INFLUENCE OF INTEGRATED USE OF MANURES AND FERTILIZER ON THE GROWTH AND YIELD OF HYBRID DHAN HIRA 2

BY

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CERTIFICATE

This is to certify that the thesis entitled "**INFLUENCE OF INTEGRATED USE OF MANURES AND FERTILIZER ON THE GROWTH AND YIELD OF HYBRID DHAN HIRA 2**" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN SOIL SCIENCE**, embodies the result of a piece of *bonafide* research work carried out by **Mst. Sharmin Sultana**, Registration number: **05-01752** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated:
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Dedicated to
My
Beloved Parents

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ABSTRACT

A field experiment was conducted to assess the effect of integrated nutrient management on the growth and yield of hybrid dhan Hira 2 at the research farm of Sher-e-Bangla Agricultural University, Dhaka-1207 in Boro season 2011-12. Growth and yield contributing characters of hybrid dhan Hira 2 were significantly affected by different treatments (**T_1**: No chemical fertilizer and no manures (Control), **T_2:**120 kg N/ha from urea, **T_3:** 90 kg N/ha from urea+ 30 kg N/ha from vermicompost (VC), **T_4**: 90 kg N/ha from urea+ 30 kg N/ha from pressmud, **T_5:** 60 kg N/ha from urea+ 60 kg N/ha from vermicompost (VC), **T_6:** 60 kg N/ha from urea+ 60 kg N/ha from pressmud, **T_7**: 30 kg N/ha from urea +90 kg N/ha from vermicompost (VC), **T_8:** 30 kg N/ha from urea+ 90 kg N/ha from pressmud, **T_9:** 120 kg N/ha from vermicompost (VC) and **T_{10}**: 120 kg N/ha from pressmud) except one, non-effective tillers per hill, which was insignificant to different treatments. The highest plant height (95.00), number of tillers per hill (16.67), effective tillers per hill (15.33), panicle length (25.64), number of grain per panicle (146.0), number of filled grain per panicle (142.3) and Weight of 1000 grains (33.33) were found from T_3 treatment. On the other hand the lowest values of these parameters were obtained from T_1 treatment receiving no manure and chemical fertilizer. The highest number of unfilled grain per panicle (8.00) found from T_8 and the lowest (3.67) from T_3 treatment. Yield parameters of hybrid dhan Hira 2 were significantly affected by different treatments. The highest raw grain yield (9.56 t/ha), raw straw yield (14.67 t/ha), dry grain yield (8.78 t/ha) and dry straw yield (7.62 t/ha) were found from T_3 treatment. On the other hand the lowest values of these parameters were obtained from T_1 treatment. Nutrient concentration in grain and straw of hybrid dhan Hira 2 was significantly affected by different treatments. The highest concentrations of N (1.092%), P (0.297%), K (0.374%) in grain and the highest K (1.213%) and S (0.091 %) in straw were recorded in T_3 treatment. The highest concentrations of S (0.124%) in grain and the highest concentrations of N (0.742%) and P (0.182%) in straw were recorded from T_2 treatment and in all cases the lowest values were observed in T_1 (control) treatment. Nutrient uptake (kg/ha) by grain and straw of hybrid dhan Hira 2 was significantly affected by different treatments. The highest amount of N (93.81), P (26.07), K (32.82) and S (10.79) uptake by grain and the highest amount of N (55.70), P (13.79), K (92.43) and S (6.91) uptake by straw were found in the T_3 treatment and in all cases the lowest values were observed in T_1 treatment. The organic matter and levels of N, P, K and S of post-harvest soil were significantly affected by different treatments whether pH of post-harvest soil was insignificant. The highest organic matter (1.67%), total N (0.070%), available P (11.71ppm) & S (11.46 ppm) and K (0.166 meq/100 g soil) were recorded from T_9, T_3, T_2, T_{10}, treatments respectively and in all cases the lowest values were observed in T_1 treatment.

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INTRODUCTION

CHAPTER I

INTRODUCTION

Rice (Oryza *sativa*) is one of the most important cereal crops of the world. More than 50% of the world population depends on rice as their staple food. It is the predominant dietary energy source for 17 countries in Asia and the Pacific, 9 countries in North and South Africa and 8 countries in Africa. It is the staple food of Bangladesh. Almost all the people depend on rice and have tremendous influence on agrarian economy of Bangladesh. Among the three types of rice, boro rice covers about 56.66% of total rice area and it contributes to 43.24% of the total rice production in the country (BBS, 2008). Rice is intensively cultivated in Bangladesh covering about 80% of arable land. Rice alone constitutes 95% of the food grain production in Bangladesh. Unfortunately, the yield of rice is low considering the other rice growing countries like South Korea and Japan where the average yield is 7.00 and 6.22 t/ha, respectively (FAO, 1999). On the other hand, the demand for increasing rice production is mounting up to feed the ever-increasing population of the world.

The rice-rice system is the most important cropping system in Bangladesh. Continuous cultivation of this highly exhaustive cropping sequence in most of the irrigated fertile lands has resulted in the decline of soil fertility in general and soil organic carbon (SOC) content in particular. This has led to a reduction in the total factor productivity and raised questions on the sustainability of this cropping system. Spiraling polices of chemical fertilizers, coupled with perceived deterioration of environment have led to a renewed interest in reliance on renewable organic materials including vermicompost and pressmud as sources of nutrients. A suitable combination of organic and inorganic sources of nutrients is necessary for sustainable agriculture that can ensure food production with high quality. Nambiar (1991) views 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.

Organic manure can supply a good amount of plant nutrients thus can contribute to crop yields. Thus, it is necessary to use fertilizer and manure in an integrated way in order to obtain sustainable crop yield without affecting soil fertility. The integrated approach by using the organic and inorganic sources of nutrients helps to improve the efficiency of nutrients. Mineralization and immobilization are biochemical in nature and are mediated through the activities of microorganisms. The rate and extent of mineralization determines availability of nutrients.

Depleted soil fertility is a major constrain to higher crop production in Bangladesh. The increasing land use intensity has resulted in a great exhaustion of nutrient in soils. The farmers of this country use on an average 102 kg nutrients/ha annually (70 kg N + 24 kg P + 6 kg K + 2 kg S and Zn) while the crop removal is about 200 kg/ha (Islam *et al.*, 1994). In Bangladesh, most of the cultivated soils have less than 1.5% organic matter while a good soil should contain at least 2% organic matter. Soil organic matter plays an important role in maintaining crop production. It is a reservoir of plant nutrients. Its maintenance is crucial for maintaining physical, chemical and biological properties of the soil (Sahrawat, 2005). With these facts, the research had conducted to the use of organic materials such as vermicompost and pressmud.

Vermicompost is the end product of the breakdown of organic matter by species of earthworm and is considered nutrient rich natural manure and conditioner. Vermicompost contains a diverse microbial population which help breakdown nutrients already present in the soil into plant available form. It benefits soils by improving its physical structure, adding plant hormones, attracting deep burrowing earthworms already present in the soil, improving root growth and structure. The use of vermicompost increases crop yield and less dependence on chemical fertilizers (Villegas, 2003; Adorado *et al.*, 2003). Grain yield and nutrient uptake of rice increased significantly with the application of vermicompost and inorganic fertilizer in a rate of 15 kg N/ha from vermicompost supplemented with 45-13-25 kg NPK/ha with a yield of 4.06 and 5.31 ton/ha (Banik and Bejbaruah, 1996). The application of vermicompost on rice crop showed a positive effects on biological and rice quality and yield performance (Tejada and Gonzales, 2008).

Pressmud from sugar mill is another enriched source of organic matter and contains substantial quantities of nutrients for improving physical conditions and improvement of soil fertility (Nisar, 2000). It also contains sulfur, which helps to acidify the soil. This acidification makes soluble calcium available and thus improves soil structure and decreases the leaching of salts.

Conjunctive use of organic manures along with inorganic fertilizers plays an important role in sustaining soil fertility. Under the scenario, balanced fertilization and complementary use of inorganic fertilizers with vermicompost and pressmud will go a long way in both improving the yield as well as improving the soil quality.

Considering the present situation the present study was undertaken with the following objectives:

1. To study the effect of integrated use of organic manures (vermicompost and pressmud) and chemical fertilizer (urea) on the growth and yield of hybrid dhan Hira 2

2. To evaluate the performance of different organic manures and inorganic fertilizer combinations for better production of hybrid dhan Hira 2

3. To investigate the improvement of soil fertility due to the use of organic manures in combination with chemical fertilizer.

CHAPTER 2
REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

Soil organic manure and inorganic fertilizer is the essential factor for sustainable soil fertility and crop productivity because it is the store house of plant nutrients. Sole and combined use of pressmud, vermicompost and inorganic fertilizer acts as a source of essential plant nutrients. Experimental evidences in the use of pressmud, vermicompost and nitrogen, phosphorus, potassium and sulphur showed an intimate effect on the yield and yield attributes of rice. Yield and yield contributing characters of rice are considerably influenced by different doses of NPKS fertilizer and pressmud, vermicompost and their combined applications. Some literature related to the Influence of integrated use of manures and fertilizer on the growth and yield of hybrid dhan Hira 2 are reviewed below-

2.1 Effect of chemical fertilizer on the soil properties, growth and yield of rice

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

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

Singh and Singh (2002) carried out a field experiment to see the effect of different S levels (0, 20 and 40 kg/ha) on rice cv. Swarna and PR-108 in Varanasi, Utter Pradesh, India. They reported that plant height, tillers/m^2, dry matter production, panicle length and grains/panicle were significantly increased with increasing levels of S up to 40 kg/ha.

Haq *et al.* (2002) conducted an experiment with twelve treatments combination of N, P, K, S, Zn and Diazinon. They found that all the treatments significantly increased the grain and straw yield of BRRI dhan 30 rice over control. 90 kg N + 50 kg P_2O_5 + 40 kg K_2O + 10 kg S + 4 kg Zn ha^{-1} + diazinon gave the highest grain and straw yield.

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

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

Phaev *et al.* (2003) concluded that freshly applied P increased rice grain yield by 95%. In the first and second crops using residual P fertilizer, yields increased by 62 and 33% relative to the nil-P plot. Cumulative removal of P in four successive rice crops accounted for 30 and 55% of the 16.5 kg/ha in the form of harvested grain and whole plants.

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

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

Saleque *et al.* (2005) found a linear relationship between P uptake and total system productivity which supports the concept that TSP depends to some extent on P availability. Phosphorus application increased rice yield in different seasons where the highest response in P was in Aus and Boro than T. Aman.

Manzoor *et al.* (2006) conducted a field experiment during the kharif seasons of three successive years from 2000 to 2002 at Rice Research Institute, Kala Shah Kaku, Lahore, Pakistan to find out the most appropriate level of nitrogen to get maximum paddy yield of rice variety, Super Basmati. Effect of nine different nitrogen levels i.e. 0, 50, 75,100,125,150,175,200 and 225 kg/ha on paddy yield and yield components were studied in this experiment. Plant height, number of productive tillers per hill, panicle length, number of grains per panicle, 1000 grains weight and paddy yield showed increasing trend from 0 kg N/ha up to 175 kg N/ha. The yield parameters including paddy yield, number of grains per panicle and 1000 grains weight started declining at 200 kg N/ha level and above . Maximum paddy yield (4.24 t/ha) was obtained from 175 kg/ha nitrogen application treatment which also produced highest values of number of grains per panicle (130.2) along with a maximum 1000 grain weight (22.92 gm). The plant height (139.8 cm) along with number of productive tillers per hill (23.42) and panicle length (29.75 cm) was maximum at 225 kg N/ha level.

Myint *et al.* (2007) carried out an experiment to study the effect of different urea fertilizer rates and plant populations on disease severity of bacterial blight of rice and yield lasses related to disease, the experiments including three plant populations (110000, 150000, 190000) and five urea fertilizer rates (0.56 lb, 112 lb, 168 lb and 224 lb per acre) were conducted at Central Agriculture Research Institute farm in 1999 and 2000 rainy seasons. Manawthukha was used as a test variety that is susceptible to bacterial blight of rice. The disease severity could be increased by the application of urea. Although urea 112 lb per acre gave moderate disease severity than without urea, its yield is highest. The higher disease severity also showed the related effect of plant population of 150000 and above. However the combination of urea 224 lb per acre with the population of 190000 and 150000 gave the highest severity of bacterial blight disease and the minimum grain yield. The application of urea 224 lbs per acre can cause yield reduction ranging from 18.67 percent to 27.57 percent over the application of urea 112 lb per acre.

Rahman *et al.* (2007) conducted a field experiment using rice (cv. BRRI dhan 29) as a test crop and found that application of S had a significant positive effect on tillers/hill, plant height, panicle length and grains/panicle. They also indicated that application of

S fertilizer at a recommended rate (20kg S/ha) might be necessary for obtaining higher grain yield as well as straw yield of Boro rice (cv. BRRI dhan 29).

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

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

Alim (2012) conducted an experiment to study the effect of different sources and doses of nitrogen application on the yield formation of boro rice. Two *indica* modern boro rice varieties (BRRI dhan28 and BRRI dhan36) and 21 nitrogen fertilizer combinations were used in the experiment. The experiment was laid out in split- plot design with three replications by assigning varieties in the main plots and nitrogen fertilizers in the sub-plots. The unit plot size was 4m X 2m. Yield and yield contributing characters were measured. Among the two varieties BRRI dhan28 produced higher grain and straw yield. Grain and straw yields were increased with the increase of nitrogen rate up to 120 kg ha-1 at all the sources. In general, organic manures alone could not produce higher grain yield but the combination of organic and inorganic fertilizers produced higher yield. The application of 60 kg N ha-1 as urea with 60 kg N ha-1 as mustard oil cake (MOC) produced maximum grain and straw yield which was statistically similar to the yield of 50 kg N ha-1 as urea with 50 kg N ha-1 as MOC. The lowest values were found in control nitrogen application. The results suggest that replacement of 50% urea N by MOC was the best source of nitrogen considering higher yield of boro rice. Therefore, fertilization of BRRI dhan 28 and BRRI dhan 36 varieties of rice with 60 kg N ha-1 as urea and 60 kg N ha-1 as

MOC or 50 kg N ha- 1 as urea with 50 kg N ha-1 as MOC was found to be the best nitrogen rate among all the treatment combinations in respect of grain and straw yields.

Hasanuzzaman *et al.* 2012 carried out an experiment at Sher-e-Bangla Agricultural University, Dhaka during November, 2010 to May 2011 to study the response of hybrid rice to different levels of nitrogen and phosphorus. The experiment was laid out on split plot design with three replications having nitrogen levels in the main plot and phosphorus in the sub plot. There were six nitrogen fertilizer levels viz., 0, 80, 120, 160, 200 kg N/ ha, urea super granules @ 75 kg N/ ha and four phosphorus fertilizer levels viz., 0, 30, 50 and 70 kg P_2O_5 /ha. Urea was top dressed in three equal splits at 10, 35 and 55 days after transplanting (DAT). One urea super granule (USG) was placed at 10 cm soil depth at 10 DAT in the centre of four hills in alternate rows @ 75 kg N /ha. Results indicated that the effect of nitrogen and phosphorus showed significant variation in respect of yield contributing characters and yield. At harvest, maximum effective tillers/hill (13.63), filled grains/panicle (154.67), 1000 grains weight (29.35 g), grain yield (9.42 t/ ha), straw yield (13.33 t/ ha) was obtained from the application of urea super granules. About 10% more grain yield was measured from urea super granules than prilled urea. Phosphorus at 50 kg P_2O_5 gave the highest grain yield (7.85 t/ha). Interaction effect showed that application of urea super granules along with 50 kg P_2O_5 /ha gave the highest (9.83 t/ ha) grain yield. On the other hand application of 160 kg N/ ha and 120 kg N/ ha prilled urea along with 50 kg P_2O_5 /ha gave grain yield as 8.83 t/ ha and 7.67 t/ ha, respectively.

Yoseftabar (2012) carried out an experiment to investigate the effect of nitrogen and phosphorus fertilizer on growth and yield in rice cultivar Tarom Hashemi, an experimental design in north of Iran in 2011 cropping season. Nitrogen fertilizer at 50,100 and 150 kg/ha was main plot and phosphorus fertilizer at 4 level 0 (control), 30, 60 and 90kg/ha as sub plot. Using randomized complete block design (RCBD) with 3 replications. The results showed that tiller number, fertile tiller, total grain, 1000-grain weight and yield increased significantly with nitrogen and phosphorus fertilizer. Interesting in comparison to 50 and 100 kg/ha level application of higher N-fertilizer 150 kg/ha showed a positive respond to application of high nitrogen for Taroom Hashemi cultivar. Effect of different application of P-fertilizer was significantly on this parameter. increase application of phosphorus increase parameter above. Study of interaction effect of N and P- fertilizer was significant in fertile tiller and 1000-grain weight.

Yoseftabar *et al.* (2012) carried out an experiment to determine comparing of yield and yield components of hybrid rice (GRH1) in different application of nitrogen fertilizer. comprising of 2 treatments, nitrogen fertilizer at 100, 200 and 300 kg/ha was main plot and spilt application at 3 levels T_1=(1/2basal-1/2mid tillering), T_2=(1/3basal-1/3mid tillering-1/3panicle initation) and T_3=(1/4basal-1/4 mid tillering-1/4panicle initation-1/4 flowering) as sub plot. Using randomized complete block design (RCBD) with 3 replications in rice research institute of Iran-departy of mazandaran (amol) in 2006 cropping season. The results showed that yield and yield components increased significantly with nitrogen fertilizer. Interesting in comparison to 100 and 200 kg/ha level application of higher N-fertilizer 300 kg/ha showed a positive respond to application of high nitrogen on hybrid cultivar. Effect of different split application N-fertilizer was significantly on parameter of above. Study interaction effect of treatments revealed that all the yield and yield parameters increased significantly with an application of 300 kg/ha N-fertilizer at 4 stages.

Sarand *et al.*(2013) carried out an experiment to investigate the effect of urea level on concentration of Fe, Mn, Zn and Cu in shoot and root of the Hashemi rice (*Oryza sativa* L.) in two soils with clay loam and loamy sand texture. This investigation is factorial experiment in a completely randomized design with four replicates and include urea in three levels (0, 100, and 200 mg N/kg), two types of soil and in greenhouse condition. Results of the study show the type of soil has a meaningful effect on concentration of Fe and Mn in root and shoot, Cu on shoot and Zn on root of the rice. The high concentration of Zn and Mn in shoot, and Fe and Mn in root is shown in loamy sand soil and high concentration of Fe in shoot and Cu in root is represented in clay loam soils. Interaction of type of soil and urea show that concentration of Mn in root decreases in 100 mg N/kg on clay loam soil, while the concentration of Cu in root is increased. Concentration of Cu in shoot decreases in 100 mg N/kg on loamy sand soils, while using urea and increasing its level in clay loam soil increases its concentration. Concentration of Zn in root is also meaningfully increased using 100 mg N/kg in loamy sand soils.

Yoseftabar (2013a) carried out an experiment to investigate the effect of nitrogen and phosphorus fertilizer on spikelet structure and yield in rice (Oryza sativa), an experimental design in north of iran in 2011 cropping season. Nitrogen fertilizer at 50,100 and 150 kg/ha was main plot and phosphorus fertilizer at 4 level 0(control), 30, 60 and 90kg/ha as sub plot. Using randomized complete block design (RCBD) with 3 replications. The results showed that spikelet number, fertile spikelet, fertile spikelet percentage (%), Spikelet sterility percentage (%), biological and grain yield increased significantly with nitrogen and phosphorus fertilizer. Interesting in comparison to 50 and 100 kg/ha level application of higher N-fertilizer 150 kg/ha showed a positive respond to application of high nitrogen for taroom hashemi cultivar. Effect of different application of P-fertilizer was significantly on this parameter, increase application of phosphorus increase parameter above. The interaction effect of nitrogen and phosphorus fertilizer had no significant effect in other parameter.

Yoseftabar (2013b) carried out an experiment in randomized complete block design with 3 replications in 2006 growing seasons. Main plot was nitrogen rates including (100,200 and 300kgN/ha) applied as urea and sub plot was split application at three level T_1(1/2basel-1/2mid tillering), T_2(1/3basel-1/3mid tillaring-1/3panicle initiation) and T_3 (1/4basel-1/4 mid tillering-1/4panicle initiation-1/4 flowering). The results showed that panicle number, panicle length, panicle dry matter, number of primary branches, total grain and grain yield, increased significantly with nitrogen fertilizer. Application of 300kg/ha N fertilizer observed high rate of this parameter. Effect of different split application N-fertilizer were significantly on this parameter, this parameter increased significantly with increase split application but the maximum number of panicle number and total grain weight observed in3 split application. study interaction effect of treatment's revealed that the panicle length at harvesting stage and total grain increased significantly with an application of 300 kg/ha N-fertilizer at four stage. According resulted of this study panicle structure such as number of panicles (heads) spikelet density, panicle length, panicle curvature and the number of grains per panicle is determined by the nitrogen application.

2.2 Effect of vermicompost on the soil properties, growth and yield of rice

Murali and Setty (2000) carried out a field experiment during kharif 1997 to study the response of scented rice to different levels of NPK fertilizers (100:50:50, 125:62.5:62.5, and 150:75:75 kg/ha), vermicompost (0 and 5 t/ha), and growth regulator (triacontanol, at 0, 250 and 500 ml/ha) at ARS, Siruguppa, Karnataka, India. The results revealed that application of 150:75:75 NPK kg/ha recorded significantly higher growth, yield attributes and yield (5261 kg/ha) compared to lower NPK rates. Scented rice cv. Pusa Basmati-1 responded significantly to manure. Application of vermicompost at 5 t/ha resulted in significantly higher yield (4889 kg/ha) compared to no vermicompost application. Significant plant response to the triacontanol spraying at 500 ml/ha was observed with respect to growth, yield attributes, and yield (4861 kg/ha) compared to spraying at 250 ml/ha and water spray.

Barik *et al.* (2006) carried out an experiment to assess the efficiency of vermicompost over farmyard manure in integrated nutrient management of rice during wet season. Integrated nutrient management constituting vermicompost and farmyard manure in combinations with different doses of recommended fertilizer (60:30:30) were studied in relation to the performance of the crops under 100% recommended fertilizer dose alone. Results showed that reduction of 50% recommended dose of fertilizer along with vermicompost @ 10 tones/ha significantly influenced the growth and yield attributes of kharif rice as compared with 100% RFD and also under different combinations of farmyard manure and mineral nutrition. The highest grain and straw yields were obtained in crops under 5070 recommended fertilizer dose along with 10 tones vermicompost/ha which was significantly higher than 100% recommended NPK fertilizers. As per production economics is concerned the highest gross return was achieved from 50% recommended dose of fertilizer with 10 tones vermicompost/ha which was significantly higher than the treatments with 75% or 50% recommended dose of fertilizer along with 10 tones/ha farmyard manure. However for net return and benefit: cost ratio these 3 treatments appeared to be at par. Such comparable economic benefits of integrated nutrient management of kharif rice with vermicornpost and farmyard manure in spite of considerable higher yields with vermicompost, were attributed to higher cost of vermicompost application as compared to farmyard manure. The study suggests nutrient concentration based application of vermicompost likely to be a more effective proposition than using this material on the basis of total weight, as is generally done for different organic manures.

Barik and Sahu (2007) conducted a field experiment at Agronomy Farm of Orissa University of Agriculture and Technology, Bhubaneswar during rainy (kharif) and winter (rabi) seasons of 2007. The treatments consisted of different combinations of PSB (2 kg/ha), FYM (15 t/ha) and vermicompost (VC) @ 5t/ha in organic rice (Oryza sativa L.). The experiment was laid out in RBD with three replications. Application of PSB recorded significantly higher yield of 3.82 and 4.20 t/ha when pooled over rainy and winter seasons. Various growth characters and yield attributes also followed a similar trend. PSB recorded significantly higher net return (Rs 14036 /ha) and benefit cost ratio (1.68).Application of 50% FYM (basal) + 25% VC (basal) + 25% VC as topdressing at 10 days after transplanting produced the highest grain yield of 4.11 and 4.48 t/ha, when average dover the kharif and rabi seasons, respectively. The net return and benefit- cost ratio of the above treatment over the two years were Rs 15657/ha and 1.73, respectively. Available N, P and K contents of the soil after harvest of the two crops were higher when PSB and organics were applied. VC @ 5 t/ha was at par with 15 t/ha of FYM almost in all the growth characters, yield attributes and yield.

Mashaee et al. (2008) carried out an experiment to investigate nitrogen mineralization rate in soils amended with compost, vermicompost and cattle manure. Four treatments (compost, vermicompost, cattle manure and soil alone), two temperature levels (8 and 25 ^{0}C) and two moisture levels (50% and 85% FC) were used for the 90 - day incubation study. Ammonium and nitrate were measured by spectrophotometer method. Results indicated that the mixed first-and zero-order kinetics model is the best model for our data. Cattle manure treatment had the highest N_{min} at 25 ^{0}C (87.78 mg N/kg equal to 14.54% N_{total}) and the least value (23.62mg N/kg equal to 4.62% N_{total}) was obtained for the compost treatment at 8 ^{0}C. N_0k (nitrogen availability index) for treatments was in the following order: Cattle manure> vermicompost >Compost. With increasing the temperature and moisture, N mineralization increased. Also N_{min} positively correlated with N_0 (r =0.583*), and N_0k (r =0.834**).

Sharma *et al.* (2008) carried out an experiment to study the effect of organics and fertilizers on scented rice (*Oryza sativa* L.) in rice-wheat sequence. Among organics, vermicompost being at per with cell rich produced significantly higher values of growth, yield, grain quality and nutrient uptake than FYM and control. FYM was found significantly superior to control in all respect. Application of 100% recommended fertilizers being *at par* with 90% fertilizers performed significantly better than lower doses of 80 and 70% fertilizers in all respect. Interaction between organics and fertilizers was not found to be significant on any of the rice characters.

Manivannan and Sriramachandrasekharan (2009) conducted a field experiments during Kharif 2006 and 2007 in clay loam soil to study the effect of organic sources and urea on N transformation and yield of rice. The treatments consisted of addition of different organics viz., composted coir pith (CCP), green manures (GM), sugarcane trash compost (STC), vermicompost (VC), poultry manure (PM) and FYM applied at 100% RDN and combination of above organics @50% N and urea@50%N besides 100% RDN as urea and control. The results revealed that addition of organics or mineral N or both significantly improved rice yields over control in both years. The highest grain yield (4942, 5332 kg ha-1) and straw yield (7314, 7725 kg ha-1) was noticed with vermicompost (50% N) + urea (50% N) which was on par with poultry manure (50%N) + urea (50%N) but superior to rest of the treatments. Rice yield was more with 100% Urea N compared to 100% RDN as organics alone. The best treatment caused 26.4% increase in grain yield over control, 3.8% over 100% urea N. Integrated use of organics and urea recorded higher concentration of ammonium and nitrate nitrogen compared to their individual addition. The N forms were more under vermicompost amended soil followed by green manure and poultry manure. The mineral N was higher at initial stages and decreased with crop growth. The NUE was higher under integrated use of organics and urea compared to organics and urea alone.

Pontillas *et al.* (2009) carried out an experiment to study the effect of vermicompost on the growth and yield of rice as well as on the return on capital was conducted on December 2007 to September 2008 at Jose Rizal Memorial State College, Katipunan Campus, Katipunan, Zamboanga del Norte. Three treatments were laid in Randomized Complete Block Design (RCBD) with four replications. The application of vermicompost alone and the combination of inorganic fertilizer and vermicompost resulted to no significant differences in the height in comparison with inorganic fertilizer at 60 DAT both in 1st and 2nd trial. It was at harvest that rice applied with inorganic produced a significantly tallest plants among the treatments in 1st trial. In 2nd trial, it generated a dramatic increase in ROI when using vermicompost supplemented with inorganic fertilizer (103.8%) which is comparably the same with inorganic fertilizer (119.6%). This signifies a favorable effect on the growth, yield and return on investment in rice production when vermicompost was supplemented with inorganic fertilizer and further implies that it can be a substitute to pure inorganic fertilizer application.

Tejada and Gonzalez (2009) carried out an experiment to study the effect of incorporating two vermicomposts of different chemical nature (cow dung, CD; and green forages, GF) at rates of 3 and 6 t C/ha, respectively, on soil biological properties (soil microbial biomass, soil respiration and soil enzymatic activities), soil humus–enzymes complexes, nutrition (N, P, and K plant contents, pigments, and leaf soluble carbohydrate concentrations), and yield parameters of rice (*Oryza sativa* cv. Puntal) over 3 yr on an Aquic Xerofluvent located near Seville, Spain. Vermicomposts had a positive effect on the soil biological properties and rice quality and yield parameters with respect to the no-vermicompost-amended soil, although at the end of the experimental period and at the high organic matter rate, the soil microbial biomass and dehydrogenase, urease, β-glucosidase, phosphatase, and arylsulfatase activities increased more in the CD-amended soils compared with the GF-amended soils (20.8, 12.8, 16.9, 17.6, 15.3, and 15.1%, respectively). However, the results obtained in the soil humus-enzymes complexes indicate that the highest values were found in the GF-compared with CD-amended soils. This increase in soil biological properties produced an increase in the plant nutrition, which increased rice quality and yield. The application of CD increased the grain protein concentration (5.6%), the grain starch concentration (7.8%), the percentage of full grains (3.1%), and the rice yield (7.9%) compared with the GF-amended soils. These results suggest that the chemical composition of the two vermicomposts influenced the soil biological properties, and therefore in the rice yield parameters. For both vermicomposts, the application of CD originated an increase in the soil biological properties and also in the rice yield parameters than did application of GF.

Dominguez *et al.* (2010) carried out an experiment to study the impact of vermicompost on rice-legume cropping system in India. Integrated application of vermicompost, chemical fertilizer and biofertilizers (Azospirillum & phosphobacteria) increased rice yield by 15.9% over chemical fertilizer used alone. The integrated application of 50% vermicompost, 50% chemical fertilizer and biofertilizers recorded a grain yield of 6.25 and 0.51 ton/ha in the rice and legume respectively. These yields were 12.2% and 19.9% higher over those obtained with 100% chemical fertilizer when used alone vermicompost is produced under mesophilic conditions and although microorganisms degrade the organic matter biochemically, earthworms are the crucial drivers of the process, as they aerate, condition and fragment the substrate, thus drastically altering the microbial activity. Earthworms act as mechanical blenders, and by fragmenting the organic matter they modify its physical and chemical status by gradually reducing the ratio of C:N and increasing the surface area exposed to microorganisms - thus making it much more favorable for microbial activity and further decomposition.

Hasanuzzaman *et al*. (2010) conducted an experiment at the Agronomy field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during June to November, 2008 with a view to observe the comparative performance of different organic manures and inorganic fertilizers on the growth and productivity of transplanted rice. The experiment comprises of 10 treatments viz. T_1 (Control), T_2 (Green manure @ 15 t/ ha), T_3 (Green manure @ 15 t/ ha + $N_{40}P_6K_{36}S_{10}$ i.e.50% NPK), T_4 (Poultry manure @ 4 t/ ha), T_5 (Poultry manure @ 4 t/ ha + $N_{40}P_6K_{36}S_{10}$ i.e. 50% NPK), T_6 (Cowdung @ 12 t/ ha), T_7 (Cowdung @ 12 t/ ha + $N_{40}P_6K_{36}S_{10}$ i.e. 50% NPK), T_8 (Vermicompost @ 8 t/ha), T_9 (Vermicompost @ 8 t/ha + $N_{40}P_6K_{36}S_{10}$ i.e. 50% NPK) and T_{10} ($N_{80}P_{12}K_{72}S_{10}$ i.e.100% NPK). Plant characters, yield attributes and yield were significantly influenced by different treatments. Except plant height, total tiller per hills and biological yield all the parameters were found to be highest with the treatment T_5 (Poultry manure @ 4 t/ ha + $N_{40}P_6K_{36}S_{10}$ i.e. 50% NPK). From our study we observed that among the treatments T_5 (Poultry manure @ 4 t/ha + 50% of recommended NPK) produced the highest grain yield (4.79 t ha-1) of rice which was statistically identical to T_{10} (100% of recommended NPK) and T_9 (Vermicompost @ 8 t/ha + $N_{40}P_6K_{36}S_{10}$) which resulted grain yield of 4.57 t/ha and 4.51 t/ha, respectively. Vermicompost was found as the best manures when it was applied alone. The economic analysis also showed that the application of T_5 maximized the profit and benefit-cost ratio (BCR) was the height (1.75) in the treatment which was almost similar to T_{10}. The lowest BCR (1.07) was obtained from control treatment (T_1).

Hossaen *et al.* (2011) conducted an experiment to evaluate the efficacy of different organic manure and inorganic fertilizer on the yield and yield attributes of Boro Rice (*Oryza sativa* L.). The experiment consisted of 8 treatments, T_0: Control, T_1: 100% $N_{100}P_{15}K_{45}S_{20}$ (Recommended dose), T_2: 50% NPKS + 5 t cowdung/ha, T_3: 70% NPKS + 3 t cowdung/ ha, T_4: 50% NPKS + 4 t poultry manure/ ha, T_5: 70% NPKS + 2.4 t poultry manure/ ha, T_6: 50% NPKS + 5 t vermicompost/ ha and T_7: 70% NPKS + 3 t vermicompost/ ha. At 30, 50, 70, 90 DAT and at harvest stage the tallest plant (24.18, 31.34, 44.67, 67.05 and 89.00 cm) and the greatest number of total tiller per hill (5.43, 11.64, 21.01 and 17.90) at same DAT was recorded from T_5 and the lowest was observed from T_0 in every aspect. The maximum number of effective tillers per hill (13.52), the longest panicle (24.59 cm), maximum number of total grain per plant (97.45), the highest weight of 1000 seeds (21.80 g), the maximum grain yield (7.30 t/ ha) and straw yield (7.64 t/ha) was recorded from T_5 treatment whereas the lowest number of effective tillers per hill (6.07) , the shortest panicle (16.45 cm) , the minimum total grain per plant (69.13) , the lowest weight of 1000 seeds (16.73 g), the lowest grain yield (2.06 t/ha) and straw yield (4.63 t/ ha) was observed from T_0 treatment. Although the highest biological yield was recorded from T_5 treatment but statistically similar result were found from T_3, T_4 and T_7 treatments. The highest harvest index also recorded for T_5 treatment. It was obvious that yield of rice can be increased substantially with the judicious application of organic manure with chemical fertilizer.

Romaniuk *et al.* (2011) carried out an experiment to evaluate the changes in soil properties with the application of different amounts of vermicompost (10 and 20 Mg·ha−1), and to construct a soil quality index that allows the evaluation of changes in the most sensitive soil parameters. The study was carried out in a cattle field of General Alvear, Buenos Aires, Argentina. Vermicompost application showed a positive effect on most of the chemical and biological soil properties evaluated, especially with the higher dose (20 $Mg.ha^{-1}$). There were slight but significant increases in electrical conductivity and soil pH with the higher dose of vermicompost. Physical soil properties were not affected by the vermicompost amend-ment. The SQI showed a significant increase of soil quality with the vermicompost dose of 20 $Mg \cdot ha^{-1}$, especially by enhancing the biochemical and biological properties.

Lakshmi *et al.* (2012) carried out an experiment to study the effect of Integrated Nutrient Management (INM) in rice and cumulative and residual effects of Integrated Nutrient Management of kharif rice on performance of rabi green gram were conducted at Regional Agricultural Research Station, Anakapalle during kharif and rabi 2009 and 2010. Rice was grown in kharif with 12 treatments, consisting of INM practices (where 50 % or 75 % recommended NPK were integrated with vermicomposts prepared from sugarcane trash, weeds, vegetable waste and rice straw), recommended fertilizer dose and control. During rabi, greengram was grown by dividing above plots into two, one receiving 50 % recommended chemical fertilizers and the other without any fertilizers. Grain and seed yields of rice and green gram were higher with INM practices, especially when vegetable market waste compost was applied. Production efficiency of rice increased with reduced chemical fertilizer levels and highest production efficiency was recorded with 50 % chemical fertilizers integrated with vermicomposts over 75 % chemical fertilizers integrated with vermicomposts. The nitrogen use efficiency with application of 75 % chemical fertilizers + weed vermicompost @ 2.5 t/ha was better than other combinations closely followed by 50 % RDF + 50 % prathista organics. Lowest production efficiency was recorded with 100 % chemical fertilizers alone. Highest profitable treatment in both the crops and in both fertilizer and without fetilizer effects was 75 % chemical fertilizers + vegetable market waste vermicompost @ 2.5 t/ha.

Mahmoud and Ibrahim (2012) carried out an experiment to evaluate the effect of vermicompost, when used alone or in combination with water treatment residuals (WTR) at mixed ratios of 2:1 and 1:1 wet weight (Vermi: WTR), on soil chemical properties of saline sodic soils, and on barley growth *(Hordeum aestivm).* The results showed that the soil EC, SAR, Cl^- and Na+ decreased significantly with the application of vermicompost alone and when mixed with WTR. Organic matter, CEC and nutrients available (N, P and K) were increased as the rate of the organic materials increased. The treatment of vermicompost: WTR (2:1 wet weight ratio) at level of 10g kg^{-1} soil gave the highest grain weight of barley plants compared to other treatments. Based on the results of the current study, the combinations of vermicompost and WTR can are considered as an ameliorating material to reclaim of salt- affected soils and to improve the yield of barley plants. Moreover, it can improve the efficiency of organic wastes and WTR disposal.

Abadi *et al.* (2012) carried out an experiment in split plot based on complete randomized block design in three replications in Sari Agricultural Sciences and Natural Resources University, to investigate the effect of vermicompost on physical and chemical properties of soil. The physical and chemical properties of soil included bulk density, particle density, total porosity, water holding capacity, field capacity, permanent wilting point, available water capacity, pH, organic carbon and electrical conductivity in soil. Six levels of fertilizer treatments (T_1= control, T_2= chemical fertilizer, T_3= 20 tons vermicompost + 1/2 T_2, T_4 = 20 tons / hac vermicompost + 1/2 T_2, T_5= 40 tons vermicompost + 1/2 T_2 and T_6= 40 tons / hac vermicompost) and three levels of application years, one year of fertilization (1385), two consecutive years of fertilization (1385 and 1386) and three consecutive years of fertilization (1385, 1386, 1387). The results of the study showed that the application of these treatments in soil were significantly effective in increasing the total porosity, water holding capacity, field capacity, permanent wilting point, available water capacity, organic carbon electrical conductivity and in decreasing the bulk density, particle density and pH compared to control. In Contrast years of consumption of fertilizer did not have any significant effect on the physical properties of the soil except for FC, PWP, AWC, pH, OC and EC. The interactions between years of consumption of fertilizers were significantly different only in particle density and field capacity.

Khursheed *et al.* (2013) conducted a pot experiment to ascertain the response of different organic sources viz., wheat straw, farm yard manure (FYM), vermicompost and poultry manure to rice (*Oryza sativa*) and also to monitor the effect of manuring on soil carbon pools. Application of poultry manure and vermicompost along with chemical fertilizers for supply of nitrogen, phosphorus and potassium (NPK) resulted in highest grain yield of rice. Soil carbon, labile carbon and water soluble carbon contents also improved with application of organic sources of N application.

2.3 Effect of pressmud on the soil properties, growth and yield of rice

Haq *et al* (2001) carried out a field study at two sites during Kharif season to examine the effect of various amendments on the yield of rice crop under saline conditions. The treatments were control, 100% GR, 20 ton FYM/ ha, 2.5 ton pressmud/ ha, 10 ton FYM/ ha + 1.25 ton pressmud/ ha, 100% GR + 20 ton FYM/ ha, 50% GR + 1.25 ton pressmud/ ha and 33% GR + 1.25 ton pressmud/ ha + 10 ton FYM/ ha. All the treatments increased the paddy yield considerably. The most effective treatment noted was the combination of gypsum, pressmud and farmyard manure (94% increases in yield over control) followed by pressmud alone (60%) or in combination with FYM (57%). Of all the treatments, gypsum proved the best in reclaiming the soil with regards to pH and gypsum requirement as it reduced pH and GR at 14-18% and GR 88-100%, respectively.

Solaimalai *et al* (2001) Pressmud is an unavoidable waste generated from sugar industries. Pressmud is rich in many plant nutrients and it also has properties to ameliorate degraded soils. For this reason pressmud is believed to be of much use in agriculture. Many research works indicate that application of pressmud improves soil fertility; nutrient uptake and yield of crops. Sulphitation pressmud can be used to amend the alkali soil whereas carbonation pressmud is useful reclaim acidic soils. This review discusses about the prospects of pressmud utilization in agriculture, especially with reference to soil conditioning and crop growth.

Bokhtiar and sakurai (2005) carried out an experiment under the high ganges river floodplain soils to examine the effects of organic manure viz. press mud and farmyard manure (FYM) in combination with inorganic fertilizer on productivity of sugarcane the maxium cane yield and sugar yield of 119.14 and 10.99 ton ha^{-1}, respectively were recorded in the treatment that received pressmud @ 15 ton ha^{-1}. Accompanied with 25 % less of recommended inorganic fertilizer i.e., N113, P39, K68, S26 and Zn2.3 kg ha^{-1}. Result also revealed that the effects of press mud were significantly alike with the other treatments that received recommended inorganic fertilizer only and 25% less of inorganic fertilizer with FYM @ 15 ton ha^{-1}. The organic carbon, total N and available P, K and S contents of soil increased slightly due to incorporation of organic manure in soils. It is indicated that 25 % chemical fertilizer could be saved by use of press mud or FYM @ 15 ton ha^{-1} for obtaining higher yield of sugarcane without deterioration of soil fertility.

Shankariah and Murthy (2005) studied the effect due to integrated use of chemical fertilizers (50%, 75% and 100% of recommended NPK) and enriched pressmud cake (10t ha^{-1} and 15 t ha^{-1}) in comparison with raw pressmud cake (15 t ha^{-1}) was studied on sugarcane crop for three seasons from 1999-2000 to 2002-2003 at zonal agricultural research station, visweswaraiah canal farm, mandya. Integrated use of enriched preesmud cake @ 15 tha^{-1} at recommended fertilizer NPK by 50 percent by the addition of enriched pressmud @ 15 t ha^{-1}. Enrichment of pressmud cake exhibited enhanced efficiency and higher returns.

Chauhan *et al.* (2008) conducted a field experiment during spring of 2006-07 at sugarcane research institute, shahjahanpur using sugarcane variety CoS 97264 to work out the biocompost 9prepared from biodegradation from pressmud) application on yield and quality of sugarcane crop and status of organic carbon content in the soil before planting and after harvest of the crop. It is clear from experimental results that highest cane yield was achieved in the treatment 50% N through biocompost + 50% N through inorganic source followed by treatments 33% N through biocompost+ 67% N through inorganic source and 75% N through biocompost + 25% N through inororganic source. The cane yield of treatments with biocompost application showed significantly superior over the treatment without biocompost application.

Kalaivanan and Hattab (2008) conducted an experiment to investigate the effect of enriched pressmud compost on soil chemical properties like pH, EC, major nutrient availability and yield of rice with five levels of pressmud compost viz., 0, 1.25, 2.50, 3.75 and 5.0 t ha^{-1} in two varieties viz., ADT 36 and ADT 43 and a hybrid ADTRH 1 during the kharif season. The results of the field experiment revealed that the hybrid ADTRH 1 manifested higher grain and straw yield, whereas, the variety ADT 43 and ADT 36 registered lower grain and straw yields, respectively. With regard to the enriched pressmud compost, the application of 1.25 t ha^{-1} of enriched pressmud compost showed its potentiality by providing more available nutrients to promote higher grain yields and it was comparable with 2.50 t ha^{-1} of enriched pressmud compost. However, the straw yield was higher with 2.50 t ha^{-1} of enriched pressmud compost and it was on par with 1.25 t ha^{-1} of pressmud compost. The soil reaction (pH) and Electrical Conductivity (EC) did not show any marked variation with application of enriched pressmud compost. The N, P and K availability in soil was at higher levels and comparable with application of 1.25 and 2.50 t ha^{-1} of enriched pressmud compost, whereas it was lower with control. The outcome of the present investigation revealed that the highest grain yield was obtained, at 1.25 t ha^{-1} of enriched pressmud compost along with inorganic fertilizers for the varieties and hybrid. Hence, the incorporation of 1.25 tha^{-1} enriched pressmud compost as basal along with required remaining nitrogen through inorganic fertilizer as top dressing in three splits may be recommended for rice crop to realize maximum yield in Kharif season.

Singh *et al.* (2008) conducted field experiments for 4 years to study the effect of press mud cake (PMC) (5 t $ha^{-1)}$ produced grain yield of rice similar to that obtained with the 120 kg N ha^{-1} in unamended plots. In the following wheat, the residual effects of PMC applied to preceding rice were equal to 40 kg N and 13 kg P ha^{-1}.

Anbhazhagan and Kathiresan (2010) conducted an experiment to study the effect of weed control treatments in integrated rice + fish + poultry farming system. The treatments were unweeded control, hand weeding twice, pressmud (10t ha^{-1}) + Azolla (1t ha^{-1}), butachlor (1.5kg ha^{-1}), anilofos (0.75kg ha^{-1}) and oxyfluorfen (0.25kg ha^{-1}). Among the different weed control methods used, application of rice herbicide oxyfluorfen at 0.25kg ha^{-1} recorded the least weed count of 12.57m-2 and weed dry matter production of 156.12kg ha^{-1} and in favouring the rice grain yield of 5.83t ha^{-1} in integrated rice + fish + poultry farming system. This treatment was followed by application of butachlor @ 1.5kg ha^{-1}.

Hossain *et al.* (2010) conducted an experiment to ascertain the effects of composted press mud (PM) and cowdung (CD) on rice. Two levels PM and CD (5 and 10 tha-1) individually or in combination with two levels of chemical fertilizers (CF=NPKSZn) @ 50 and 75% of the recommended dose were applied. One control and one 100% CF were also included. RCBD experimental design was followed with four replications. PM @ 10 t ha-1 in combination with 75% CF performed either the highest or identical to the maximum grain, straw and TDM (total dry matter) yields and also influenced the yield contributing characters during two consecutive years. The highest grain (5.62 t ha^{-1}) and straw (6.96 t ha^{-1}) yields in 2002 were obtained from PM 10 t ha^{-1} + 75% CF against control (2.2 and 2.64 t ha^{-1}). In 2003, the highest grain (6.81 t ha^{-1}) and straw (8.24 t ha^{-1}) yields were recorded by the treatment CD 10 t ha-1 + 75% CF whereas lowest recorded in control (2.61 t ha^{-1}, 3.20 t ha^{-1}, respectively). Rice yield and yield attributes significantly increased with the increasing amount of composted PM in combination with 50 or 25% reduced recommended rate of CF. The overall findings suggest that the composted PM combined with 50 or 75% CF can be an efficient practice for ensuring higher rice yield without deteriorating soil fertility.

Dash *et al.* (2011) carried out an experiment to investigate the effect of organic and inorganic sources of nitrogen (N) on yield attributes and yield of rice (*Oryza sativa*). The experiment was done during kharif season to rice crop. Application of 120 kg N ha-1 through chemical fertilizer (T_9) and combination of digested sludge (D.S), press mud (P.M) and woolen carpet wastes (C.W) (T_8) increased effective tillers m^{-2} as well as HI significantly as against the other N sources along with control (T_1) and remained at par to each other. However, highest number of effective tillers m^{-2}, filled grains per panicle, 1000 grain test weight and HI were observed in the treatment receiving recommended doses of chemical fertilizer (T_9) followed by the treatment T_8 (@ 40 kg N ha^{-1} each source). Application of N through chemical fertilizer (T_9) brought about significant improvement in grain and straw yields of rice crop and established superiority over rest of the treatments. Among organic N sources, supplication of N through combination of D.S + P.M + C.W @ 40 kg N ha^{-1}each (T_8) increased the grain and straw yield significantly as against the application of rest of the organic N sources and the control (T_1) except the straw yield due to incorporation of P.M alone (T_3) which remained at par.

Kalyanasundaram and Kavitha (2012) conducted an experiment to device suitable weed control measures for direct seeded puddled rice and to study the effect of the weed control measures on the soil microbial population. The treatments comprised of incorporation of pressmud @ 6.25 t ha^{-1} and application of herbicide butachlor @1.5 kg a. i. ha^{-1} with and without safener 4 days after sowing (DAS), 8 DAS alone and also in conjunction with hand weeding at 30 DAS. Hand weeding twice and a weedy check were also maintained. At maximum tillering stage, the population of bacteria was significantly reduced by butachlor application. The injury to microbes caused by herbicide disappeared with the advancement of crop's age and at flowering stage of crop, there was no significant difference among the treatments. The fungal and actinomycetes population remained unaltered by weed control treatments at both the stages of observation.

The literature review discussed above indicates that organic manure can supply a good amount of plant nutrients and thus can contribute to rice yields. The properties of soils are also influenced by the inclusion of organic manure and crop residues in the soil fertility management system either directly or through residual action. The integrated approach by using the organic and inorganic sources of nutrients helps improve the efficiency of nutrients. Hence, an effort should be undertaken to investigate the effect of integrated nutrient management on subsistance of crop productivity and maintenance of soil fertility in a rice cropping.

CHAPTER 3
MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted in the Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from December 2011 to April 2012 to study the influence of integrated use of manures and fertilizer on the growth and yield of hybrid dhan Hira 2. This chapter includes materials and methods that were used in conducting the experiment. The details are presented below under the following headings -

3.1 Experimental site and soil

The experiment was conducted in typical rice growing silty clay loam soil at the Sher-e-Bangla Agricultural University Farm, Dhaka during the Boro season of 2011-2012. The morphological, physical and chemical characteristics of the soil are shown in the Table 3.1 and 3.2.

Table 3.1. Morphological characteristics of the experimental field

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

(FAO and UNDP, 1988)

Table 3.2. Initial physical and chemical characteristics of the soil

Characteristics	Value
Mechanical fractions:	
% Sand (2.0-0.05 mm)	29.04
% Silt (0.05-0.002 mm)	41.80
% Clay (<0.002 mm)	29.16
Textural class	Silty Clay Loam
pH (1: 2.5 soil- water)	5.8
Organic Matter (%)	1.09
Total N (%)	0.04
Available K (meq/100g soil)	0.14
Available P (mg/kg)	16.5
Available S (mg/kg)	14.4

3.2 Climate

The climate of the experimental area is characterized by high temperature, high humidity and medium rainfall with occasional gusty winds during the kharif season (March-September) and a scanty rainfall associated with moderately low temperature in the rabi season (October-March). The weather information regarding temperature, rainfall, relative humidity and sunshine hours prevailed at the experimental site during the cropping season December 2011 to April 2012 have been presented in Appendix I.

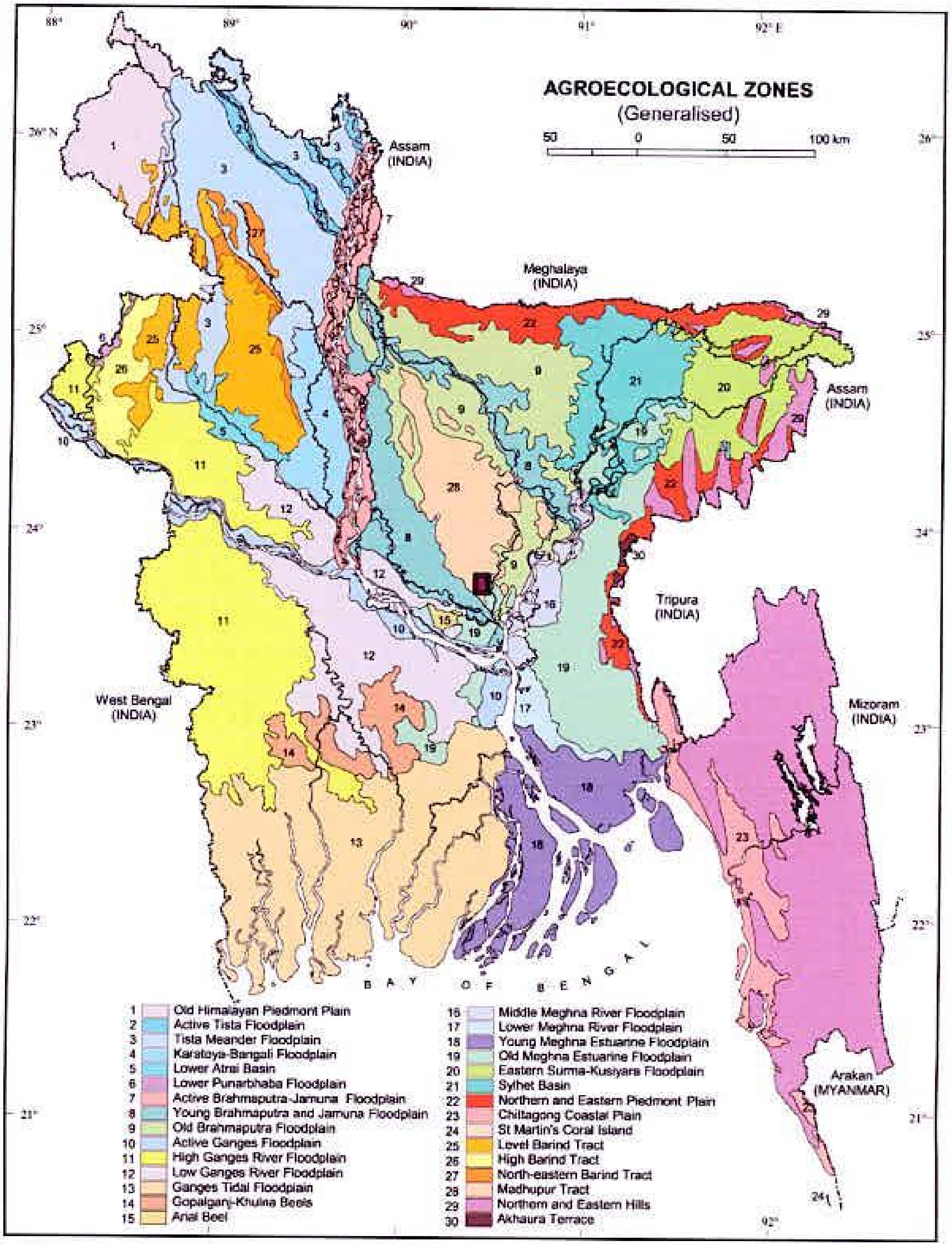


Figure 3.1. Map showing the experimental sites under study

3.3 Initial soil sampling

Before land preparation, initial soil samples at 0-15 cm depth were collected from different spots of the experimental field. The composite soil sample were air-dried, crushed and passed through a 2 mm (8 meshes) sieve. After sieving, the soil samples were kept in a plastic container for physical and chemical analysis of the soil.

3.4 Planting material

Hybrid dhan Hira 2 was used as the test crop in this experiment. This variety was imported from China. It is recommended for Boro season. Average plant height of the variety is 90-95 cm at the ripening stage. The grains are medium fine and white. It requires about 140-145 days completing its life cycle.

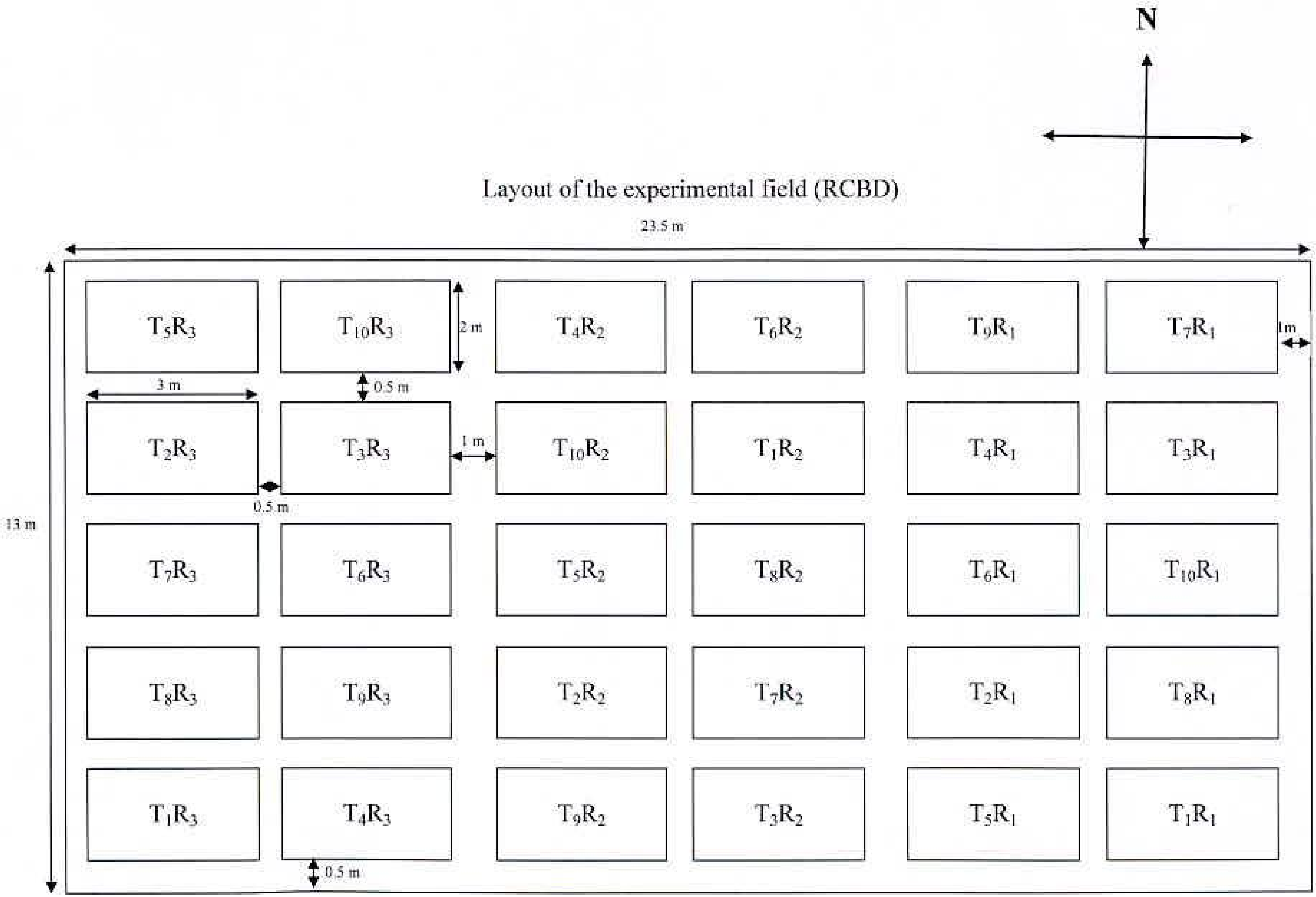
3.5 Land preparation

The land was first opened on 10 December, 2011 by a tractor and prepared thoroughly by ploughing and cross ploughing with a power tiller followed by country plough. Laddering helped breaking the clods and leveling the land followed every ploughing. Before transplanting each unit of plot was cleaned by removing the weeds, stubbles and crop residues. Finally each plot was prepared by puddling.

3.6 Experimental design and layout

The experiment was laid out in a Randomized Completely Block Design (RCBD) with three replications. The entire experimental area was divided into 3 blocks representing the replications to reduce soil heterogeneity and each block was subdivided into 10 unit plots with raised band as per treatments. Thus, the total number of unit plots was 30, treatments were ten. The unit plot size was 3.0 m × 2.0 m and the plots were separated through raising soil band upto 25 cm from the soil level. The block to block and plot to plot distance was 1.0m and 0.5m, respectively. The treatments were randomly distributed within each block.

Layout of the experimental field (RCBD)



Total area= 23.5 x 13=305.5 m^2

Fig. 3.2. Layout of the field experiment showing treatment assigned

3.7 Treatments

The experiment consists of 10 treatments each with three replications is presented below:

T_1: No nitrogenous chemical fertilizer and no manures (Control)

T_2:120 kg N/ha from urea

T_3: 90 kg N/ha from urea+ 30 kg N/ha from vermicompost (VC).

T_4: 90 kg N/ha from urea+ 30 kg N/ha from pressmud

T_5: 60 kg N/ha from urea+ 60 kg N/ha from vermicompost (VC)

T_6: 60 kg N/ha from urea+ 60 kg N/ha from pressmud

T_7: 30 kg N/ha from urea +90 kg N/ha from vermicompost (VC)

T_8: 30 kg N/ha from urea+ 90 kg N/ha from pressmud

T_9: 120 kg N/ha from vermicompost (VC)

T_{10}: 120 kg N/ha from pressmud

3.8. Fertilizer application

The amounts of nitrogenous fertilizer required per plot were calculated as per the treatments. Full amounts of recommended dose of TSP, MP, gypsum and zinc sulphate were applied as basal dose in all plots including control treatment plot before transplanting of rice seedlings. Urea were applied in 3 equal splits: one third was applied at basal before transplanting, one third at active tillering stage (30 DAT) and the remaining one third was applied at 5 days before panicle initiation stage (55 DAT).

3.9. Organic manure incorporation

Two different types of organic manure viz. pressmud and vermicompost were used. The rates of vermicompost per plot were 1, 2, 3 and 4 kg in treatment T_3, T_5, T_7 and T_9, respectively. The rates of pressmud per plot were 1.7, 3.34, 5.1 and 6.8 kg in treatment T_4, T_6, T_8 and T_{10}, respectively. Vermicompost and pressmud were applied before four days of final land preparation. Chemical compositions of the manures used have been presented in Table 3.3.

Table 3.3. Chemical compositions of the vermicompost and pressmud (oven dry basis)

Sources of organic manure	Nutrient content			
	N (%)	P (%)	K (%)	S (%)
Vermicompost	2.1	0.29	0.74	0.24
Pressmud	1.24	0.77	2.8	0.29

3.10 Raising of seedlings

The seedlings of rice were raised in wet-bed methods. Seeds (95% germination) @ 10 kg/ha were soaked and incubated for 48 hour and. Then seeds were sown directly in the raised seedbed on 1st December' 2011 for raising seedlings. During seedling growing, no fertilizers were used. Proper water and pest management practices were followed whenever required.

3.11 Transplanting

Seedlings of hybrid dhan hira 2 were carefully uprooted from the seedling nursery and transplanted on 2nd January, 2012 in well puddled plot. Two seedlings per hill were used following a spacing of 15 cm × 20 cm. After one week of transplanting all plots were checked for any missing hill, which was filled up with extra seedlings whenever required.

3.12 Intercultural operations

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

3.12.1 Irrigation

Necessary irrigations were provided to the plots as and when required during the growing period of rice crop.

3.12.2 Weeding

The plots were infested with some common weeds, which were removed by uprooting them from the field three times during the period of the cropping season.

3.12.3 Insect and pest control

There was no infestation of diseases in the field but leaf roller (*Chaphalocrosismedinalis*, Pyralidae, Lepidoptera) was observed in the field and used Malathion @ 1.12 L ha^{-1}.

3.13 Crop harvest

The crop was harvested at full maturity when 80-90% of the grains were turned into straw colored on 27 April, 2012. The crop was cut at the ground level and plot wise crop was bundled separately and brought to the threshing floor. Ten hills of rice plant were selected randomly from the plants for measuring yield contributing characters.

3.14 Yield components

3.14.1 Total number of effective tiller/hill

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

3.14.2 Total number of non- effective tiller/hill

The total number of non-effective tiller/hill was counted as the number of non-panicle bearing plant/hill. Data on non- effective tiller/hill were counted from 10 randomly selected hills and average value was recorded.

3.14.3 Plant height (cm)

The height of plant was recorded in centimeter (cm) at harvesting stage. Data were recorded as the average of 10 plants selected at random from the inner rows of each plot. The height was measured from the ground level to the tip of the panicle.

3.14.4 Length of panicle (cm)

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

3.14.5 Number of unfilled and filled grain per panicle

The total numbers of unfilled grains were calculated from selected 10 plants of a plot on the basis of not filled grain in the spikelet and then average numbers of unfilled grain per panicle was recorded. Similarly filled grains panicle^{-1} were counted.

3.14.6 Weight of 1000 seeds (g)

One thousand seeds were counted randomly from the total cleaned harvested seeds and then weighed in grams and recorded.

3.14.7 Straw yield (kg)

Straw obtained from each unit plot were sun-dried and weighed carefully. The dry weight of straw of the respective unit plot yield was converted to t/ha.

3.14.8 Grain yield (kg)

Grains obtained from each unit plot were sun-dried and weighed carefully. The dry weight of grains of the respective unit plot yield was converted to t ha^{-1}.

3.15 Chemical analysis of plant samples

3.15.1 Collection and preparation of plant samples

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

3.15.2 Digestion of plant samples with sulphuric acid for N

For the determination of nitrogen an amount of 0.5 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 7 ml conc. H_2SO_4 were added. The flasks were heated at 160^0C and added 2 ml 30% H_2O_2 then heating was continued at 360^0C until the digests become clear and colorless. After cooling, the content was taken into a 50 ml volumetric flask and the volume was made up to the mark with de-ionized water. A reagent blank was prepared in a similar manner. Nitrogen in the digest was estimated by distilling the digest with 10 N NaOH followed by titration of the distillate trapped in H_3BO_3 indicator solution with 0.01N H_2SO_4.

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

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

3.15.4 Determination of P, K and S from plant samples

3.15.4.1 Phosphorus

Plant samples (grain and straw) were digested by di-acid (Nitric acid and Perchloric acid) mixture and P content in the digest was measured by blue color development (Olsen *et al.*, 1954). Phosphorus in the digest was determined by using 5 ml for grain and straw sample from 50 ml digest by developing blue color with reduction of phosphomolybdate complex and the color intensity were measured colorimetrically at 660 nm wavelength and readings were calibrated with the standard P curve (Page *et al.*, 1982).

3.15.4.2 Potassium

One milli-liter of digest sample for the grain and straw were taken and diluted 20 ml volume to make desired concentration so that the flame photometer reading of samples were measured within the range of standard solutions. The concentrations were measured by using standard curves.

3.15.4.3 Sulphur

Sulphur content was determined from the digest of the plant samples (grain and straw) with $CaCl_2$ (0.15%) solution as described by Page *et al.* (1982). The digested S was determined by developing turbidity by adding acid seed solution (20 ppm S as K_2SO_4in 6N HCl) and $BaCl_2$ crystals. The intensity of turbidity was measured by spectrophotometer at 420 nm wave lengths (Hunter, 1984).

3.16 Nutrient uptake

After chemical analysis of straw and grain samples the nutrient contents were calculated and from the value of nutrient contents, nutrient uptakes were also calculated by following formula:

Nutrient uptake (Kg/ha) = Nutrient content (%) × Yield (kg/ha)/100

3.17 Post harvest soil sampling

After harvest of crop soil samples were collected from each plot at a depth of 0 to 15 cm. Soil sample of each plot were air-dried, crushed and passed through a two mm (10 meshes) sieve. The soil samples were kept in plastic container to determine the physical and chemical properties of soil.

3.18 Soil analysis

Soil samples were analyzed for both physical and chemical characteristics viz. organic matter, pH, total N and available P, K, and S contents. The soil samples were analyzed by the following standard methods as follows:

3.18.1 Textural class

Mechanical analysis of soil were done by hydrometer method (Bouyoucos, 1926) and the textural class was determined by plotting the values of % sand, % silt and % clay to the Marshall's textural triangular co-ordinate following the USDA system.

3.18.2 Soil pH

Soil pH was measured with the help of a glass electrode pH meter, the soil water ratio being maintained at 1: 2.5 (Jackson, 1962).

3.18.3 Organic matter

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

3.18.4 Total nitrogen

Total N content of soil were determined followed by the Micro Kjeldahl method. One gram of oven dry ground soil sample was taken into micro kjeldahl flask to which 1.1 gm catalyst mixture (K_2SO_4: $CuSO_4$. $5H_2O$: Se in the ratio of 100: 10: 1), and 7 ml H_2SO_4 were added. The flasks were swirled and heated 160^0C and added 2 ml H_2O_2 and then heating at 360 ^0C was continued until the digest was clear and colorless. After cooling, the content was taken into 50 ml volumetric flask and the volume was made up to the mark with distilled water. A reagent blank was prepared in a similar manner. These digests were used for nitrogen determination (Page *et al.*, 1982).

Then 20 ml digest solution was transferred into the distillation flask, Then 10 ml of H_3BO_3 indicator solution was taken into a 250 ml conical flask which is marked to indicate a volume of 50 ml and placed the flask under the condenser outlet of the distillation apparatus so that the delivery end dipped in the acid. Add sufficient amount of 10N-NaOH solutions in the container connecting with distillation apparatus. Water runs through the condenser of distillation apparatus was checked. Operating switch of the distillation apparatus collected the distillate. The conical flask was removed by washing the delivery outlet of the distillation apparatus with distilled water.

Finally the distillates were titrated with standard 0.01 N H_2SO_4 until the color changes from green to pink.

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 (ml) value of standard H_2SO_4

B = Blank titration (ml) value of standard H_2SO_4

N = Strength of H_2SO_4

S = Sample weight in gram

3.18.5 Available phosphorus

Available P was extracted from the soil with 0.5 M $NaHCO_3$ solutions, pH 8.5 (Olsen *et al.*, 1954). Phosphorus in the extract was then determined by developing blue color with reduction of phosphomolybdate complex and the color intensity were measured colorimetrically at 660 nm wavelength and readings were calibrated the standard P curve (Page *et al.*, 1982).

3.18.6 Exchangeable potassium

Exchangeable K was determined by 1N NH_4OAc (pH 7) extraction methods and by using flame photometer and calibrated with a standard curve Page *et al.*,(1982).

3.18.7 Available sulphur

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

3.19 Statistical analysis

The data obtained for different parameters were statistically analyzed to find out the significant difference of different treatments on yield and yield contributing characters of hybrid dhan Hira 2. The mean values of all the characters were statistically analyzed by following the analysis of variance (ANOVA) technique using the MSTAT-C computer package program. The mean differences among the treatments were compared by least significant difference (LSD) test at 5% level of significance.

CHAPTER 4

RESULTS AND DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

The results of the experiment conducted under field conditions are presented in several Tables and Figures. The experiment was conducted to study the effect of integrated use of manures and fertilizer on the growth and yield of hybrid dhan Hira 2. The results are presented and discussed under the following parameters.

4.1 Effect on plant height

Plant height was significantly influenced by vermicompost and pressmud along with inorganic nitrogenous fertilizer (Table 4.1). Plant height ranged from 82 to 95 cm. The highest plant height (95cm) was recorded in the treatment T_3 receiving 90 kg N/ha as the source of urea with combination of 30 kg N/ha from vermicompost. The lowest plant height (82 cm) was produced by T_1treatment receiving no inorganic and organic fertilizer. Treatment T_3 produced 15.85 % higher plant height over control treatment (Figure 4.1). This might be due to the balanced supply of nutrients from vermicompost along with urea fertilizer, which enhanced plant height. Plant height in hybrid dhan Hira 2 increased by the application of farm wastes (Budhar *et al*. 1991). Hoque (1999) found that plant height significantly increased with the application of cowdung along with chemical fertilizer. The increased plant height through the application of FYM along with N, P and K was also reported by many other scientists (Kobayashi *et al*. 1989, Maskina *et al*. 1987).

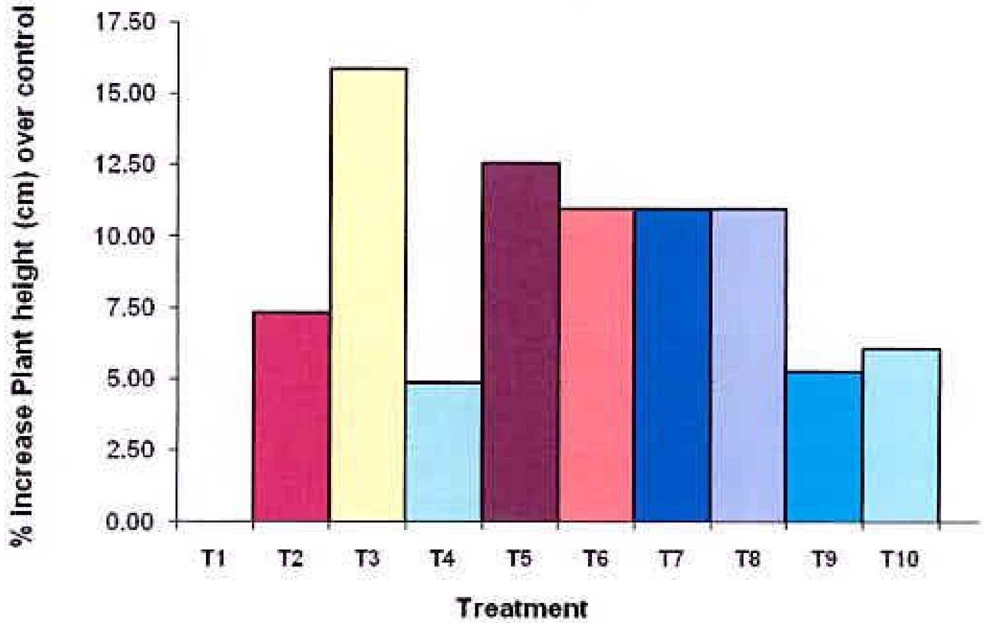


Figure 4.1. Effect of integrated use of manures and fertilizer on percent increase in plant height of hybrid dhan Hira 2 over the control

4.2 Effect on number of tillers per hill

Number of tillers per hill was significantly influenced by vermicompost and pressmud along with chemical nitrogenous fertilizer (Table 4.1). Maximum number of tillers per hill (16.67/hill) was recorded in T_3 treatment receiving 90 kg N/ha as the source of urea with combination of 30 kg N/ha from vermicompost. Vermicompost in association with chemical nitrogen fertilizer exerted positive effect on the number of tillers per hill. The lowest number of tillers per hill (8.33/hill) was noted by control (T_1) treatment. Treatment T_3 produced 100% higher number of tiller per hill than control treatment (Figure 4.2). Ahmed and Rahman (1991) recorded significantly increased tiller number of rice due to cowdung or vermicompost along with chemical nitrogen fertilizers. Aptosol (1989) also found that combined application of organic and inorganic fertilizers increased the number of tillers per hill.

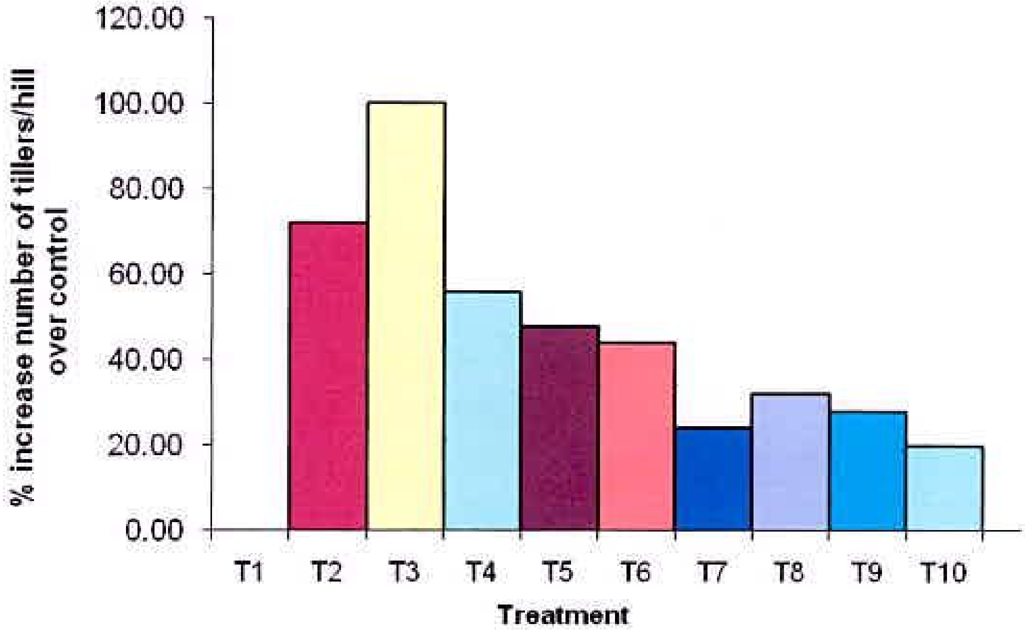


Figure 4.2. Effect of integrated use of manures and fertilizer on percent increase in tillers number per hill of hybrid dhan Hira 2 over the control

4.2.1 Effect on number of effective tillers per hill

There was a significant effect of the treatments on number of effective tillers per hill (Table 4.1). All the treatments significantly produced higher number of effective tillers per hill over control treatment. Treatment T_3 receiving 90 kg N/ha as the source of urea with combination of 30 kg N/ha from vermicompost produced the highest number of effective tillers (15.33/hill). The lowest number of effective tillers per hill (7.0/hill) was noted by control (T_1) treatment.

4.2.2 Effect on number of non-effective tiller

There was an insignificant effect of the different levels of treatments on non-effective tiller per hill which is shown in Table 4.1. Whether, the maximum number of non-effective tillers (2/hill) was recorded in treatment T_2 receiving 120 kg N/ha from urea and the minimum number of non-effective tillers per hill (0.67/hill) was noted in T_6, T_8 and T_{10}.

Table 4.1. Effect of integrated use of manures and fertilizer on plant height, number of tillers per hill, effective tillers and non-effective tillers per hill of hybrid dhan Hira 2

Treatment	Plant height (cm)	Number of tillers/hill	Number of effective tillers/hill	Number of non-effective tillers/hill
T_1	82.00 d	8.33 f	7.00 e	1.33 ab
T_2	88.00 c	14.33 b	12.33 b	2.00 a
T_3	95.00 a	16.67 a	15.33 a	1.33 ab
T_4	86.00 c	13.00 bc	12.00 b	1.00ab
T_5	92.33 ab	12.33 cd	11.33bc	1.00ab
T_6	91.00 b	12.00 cd	11.33bc	0.67 b
T_7	91.00 b	10.33 e	9.33 d	1.00ab
T_8	91.00 b	11.00 de	10.33 cd	0.67 b
T_9	86.33 c	10.67 e	9.67 d	1.00ab
T_{10}	87.00 c	10.00 e	9.33 d	0.67 b
LSD	2.75	2.34	2.33	0.892
CV (%)	1.80	7.22	7.50	62.40

Means in a column followed by same letter (s) are not significantly different at 5% level of significance by LSD

Note: T_1: No chemical fertilizer and no manures (Control), T_2: 120 kg N/ha from urea, T_3: 90 kg N/ha from urea+ 30 kg N/ha from vermicompost (VC), T_4: 90 kg N/ha from urea+ 30 kg N/ha from pressmud, T_5: 60 kg N/ha from urea+ 60 kg N/ha from vermicompost (VC), T_6: 60 kg N/ha from urea+ 60 kg N/ha from pressmud, T_7: 30 kg N/ha from urea +90 kg N/ha from vermicompost (VC), T_8: 30 kg N/ha from urea+ 90 kg N/ha from pressmud, T_9: 120 kg N/ha from vermicompost (VC), T_{10}: 120 kg N/ha from pressmud

4.3 Effect on panicle length

The effects of different treatments on panicle length are shown in Table 4.2. The highest panicle length (25.64 cm) was noted in T_3 treatment receiving 90 kg N/ha from the source urea with combination of 30 kg N/ha from vermicompost. The lowest panicle length (23.18 cm) was produced by T_1 treatment receiving no inorganic and organic fertilizer. Treatment T_3 produced 10.61% higher panicle length over control treatment (Figure 4.3). This might be due to the balanced supply of nutrients from vermicompost along with urea fertilizer, which enhanced panicle length.

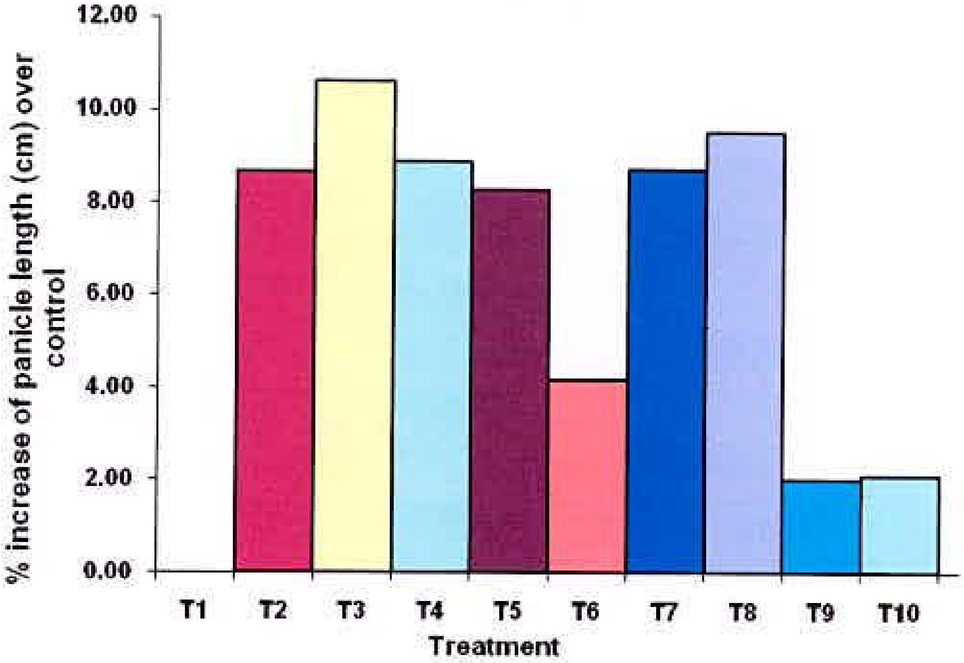


Figure 4.3. Effect of integrated use of manures and fertilizer on percent increase of panicle length of hybrid dhan Hira 2

4.4 Effect on number of grains per panicle

Number of grains per panicle of hybrid dhan Hira 2 varied from 133.3 to 146 and the highest and the lowest number of grains per panicle was found in the treatment T_3 and T_1, respectively (Table 4.2). Application of 90 kg N/ha from the source urea along with 30 kg N/ha from vermicompost produced the maximum number of grains per panicle (146) with an increase of 9.5% over control treatment under study (Figure 4.4). Inorganic nitrogen with the combination of vermicompost was found to be more effective in producing number of grains per panicle compared to other treatments even with only inorganic nitrogenous fertilizer.

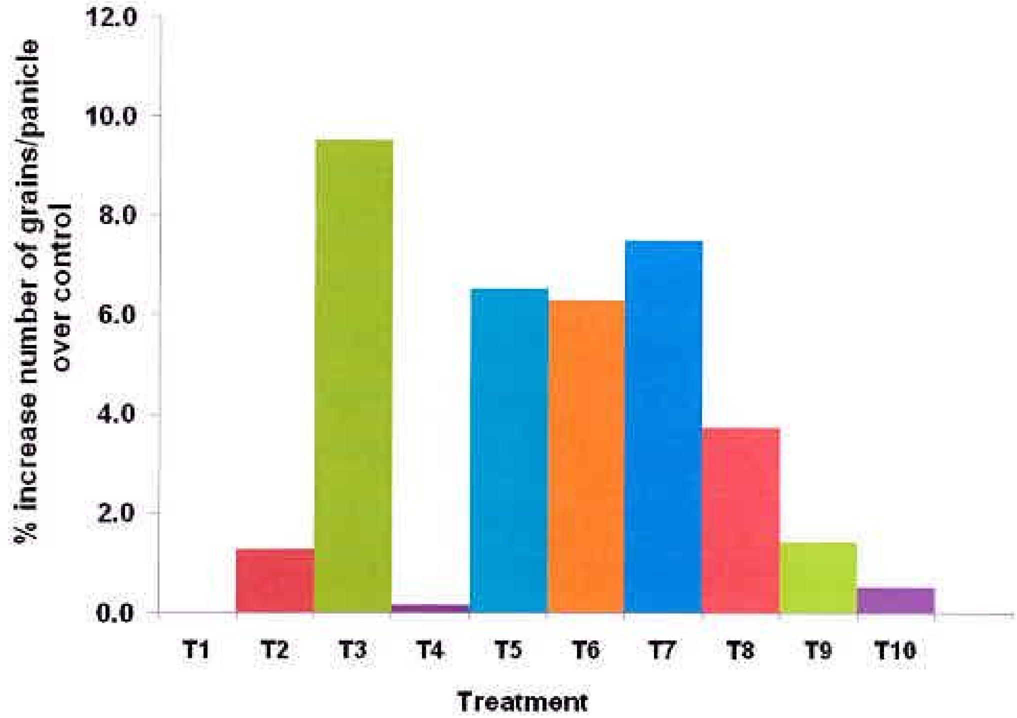


Figure 4.4. Effect of integrated use of manures and fertilizer on percent increase of number of grain/panicle of hybrid dhan Hira 2

4.4.1 Effect on number of filled grains per panicle

There was a significant effect of the treatments on number of filled grains per panicle (Table 4.2). The maximum number of filled grains per panicle (142.3) was noted when 90 kg N/ha from the source urea along with 30 kg N/ha from vermicompost (T_3) was applied. The minimum number of filled grains per panicle (128.7) was recorded in T_1 treatment receiving no chemical fertilizer and manure. Mondal *et al.* (1990) stated that increasing NPK rates and FYM gave significant number of filled grains per panicle of rice.

4.4.2 Effect on number of unfilled grains per panicle

The effects of different treatments on number of unfilled grains per panicle are shown in Table 4.2. With respect to number of unfilled grains per panicle, the highest number of unfilled grains per panicle (8.00) was noted in treatment T_8 receiving 30kg N/ha from urea and 90 N/ha from pressmud. The lowest number of unfilled grains per panicle (3.67) was observed by treatment (T_3) receiving 90 kg N/ha from the source urea along with 30 kg N/ha from vermicompost.

4.5 Effect on weight of 1000 grains

Weight of 1000 grains was significantly influenced by different combinations of organic fertilizers and inorganic fertilizer (Table 4.2).Weight of 1000 grains varied from 27.5g to 33.33g. The maximum weight of 1000 grains (33.33g) was recorded under the treatment T_3 whose effect was statistically similar to T_7 treatment but superior to the rest of the treatments. Treatment T_3 produced 21.2% higher weight of 1000 grains per panicle over control treatment of hybrid dhan Hira 2 (Fig. 4.5). The lowest weight of 1000 grains (27.5g) was noted in control treatment (T_1). The effect of this treatment was statistically identical to T_2 and T_{10} treatments of hybrid dhan Hira 2.

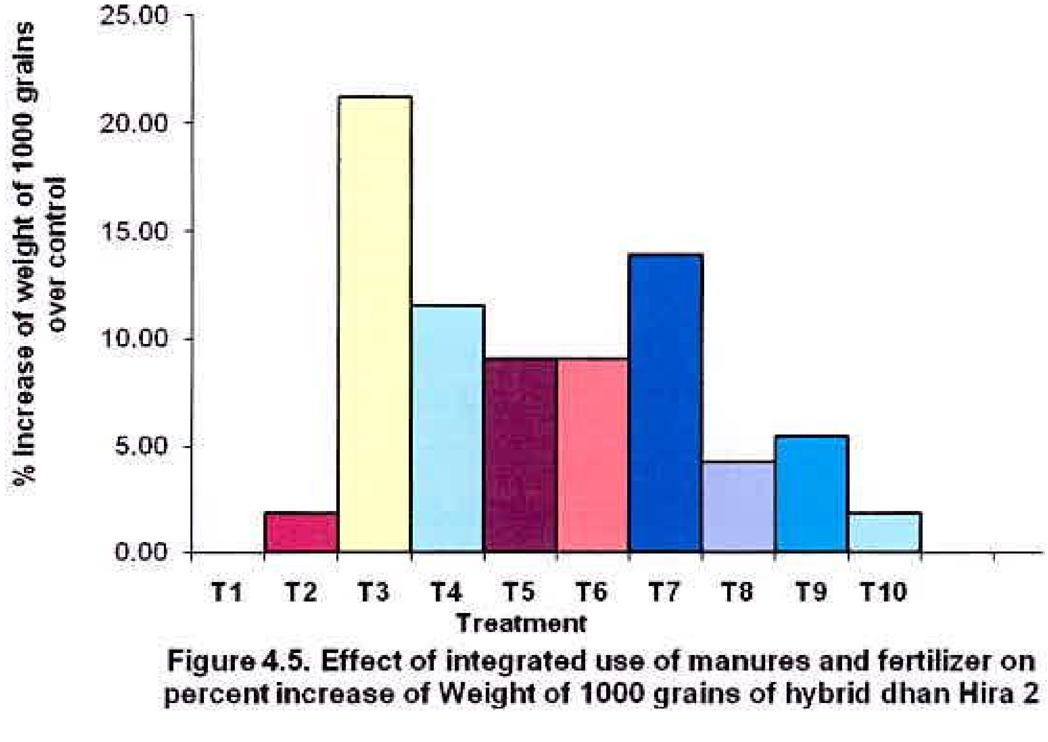


Figure 4.5. Effect of integrated use of manures and fertilizer on percent increase of Weight of 1000 grains of hybrid dhan Hira 2

Table 4.2. Effect of integrated use of manures and fertilizer on panicle length, number of grains, number of filled grains, number of unfilled grains per panicle, Weight of 1000 grains of hybrid dhan Hira 2

Treatment	Panicle length (cm)	Number of grains/ panicle	Number of filled grains/ panicle	Number of unfilled grains/panicle	Weight of 1000 grains
T_1	23.18 c	133.3 d	128.7d	4.67 cde	27.5d
T_2	25.19 ab	135.0cd	130.7 cd	4.33 de	28.00 d
T_3	25.64 a	146.0a	142.3 a	3.67e	33.33a
T_4	25.24ab	133.5d	129.5d	4.00de	30.67bc
T_5	25.10 ab	142.0abc	135.0bcd	7.00 ab	30.00bcd
T_6	24.15bc	141.7abc	136.7 abc	5.00 cde	30.00 bcd
T_7	25.2ab	143.3ab	138.0 ab	5.33 cd	31.33 ab
T_8	25.39ab	138.3bcd	130.3 cd	8.00a	28.67 cd
T_9	23.65 c	135.2cd	129.2 d	6.00 bc	29.00 cd
T_{10}	23.67 c	134.0 d	129.0 d	5.00cde	28.00 d
LSD	1.278	7.252	4.62	1.32	2..056
CV (%)	3.02	3.06	2.98	15.60	4.04

Means in a column followed by same letter (s) are not significantly different at 5% level of significance by LSD.

4.6 Effect on raw grain yield

There was a significant effect of the treatments on raw grain yield (t/ha) (Table 4.3). The highest raw grain yield (9.56 t/ha) was found when 90 kg N/ha from the source urea along with 30 kg N/ha from vermicompost (T_3) was applied. The lowest raw grain yield (5.36 t/ha) was noted in control (T_1) treatment. Treatment T_3 produced 90.46 % higher raw grain yield (t/ha) over control treatment of hybrid dhan Hira 2 (Figure 4.6). Khursheed *et al.* (2013) found that application of poultry manure and vermicompost along with chemical fertilizers for supply of nitrogen, phosphorus and potassium (NPK) resulted in the highest grain yield of rice.

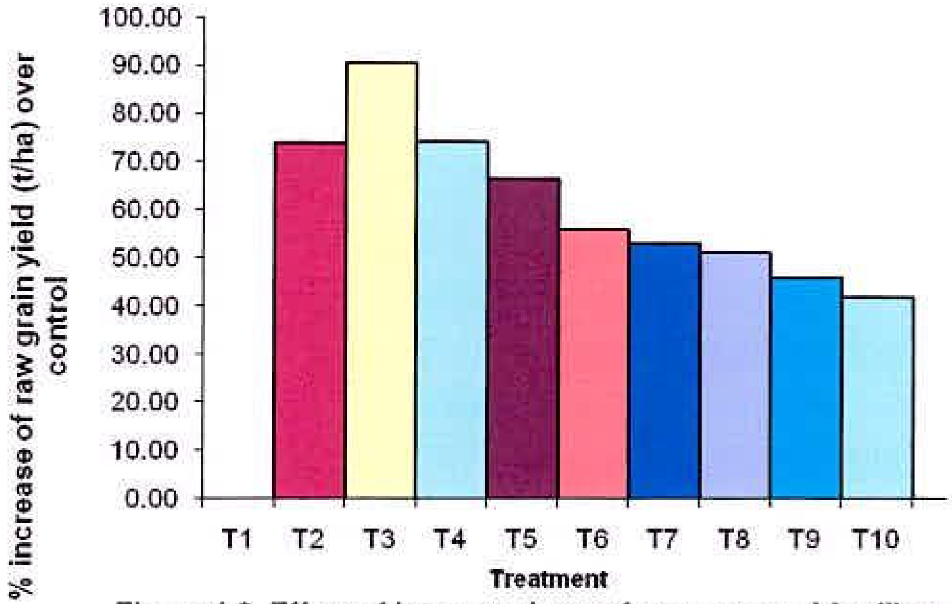


Figure 4.6. Effect of integrated use of manures and fertilizer on percent increase of raw grain yield (t/ha) of hybrid dhan Hira 2

4.7 Effect on raw straw yield

Raw straw yield was significantly influenced by different combinations of pressmud and vermicompost along with chemical nitrogen fertilizer (Table 4.3). Raw straw yield varied from 9.12 to 13.42 t/ha of hybrid dhan Hira 2. The highest raw straw yield (13.42 t/ha) was recorded by the treatment T_3. The lowest raw straw yield (9.12 t/ha) was found in control (T_1) treatment. Treatment T_3 produced 68.58 % higher raw straw yield (t/ha) over control treatment of hybrid dhan Hira 2 (Figure 4.7).

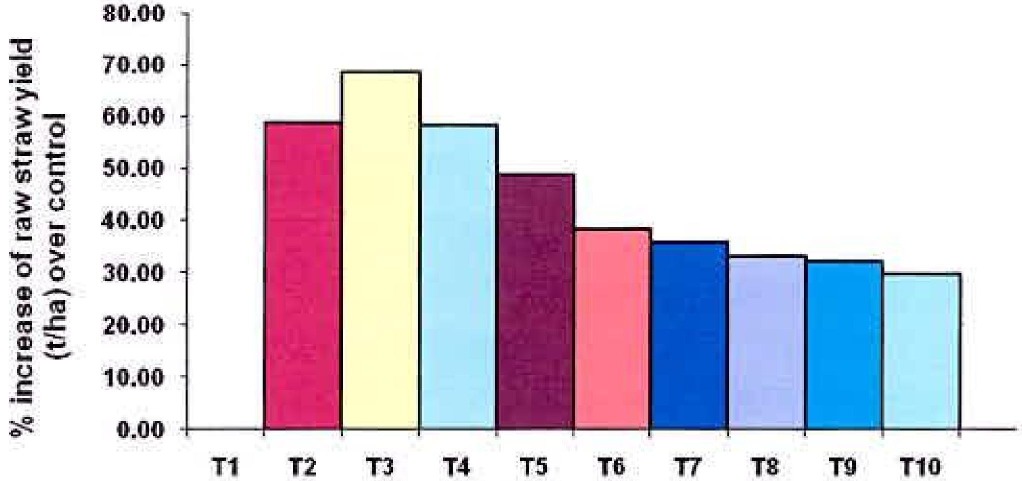


Figure 4.7. Effect of integrated use of manures and fertilizer on percent increase of raw straw yield (t/ha) of hybrid dhan Hira 2

4.8 Effect on dry grain yield

Dry (15% moisture) grain yield was significantly influenced by different fertilizer treatments (Table 4.3). The maximum dry grain yield (8.78 t/ha) of hybrid dhan Hira 2 was recorded when 90 kg N/ha as the source of urea along with 30 kg N/ha from vermicompost (T_3) was applied and the lowest dry grain yield (4.61 t/ha) was obtained from the control (T_1) treatment. Treatment T_3 produced 90.46 % increased dry grain yield (t/ha) over control treatment of hybrid dhan Hira 2 (Figure 4.8).

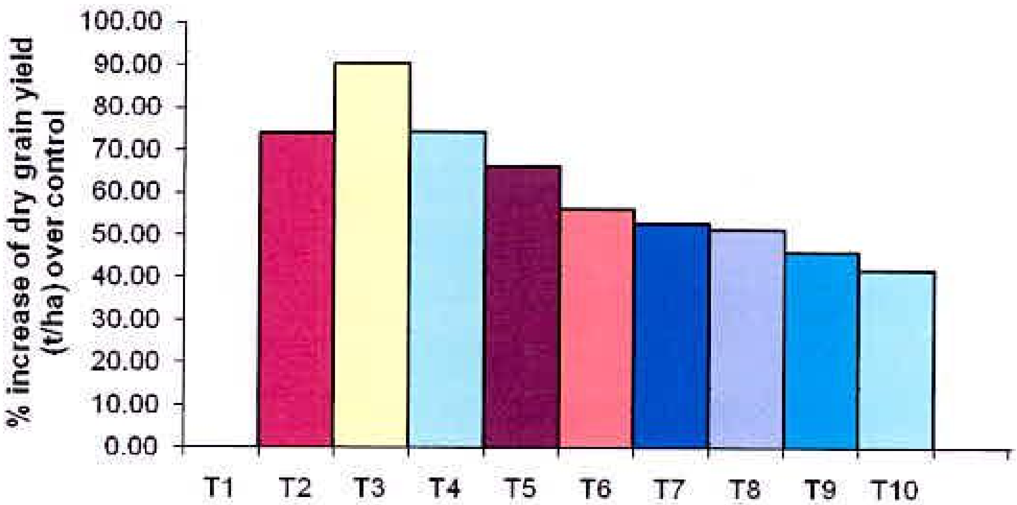


Figure 4.8. Effect of integrated use of manures and fertilizer on percent increase of dry grain yield (t/ha) of hybrid dhan Hira 2

4.9 Effect on dry straw yield

There was a significant effect of different levels of pressmud and vermicompost along with chemical nitrogenous fertilizer of hybrid dhan Hira 2 (Table 4.3). The highest dry straw yield (7.62 t/ha) was noted in T_3 treatment. The lowest dry straw yield (4.52 t/ha) was obtained from the control (T_1) treatment. Treatment T_3 produced 68.58 % increased dry straw yield (t/ha) over control treatment (Figure 4.9).

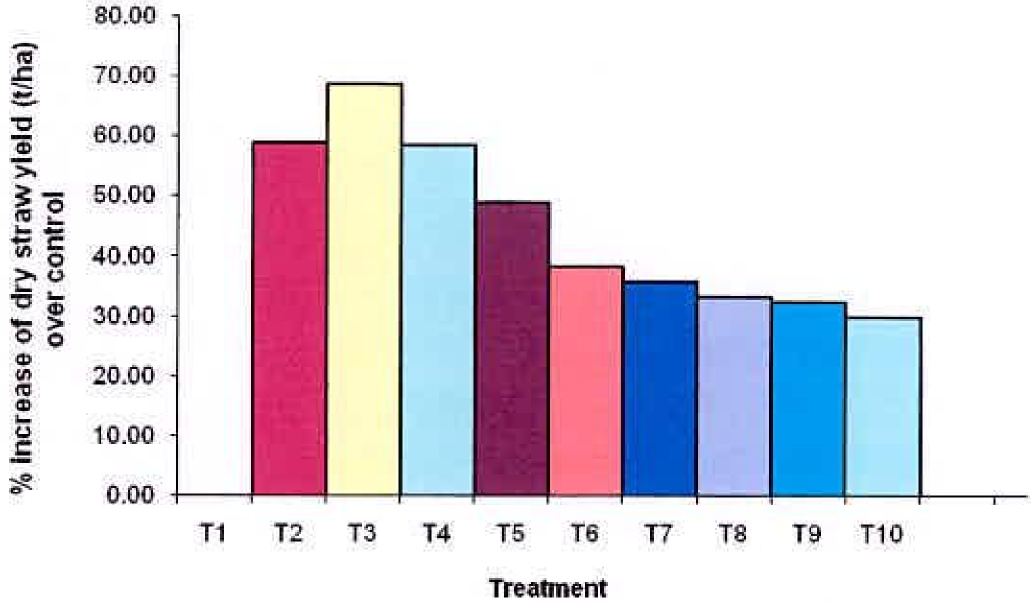


Figure 4.9. Effect of integrated use of manures and fertilizer on percent increase of dry straw yield (t/ha) of hybrid dhan Hira 2 over control

Table 4.3. Effect of integrated use of manures and fertilizer on raw grain yield, raw straw yield, dry grain yield and dry straw yield of hybrid dhan Hira 2

Treatment	Raw grain yield(t/ha)	Raw straw yield(t/ha)	Dry grain yield(t/ha)	Dry straw yield(t/ha)
T_1	5.36j	9.12 j	4.61 i	4.52 j
T_2	8.78 b	13.42b	8.02b	7.18 b
T_3	9.56a	14.67a	8.78 a	7.62 a
T_4	8.74 c	13.03 c	8.03 b	7.16 c
T_5	8.42 d	12.79 d	7.67 c	6.73 d
T_6	7.97e	12.15e	7.19 d	6.25 e
T_7	7.83 f	11.57f	7.05 e	6.14 f
T_8	7.68 g	11.04g	6.97 f	6.02 g
T_9	7.41h	10.68h	6.73 g	5.98 h
T_{10}	7.15i	10.26i	6.54 h	5.87 i
LSD	0.0172	0.0172	0.0543	0.0172
CV (%)	0.20	0.16	0.33	0.32

Means in a column followed by same letter (s) are not significantly different at 5% level of significance by LSD

4.10 Effect on nitrogen content in grain

There was significant difference among the treatments in recording nitrogen content in grain (Table 4.4). The maximum nitrogen content in grain (1.092%) was noted in the treatment T_3 receiving 90 kg N/ha from the source of urea along with 30 kg N/ha from vermicompost. The lowest nitrogen content in grain (0.542%) was found in control treatment (T_1). Jeong *et al*. (1996) found that 5 t/ha application of fermented chicken manure increased nitrogen concentration in rice plant.

4.11 Effect on phosphorus content in grain

Phosphorus content in grain was varied significantly due to the influence of inorganic and organic fertilizers (Table 4.4). The phosphorus content in grain varied from 0.209 to 0.297 %. The highest phosphorus content (0.297 %) in grain was found in treatment T_3 which was statistically similar to T_2. The lowest phosphorus content in grain 0.209 % was found in control (T_1) treatment.

4.12 Effect on potassium content in grain

Potassium content in grain was statistically significant due to the application of different levels of organic fertilizers and inorganic fertilizer (Table 4.4). The maximum potassium content in grain (0.374 %) was recorded in treatment T_3 receiving 90 kg N/ha from the source of urea along with 30 kg N/ha from vermicompost which was statistically identical to T_2 and T_4. The lowest potassium content in grain (0.247 %) was noted in control (T_1) treatment. Kadu *et al*. (1991) obtained highest potassium content in rice grain due to the application of highest doses of NPK with the association of farmyard manure.

4.13 Effect on sulphur content in grain

Sulphur content in grain was statistically significant due to the application of different levels of organic fertilizers and inorganic fertilizer (Table 4.4). The maximum sulphur content in grain (0.124 %) was recorded in treatment T_2 receiving 120 kg N/ha from urea which was statistically similar to T_3, T_4 and T_5. The lowest sulphur content in grain (0.069 %) was noted in control (T_1) treatment.

Table 4.4. Effect of integrated use of manures and fertilizer on nitrogen, phosphorus and potassium content of grain of hybrid dhan Hira 2

Treatment	Nitrogen content (%)	Phosphorus content (%)	Potassium content (%)	Sulphur content (%)
T_1	0.542 i	0.209 f	0.247 g	0.069 d
T_2	1.054 b	0.285 ab	0.368 ab	0.124 a
T_3	1.092 a	0.297 a	0.374 a	0.123 a
T_4	0.976 c	0.279 b	0.361 abc	0.118 a
T_5	0.902 d	0.261 c	0.352 bcd	0.112 a
T_6	0.821 e	0.258 cd	0.347 cd	0.108 ab
T_7	0.785 f	0.250 cde	0.341 de	0.093 bc
T_8	0.713 g	0.243 de	0.336 def	0.087 c
T_9	0.682 h	0.241 de	0.325 ef	0.084 cd
T_{10}	0.675 h	0.238 e	0.321 f	0.079 cd
LSD	0.017	0.017	0.017	0.017
CV (%)	1.02	0.47	0.80	3.18

Means in a column followed by same letter (s) are not significantly different at 5% level of significance by LSD

4.14 Effect on nitrogen content in straw

There was significant difference among the treatments in recording nitrogen content in straw (Table 4.5). Nitrogen content in straw varied from 0.405 % to 0.742 %.The maximum nitrogen content in straw (0.742%) was found in the treatment T2 receiving 120kg N/ha from urea, which was statistically similar to T_3. The lowest nitrogen content in straw (0.405 %) was found in the control (T_1) treatment. Jeong *et al*. (1996) found that 5 t/ha fermented chicken manure increased nitrogen concentration in rice plant.

4.15 Effect on phosphorus content in straw

Phosphorus content in straw was varied significantly due to the application of chemical nitrogenous fertilizer along with organic manure (Table 4.5). The highest phosphorus content (0.182 %) in straw was found in treatment T_2 receiving 120 kg N/ha from urea, which was statistically similar to T_3, T_4 and T_5. The lowest phosphorus content (0.095%) in straw was found in the control (T_1) treatment.

4.16 Effect on potassium content in straw

The content of potassium in straw was significantly influenced due to the application of different levels of chemical nitrogenous fertilizer along with organic manure (Table 4.5). The highest potassium content in straw (1.213%) was found in treatment T_3 receiving 90 kg N/ha from the source urea along with 30 kg N/ha from vermicompost. The lowest potassium content in straw (0.957 %) was noted in control (T_1) treatment.

4.17 Effect on sulphur content in straw

Sulphur content in straw was statistically significant due to the application of different levels of organic and inorganic fertilizer (Table 4.5). The maximum sulphur content in straw (0.091%) was recorded in treatment T_3 receiving 90 kg N/ha from the source urea along with 30 kg N/ha from vermicompost. The lowest sulphur content in straw (0.048%) was noted in control (T_1) treatment.

Table 4.5. Effect of integrated use of manures and fertilizer on nitrogen, phosphorus, potassium and sulphur content of straw of hybrid dhan Hira 2

Treatment	Nitrogen content (%)	Phosphorus content (%)	Potassium content (%)	Sulphur content (%)
T_1	0.405g	0.095f	0.957i	0.048 d
T_2	0.742a	0.182a	1.202ab	0.084 ab
T_3	0.731a	0.181ab	1.213 a	0.091 a
T_4	0.704b	0.174abc	1.192 bc	0.081 ab
T_5	0.683c	0.171abcd	1.183cd	0.072bc
T_6	0.675c	0.164bcde	1.173de	0.068bc
T_7	0.637d	0.161cde	1.160 e	0.063cd
T_8	0.615e	0.159cde	1.127f	0.060cd
T_9	0.592f	0.156de	1.081 g	0.058cd
T_{10}	0.582f	0.153e	1.012 h	0.057cd
LSD	0.017	0.017	0.017	0.017
CV (%)	0.37	1.93	0.38	2.43

Means in a column followed by same letter (s) are not significantly different at 5% level of significance by LSD

4.18 Effect on nitrogen uptake by grain

Nitrogen uptake by grain was significantly influenced by the application of different levels of vermicompost and pressmud along with chemical nitrogenous fertilizer (Table 4.6).The uptake of nitrogen by grain ranged from 25 to 93.81 kg/ha. The highest nitrogen uptake by grains (93.81 kg/ha) of rice was observed in T_3 treatment receiving 90 kg N/ha from the source urea along with 30 kg N/ha from vermicompost which was statistically superior to the rest of the treatments. The lowest nitrogen uptake by grain (25 kg/ha) was found in control (T_1). These results are in good agreement with the findings of Sharma and Mitra (1991). Azim (1999) and Hoque (1999) carried out experiments with organic manures and fertilizers and found significantly higher N uptake in grain over control.

4.19 Effect on phosphorus uptake by grain

A significant variation in phosphorus uptake by grain was observed due to the application of different levels of pressmud or vermicompost along with nitrogen fertilizer (Table 4.6). The maximum phosphorus uptake (26.07 kg/ha) was noted in the treatment T_3 receiving 90 kg N/ha from the source urea along with 30 kg N/ha from Vermicompost, which was statistically superior to the rest of the treatments. The lowest phosphorus uptake (9.64 kg/ha) by grain was found in control treatment (T_1). Gupta *et al.* (1995) reported the highest phosphorus uptake by rice with combined application of poultry manure (PM) and fertilizer phosphorus. Similar results were also reported by Hoque (1999) and Azim (1999).

4.20 Effect on potassium uptake by grain

A significant variation in potassium uptake by grain was observed due to the application of different levels of nitrogenous fertilizer along with organic manures (Table 4.6). The maximum potassium uptake by grain (32.82 kg/ha) was found by T_3 treatment. The lowest potassium uptake by grain (11.40 kg/ha) was found in control (T_1) treatment. The results of this experiment showed that potassium uptake by rice grain was increased due to the application of chemical nitrogen fertilizer along with manures. Cassman (1995) found that potassium uptake increased with the increasing organic matter. These results are in good agreement with Jeegadeeswari *et al.* (2001) who reported increased potassium uptake in rice grain due to the application of cowdung along with NPK fertilizers.

4.21 Effect on sulphur uptake by grain

A significant variation in sulphur uptake by grain was observed due to the application of different levels of pressmud or vermicompost along with nitrogen fertilizer (Table 4.6). The maximum sulphur uptake (10.79 kg/ha) was noted in the treatment T_3 receiving 90 kg N/ha from the source urea along with 30 kg N/ha from vermicompost which was statistically superior to the rest of the treatments. The lowest sulphur uptake (3.17 kg/ha) by grain was found in control treatment (T_1).

Table 4.6. Effect of integrated use of manures and fertilizer on nitrogen, phosphorus, potassium and sulphur uptake by grain of hybrid dhan Hira 2

Treatment	Nitrogen uptake by grain (kg/ha)	Phosphorus uptake by grain (kg/ha)	Potassium uptake by grain (kg/ha)	Sulphur uptake by grain (kg/ha)
T_1	25.00i	9.64 j	11.40 j	3.17 j
T_2	84.56 b	22.87 b	29.52 b	9.95 b
T_3	93.81 a	26.07 a	32.82 a	10.79 a
T_4	78.38 c	22.40 c	28.96 c	9.47 c
T_5	69.18 d	20.02 d	27.00 d	8.59 d
T_6	59.03 e	18.55 e	24.92e	7.77 e
T_7	55.34 f	17.62 f	24.04 f	6.56 f
T_8	49.70 g	16.96 g	23.42 g	6.06 g
T_9	45.92 h	16.23 h	21.88 h	5.66 h
T_{10}	44.14 h	15.57 i	20.99 i	5.17 i
LSD	2.350	0.237	0.359	0.406
CV (%)	2.26	0.74	0.85	3.24

Means in a column followed by same letter (s) are not significantly different at 5% level of significance by LSD

4.22 Effect on nitrogen uptake by straw

Nitrogen fertilizer along with vermicompost and pressmud significantly increased N uptake by straw (Table 4.8). The maximum N uptake of 55.70 kg/ha was noted in treatment T_3 receiving 90 kg N/ha from the source urea along with 30 kg N/ha from Vermicompost which was statistically superior to the rest of the treatments. The lowest N uptake by straw (18.29 kg/ha) was noted in control treatment (T_1).

4.23 Effect on phosphorus uptake by straw

Effect of vermicompost, pressmud along with nitrogen fertilizer on phosphorus uptake by straw was significant (Table 4.8). Treatment T_3 recorded the maximum P uptake (13.79 kg/ha). The minimum P uptake by straw (4.29 kg/ha) was found in control (T_1) treatment. This might be due to the application of chemical nitrogen fertilizer in association with organic manures which might have increased efficiency of phosphorus accumulation in straw and resulted higher phosphorus uptake in straw.

4.24 Effect on potassium uptake by straw

Potassium uptake by straw was significantly varied with different levels of chemical nitrogen fertilizer along with vermicompost and pressmud (Table 4.8). The maximum K uptake (92.43 kg/ha) by straw was found in T_3 treatment receiving 90 kg N/ha from the source urea along with 30 kg N/ha from vermicompost which was statistically superior to the rest of the treatments. Control (T_1) treatment produced the minimum potassium uptake (43.22 kg/ha). Jeegadeeswari *et al.* (2001) also observed that the potassium uptake by rice was increased by the application of organic manure with nitrogen, phosphorus and potassium.

4.25 Effect on sulphur uptake by straw

A significant variation in sulphur uptake by straw was observed due to the application of different levels of pressmud or vermicompost along with nitrogen fertilizer (Table 4.7). The maximum sulphur uptake by straw (6.91 kg/ha) was noted in the treatment T_3 receiving 90 kg N/ha from the source urea along with 30 kg N/ha from vermicompost which was statistically superior to the rest of the treatments. The lowest uptake (2.17 kg/ha) by straw was found in control treatment (T_1).

Table 4.7. Effect of integrated use of manures and fertilizer on nitrogen, phosphorus, potassium and sulphur uptake by straw of hybrid dhan Hira 2

Treatment	Nitrogen uptake by straw (kg/ha)	Phosphorus uptake by straw (kg/ha)	Potassium uptake by straw (kg/ha)	Sulphur uptake by straw (kg/ha)
T_1	18.29j	4.29 i	43.22 j	2.17 i
T_2	53.27 b	13.06 b	86.30 b	6.03 b
T_3	55.70 a	13.79 a	92.43 a	6.91 a
T_4	50.40c	12.46c	85.35c	5.80 c
T_5	45.97d	11.51 d	79.62d	4.84 d
T_6	42.19e	10.25e	73.29e	4.25 e
T_7	39.11 f	9.86 f	71.22f	3.87 f
T_8	37.02g	9.57 fg	67.86g	3.61 g
T_9	35.38h	9.32 g	64.61h	3.47 gh
T_{10}	34.16i	8.98 h	59.40i	3.34 h
LSD	0.431	0.297	0.736	0.188
CV (%)	0.61	1.68	0.59	2.52

Means in a column followed by same letter (s) are not significantly different at 5% level of significance by LSD

4.26 Effect on pH of post- harvest soil

There was an insignificant effect of the different levels of treatments on soil pH of post-harvest soil of research field (Table 4.9). Wheather, treatment T_2 showed the highest pH (6.0) and T_1 showed the lowest pH (5.3) in post-harvest soil.

4.27 Effect on organic matter (%)

The level of organic matter in post-harvest soil increased due to combined application of vermicompost and pressmud with the combination of chemical nitrogenous fertilizer (Table 4.9). The maximum organic matter of post-harvest soil (1.67 %) was recorded from T_9 treatment receiving 120 kg N/ha from vermicompost. The lowest organic matter (1.01%) of post-harvest soil was recorded in control (T_1) treatment. Xu *et al.* (2008) reported that application of chemical fertilizer with organic manure increase soil organic matter. Treatment T_9 produced 65.35 % higher Organic matter over control treatment of hybrid dhan Hira 2 (Figure 4.10).

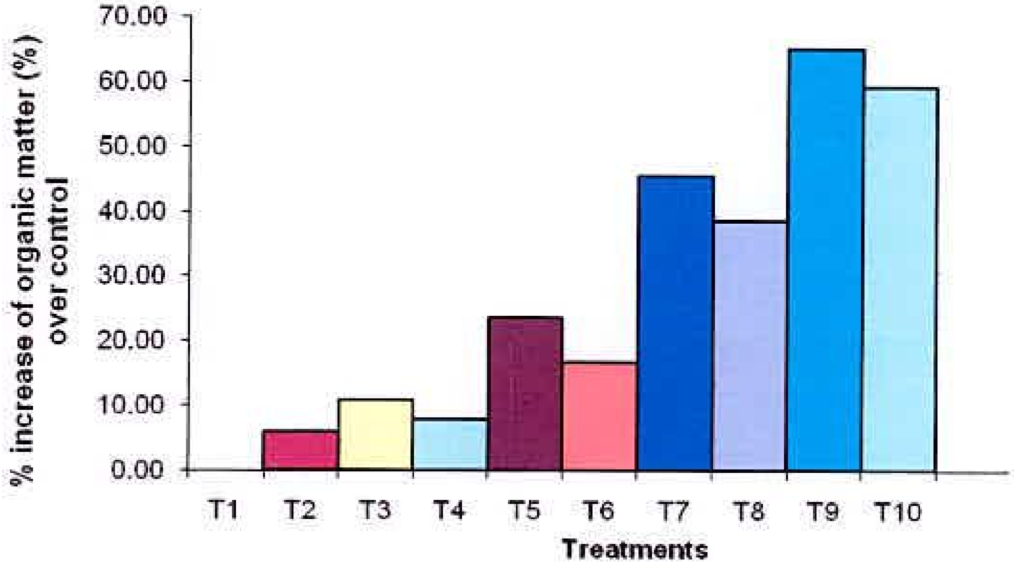


Figure 4.10. Effect of integrated use of manures and fertilizer on percent increase of organic matter (%) of hybrid dhan Hira 2

4.28 Effect on total nitrogen of post harvest soil

The combined effect of different levels of vermicompost and pressmud with the association of chemical nitrogen fertilizer on total nitrogen of post harvest soil was significant (Table 4.9).The highest total nitrogen of post harvest soil (0.07%) was recorded in T_3 treatment receiving 90 kg N/ha from the source urea along with 30 kg N/ha from vermicompost. The lowest total nitrogen of post harvest soil (0.035%) was recorded in control (T_1) treatment. Treatment T_3 gave 100 % higher total nitrogen (%) of post harvest soil over control treatment of hybrid dhan Hira 2 (Figure. 4.11).

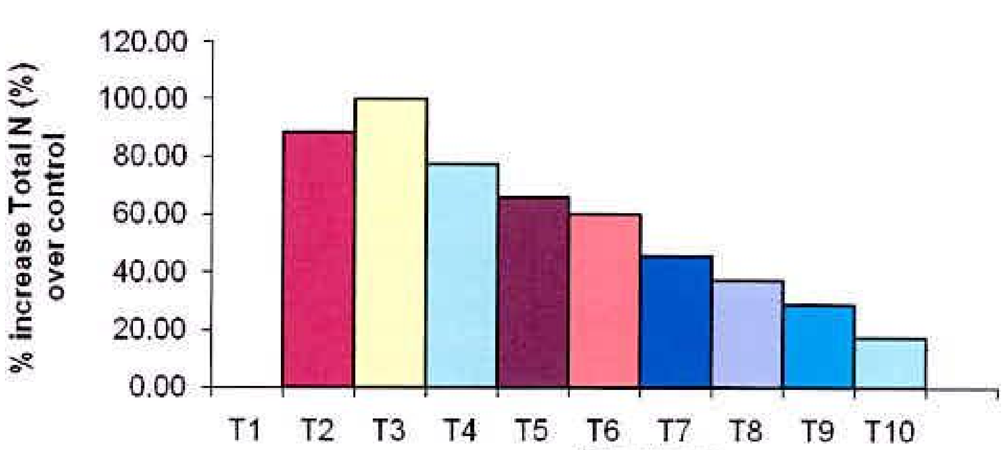


Figure 4.11. Effect of integrated use of manures and fertilizer on percent increase of total N (%) of hybrid dhan Hira 2

4.29 Effect on available phosphorus of post harvest soil

A significant difference in available phosphorus content of post harvest soil was observed at different levels of vermicompost and pressmud along with chemical nitrogenous fertilizer as the source of urea (Table 4.9). The highest available P (11.71ppm) in post harvest soil was recorded in T_2 treatment receiving 120 kg N/ha from urea which was statistically similar with T_3 and the lowest available P (9.97 ppm) in post harvest soil was noted in control (T_1) treatment. Treatment T_2 gave17.45 % higher available phosphorus of post harvest soil over control treatment of hybrid dhan Hira 2 (Figure. 4.12).

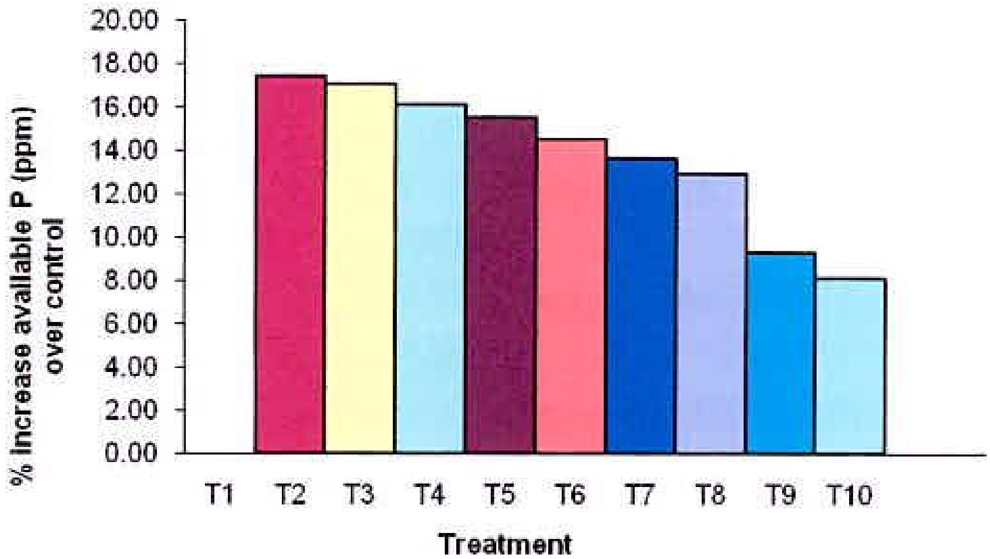


Figure. 4.12. Effect of integrated use of manures and fertilizer on percent increase available P (ppm) over control of hybrid dhan Hira 2

4.30 Effect on available potassium of post harvest soil

There was significant difference among the treatments in recording exchangeable potassium content of post harvest soil (Table 4.8). The maximum exchangeable potassium of post harvest soil (0.166 meq/100 g soil) was found in treatment T_{10} receiving 120 kg N/ha from pressmud which was statistically superior to the rest of the treatments under study. The lowest exchangeable potassium content (0.104 meq/100 g soil) in post harvest was found in control (T_1) treatment. Treatment T_{10} gave 6.2 % higher available potassium of post harvest soil over control treatment of hybrid dhan Hira 2 (Figure 4.13).

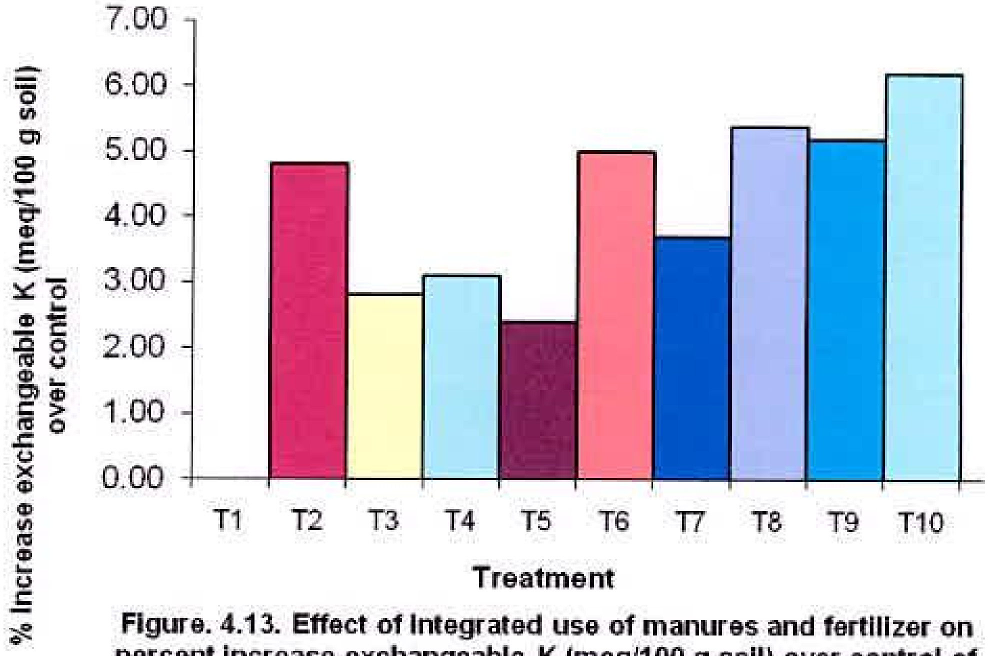


Figure. 4.13. Effect of integrated use of manures and fertilizer on percent increase exchangeable K (meq/100 g soil) over control of hybrid dhan Hira 2

4.31 Effect on available sulphur content in post harvest soil

Available sulphur in post harvest soil showed statistically significant differences due to the application of different levels of vermicompost and pressmud along with chemical fertilizer urea as the source of nitrogen (Table 4.9). The highest available sulphur in post harvest soil (11.46 ppm) was recorded from T_1 receiving 90 kg N/ha from the source urea along with 30 kg N/ha from vermicompost. On the other hand, the lowest available sulphur in post harvest soil (9.25 ppm) was obtained from T_1 (control) treatment. Treatment T_3 treatment gave 23.89 % increased available sulphur in post harvest soil over control treatment of hybrid dhan Hira 2 (Figure 4.14).

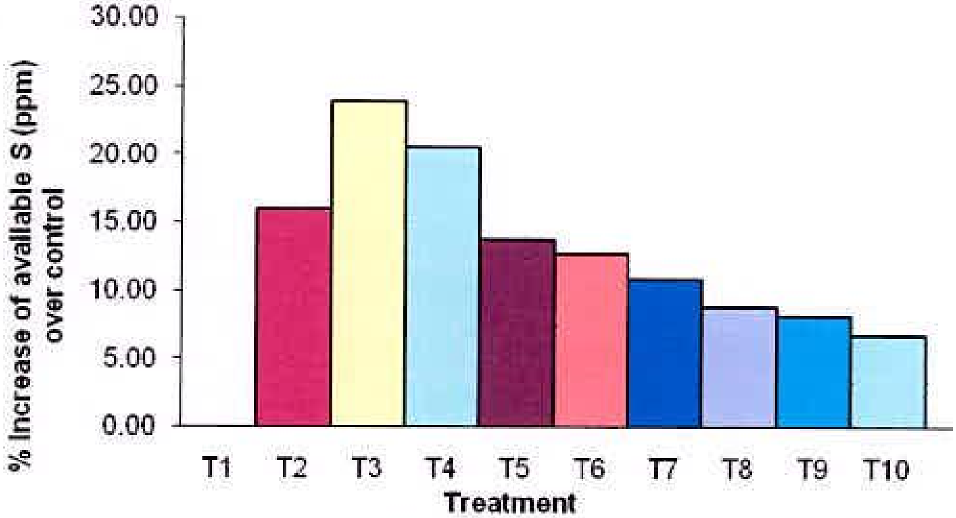


Figure 4.14. Effect of integrated use of manures and fertilizer on percent increase of available S (ppm) of hybrid dhan Hira 2

Table 4.8. Effect of integrated use of manures and fertilizer on the pH, organic carbon and NPK content in post harvest soil of hybrid dhan Hira 2

Treatment	pH	Organic matter (%)	Total N (%)	Available P (ppm)	Exchangeable K (meq/100g soil)	Available S (ppm)
T_1	5.3	1.01 j	0.035e	9.97i	0.104 e	9.25i
T_2	6.0	1.07 i	0.066 ab	11.71 a	0.152 abc	11.46 a
T_3	5.8	1.12 g	0.070 a	11.67 a	0.132 d	10.73 c
T_4	5.7	1.09 h	0.062 abc	11.58 b	0.135 cd	11.15 b
T_5	5.8	1.25 e	0.058 abcd	11.52c	0.128 d	10.52d
T_6	5.7	1.18 f	0.056 abcd	11.42d	0.154 ab	10.43 e
T_7	5.5	1.47 c	0.051 bcde	11.33 e	0.141 bcd	10.26 f
T_8	5.6	1.40 d	0.048 cde	11.26 f	0.158 ab	10.07 g
T_9	5.4	1.67 a	0.045 de	10.90 g	0.156 ab	10.01g
T_{10}	5.5	1.61 b	0.041 de	10.78 h	0.166 a	9.88 h
LSD	0.153	0.017	0.017	0.054	0.172	0.054
CV (%)	1.43	1.63	3.00	0.27	2.72	0.30

Means in a column followed by same letter (s) are not significantly different at 5% level of significance by LSD

CHAPTER 5
SUMMARY AND CONCLUSION

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted in the Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from December 2011 to April 2012 to study the effect of different integrated nutrient management of vermicompost and pressmud along with urea as the source of nitrogen on the growth and yield contributing characters, nutrients content and uptake of hybrid dhan Hira 2. Hybrid dhan Hira 2 was used as the test crop in this experiment. The experiment consists of 10 treatments each with three replications, as T_1: No chemical fertilizer and no manures (Control), T_2:120 kg N/ha from urea, T_3: 90 kg N/ha from urea+ 30 kg N/ha from vermicompost (VC)., T_4: 90 kg N/ha from urea+ 30 kg N/ha from pressmud, T_5: 60 kg N/ha from urea+ 60 kg N/ha from vermicompost (VC), T_6: 60 kg N/ha from urea+ 60 kg N/ha from pressmud, T_7: 30 kg N/ha from urea +90 kg N/ha from vermicompost (VC), T_8: 30 kg N/ha from urea+ 90 kg N/ha from pressmud, T_9: 120 kg N/ha from vermicompost (VC), T_{10}: 120 kg N/ha from pressmud.

Growth and yield contributing characters of hybrid dhan Hira 2 were significantly affected by different treatments except one, non effective tillers per hill, which was insignificant to different treatments. The highest plant height, number of tillers per hill, effective tillers per hill, panicle length, number of grains per panicle, number of filled grains per panicle and weight of 1000 grains were found from T_3 treatment. On the other hand the lowest values of these parameters were obtained from T_1 treatment. The highest numbers of unfilled grains per panicle were found in T_8 and the lowest in T_3 treatment.

Yield parameters of hybrid dhan Hira 2 were significantly affected by different treatments. The highest raw grain yield, raw straw yield, dry grain yield and dry straw yield were found under T_3 treatment. On the other hand the lowest values of these parameters were obtained from T_1 treatment.

Nutrient concentration in grain and straw of hybrid dhan Hira 2 was significantly affected by different treatments. In grain the highest concentrations of N (%), P (%) and K (%) were recorded from T_3 treatment and S (%) from T_2 treatment and in all cases the lowest values were observed in T_1 treatment. In straw the highest concentrations of N (%) and P (%) were recorded from T_2 treatment and K (%) and S (%) from T_3 treatment and in all cases the lowest values were observed in T_1 treatment.

Nutrient uptake by grain and straw of hybrid dhan Hira 2 was significantly affected by different treatments. The highest amount of N (kg/ha), P (kg/ha), K (kg/ha) and S (kg/ha) uptake by grain were found in the T_3 treatment and in all cases the lowest values were observed in T_1 treatment. Similarly the highest amount of N (kg/ha), P (kg/ha), K (kg/ha) and S (kg/ha) uptake by straw were found in the T_3 treatment and in all cases the lowest values were observed in T_1 treatment.

The organic matter and levels of N, P, K and S of post harvest soil were significantly affected by different treatments, wheather pH of post harvest soil was insignificant. The highest pH, organic matter (%), total N (%), available P (ppm), K (meq/100 g soil) and S (ppm) were recorded from T_2, T_9, T_3, T_2, T_{10} and T_3 treatments respectively and in all cases the lowest values were observed in T_1 treatment.

From the above discussion it can be concluded that among the organic sources vermicompost performed the best in regarding growth, yield and yield attributing characters as well as NPK content and uptake by hybrid dhan Hira 2. Organic manuring slightly increased pH, organic matter, total N, available P and exchangeable K in post harvest soil compared to initial soil.

From the findings of the present study, the following recommendations and suggestions may be made:

1. Application of 90 kg N/ha as the source of urea along with 30 kg N/ha from vermicompost is most favorable for improving growth, yield and yield contributing characters of hybrid dhan Hira 2 in Boro season.

2. Similar study should be conducted in different agro-ecological zones (AEZ) of Bangladesh for regional adaptability and other performance.

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Appendices

APPENDICES

Appendix I. Monthly record of air temperature, rainfall, relative humidity, soil temperature and Sunshine of the experimental site during the period from December 2011 to April 2012

Month	*Air temperature (°c)		*Relative humidity (%)	*Rain fall (mm) (total)	*Sunshine (hr)
	Maximum	Minimum			
December, 2011	26.4	14.1	69	12.8	5.5
January, 2012	25.4	12.7	68	7.7	5.6
February, 2012	28.1	15.5	68	28.9	5.5
March, 2012	32.5	20.4	64	65.8	5.2
April, 2012	33.7	23.6	69	165.3	4.9

* Monthly average.

Source: Bangladesh Meteorological Department (Climate & weather division) Agargoan, Dhaka – 1212.

Appendix II. Analysis of variance on data with the effect of integrated use of manures and fertilizer on plant height, number of tillers per hill, effective tillers and non effective tillers per hill of hybrid dhan Hira 2

Source of variance	Degrees of freedom	Mean square of			
		plant height (cm)	number of tillers per hill	number of effective tillers per hill	number of non effective tillers per hill
Replication	2	2.533	2.433	3.10	0.233
Treatment	9	43.070**	17.130 **	15.20 **	0.552 ns
Error	18	2.570	0.730	0.656	0.419

NS Not significant; * Significant at 5% level; ** Significant at 1% level

Appendix III. Analysis of variance on data with the effect of integrated use of manures and fertilizer on panicle length, number of grain, number of filled grain, number of unfilled grain, weight of 1000 grains of hybrid dhan Hira 2

Source of variance	Degrees of freedom	Mean square of				
		panicle length	number of grains	number of filled grains	number of unfilled grains	weight of 1000 grains
Replication	2	1.170	4.800	2.433	4.433	0.400
Treatment	9	2.348**	66.830 **	69.644**	5.481 **	9.070**
Error	18	0.555	17.87	15.656	0.693	1.437

NS Not significant; * Significant at 5% level; ** Significant at 1% level

Appendix IV. Analysis of variance on data with the effect of integrated use of manures and fertilizer on raw grain yield, raw straw yield, dry grain yield and dry straw yield of hybrid dhan Hira 2

Source of variance	Degrees of freedom	Mean square of			
		raw grain yield (t/ha)	raw straw yield (t/ha)	dry grain yield (t/ha)	dry straw yield (t/ha)
Replication	2	0.143	0.195	0.053	0.159
Treatment	9	3.935**	8.279**	3.826 **	2.332**
Error	18	0.0001	0.0001	0.001	0.0001

NS Not significant; * Significant at 5% level; ** Significant at 1% level

Appendix V. Analysis of variance on data with the effect of integrated use of manures and fertilizer on nitrogen, phosphorus, potassium and sulphur content of grain of hybrid dhan Hira 2

Source of variance	Degrees of freedom	Mean square of			
		nitrogen content of grain	phosphorus content of grain	potassium content of grain	sulphur content of grain
Replication	2	0.000	0.000	0.000	0.000
Treatment	9	0.097**	0.018 **	0.004**	0.001**
Error	18	0.0001	0.0001	0.0001	0.0001

NS Not significant; * Significant at 5% level; ** Significant at 1% level

Appendix VI. Analysis of variance on data with the effect of integrated use of manures and fertilizer on nitrogen, phosphorus, potassium and sulphur content of straw of hybrid dhan Hira 2

Source of variance	Degrees of freedom	Mean square of			
		nitrogen content of straw	phosphorus content of straw	potassium content of straw	sulphur content of straw
Replication	2	0.000	0.000	0.000	0.000
Treatment	9	0.029 **	0.002 **	0.023 **	0.001 **
Error	18	0.0001	0.0001	0.0001	0.0001

^{NS} Not significant; * Significant at 5% level; ** Significant at 1% level

Appendix VII. Analysis of variance on data with the effect of integrated use of manures and fertilizer on nitrogen, phosphorus, potassium and sulphur uptake by grain of hybrid dhan Hira 2

Source of variance	Degrees of freedom	Mean square of			
		nitrogen uptake by grain	phosphorus uptake by grain	potassium uptake by grain	sulphur uptake by grain
Replication	2	9.994	0.177	0.000	0.185
Treatment	9	1323.150 **	63.054**	104.367 **	17.412**
Error	18	1.876	0.019	0.044	0.056

^{NS} Not significant; * Significant at 5% level; ** Significant at 1% level

Appendix VIII. Analysis of variance on data with the effect of integrated use of manures and fertilizer on nitrogen, phosphorus, potassium and sulphur uptake by straw of hybrid dhan Hira 2

Source of variance	Degrees of freedom	Mean square of			
		nitrogen uptake	phosphorus uptake	potassium uptake	sulphur uptake
Replication	2	5.183	0.305	18.846	0.164
Treatment	9	364.823 **	21.813 **	639.365 **	6.324**
Error	18	0.063	0.030	0.184	0.012

^{NS} Not significant; * Significant at 5% level; ** Significant at 1% level

Appendix IX. Analysis of variance on data with the effect of integrated use of manures and fertilizer on pH, organic carbon and NPKS content in post harvest soil of hybrid dhan Hira 2

Source of variance	Degrees of freedom	Mean square of					
		pH	Organic matter (%)	total nitrogen	phosphorus	potassium	sulphur
Replication	2	0.018	0.000	0.000	0.008	0.000	0.001
Treatment	9	0.017 ns	0.165 **	0.000**	0.860**	29.957 **	1.232**
Error	18	0.008	0.0001	0.0001	0.001	0.002	0.001

NS Not significant; * Significant at 5% level; ** Significant at 1% level