	23.50	21.00 ab	104.3 c-e
C_1	Fo	21.83	20.02 ab	110.0 bcd
	F_1	22.83	20.62 ab	102.7 def
	F_2	23.00	22.98 ab	106.7 b-e
	F_3	22.83	21.43 ab	106.7 b-e
C_2	Fo	23.00	20.33 ab	100.7 ef
	F_1	23.33	22.10 ab	113.3 ab
	F_2	22.17	24.00 a	109.3 b-e
	F_3	22.50	21.67 ab	112.3 bc
C_3	Fo	21.67	23.33 ab	105.7 b-e
	F_1	21.67	22.00 ab	113.7 ab
	F_2	23.00	22.60 ab	109.7 bcd
	F_3	24.17	23.67 ab	121.0 a
LSD		2.529$^{(NS)}$	3.484	7.65
CV %		6.72	9.64	4.09

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

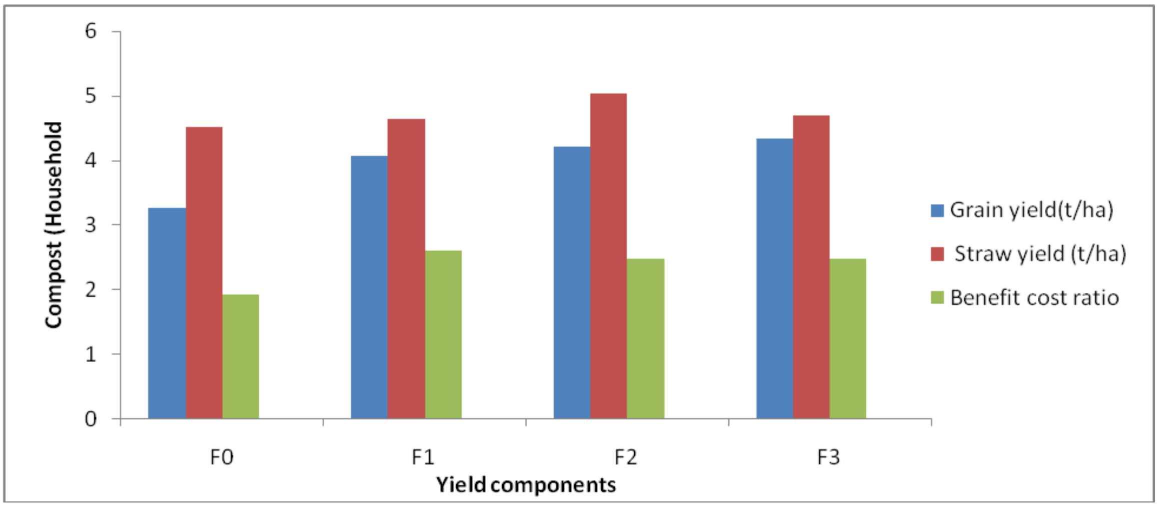
Compost (C) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose.

CV=Co-efficient of Variance NS=Non significant. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability



Compost(C) (Household wastes) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose

Figure 1. Effects of compost on different yield components of BRRI dhan49.



Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Figure 2. Effects inorganic fertilizer on different yield components of BRRI dhan49.

4.4.6 Interaction effect of compost and inorganic fertilizer on grain yield, straw yield and Benefit cost ratio of BRRI dhan49

4.4.6.1 Grain and straw yield

The interaction effects of compost and inorganic fertilizers varied significantly on grain and straw yields of BRRI dhan49, where the maximum grain and straw yields were found in 100% compost and 100% inorganic fertilizers combination i.e. C_3F_3 (4.467 t ha^{-1}) and 50% compost and 75% inorganic fertilizer combination i.e.C_2F_3 (5.53 t ha^{-1}) treatment, which are statistically similar to several combination of the treatments (Table 5). The minimum grain and straw yields (2.867 and 0.452 t ha^{-1}) were obtained in the combination 0% compost and 0% inorganic fertilizer application (C_0F_0) respectively..

4.4.6.2 Benefit cost ratio

The interaction effects (Table 5) of compost and inorganic fertilizer application on benefit cost ratio differed significantly. It was observed that the maximum benefit cost ratio was found in 100% compost and 100% inorganic fertilizer i.e. C_3F_3(2.64) treatment which was statiscally similar with C_3F_2, C_3F_1 and several

Table 5. Interaction effects of compost and inorganic fertilizer on different yield and yield components of BRRI dhan49

Interaction		Grain yield (tha^{-1})	Straw yield (tha^{-1})	Benefit cost ratio
Compost	Fertilizer			
C_0	Fo	2.867 b	4.031 d	1.690 c
	F_1	3.000 b	4.120 cd	1.780 c
	F_2	3.583 ab	4.033 d	2.120 b
	F_3	3.583 ab	4.843 a-d	2.110 b
C_1	Fo	3.590 ab	5.030 a-d	2.660 a
	F_1	4.107 a	4.503 a-d	2.610 a
	F_2	4.207 a	4.563 a-d	2.560 a
	F_3	4.350 a	4.827 a-d	2.570 a
C_2	Fo	4.287 a	4.633 a-d	2.460 a
	F_1	4.200 a	4.513 a-d	2.480 a
	F_2	4.207 a	5.223 ab	2.480 a
	F_3	4.150 a	5.530 a	2.460 a
C_3	Fo	4.150 a	4.853 a-d	2.450 a
	F_1	4.300 a	5.140 abc	2.220 b
	F_2	4.400 a	4.333 bcd	2.610 a
	F_3	4.467 a	4.500 a-d	2.640 a
LSD		0.8421	0.9042	0.18
CV %		12.74	11.5	5.36

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Compost (C) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose.

CV=Co-efficient of Variance . In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

treatments respectively and the lowest result (1.69) was found in C_0F_0 treatment having no use of inorganic fertilizer and compost.

4.4.7 Effect of compost and inorganic fertilizer on Nitrogen, Phosphorus and Potassium content in grain of BRRI dhan49

4.4.7.1 N content in grain

In case of compost (household waste), (Figure 3 4 and appendix Xlll). the maximum N content (1.277 %) was noted in 100% compost C_3 treatment and In case of inorganic fertilizer application, the highest N content (1.210%) were found in F_3 (100% inorganic fertilizer) treatment and it is statistically similar with F_2 treatments and in both cases the lowest N content (1.087%) was produced by 0 % compost C_0 treatment (1.167%) found in F_0 respectively.

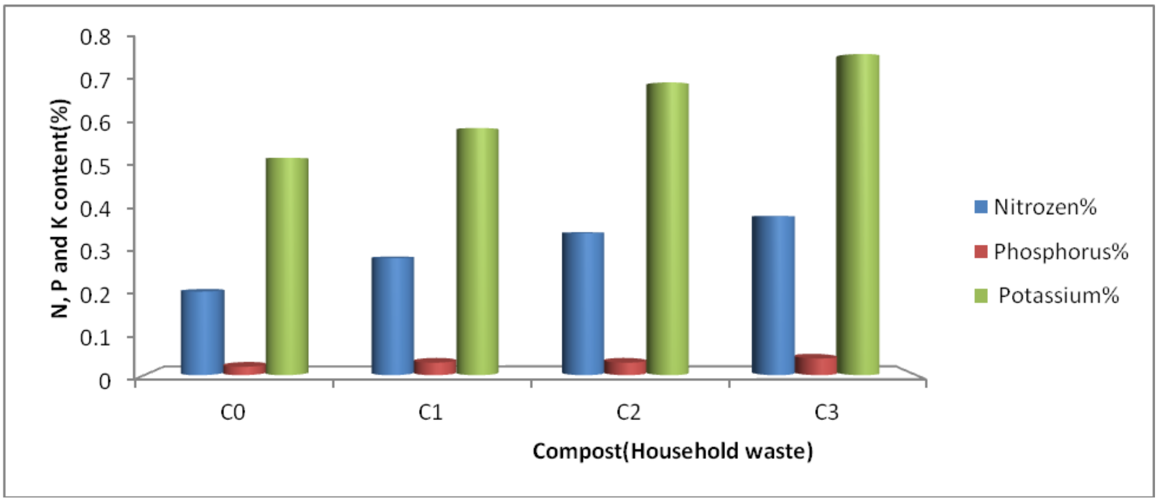
4.4.7.2 Phosphorus and Potassium content

The content of P and K in BRRI dhan49 varied significantly due to the effects of compost (Household waste) and inorganic fertilizer separately or combinedly (figure 4 and 5 and appendics XIII). The top amount of of P and K content in grain using only household wastes (0.211 and 0.168%) were observed in the treatments C_3 which were statistically identical with C_2 and non significant relationship exists on using inorganic fertilizer in both P and K content in grain respectively. Subbian *et al*. (1989) reported that total P level increase in both grain and straw with increasing level of P.

4.4.8 Interaction effect of compost and inorganic fertilizer on Nitrozen, Phosphorus and Potassium content in grain of BRRI dhan49

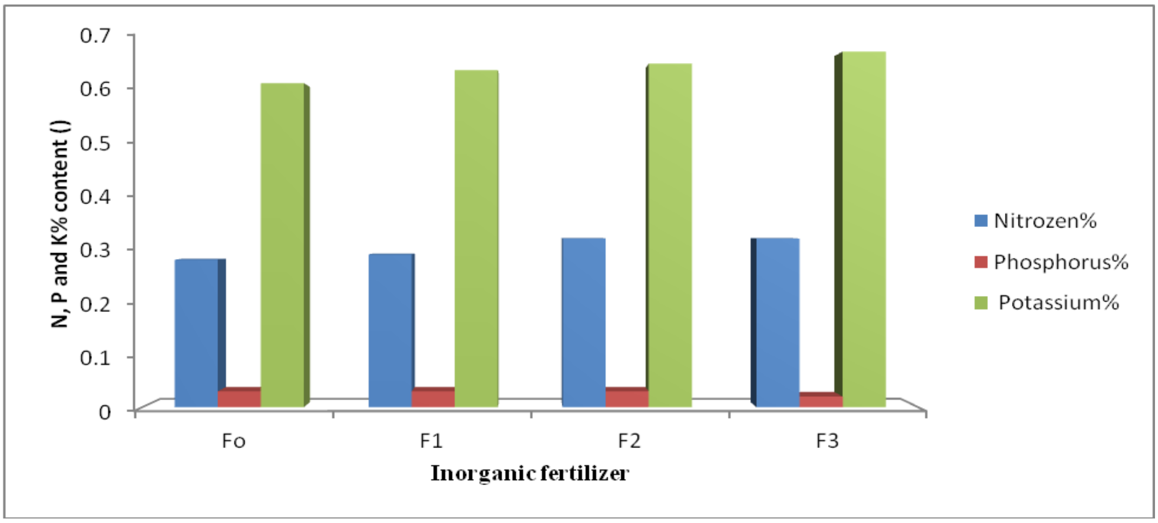
4.4.8.1 N content in grain

The interaction effects of compost and inorganic fertilizer significantly increased the N content with increasing the level of organic and inorganic fertilizers. It was



Compost(C) (Household wastes) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose

Figure 4. Effects of compost with NPK content in grain in BRRI dhan49.



Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Figure 5. Effects of inorganic fertilizers with NPK content in grain in BRRI dhan49.

Table 6. Interaction effects of compost and inorganic fertilizer of NPK content in grain of BRRI dhan49

Interaction		% N	% P	% K
Compost	Fertilizer			
C_0	Fo	1.073 i	0.163 a	0.096 d
	F_1	1.077 hi	0.168 a	0.106 cd
	F_2	1.087 ghi	0.179 a	0.116 bcd
	F_3	1.113 ghi	0.185 a	0.130a-d
C_1	Fo	1.133 fgh	0.120 de	0.160 abc
	F_1	1.133 fgh	0.100 e	0.186 a
	F_2	1.143 fg	0.123 cde	0.166 abc
	F_3	1.187 ef	0.125 cde	0.143 a-d
C_2	Fo	1.207 de	0.150 b-e	0.153 a-d
	F_1	1.200 de	0.170 a-d	0.156 a-d
	F_2	1.220 cde	0.153 b-e	0.170 ab
	F_3	1.240 b-e	0.18 abc	0.170 ab
C_3	Fo	1.267 abc	0.183 abc	0.170 ab
	F_1	1.257 a-d	0.203 ab	0.160 abc
	F_2	1.287 ab	0.210 ab	0.160 abc
	F_3	1.300 a	0.216 a	0.183 a
LSD		0.052	0.052	0.052
CV %		1.35	11.59	12.41

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Compost (C) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose.

CV=Co-efficient of Variance. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

observed that the maximum N content (1.300%) found in 100% compost and 100% inorganic fertilizer (C_3F_3) and minimum result found in (C_0F_0) treatment which is statistically similar with several treatments (Table 6).

4.4.8.2 P and K content in grain

The interaction effects of compost and inorganic fertilizer application, the highest amount P and K content in grain were obtained in 0.216 and 0.183 (100% compost and 100% inorganic fertilizer (C_3F_3) combination, which is statistically identical with several treatments. On the other hand, the lowest results were found at 0 % compost and inorganic fertilizer application combined (C_0F_0). .

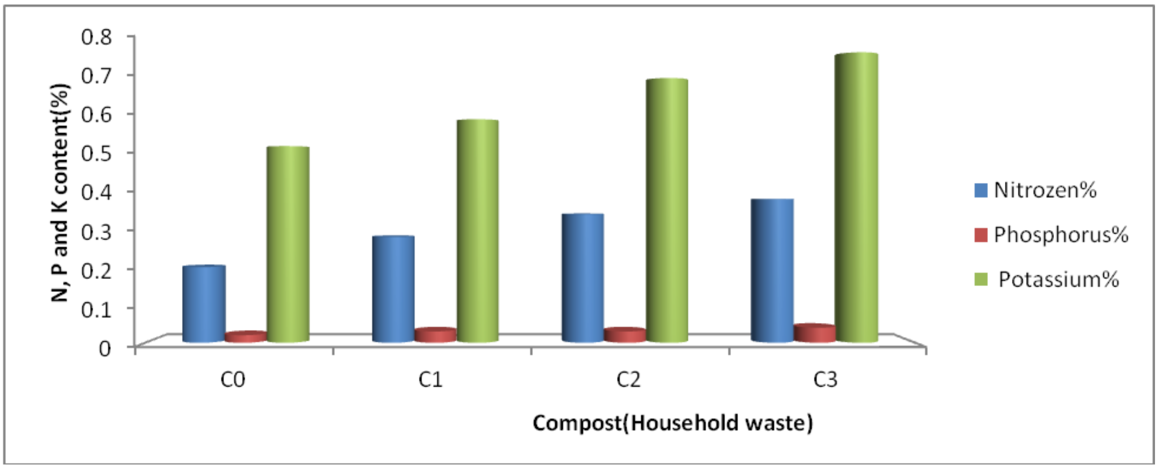
4.4.9 Effect of cowdung and inorganic fertilizer on Nitrogen, Phosphorus and Potassium content in straw of BRRI dhan49

4.4.9.1 % N and K content in straw

In case of compost (household waste), (Figure 6 and 7 and appendices XlV). the maximum N and K content in straw (0.384 and 0.768%) were noted in 100% compost C_3 treatment and In case of inorganic fertilizer application, the highest N and K content in straw (0.320 and 0.675%) were found in F_3 (100% inorganic fertilizer) and F_2 respectively and it is statistically similar with F_2 treatments and F_3 respectively. In both cases the lowest N and K content in straw (0.204 and 0.520%) were produced by 0% compost C_0 treatment (0.279 and 0.615%) found in F_0 respectively.

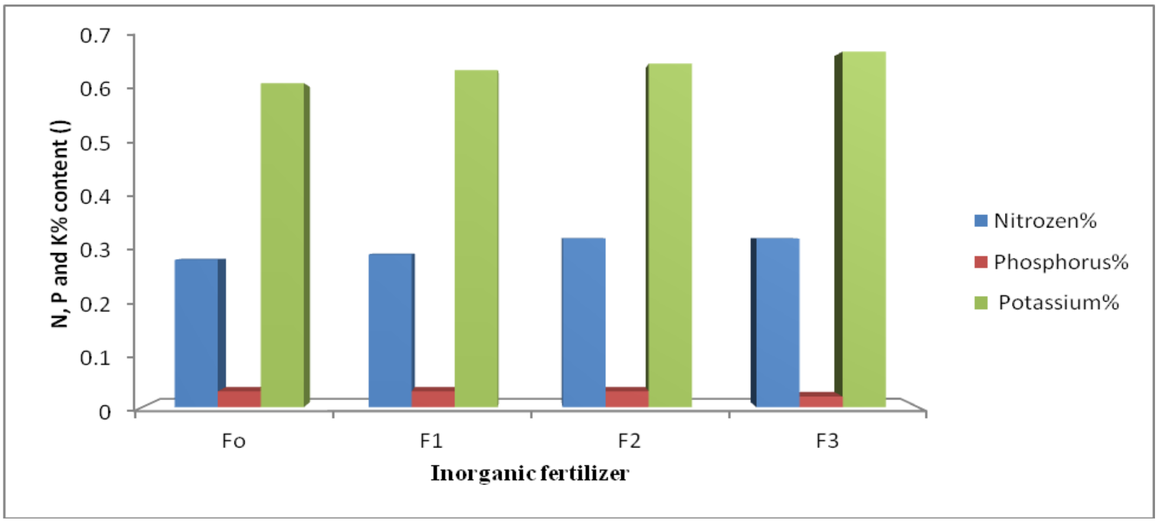
4.4.9.2 (%) P content in straw

The effect of different levels of composts (Household waste) and inorganic fertilizer application on P content of BRRI dhan49 was not differed significantly (figure 6 and 7 and appendices XlV). There is no significant relationship exists on using composts (Household waste) and inorganic fertilizer. Even using both of composts (Household waste) and inorganic fertilizer i.e. interaction effects there is no significant relation exists on.



Compost(C) (Household wastes) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose

Figure 5. Individual effects of compost with NPK content in straw in BRRI dhan49.



Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Figure 6. Effects of inorganic fertilizers with NPK content in straw in BRRI dhan49.

4.4.10 Interaction effect of compost and inorganic fertilizers on Nitrogen, Phosphorus and Potassium content in straw of BRRI dhan29

4.4.10.1 % N and % K content in straw

The interaction effects of compost and inorganic fertilizers significantly increased the N and K content in straw with increasing the level of organic and inorganic fertilizers. It was observed that the maximum N and K content in straw (0.426 and 0.786%) found in 100% compost and 100% inorganic fertilizer (C_3F_3) and (C_3F_2) respectively which were statistically similar with several treatments (Table 7).

4.4.10.2 % P content in straw

The effect of different levels of composts (Household waste) and inorganic fertilizers application on P content of BRRI dhan49 was not differed significantly (Table 7). There is no significant relationship exists on using composts (Household waste) and inorganic fertilizer. Even using both of composts (Household waste) and inorganic fertilizer i.e interaction effects there is no significant relation exists on.

Table 7. Interaction Effects of different levels of compost and inorganic fertilizer in straw in BRRI dhan49

Interaction		% N	% P	% K
Compost	**Fertilizer**			
C_0	Fo	0.16 h	0.021	0.490 h
	F_1	0.203 gh	0.024	0.520 gh
	F_2	0.210 fgh	0.024	0.523 gh
	F_3	0.236 efg	0.026	0.550 fg
C_1	Fo	0.256 efg	0.027	0.563 efg
	F_1	0.276 de	0.033	0.576 efg
	F_2	0.320 cd	0.033	0.606 def
	F_3	0.263 ef	0.020	0.620 de
C_2	Fo	0.323 cd	0.026	0.640 d
	F_1	0.350 bc	0.025	0.720 bc
	F_2	0.323 cd	0.030	0.706 c
	F_3	0.363 bc	0.032	0.743 abc
C_3	Fo	0.370 bc	0.036	0.770 ab
	F_1	0.333 cd	0.036	0.743 abc
	F_2	0.426 a	0.038	0.773 ab
	F_3	0.406 ab	0.040	0.786 a
LSD		0.052	0.052 (NS)	0.052
CV %		8.65	8.30	2.74

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Compost (C) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose.

CV=Co-efficient of Variance NS=Non significant. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

4.4.11 Effects of compost and inorganic fertilizers on post harvest soil properties of BRRI dhan49

4.4.11.1 Soil pH

The effect of compost and inorganic fertilizers on post harvest soil pH differed significantly by using compost and inorganic fertilizer application separately and combined treatments (Table 8). The highest soil pH values (5.975 and 5.608) were found 100% compost (C_3) and 100% fertilizers (F_3), respectively and the lowest soil pH values (4.711 and 5.297) were observed in 0% compost (C_0) and 0% fertilizers (F_0) treatments, respectively. Similar observation was also revealed by (Shishupal *et al.*, 2010).

4.4.11.2 Organic matter content

The effect of different levels of compost (from household waste) and inorganic fertilizer application on organic matter content of post harvest soil differed significantly due to separate application of organic and inorganic fertilizers (Table 8). In case of compost, the maximum organic matter content was found in 100% compost (C_3) (3.518%) treatment and the minimum organic matter content (3.221%) found in C_0 treatment. In case of inorganic fertilizers, the maximum organic matter content (3.433%) was found in F_3 treatment and the lowest amount (3.353%) found in F_0 statistically simillar with $F_{1.}$ Application of compost to soil is of considerable interest as a means of maintaining a suitable soil structure, as well as a means of adding organic material to soil whose organic matter content has been reduced by the practice of intensive agriculture published by (Legros and Petruzzelli, 2001).

4.4.11.3 Total nitrogen

The effect of compost and inorganic fertilizers separately or combinedly on N content of post harvest soil was differed significantly (Table 8). The highest amounts of N (0.091 and 0.052%) were observed at 100% compost (C_3) and C_0 using no inorganic fertilizers of treatments which is statistically identical with

75% compost (C_2) and the non significant results found in compost and fertilizer, respectively. Similar results were also reported by (Hossain *et al*. 2010)

4.4.11.4 Available phosphorus

The effect of compost and inorganic fertilizers on available P content of post harvest soil was differed significantly (Table 8). The highest amounts of P (17.30 and 16.30 ppm) were observed at 100% compost (C_3) and 100% inorganic fertilizers (F_3) treatments, respectively and the lowest amount P (11.23 and 14.26 ppm) found in 0% compost and 0% fertilizer, respectively . Melero *et al.* (2008) investigated that organically fertilized soils show significant increases in total organic carbon, Kjeldahl N, available P, ammonium acetate-extractable K, microbial biomass carbon and enzymatic activities compared with inorganically fertilized plots.

4.4.11.5 Exchangeable potassium

The effect of different levels of composts (Household waste) and fertilizers on K content of BRRI dhan49 differed non significantly (Table 8). There is no significant relationship exists on using composts (Household waste) and inorganic fertilizer. Even using both of composts (Household waste) and inorganic fertilizer i.e interaction effects there is no significant relation exists on.

4.4.12 Interaction effect of compost and inorganic fertilizer on post harvest soil properties of BRRI dhan49

4.4.12.1 Soil pH

The interaction effects of compost and inorganic fertilizer application varied significantly on post harvest soil pH, where the maximum soil pH was found in

Table 8. Effects of different levels of compost and inorganic fertilizer on post-harvest soil properties BRRI dhan49

Compost	Soil pH	%Organic matter	%N	P(ppm)	K(meq/100 g soil)
Co	4.711 d	3.221 d	0.052 d	11.23 c	0.099
C_1	5.522 c	3.345 c	0.059 c	16.18 b	0.125
C_2	5.849 b	3.465 b	0.078 bc	16.83 ab	0.131
C_3	5.975 a	3.518 a	0.091 ab	17.30 a	0.153
$LSD_{0.05}$	0.026	0.026	0.026	0.840	0.840 (NS)
CV%	0.38	0.65	2.65	6.55	18.09
Fertilizer					
F_0	5.297 c	3.353 c	0.079	14.26 b	0.114
F_1	5.561 c	3.375 bc	0.084	15.02 b	0.129
F_2	5.592 a	3.388 b	0.087	15.95 a	0.131
F_3	5.608 a	3.433 a	0.093	16.30 a	0.135
$LSD_{0.05}$	0.026	0.026	0.026 (NS)	0.840	0.840 (NS)
CV%	0.38	0.65	2.65	6.55	18.09

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Compost (C) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose.

CV=Co-efficient of Variance NS=Non significant. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

100% compost and inorganic fertilizers combination i.e. C_3F_3 (6.037), which is statistically similar to 100% compost and 75% inorganic fertilizers combination (C_3F_2) treatment, respectively (Table 9). The minimum soil pH was obtained in the combination 0% compost and 0% inorganic fertilizers i.e. C_0F_0 (4.68) treatment followed by several treatments.

4.4.12.2 Organic matter content

The interaction effects of compost and inorganic fertilizers significantly increased the organic matter content with increasing the level of organic and inorganic fertilizers. It was observed that the maximum organic matter content (3.527%) found in C_3F_3 treatment which is statistically similar with C_1F_2 treatment and the minimum organic matter content (3.187%) obtained C_1F_0 treatment (Table 9). The organic matter content of post harvest soils increased due to application of manures and fertilizers.

4.4.12.3 Total nitrogen

In case of interaction of compost and inorganic fertilizers, the highest amounts of N (0.120%) was obtained at 100% compost and 100% inorganic fertilizers combination(C_3F_3), which is statistically similar to 100% compost with 75% inorganic fertilizers combination (C_3F_2). The lowest amount of N (0.048%) was found in C_0F_0 treatment statistically identical with C_0F_1.

4.4.12.4 Available phosphorus

The interaction effect of compost and inorganic fertilizers on available P content of post harvest soil were varied significantly (Table 9). The highest amount of P (17.48 ppm) was obtained at C_3F_3 treatment, which is statistically similar to several treatments and the lowest amount of P (9.197 ppm) was found in C_1F_0 treatment, which is statistically similar to C_1F_1 treatment.

Table 9. Interaction effects of compost and inorganic fertilizer on post harvest soil properties on BRRI dhan49

Interaction		Soil pH	% Organic matter	% N	P (ppm)	K(meq /100 g soil)
Compost	**Fertilizer**					
C_0	Fo	4.68 f	3.35 c	0.048 c	14.26 b	0.079
	F_1	4.73 f	3.37 bc	0.056 c	15.02 c	0.10
	F_2	4.71 f	3.38 b	0.06 bc	15.95 bc	0.10
	F_3	4.707 f	3.433 a	0.069 a-c	16.30 abc	0.113
C_1	Fo	4.730 f	3.187 k	0.073 a-c	9.197 e	0.118
	F_1	5.757 e	3.210 jk	0.077 a-c	10.13 e	0.120
	F_2	5.800 de	3.230 jk	0.081 a-c	12.42 d	0.126
	F_3	5.800 de	3.257 ij	0.083 a-c	13.15 d	0.137
C_2	Fo	5.840 cd	3.293 hi	0.085 a-c	15.90 bc	0.143
	F_1	5.820 d	3.327 gh	0.089 a-c	16.47 a-c	0.124
	F_2	5.85 cd	3.357 fg	0.091 a-c	15.90 bc	0.117
	F_3	5.88 bc	3.403 ef	0.100 a-c	16.47 a-c	0.140
C_3	Fo	5.930 b	3.420 de	0.112 ab	15.03 c	0.116
	F_1	5.933 b	3.46 b-d	0.114 ab	17.39 ab	0.173
	F_2	6.000 b	3.45 c-e	0.113 ab	17.39 ab	0.173
	F_3	6.037 a	3.527 a	0.120 a	17.48 a	0.150
LSD		**0.052**	**0.052**	**0.052**	**1.681**	**1.681(NS)**
CV %		**0.38**	**0.65**	**2.65**	**6.56**	**18.09**

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Compost (C) → C_0 =0, C_2 = 50%, C_2 = 75% and C_3 =100% of the recommended dose.

CV=Co-efficient of Variance NS=Non significant. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

4.4.12.5 Exchangeable potassium

The effect of different levels of composts (Household waste) and fertilizers on K content of BRRI dhan49 differed non significantly (Table 8). There is no significant relationship exists on using composts (Household waste) and inorganic fertilizer. Even using both of composts (Household waste) and inorganic fertilizer i.e interaction effects there is no significant relation exists on (Table 9).

4.5 EXPERIMENT TITLE: EFFECTS OF COWDUNG AND DIFFERENT INORGANIC FERTILIZER ON GROWTH YIELD AND NUTRIENT CONTENT OF AMAN RICE (BRRI dhan49)

4.5.1 Effect of cowdung and inorganic fertilizer on plant height, number of effective tiller, non effective and total tiller per hill of BRRI dhan49

4.5.1.1 Plant height

Plant height of rice is one of the most important growth and development parameter. The effect of cowdung and inorganic fertilizer on plant height (cm) differed significantly (Table 1). The tallest plant height (89.92 cm) was recorded in 100% cowdung in CD_3 which was statistically similar with 75% cowdung (CD_2). In case of using inorganic fertilizer, the tallest plant height (90.42 cm) was recorded in 75% inorganic fertilizer application(F_2) which is closely associate with F_3 and F_1 . Plant height recorded either with single or combined application of fertilizer and manure was higher than that of control treatment. The smallest plant height (83.00 and 86.67 cm) were observed in CD_0 and F_0 by control treatment having no use of cowdung and inorganic fertilizer, respectively. In upland rice organic manure and inorganic fertilizer combination was found better by (Umanah *et al*., 2003) and Channabasavanna (2003) in wetland rice than only inorganic fertilizers.

4.5.1.2 Number of effective, non-effective and total tillers per hill

There is no significant relationship exists in effective tiller using both cowdung and inorganic fertilizer (Table 1). Cowdung along with inorganic fertilizer plays vital effect on the tillers per hill of BRRI dhan49. The highest number of non effective per hill (4.25) was recorded in CD_2 treatment in 75 % cowdung application in and F_3 in 100% inorganic fertilizer application (3.41) and total tiller per hill was observed maximum in CD_1 and F_3 respectively which were statistically identical with 75% cowdung (CD_2) and 75% fertilizers (F_2) respectively (Table 1). Mirza *et al.* (2010) investigated that increase in number of tillers in rice plants due to influence of different inorganic fertilizer combinations. These findings are similar with the findings of (Akhtar, 1990).

4.5.2 Interaction effect of cowdung and inorganic fertilizer on plant height, number of effective tiller, non effective and total tiller per hill of BRRI dhan49

4.5.2.1 Plant height

From Table 2 the interaction effect of different doses of cowdung and inorganic fertilizer application on plant height of BRRI dhan49 differed significantly. The tallest plant height was found in 100% cowdung in CD_3 (94.67 cm) and 75% inorganic fertilizer (CD_3F_2) and directly followed by (CD_3F3) the smallest value (77 cm) was obtained in 0% cowdung and 0% inorganic fertilizers (CD_0F_0).

4.5.2.2 Number of effective tiller, non effective and total tiller per hill

The interaction effects of cowdung and inorganic fertilizer application on effective and total tillers per hill of BRRI dhan49 were significantly differed (Table 2), where the highest results obtained at the combination of 100% cowdung and 75% inorganic fertilizers and 50% cowdung and 100% inorganic fertilizer CD_3F_2 and CD_1F_3 (11.33 and 15.00) respectively several treatments shows more or less simillar results. The lowest numbers of effective and total tillers per hill were found in the combination of 0% cowdung and 0% fertilizers (9.83 and 12.16) CD_0F_0 in both cases. On the other hand, the non-effective tillers hill^{-1} were found higher at 50% cowdung and 50% inorganic fertilizers combinations and the lower in 0% cowdung and 50% inorganic fertilizer combinations.

Table 1. Effects of cowdung and inorganic fertilizer on different crop characters of BRRI dhan49

Cowdung	Plant height (cm)	Effective tiller hill^{-1} (No.)	Non effective tiller hill^{-1} (No.)	Total tiller hill^{-1} (No.)
CD_0	86.67 b	10.25	2.750 b	13.00 ab
CD_1	86.83 b	9.67	4.250 a	13.92 a
CD_2	88.50 ab	10.58	2.500 b	12.75 ab
CD_3	89.92 a	10.25	1.583 c	11.83 b
$LSD_{0.05}$	1.780	0.948	0.779	1.140
CV%	2.43	11.17	33.73	10.63
Fertilizer				
F_0	83.00 b	9.833	2.083 c	12.00 b
F_1	88.58 a	10.00	3.167 ab	12.83 ab
F_2	90.42 a	10.75	2.417 bc	13.00 ab
F_3	89.92 a	10.17	3.417 a	13.58 a
$LSD_{0.05}$	1.780	0.948 $^{(NS)}$	0.779	1.140
CV%	2.43	11.17	33.73	10.63

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Cowdung (CD) → C_0 =0, CD_2 = 50%, CD_2 = 75% and CD_3 =100% of the recommended dose.

CV=Co-efficient of Variance NS=Non significant. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

Table 2. Interaction effects of cowdung and inorganic fertilizer on different crop characters of BRRI dhan49

Interaction		Plant height (cm)	Effective tiller $hill^{-1}$ (No.)	Non-effective tiller $hill^{-1}$ (No.)	Total tiller $hill^{-1}$ (No.)
Cowdung	**Fertilizer**				
CD_0	Fo	77.00 d	9.833 b	2.33 c-e	12.16 b
	F_1	91.67 ab	10.00 a-c	3.66 a-d	13.66 ab
	F_2	89.67 b	10.75 ab	2.00 de	12.75 ab
	F_3	88.33 b	10.17 a-c	3.00b-e	13.17 ab
CD_1	Fo	88.33 b	9.33 bc	2.33 c-e	12.66 b
	F_1	82.00 c	9.66 bc	5.33 a	13.33 ab
	F_2	89.00 b	9.00 c	4.00a-c	13.00 ab
	F_3	88.00 b	10.00 a-c	5.00 a	15.00 a
CD_2	Fo	83.67 c	10.00 a-c	2.00 de	12.00 b
	F_1	90.67 b	9.00 c	2.00 de	14.33 ab
	F_2	88.33 b	10.67 a-c	2.00 de	14.33 ab
	F_3	91.33 ab	10.00 a-c	4.00 a-c	14.00 ab
CD_3	Fo	83.00 c	10.00 a-c	1.66 e	11.67 b
	F_1	90.00 b	11.00 a	1.66 e	11.67 b
	F_2	94.67 a	11.33 a	1.33 e	12.66 b
	F_3	92.00 ab	10.00 a-c	1.66 e	14.00 ab
LSD		3.56	1.897	1.559	2.279
CV %		2.43	11.17	33.73	10.63

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Cowdung (CD) → C_0 =0, CD_2 = 50%, CD_2 = 75% and CD_3 =100% of the recommended dose.

CV=Co-efficient of Variance. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

4.5.3 Effect of cowdung and inorganic fertilizer on panicle length, 1000 grain weight and filled grains/panicles of BRRI dhan49

4.5.3.1 Panicle length

Panicle length is another important yield component of rice, which affect the number of grains per panicle. The effect of different levels of cowdung and inorganic fertilizer on panicle length (cm) of BRRI dhan49 not differed significantly (Table 3). There is no significant relationship exists on using cowdung and inorganic fertilizer. Saitoh *et al.* (2001); revealed an experiment to evaluate the effect of organic manure (cowdung and chicken manure) and pesticides on the growth and yield of rice and revealed that the yield of organic manure treated and pesticide free plots were 10% lower than that of chemical fertilizer and pesticide-treated plot clue to a decrease in the number of panicle.

4.5.3.2 1000-grain weight

The effect of using cowdung and inorganic fertilizer on 1000-grain weight (g) differed significantly (Table 3). The highest 1000-grain weight was recorded in CD_3 in 100% cowdung (24.72 g) and lowest value fond in 0% cowdung (CD_0). In case of using inorganic fertilizer, the highest 1000-grain weight was recorded in F_3 in 100% inorganic fertilizers (23.45 g) and lowest value found in 0% cowdung (CD_0). Records keeping by Hoque (1999), by the application of organic manure 1000-grain weight were increased.

4.5.3.3 Filled grains/panicle:

The effect of cowdung and inorganic fertilizer application on filled grains/panicle differed significantly (Table 3). The highest filled grains/panicles (121.3 and 105.9) were recorded in 100% cowdung (CD_3) and 100% inorganic fertilizers F_3 and lowest value was observed in (88.75 and 98.00) CD_0 and F_0 respectively. Due to increase of NPK rates percentage of filled grains of rice was increased (Mondol, 1990).

Table 3. Effects of cowdung and inorganic fertilizer on panicle length(cm), 1000 grain wt.(g) and filled grains/panicles of BRRI dhan49

Cowdung	**Panicle length(cm)**	**1000 grain wt.(g)**	**Filled grains/panicles (No.)**
CD_0	22.54	18.98 d	88.75 d
CD_1	22.00	20.90 c	95.33 c
CD_2	22.42	23.15 b	106.2 b
CD_3	22.33	24.72 a	121.3 a
LSD $_{0.05}$	$1.165^{(NS)}$	1.099	3.42
CV%	6.26	6.01	3.43
Fertilizer			
F_0	22.50	20.79 c	98.00 b
F_1	22.21	21.32 bc	103.0 a
F_2	22.33	22.19 b	104.6 a
F_3	22.25	23.45 a	105.9 a
LSD $_{0.05}$	$1.165^{(NS)}$	1.099	3.42
CV%	6.26	6.01	3.43

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Cowdung (CD) → C_0 =0, CD_2 = 50%, CD_2 = 75% and CD_3 =100% of the recommended dose.

CV=Co-efficient of Variance NS=Non significant. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

4.5.4 Interaction effect of cowdung and inorganic fertilizers on panicle length, 1000 grain weight and filled grains/panicles of BRRI dhan49

4.5.4.1 Panicle length

The interaction effects of even using cowdung and inorganic fertilizers application there is no significant relation exists on.

4.5.4.2 1000 grain weight

The interaction effects of cowdung and inorganic fertilizers on 1000-grain weight differed significantly. It was observed that the maximum weight of 1000 grain (26.43g) was found in CD_3F_3 treatment and the lowest result (17.53g) was found in CD_0F_0 treatment.

4.5.4.3 Filled grains/panicle

The interaction effects of cowdung and inorganic fertilizers on filled grains/panicle differed significantly. It was observed that the maximum filled grains/panicles (126.00) was found in 100% cowdung and 100% inorganic fertilizer (CD_3F_3) treatment and the lowest result (85.00) was found in CD_0F_0 treatment having no use of fertilizer and manure.

Table 4. Interaction effects of cowdung and inorganic fertilizers on fertilizer on panicle length(cm), 1000 grain wt.(g) and filled grains/panicles of BRRI dhan49

Interaction		Panicle length(cm)	1000 grain wt.(g)	Filled grains/panicle (No.)
Cowdung	Fertilizer			
CD_0	Fo	23.67	17.53 g	85.00 g
	F_1	22.5	18.52 fg	86.33 g
	F_2	23	18.50 fg	92.00fg
	F_3	21	21.37 de	91.67 fg
CD_1	Fo	22	18.82 fg	91.67 fg
	F_1	22.33	20.33 ef	95.33 f
	F_2	21	21.76 c-e	98.33 def
	F_3	22.67	22.67 b-e	96.00 ef
CD_2	Fo	22.67	23.99 bc	103.0 cde
	F_1	21.33	21.76 c-e	108.0 bc
	F_2	23	23.50 b-d	103.7 cd
	F_3	22.67	23.33 b-d	110.0 bc
CD_3	Fo	21.67	22.81 b-d	112.3 b
	F_1	22.67	24.67 ab	122.3 a
	F_2	22.33	24.98 ab	124.3 a
	F_3	22.67	26.43 a	126.0 a
LSD		2.33 (NS)	2.198	6.84
CV %		6.26	6.01	3.43

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Cowdung (CD) → C_0 =0, CD_2 = 50%, CD_2 = 75% and CD_3 =100% of the recommended dose.

CV=Co-efficient of Variance NS=Non significant. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

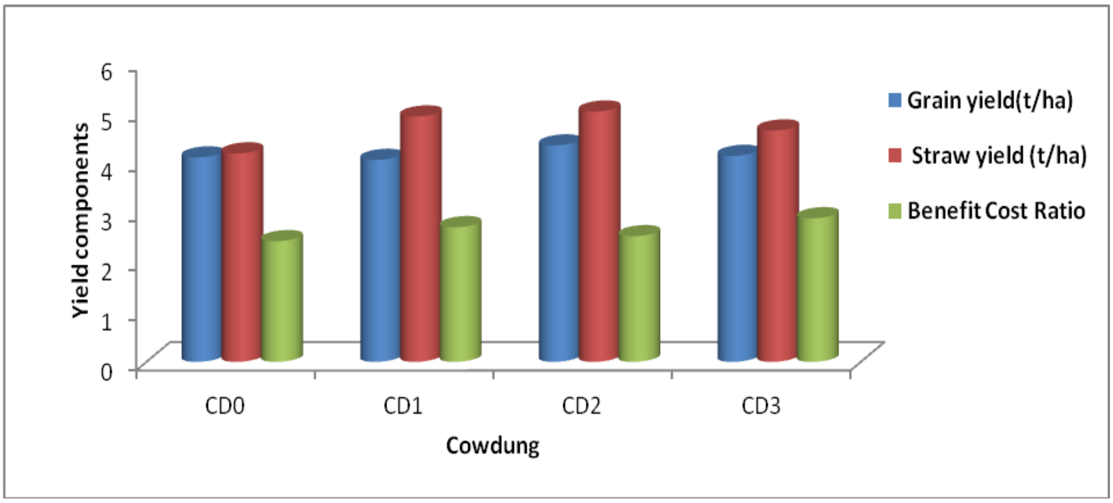
4.5.5 Effect of cowdung and inorganic fertilizers on grain yield, straw yield and benefit cost ratio of BRRI dhan49

4.5.5.1 Grain and straw yield

The grain and straw yield (t ha^{-1}) of BRRI dhan49 varied significantly due to the effects of cowdung and inorganic fertilizers application separately or combinedly (figure 1and 2 and appendics xv). The highest grain and straw yields were observed in CD_3 in 100% cowdung (4.34 and 5.023 t ha^{-1}) treatment and the lowest grain and straw yields (4.05 and 4.18 t ha^{-1}) obtained in 50% cowdung and 0% cowdung respectively. Due to application of inorganic fertilizers the highest grain yield (4.55) and the effect of cowdung on straw yield (t/ha) was non-significant (figure no 1) and the lowest grain yields (3.67 t ha^{-1}) and effect of inorganic fertilizers was non-significant from same figure. Yakub *et al.* (2010); and Asit *et al*. (2007) examined that 6% increase of grain yield by applying urea-N and manures. Khan *et al.* (2007) reported that the application of NPK and organic manures significantly increased the rice grain and straw yields of rice crop.

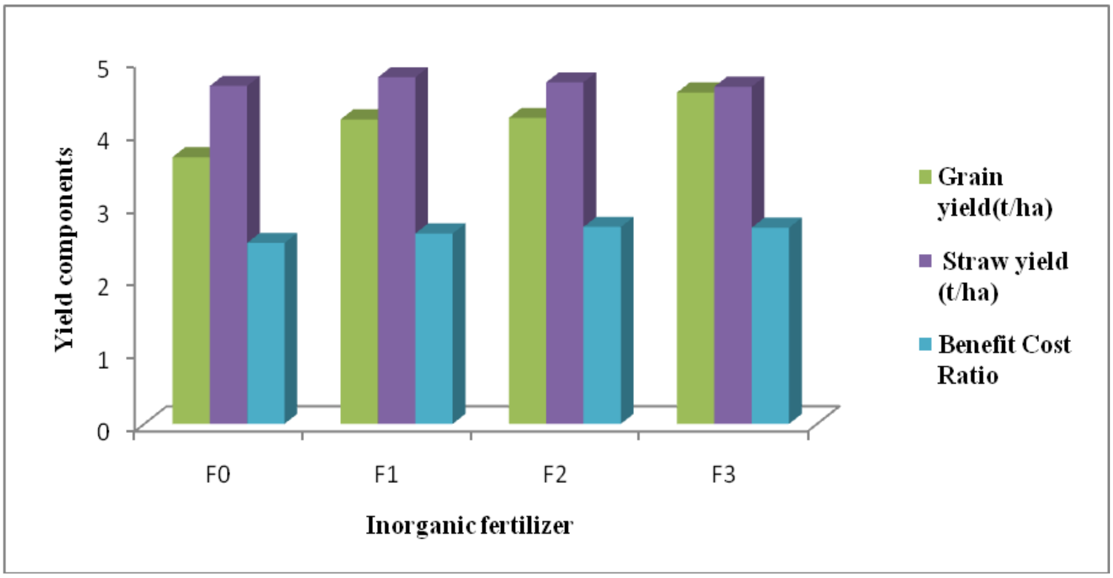
4.5.5.2 Benefit cost ratio

The effect of cowdung and inorganic fertilizers on benefit cost ratio differed significantly (figure 1and 2 and appendices xv). The highest benefit cost ratios were recorded in 100% cowdung CD_3 in (2.88) and 100% inorganic fertilizers F_2 in (2.71) respectively. Similar supports were reported by Yaduvanshi (2003), who observed that higher profit was obtained when inorganic fertilizer was combined with organic manures.



Cowdung (CD) → CD_0 = 0%, CD_1 = 50%, CD_2 =75% and CD_3 = 100% of the recommended dose

Figure 1. Effects of cowdung on different yield components of BRRI dhan49.



Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Figure 2. Effects inorganic fertilizer on different yield components of BRRI dhan49.

Table 5. Interaction effects of cowdung and inorganic fertilizer on different yield and yield components of BRRI dhan49

Interaction		Grain yield (tha^{-1})	Straw yield (tha^{-1})	Benefit cost ratio
Cowdung	**Fertilizer**			
CD_0	Fo	3.490 h	3.780 c	2.07 i
	F_1	4.320 d	4.200 bc	2.55 fgh
	F_2	4.200 e	4.757 a-c	2.48 gh
	F_3	4.370 d	3.990 c	2.59 efg
CD_1	Fo	3.290 i	5.137 ab	2.65 def
	F_1	4.110 f	4.793 a-c	2.70 c-f
	F_2	4.207 e	4.617 a-c	2.73 cde
	F_3	4.627 b	5.130 ab	2.74 cde
CD_2	Fo	4.200 e	4.880 a-c	2.42 h
	F_1	4.110 f	4.627 a-c	2.43 gh
	F_2	4.320 d	5.430 a	2.68 c-f
	F_3	4.500 c	5.157 ab	2.58 e-h
CD_3	Fo	3.713 g	4.817 a-c	2.84 abc
	F_1	4.200 e	4.267 bc	2.80 bcd
	F_2	4.110 f	4.000 c	2.92 ab
	F_3	4.730 a	5.467 a	2.97 a
LSD		0.052	0.9418	0.14
CV %		0.34	12.04	4.69

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Cowdung (CD) → C_0 =0, CD_2 = 50%, CD_2 = 75% and CD_3 =100% of the recommended dose.

CV=Co-efficient of Variance. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

4.5.6 Interaction effect of cowdung and inorganic fertilizer on grain yield, straw yield and Benefit cost ratio of BRRI dhan49

4.5.6.1 Grain and straw yield

The interaction effects of cowdung and inorganic fertilizers, the maximum grain and straw yields (4.70 and 5.46 t ha^{-1}) were found in 100% cowdung and 100% inorganic fertilizers combination CD_3F_3 and CD_3F_1 respectively which were statistically similar with several treatments (Table 5). The minimum grain and straw yields (3.490 and 3.78 t ha^{-1}) were noted in 0% cowdung and 0% inorganic fertilizer combination (CD_0F_0) respectively.

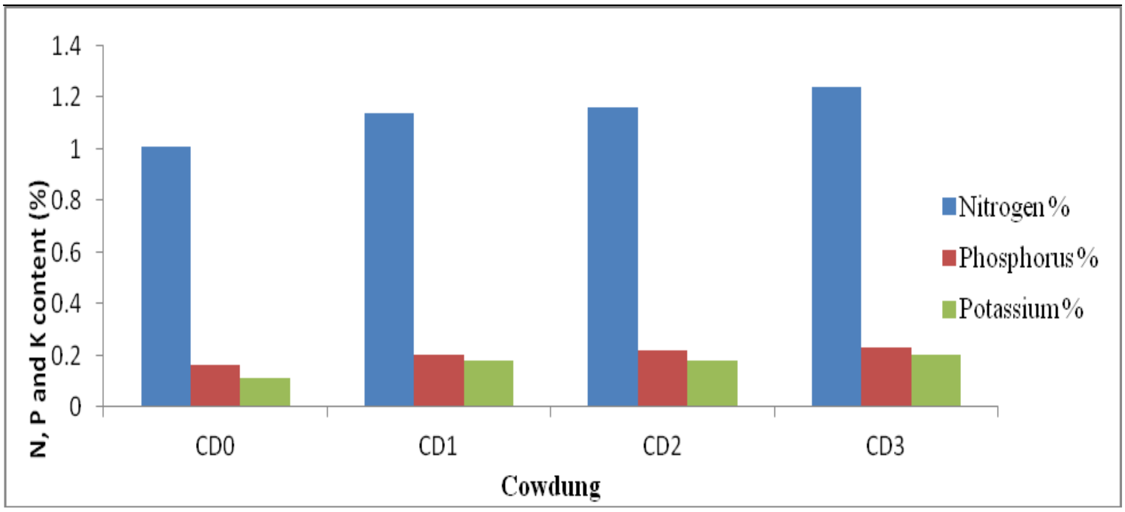
4.5.6.2 Benefit cost ratio

The interaction effects (Table 5) of cowdung and inorganic fertilizers on benefit cost ratio differed significantly. It was observed that the maximum benefit cost ratio (2.97) was found in 100% cowdung and 100% inorganic fertilizer (CD_3F_3) treatment which was statistically similar with CD_3F_2 and the lowest result (2.07) was found in CD_0F_0 treatment having no use of cowdung and inorganic fertilizer.

4.5.7 Effect of cowdung and inorganic fertilizer on Nitrogen, Phosphorus and Potassium content in grain of BRRI dhan49

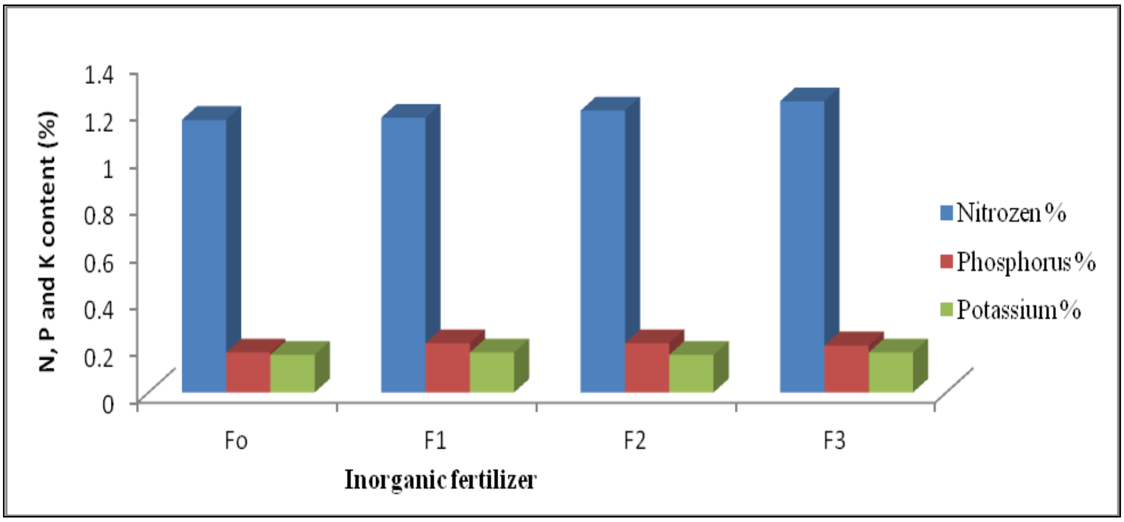
4.5.7.1 N, P and K content in grain

The data presented on N, P and K content in grain in rice at differed significantly and influenced by cowdung and inorganic fertilizer were presented in (Figure 3 and 4 and appendics XVI). The highest N, P and K content in grain (1.24, 0.225 and 0.19%) were recorded in 100% cowdung (CD_3) in using only cowdung respectively, which were statistically simillar with 50% cowdung (CD_1) in N content and CD_1 CD_2 in P and K content respectively. On the other hand the lowest observation was found in 0% cowdung CD_0 (1.01, 0.15 and 0.10%). However, due to using inorganic fertilizer the highest N, P and K content in grain



Cowdung (CD) → CD_0 = 0%, CD_1 = 50%, CD_2 =75% and CD_3 = 100% of the recommended dose

Figure 3. Effects of cowdung with NPK content in grain in BRRI dhan49.



Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Figure 4. Effects of inorganic fertilizer with NPK content in grain in BRRI dhan49.

(1.24, 0.21% and non significant) was recorded in 100% fertilizer (F_3) which were statistically simillar with F_2 . The lowest amount of N, P and K content in

Table 6. Interaction effects cowdung and inorganic fertilizer of NPK content in grain of BRRI dhan49

Interaction		**% N**	**% P**	**% K**
Cowdung	**Fertilizer**			
	Fo	1.06 f	0.128 d	0.086 e
CDo	**F1**	1.06 f	0.180 bcd	0.106 de
	F2	1.12 ef	0.176 bcd	0.116 cde
	F3	1.14 def	0.135 d	0.120 cde
	Fo	1.12 ef	0.170 cd	0.198 ab
CD1	**F1**	1.15 def	0.203 abc	0.206 ab
	F2	1.16 c-f	0.22 abc	0.173 abc
	F3	1.23 bcd	0.213 abc	0.156 bcd
	Fo	1.22 b-e	0.196 abc	0.193 ab
CD2	**F1**	1.20 b-e	0.253 a	0.180 ab
	F2	1.23 bcd	0.236 ab	0.166 abc
	F3	1.26 abc	0.216 abc	0.176 abc
	Fo	1.26 ab	0.203 abc	0.176 abc
CD3	**F1**	1.27 ab	0.220 abc	0.196 ab
	F2	1.30 ab	0.22 abc	0.196 ab
	F3	1.34 a	0.253 a	0.220 a
LSD (0.05)		0.09	0.052	0.052
CV%		4.43	11.11	12.36

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Cowdung (CD) → C_0 =0, CD_2 = 50%, CD_2 = 75% and CD_3 =100% of the recommended dose.

CV=Co-efficient of Variance. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

grain (1.16, 0.17% and non significant) were observed by treatment 0% fertilizer ($F_{0)}$. Bari *et al.* (2013) examined that nutrient content in grain increased while organic manure combined with inorganic fertilizers

4.5.8 Interaction effect of cowdung and inorganic fertilizers on N, P and K content in grain of BRRI dhan49

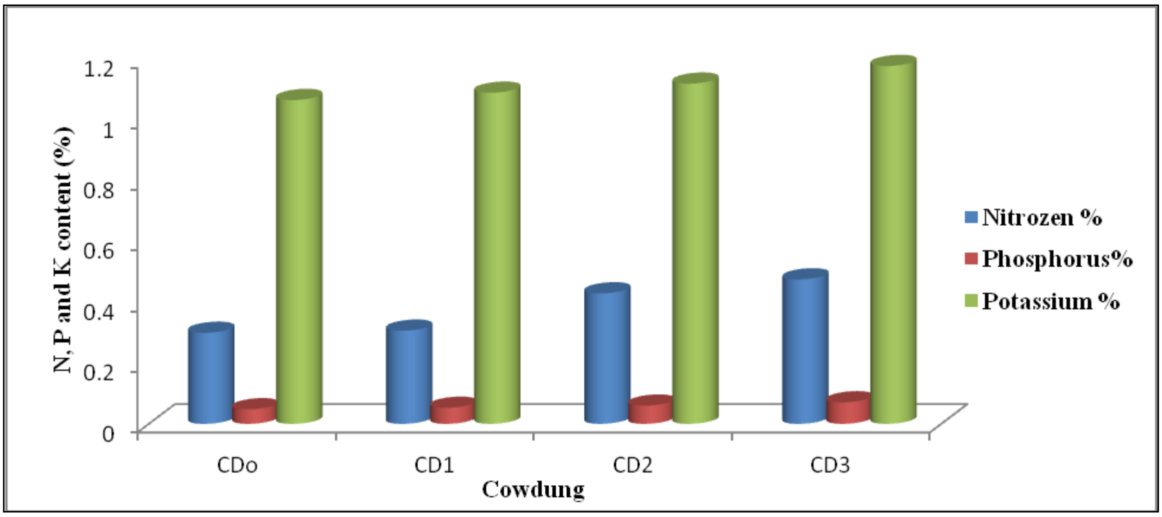
4.5.8.1 N, P and K content in grain

The interaction effect of different doses of cowdung and fertilizers of BRRI dhan49 were observed significantly higher N, P and K content in grain (1.34, 0.253 and 0.22%) were recorded in CD_3F_3 (100% Inorganic fertilizer and 100% cowdung) which were closely followed by CD_3F_2 CD_3F_1 and CD_3F_0 and the lowest value in (0 % Inorganic fertilizer + 0% cowdung t ha^{-1}) $CD_0F_{0.}$ (1.06, 0.12 and 0.08%).which were closely followed by CD_0F_3 and several treatments. Salam *et al.* (2004) conducted a field experiment to determine the level of nitrogen (0, 40, 80 and 120 kg ha^{-}) and the highest grain yield was recorded from the application of 80 kg N ha^{-1}.

4.5.9 Effect of cowdung and inorganic fertilizer on N, P and K content in straw of BRRI dhan49

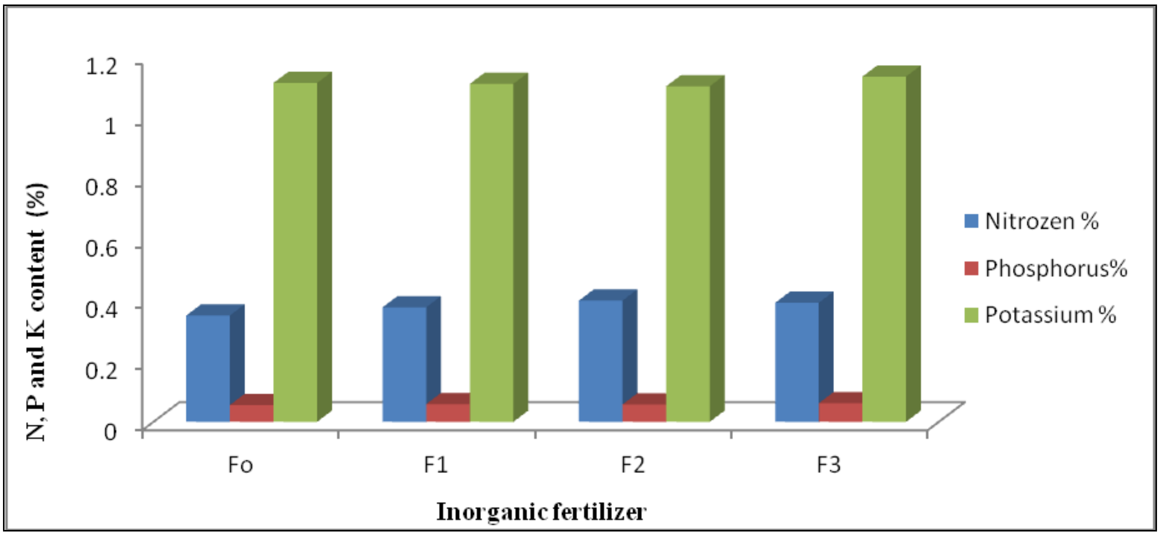
4.5.9.1 % N and K content in straw

Due to application of cowdung coupled with inorganic fertilizer, the N and K content of BRRI dhan49 was increased to a significant extent (figure 5, 6 and appendics XVII) and differed significantly among the different combinations of cowdung and inorganic fertilizer. The highest N and K content in straw were recorded in CD_3 in (0.476 and 1.179%) and lowest observation were found in CD_0 (0.300 and 1.067%). From the figure 6 in inorganic fertilizer level the greatest N and K content were recorded in F_2 and F_3 (0.398 and 1.13%) respectively and the lowest amount of N and K content (0.349 and 1.113%) wre observed by treatment F_0 which was statistically simillar with $F_{1.}$ N and K content recorded either with single or combined application of in organic



Cowdung (CD) → CD_0 = 0%, CD_1 = 50%, CD_2 =75% and CD_3 = 100% of the recommended dose

Figure 5. Effects of cowdung with NPK content in straw in BRRI dhan49.



Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Figure 6. Effects of inorganic fertilizer with NPK content in straw in BRRI dhan49.

Table 7. Interaction effects of different levels of cowdung and inorganic fertilizers in straw in BRRI dhan49

Interaction		% N	% P	% K
Cowdung	**Fertilizer**			
CDo	**F_0**	0.226 e	0.044	1.043 d
	F_1	0.338 cd	0.047	1.063 cd
	F_2	0.330 cd	0.046	1.073 cd
	F_3	0.306 de	0.054	1.090 cd
CD1	**F_0**	0.306 de	0.050	1.117 bc
	F_1	0.290 de	0.055	1.117 bc
	F_2	0.336 cd	0.049	1.043 d
	F_3	0.29 de	0.058	1.088 cd
CD2	**F_0**	0.394 bc	0.059	1.117 bc
	F_1	0.437 ab	0.062	1.093 cd
	F_2	0.440 ab	0.062	1.117 bc
	F_3	0.450 ab	0.058	1.157 ab
CD3	**F_0**	0.471 ab	0.067	1.174 ab
	F_1	0.440 ab	0.069	1.167 ab
	F_2	0.486 a	0.072	1.173 ab
	F_3	0.506 a	0.075	1.200 a
LSD (0.05)		0.074	0.052 (NS)	0.052
CV%		12.57	7.51	2.84

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Cowdung (CD) → C_0 =0, CD_2 = 50%, CD_2 = 75% and CD_3 =100% of the recommended dose.

CV=Co-efficient of Variance NS=Non significant. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

fertilizer and manure was higher than that of control treatment. Uptake of K was much higher than straw (Ali *et al.* 2007)

4.5.9.2 % P content in straw

The effect of different levels of cowdung and organic fertilizer on P content of BRRI dhan49 not differed significantly (figure 5 and 6). There is no significant relationship exists on using cowdung and inorganic fertilizer even using both of cowdung and inorganic fertilizer I.e interaction effects there is no significant relation exists on.

4.5.10 Interaction effect of cowdung and inorganic fertilizers on N and K content in straw of BRRI dhan49

4.5.10.1 % N and K content in straw

From (Table 04). the interaction effect of different doses of cowdung and fertilizer of BRRI dhan49 Significantly higher N and K content in straw (0.506 and 1.20%) were recorded in CD_3F_3 (100% Inorganic fertilizer +100% cowdung t/ha) which was closely followed by CD_3F_2 (75 % Inorganic fertilizer + 100% cowdung t/ha).

4.5.10.2 % P content in straw

There is no significant relationship exists on using cow dung and inorganic fertilizer. Even using both of cowdung and inorganic fertilizer i.e interaction effects there is no significant relation exists on.

4.5.11 Effects of cowdung and inorganic fertilizer on post harvest soil properties of BRRI dhan49

4.5.11.1 Soil pH

The effect of different levels of cowdung and inorganic fertilizers on organic matter content of post harvest soil differed non significantly (Table 8) in both individual use of cowdung and inorganic fertilizer. Soil pH, organic matter in soil can improve soil structure as well as major and trace elements, record keeping by (Tran *et al.*, 2006).

4.5.11.2 Organic matter content

The effect of different levels of cowdung and inorganic fertilizers on organic matter content of post harvest soil differed non significantly (Table 8) where the maximum organic matter content were obtained in CD_3 i.e.100% cowdung (3.579%) and F_3 in 100% inorganic fertilizers (3.514%) respectively. The lowest organic matter content (3.314 and 3.417%) were found at CD_0 and F_0 (no cowdung and inorganic fertilizer), respectively. Addition of organic materials of various sources to soil has been one of the most familiar practices to improve soil physical properties supported by (Celik *et al.,* 2004).

4.5.11.3 Total nitrogen

The significant effect was found on total nitrogen (N) content of post harvest soil due to cowdung and inorganic fertilizers application (Table 8). All the treatments significantly influence on higher N content over control treatment. The highest N content of post harvest soil (0.146%) was recorded in 75% cowdung (CD_2) which is statistically similar with CD_3 treatment and the lowest N content of post harvest soil (0.09%) found in 0% cowdung (CD_0) treatment. In case of application of inorganic fertilizer, data shows no significant relation. Several workers also reported that organic manures had a positive influence on total and available N content of soil. Conducted an experiment by Choudhury and hanif (2002) in Malaysia to determine the effect of N application on the yield and nutrition of rice (cv.MR84). Rice yield significantly increased with application of 20 kg N ha^{-1} over farmers practice (0 kg N ha^{-1}).

4.5.11.4 Available phosphorus

Available phosphorus (P) content of the post-harvest soils was significantly influenced by the application of cowdung and inorganic fertilizer (Table 8). The highest amount of available P content of the post-harvest soils was found in

CD_3 in 100% cowdung (19.85 ppm) and the lowest value (12.37 ppm) was observed in 0% cowdung (CD_0) treatment. In case of fertilizer, the highest

Table 8. Effects of different levels of inorganic fertilizer on post-harvest soil properties BRRI dhan49

Cowdung	Soil pH	% Organic matter	Total N (%)	P (ppm)	K(meq/100 g soil)
CD_0	5.147	3.314 d	0.090 b	12.37 d	0.131 c
CD_1	5.257	3.403 c	0.133 a	15.13 c	0.174 b
CD_2	5.264	3.524 b	0.146 a	17.02 b	0.185 b
CD_3	5.296	3.579 a	0.145 a	19.85 a	0.245 a
$LSD_{0.05}$	0.195 (NS)	0.026	0.026	0.518	0.026
CV%	4.47	0.66	3.75	3.86	9.14
Fertilizer					
F_0	5.182	3.417 c	0.113	15.65 bc	0.170 a
F_1	5.242	3.430 c	0.127	15.29 c	0.181 a
F_2	5.257	3.459 b	0.136	16.05 b	0.189 a
F_3	5.284	3.514 a	0.138	17.38 a	0.195 a
$LSD_{0.05}$	0.195 (NS)	0.026	0.026(NS)	0.518	0.026(NS)
CV%	4.47	0.66	3.75	3.86	9.14

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Cowdung (CD) → C_0 =0, CD_2 = 50%, CD_2 = 75% and CD_3 =100% of the recommended dose.

CV=Co-efficient of Variance NS=Non significant. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

amount of available P (17.38 ppm) was recorded in 100% fertilizers (F_3) treatment and the lowest amount available P (15.29 ppm) was observed by treatment 50% fertilizers (F_1). Phosphorous is essential for energy transfer system.

4.5.11.5 Exchangeable potassium

Exchangeable potassium content of the post harvest soils was significantly influenced due to the application of cowdung and inorganic fertilizers **(**Table 8). The highest exchangeable K content (0.245 meq/100g soil) of post harvest soil was recorded in 100% cowdung (CD_3) and the lowest exchangeable K content (0.131 meq/100g soil) of post harvest soil found in 0% cowdung (CD_0) treatment. In case of inorganic fertilizer, there is no significant relation exists on.

4.5.12 Interaction effect of cowdung and inorganic fertilizers on post harvest soil properties of BRRI dhan49

4.5.12.1 Soil pH

The interaction effects of different doses of cowdung and inorganic fertilizers on post-harvest soil pH differed significantly, the maximum soil pH (5.417) was recorded in CD_2F_1 (75 % Inorganic fertilizers + 50% cowdung) statistically simillar with most of the treatments and the lowest pH value (4.90) in CD_0F_0 which was closely related with CD_0F_1 combination (Table 9).

4.5.12.2 Organic matter

The interaction effects of cowdung and inorganic fertilizer application on organic matter content also differed significantly (Table 9) It was observed that the highest organic matter content (3.617%) was found in CD_3F_3 combination which was statistically identical with CD_3F_2 treatment. The lowest result (3.237%) noted in CD_0F_0 treatment.

4.5.12.3 Total nitrogen

The interaction or combination effects of cowdung and inorganic fertilizers on N content of post harvest soil differed significantly (Table 9), where the highest N content (0.149%) obtained at the combination of 100% cowdung (CD_3) and 100% inorganic fertilizers (F3) i.e CD_3F_0 treatment, which is statistically similar with most of the treatment.The lowest amount of N content (0.036%) was found in the combination of 0% cowdung and 0% fertilizers (CD_0F_0) treatment, which is statistically identical with CD_0F_1.

4.5.12.4 Available phosphorus

The interaction effect of different doses of cowdung and inorganic fertilizer application on available P content of post harvest soil differed significantly (Table 09). The maximum available P was recorded in CD_3F_3 in (100% cowdung + 100 % Inorganic fertilizer (21.04 ppm) treatment which is closely followed by CD_3F_2 treatment. The lowest amount available P was observed in the treatment 0% cowdung and 0% chemical fertilizers F_0 in (11.03 ppm) combination, which is statistically identical with CD_0F_1 treatment.

4.5.12.5 Exchangeable potassium

The interaction effects of cowdung and inorganic fertilizers on exchangeable K content of post harvest soil differed significantly (Table 9), where the highest K content in CD_3 obtained at the combination of 100% cowdung (0.270 meq/100g soil) and 100% inorganic fertilizer (F_3) i.e CD_3F_3 treatment, which is statistically similar with CD_3F_2 and CD_3F_1 treatments. The lowest amount of exchangeable K (0.110 meq/100g soil) was found in the combination of 0% cowdung and 0% fertilizers (CD_0F_0) treatment.

Table 9. Interaction effects of cowdung and inorganic fertilizers on post harvest soil properties in BRRI dhan49

Interaction		Soil pH	% Organic matter	Total N (%)	P (ppm)	K(meq/100 g soil)
Cowdung	Fertilizer					
CDo	F_0	4.900 b	3.237 j	0.036 b	11.03 h	0.110 f
	F_1	5.050 ab	3.277 ij	0.087 ab	13.00fg	0.141ef
	F_2	5.323 ab	3.317 i	0.114 a	12.gh	0.138 ef
	F_3	5.317 ab	3.427 fgh	0.122 a	13.44ef	0.135 ef
CD1	F_0	5.220 ab	3.400 gh	0.124 a	14.78d	0.172 de
	F_1	5.230 ab	3.370 h	0.13 a	13.4 f	0.172 de
	F_2	5.250 ab	3.407 gh	0.137 a	14.78 d	0.186cde
	F_3	5.327 ab	3.433 fg	0.143 a	17.51 c	0.167def
CD2	F_0	5.313 ab	3.477 ef	0.146 a	18.40 c	0.17 de
	F_1	5.417 a	3.513 de	0.147 a	14.52de	0.172de
	F_2	5.153 ab	3.527 cde	0.147 a	17.64c	0.18 cde
	F_3	5.173 ab	3.580 abc	0.146 a	17.51c	0.210bcd
CD3	F_0	5.293 ab	3.553 bcd	0.149 a	18.40c	0.226a-d
	F_1	5.270 ab	3.560 a-d	0.146 a	20.20ab	0.24abc
	F_2	5.300 ab	3.587 ab	0.145 a	19.76b	0.24ab
	F_3	5.320 ab	3.617 a	0.141 a	21.04a	0.270a
LSD		0.3911	0.052	0.052	1.036	0.052
CV %		4.47	0.66	3.75	3.86	9.14

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Cowdung (CD) → C_0 =0, CD_2 = 50%, CD_2 = 75% and CD_3 =100% of the recommended dose.

CV=Co-efficient of Variance . In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

4.6 EXPERIMENT TITLE: EFFECTS OF POULTRY MANURE AND DIFFERENT INORGANIC FERTILIZERS ON GROWTH, YIELD AND NUTRIENT CONTENT OF AMAN RICE (BRRI dhan49)

4.6.1 Effect of poultry manure and inorganic fertilizers on plant height, number of effective tiller, non effective and total tiller per hill of BRRI dhan49

4.6.1.1 Plant height

Use of poultry manure and inorganic fertilizers significantly differed the plant height of BRRI dhan49 (Table 1). The tallest plant height (90.70 cm) was recorded in (PM_3) i.e. 100% poultry manure. In case of inorganic fertilizer application, the tallest plant was recorded in 75% inorganic fertilizers (92.53 cm) i.e. (F_2) which is statistically similar with 100% inorganic fertilizer (F_3). The lowest plant height (87.75 and 84.25 cm) were observed by 0% poultry manure and 0% inorganic fertilizers *i.e* no poultry manure or inorganic fertilizer respectively. Increasing nitrogen level up to 144 kg ha^{-1} plant height significantly increased found by (Ravisankar *et al.*, 2003).

4.6.1.2 Number of effective, non-effective and total tillers per hill

Significant relationships were found by using poultry manure and inorganic fertilizer application on effective, non effective and total tillers per hill of BRRI dhan49 (Table 1). The highest numbers of effective and total tillers per hill were recorded at 75% poultry manure (PM_2) and 50% inorganic fertilizers (F_1) respectively. The lowest numbers of effective and total tillers per hill were found by 0% poultry manure (PM_0) and 0% fertilizers (F_0) respectively. In case of noneffective tillers per hill, the highest and the lowest results were observed in 0% poultry manure (PM_0) & 0% fertilizers (F_0) and 100% poultry manure (PM_3) and 100% fertilizers (F_3) respectively. Rajni *et al*. (2001); who was found increased

Table 1. Effects of poultry manure and inorganic fertilizer on different crop characters of BRRI dhan49

Poultry manure	Plant height (cm)	Effective tiller hill^{-1} (No.)	Non- effective tiller hill^{-1} (No.)	Total tiller hill^{-1} (No.)
PM_0	87.75 b	10.75 d	4.083 a	14.83 c
PM_1	89.17 ab	11.42 c	3.167 b	14.58 c
PM_2	88.42 b	14.75 a	2.667 bc	17.42 a
PM_3	90.70 a	13.75 b	2.167 c	15.92 b
$LSD_{0.05}$	2.057	0.563	0.539	0.750
CV%	2.77	5.34	18.40	5.74
Fertilizer				
F_0	84.25 c	10.83 c	3.250 a	14.08 c
F_1	87.83 b	13.83 a	3.167 a	17.00 a
F_2	92.53 a	12.67 b	2.583 b	15.25 b
F_3	91.42 a	13.33 a	3.083 ab	16.42 a
$LSD_{0.05}$	2.057	0.563	0.5390	0.750
CV%	2.77	5.34	18.40	5.74

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Poultry manure (PM) → PM_0 =0, PM_2 = 50%, PM_2 = 75% and PM_3 =100% of the recommended dose.

CV=Co-efficient of Variance. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

number of effective tiller hill^{-1} with the integrated use of vermicompost, poultry manure and nitrogenous fertilizers. Either poultry manure or organic fertilizer to the soil increases tiller number reported Belefant *et al.* (2007); but the combination of poultry manure and organic fertilizer resultsin 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.

4.6.2 Interaction effect of poultry manure and inorganic fertilizer on plant height, number of effective tiller, non effective and total tiller per hill of BRRI dhan49

4.6.2.1 Plant height

The interaction effects of different doses of poultry manure and inorganic fertilizer application on plant height of BRRI dhan49 significantly differed (Table 2). The tallest plant was found in (PM_3F_2) i.e. 100% poultry manure and 75% inorganic fertilizers in (94.80 cm) which is statistically similar with several interaction and the lowest value (82.67 cm) observed in PM_0F_1 (0% poultry manure and 50% inorganic fertilizers).

4.6.2.2 Number of effective tiller, non effective and total tiller per hill

In combine effect of poultry manure and inorganic fertilizers plays vital rule on the effective and total tillers per hill, where 100% poultry manure (PM_3) and 100% inorganic fertilizers (F_3) statistically identical with 100% poultry manure and 75% inorganic fertilizers (PM_3F_2). The no. of non effective tiller per hill the highest counting was found in PM_0F_3 which is closely followed by several combination and lowest no. of non effective tiller was observed in PM_3F_0.

Table 2. Interaction effects of poultry manure and inorganic fertilizer on different crop characters of BRRI dhan49

Interaction		Plant height (cm)	Effective tiller hill^{-1} (No.)	Non-effective tiller hill^{-1} (No.)	Total tiller hill^{-1} (No.)
Poultry manure	Fertilizer				
PM_0	F_0	84.00 b	8.333 h	4.333 a	12.67 e
	F_1	82.67 b	12.33 f	4.000 ab	16.33 d
	F_2	92.00 a	13.00 ef	3.667 a-c	16.67 cd
	F_3	92.33 a	9.333 h	4.333 a	13.67 e
PM_1	F_0	82.00 b	12.00 f	3.667 a-c	15.67 d
	F_1	92.00 a	12.67 ef	4.000 ab	16.67 cd
	F_2	91.00 a	8.333 h	2.000 ef	10.33 f
	F_3	91.67 a	12.67 ef	3.000 b-e	15.67 d
PM_2	F_0	85.67 b	12.33 f	3.333 a-d	15.67 d
	F_1	85.67 b	16.00 ab	2.667 c-f	18.67 ab
	F_2	92.33 a	15.67 ab	2.333 d-f	18.00 a-c
	F_3	90.00 a	15.00 bc	2.333 d-f	17.33 b-d
PM_3	F_0	85.33 b	10.67 g	1.667 f	12.33 e
	F_1	91.00 a	14.33 cd	2.000 ef	16.33 cd
	F_2	94.80 a	13.67 de	2.333 d-f	16.00 d
	F_3	91.67 a	16.33 a	2.667 c-f	19.00 a
$LSD_{0.05}$		4.115	1.127	1.078	1.501
CV%		2.77	5.34	18.4	5.74

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Poultry manure (PM) → PM_0 =0, PM_2 = 50%, PM_2 = 75% and PM_3 =100% of the recommended dose.

CV=Co-efficient of Variance . In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

4.6.3 Effect of poultry manure and inorganic fertilizer on panicle length, 1000 grain weight and filled grain/panicles of BRRI dhan49

4.6.3.1 Panicle length

The data showed on panicle length are presented in Table 3, which indicated significant differences among various treatments. Using poultry manure and inorganic fertilizer on panicle length of BRRI dhan49. The longest panicle length were (23.71) recorded at 100% poultry manure (PM_3) and 75% inorganic fertilizers (F_2) (23.38) separately or their combined. (Table 03). Suggestion provided by Deng *et al.* (2010); that the slow release of nitrogen from poultry manure increased panicle length and grains per panicle in rice plants and enhance the lodging resistance capability of high quality rice to achieve the goal of high quality and high yield.

4.6.3.2 1000-grain weight

The 1000-grain weight significantly differed due to the effects of poultry manure and combined with inorganic fertilizer (Table 3). The maximum weight of 1000-grain was observed in the treatment 50% poultry manure i.e. PM_1 (22.82 g) and the lowest weight of 1000- grain was found in 0% poultry manure i.e. PM_0 (20.21 g). But the effect of inorganic fertilizers on 1000-grain weight of BRRI dhan49 was non-significant. Similar findings were illustrated by Song *et al.* (1998); who found that combination of organic manures associate with NPK fertilizer had a significant effect on 1000 grains weight.

4.6.3.3 Filled grains/panicle

The effect of poultry manure and inorganic fertilizers on filled grains/panicle differed significantly shown in (Table 3). The highest filled grains/panicles were recorded in 100% poultry manure ($PM_{3)}$ (116.2) and 100% inorganic fertilizer application F_3 (108.4) respectively.

Table3. Effects of poultry manure and inorganic fertilizer on panicle length (cm), 1000 grain wt.(g) and filled grains/panicle of BRRI dhan49

Poultry manure	Panicle length(cm)	1000 grain wt.(g)	Filled grains/panicle
PM_0	22.38 b	20.21 b	85.83 c
PM_1	22.63 b	22.82 a	96.67 b
PM_2	22.38 b	22.72 a	113.3 a
PM_3	23.71 a	22.66 a	116.2 a
$LSD_{0.05}$	0.868	1.347	4.89
CV%	4.57	7.31	5.7
Fertilizer			
F_0	21.96 b	21.51	99.08 b
F_1	22.79 ab	21.92	101.3 b
F_2	23.38 a	22.40	103.1 b
F_3	22.97 a	22.58	108.4 a
$LSD_{0.05}$	0.868	$1.347^{(NS)}$	4.89
CV%	4.57	7.31	5.7

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Poultry manure (PM) → PM_0 =0, PM_2 = 50%, PM_2 = 75% and PM_3 =100% of the recommended dose.

CV=Co-efficient of Variance NS=Non significant. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

4.6.4 Interaction effect of poultry manure and inorganic fertilizers on panicle length, 1000 grain weight and filled grains/panicle of BRRI dhan49

4.6.4.1 Panicle length

In combine effect of poultry manure and inorganic fertilizers plays vital rule on the panicle length where 100% poultry manure PM_3 (25.17) and 75% inorganic fertilizers (F_3) statistically identical with 100% poultry manure and 100% inorganic fertilizers (PM_3F_3). The smallest panicle length were found by 0% poultry manure and 0% fertilizers (F_0) separately or their combined effect (PM_0F_0) (Table 4).

4.6.4.2 1000 grain weight

All the treatments of inorganic fertilizer application with the association of poultry manure performed better on 1000-grain weight over control treatment ($PM_0F_{0)}$, where the highest 1000 grain weight was observed (24.13 g) several treatments shows similar value and the lowest 1000 grain weight was visible in PM_1F_3 (18.53 g) and PM_0F_0 respectively (Table 4).

4.6.4.3 Filled grains/panicle

The interaction effects of poultry manure and inorganic fertilizers application on filled grains/panicle differed significantly. It was observed that the maximum filled grains/panicles was found in 100% poultry manure and 100% inorganic fertilizer (PM_3F_3) (122.3) treatment statically identical with several treatments and the lowest filled grains/panicles was found in PM_0F_1 (81.00) treatment having no use of fertilizer and manure(Table 4). Hemalatha *et al.* (2004); reported that all the sources of organic manures improve the soil fertility, yield and quality of rice.

Table 4. Interaction effects of poultry manure and inorganic fertilizer on panicle length(cm), 1000 grain wt.(g) and filled grains/panicle of BRRI dhan49

Interaction		Panicle length(cm)	1000 grain wt.(g)	Filled grain/panicles
Poultry manure	**Fertilizer**			
PM_0	F_0	22.50 bc	18.53 c	85.67 ef
	F_1	21.67 c	19.99 bc	81.00 f
	F_2	22.67 bc	21.08 abc	82.67 f
	F_3	22.67 bc	21.23 abc	94.00 de
PM_1	F_0	21.83 c	21.35 abc	93.33 de
	F_1	22.83 bc	23.37 a	97.00 d
	F_2	23.00 bc	22.43 ab	96.00 de
	F_3	22.83 bc	24.13 a	100.3 cd
PM_2	F_0	21.67 c	23.99 a	108.3 bc
	F_1	23.00 bc	21.76 ab	113.0 ab
	F_2	22.67 bc	22.67 ab	114.7 ab
	F_3	22.20 bc	22.46 ab	117.0 ab
PM_3	F_0	21.83 c	22.18 ab	109.0 ab
	F_1	23.67 abc	22.56 ab	114.3 ab
	F_2	25.17 a	23.44 a	119.0 ab
	F_3	24.17 ab	22.48 ab	122.3 a
$LSD_{0.05}$		1.736	2.694	9.78
CV%		4.57	7.31	5.7

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Poultry manure (PM) → PM_0 =0, PM_2 = 50%, PM_2 = 75% and PM_3 =100% of the recommended dose.

CV=Co-efficient of Variance . In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

4.6.5 Effect of poultry manure and inorganic fertilizers on grain yield, straw yield and benefit cost ratio of BRRI dhan49

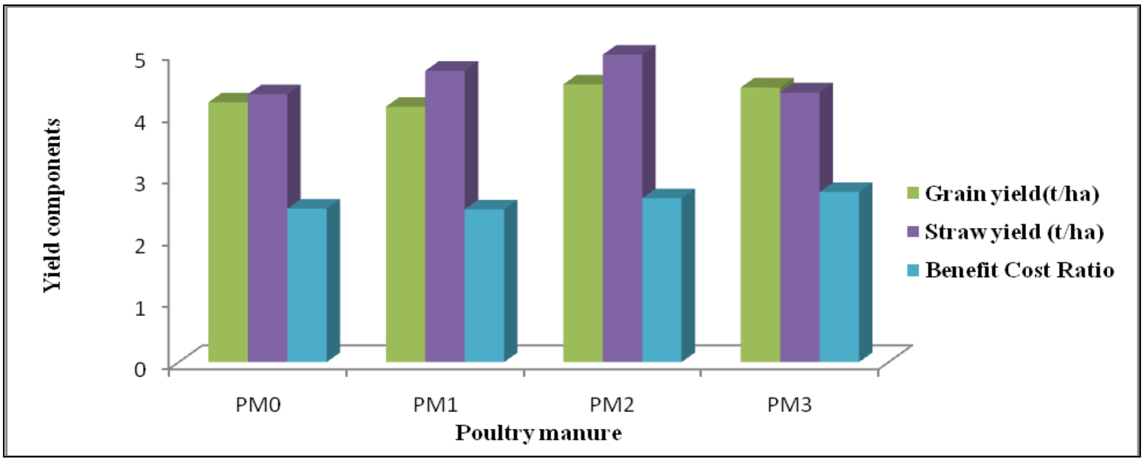
4.6.5.1 Grain and straw yield

In case of poultry manure and inorganic fertilizers, the grain and straw yields varied significantly due to the application of poultry manure and inorganic fertilizer application separately (Figure 1 and 2 and appendics XVIII). The highest grain and straw yields (and were observed in 75% poultry manure PM_2 (4.485 t ha^{-1}) and 75% poultry manure PM_2 (4.974 t ha^{-1}) respectively. The lowest grain and straw yields were found in 50% poultry manure ($PM_{1)}$ (4.126 t ha^{-1}) and 0% poultry manure i.e. PM_0 (4.326 t ha^{-1}) treatment, which were statistically identical with 0% poultry manure (PM_0), respectively. In case of inorganic fertilizer application, the highest grain and straw yields (4.574 and 4.775 t ha^{-1}) and the lowest grain and straw yields (3.858 and 4.403 t ha^{-1}) were found in 0% inorganic fertilizers (F_1) treatments in both case although there is a numerical variation in grain yield among the treatments. Meher (2011) and Sangeetha *et al.* (2011) record keeping 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. Similar observation was also revealed by (Chaudhary *et al.*, 2011).

4.6.5.2 Benefit cost ratio:

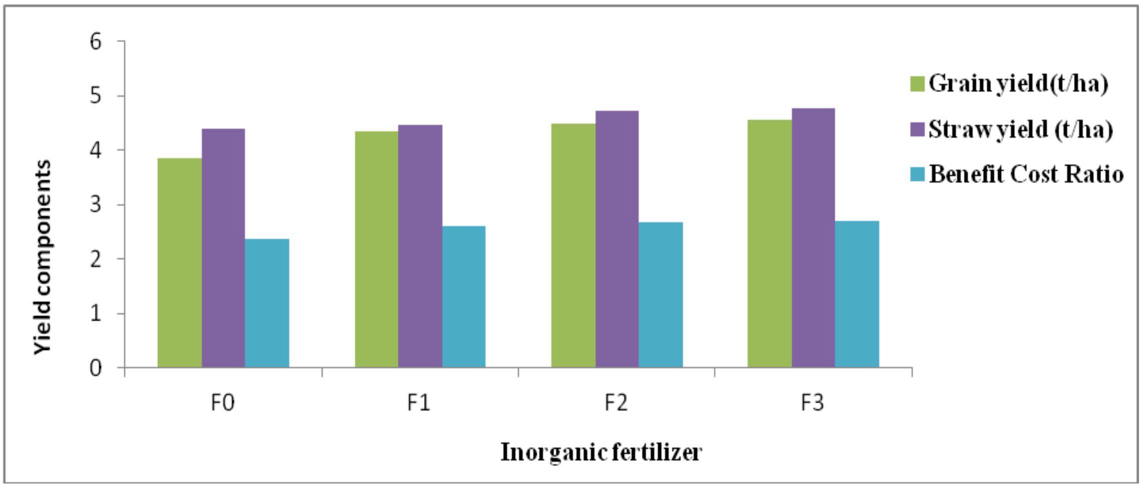
The effect of poultry manure and inorganic fertilizers on benefit cost ratio differed significantly shown in (Figure 1 and 2 and appendics XVIII). The highest benefit cost ratio was recorded in 100% poultry manure i.e. PM_3 (2.75) and 100% inorganic fertilizers i.e. F_3 (2.69). Similar data were reported by

Alam *et al*. (2005), who observed that higher profit was obtained when inorganic fertilizer was combined with poultry manures.



Poultry manure (PM) → PM_0 = 0%, PM_1 = 50%, PM_2 =75% and PM_3 = 100% of the recommended dose

Figure 1. Effects of poultry manure on different yield components of BRRI dhan49



Inorganic Fertilizer (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Figure 2. Effects inorganic fertilizer on different yield components of BRRI dhan49**.**

4.6.6 Interaction effect of poultry manure and inorganic fertilizer on grain yield, straw yield and Benefit cost ratio of BRRI dhan49

4.6.6.1 Grain and straw yield

The interaction effects of poultry manure and inorganic fertilizers, the maximum grain and straw yields were observed in 100% poultry manure and 50% inorganic fertilizers combination i.e. PM_3F_1 (4.83 t ha^{-1}), in 100% poultry manure and 75% inorganic fertilizers combination i.e. PM_3F_2 (5.13 t ha^{-1}) which were statistically similar with several treatment (Table 05). The minimum grain and straw yields (4 and 3.60 t ha^{-1}) were found in 0% poultry manure and 0% inorganic fertilizers combination (PM_0F_0), which are statistically similar with PM_0F_1 treatment, respectively.

4.6.6.2 Benefit cost ratio

The interaction effects (Table 5) of poultry manure and inorganic fertilizers on benefit cost ratio differed significantly. It was observed that the maximum benefit cost ratio (2.81) was found in 100% poultry manure and 100% inorganic fertilizer (PM_3F_3) which was statistically similar with PM_3F_2 and the lowest result (2.12) was found in PM_0F_0 treatment having no use of fertilizer and manure.

Table 5. Interaction effects of poultry manure and inorganic fertilizers on different yield and yield components of BRRI dhan49

Interaction		Grain yield (tha^{-1})	Straw yield (tha^{-1})	Benefit cost ratio
Poultry manure	**Fertilizer**			
PM_0	Fo	3.60 h	4.00 e	2.12 d
	F_1	4.31 e	4.07 de	2.55 c
	F_2	4.32 e	4.48 bcd	2.55 c
	F_3	4.56 bc	4.74 abc	2.70 abc
PM1	Fo	3.35 i	3.84 e	2.09 d
	F_1	4.41 de	4.80 abc	2.61 bc
	F_2	4.37 de	4.03 de	2.59 c
	F_3	4.37 de	5.06 ab	2.59 c
PM_2	Fo	4.37 de	4.98 ab	2.60 bc
	F_1	4.42 d	4.94 ab	2.59 c
	F_2	4.62 b	5.01 ab	2.73 abc
	F_3	4.52 c	4.95 ab	2.68 abc
PM_3	Fo	4.10 g	4.77 abc	2.72 abc
	F_1	4.20 f	5.13 a	2.71 abc
	F_2	4.61 bc	4.29 cde	2.79 ab
	F_3	4.83 a	4.33 cde	2.81 a
LSD		0.091	0.508	0.16
CV %		1.17	6.63	4.21

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Poultry manure (PM) → PM_0 =0, PM_2 = 50%, PM_2 = 75% and PM_3 =100% of the recommended dose.

CV=Co-efficient of Variance. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

4.6.7 Effect of poultry manure and inorganic fertilizers on Nitrogen, Phosphorus and Potassium content in grain of BRRI dhan49

4.6.7.1 N content in grain

The effect of different levels of poultry manure and inorganic fertilizers separately or combined on N content significantly differed (Figure 3 and 4 and appendics XIX). The highest N content (1.25%) was noted in PM_3 treatment 100% poultry manure. The lowest N content (0.80%) was produced by 0 % poultry manure (PM_0) treatment. In case of inorganic fertilizers, the highest proportion of N found in (1.22%) and lowest (1.06%) N content were noted in 0% inorganic fertilizers $F_{1.}$

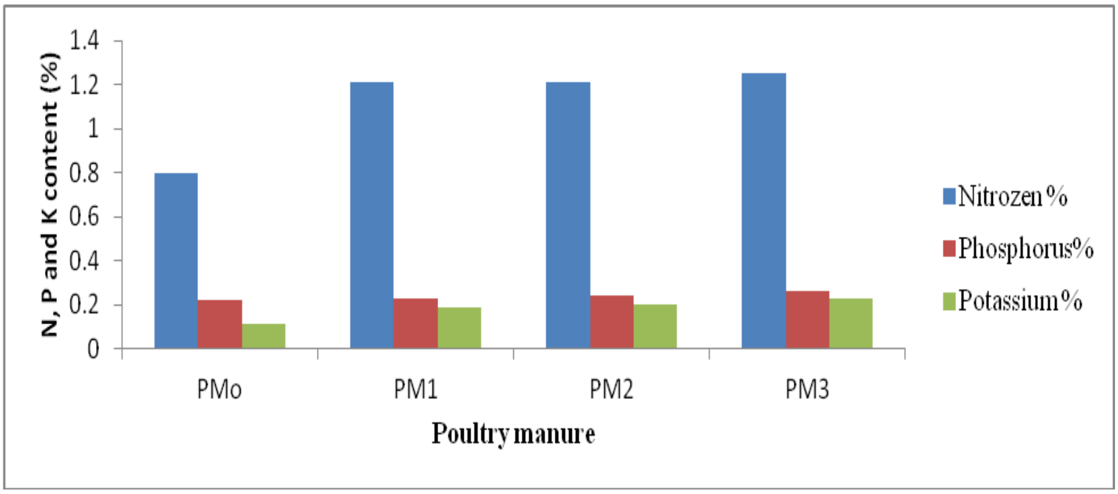
4.6.7.2 Phosphorus and Potassium content

The P and K content significantly differed due to the effects of poultry manure and combined with inorganic fertilizers (Figure 2, 3 and appendices XIX). The maximum P and K content was observed in the treatment 100% poultry manure PM_3 (0.262 and 0.225%) respectively and the lowest content (0.219 and 0.110) of P and K content was found in 0% poultry manure (PM_0). The effects of fertilizer shows no significant performance in P and K content in grain. Subbian *et al*. (1989) revealed that total P level increase in both grain and straw with increasing level of P.

4.6.8 Interaction effect of poultry manure and inorganic fertilizers on Nitrogen, Phosphorus and Potassium content in grain of BRRI dhan49

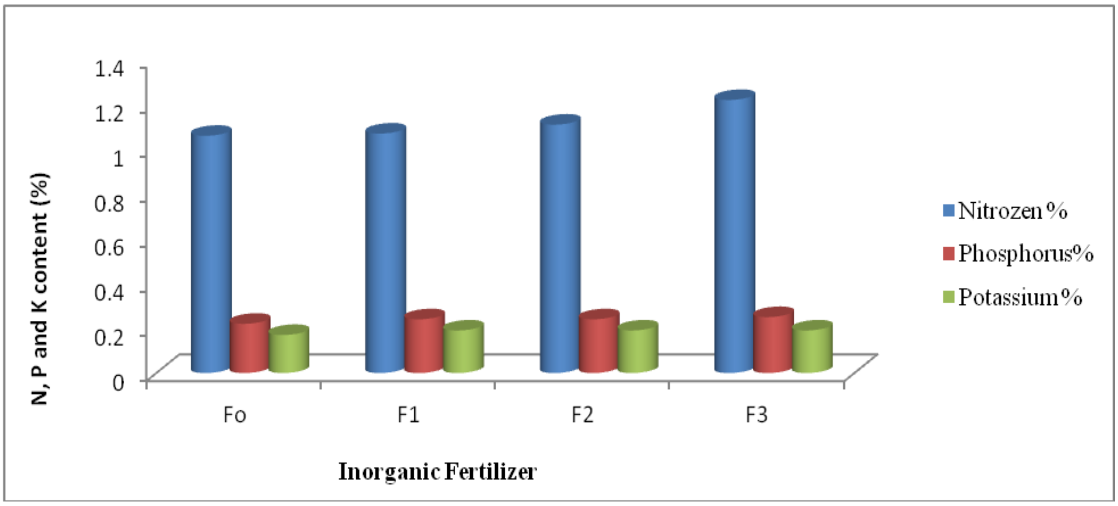
4.6.8.1 N content in grain

In case of interaction effects of different levels of poultry manure and inorganic fertilizers on N content of BRRI dhan49, the highest N content was found in 100% inorganic fertilizers and 100 % poultry manure i.e. PM_3F_3 (1.28%) which is statistically similar with most of the treatments (Table 6). The lowest result (0.68%) noted in PM_0F_0 treatment which is also statistically similar with several of the treatments



Poultry manure (PM) → PM_0 = 0%, PM_1 = 50%, PM_2 =75% and PM_3 = 100% of the recommended dose

Figure 3. Effects of poultry manure with NPK content in grain in BRRI dhan49.



Inorganic Fertilizer (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Figure 4. Effects of inorganic fertilizer with NPK content in grain in BRRI dhan49.

Table 6. Interaction effects of poultry manure and inorganic fertilizer of NPK content in grain of BRRI dhan49

Interaction		**% N**	**% P**	**% K**
Poultry manure	**Fertilizer**			
PM_0	Fo	0.68 b	0.200 c	0.066 f
	F_1	0.71 b	0.220 bc	0.116 ef
	F_2	0.71 b	0.220 bc	0.133cde
	F_3	1.12 a	0.236 bc	0.126 de
PM_1	Fo	1.18 a	0.230 bc	0.198 ab
	F_1	1.20 a	0.223 bc	0.206 ab
	F_2	1.22 a	0.220 bc	0.186 abc
	F_3	1.24 a	0.240 bc	0.176 bcd
PM_2	Fo	1.18 a	0.243 abc	0.193 ab
	F_1	1.14 a	0.253 abc	0.217 ab
	F_2	1.26a	0.236 bc	0.206 ab
	F_3	1.26 a	0.216 bc	0.196 ab
PM_3	Fo	1.22 a	0.220 bc	0.220 ab
	F_1	1.24 a	0.256 abc	0.216 ab
	F_2	1.26 a	0.273 ab	0.226 ab
	F_3	1.28 a	0.300 a	0.240 a
LSD		0.16	0.052	0.052
CV %		9.12	9	9.75

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Poultry manure (PM) → PM_0 =0, PM_2 = 50%, PM_2 = 75% and PM_3 =100% of the recommended dose.

CV=Co-efficient of Variance. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

4.6.8.2 Phosphorus and Potassium content

All the treatments of inorganic fertilizers with the association of poultry manure performed better on P and K content content over control treatment (PM_0F_0), where the highest (0.300 and 0.240%) and the lowest (0.200 and 0.066%) content found in PM_3F_3 and PM_0F_0 treatments respectively which were statistically identical with most of the treatments (Table 6).

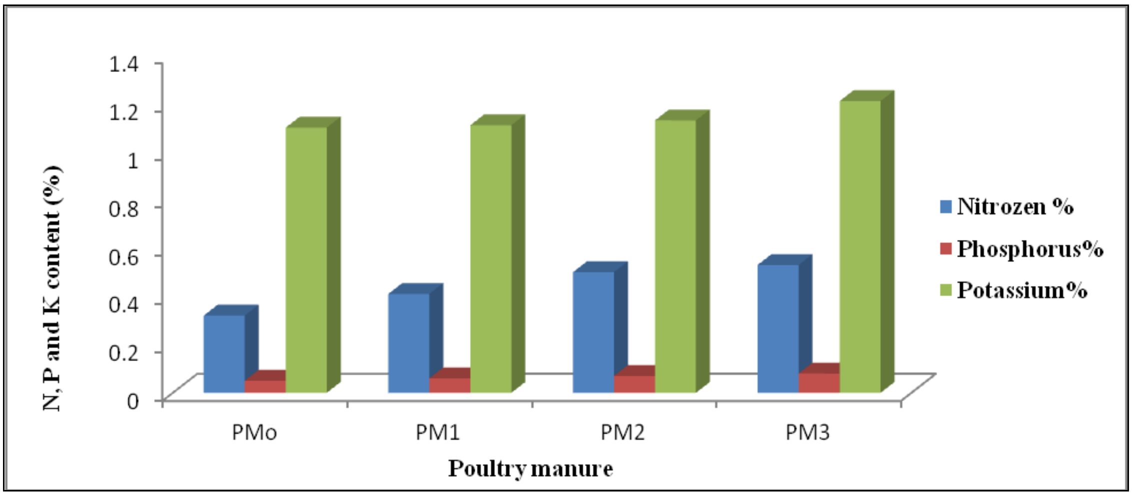
4.6.9 Effect of poultry manure and inorganic fertilizers on Nitrogen, Phosphorus and Potassium content in straw of BRRI dhan49

4.6.9.1 % N and K content in straw

The N and K content in straw significantly differed due to the effects of poultry manure and combined with inorganic fertilizers application (Figure 5, 6 and appendics XX). The maximum amount of N and K content in straw (0.531 and 1.213%) was observed in the treatment 100% poultry manure (PM_3) and the minimum amount is (0.323 and 1.09%) was found in 0% poultry manure (PM_0).

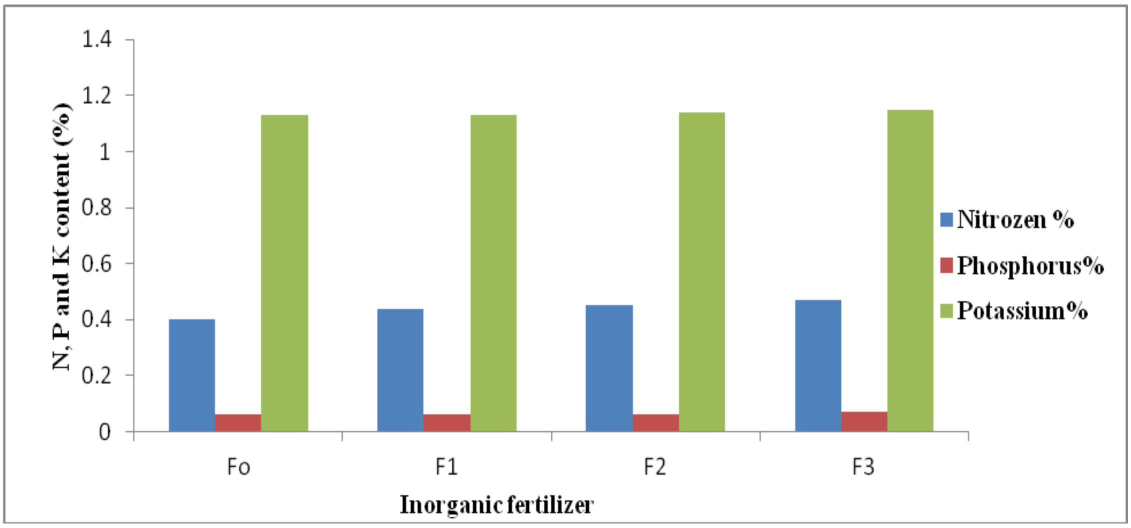
4.6.9.2 % P content in straw

There is no significant relationship exists on using poultry manure and inorganic fertilizer. Even using both of poultry manure and inorganic fertilizer i.e. interaction effects there is no significant relation exists on (Figure 5, 6 and appendics XX)



Poultry manure (PM) → PM_0 = 0%, PM_1 = 50%, PM_2 =75% and PM_3 = 100% of the recommended dose

Figure 5. Effects of poultry manure with NPK content in straw in BRRI dhan49.



Inorganic Fertilizer (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Figure 6. Effects of inorganic fertilizer with NPK content in straw in BRRI dhan49.

Table 7: Interaction Effects of different levels of poultry manure and inorganic fertilizer in straw in BRRI dhan49

Interaction		**% N**	**% P**	**% K**
Poultry manure	**Fertilizer**			
PM_0	Fo	0.26 h	0.05	1.08 e
	F_1	0.33 g	0.05	1.09 e
	F_2	0.33 g	0.05	1.10 de
	F_3	0.36 fg	0.05	1.10 de
PM_1	Fo	0.36 fg	0.05	1.11 de
	F_1	0.41 ef	0.05	1.12 de
	F_2	0.43 de	0.06	1.08 e
	F_3	0.45 cde	0.06	1.10 de
PM_2	Fo	0.48 bcd	0.06	1.12 de
	F_1	0.48 bcd	0.06	1.11 de
	F_2	0.51 ab	0.06	1.14 cde
	F_3	0.50 abc	0.07	1.16 bcd
PM_3	Fo	0.50 abc	0.07	1.18 abc
	F_1	0.53 ab	0.07	1.20 ab
	F_2	0.52 ab	0.07	1.27 a
	F_3	0.56 a	0.080	1.24 a
LSD		0.052	0.052 (NS)	0.052
CV %		4.39	3.27	3

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Poultry manure (PM) → PM_0 =0, PM_2 = 50%, PM_2 = 75% and PM_3 =100% of the recommended dose.

CV=Co-efficient of Variance NS=Non significant. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

4.6.10 Interaction effect of poultry manure and inorganic fertilizer on Nitrogen, Phosphorus and Potassium content in straw of BRRI dhan49

4.6.10.1 % N and % K content in straw

The interaction effect of different doses of poultry manure and fertilizer of BRRI dhan49 Significantly higher N and K content in straw (0.560 and 1.240%) were recorded in PM_3F_3 (100% Inorganic fertilizer +100% poultry manure t/ha) which was closely followed by PM_3F_2 (75 % Inorganic fertilizer + 100% cowdung t/ha) follower by several treatments. (Table7). All the treatments of inorganic fertilizer application with the association of poultry manure performed better on N and K content in straw over control treatment (PM_0F_0), the lowest (0.260 and 1.087%) amount found in PM_0F_0 treatments (Table 7).

4.6.10.2 % P content in straw

There is no significant relationship exists on using poultry manure and inorganic fertilizer. Even using both of poultry manure and inorganic fertilizer i.e. interaction effects there is no significant relation exists on (figure 5,6 and appendices XX)

4.6.11 Effects of poultry manure and inorganic fertilizers on post harvest soil properties of BRRI dhan49

4.6.11.1 Soil pH

The effect of different levels of poultry manure and fertilizers on soil pH of BRRI dhan49 was not differed significantly (Table 08). There is no significant relationship exists on using poultry manure and inorganic fertilizer. Even using both of poultry manure and inorganic fertilizer I.e interaction effects there is no significant relation exists on.

4.6.11.2 Organic matter content

The effect of different levels of poultry manure and inorganic fertilizers separately or combinedly on organic matter content of post harvest soil significantly differed (Table 8). The highest organic matter content was obtained in 100% poultry manure i.e. PM_3 (3.649%) treatment. The lowest organic matter content of post harvest soil was found by 0% poultry manure i.e. PM_0 (3.331%) respectively. In case of inorganic fertilizer application, the highest organic matter content of post harvest soil was found in 100% inorganic fertilizers treatment F_3(3.537%), which is statistically identical with F_2 treatment and the lowest organic matter content of post harvest soil was noted in F_0 (3.459%). Presence of organic matter is advantageous for good soil structure, strong activities of microorganism, and available nutrients and soil absorption ability investigated by (Tran *et al.*, 2006).

4.6.11.3 Total nitrogen

Application of poultry manure in combination with inorganic fertilizer application showed more pronounced effect in increasing N content in post harvest soil in rice. Significant relationships were found on N content of post harvest soil by the application of poultry manure and inorganic fertilizer (Table 8). The highest N content of post harvest soil, were found at 100% poultry manure i.e. PM_3 (0.101%) and nonsignificant data observed in inorganic fertilizer respectively. and their combined (PM_3F_3) application, respectively. The lowest amount of N content of post harvest soil, were obtained at 0% poultry manure PM_0 (0.04%) no significant data observed in inorganic fertilizer respectively (Table 08). Wopereis *et al.* (2002); stated that rice yields increased significantly as a result of N application on two N dressing (applied of the onset of tillering and at panicle initiation with a total of approximately 120 kg N ha-1 in farmer's field.

4.6.11.4 Available phosphorus

Significant influences were observed on available P content of post harvest soil due to the application of poultry manure and inorganic fertilizer separately and combined (Table 09). The highest amounts of available P content in post harvest soil (21.09 and 16.99 ppm) were found at 100% poultry manure (PM_3) and 75% inorganic fertilizers (F_2) treatments, respectively and the lowest values of P content in post harvest soil (12.66 and 14.64 ppm) were obtained at 0% poultry manure (PM_0) and 0% inorganic fertilizers (F_0) treatments, respectively. 75% recommended dose of N fertilizer + 25% N as poultry manure increased growth, yield attributes and yield, and nutrient uptake of rice higher soil available organic carbon, nitrogen and phosphorus applied by (Vennila *et al*., 2007).

4.6.11.5 Exchangeable potassium

The effect of different levels of poultry manure and inorganic fertilizers on exchangeable K content of post harvest soil differed significantly (Table 08). The highest amount exchangeable K (0.27 meq/100g soil) was observed in 100% poultry manure (PM_3) treatment and the lowest exchangeable K content (0.153 meq/100g soil) of post harvest soil was found in 0% poultry manure (PM_0) treatment. In case of chemical fertilizers, the highest exchangeable K content of post harvest soil (0.216 meq/100g soil) was found in 100% inorganic fertilizers

Table 8. Effects of different levels of poultry manure and inorganic fertilizer on post harvest soil properties of BRRI dhan49

Poultry manure	Soil pH	% Organic matter	% N	P (ppm)	K(meq/100 g soil)
PM_0	5.086	3.331 d	0.047 b	12.66 d	0.153 c
PM_1	5.262	3.463 c	0.076 a	13.94 c	0.165 c
PM_2	5.256	3.560 b	0.086 a	16.86 b	0.205 b
PM_3	5.302	3.649 a	0.101 a	21.09 a	0.270 a
$LSD_{0.05}$	0.299 (NS)	0.026	0.026	0.88	0.026
CV%	6.88	0.98	3.23	6.55	9.75
Fertilizer					
F_0	5.108	3.459 c	0.067	14.64 c	0.176 b
F_1	5.195	3.489 b	0.074	16.01 b	0.195 ab
F_2	5.262	3.517 a	0.08	16.99 a	0.20 a
F_3	5.342	3.537 a	0.087	16.93 a	0.21 a
$LSD_{0.05}$	0.299 (NS)	0.026	0.026(NS)	0.840	0.026
CV%	6.88	0.65	2.65	6.55	18.09

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Poultry manure (PM) → PM_0 =0, PM_2 = 50%, PM_2 = 75% and PM_3 =100% of the recommended dose.

CV=Co-efficient of Variance NS=Non significant. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

treatment (F_3), which is statistically identical with F_2 treatment and the lowest exchangeable K (0.176 meq/100g soil) of post harvest soil was noted in F_0 treatment . Both soil puddling and K fertilizer application at 80 kg /ha significantly increased grain and straw yields of rice revealed by (Choudhury *et al.*, 1997 and Kundu *et al.*, 2007).

4.6.12 Interaction effect of cowdung and inorganic fertilizers on post harvest soil properties of BRRI dhan49

4.6.12.1 Soil pH

There is no significant relationship exists on using poultry manure and inorganic fertilizers. Even using both of poultry manure and inorganic fertilizer I.e interaction effects there is no significant relation exists on(Table 9).

4.6.12.2 Organic matter

In case of interaction effects of different levels of poultry manure and inorganic fertilizers on organic matter content of post harvest soil, the maximum organic matter content was found in PM_3F_3 (3.690%) which is statistically similar with PM_3F_2 treatment (Table 9). The lowest organic matter was noted in PM_0F_0 (3.247%) treatment, which is statistically similar with PM_0F_1.

4.6.12.3 Total nitrogen

In case of interaction effects of different doses of poultry manure and inorganic fertilizers, the maximum total N shows their combined results maximum in (0.113%) (PM_3F_3) respectively. The lowest amount of N content of post harvest soil (0.03%) were obtained at 0% poultry manure (PM_0) and 0% inorganic fertilizer (PM_0) combined (PM_0F_0) application, respectively (Table 9).

4.6.12.4 Available phosphorus

In case of interaction effects of different doses of poultry manure and inorganic fertilizer, the maximum available P was found in PM_3F_3 (23.26 ppm), which is statistically similar with PM_3F_2 treatment and the minimum available P found in PM_0F_0 (10.24 ppm) treatment (Table 09).

4.6.12.5 Exchangeable potassium

The interaction effects of poultry manure and chemical fertilizers on exchangeable K content of post harvest soil varied significantly (Table 09). The maximum exchangeable K (0.300) was observed in PM_3F_3 treatment, which is statistically identical with PM_3F_2 treatment (Table 9). The lowest amount exchangeable K (0.136%) was found in PM_0F_0 treatment.

Table 9. Interaction effects of poultry manure and fertilizer on post-harvest soil properties in BRRI dhan49

Interaction		**soil pH**	**% Organic matter**	**% N**	**P (ppm)**	**K(meq/100 g soil)**
Poultry manure	**Fertilizer**					
PM_0	Fo	4.743	3.247 k	0.030 b	10.24 h	0.136 g
	F_1	5.11	3.300 j	0.046 b	12.04 g	0.157 fg
	F_2	5.2	3.370 i	0.053 ab	14.18 ef	0.167 efg
	F_3	5.29	3.407 hi	0.061 ab	14.18 ef	0.153 fg
PM_1	Fo	5.183	3.460 gh	0.067 ab	13.20 fg	0.147 fg
	F_1	5.137	3.460 f-h	0.072 ab	14.18 ef	0.167 e-g
	F_2	5.25	3.460 f-h	0.077 ab	15.26 de	0.169 e-g
	F_3	5.48	3.473 fg	0.088 ab	13.13 fg	0.178 d-g
PM_2	Fo	5.427	3.517 ef	0.082 ab	16.58 d	0.193 d-g
	F_1	5.233	3.563 de	0.086 ab	17.15 cd	0.190 d-g
	F_2	5.26	3.580 cd	0.088 ab	16.58 cd	0.206 d-f
	F_3	5.303	3.580 cd	0.088 ab	17.15 cd	0.233 b-d
PM_3	Fo	5.277	3.613 b-d	0.089 ab	18.52 c	0.226 c-e
	F_1	5.3	3.633 bc	0.091 ab	20.67 b	0.266 a-c
	F_2	5.337	3.660 ab	0.111 a	21.92 ab	0.286 ab
	F_3	5.297	3.690 a	0.113 a	23.26 a	0.300 a
LSD		$0.59^{(NS)}$	0.052	0.052	0.052	1.76
CV %		6.88	0.65	2.65	6.55	18.09

Inorganic Fertilizers (F) → F_0 = 0%, F_1 = 50%, F_2 = 75% and F_3 = 100% of the recommended dose

Poultry manure (PM) → PM_0 =0, PM_2 = 50%, PM_2 = 75% and PM_3 =100% of the recommended dose.

CV=Co-efficient of Variance. In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

CHAPTER V

SUMMARY AND CONCLUSION

The three research works in each Boro and Aman season entitled 1.a) Effects of compost (household wastes) and different inorganic fertilizers on growth, yield and nutrient content in Boro rice (BRRI dhan29) b) Effects of cowdung and different inorganic fertilizers on growth, yield and nutrient content in Boro rice (BRRI dhan29) and c) Effects of poultry manure and different inorganic fertilizer on growth, yield and nutrient content in Boro rice (BRRI dhan29) and under the experiment **"Effects of different inorganic fertilizers and organic manures on growth, yield and nutrient content of Boro rice"** and another three research works 2. a) Effects of compost (household wastes) and different inorganic fertilizers on growth, yield and nutrient content in aman rice (BRRI dhan49) b) Effects of cowdung and different inorganic fertilizers on growth, yield and nutrient content in aman rice (BRRI dhan49) and c) Effects of poultry manure and different inorganic fertilizers on growth, yield and nutrient content in aman rice (BRRI dhan49) under the experiment **"Effects of different inorganic fertilizers and organic manures on growth, yield and nutrient content of Aman rice"** were conducted at the farmer fields of Shakhepur upazila under Tangail District and Shere Bangla Agricultural University (SAU) Farm, Dhaka, respectively during period from 2013 to 2015 to study the inorganic fertilizers use efficiency coupled with organic manures under rice-rice cropping pattern in Bangladesh. The research works consisted of 4 doses (0, 50, 75 and 100% of recommended dose) of each organic manure such as compost (C), cowdung (CD) and poultry manure (PM) 4 doses (0, 50, 75 and 100% of recommended dose) of inorganic fertilizers (Urea, TSP and MOP) which were laid out in a factorials randomized complete block design (RCBD) with three replications. At maturity, the crop was harvested. Grain and straw yields were recorded at 14% moisture basis. The grain and straw samples were analyzed for N, P and K contents. Then post harvest soil properties were calculated. Initial and post harvest soil samples were analyzed for physical and chemical properties. All the data were statistically analyzed and the mean differences were ad judged by Least Significant Difference Test (LSD) at 5%.The results of the experiment are summarized below:

The parameters including plant height, effective, non-effective tillers & total tillers hill^{-1}, panicle length, 1000-grain weight, grain & straw yield, benefit cost ratio, nutrient content in rice grain and straw, post harvest soil properties such as pH, organic matter, total N, available P and exchangeable K were studied. The different doses of inorganic fertilizer and each organic manure such as compost, cowdung and poultry manure had significant influenced on all growth and yield parameters of BRRI dhan29, nutrient content in rice grain and straw and also post harvest soil properties.

In case of Experiment 1 (a) The different doses of inorganic fertilizer and each organic manure (compost) had significant influenced on all growth and yield parameters of BRRI dhan29, nutrient content in rice grain and straw and also post harvest soil properties. Here the highest plant height (90.28 cm), effective tillers per hill (21.83), total tillers per hill (24.17), panicle length (27.97 cm), 1000-grain weight (27.11 g), filled grain/panicles (114.6) grain yield (5.82 tha^{-1}) straw yield (6.54 tha^{-1}) and benefit cost ratio (3.60) were recorded in 100% compost (C_3), respectively. In cases of inorganic fertilizer application, above the parameters are also higher in 100% inorganic fertilizer (F_3). The lowest growth and yield data of BRRI dhan29 were found in 0% compost (C_0) and also observed in 0% inorganic fertilizer application (F_0).

The interaction effects of different doses of organic manures (compost) and inorganic fertilizers on all growth and yield parameters of BRRI dhan29 differed significantly. The highest plant height (97.30 cm), effective tillers hill^{-1} (24.00), total tillers hill^{-1} (25.67), panicle length (28.67 cm), 1000-grain weight (28.20 g),filled grains/panicle (119) grain yield (6.52 tha^{-1}) and straw yield (7.16 tha^{-1}) and Benefit Cost ratio (3.82) were recorded in and 100% compost and 75% inorganic fertilizer (C_3F_2) combinations, respectively. The lowest values of all growth and yield data were observed in 0% compost and 0% inorganic fertilizers (C_0F_0) combinations. On the other hand, the non-effective tillers hill^{-1} were higher at 0% compost and 0% inorganic fertilizer combinations and lower in 100% compost and 100% inorganic fertilizer combinations. However the nutrient content in rice grain and straw using different doses of inorganic fertilizer and compost had significant influenced on BRRI dhan29. Here the maximum N content (1.29%), P content (0.21%) and K content (0.27%) in grain were recorded in 100% compost (C_3), respectively. The maximum N content (0.484%), P content (0.064%) and K content (1.28%) in straw were recorded in 100% compost (C_3), respectively. In cases of inorganic fertilizer application, above all of these parameters were also higher in 100% inorganic fertilizer (F_3). The lowest growth and yield data of BRRI dhan29 were found in 0% compost (C_0) and also observed in 0% inorganic fertilizer application (F_0).

The interaction effects of different doses of compost and inorganic fertilizers on nutrient content in rice grain and straw of BRRI dhan29 differed significantly. The highest N content in grain and straw (1.34 and 0.516%), P content (0.226 and 0.071%), and K content (0.313 and 1.40%) were recorded in 100% compost and 100 % inorganic fertilizer (C_3F_3) combinations, respectively. In case of post harvest soil properties the highest results of pH (5.53), organic matter (2.75%), total N (0.085%), available P (13.61 ppm) and exchangeable K (0.174 meq/100 g of soil) were observed in 100% compost (C_3), respectively. In inorganic fertilizer treatment, pH, organic matter, total N, available P and exchangeable K of post harvest soils were also higher in 100% inorganic fertilizers (F_3). The lowest values of above all post harvest parameter were found 0% compost (C_0) and 0% inorganic fertilizers (F_0) application separately or their combinations.

The interaction effects of different compost and inorganic fertilizers on post harvest soil properties varied significantly. The maximum values of pH, organic matter, total N, available P and exchangeable K were noted in 100%

compost and 100% chemical fertilizers (C_3F_3) combinations and the minimum results were 0% compost and 0% inorganic fertilizers (C_0F_0) treatments.

In case of Experiment 1(b) The effects of different doses of cowdung and inorganic fertilizers on all growth and yield parameters of BRRI dhan29 differed significantly. The highest plant height (89.37 cm), effective tillers per hill (15.52,), total tillers per hill (16.90), panicle length (21.93), 1000-grain weight (26.00), filled grain/panicles (102.9) grain yield (6.402 t/ha) straw yield (6.572 t/ha) and benefit cost ratio (3.57) were recorded in 100% cowdung (CD_3). In cases of inorganic fertilizer application, above all these parameters were also higher in 100% inorganic fertilizer (F_3). The lowest growth and yield data of BRRI dhan29 were found in 0% cowdung (CD_0), also observed in 0% inorganic fertilizer application (F_0).

The interaction effects of different doses of organic manures (cowdung) and inorganic fertilizers on all growth and yield parameters of BRRI dhan29 also differed significantly. The highest plant height (96.13 cm), effective tillers $hill^{-1}$ (17.67), total tillers $hill^{-1}$ (18.93), panicle length (22.60), 1000-grain weight (26.62),filled grain/panicles (107.7) grain yield (6.772 tha^{-1}), straw yield (6.84 tha^{-1}) and BCR (3.81) were recorded in 100% cowdung and 100% inorganic fertilizers (CD_3F_3). The lowest values of all growth and yield data were observed in 0% cowdung and 0% inorganic fertilizer (CD_0F_0). On the other hand, the non-effective tillers $hill^{-1}$ were higher at 0% cowdung and 0% inorganic fertilizer combinations and lower in 100% cowdung and 100% inorganic fertilizer combinations.

However the nutrient content in rice grain and straw using different doses of inorganic fertilizer and cowdung had significant influenced on BRRI dhan29. Here the maximum N content (1.08 %), P content (0.192 %) and K content (0.271 %) in grain were recorded in 100% cowdung (CD_3). The maximum N content (0.50 %), P content (0.071 %) and K content (1.112%) in straw were recorded in 100% cowdung (CD_3). In cases of inorganic fertilizer application, above all of these parameters were also higher in 100% inorganic fertilizer (F_3).

The lowest growth and yield data of BRRI dhan29 were found in 0% cowdung (CD_0) in 0% inorganic fertilizer application (F_0).

The interaction effects of different doses of cowdung and inorganic fertilizers on nutrient content in rice grain and straw of BRRI dhan29 differed significantly. The highest N content in grain and straw (1.14 and 0.530%), P content (0.206 and 0.068%), and K content in grain (0.303 and 1.137%) were recorded in 100% cowdung and 100% inorganic fertilizers (CD_3F_3) combinations. The lowest values of all growth and yield data were observed in 0% cowdung and 0% inorganic fertilizer (CD_0F_0). On the other hand the effects of P and K content in straw both individual use of cowdung and inorganic fertilizer application and also combined application shows no significant values.

In case of post harvest soil properties such as pH, organic matter, total N, available P and exchangeable K were significantly influenced by the application of organic manures (cowdung) and inorganic fertilizer application. The highest results of pH (5.29), organic matter (2.888 %), total N (0.165%), available P (14.94 ppm) and exchangeable K (0.21%) were observed in 100% cowdung (CD_3). In inorganic fertilizer treatment, pH, organic matter, total N, available P and exchangeable K of post harvest soils were also higher in 100% inorganic fertilizers (F_3). The lowest values of pH, organic matter, total N, available P and exchangeable K were recorded in 0% cowdung (CD_0) and 0% inorganic fertilizers (F_0) application separately or their combinations.

The interaction effects of different doses of organic manures (cowdung) and inorganic fertilizers shows the maximum values organic matter, total N, available P and exchangeable K were noted in 100% cowdung and 100% inorganic fertilizer (CD_3F_3) combination and the minimum results were found in 0% cowdung and 0% inorganic fertilizers (CD_0F_0). On the other hand the effects of soil pH in both individual use of cowdung and inorganic fertilizer application and also combined application shows no significant values.

In case of Experiment 1(c) The different doses of inorganic fertilizer and poultry manure had significant influenced on all growth and yield parameters of BRRI dhan29, nutrient content in rice grain and straw and also post harvest soil properties. Here the highest plant height (92.49 cm), effective tillers per hill (17.67), total tillers per hill (19.95), panicle length (29.45 cm), 1000-grain weight (25.59 g), filled grain/panicles (114.9) grain yield (6.144 tha^{-1}) straw yield (7.081 tha^{-1}) and benefit cost ratio (3.69) were recorded in 100% poultry manure (PM_3). In cases of inorganic fertilizer application, above all these parameters were also higher in 100% inorganic fertilizer (F_3). The lowest growth and yield data of BRRI dhan29 were found in 0% poultry manure (PM_0) also observed in 0% inorganic fertilizer application (F_0).

The interaction effects of different doses of poultry manure and inorganic fertilizers the highest plant height (97.10 cm), effective tillers $hill^{-1}$ (20.80), total tillers $hill^{-1}$ (22.37), panicle length (31.27 cm), 1000-grain weight (26.67 g),filled grain/panicles (117.3) grain yield (6.838 t/ha^{-1}) and straw yield (7.63 t/ha^{-1}) were recorded in 100% poultry manure and 100% inorganic fertilizers (PM_3F_3) and 100% compost and 75% inorganic fertilizer (C_3F_2) combinations respectively. The lowest values of all growth and yield data were observed in 0% poultry manure and 0% inorganic fertilizer (PM_0F_0). On the other hand, the non-effective tillers $hill^{-1}$ were higher at 0% poultry manure and 0% inorganic fertilizer combinations and lower in 100% organic manures (poultry manure) and 100% inorganic fertilizer combinations. The maximum N content (1.142 %), P content (0.229 %) and K content (0.291 %) in grain were recorded in 100% poultry manure (PM_3) respectively. The maximum N content in straw (0.485 %), P content (0.05%) and K content (0.842 %) were recorded in 100% poultry manure (PM_3) respectively. In cases of inorganic fertilizer application, above the parameters were also higher in 100% inorganic fertilizer (F_3). The lowest growth and yield data of BRRI dhan29 were found in 0% poultry manure (PM_0) also observed in 0% inorganic fertilizer application (F_0).

The interaction effects of different doses of poultry manure and inorganic fertilizers on nutrient content in rice grain and straw of BRRI dhan29 differed significantly. The highest N content (1.157 and 0.506%), P content (0.244 and NS), and K content (0.32 and 0.866%) were recorded in 100% poultry manure and 75% inorganic fertilizers (PM_3F_2)combinations, respectively. The lowest values of all growth and yield data were observed in 0% cowdung 0% poultry manure and 0% inorganic fertilizer (PM_0F_0) combinations. In case of post harvest soil properties were significantly influenced by the application of organic manures (poultry manure) and inorganic fertilizer application. The highest results of organic matter (2.675 %), total N (0.153%), available P (16.32 ppm) and exchangeable K (0.241 meq/100 g soil) were observed in 100% poultry manure (PM_3) respectively. In inorganic fertilizer treatment, pH, organic matter, total N, available P and exchangeable K of post harvest soils were also higher in 100% inorganic fertilizers (F_3). The lowest values of pH, organic matter, total N, available P and exchangeable K were recorded in, 0% poultry manure (PM_0), and 0% inorganic fertilizers (F_0) application separately or their combinations.

The interaction effects on organic matter, total N, available P and exchangeable K of post harvest soils varied significantly. The maximum values of pH, organic matter, total N, available P and exchangeable K were noted in 100% poultry manure and 100% inorganic fertilizer (PM_3F_3); combinations and the minimum results were found in 0% poultry manure and 0% inorganic fertilizers (PM_0F_0) treatments combination. On the other hand the effects of soil pH in both individual use of cowdung and inorganic fertilizer application and also combined application shows no significant values.

From the above results it can be concluded that the integrated use of organic manures (compost, cowdung and poultry manure) with inorganic fertilizers performed better on all growth and yield parameters of BRRI dhan29 than inorganic fertilizers alone. From the post harvest soil analysis results, it appeared that continuous application of organic manures could enhance the soil properties and contribute to higher sustainable crop production and soil fertility status.

In case of experiment 2(a) the different doses of inorganic fertilizer and compost had significant influenced on all growth and yield parameters of BRRI dhan49, nutrient content in rice grain and straw and also post harvest soil properties. Here the highest plant height (NS), effective tillers per hill (12.35), total tillers per hill (14.33), panicle length (22.75 cm), 1000-grain weight (22.9 g), filled grain/panicle (112.5) grain yield (4.33 tha^{-1}) straw yield (5.03 tha^{-1}) and benefit cost ratio (2.48) were recorded in 100% compost (C_3) respectively in some exceptional cases some treatment found highest in 75% compost (C_2), respectively. In cases of inorganic fertilizer application, above all these parameters were also higher in 100% inorganic fertilizer (F_3). The lowest growth and yield data of BRRI dhan49 were found in 0% compost (C_0) and also observed in 0% inorganic fertilizer application (F_0).

The interaction effects of different doses of compost and inorganic fertilizers on all growth and yield parameters of BRRI dhan49 differed significantly. The highest plant height (94.67 cm), effective tillers $hill^{-1}$ (14.00), total tillers $hill^{-1}$ (15.33), panicle length (ns), 1000-grain weight (22.90 g), filled grain/panicles (112) grain yield (4.467 tha^{-1}) and straw yield (5.53 tha^{-1}) were recorded in 100% compost and 75% inorganic fertilizer (C_3F_2) combinations, respectively. The lowest values of all growth and yield data were observed in 0% compost and 0% inorganic fertilizers (C_0F_0) combinations. On the other hand, the non-effective tillers $hill^{-1}$ were higher at 0% compost and 0% inorganic fertilizer combinations and lower in 100% compost and 100% inorganic fertilizer combinations. On the other hand the effects of panicle length in both individual use of compost (household wastes) and inorganic fertilizer application and also combined application shows no significant values. However the nutrient content in rice grain and straw using different doses of inorganic fertilizer and compost had significant influenced on BRRI dhan49. Here the maximum N content in grain of BRRI dhan49 (1.277%), P content (0.212%) and K content (0.17%) in grain were recorded in 100% compost (C_3), respectively. The maximum N content in straw (0.384%), P content (non significant) and K content (0.768%) in straw were recorded in 100% compost (C_3), respectively. But the effects of P content in compost application shows no significant results. In cases of inorganic fertilizer application, above all of these parameters were also higher in 100% inorganic fertilizer (F_3). The lowest growth and yield data of BRRI dhan49 were found in 0% compost (C_0) and also observed in 0% inorganic fertilizer application (F_0).

The interaction effects of different doses of compost and inorganic fertilizers on nutrient content in rice grain and straw of BRRI dhan49 differed significantly. The highest N content in grain (1.30%), P content in grain (0.21), and K content in grain (0.18) were recorded in 100% compost and 100 % inorganic fertilizer (C_3F_3) combination respectively and N, P and K content in straw (0.426, NS and 0.786%). The lowest values of all growth and yield data were observed in 0% compost and 0% inorganic fertilizers (C_0F_0) combinations. In case of post harvest soil properties were significantly influenced by the application of compost and inorganic fertilizer application. The highest results of pH (5.975), organic matter (3.518%), total N (0.09%), available P (17.3 ppm) and exchangeable K (non significant) were observed in 100% compost (C_3), respectively. In inorganic fertilizer treatment, pH, organic matter, total N, available P and exchangeable K of post harvest soils were also higher in 100% inorganic fertilizers (F_3). The lowest values of pH, organic matter, total N, available P and exchangeable K were recorded in 0% compost (C_0) and 0% inorganic fertilizers (F_0) application separately or their combinations.

The interaction effects of different doses of compost and inorganic fertilizers on pH, organic matter, total N and available P of post harvest soils varied significantly. The maximum values of pH, organic matter, total N, available P and exchangeable K were noted in 100% compost and 100% inorganic fertilizer (C_3F_3) combinations and the minimum results were found in 0% compost and 0% inorganic fertilizers (C_0F_0) treatments. But the effects of using cowdung and inorganic fertilizers of exchangeable K was non significant.

In case of Experiment 2(b) The different doses of inorganic fertilizer and cowdung had significant influenced on all growth and yield parameters of BRRI dhan49, nutrient content in rice grain and straw and also post harvest soil properties. Here the highest plant height (89.92,cm), effective tillers per hill (10.58), total tillers per hill (12.75), panicle length (22.33cm), 1000-grain weight (24.72 g), filled grain/panicles (121.3) grain yield (4.34 t ha^{-1}) straw yield (5.02 t ha^{-1}) and benefit cost ratio (2.88) were recorded in 100% cowdung (CD_3) respectively in some exceptional cases some treatment found highest in 75% cowdung (CD_2). In cases of inorganic fertilizer application, above all these parameters were also higher in 100% inorganic fertilizer (F_3). The lowest growth and yield data of BRRI dhan49 were found in 0% cowdung (CD_0) and also observed in 0% inorganic fertilizer application (F_0).

The interaction effects of different doses of compost and inorganic fertilizers on all growth and yield parameters of BRRI dhan49 differed significantly. The highest plant height (96.13 cm,), effective tillers $hill^{-1}$ (17.67), total tillers $hill^{-1}$ (18.93), panicle length (22.60 cm), 1000-grain weight (26.62 g), filled grain/panicles (107.7) grain yield (6.77 tha^{-1}) and straw yield (6.84 tha^{-1}) were recorded in 100% cowdung and 100% inorganic fertilizers (CD_3F_3) combinations, respectively. The lowest values of all growth and yield data were observed in 0% cowdung and 0% inorganic fertilizer (CD_0F_0) combinations. On the other hand, the non-effective tillers $hill^{-1}$ were higher at 0% organic manure (cowdung) and 0% inorganic fertilizer combinations and lower in 100% cowdung and 100% inorganic fertilizer combinations. The maximum N content in grain of BRRI dhan49 (1.24%), P content (0.26 %) and K content (0.20%) in grain were recorded in 100% cowdung (CD_3) respectively. The maximum N content in straw (0.47 %), P content (non significant) and K content (1.17 %) in straw were recorded in 100% cowdung (CD_3) respectively. But the effects of P content in cowdung application shows no significant results. In cases of inorganic fertilizer application, above all of these parameters were also higher in 100% inorganic fertilizer (F_3).

The interaction effects of different doses of organic manures (cowdung, poultry manure & compost) and inorganic fertilizers on nutrient content in rice grain and straw of BRRI dhan49 differed significantly. The highest N content in grain (1.34 %), P content in grain (0.25), and K content in grain (0.22) were recorded in 100% cowdung and 100% inorganic fertilizers (CD_3F_3) combinations, respectively. The lowest values of all growth and yield data were observed in 0% cowdung and 0% inorganic fertilizer (CD_0F_0). On the other hand the effects of P and K content in straw both individual use of cowdung and inorganic fertilizer application and also combined application shows no significant values.

The post harvest soil properties were also significantly influenced by the application of organic cowdung and inorganic fertilizer application. The highest results of pH (5.2), organic matter (3.57%), total N (0.14%), available P (19.85 ppm) and exchangeable K (0.24) were observed in 100% cowdung (CD_3) respectively. In inorganic fertilizer treatment post harvest properties of soils were also higher in 100% inorganic fertilizers (F_3) and lowest 0% cowdung (CD_0).The interaction effects of different doses of cowdung and inorganic fertilizers on pH, organic matter, total N, available P and exchangeable K of post harvest soils varied significantly. The maximum values of pH, organic matter, total N, available P and exchangeable K were noted in 100% cowdung and 100% inorganic fertilizer (CD_3F_3) combinations and the minimum results were found in 0% cowdung and 0% inorganic fertilizers (CD_0F_0) treatment combination.

In case of Experiment 2 (c) the different doses of inorganic fertilizer and poultry manure had significant influenced on all growth and yield parameters of BRRI dhan49, nutrient content in rice grain and straw and also post harvest soil properties. Here the highest plant height (90.70 cm), effective tillers per hill (14.75), total tillers per hill (17.42), panicle length (23.71 cm), 1000-grain weight (22.82 and g), filled grain/panicles (116.2) grain yield (4.485 tha^{-1}) straw yield (4.94 tha^{-1}) and benefit cost ratio (275) were recorded in 100% poultry manure (PM_3) respectively in some exceptional cases some treatment found highest in 75% poultry manure (PM_2) respectively. In cases of inorganic fertilizer application, above all these parameters were also higher in 100% inorganic fertilizer (F_3). The lowest growth and yield data of BRRI dhan49 were found in 0% poultry manure (PM_0) and also observed in 0% inorganic fertilizer application (F_0).

The interaction effects of different doses of poultry manure and inorganic fertilizers on all growth and yield parameters of BRRI dhan49 differed significantly. The highest plant height (94.80 cm), effective tillers $hill^{-1}$ (16.33), total tillers $hill^{-1}$ (19), panicle length (25.17 cm), 1000-grain weight (24.13 g),filled grains/panicle (122.3) grain yield (4.83 t/ha) and straw yield (5.13 t/ha) were recorded in 100% poultry manure and 100% inorganic fertilizers (PM_3F_3) and combination, respectively. The lowest values of all growth and yield data were observed in 0% poultry manure and 0% inorganic fertilizer (PM_0F_0) combinations. On the other hand, the non-effective tillers $hill^{-1}$ were higher at 0% organic manure poultry manure and 0% inorganic fertilizer combinations and lower in 100% organic manures poultry manure and 100% inorganic fertilizer combinations. However the nutrient content in rice grain and straw using different doses of inorganic fertilizer and poultry manure and compost had significant influenced on BRRI dhan49. Here the maximum N content in grain of BRRI dhan49 (1.25 %), P content (0.23%) and K content (0.23 %) in grain were recorded in 100% poultry manure (PM_3) respectively. The maximum N content in straw (0.531 %), P content (non significant) and K content (1.21 %) in straw were recorded in 100% poultry manure (PM_3) respectively. But the effects of P content in poultry manure application shows no significant results. In cases of inorganic fertilizer application, above all of these parameters were also higher in 100% inorganic fertilizer (F_3). The lowest growth and yield data of BRRI dhan49 were found in 0% poultry manure (PM_0), and also observed in 0% inorganic fertilizer application (F_0).

The interaction effects of different doses of poultry manure and inorganic fertilizers on nutrient content in rice grain and straw of BRRI dhan49 differed significantly. The highest N content in grain (1.28 and 0.560%), P content (0.300 and NS), and K content (0.24 and 1.24) were recorded in 100% poultry manure and 75% inorganic fertilizers (PM_3F_3) combination, respectively. The lowest values of all growth and yield data were observed in 0% poultry manure and 0% inorganic fertilizer (PM_0F_0) combination. In case of post harvest soil properties were significantly influenced by the application of poultry manure and inorganic fertilizer application. But the individual and combined effects of P showed no significant relation. The highest results of organic matter (3.65 %), total N (0.10 %), available P (21.09 ppm) and exchangeable K (0.27%) were observed in 100% poultry manure (PM_3) respectively. In inorganic fertilizer treatment, post harvest soil properties were also higher in 100% inorganic fertilizers (F_3). The lowest values of pH, organic matter, total N, available P and exchangeable K were recorded in 0% poultry manure (PM_0), 0% inorganic fertilizers (F_0) application separately or their combinations.

The interaction effects of different doses of poultry manure and inorganic fertilizers on pH, organic matter, total N, available P and exchangeable K of post harvest soils varied significantly. The maximum values of pH, organic matter, total N, available P and exchangeable K were noted in 100% poultry manure and 100% inorganic fertilizer (PM_3F_3); and combination and the minimum results were found in 0% poultry manure and 0% inorganic fertilizers (PM_0F_0) and 0% compost treatment combination. But the effects of pH showed no significant relation.

From the above results it can be concluded that the integrated use of organic manures (compost, cowdung and poultry manure) with inorganic fertilizersperformed better on all growth and yield parameters of fertilizers in both boro (BRRI dhan29) and aman (BRRI dhan49) than inorganic fertilizer alone. From the post harvest soil analysis results in both season boro and aman, it appeared that continuous application of organic manures (compost, cowdung and poultry manure) could enhance the soil properties and contribute to higher sustainable crop production in rice and soil fertility status.

The treatments which received different doses of inorganic fertilizer and each organic manures such as cowdung, poultry manure and compost 100% cowdung and 100% inorganic fertilizer (CD_3F_3); 100% poultry manure and 100% inorganic fertilizer (PM_3F_3); and 100% compost and 100% inorganic fertilizer (C_3F_3) combinations produced higher yield than receiving only inorganic fertilizer. The best results were obtained from plots, which receive 100% poultry manure and 100% inorganic fertilizer (PM_3F_3) from combined use of poultry manure and inorganic fertilizer.

In association with same recommended poultry manure and inorganic fertilizer doses (PM_3F_3) treated plots gave highest grain yield than cowdung and compost treated plots and poultry manure took superior position. Poultry manure contained with uric acids that’s why it might be accelerated the release of nutrients from poultry manure than cowdung and compost (house hold waste) in both BRRI dhan29 and BRRI dhan49 respectively. From analysis of data the treatment combination (100% Organic Manure +75% Inorganic Fertilizer) and (100% Organic Manure +100% Inorganic Fertilizer) found in highest grain yield with maximum BCR. On the basis of economic analysis (benefit cost ratio) it can be summarized that above two treatment combination shows statistically similar results and considering inorganic fertilizer use efficiency comparatively low cost can be used for profitable cultivaiton of both boro rice (BRRI dhan29) and aman rice (BRRI dhan49). So treatment combination (100% Organic Manure +75% Inorganic Fertilizer) used best for both boro and aman rice.

RECOMMENDATIONS

Based on the findings of the experiment, the following recommendations may be made :

- Farmers can adopt BRRI dhan29 and BRRI dhan49 to get better yield in both boro and aman season respectively.
- Application of 100% of organic manure and 75 % of inorganic fertilizer of recommended dose could be suggested for farmers practice for sustainable rice yield and maintain soil fertility.
- Studies are needed to find out the effect of other nutrients for soil like Boron, Zinc etc.
- Such study is needed in different agro-ecological zones (AEZs) of Bangladesh where boro and aman rice are cultivated.

However, further studies are also suggested to carry out similar experiments with more promising treatments incorporating more varieties for drawing conclusive inference. The technology and the nutritional and physiological parameter of both rice subjected to various treatments and economic analysis are also need to be extensively investigated to further confirm the findings of the present study. Besides this the study would help enhance the knowledge of students and researchers relating to rice researches. It would help the policy makers to formulate policy towards increasing rice production with view to easing access to food by the people of Bangladesh.

Future Research

Accumulation of heavy metals in food crops from poultry manure is a global concern, which is not elaborated in the present study. Therefore the future research should be addressed considering the burning issue.

CHAPTER VI

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CHAPTER VII

APPENDICES

Appendix I. Monthly air temperature, rainfall, relative humidity and sunshine hours during the growing season (July to December 2013)

Month	***Air temperature (OC)**			****Rainfall (mm)**	***Relative humidity (%)**	**** Sunshine (hrs)**
	Maximum	Minimum	Mean			
July	28.77	15.33	22.05	0	73.57	223.40
August	30.93	18.95	24.94	18.1	75.16	202.10
September	28.53	16.85	22.69	19.58	79.58	119.65
October	27.15	15.99	21.57	23.21	81.62	101.41
November	26.54	14.61	20.58	21.54	82.35	111.26
December	24.92	13.46	19.19	0	86.16	160.40

* Monthly average and ** Monthly total

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

Appendix II. Monthly records of Temperature, Rainfall, and Relative humidity of the experiment site during the period from July 2014 to October 2014

Year	Month	Air Temperature (0c)			Relative humidity (%)	Rainfall (mm)	Sunshine (hr)
		Maximum	Minimum	Mean			
2014	July	35.80	29.60	32.70	75.70	2.70	230.50
2014	August	36.30	30.50	33.40	74.60	3.00	227.80
2014	September	34.30	28.60	31.45	68.40	2.00	222.60
2014	October	33.50	26.80	30.15	65.70	1.80	220.50

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1207.

Appendix lll. Effects of compost and inorganic fertilizers on different yield and yield components of BRRI dhan29

Compost	**Grain yield(tha^{-1})**	**Straw yield (tha^{-1})**	**Benefit cost ratio**
C_0	3.88 d	4.55 d	2.39 d
C_1	5.18 c	5.29 c	3.05 c
C_2	5.47 b	5.86 b	3.33 b
C_3	5.82 a	6.54 a	3.60 a
LSD $_{0.05}$	0.26	0.35	0.13
CV%	6.32	7.58	5.36
Fertilizer			
F_0	4.14 c	4.90 c	2.75 c
F_1	5.19 b	5.53 b	3.05 b
F_2	5.43 ab	5.90 a	3.26 a
F_3	5.58 a	5.91 a	3.32 a
LSD $_{0.05}$	0.26	0.35	0.13
CV%	6.32	7.58	5.36

Appendix lV. Effects of compost and inorganic fertilizers with NPK content in grain of BRRI dhan29

Compost (Household waste)	**% N**	**% P**	**% K**
C_o	1.09 d	0.104 d	0.137 c
C_1	1.16 c	0.144 c	0.220 b
C_2	1.23 b	0.170 b	0.221 b
C_3	1.29 a	0.208 a	0.272 a
LSD (0.05)	0.04	0.008	0.008
CV%	4.43	5.83	7.11
Fertilizer			
Fo	1.16 b	0.138 c	0.186 c
F1	1.17 b	0.156 b	0.215 b
F2	1.20 ab	0.163 b	0.217 b
F3	1.24 a	0.169 a	0.233 a
LSD (0.05)	0.04	0.008	0.008
CV%	4.43	5.83	7.11

Appendix V. Effects of compost and inorganic fertilizers with NPK content in straw of BRRI dhan29

Compost(Household waste)	**% N**	**% P**	**% K**
Co	0.330 c	0.040 c	1.20 b
C1	0.430 b	0.045 bc	1.22 b
C2	0.461 a	0.053 b	1.24 b
C3	0.484 a	0.064 a	1.28 a
LSD (0.05)	0.026	0.008	0.037
CV%	5.57	5.29	3.41
Fertilizer			
Fo	0.373 b	0.041 b	1.12 b
F1	0.430 b	0.050 a	1.14 b
F2	0.451 a	0.053 a	1.33 a
F3	0.451 a	0.053 a	1.35 a
LSD (0.05)	0.026	0.008	0.037
CV%	5.57	5.29	3.41

Appendix Vl. Effects of cowdung and inorganic fertilizer on different yield and yield components of BRRI dhan29

Cowdung	**Grain yield(tha^{-1})**	**Straw yield (tha^{-1})**	**Benefit cost ratio**
CD_0	4.763 c	4.734 d	2.24 d
CD_1	5.680 b	5.375 c	3.04 c
CD_2	5.628 b	5.628 b	3.25 b
CD_3	6.402 a	6.572 a	3.57 a
LSD $_{0.05}$	0.387	0.4251	0.11
CV%	8.27	9.01	4.69
Fertilizer			
F_0	5.410 b	5.363 b	2.74 c
F_1	5.528 b	5.518 ab	3.02 b
F_2	5.567 b	5.837 a	3.32 b
F_3	5.968 a	5.935 a	3.57 a
LSD $_{0.05}$	0.387	0.4251	0.11
CV%	8.27	9.01	4.69

Appendix VlI. Cowdung and inorganic fertilizers with NPK content in grain of BRRI dhan29

Cowdung	**% N**	**%P**	**% K**
CDo	0.92 b	0.100 d	0.138 c
CD1	1.07 a	0.145 c	0.222 b
CD2	1.10 a	0.167 b	0.217 b
CD3	1.08 a	0.192 a	0.271 a
LSD (0.05)	0.037	0.008	0.026
CV%	4.76	7.49	13.45
Fertilizer			
Fo	0.98 c	0.134 c	0.197 b
F1	1.05 b	0.152 b	0.206 ab
F2	1.03 b	0.155 b	0.214 ab
F3	1.10 a	0.163 a	0.232 a
LSD (0.05)	0.04	0.008	0.026
CV%	4.76	7.49	13.45

Appendix Vlll. Cowdung and inorganic fertilizers with NPK content in straw of BRRI dhan29

Cowdung	% N	% P	% K
Cdo	0.362 c	0.038 c	1.019 b
CD1	0.425 b	0.052 b	1.020 b
CD2	0.479 a	0.054 b	1.086 a
CD3	0.499 a	0.066 a	1.112 a
LSD (0.05)	0.026	0.008	0.045
CV%	5.42	9.14	4.97
Fertilizer			
Fo	0.428 b	0.052	1.051
F1	0.431 b	0.052	1.054
F2	0.440 b	0.052	1.066
F3	0.467 a	0.054	1.066
LSD (0.05)	0.026	0.008 NS	0.045 NS
CV%	5.42	9.14	4.97

Appendix lX. Effects of poultry manure and inorganic fertilizers on different yield and yield components of BRRI dhan29

Poultry manure (PM)	Grain yield(tha^{-1})	Straw yield (tha^{-1})	Benefit cost ratio
PM_0	4.005 d	4.879 c	2.62 c
PM_1	4.717 c	5.199 c	3.25 b
PM_2	5.322 b	6.153 b	3.26 b
PM_3	6.144 a	7.081 a	3.69 a
LSD (0.05)	0.3812	0.4412	0.11
CV%	9.05	9.08	4.21
Fertilizer			
Fo	4.617 c	5.380 c	3.00 c
F1	4.877 bc	5.757 bc	3.20 b
F2	5.072 b	5.955 ab	3.23 b
F3	5.622 a	6.221 a	3.40 a
LSD (0.05)	0.3812	0.4412	0.11
CV%	9.05	9.08	4.21

Appendix X. Effects of poultry manure and inorganic fertilizers with NPK content in grain of BRRI dhan29

Poultry manure	**% N**	**% P**	**% K**
PMo	1.070 c	0.122 d	0.152 d
PM1	1.104 b	0.154 c	0.209 c
PM2	1.124 a-b	0.202 b	0.234 b
PM3	1.142 a	0.229 a	0.291 a
LSD (0.05)	3.38	7.73	9.51
CV%	0.026	0.008	0.008
Fertilizer			
Fo	1.118	0.163 c	0.208 c
F1	1.102	0.176 b	0.220 b
F2	1.109	0.180 a-b	0.224 b
F3	1.111	0.188 a	0.235 a
LSD (0.05)	3.38 NS	7.73	9.51
CV%	0.02637	0.008	0.008

Appendix Xl. Effects of poultry manure and inorganic fertilizers with NPK content in straw of BRRI dhan29

Poultry manure	**% N**	**% P**	**% K**
PMo	0.344 c	0.036 c	0.683 c
PM1	0.436 b	0.040 b-c	0.804 b
PM2	0.472 a	0.046 a-b	0.829 ab
PM3	0.485 a	0.050 a	0.842 a
LSD (0.05)	5.37	6.15	4.36
CV%	0.2637	0.008	0.026
Fertilizer			
Fo	0.415 b	0.04	0.760 c
F1	0.427 a-b	0.041	0.785 b-c
F2	0.440 a-b	0.044	0.798 a-b
F3	0.454 a	0.046 NS	0.815 a
LSD (0.05)	5.37	6.15	4.36
CV%	0.026	0.008	0.026

Appendix XII. Effects of compost and inorganic fertilizers on different yield and yield components of BRRI dhan49

Compost	**Grain yield(tha^{-1})**	**Straw yield (tha^{-1})**	**Benefit cost ratio**
C_0	3.258 b	4.507 b	1.92 c
C_1	4.063 a	4.63 ab	2.60 a
C_2	4.211 a	5.03 a	2.47 b
C_3	4.329 a	4.69 ab	2.48 b
LSD $_{0.05}$	0.4210	0.45	0.09
CV%	12.74	11.50	5.36
Fertilizer			
F_0	3.723	4.569	2.35 b
F_1	3.902	4.538	2.27 b
F_2	4.099	4.925	2.45 a
F_3	4.137	4.829	2.43 a
LSD $_{0.05}$	0.42 NS	0.45 NS	0.09
CV%	12.74	11.50	5.36

Appendix XIII. Effects of compost and inorganic fertilizers with NPK content in grain of BRRI dhan49

Compost (Household waste)	**% N**	**% P**	**% K**
C_o	1.087 d	0.117 c	0.112 b
C_1	1.149 c	0.164 b	0.164 a
C_2	1.217 b	0.203 a	0.162 a
C_3	1.277 a	0.211 a	0.168 a
LSD (0.05)	0.026	0.026	0.026
CV%	1.35	11.59	12.41
Fertilizer			
Fo	1.170 b	0.163	0.145
F1	1.167 b	0.168	0.152
F2	1.184 ab	0.179	0.153
F3	1.210 a	0.186	0.156
LSD (0.05)	0.03	0.026 NS	0.026 NS
CV%	1.35	11.59	12.41

Appendix XlV. Effects of compost and inorganic fertilizers with NPK content in straw of BRRI dhan49

Compost(Household waste)	**% N**	**% P**	**% K**
Co	0.204 d	0.02	0.520 d
C1	0.279 c	0.03	0.591 c
C2	0.340 b	0.03	0.70 b
C3	0.384 a	0.04	0.768 a
LSD (0.05)	0.026	0.026 NS	0.026
CV%	8.65	8.30	2.74
Fertilizer			
Fo	0.279 b	0.03	0.615 c
F1	0.290 b	0.03	0.640 bc
F2	0.320 a	0.03	0.652 ab
F3	0.317 a	0.02	0.675 a
LSD (0.05)	0.03	0.02 NS	0.026
CV%	8.65	8.30	2.74

Appendix XV. Effects of cowdung and inorganic fertilizer on different yield and yield components of BRRI dhan49

Cowdung	**Grain yield(t/ha)**	**Straw yield (t/ha)**	**Benefit cost ratio**
CD_0	4.095 c	4.182 b	2.42 d
CD_1	4.05 d	4.919 a	2.70 b
CD_2	4.340 a	5.023 a	2.52 c
CD_3	4.131 b	4.637 ab	2.88 a
$LSD_{0.05}$	0.02637	0.4709	0.07
CV%	0.34	12.04	4.69
Fertilizer			
F_0	3.673 c	4.653	2.49 c
F_1	4.185 b	4.772	2.62 b
F_2	4.209 b	4.701	2.71 a
F_3	4.557 a	4.636	2.70 a
$LSD_{0.05}$	0.02637	0.4709 NS	0.07
CV%	0.34	12.04	4.69

Appendix XVI. Effects of cowdung and inorganic fertilizers with NPK content in grain of BRRI dhan49

Cowdung	**% N**	**%P**	**% K**
CDo	1.01 c	0.155 b	0.107 b
CD1	1.14 b	0.201 a	0.183 a
CD2	1.16 b	0.22 a	0.179 a
CD3	1.24 a	0.225 a	0.197 a
LSD (0.05)	0.04	0.026	0.026
CV%	4.43	11.11	12.36
Fertilizer			
Fo	1.16 b	0.174 b	0.163
F1	1.17 b	0.214 a	0.172
F2	1.20 ab	0.214 a	0.163
F3	1.24 a	0.204 a	0.168
LSD (0.05)	0.04	0.026	0.026 NS
CV%	4.43	11.11	12.36

Appendix XVII. Effects of cowdung and inorganic fertilizers with NPK content in straw of BRRI dhan49

Cowdung	**% N**	**%P**	**% K**
CDo	0.300 c	0.048	1.067 c
CD1	0.307 c	0.053	1.091 c
CD2	0.430 b	0.060	1.121 b
CD3	0.476 a	0.071	1.179 a
LSD (0.05)	0.037	0.026 NS	0.026
CV%	12.57	7.51	2.84
Fertilizer			
Fo	0.349 b	0.055 a	1.113 ab
F1	0.376 ab	0.058 a	1.110 ab
F2	0.398 a	0.057 a	1.102 b
F3	0.391 a	0.061 a	1.134 a
LSD (0.05)	0.037	0.026 NS	0.026
CV%	12.57	7.51	2.84

Appendix XVIII: Effects of poultry manure and inorganic fertilizers on different yield and yield components of BRRI dhan49

Poultry manure (PM)	**Grain yield(tha^{-1})**	**Straw yield (tha^{-1})**	**Benefit cost ratio**
PM_0	4.201 b	4.326 c	2.48 c
PM_1	4.126 c	4.711 b	2.47 c
PM_2	4.485 a	4.974 a	2.65 b
PM_3	4.440 a	4.359 c	2.75 a
LSD (0.05)	0.045	0.254	0.08
CV%	1.17	6.63	4.21
Fertilizer			
Fo	3.858 d	4.403 b	2.38 b
F1	4.338 c	4.463 b	2.61 a
F2	4.483 b	4.730 a	2.67 a
F3	4.574 a	4.775 a	2.69 a
LSD (0.05)	0.04567	0.2543	0.08
CV%	1.17	6.63	4.21

Appendix XlX: Effects of poultry manure and inorganic fertilizers with NPK content in grain of BRRI dhan49

Poultry manure	**% N**	**% P**	**% K**
PMo	0.80 b	0.219 b	0.110 c
PM1	1.21 a	0.228 b	0.192 b
PM2	1.21 a	0.237 ab	0.201 ab
PM3	1.25 a	0.262 a	0.225 a
LSD (0.05)	0.08	0.026	0.026
CV%	9.12	9	9.75
Fertilizer			
Fo	1.06 b	0.223	0.169
F1	1.07 b	0.238	0.187
F2	1.11 b	0.237	0.188
F3	1.22 a	0.248	0.185
LSD (0.05)	0.08	0.026 NS	0.026 NS
CV%	9.12	9	9.75

Appendix XX: Effects of poultry manure and inorganic fertilizers with NPK content in straw of BRRI dhan49

Poultry manure	**% N**	**% P**	**% K**
PMo	0.323 d	0.052	1.096 c
PM1	0.413 c	0.058	1.107 bc
PM2	0.498 b	0.066	1.133 b
PM3	0.531 a	0.077	1.213 a
LSD (0.05)	0.026	0.026 NS	0.026
CV%	4.39	3.27	3
Fertilizer			
Fo	0.403 c	0.060	1.128
F1	0.443 b	0.061	1.131
F2	0.449 ab	0.064	1.140
F3	0.470 a	0.067	1.150
LSD (0.05)	0.026	0.026 NS	0.026 NS
CV%	4.39	3.27	3