IMPACT OF POULTRY LITTER ON SOIL PROPERTIES AND PRODUCTION OF JUTE

Ph. D. THESIS

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BY

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Declaration

I do hereby declare that the submitted thesis entitled **"Impact of Poultry Litter on Soil Properties and Production of Jute"** has been composed by me and all the works presented herein are of my own experimental findings. I further declare that this work has not been submitted anywhere for any academic degree, prize or scholarship and not published any where.

(Md. Nasimul Gani)

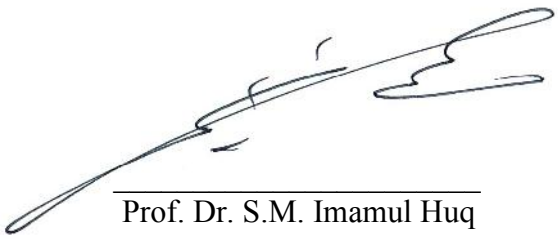
Dedicated to my

_____

Departed Mother and Beloved Father

Certificate

I have much pleasure to certify that the research work presented in this dissertation entitled "**Impact of Poultry Litter on Soil Properties and Production of Jute"** has been performed by **Mr. Md. Nasimul Gani** in the experimental fields of Bangladesh Jute Research Institute and the Department of Soil, Water and Environment, University of Dhaka, Bangladesh. He accomplished all sorts of research activities under my supervision and guidance. The part of this dissertation has not been submitted to elsewhere for any degree or diploma. It is further certified that the work presented herewith is original and very suitable for submission for the award of the degree of Ph.D.



Prof. Dr. S.M. Imamul Huq

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The Author

Abstract

Experiments were carried out at Manikganj and Kishoreganj during the year 2004-05 to 2007-08 under Sonatala and Silmondi soil series of Bangladesh. The soils of the Manikganj experimental field represents the Non Calcareous Grey Flood Plain Soil(General Soil Type) which belong to the Agro Ecological Zone No.8 (Young Bramahputtra and Jamuna Floodplain) and the soils of Kishoreganj field was Dark Gray Floodplain soils (General Soil Type) under Agro Ecological Zone No.9 (Old Bramahputtra Floodplain). The treatments were T_1-Control (Without fertilizer), T_2-RDF N 25% from poultry litter(PL),T_3-RDF N 25% from PL + 75% RDF,T_4-RDF N 50% from PL,T_5-RDF N 50% from PL+50% RDF, T_6- RDF N 75% from PL, T_7- RDF N 75% from PL +25% RDF,T_8-RDF N 100 % from PL, T_9- RDF N 100 % from PL +100% RDF and T_{10}-Sole RDF(Recommended dose of inorganic fertilizer N_{90}-P_{10}-K_{30}-S_{20} Kg^{-ha} respectively). The objectives of the research work were**:** (1) to study the effect of poultry litter on the growth and yield of jute. (2) to study the effect of poultry litter on soil properties (physical, chemical and biological) (3) to study the effect of poultry litter on the reduction of chemical fertilizer for jute cultivation.(4) to study the integrated effect of poultry litter and inorganic fertilizer on fibre quality and (5) to make an integrated fertilizer recommendation for jute crop. The high yielding jute (*Corchorus olitorius* L.) variety Falgoony Tossa (O-9897) developed by Bangladesh Jute Research Institute was used in the experiment as test crop. Application of poultry litter enhanced the different parameters of growth, yield of jute, soil chemical, physical, biological status and quality of fibre. Observations of the study show that integrated use of poultry litter and chemical fertilizer is better than either sole application of poultry litter or chemical fertilizer. The tallest plant, highest base diameter, yield of fibre and stick, were found for T_5 both at Manikganj and Kishoreganj. In producing the highest yield, the treatment T_5 also saved 50% N of chemical fertilizer that was supplemented from poultry litter. Highest cost benefit ratio was also obtained with T_5. Post harvest soil properties such as chemical, physical and biological status were also influenced by integrated treatments. In Manikganj site maximum amount of OM and N were found with T_5. Amount of S and Zn with T_7 but P for T_9. Lowest bulk density, highest particle density and pore space were obtained with T_7. Maximum water retentive characteristics were found with T_9 at Manikganj. At Kishoreganj site, highest amount of OM, N, K, S and Zn were obtained with T_7 and P with T_4. Highest particle density,

maximum water retentive characteristics and reduced bulk density were found with T_7. Highest pore space was recorded with T_9 at Kishoreganj. Bacterial population was also found to be the highest with T_7 both at Manikganj and Kishoreganj

site. Fibre quality *viz*. lusture, fineness and bundle strength of fibre were also improved by the integrated treatments. Maximum lusture and finest fibre were obtained with T_5 and bundle strength with T_7 at Manikganj. In Kishoreganj the finest fibre was found with T_5. Highest lusture and bundle strength were found for T_7. Although the sole application of poultry litter enhanced growth, yield of jute and soil properties of different parameters over the control. Yet it could not cross the achievement observed for the integrated treatments. Study indicates that the combined use of poultry litter and chemical fertilizer in jute is better for growth, yield and improvement of soil fertility to the context of Bangladesh. Study further showed that accumulation of heavy metal and toxic element in soil was very low (below allowable limit) due to four years application of poultry litter. An evidence is created by the study that application of poultry litter is beneficial for jute cultivation without any adverse affect. The integrated treatments may be ranked as $T_5 > T_7 > T_3 > T_9$ on the basis of performance on jute yield. Study suggested to use the integrated treatment T_5 (RDF N 50% from PL+ 50% RDF (2.38 t PL/ ha + 50% inorganic fertilizer) and T_7 (RDF N 75% from PL + 25% RDF (3.57 t PL/ ha + 25% inorganic fertilizer) in jute cultivation as the treatments are effective in all the studied parameter in accordance to the objectives. It is concluded that, mixing poultry litter with chemical fertilizer not only enhances the yield of jute crop, quality of fibre and soil fertility it can also minimize the cost of fertilizer. Study reveals that poultry litter may be an alternative source of organic matter in Bangladesh to produce crops.

CHAPTER -1

INTRODUCTION

1. Global position of Bangladesh

Bangladesh is situated at the northeastern part of South Asia between 20^0 84′ and 26 ^{0}38′ north latitude and 92^0 4′ east longitude with an area of 147570 sq. kilometers (Alam.2007). Bangladesh is known as tropical and sub tropical country located on the deltas of two of the greatest rivers of the world, i.e the Ganges and the Brahmaputtra (Alam *et al.,* 1991). The annual rainfall intensity is 1300 to 5000 mm and rain fall duration 90% occurs in between March to October. The annual temperature ranges from 7.0 to 32^0 Celsius (E) with a minimum range 7^0C to12.77^0 C during winter (November to February) and maximum range of 23.88^0 C to 31.55^0 C during summer (Alam, 2007). Jute is the main cash crop of Bangladesh.

1.1 General background

Jute is the commercial crop and most important of all the textile fibres next to cotton. It is the foreign exchange earning crop of Bangladesh which plays a significant role in the national economy of the country. According to BBS (2011) about 5.40% of total annual foreign exchange was earned by exporting jute and jute products. Among the total achievements of agriculture sector jute alone contributes to 1.58% of the total national GDP. Bangladesh ranks first to export raw jute and second among the jute growing countries in respect to production. It produced on and average 0.7-1.52 million metric tones of jute from 0.50-0.80 million hectares of land, which was 2.7% of total net crop area of Bangladesh (BBS, 2011). Other major jute growing countries of the world are India, Myanmar, China, Venezuela, Australia, Indonesia and The Philippines.

Millions of people in Bangladesh earn their livelihood from agricultural and industrial activities based on jute (Khandker 1987). A large number of farm families grow jute for hard cash (Dhali, 2003). There are 219 jute and jute yarn spinning mills in Bangladesh under public and private sector. These mills are installed with 20181 looms but now operating 10139 looms. On an average, the mills manufacture 663 thousand metric tons of jute products annually. The jute industries in Bangladesh had employed about 156.55 thousand officers, staffs and workers in 2011 (BBS, 2011). Jute industry and the allied trade and services including processing, marketing and transportation also provide employment to millions of people. Moreover, jute is a good source of revenue for the government of Bangladesh which earns a substantial amount of customs duties on jute and goods apart from foreign exchange earnings (Hussain, 2013).

1.2 Importance of Jute

Jute is extensively used throughout the world because of its versatility, durability and eco-friendly nature. It's fibre is mainly used in manufacturing various types of industrial products such as hessian, sacking, carpet backing, cloths, mats,

blankets, fabrics, packing materials, etc. The fibre is also used to prepare ropes and housing materials for domestic uses. Quite recently, jute has entered the technical industry (non woven industry) where wood substitute, furniture materials, ceiling goods, sanitary napkin, automobile things, fire proof fibre etc. are made instead of fabrics as it is one of the most cost effective high tensile natural fibre .Therefore, gradually the demand for jute has made its way into the automobile industry. Jute is now being used to manufacture more eco friendly interiors for cars and automobiles (Website). Jute sticks are used as fuel and fence in rural area. In recent years, green jute plants are being used as raw materials for paper pulp in the paper mills. Jute is also used for partex and geo-jute textile. Bangladesh jute research institute has succeeded in Research and development for using jute fibre as an alternative to cotton, wool and manufacturing fabrics (BJRI, 1987). Jute is bio degradable, putting valuable nutrients back in to the soil and eco friendly. One hectare of jute plants consumes 15 tonnes of CO_2 and release 14 tonnes of $O_{2\ which}$ is several times higher than trees (Website[1]). It's young leaves are widely used as vegetables in many countries, jute leaves also have been used as herbal medicine, has much advantage over synthetics and protects the environment and maintains the ecological balance (Tahsin, 2008). Present world demand of using the natural fibre instead of synthetic (to save the environment) is also regaining the past glory of Jute. Bangladesh government has also taken different steps for strengthening the jute sector.

1.3 National Jute policy of Bangladesh (2002 and 2011)

Government of Bangladesh recognized the significance of jute in Bangladesh's economy. In jute sector, there is involve more than 35 million people including jute farmers, businessmen, workers, laborers and self employed artisans and weavers in the country. Taking note of new opportunities presented by changing global environment of integration in the development of natural fibres, the strength and weakness of the product in the world market, the Govt. of Bangladesh announced "National jute policy-2002'' which was revised as "National jute policy-2007'' (Rahim, 2006). By the last council of International Jute Study Group (IJSG) has adopted important and up-to-date dynamic Road Map for the development of jute sector both in national and international perspectives with specific goal & objectives having a strategic country programmes. Bangladesh has already started to incorporate and update its jute policy according to the Road Map. Moreover the government of Bangladesh has observed "International Year of Natural Fibres 2009'' declared by UN General Assembly in a befitting manner in collaboration with IJSG. The government of Bangladesh has given emphasized towards jute sector and established "National jute policy-2011''which was published in the year 2012 to define the goals and objectives (Ministry of Textile & Jute, 2012).

The main objective of the policy is to facilitate the jute sector in Bangladesh to attain and sustain a pre-eminent global standing in production of raw jute and in the manufacture and export of jute goods by enabling the jute Industry. The policy seeks to R&D activities in agricultural practices with a vision to ensure remunerative prices to jute farmers by enabling them to produce better quality jute fibres and enhance per hectare yield of jute.

For achieving the goal and objective as mentioned above the following outlines have been

Undertaken for upgrading national jute policy;

- Produce quality jute and seed at farmer's level.
- Land use planning for jute cultivation.
- to motivate the farmers in HYV jute cultivation with improve/cost effective technique.
- Retain / increase market of the traditional jute products
- Develop new application of traditional products.
- Development of new products using the advantages of natural fibres Improve fibre quality
- Improve fibre quality as industrial feed.
- Improve productivity and product quality.
- Make use of sustainable development agenda.
- Increase consumer awareness by highlighting the environment friendliness of jute and kenaf
- Address the trade issues.
- Address supply and management issue
- Create R&D net work
- Create employment opportunities and develop human resources
- To provide price to the farmer keeping in view the production of raw jute
- restructuring of jute industry to make it commercially profitable and viable.
- Research towards development of diversified products of jute goods and introduction and expansion of their uses in the local and foreign market.
- Adequate production and supply of some diversified jute items to meet wide demand.
- Production of food grade jute bags as per compliance of the foreign buyer to meet international demand.
- . Maintain liaison and cooperation with and foreign Research Laboratories, universities and other bodies in respect of research work on jute & jute products.

1.3.1. Future national target of fibre production

As jute is the large foreign currency earner of the country and great labour employment opportunity are involved in jute sector so the ministry of agriculture of Bangladesh has taken an action plan to increase jute production (per unit area) by two hundred thousand metric ton by the year 2014-15 (MoA, 2005).The existing total jute production target of the government of Bangladesh is nine hundred thousand per year and production per unit land is 2.20 t/ha respectively.

1.4. Problems of jute cultivation

Now -a –day's jute have been facing an intense competition in the international market with synthetic fibre resulting in an acute problem for the indigenous jute enterprises. Recently, the cost of cultivation of jute has increased substantially in comparison to its market price due to rise of various input costs. Low price of fibre and low yield production (yield gap) due to depleted soil in the country is also a great problem to increase jute production. Therefore, the farmers are gradually losing their interest in its cultivation. Consequently, the area and production of this crop are declining day by day (Dhali, 2003).To re-adjust this structural problem, it is important to increase the productivity and improve the efficiency of soil fertility (Haque, 1989).

1.4.1. Soil nutrient status of Bangladesh

The organic matter content in Bangladesh soil is vary low (0.82-1.2%) as compared to desired (2.5% and above) level (Islam, 1909, Nabi *et al.,* 1998 and BARC, 2005). As our land resource is limited, so the necessity of intensive cropping and cropping patterns will increase in near future because of the increasing population pressure of the country (Bhuiayn 1992). In such a situation it is very alarming for future agriculture production. Continuous use of chemical fertilizer is found to be detrimental to soil, and the status of soil organic matter content has been decreasing day by day. About 5.6 million ha of land is deficient in phosphorus, 7.5 million ha of land is deficient in potassium and 8.7 million ha are deficient in sulfur, zinc deficiency has been identified in about 1.74 million ha and Boron deficiencies are now being greatly noticed in Bangladesh land for the production of upland crops(Hasan and Alam, 2006).

1.4.2. Reason of soil degradation

Increasing cropping intensity to meet the demands for food for a swelling population has led to mining out the inherent plant nutrients from the crop fields, where fertility status has severely declined over the years (Ali *et al.,* 1997).Beside this low or no use of organic materials, sole chemical fertilizer application and imbalance use of chemical fertilizer caused rapid depletion of the soil fertility (Bhuiayn, 1992 and Islam, 2008).

1.4.3. Now what ought to be done

Now it is essential to improve the soil health (Islam 1992) and it is high time to be conscious to minimize the land degradation (Hassan 2006). The use of organic materials is the only option left to us and the need to research on integrated use of organic and inorganic fertilizer on crops and cropping pattern to develop soil fertility and low level of organic matter status of Bangladesh for saving the soil resource for further degradation (Islam, 1999 and Paul *et al.* ,2005) is imminent. Therefore, the use of organic and chemical fertilizer has become indispensable for increasing crop yield.

1.4.4. Availability of the source of organic materials

The conventional sources of organic materials such as cowdung, rice straw, wheat straw, husking materials, tree leaves, weeds etc. which could build organic matter in soil are being used as fuel, fodder and other purposes (Anonymous, 1999 and Islam et al.2010). For these reasons addition of organic materials to soil through farmyard manure, compost and organic residues has been reduced considerably (Gani *et al.,* 2001). Even then, there is little or no opportunity for green manuring practices due to intensive cropping pattern. But there is a scope to use other non conventional source of organic materials such as poultry litter, sewage sludge, city waste compost, industrial waste, saw dust, forest litter and kitchen garbage etc. Among them poultry litters are most available and have huge accumulation in Bangladesh and poultry industry is gradually increasing day by day science 1980 which is extended in rural areas rapidly (Krishna, 1996).

1.4.5. Amount of poultry litter and environment

At present there are about 0.15 million poultry farmers and 6 million livelihoods directly depend on poultry industry (Rahman, 2007). The total population of poultry is 200-220 million and the daily waste produced from this industry is 15-20 million ton which is annually about 6570 million ton (Waste concern, 2005 and Bhuyian, 2007). In general each kg of feed consumed, a chicken approximately produces 1 kg of fresh manure with variable water content, while a commercial layer produces about 20 kg waste per year (Vasanthi and Kumaraswamy, 2000). Lack of proper disposal of voluminous excreta is creating environmental and health hazards and spread foul smell in the adjoining area in the poultry farms. Sometimes local communities complain against farm that may become threat to the sustainability of poultry industries. The amount of poultry droppings are increasing day by day with rapid increase of poultry population (Khaleduzzaman and Khandker, 2009). So, poultry droppings create an endangered per urban life and deteriorate the daily life of people with a consequent degradation of the environment. The concept of the poultry droppings disposal has taken a new dimension and emphasis has been put on proper disposal of poultry droppings which is not only profitable but also environment friendly. The situation of poultry dropping management is inefficient in the underdeveloped countries than that in the developed countries. Developed countries spent a lot money for poultry dropping management and they are also able to use develop technologies that help a better management of droppings. The people of developed countries are more conscious about droppings management and they maintain a hygienic system which reduces hazards. On the other hand, situation is much complicated in developing countries including Bangladesh for illiteracy, lack of consciousness and low per capita income. They face various hygienic and environmental problems for poor dropping management. Environmental pollution is becoming threat a to our country. Poultry waste has added a new dimension to environmental pollution factor to environment (Al-Amin *et al.,* 2009). If managed properly, it would become an asset to us.

1.4.6. Prospect and potential of poultry litter

Poultry litter appeared as the best source of organic manure over cowdung (FRG, 2005 and Khan *et al.,* 2008).The N content of the poultry litter is in the range of 1.99 to 2.51%, with a mean of approximately 2.25% (Simpson, 1991 and FRG, 2005). Adekiya and Agbedi (2009) also reported that poultry litter contains about 2.25 % N. Miah *et al.,* (2003-04) analyzed fresh poultry litter in the laboratory of Bangladesh Rice Research Institute and found that poultry litter has N - 2.25 % ,P-1.88%, K-2.80%,S-0.16% and Zn-279 ppm respectively As nutrient rich products, the droppings need to be managed in a sustainable manner without causing environmental pollution. Poultry droppings could be used as organic manure for crops, vegetables and psiculture (Sarker *et al.,* 2009). Poultry manure is important for continuous supply of nutrient elements which hold a great promise as source of multiple nutrients and ability to improve the soil physical, chemical and biological properties (Ravikumar and Krisnamoorthy, 1975, Skidmore *et al.,* 1986, Agbede *et al.,* 2008, Li, 2009 and Alabadan *et al.,* 2009) and increased the crop yield.

The C:N ratio of poultry manure is narrow,(range 7.9-9.1) as reported by Karchmann and Witter (1992) which probably contributes to higher mineralization (the process converting organic-N to ammonium -N) rate of N available for plant uptake(Amanullah ,2007).

1.4.7. Effect of poultry litter on soil physical properties

Poultry litter application improves the soil physical properties, it significantly decreases bulk density, increases total porosity, infiltration capacity and water holding capacity (Mbagwu, 1992). Agbede *et al.,* (2008) reported that poultry litter improved soil physical properties significantly, by increasing total porosity and moisture content. Mbagwu (1992) also supported that the utilization of poultry waste reduced the bulk density, increased total and macro porosity, infiltration capacity and available water capacity.

Effect of poultry litter on soil nutrient availability:

Poultry litter is the store house of organic matter. It not only contains N but other elements like P,K,S,Ca,Mg,S and micro nutrients also (Egrinya *et al.,* 2001) Land applied poultry litter supplies nutrients necessary for crop growth , the most prevalent being nitrogen (Sims,1987, Bitzer and Sims,1988).The combination of nitrogen from different organic manures was comparable on equivalent N basis in which poultry litter proved to be a better source (Ketker,1993).

Ravikumar and Krishnamoorthy (1983) reported that application of poultry litter increased the available P content of soil. The availability P content is accelerated when super phosphate is mixed with poultry litter and applied to soil (More and Ghonsikar, 1988). From a study by Das *et al.,* (1991), it is known that marked increase in exchangeable K content in soil was due to the application of poultry manure.

1.4.9. Effect of poultry litter on soil micronutrients:

Ghosh *et al.,* (2004) stated that poultry litter can increase Cu,Fe,Mn,Zn and B in soil which is needed for plant growth. Ayeni and Adetunji (2010) reported that integrated application of poultry litter and mineral fertilizer ensured availability of more soil micronutrients.

1.4.10. Effect of poultry litter on soil biological condition

Addition of poultry manure increases microbial activity in the soils which may increases the organic matter contents in soils compared to control (Priyadi *et al.,* 2005).

Tajeda *et al.,* (2006) cited that poultry litter contributes to soil biological properties (soil microbial biomass).They applied the sources of organic wastes *viz:* a crushed cotton gin compost(CCGC) and poultry litter (PL) to observe the effect of soil biological properties. After completion of study soil microbial biomass and soil enzyme activities were generally higher in the PL amended soil compared to the CCGC amended soil. Kaur *et al.,* (2005) found that the highest value of soil microbial quotients was observed in soils that received poultry litter and lowest in soils that received only chemical fertilizer.

1.4.11. Influence of poultry litter on crop yield

In a degraded soil in Southern Nigeria, Obi and Ebo (1995) found that average maize grain yield was significantly improved due to 100% poultry manure application. Abdel- Magid *et al.,(*1995) reported that grain and straw yield of wheat increased with increased rate of chicken manure in Saudi Arabia and obtained greatest economic return at 8.25 t/ha. In India, Mohamoud and Sharanappa (2002) found that the maize yields were the highest with composted poultry waste applied at the rate of 10 t/ha.

Higher grain yields of rice was obtained under lowland conditions by Budhar *et al.,* (1991) by incorporation of farm wastes and green manures, with the highest yield from poultry manure indicating the superiority of poultry litter.

1.4.12. Integrated effect of poultry litter and inorganic fertilizer on crop yield

Integrated nutrient management is a recent approach stabilizing production of crops(Patil *et al.,*1999). Savithri *et al.,* (1991) reported that application of poultry litter at the rate of 6.35 t/ha along with recommended levels of NPK registered highest yield of sorghum. Das *et al.,*(1991) recorded highest grain yield of maize by application of 5 t poultry litter + 28 kgP_2O_5 /ha as single super phosphate.Giardini *et al.,*(1992) reported an increased yield of onion bulbs due to poultry litter , which produced yields of more than 35 t/ha.

1.4.13. Effect of poultry litter on quality of crop

There are many references that poultry litter improves the quality of cereal crops, fruits and fibre crops. Poultry litter with inorganic fertilizer promoted the quality of soybean (Li-Mingly *et al.,* 2007) over inorganic fertilizer. Zhang *et al.,* (2008) cited improve fruit quality of peach with chicken litter. The findings of Endale *et al.,* (2004) and Tewolde *et al.,* (2004 and 2007) suggest that the effect of Poultry litter/broiler litter both sole and integrated application on cotton fibre quality (fibre strength, elongation , uniformity index, fineness and micronaire) is similar to or better than the effect of conventional manufactured fertilizers.

Considering the above facts as stated, the present study was undertaken with the following objectives:

(1) To study the effect of poultry litter on the growth, yield and properties of fibre quality of jute.

(2) To study the effect of poultry litter on soil properties (physical, chemical and biological).

(3) To study the effect of poultry litter on the reduction of chemical fertilizer use for jute Cultivation.

(4) To make an integrated fertilizer recommendation for jute crop.

(5) To analyze the cost and return due to poultry litter application to assess beneficial effect.

CHAPTER 2

REVIEW OF LITERATURE

Poultry litter is a mixture of manure and bedding material which is produced in large amount annually in the country. Poultry litter, if properly handled, is a valuable organic source of essential plant nutrients and soil amendment to improve soil quality (Mullins 2002). Applying poultry litter to agricultural lands is a proven, environmentally sound method for recycling essential nutrients as well as crop production. Literature of earlier workers has been reviewed on the utilization of poultry litter in the production of jute and its effect on soil properties with the following broad aspects:

i) Poultry litter as a source of plant nutrients.
ii) Effect of poultry litter on the growth and yield contributing characteristics of crops.
ii) Effect of integrated use of chemical fertilizer and poultry litter on the growth and yield contributing characteristics of crops.
iii) Effect of poultry litter on the chemical properties of soil.
iv) Effect of poultry litter on the physical properties of soil.
v) Effect of poultry litter on the biological properties of soil.
vi) Effect of poultry litter on the quality of crop

2. Poultry litter a source of plant nutrients

Hammond et *al.,* (1997) reported that approximately 75% of the total N and majority (90-100%) of the P and K in poultry litter are available for plant.

John and Charles (1999) stated that poultry litter contains nitrogen, phosphorus, potassium and micronutrients essential for plant growth. They also found incremental crop yield with the addition of poultry litter.

Poultry litter contains (NRAES, 1999) all 13 of the essential plant nutrients that are used by plants. These include nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), manganese (Mn), copper (Cu). Zinc (Zn), chlorine (Cl), boron (B), iron (Fe), and molybdenum (Mo).

Egrinya *et al.,* (2001) cited that poultry litter contains not only N, but also other elements like P,K,S,Ca and micronutrients.

Tewolde *et al., (*2005) reported that broiler litter not only supplied enough N but also supplied the four other macronutrients *viz*. P, K, Ca and Mg in amounts of sufficient to support normal cotton growth.

Miah *et al.,* (2006) reported that application of 2 tons poultry manure/ ha may replace the full dose of P and S and 60% N and K fertilizer requirement for a target yield of 5-6 t/ha rice.

2.1. Effect of poultry litter on the growth and yield contributing characteristics of crops.

Moberly and Stevenson (1971) conducted an evaluation study of poultry litter as a sugarcane (variety N 50/211) fertilizer at the South African Sugar Association Experiment Station Farm near Umhalanga Rocks. They reported that the furrow application of poultry litter (5.6 t/ha) at planting increased tillering in early stage of growth and cane yield in comparison to NPK incorporation (165 kg N, 38 Kg P and 165 kg K/ha).

John and Charles (1999) stated that poultry litter contains nitrogen, phosphorus, potassium and micronutrients essential for plant growth. They also found incremental crop yield with the addition of poultry litter.

A comparative effect of poultry manure and mineral fertilizer study was carried out by Corrales *et al.,* (2000) on guavas in Cuba. The experiment was conducted under production conditions with 0, 10, 20 and 30 kg poultry manure / plant and 0, 33, 66 and 100 % mineral fertilizer. Application of poultry manure resulted in more vigorous plants and good yields.

Alsup *et al.,* (2002) were grew cow pea *(Vigna unguiculata*) cover crops during the year 1995-97, in a rotation with broccoli (*Brassica oleracea* var. italica),spinach (*Spinacia oleracea)* and turnip greens(*Brassica rapa* [*B.campestris]var.utilis*) to evaluate the legume's ability to remove excess P from soils when poultry litter was used as a fertilizer. Fertilizer treatments were: (1) poultry litter to meet each crop,s recommended preplant N requirements (1x), (2) poultry litter at twice the recommended rate (2x) , and urea at 1x rate as the control. Following the vegetables crops, cow peas were planted on one- half of each replication, while the other half was followed by broccoli, spinach. The cow peas were harvested at the greenshell seed stage and then underwent a simulated haying operation to remove remaining shoot material from the field. Soil samples were taken at 0 to 15 cm and 15 to 30 cm depths at the onset of the study and after each crop to monitor plant nutrient concentrations. The cowpeas lowered soil test N concentrations at both soil sampling depths, but had no consistent effect on soil test P concentrations. Soil test P at the 0-15 cm depth was not increased by litter at the 2x rate relative to the urea control, regardless of cropping system. Poultry litter was effective as a fertilizer for all three vegetable crops, but the 2x rate was adequate for maximum production of broccoli and turnip greens.

Endale *et al*., (2002) cited that poultry litter enhanced the yield of cotton (*Gossypium hirsutum)* and corn in south eastern USA. It is largely grown using conventional tillage and fertilizers. They measured and compared cotton yield from conventional tillage (CT) and no till (NT) plots fertilized either with ammonium nitrate as conventional fertilizer (CF) or poultry litter (PL) from 1996 to 2000 near Wat Kinsville, Georgia. The four treatments were CT+CF, CT+PL, NT+CF and NT +PL with both the crop cotton and corn. The highest mean yield after 5 years were found with poultry litter + no till treatment for both the crop cotton 971 *1bs*/acre and corn 943 *1bs*/acre respectively. They further reported that it is

possible to increase cotton productivity in the Southern Piedmont by adopting no till and fertilizing with poultry litter instead of tilling and fertilizing conventionally.

Experiments were conducted by Lathif and Maraikar (2003) commencing in the maha season of 1999 / 2000, on a reddish brown latosolic soil, at Gannoruwa in the mid country wet zone of Srilanka to study the performance of different vegetable crops when grown as a monocrop and as mixed crops under an organic farming system. Cattle (CM) and poultry manure (PM), applied at rates of 20, 30, 40 and 10, 20, 30 t / ha, were the only source of nutrients for the crops. For comparison, a chemical fertilizer treatment, using recommended quantities of NPK, was included in all experiments conducted. In the monocrop experiments, aubergine, cabbage, and tomato gave higher yield when treated with manure with NPK. In the mixed crop experiments, where the performance different combination of bushbean , cabbage, capsicum, carrot and knol khol(*Brassica oleracea var.* gongylodes*)* were tested, there was no significantly yield increase with the increasing rates of cattle manure, but there was significant difference between yield obtained with poultry manure at 10 and 30 t/ha. Poultry manure also enhances soil quality and Olsen P content.

A project was conducted by Evelyn *et al*., (2004) at the Central Experimental Station of the Philippine Rice Research Station at Maligaya, Nueva Ecija for three years to observe the effect of different organic materials on paddy rice of PSB Rc 18. The organic materials were used sole incorporation of poultry manure, rice straw, azolla, sunflower and inorganic fertilizer. Grain yield (3 years average) was found highest (4.87 t/ha) with sole poultry manure over other organic sources and inorganic fertilizer. Lowest grain yield (4.11 t/ha) was shown with sole rice straw incorporation.

Liedl *et al.,* (2004) conducted an experiment on lettuce (*Lactuca sativa*) using liquid effluent from poultry litter waste. In trial, lettuce was grown hydroponically using nutrient film technique to evaluate the effects of liquid effluent as a nutrient solutions versus a commercial nutrient solutions. They observed effluent concentration produced shoot fresh weight of lettuce higher than those produced in a commercial solution. Also increasing the taste of lettuce by enhancing bitter characteristics and root fresh weight increased with the effluent of poultry litter waste.

An investigation by Ogboghodo *et al.,* (2005) of the effects of poultry manure to crude oil polluted soils on the growth of maize and soil properties was carried out under natural conditions at the Ambrose Ali University, Ekpoma, Nigeria. Potted maize plants were treated to crude oil pollution at four different levels (0,25,50 and 75 ml) and amended with poultry manure at four rates of application(0, 50,100 and 150 kg /ha) two weeks after pollution. Results obtained showed that percent survival rate, plant height and dry matter yield decreased with increase in crude oil contamination. For example % seed germination decreased 93 to 0% as crude oil increased from 0 to 75 ml without poultry manure application while plant height decreased 97 to 20 cm. However, when amended with the poultry manure, statistical analysis showed that highest rate of crude oil application (75 ml) and the 150 kg /ha rate poultry manure application affected maize growth , dry matter yield and soil properties significantly. For example at the rate of 75 ml crude oil

application, plant height increased from 20 to149 cm as level of poultry manure applied increased 0 to 150 kg/ha while dry matter yield increased from 27 to 58 g.

Mitchel and Shuxin (2005) stated, land application of poultry litter in agricultural production is a widely used practice. They conducted field experiments for 13 years to study the poultry litter application on cotton and maize and obtained enhanced yield (cotton 30 to 50% yield and maize 25 to 65% yield) than control.

Noufal (2005) accomplished an experiment in Meet Kenna soil,Egypt to observe the effects of poultry manure, charred rice straw , sugarbeet residues compost and sugar lime on sandy soil properties and impact on maize and barely.The rates of organic materials were 10,20 and 40 metric t/ feddan based on 30 cm soil depth. All the organic materials except charred rice straw increased yield of maize and barley. Among the materials poultry manure contributed highest yield.

Charles *et al.,* (2005) reported that land application of poultry broiler litter (BL) in agricultural production is a widely used practice. They conducted field experiments in poultry-producing regions of the southern USA to study the effect of broiler litter on cotton (*Gossypium hirsutum* L.) under conventional and conservation tillage system. Broiler litter application resulted in 30 to 50% increase of the cotton lint yield have been increased.

Poultry manure, olive mill wastes and mineral rich wastes water, were studied (Hachicha *et al.,* 2006) as an alternative fertilizer in Tunisia. Poultry manure and olive mill wastes contain good source of nutrients among the wastes. The poultry manure waste was of high quality, characterized by high level of nutrients, relatively low C/ N ratio (15/17) and a fertilizing value similar to that of conventional cattle manure, without phytotoxicity. Field experiments showed an increase in potato production of 31.50 to 35.50 t/ha with poultry manure compared to 30.50 t/ha using cattle manure. Poultry manure and olive mill by products appear therefore, as a promising ecological alternative to classical fertilizers.

Two field experiments were carried out (El-Bassiony *et al*., 2007) at Banha, Cairo, Egypt during the two successive seasons of 2005 and 2006 to study the three rates of poultry litter (50,75 and 100N unit/fed.) and the bio fertilizer nitrogen on growth, yield and quality of squash. Obtained data showed that 100N unit /fed., from poultry litter gave the highest vegetative growth characters, yield and quality.

Poultry litter is used as soil amendments for numerous crops including rice (*Oryza sativa* L.) and from a study Belefant (2007) found overall rice growth, tiller number and yield increased by poultry litter than control.

Sistani *et al.,* (2008) conducted a study in south east USA to examine the use of poultry litter as a source of nutrients for crop production. The treatments consisted of two rates of poultry litter application, 11 and 22Mg /ha on wet weight basis and one rate of chemical fertilizer applied. Four years experiment showed that poultry litter application produced significantly greater corn grain yield than chemical fertilizer application.

2.2. Integrated effect of poultry litter and chemical fertilizer on the growth and yield contributing characteristics of crops.

Koen *et al.,* (2000) conducted a study to compare rice yield to various rates of poultry litter and phosphorus (P) fertilizer on high pH soils. Field studies were conducted during 1998 and 1999 on alkaline DeWitt silt loam soil located in production fields in Arkansas County. The 16 treatments included fresh poultry litter, palletized poultry litter, and P fertilizer (triple super phosphate) applied at various rates and combinations. Zinc (Zn) fertilizer was also included in select treatment. In 1999, only fresh litter was used, and other treatments included P fertilizer rates and ammonium sulfate. Both poultry litter and P significantly increased grain yield. Poultry litter applied at the proper rates appeared to be an adequate source of P fertilizer.

Vasanti and Kumaraswamy (2000) observed that the poultry litter is more efficacious than the sheep and goat manure, farmyard manure, and biogas manure in producing the green and dry fodder yield of the cereal fodder and soil fertility. In field experiment conducted during 1993 and 1994 in Tamil Nadu , India, on a clay loam soil, three cereal crops of sorghum (Co.27), maize(African tall), and pearl millet (Co. 8) were grown in main plots with eighteen sub plots treatments involving four manures (poultry litter , sheep –goat manure, biogas manure and FYM) at 5 and 10 t /ha and NPK at 50 and 100% of recommended levels (60-40-20 kg of NPK / ha) . The green and dry fodder yields of the cereal fodders, the soil fertility status, and he content of and uptake of N, P and K were significantly higher in the treatment that received poultry litter at 10 t/ha with 50% of the recommended NPK schedule than the yields in the treatment that had received NPK alone.

Rajni and Srivastava (2001) was conducted a pot experiment in a glass house in Varanasi , Uttar Pradesh, India during kharif season to assess the response of rice to different treatments combinations of vermi compost ,poultry manure and nitrogen fertilizers. Treatments used in the experiments used in the experiment were: contol (no nitrogen), (T_0), 100 ppm N(T_1), 2/3 N through fertilizer + 1/3 N through vermi compost (T_2), 2/3 N through fertilizer + 1/3 N through poultry manre, (T_3), ¾ N through fertilizer + 1/4 N through vermi compost (T_4), 3/4 N through fertilizer + 1/3 N through poultry manure (T_5), 1/3 N through vermi compost (T_6) and 1/3 N through poultry manure(T_7). Results showed that all integrated treatments significantly increased plant height, number of effective panicles per pot and dry weight per panicle over the full N dose (T_1) through urea. Grain weight ranged from 6.5 - 20.0 gm/pot among the combinations. They concluded that the combined application of organic and inorganic fertilizer has a greater potential for fertilizer management for rice crops. But combined dose of poultry litter performed better for having the highest grain yield.

A study was carried out by Blay *et al.,* (2002) during the year 1998-1999 to determine the optimum levels of poultry manure, inorganic fertilizer and their combined effect on yield on shallots grown on sandy Anloga soils in Ghana (Africa). Treatments comprised a 4 x 3 factorial combination of poultry manure at 0, 10, 20 and 40 t/ha and three levels

of NPK 15-15-15 fertilizer at 0, 300 and 600 kg / ha. A combination of 40 tonnes poultry manure / ha with 300 kg /ha and 600 kg NPK 15-15-15 fertilizer / ha increased plant height, number of leaves per plant and number of plantlets per plant and dry matter content.

Amujoyegbe and Alofe (2003) reported integrated effect of poultry manure and inorganic fertilizer increased yield and quality of cowpea. A study on the effects of poultry manure and inorganic nitrogen fertilizer on the grain yield and proximate composition of two cultivars of cow pea (If brown and IT 86D-719) was carried out in Ile-Ife, Nigeria, during1998. Cultivars were sown in a randomized complete block design laid out in a split plot arrangement and treated with 4 sources of fertilizer (inorganic fertilizer (IF), mixture of inorganic fertilizer and poultry manure (IFPM), poultry manure (PM) and no fertilizer or manure treatment or control(C). Each fertilizer source supplied 20 kg N /ha The effect of yield and yield component and proximate of both the cultivars were significantly higher than control. The crude protein, percentage of crude fibre, total nitrogen and carbohydrate contents were composition clearly highest with poultry manure and inorganic fertilizer treatment.

Adeniyan and Ojeniyi, (2003) studied the comparative efficiency of residual effects of 300 kg NPK(15-15-15) /ha, 7t poultry manure (PM) /ha, 5 combinations of reduced levels of NPK and PM(250 kg NPK+ 2 t PM / ha), 200 kg NPK + 4 t PM/ha,150 kg NPK + 4 t PM/ha, 100kg NPK + 5 t PM /ha and 50 kg NPK+ 6 t/PM /ha) and a control (no fertilizer) on soil, nutrient uptake and yield of maize was investigated in a field trial during the 1996 and 1997 second cropping seasons on a lowly fertile loamy sand at Akure, Nigeria. Application of PM and combinations of PM with NPK gave residual effects on soil chemical composition and increased plant height, leaf area, dry matter yield, nutrient uptake and grain yield of maize significantly compared to the application of 300 kg N and the control.

Balcom *et al*., (2003) evaluated the use of poultry litter and sewage sludge as a source of nutrient for peanuts (*Arachis hypogaea* L.) production and found greater performance in compare to sewage sludge. From 1995 to 1998 poultry litter was applied on 13 on farm sites and composted municipal sludge was used in three of these on farm experiments at Georgia, USA. Fertilizer was also applied in all the experiments. Rates of poultry litter ranged from 1.90 to 7.20 Mg /ha. Composted sewage sludge rate was 2.0, 4.0 and 8.10 Mg/ha. Commercial fertilizer was mixed and applied mixed together at 180, 40 and 111 kg /ha N,P and K respectively. Fertilizer increased yield only in two experiments. Sewage sludge increased yield only in one experiment. Remaining 10 sites showed increased yield as a result of poultry litter over the fertilizer.

ZongXin *et al*., (2004) carried out a field experiment with 2 hybrids (Keduo No. 4 and Ludan 50) was conducted in 2002-2003 in Tian, Shangdon, China. Five fertilizer treatments were designed. They were wheat straw (7500kg/ha) + rotted chicken manure (120 kg/ha,), rotted chicken manure (5500 kg/ha) + N fertilizer (120 kg/ha), high N fertilizer (600 kg/ha), medium N fertilizer (300 kg/ha) and control treatment (no fertilizer).Chicken manure +N fertilizer significantly

enhanced biomass and kernel yield followed by high N fertilizer treatment. Chicken manure +N fertilizer improved fertility and structure of top soil than the other treatments.

McElvany *et al.*, (2004)established a study area which was in the coastal plain(Quitman country)of Georgia to determine the benefits of application of diammonium phosphate(DAP) and poultry litter to planted loblolly pine (*Pinus taeda* L.) seedlings on an old field site. Treatments were 1) Control=No treatment, 2) Spot surface application of DAP,3) Poultry litter sole,4)Banded herbicide only,5) DAP+ herbicide,6) Poultry litter+ herbicide. Loblolly pine ground line diameter (GLD), total height and soil pH, P, K, Ca, Mg, Cu, Zn, were not significantly effect with the application of DAP and poultry litter alone. But combined application of DAP and poultry litter illustrated the beneficial results.

Silva *et al., (*2005) performed an experiment at Aralaganwila Research Station, Srilanka to evaluate the possibilities of increasing crop yields and soil nutrients by combined application of organic manure (rice straw, cattle manure, poultry litter and compost) and chemical fertilizers under maize / rice crop rotation in 2004 yala and 2004-05 maha seasons. Results of the experiment revealed that higher crop growth and yield can be obtained by combining organic manure and chemical fertilizers. Among the organic manure +chemical fertilizer combination tested, poultry litter +NPK showed the highest (493% in yala and 256% in maha) and rice straw +NPK combinations showed the lowest (361%in yala and 145% in maha) grain yields and increase of soil nutrient status respectively.

Ayoola, and Adeniyan, (2006) conducted field studies in two villages (Oniyo and Moloko Ashipa) representing two agro ecologies in the south west area of Nigeria during 2000 and 2001 cropping seasons. The objectives was to determine the effects of NPK fertilizer and poultry manure on the yield and yield components in cassava /maize/melon system.The factors were (1) cropping system: cassava /maize /melon system, sole cassava, sole maize and (2) fertilizer : no fertilizer , NPK 15-15-15 (400 kg/ha),poultry manure (5 t/ha), 2.5 t/ha +200 kg/ha NPK 15-15-15 and mineral fertilizer(NPK 15-15-15). Crop yields were increased significantly with the NPK + poultry manure than either NPK alone or control.

Mukharjee *et al.,* (2006) conducted an experiment at the alluvial soil West Bengal, India during 1999-2000 to observe the productivity of rice bean as affected by chemical fertilizer and poultry litter. Results revealed that maximum growth and seed yield of rice bean (1.51 t/ha) was recorded where the crop received 50% recommended dose of nutrients applied through chemical fertilizer along with another 50% recommended dose of nutrients through poultry litter.

Rathiya *et al.,* (2007) established a field experiment in Raipur,Chhattisgarh, India, during the 2003-04 summer season to study the effect of different organic amendments (cowdung manure, poultry manure and bio fertilizer) combined with different chemical fertilizer rates on the growth and yield parameters of sunflower hybrid MSFH-17.
The treatment50%NPK+2.5 t/ha poultry manure gave maximum plant height(149.00cm),

Stem diameter(7.29mm),dry matter yield (95 gm/plant),head diameter (13.96 cm), test weight (5.40gm),seed yield (18.43q/ha)and stick yield(36.07q/ha).

Behera *et al.,*(2007) conducted a long term experiment during the year 1995 to 2000 on the fine textured Vertisols at Indore, India to study the effect of combined use of farm yard manure(FYM),poultry manure(PM),vermicompost and biofertilizer + phosphate solublebilizing bacteria with 0.5 and 1.0 NPK (120 kg N+26.2 kg P+ 33.3 kg K /ha) on wheat, and residual effect on following soybean. Grain yield of aestivum wheat in the initial 2 years and the durum wheat in the later 3 years was significantly increased with 0.5 NPK+ poultry manure at 2.5 t/ha compared other treatments.

Fallah *et al.,* (2007) conducted an experiment during 2004 in Iran, to study the effects of manure incorporation methods and integrated effect of poultry manure with chemical fertilizers on the grain yield and yield components of maize. The main plots consisted of incorporation of fertilizer with soil by furrower or disk. The sub plots comprised T_0 –Control (No consumption of fertilizer and poultry manure), T_1-200 kg N, 100 kg P and 100 kg K/ha, T_2- 80% of T_1+ 4 t/ha Poultry manure, T_3- 60% of T1+8 t /ha Poultry manure, T_4- 40% T_1 + 12 t/ha Poultry manure, T_5-20% of T_1 + 16 t/ha Poultry manure and T_6-20 t/ha Poultry manure. The incorporation of fertilizer furrower, compared with disk, significantly increased plant height, 1000 seed weight and grain and biological yields. However, there were no significant differences in the number of seeds per year and harvest index between the two fertilizer incorporation methods. Fertilizer treatments significantly increased yield characteristics except for harvest index. Effectiveness of integrated poultry manure and chemical fertilizer on maize yield components was higher than either poultry manure or chemical fertilizer alone.

Changlek, *et al.,* (2008) carried out a study to evaluate the effects of chicken manure (Cm, in ton/rai), gypsum (G, in kg/rai) and chemical fertilizers (F, kg/rai) on root yield and starch content of cassava planted on Warin soil series, Thailand. The resuls from chicken manure, gypsum and chemical fertilizer treatment significantly affected the average fresh root yield of cassava. Application of chemical fertilizers(50 kg/rai) and chicken manure (at 1000 kg/rai) gave maximum root yield of 4565 kg/rai (6.25 rai = 1 ha.) as compared to the control plots, where cassava root yield was lowest (2862 kg/rai).

Saha *et al.,* (2008) conducted a field experiment during 2003 – 04 to study the effect of combined application of in organic fertilizer, organic manure and biofertilizer on the productivity , mineral nutrition of roselly(*Hibiscas sabdarifa* L.) and on soil properties. Seventy five percent NPK applied through chemical fertilizer in conjunction with organic manure and biofertilizer (azotobactor) improved roseelle fibre yield by 3-13% over 100% NPK through chemical fertilizer. Integrated use of 75 % NPK + poultry manure + Azotobacter was found optimum for roselle fibre production.

Nasreen *et al.,* (2009) studied the response of garlic (var. BARI Garlic-2) to Zn, B, and poultry manure application along with blanket dose of 150 kg N, 50 kg p, 100 kg K and 40 kg S /ha through field trials in the Grey Terrace Soil under AEZ-25 (Level Barind Tract) at Spice Research Centre, Bogura during two consecutive rabi seasons(2005 -2006 and 2006-2007). There were two levels of Zn (0 and 5 kg /ha), two levels of B (and 1 kg B /ha) and three levels of poultry manure (0, 2.5 and 5t/ha). Every plot except the absolute control had received blanket dose of 150 kg N , 50 kg p, 100 kg K and 40 kg S /ha. Application of Zn, B and poultry manure significantly had increased plant height. No. of leaves/ plant, cloves /bulb, diameter and weight of bulb and yield / ha in both the years. The highest bulb yield of 6.10 t /ha in 2005-2006 and 6.23 t /ha in 2006-2007 were obtained from the Zn_5B_1 kg / ha plus 5 t /ha poultry manure treatment and it was significantly higher over all other treatments.

Liedl *et al.,* (2004) conducted an experiment on lettuce (*Lactuca sativa*) using liquid effluent from poultry litter waste. In trial lettuce was grown hydroponically using nutrient film technique to evaluate the effects of liquid effluent as a nutrient solutions versus a commercial nutrient solutions. They observed that effluent concentration produced shoot fresh weight of lettuce higher than those produced in a commercial solution. Also increasing the taste of lettuce by enhancing bitter characteristics and root fresh weight increased with the effluent of poultry litter waste.

Millhollon *et al.,* (2003) conducted a study in Louisiana, USA to compare the effect of poultry litter and inorganic fertilizer (60 pounds of nitrogen) treatments in conventional (incorporating shredded cotton stalks followed by deep tillage in the autumn) and conservation tillage system. Conventionally tilled and conservation plots were treated with either 60 pound of nitrogen or 2 tonnes of poultry litter per acre and another conservation plot was treated 4 tonnes of poultry litter per acre. All plots that received poultry litter produced higher seed cotton and yield than plots that received inorganic fertilizer. Two tones of poultry litter per acre appeared to be optimum rate because; four tones poultry litter per acre decreased the yield. Conventional tillage and 60 pounds of nitrogen per acre, considered a standard practice for cotton production, resulted in the lowest seed cotton and lint yields.

Sittitoon *et al.,* (2003) recorded higher growth and yield of corn (maize) with both chicken manure sole application and combined with chemical fertilizer + chicken manure treatments than sole chemical fertilizer. They observed the supplying P as a chemical fertilizer (PF, at 50,100 and 200 mg /kg), as chicken manure (CM 50, 100 and 200mg P/kg soil) or as PF +CM (at 25 +25, 50+50 and 100 +100 mg/kg) growth ,yield and P uptake of maize were compared in a pot experiment. All treatments resulted in higher growth, yield and P uptake compared to control (no fertilizer applied). Plant height, girth, dry matter yield and P uptake increased with the increasing P rates. CM and PF + CM treatments contributed higher growth, ear yield and total P uptake compared to the PF treatment.

Dickens *et al.,* (2004) carried out an experiment in South Carolina on loblolly pine (*Pinus taeda* L.) with the treatments *viz*.1).Control (No fertilization, 2)125diammoniumphosphate (DAP) +385 pounds urea per acre and 3) 7 tones per acre poultry litter. They observed after 4 years, poultry litter treatment had greater loblolly pine growth increment than the DAP urea and Control.

Clark and Mullins (2004) reported the significant yield response in wheat by raw broiler litter application. In a three years research project (1997/98, 1999/2000 and 200/01), conducted in Virginia, USA, investigated yield response by applying raw broiler litter, granulated poultry litter, pelleted poultry litter and commercial fertilizer nitrogen(N) to wheat (*Triticum aestivum*). All the sources of litter increased the wheat yield. But raw broiler litter and commercial fertilizer N resulted in a significant yield response to N additions, and the raw broiler litter in yields equivalent to that obtained using commercial fertilizer N.

Agbede *et al.,* (2010) conducted field experiments in 2006,2007 and 2008 cropping seasons at the teaching Research Farm of Rufus Giwa Polytechnic, Owo in the forest –savanna transition zone of south west Nigeria to evaluate the poultry manure and NPK fertilizer on soil physical , chemical properties , leaf nutrient concentrations, growth and yield of yam. The treatments were no fertilizer/manure (control). 400 kg / ha NPK fertilizer, 20 t /ha poultry manure and 200 kg / ha NPK fertilizer + 10 t /ha poultry manure, laid out in randomized complete block design with three replications. Application of poultry manure, poultry manure + NPK fertilizers significantly reduced soil bulk density , temperature and increased soil water content and porosity, where as application NPK fertilizer alone did not improve soil physical properties . Compared with the control, application of poultry manure , NPK fertilizer and poultry manure + NPK fertilizer significantly increased soil organic carbon, N,P,K,Ca and Mg as well as leaf N,P,K,Ca and Mg concentration. Poultry manure tended to improve soil pH, soil organic carbon, N,P,K,Ca and Mg concentrations compared with NPK fertilizer and gave higher leaf nutrient concentrations, growth and tuber weight , quality than NPK fertilizer. The highest leaf area, tuber length, tuber girth and tuber weight were obtained with combined application of sub optimal rates of poultry manure + NPK fertilizer in 2006, 2007 and 2008. Compared with the control, the use of NPK fertilizer, poultry manure and poultry manure + NPK fertilizer increased tuber weight by 53, 86 and 131%, respectively. Therefore the use of poultry manure + NPK fertilizer is recommended for soil conservation and yam production simultaneously.

2.3. Effect of poultry litter on chemical properties of soil

Rasnake *et al.,* (2000) reported that poultry litter can serve as an economical source of nutrients for crop production. However repeated use of litter can lead to an accumulation of some nutrients in the soil. A study was started in 1991 in West Kentucky, USA, to evaluate nutrient availability from poultry litter for tall fescue hay production. After five years of litter application (a maximum of 45 t / ha) the soils were sampled to determined nutrient accumulation and movement in the soil. Phosphorus, Copper and Zinc increased significantly in the surface soil layer. This study indicates that applying manure to these soils at rates that will supply the nutrient needs of crops.

Changes in chemical (Mbah *et al.,* 2000) and microbiological properties of a sandy clay loam soil in southeastern Nigeria following amendment with some animal wastes were studied. The research was conducted in a dystric Leptosol at the teaching and research farm of Ebony State University, Abakaliki, Nigeria. The treatments comprised three animal waste sources (cow dung, pig manure and poultry droppings) and unamended plots laid out in the field using a randomized compete block design. The results of the study show that the waste materials increased cation exchange capacity between 3% and 18% relative to control. Similarly, higher Ca, Mg, K, Na, based saturation were recorded with amended plots relative to the unamended plots, Poultry droppings accounting for the highest increase.

A study was carried out by Lopez *et al.,* (2001) in Guantanamo's county, Cuba to determine the type of fermented manures more recommended ecologically for healthy vegetable production. Three types of manure were used, poultry, cattle and sheep. It was proven that all the studied manures were of quality 1 and can be applied to all the cultivations. The best germination percentage was obtained with the fermented poultry manure. The variable with higher number of leaves presented was the one fermented with poultry manure. With use of poultry manure US $ 16.80 [per hectare] was saved .They were found improved soil chemical and physical properties and the products obtained were ecologically healthy.

Santos *et al.,* (2004) investigated the effects of application rates of limestone, and types and doses of organic composts and of recommended mineral fertilizer, on the chemical properties of a Typic Haplorthrox soil, cultivated with sorghum, at Jaboticabal, Sao Paulo, Brazil. The treatments comprised two doses of limestone (2.5 and 5.0 t/ ha), two doses of chicken litter (3 and 6 t /ha), three types of organic compost (pine saw dust, rice husk and groundnut husk), and recommended dose of mineral fertilizer. Lime stone increase the pH, Ca content and decrease the H+Al.
Chicken litter favoured the elevation of pH, sum bases cation exchange capacity, base saturation and decreased H+ Al and supplied P,K,Mg,Cu and Zn in compare to other organic composts.

Ewulo (2005) observed poultry manure gave higher concentration of soil chemical properties of clay loam soil. In order to investigate the effect of poultry dung and cattle manure on clay loam and sandy clay loam soil chemical properties , an incubation experiment was conducted in which clay and sandy clay loam soil were amended with poultry and cattle manure at 0 ,20 ,40 and 60 g / kg. The soil treated was incubated in the dark at 25 degrees C for eight weeks at field capacity. Soil pH , organic carbon, N,P,K, C a, Mg, Na and cation exchange capacity increased with rate of manure, while exchangeable acidity decreased irrespective of soil type. The poultry manure gave quick response and higher concentration of soil chemical properties especially in case of the clay soil.

Codling *et al.,* (2008) was performed a research to asses the long term effect of poultry litter applications on soil Phosphorus (P), Copper (Cu), Zinc (Zn), Manganese (Mn) and Arsenic (As) concentration in Chesapeake Bay watershed coastal plain soils. Litter and soil samples were collected ten farms with more than 40 years of broiler production and from wooded sites adjacent to fields and analyzed for P and metal contents. Averaged over farms, total P and metal concentration in the litter were 12.80 gm/kg P and 332, 350,334 and 2.93 mg/kg Cu, Zn, Mn, and as respectively. Surface (0-15cm) soil pH values were greater (5.7-6.4) than the 0 to 15 cm wooded sites (3.5-4.3). Surface soil Bray 1 P values (149-796 mg/kg) in amended fields were greater than wooded sites (4.4-17 mg/kg). The 1N nitric acid extractable metal concentrations were higher in amended soils than in wooded areas and were 7.7-32 ,5.7-26, 12.3-71 and 0.6-3.0 mg kg /ha for Cu, Zn, Mn, and As, respectively, compared to 0.76-14, 4.6-22, 1.6-70, and 0.14- 0.59 mg /kg for the same metals respectively, in wooded areas. Results from this study demonstrated that long term broiler litter applications have altered the chemical properties of the Coastal Plain soils of the Maryland Eastern Shore. Metal concentrations were low in the surface layer of amended fields and typically decreased with depth. Phosphorus additions rather than metals are most likely to contribute to the degradation of the Chesapeak Bay watershed.

Saha *et al.,* (2008) conducted a field experiment during 2003 – 04 to study the effect of combined application of in organic fertilizer, organic manure and biofertilizer on the productivity , mineral nutrition of roselly (*Hibiscas sabdarifa* L.) and on soil properties. Post harvest soil analysis showed that the soil fertility status was enriched in respect of organic carbon, available N ,P and K where inorganic fertilizer was incorporated in association with poultry manure and bio fertilizer over the 100% NPK through chemical fertilizer .

Ullah *et al.,* (2008) reported that poultry manure enhanced brinjal yield and soil chemical properties. They were conducted a field experiment at the Horticulture Farm of Bangladesh Agricultural University (BAU), Mymenshing during the period from December 2004 to April 2005 to evaluate the effect of manures and fertilizers on the yield of brinjal and soil chemical chemical properties. The treatments were T1(Cowdung @ 22857 kg/ha), T2(mustard oil cake @ 1600 kg/ha) ,T3(poultry manure 5000 kg /ha), T4(chemical fertilizer @ 174 kg urea /ha, 125 kg TSP /ha and 50 kg MoP /ha) and T5 (20% cow dung ,+ 20% mustard oil cake + 20% poultry manure +40% N+P+K fertilizer). The N,P and K content of the manures were tested in the laboratory and according to the results the doses of manures were set in such a way that all the treatments contains same amount of N,P and K. The test crop was brinjal (cv. Shingnath). Application of sole poultry manure and mustard oil cake gave better performance compared to sole chemical fertilizer on the yield and increasing different growth parameters. Soil organic matter decreased by chemical fertilizer and increased with all types of manures application. In all the cases nutrient availability increased and highest availability of N, P and S was found from poultry manure.

2.4. Effect of poultry litter on physical properties of soil

Apparvu and Saravanan (1999) conducted a field study, Tamil Nadu, India, to study the effect organic manure application on soil physical properties at the harvest of the sorghum crop and its residual effect on the succeeding crop of soybeans. The addition of organic manure to first crop especially poultry manure and farmyard manure increased the yield besides physical properties of soil and organic carbon status. Application of organic matter reduced the bulk density; the capillary non capillary porosity and soil organic carbon improved by the addition of organic manure especially poultry manure followed by farmyard and goat manure compared with the control. Disc ploughing and poultry manure and farmyard manure management without irrigation enhanced the total porosity and hydraulic conductivity of soil significantly.

Mathan (1999) evaluated from a study in a Vertisol (Typic chromustert) soil the influence of applying agricultural, Industrial and mineral wastes as amendments to improve physical properties of black soil and yield of finger millet (*Eleusine coracaa*). The efficacy of amendment may be graded as follows: organic wastes > industrial wastes > mineral wastes. Within he above group, the order of efficacy in each group was as follows: (1) Organics: poultry manure > farmyard manure>maize straw > cotton waste. (2) Industrial wastes: lime sludge > furnace slag > cement dust (3) Mineral amendments: gypsum > magnesite > tank silt. Incorporation of amendments significant reduction in bulk density, soil strength, and increase in hydrolic conductivity, stability index, aggregate stability and water content and best with poultry manure.

Field experiments were carried out by *Bhattacharya and Nain* (2001) in Tripura, India during 1997, 1998 in upland sandy loam soils planted with direct seeded rice to evaluate the performance of different soil amendments viz., clay mix (T1), Jalashakti [hydrophonic polymer](T2), poultry manure (T3), ground nut husk (T4), jute coir waste (T5) and Gliricidia maculate residue (T6). All the applied soil amendments showed greater influence on soil physical properties compare to control but poultry manure was found best to reduce soil physical parameters such as bulk density (0-30cm depth), mean weight diameter (0-30 cm), and basic infiltration rate to the extent of 11.3- 31.3%, 6.7-18.0 %, 37.20- 76.5 %, respectively.

Andreola *et al.,* (2001) stated that poultry manure increased the soil physical properties. In field studies in Santa Catarina, Brazil, in 1990-95 on structured terra Roxa soil, the effect of the winter plant cover of black oats (*Avena strigosa* [*A.nuda*])and forage turnips [radishes] (*Raphanus sativus*) and application of poultry manure or organomineral fertilizers on soil physical properties were investigated. Soils were analyzed in August 1994 and January 1995 at depths of 0-10, 10-20, and 20-30 cm. Soil aggregate stability of aggregates greater than 4.76 mm was decreased and that of aggregates 2.0-4.76 and 1.0-2.0 mm increased with application of poultry manure. Macroporosity increased and soil density decreased in the 0-10cm soil layer with application of poultry manure.

Motavalli *et al.,*(2003) reported that application of poultry litter at judicial rates can be contributed initial and residual effects on the compactability and remediation of claypan soils. It also influenced on soil physical characteristics and N availability. They carried out a study which objectives were to determine the first year and residual effects of surface compaction on soil physical properties, crop yield and N availability in a claypan soil; and evaluate the poultry litter to manage surface compaction. A field trial planted to corn (*Zea mays* L.) was conducted on a Mexico silt loam clay pan soil in North Central Missouri for two years (2000 and 2001).Treatments consisted of two levels of surface compaction (0 and 2 passes with a field wagon) and four rates (0, 4.8, 9.6 and 16 Mg /ha) of turkey litter in a split block design with four replications. Surface compaction in unamended soils increased soil bulk density (an average of 0.19 Mg m^{-3} in the 0-10 cm depth and 0.09 Mg m^{-3} in the 10-20 cm depth) and penetrometer resistance (an average of 3.11 MPa in the 0-5 cm depth, 2.18 MPa in the 5-10 cm depth and 0.98 MPa in the 10-20 cm depth) over the 2 years of the experiment. Addition of 16 Mg /ha of turkey litter significantly lowered soil penetrometer resistance an average of 1.04 MPa at the 0-5 cm depth in 2000 and 2001. Surface compaction decreased soil inorganic N regardless of whether it received turkey litter. Silage and grain yield and N uptake increased with the increasing rates of turkey litter 2000 and 2001. Surface compaction reduced both silage and grain yield approximately 470 g / kg in 2000, 200 g / kg in 2001 and 180 g /kg in the following season after compaction occurred. Niotrogen recovery efficiency was reduced from 290 to 140 g /kg by compaction in 2000. Study suggested that the single application of organic amendment applied at agronomic rates several initial and residual effects on the compactability and remediation of claypan soils, including beneficial effects on soil physical properties and N availability.

Alabadan *et al.,* (2009) conducted an experiment with the waste of cockerel, layer and broiler in sandy clay loam soil to investigate soil properties. Plot was divided in to four portions and every unit plot was 7m X 7m. The amount of 7.5 kg of each cockerel, layer and broiler waste was applied to plot A, B and C in slurry form while plot D was used as control (no application). After the completion experiment, the soil samples were taken for laboratory analysis. The results showed that all the wastes have effect on the soil physical properties. Reduced bulk density(Plot A-1.47g cm^{3},B-1.46 g cm^{3},C-1.39 g cm^{3} and D-1.57 g cm^{3}) and increased particle density(in plot A-2.84g cm^3, B- g cm^3, B-4.19 g cm^3, C-2.25 g cm^3, and D-1.48 g cm^3,) and porosity(in plot A-0.56,B-0.68,C-0.57 and D-0.12) were observed in treated plots in compare to control- D plot .The results also revealed that, application of broiler manure comparatively better performance to increase soil physical properties.

2.5. Effect of poultry litter on biological properties of soil

Dinesh *et al.,* (2000) observed that significantly increased the microbial biomass poultry litter amended soil. Soils exclusively amended with poultry manure, farmyard manure, sesbania and gliricidia for three successive rice- rice – cowpea systems were incubated as such or after fresh addition of the respective organic manure at 37 + or-1 degrees C

under submergence. The treatments also included fresh incorporation of these organic manures in to soils with no amendment history. Soil microbial biomass (total, fungi, actinomycetes, bacteria), biomass C, N flush and the activities of enzyme like amylase, cellulase, arylsulfatase, beta – gluglucosidase and inorganic pyrophosphatase were determined at different stages of incubation and the data pertaining to peak enzyme activity (30thday) are reported. Soils amended with organic manures consistently registered significantly greater microbial biomass, bio mass C, N flush and enzyme activities compared to the unamended soil and poultry manure showed superior performance.

Tejada *et al.,* (2006) reported poultry manure amended soil had a positive effect on soil biological properties. One method for recovering degraded soils in semiarid region is to add organic matter to improve soil characteristics, thereby enhancing biogeochemical nutrient cycling. In this paper, they studied the changes in soil biological properties as a result of adding a crushed cotton gin compost (CCGC) and a poultry manure (PM) for 4 year to restore a Xerollic Calciorthid located near Seville (Guadalquivir Velly, Andlusia, Spain). Organic wastes were applied at rates of 5, 7.5 and 10Mg organic matter/ha. One year after the assay began; spontaneous vegetation had appeared in the treated plots, particularly in that receiving a high PM and CCGC dose. After 4 years, the plant cover in these treated plots was around 88 and 79%, respectively, compared with 5% for the control.The effects on soil microbial biomass and six soil enzymatic activities (dehydrogenase, urease, BBA-protease, beta –glucosidase, arylsulfatase, and alkaline phosphatase activities) were ascertained. Both added organic wastes had appositive effect on the biological properties of the soil, although at the end of the experimental period and at high dosage, soil microbial biomass and soil enzyme activities were generally higher in the PM amended soil compared to the CCGC – amended soils.Enzyme activity from the PM – amended soil was 5, 15, 13, 19, 22, 30, and 60% greater than CCGC –amended soil for microbial biomass, urease, BBA-protease, beta – glucosidase, alkaline phosphatease, arylsulfatase, and dehydrogenase activities, respectively.

Maguire *et al.,* (2006) carried out an experiment with different level of poultry litter to asses the bacteria population in soil. They reported that application of poultry litter to soil increased the bacteria population which is also responsible for soil fertility.

Ibekwe, *et al.,* (2006) investigated the effect of poultry manure on biodegradation of soil (5 kg) contaminated with crude oil (50 gm) for seven weeks. Four different test options were prepared namely; (i) 100 gm contaminated soil + 30 gm of poultry manure ,(ii) 100 gm contaminated soil + 60 gm of poultry manure, (iii) 100 gm contaminated soil + 90 gm of poultry manure, (iv) 100 gm contaminated soil only(control). The microbial degradation was monitored by the measurement of total heterotrophic count (THC), hydrocarbon utilizing bacterial count (HUB) and gravimetric loss of the crude oil with time. The cumulative THC of 6.9 x 107 , 9.0 x 107 , 1.03 x 108 and 3.1 x 107 cfu / gm were recorded for test options (i),(ii), (iii) and (iv) respectively. The hydrocarbon utilizing bacterial counts (HUB) were 1.68 x 105, 1.63

x 105, 1.9 x 105 and 4.8 x 104 cfu / g for test options (i), (ii), (iii) and (iv), respectively. There was a corresponding gravimetric hydrocarbon loss of 40.0 , 45.26, 49.47 and 29.47 % for test options (i),(ii), (iii) and (iv) respectively. The results of the study suggested that addition of organic manure (especially 90 gm poultry manure) will further enhance microbial utilization of hydrocarbons.

Cook *et al.,* (2008) reported that poultry litter contains a large and diverse population of bacteria, fungi and protozoa. Microbial concentration in poultry litter can exceed 10^{10} cells /gm and gram positive bacteria (i.e Actinomycetes, Clostridia/Eubacteria, Bacilli/Lactobacilli) account for nearly 90% of the microbial diversity

LuSanchez *et al.,* (2003) evaluated by using the 16 S RNA and functional gene markers that broiler litter enhances the population of bacteria in soil.

Khandker and Shivaji, (2006) observed the higher number of fungal and bacterial population with poultry manure on a study of soybean wheat cropping sequence.

Abdel Hamid *et al.,* (2004) found from an experiment that composting of rice straw with poultry manure enhanced soil chemical and biological properties. A pot experiment was carried out in Gifu University, Japan, in 2001-2002. The composts of rice straw and poultry manure reached maturity in 90 days, were reaching in organic matter and mineral nutrients, and had a high level of stability and no phytotoxicity. The addition of rice straw and poultry manure compost (20 -200 g / pot) improved selected soil chemical (increased total N, total C and CEC) and biological (increased soil respiration rate) properties.

2.6. Effect of poultry litter on crop quality

There are references, poultry litter /wastes contributing in different parameters of quality of crops.

Shelke *et al.,* (2001) investigated the effect of farmyard manure and poultry manures alone or with urea on the available nutrients, yield and quality of brinjal (*Solanum melongena* cv.Krishna hybrid) in Inceptisol during kharif 1995 at Rahuri, Maharastra, India. The study revealed that both the organic sources with urea increased yield and quality of brinjal and the enrichment of soil nutrient N,P,K,Ca,Mg,Cu and Zn. Poultry manures performed better in respect to yield, quality and supply of soil nutrients.

Mikhailovskaya and Batchilo (2002) studied the effect of wet poultry manure (WPM) on sod podzolic sandy loam soil. Spring wheat “Belaruskaya-80” was grown during three years. WPM was used with out additives and in combination with NK fertilizer. WPM studied doses -25, 50 and 75 t /ha. The different composition of wheat grain quality was affected by wet poultry manure application. WPM applied with doses 25 and 50 t /ha resulted in the increase of protein content from 15.8% to 17.1and 19.7 %. Combination of WPM with NK fertilizers provided the improvement of grain

amino acid composition. Higher dose of WPM (75 t/ha) has lead to the reduction of grain protein. Gluten content in wheat grain achieved with 30. 40% at optimal dose of WPM (50 t /ha).

Pimpini *et al.,* (1992) found different quality parameters in the crops of onion, potato, spinach and fruit with the addition of poultry manure. Poultry manure and mineral ferttilizers at two rates of application (medium and high) and in different combinations, together with a non –fertilized control, were tested at the Experimental Station of the Agricultural University of Padova, Italy in 1985 to 89. Compared to the control all the fertilization treatments increased the incidence of larger – sized bulbs of onion and tubers of potato, improved the fruit color of processing tomato and the raw protein content of spinach, reduced the acidity and acids: soluble solids ratio of tomato and the dry matter content of spinach leaves. In addition, the application of 140 kg /ha N, 140 kg /of P_2O_5, and 100 kg / ha K_2O. as mineral fertilizer or as poultry manure gave the best scores of processing suitability of potato, both for sticks and chips. All the fertilization formulae, except for 140 kg /ha N, 1470 kg /ha P_2O_5 and 100 kg / ha K_2O as poultry manure alone, showed significantly increases in the extractable sucrose ratio in sugar beat, compared with the control. In processing tomato, the best scores of suitability for paste transformation were obtained with mixed fertilization (1/3 poultry manure and 2/3 mineral fertilizers) applying 210 kg /ha N, 210 kg /ha P_2O_5 and 150 kg /ha of K_2O and the plots receiving only mineral fertilizers produced fruits with less favourable values of pH and electrical conductivity compared to the poultry manured ones.

Magid *et al.,* (1998) studied the treatment effects of chicken manure on wheat crop in sandy soil of Saudi Arabia. The intention of the study was to assess the quality of crop. Chicken manure significantly improved wheat grain quality, as it resulted in higher crude protein, lower crude fibre and good shape and size of wheat grain. The percent Ca, Mg, and P in plant tissue were also improved in manure additions. This is expected as the chemical analysis of the manure indicated higher contents of these elements.

Gani *et al.,* (2002) reported that organic materials enhanced the jute fibre quality. The study was conducted to estimate the chemical and physico- mechanical characteristics (quality of fibre) of jute fibre, the jute was grown with the application of water hyacinth, chemical fertilizer in soil and control with proper agriculture management. The water hyacinth responded comparatively better in enhancing fibre quality than chemical fertilizer. Lower chemical constitutes the non-cellulosic portion (lignin and hemicellulose) in fibre indicates good quality, which found with water hyacinth. The percentage of lignin and hemicellulose in fibre with water hyacinth 12 and 20%, with chemical fertilizer 13 and 21 % and with control 13.60 and 21.20% respectively. The enriched physico-mechanical properties obtained with water hyacinth over the chemical fertilizer and control. The lower values of fineness (35μ) and higher values of brightness (22.30%), bundle strength (7.61 Ibs/mg), tensile strength (80.30 Ibs/mg) and breaking tenacity (39.50 Ibs/mg)ascertain the high quality of fibre found with water hyacinth . And the values found in fibre with chemical fertilizer, fineness

36.50 µ, whiteness 21%, bundle strength 6.99 Ibs/mg , tensile strength 78.98 Ibs/mg and breaking tenacity-39 Ibs/mg. Study showed that chemical and physico- mechanical properties of fibre increased with water hyacinth. The results also indicate that the sole chemical fertilizer application may not be possible to maintain the quality of fibre, it may be need an integration of organic matter and chemical fertilizer application in soil to enrich the fibre quality.

Tewolde *et al.,* (2004) suggested that the effect of broiler litter on cotton fibre quality is better than the effect of conventional manufactured fertilizers. The research was conducted in 2003 at two commercial cotton farm in Mississipi with the objective was to determine whether fibre quality of cotton grown with broiler litter with or with out supplemental conventional N fertilizer is the same as the fibre quality of cotton grown with manufactured fertilizers. Litter rates of 2.2, 4.5 and 6.7 Mg/ ha were tested with combination with 0, 34 or 67 kg /ha UAN- N as a supplement . Thease treatments were also compared against an untreated control and farm standard fertilized with 112 or 135 kg /ha UAN-N and other conventional fertilizers as recommended for each farm. Litter with or without UAN-N resulted in a large lint yield response at both places .However litter and UAN-N treatments that increased fibre length, strength, elongation and micronaire.

Zamil *et al.,* (2004) found from a study, supreme quality seed of mustard with poultry manure. They conducted a pot experiment at the researcher net house of Bangladesh Agricultural University, Mymenshing from November 2003 to February 2004 to find out the effects of different animal manure on yield, quality and nutrient uptake mustard cv.Agrani. The experiments comprised of two levels of cage system poultry manure, cowdung and biogas slurry viz. 10 and 20 ton / ha, one control and one chemical fertilizer @ recommended dose. The quality parameters of mustard seed such as protein and oil content showed highest with cage system poultry manure @ 20 t /ha over the all treatments.

Tewolde *et al.,* (2007) conducted research to determine adequate rates of broiler litter and whether supplementation with inorganic N would be necessary for optimum cotton yield lint yield and fibre quality. The research was conducted from 2002 to 2004 on two commercial farms representing conventional-till (CT) and no till (NT) systems. The treatments consisted of an unfertilized control, a farm standard (STD) fertilized with inorganic fertilizers, and broiler litter of 2.2, 4.5, and 6.7 Mg /ha in an incomplete factorial combination with 0, 34, or 67 kg / ha N as urea – ammonium nitrate solution (UAN). Litter with out supplemental UAN-N increased yield by 23 to 110 kg lint /ha for every 1.0 Mg / ha litter under both CT and NT. Fibre quality, fibre length, and micronaire in particular also responded to litter. Study also revealed that litter when adequately supplemented with UAN-N did not adversely affect fibre quality.

Taher *et al.,* (2009) conducted an experiment during the year 2005-2007 at Rangpur regional station of Bangladesh Jute Research Institute. The aim of the study was to observe the effect of rice straw and chemical fertilizer in different

combinations on the growth, yield of jute and different parameters of fibre quality *viz*: fineness, lusture and bundle strength. The treatments were T_1 – Control, T_2-Rice straw 3 t/ha, T_3-Rice straw 3 t/ha + ½ RDF, T4- Rice straw 5 t/ha, T_5 - Rice straw 5 t/ha + 1/2 RDF, T6- Rice straw 7 t/ha, T7- Rice straw 7 t/ha + ½ RDF, and T_8-RDF(Recommended dose of chemical fertilizers). All the treatments enhanced the different parameters of jute growth, yield and quality of fibre over control. The tallest plant (3.43 m), highest base diameter (12.25mm), yield of fibre (3.40 t/ha) and stick (6.80 t/ha) were achieved with rice straw 5 t /ha+ ½ RDF. Application of rice straw along with chemical fertilizer yielded finner fibre than that of sole rice straw or sol chemical fertilizer application. Finest fibre (33.20µ) was foud with the rice straw 3 t/ha + ½ RDF. Highest lusture value (22.10%) and bundle strength (10.40 ibs/mg) were found with rice straw 5 t/ha + ½ dose of chemical fertilizer than control and sole chemical fertilizer application. Soil fertility status increased with all the treated plots over initial soil. Highest organic matter (1.20%), N (0.09%), P (17 ppm), and K0.18 meq /100) were found with rice straw 7 t/ha + ½ RDF. Study also created evidence that combined use of organic and inorganic fertilizer increased production, yield, and quality and soil fertility.

CHAPTER- 3

MATERIALS AND METHODS

Methodology is very important in any scientific research. It deserves a very careful consideration for conducting research. The basic materials for establishment of research are the unbiased information and facts. The reliability of a scientific research depends on the proper and appropriate methodology for such research. It should be such that it would enable the researcher to collect reliable information to arrive at correct conclusions. Two locations were selected for conducting the study. These were Manikganj and Kishoreganj district under Dhaka Division. The detailed research programme and methodology are presented in this chapter.

3.1. Geographic location and description of the study area:

Two sites were selected for conducting the experiment. One of the sites is situated at Manikganj (23^{o} 46´N latitude & 90^{0} 23´ E longitude) and the other at Kishoreganj(24^{0}26' N latitude & 90^{0} 46' E longitude) district respectively under Dhaka Division of Bangladesh.

Manikganj

Manikganj district is 70 kilometer North West of Dhaka. Total area of Manikganj is about 1379 sq.kilometer (BBS-2005) .The study area is situated at 8.8 meter above the sea level. The cropping intensity is about 173.90% (Alam, 2007). Jute was cultivated 6216ha of land where fibre year produced 64977 bales at Manikganj during the year 2010-11(BBS, 2011). Total population is 1301900 and the number of household is 276540(BBS 2005). The district is bounded on the north by Tangail and Sirajganj, on the east by Dhaka, on the south by Dhaka and Faridpur, on the west by Pabna and Rajbari. General soil types include predominantly Gray Floodplain soils. Organic matter content is low to medium in ridges and basins. Soils are deficient in N, P, S and B but the status of K and Zn is low to medium. Top soil pH ranges from strongly acidic to neutral. The morphological characteristics of the soil of Manikganj are presented in Table1.

Table 1. Morpholgical description of the study area of Manikganj.

AEZ-8	Young Bramahputtra and Jamuna Floodplain(UNDP and FAO)
Soil Series	Sonatala
Land Type	High land 18 %,Medium high land 42%,Medium low land 19% , Low land and Homestead+ Water 21%
Soil Tract	Non Calcerious Grey Flood Plain Soil
Flood level	Normal
Drainage	Moderate
Vegetation	Some weeds

Climate

The climate of Manikganj experimental area is characterized by sub tropical accompanied by heavy rain fall during the months from May to September and scanty rainfall during rest of the year .The weather condition of crop growing period was as usual. The temperature, rainfall and humidity (BBS, 2006 and 2008) during the year 2004-05 to 2007-08 (Source: Bangladesh Metrological Department,) of Manikganj experimental area were as followes:

Annual maximum temperature ranged from 32 ^{O} C to 37 ^{O} C and the minimum between 9.6 ^{O} C to 15.8 ^{O} C with a mean temperature of 34.78 ^{O}C maximum and 13.02 ^{O}C minimum. The rainfall ranged from 4 mm during January - February to 374.32 mm during May –September with annual mean rainfall of 2326 mm. The humidity throughout the year was with a mean value of 76.24%.

Kishoreganj

Kishoreganj district is about 170 kilometer north east from the capital city Dhaka. The area is 18 meter above the sea level. At Kishoreganj, during the year 2010-11 jute was cultivated 14884 ha of land where fibre obtained 146373 bale (BBS, 2011). Total population is 2557240 and the number of household is 528520(BBS 2005). The district is bounded on the north by Mymenshing and Netrokona, on the east by Sylhet and Brahmanbaria, on the south by Narshingdi, on the west by Gazipur and Mymenshing. General soil type predominantly

includes Dark Gray Floodplain soils. Organic matter content is low on the ridges and moderate in the basins, top soils are strongly acidic to neutral and sub-soils are neutral in reaction. There is lowering of soil pH in high land. General fertility level including N, P, KS and B is low. Morphological characteristics are presented in Table 1.1

Table 1.1. Morphological description of study area of Kishoreganj.

AEZ-9	Old Bramahputtra Floodplain(UNDP and FAO)
Soil Series	Silmondi
Land Type	High land 28%,Medium high land 35%,Medium low land 20%,Low land , Homestead and Water 17%
Soil Tract	Dark Gray Floodplain soils
Flood level	Above flood level
Drainage	Moderate
Vegetation	Some weeds/crop residues

Climate

The climate of Kishoreganj experimental area is sub tropical wet and humid. Heavy rain fall during the monsoon and low temperature prevails in the winter season. During the month of May to September heavy rainfall only. The weather condition of crop growing period was as usual.

The temperature, rainfall and humidity (BBS, 2006 and 2008) during the year 2004-05 to 2007-08 (Source: Bangladesh Metrological Department,) of Kishoreganj experimental area were as follows:

Annual maximum temperature ranged from 32.2 ^{O} C to 37 ^{O} C and the minimum between 6.00 ^{O} C to 12.6 ^{O} C with a mean maximum temperature of 32.84^{O}C and minimum of 10.58 ^{O}C. The rainfall ranged from 4 mm during January - February to 435.84mm during May –September with annual mean rainfall 2330 mm. The humidity was throughout the year with a mean value of 73.64%.

3.2. Description of the experimental fields Manikganj

The experiment was conducted for four years at Central Jute Agricultural Research Station, Manikganj of Bangladesh Jute Research Institute, Jagir, under sadar upazilla of Manikganj district, Bangladesh. The experimental field is located at 23º 46′ north latitude 90º 23′ east longitude. Soil properties of the experimental plot are presented in Table 2.

Table 2. Initial soil physical, biological and chemical properties of the experimental field of Manikganj

Parameters	**Observation**
Sand (%)	50
Silt (%)	35
Clay (%)	15
Textural class	Silt loam
Bulk density (0 to 15 cm depth) gm/cm^3	1.45
Bulk density (15 to 30 cm depth) gm/cm^3	1.50
Particle density (gm/cm^3)	2.58

Pore space %	43
Maximum water retentive characteristics (V %)	33
Bacterial population ($X10^5$)	25
pH	6.70
Organic carbon (OC) %	0.62
Organic matter (OM) %	1.06
Total Nitrogen (N)%	0.065
C/N ratio	9.54
Available Phosphorus (P)ppm	10
Exchangeable K(meq/100gm)	0.11
Available Sulphur (S) ppm	8
Exchangeable Calcium(Ca) meq/100gm	3.80
Exchangeable Magnesium(Mg) meq/100gm	0.80
Available Zinc(Zn) ppm	0.62
Available Boron(B) ppm	0.27
Available lead(Pb) ppm	0.21
Arsenic(As) ppm	0.32

Kishoreganj

The experiment was set up for four years at the Regional Station of Bangladesh Jute Research Institute, situated in Gaital under sadar upazilla of Kishoreganj district, Bangladesh. The experimental field is located at 24ºdegree38′minute north latitude and 90ºdegree13′ minute east longitude. Soil properties of the experimental plot of are presented in Table 2.1.

Table 2.1. Initial soil physical, biological and chemical properties of the experimental field of Kishoreganj

Parameters	**Observation**
Sand (%)	28
Silt (%)	55
Clay (%)	17
Textural class	Silt loam
Bulk density (0 to 15 cm depth) gm/cm^3	1.41
Bulk density (15 to 30 cm depth) gm/cm^3	1.45
Particle density (gm/cm^3)	2.65
Pore space %	46
Maximum water retentive characteristics (V %)	35
Bacterial population ($X10^5$)	27
pH	5.40
Organic carbon (OC) %	0.70
Organic matter (OM) %	1.20
Total Nitrogen (N)%	0.074
C/N ratio	9.46
Available Phosphorus (P)ppm	12
Exchangeable K(meq/100gm)	0.12
Available Sulphur (S) ppm	11
Exchangeable Calcium(Ca) meq/100gm	3.60
Exchangeable Magnesium(Mg) meq/100gm	0.90
Available Zinc(Zn) ppm	0.71

Available Boron(B) ppm	0.36
Available lead(Pb) ppm	0.26
Arsenic(As) ppm	0.38

3.3. Collection of initial and post harvest soil samples

The initial soil samples were collected before land preparation at both the locations. Soil samples were collected randomly from 40 to 45 different spots (cores) at 0-15cm depth. The collected soil samples were mixed in a plastic pot and finally a composite of 500 gm soil was preserved. Post harvest soil was also collected and processed in a similar way. The soil was air dried ground and sieved through a 0.5mm sieve for chemical analyses and 2mm sieve for physical analysis.

3.4. Methods of soil chemical analyses:

Soil pH:

The glass electrode pH meter was used to determine pH of the soil. The ratio of the soil and water in the suspension was maintained at 1:2.50 (Hunter, 1984).

Soil organic carbon:

Organic carbon in soil was determined by wet oxidation method as described by Walkley and Black (1934).

Organic matter:

Organic matter was calculated by multiplying the organic carbon with the Van Bemmelon factor, 1.724 as described by Peper (1942).

Total nitrogen:

Total nitrogen of soil was determined by microkjeldahl method where soil was digested with 30%H_2O_2, conc. H_2SO_4 and catalyst mixture (K_2SO_4, $CuSO_4$, $5H_2O$: Selinium powder in the ratio100:10:1). Nitrogen in the digest was estimated by distillations with 40%NaOH followed by titration of the distillate trapped in H_3BO_3 with 0.01N H_2SO_4 (Black 1965).

Available nitrogen:

The soil sample was extracted with 1NKCl solution and alkali distilled with a reducing agent as described by Bremmer (1965).

Available phosphorus:

Available Phosphorus was extracted from soil, the extraction was made with Bray and Kurtz (1945) dilute acid fluride method described by Kuo(1996).Spectronic- 21,Baush and Lomb spectrophotometer was used to measure the colour intensity at the wave lengths of 880nm following the ascorbic acid blue colour method(Watanable and Olsen1965).

Exchangeable potassium:

Exchangeable potassium was determined by neutral 1N NH_4OAc ($pH_7.0$ (one normal ammonium acetate) extract of the soil by using flame photometer (Huq and Alam, 2005).

Exchangeable calcium and magnesium:

Exchangeable calcium and magnesium were extracted with neutral1N NH_4OAc (One normal Ammonium acetate) as described by Jacson (1973). The calcium and magnesium were determined by atomic absorption spectrophotometer.

Available sulphur:

Availble Sulphur was determined by extracting the soil sample with0.15% $CaCl_2$ solution (Page *et al.,* 1982). The Sulphur content in the extract was determined turbdimetrically and the intensity of tubid was measured by spectrophotometer at 420 nm wavelength.

Available zinc and lead,

The content of zinc and lead of the soil sample was extracted by aqua-regia (concentrated HCL: concentrated HNO_3 :3:1) digestion (Portman and Riley, 1964). The lead and zinc Concentrations were analyzed by Flame Emission Atomic Absorption Spectrometer (Huq and Alam 2005).

Available boron

Available boron was determined by curcumin in glacial acetic acid solution at a wavelength of 555nm described by Hunter (1984).

Arsenic in soil:

Arsenic in soil (both pre and post experiment) was extracted by digestion with aqua –regia. For determining the aqua -regia extractable arsenic, 2.5 gm of soil was digested in about 15 ml of aqua -regia (HCL:HNO_3::3:1) for approximately 4-5 hours using a sand bath as a heating source (app.110^0c). the sample and acid were placed in 100 ml pyrex glass beakers. After dissolution, samples were diluted up to a volume of 50 ml, mixed and filtered prior to analysis (Portman and Riley, 1964). Then Arsenic in the extract was estimated by Atomic Absorption Spectrometer (AAS) with help of potassium iodide and urea flowing calibration of the equipment. As standard of 5, 10,20,30,40 and 50 microgram/L were used. For every 10 samples, a certified reference material (CRM) was included to ensure quality control (Huq and Alam, 2005).

Available copper, iron and manganese:

The soil samples were extracted by DTPA-TEA method as proposed by Lindsay and Norvell (1978) and the elements were determined by atomic absorption spectrophotometer.

3.5. Method of soil physical properties:

The soil samples were collected two times. First time before setting the experiment to observe the initial physical status of soil. Finally, at the time of four years completion of the experiment.

Particle size analysis:

Particle size analysis of soil was done by hydrometer method (Bouyoucos, 1962).

Textural class:

The textural class was determined by plotting the values % sand,% silt and % clay to the "Marshall textural triangular co-ordinate" following the USDA system(Marshall,1951).

Bulk density:

Core sampler was used to collect the soil samples from 0-15 cm and 15-30 cm depth to determine the bulk density. Precaution was taken to avoid compaction. The soil was trimmed to the exact volume of the core and oven dried at 105 ^{C} for constant weight (Black 1965).

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Particle density:

The pycnometer method was followed to determine particle density of soil as described by Trout et al.(1982).

Pore space:

The derivation of the formula used to calculate the (Karim et al. 1983) percentage of pore space in soil is as follows:

$$\% \text{ Solid space} = \frac{\text{Bulk density}}{\text{Particle density}} \times 100$$

% Pore space + % Solid space =100 and % Pore space =100- % Solid space

$$\text{Then \% pore space} = 100 - \left(\frac{\text{Bulk density}}{\text{Particle density}} \times 100\right)$$

Maximum water retentive capacity:

Maximum water retentive capacity of the undisturbed soil was carried out with the help of a core sampler as described by Gardener (1965).

The maximum water retentive capacity of soils were determined by using a core sampling method. Particle density was determined by pycnometer method as described by Karim et al. (1983) and Huq and Didar, (2005).

3.6. Method of soil microbiological analysis:

At first the soil samples were collected from the plots before starting the experiment and every year just after the harvest from each unit plot covering the rhizosphere and non rhizosphere soil zone at a depth of 0-15cm. The collected samples were kept in a polythene bag and brought to laboratory and put in a refrigerator.

Media for bacteria:

Nutrient agar media (Scmidt and Colwell ,1967) and plate count method was used to monitor the bacterial population and Czapck –Dox- Agar media (Thom and Raper; 1945) was used for identifying the cellulose decomposing bacteria, where 1% cellulose was used instead of sucrose.

3.7. Method of plant sample analysis

Plant sample collection:

Plant samples were collected from individual plot (according to the treatments) for chemical analysis. Ten plants were randomly selected from each plot by avoiding the border area of the plot. The plants were separated into leaves, roots and stem to obtain the chemical results of different parts of the jute plant. The samples were washed with tap water and then with distilled water for several times. These plants samples were dried in the electrical oven at 70^0C for72 hours. After that the plant samples were ground in an electric grinding machine and stored for analysis. In getting the chemical analytical results of whole plant of jute the ground materials of leaves, roots and stem were mixed together maintaining a ratio (Stem 15gm:root 10gm: leaves 5gm) and kept in a polythene bag.

Chemical analysis of plant sample:

Sample processing:

Oven dried roots and stems were chopped into small pieces by local chopping device. The different parts of jute plant i.e. leaves, roots and stems were ground separately. And the ground materials were kept into airtight plastic containers.

Digestion of plant sample:

Plant samples were digested with sulphuric acid and digestion mixture (catalyst) and nitrogen was determined by alkali distillation of the Kjeldahl digest (Jackson,1973).

Digestion of plant samples with nitric perchloric acid mixture:

An amount of 0.5gm of sub samples was taken into a dry clean 100ml of Kjeldahl flask, 10ml of di- acid mixture (HNO_3,HCl_4 in the ratio of 2:1)was added and kept for few minutes. Then the flask was heated at a temperature rising slowly to200^0C. Heating was instantly stopped as soon as the dense white fumes of $HClO_4$ occurred and after cooling, 6ml 6NHCl were added to it. The content of the flask was boiled until it became clear and colour less. The digest was used for determining Phophorus (P), Potassium (K) and Sulphur (S).

Phophorus:

Phosphorus in plant samples is determined by the yellow colour method (Murphy and Riley, 1962) with help of a spectrophotometer.

Potassium:

Potassium was determined directly by flame photometer (Jenway PFP-7) as described by Jackson (1973).

Sulphur:

Sulphur content in the digest was determined by turbidimetric method as described by Hunt (1980) using spectrophotometer.

3.8. Method of determination of the different parameter of fibre quality:

The collected fibre samples were tested for physico-mechanical properties viz brightness, fineness and bundle strength at the sample Testing Laboratory in BJRI. Leokometer was used (Anonymous 1981) for brightness/lusture estimation of fibre, Bundle strength was determined with pressly Bundle as Strength Tester using zero gauge length (Anonymous 1981). Fineness was estimated by Air flow method as described by Grover and Humbly (1960).

3.9. Experimental set up:

3.9.1. Treatments

T_1- Control (Without fertilizer)

T_2-RDF N 25% from Poultry litter (PL).

T_3- RDF N 25% from PL+ 75%RDF

T_4- RDF N 50% from PL

T_5- RDF N 50% from PL +50%(RDF

T_6- RDF N 75% from PL

T_7- RDF N 75% from PL +25% RDF

T_8- RDF N 100 % from PL

T_9- RDF N 100 % from PL +100% RDF

T_{10}--Sole RDF (Recommended dose of inorganic fertilizer N_{90}-P_{10}-K_{30}-S_{20} Kg^{-ha} as per fertilizer Recommendation Guide of Bangladesh Agriulture Research council (BARC 2005).

The following formulae was used to calculate the amount of poultry letter needed (Kg/ha) to make the dose for RDF equivalent 100% N from PL:

$$\text{Amount of poultry letter (kg/ha) for RDF N 100\% from PL} = \frac{\text{RDF inorganic fertilizer N for jute} \times 100}{\text{\% N content in poultry letter}}$$

There by amount of poultry letter (kg/ha) for 25%, 50% and 75% RDF equivalent dose of N from PL were calculated. Formulae used for RDF N from PL is given below:

$$\text{Total RDF N from PL} = \frac{\text{Required PL (Kg}^{-\text{ha}}\text{) X \% N content in PL}}{100}$$

3.9.2. Variety:

The high yielding jute Falgoony Tossa (O-9897) developed by Bangladesh Jute Research Institute was used in the experiment.

3.9.3. Experimental design:

The experiment was laid out in randomized complete block design (RCBD) with three replications. Each replication contained fourteen sub plots. The numbers of plots were 42 and dimension of each plot was 3m x 3m.

The space between the plots, blocks and around the field was 1.50 meter. There was a deep drain around the blocks and plots. Total 14 treatment combinations of poultry litter and chemical fertilizer along with a control were distributed randomly in each plot as one replication. The layout of the experiment is shown in Appendix Fig. VI.

3.9.4. Land preparation:

At the beginning of the experiment land was prepared finely with repeat ploughing and cross ploughing four times by power tiller followed by laddering. After ploughing the clods and lumps were broken with the help of bamboo stick to make the soil in good tilth. Weed and residues of previous crops were cleaned properly. Drainage channel was made around the field to remove the excess rain water from the plot.

After completion of the first year experiment the land was prepared without disturbing the lay out (From the second year) of the previous experiment. The tillage was done very carefully giving the extra attention so that the lay out remains intact. Any sorts of weeds and roots of the previous crops were removed manually from the plots.

3.9.5. Fertilizer application method:

Inorganic fertilizers of Jute were calculated on the basis of soil chemical test as per Fertilizer Recommendation Guide (FRG, 2005) of Bangladesh Agricultural Research Council (BARC). The above FRG Guide (2005) of BARC was also reported that Poultry litter content 1.9% N, which was the basis to calculate RDF equivalent dose of N from poultry litter. Treatment combinations of recommended nutrients for jute experiment from poultry litter and inorganic fertilizer are presented below:

Tr. #	**Treatment combinations**	**Amount of PL incorporated t/ha**	**Applied RDF equivalent N from PL Kg/ha**	**Applied nutrient from inorganic fertilizer Kg/ha**			
				N	P	K	S
T_1	Control (Without fertilizer)	0	0	0	0	0	0
T_2	RDF N 25% from Poultry litter (PL).	1.19	22.50	0	0	0	0
T_3	RDF N 25% from PL+ 75%RDF	1.19	22.50	67.50	7.50	22.5	15
T_4	RDF N 50% from PL	2.38	45.00	0	0	0	0
T_5	RDF N 50% from PL+ 50%RDF	2.38	45.00	45.00	5.00	15	10
T_6	RDF N 75% from PL	3.57	67.50	0	0	0	0
T_7	RDF N 75% from PL + 25%RDF	3.57	67.50	22.50	2.50	7.5	5
T_8	RDF N 100% from PL	4.76	90.00	0	0	0	0
T_9	RDF N 100% from PL+ 100 %RDF	4.76	90.00	90	10	30	20

T_{10}	RDF(Recommended of inorganic fertilizer)	0	0	90	10	30	20

Every year fertilizers (poultry litter and inorganic fertilizers) doses were assessed by chemical soil test. Fertilizers were applied according to the treatment design. The full dose of poultry litter, P as triple super phosphate (TSP), K as muriate of potash (MoP), S as Gypsum and half dose of N from urea were applied before sowing of jute seed. The rest half of amount of N was top dressed at 45 days of sowing after final thinning.

3.9.6. Poultry litter (organic fertilizer) application:

Air dried poultry litter was incorporated to soil as per treatment. Poultry litter was collected every year before setup of the experiment from different poultry farms and made a representative poultry litter and added to the soil. Year wise chemical compositions of incorporated poultry litter are given in appendix Table iv and v.

3.9.7. Sowing of seeds:

After final land preparation every year jute seeds were sown in line at a distance of 30 cm interval at depth of 2.50cm. After sowing, seeds were covered with soil by hand. The rate of seed was 8 kg /ha. The seeds were sown during first week of April.

3.9.8. Germination of seeds:

Healthy and quality seeds were collected from Breeding Division of BJRI and sown in the experimental sites. Germination of seeds started from 3 days. The percentage of germination was satisfactory every year. All the seeds germinated within 7 days.

3.9.9Intercultural practices:

All the intercultural operations were duly employed during the field study.

3.10. Weeding and thinning:

Three weedings were done at the stage of 10, 25 and 40 days after sowing and two thinning were executed at the second and the third weeding. No pesticides were required during the growing period. A few jute leaves were affected by hairy caterpillars, which were removed by hand picking.

3.11. Harvesting:

The jute plants were harvested at the early pod stage after total growth duration of 120 days. The plant population of each plot was counted at the time of harvest. A randomly selected 10 plants were uprooted from each plot and attached soil was removed carefully without damaging the root and root hair. Then plants were cut of ground level, the jute plants were made into small bundles and kept standing on ground for 4 days for shedding of leaves.

3.12. Retting of Jute:

After shedding of jute leaves, the bundles were steeped plot wise in pond water for retting. The retting process was completed in 21 days after steeping. In the retting process fibre in the bark get loosened and separated from the woody stalk due to removal of pectin, gums and other mucilaginous substance. This is usually caused by the combined action of water and microorganisms (Kundu, 1956).

3.13. Extracting (stripping), decortications, washing and drying:

After proper retting the fibres were extracted by stripping and washed thoroughly in water. The extracted fibres were dried in sun plot wise on bamboo bars. After drying the fibres were weighed to get the fibre yield. After stripping, the jute sticks were dried in the sun for several days and weighed to record the yield of stick.

3.14. Growth and yield component of jute:

Base diameter and plant height of ten randomly selected uprooted jute plants were taken with a slide calipers and meter scale respectively. Then the plant roots, shoots and leaves were separated and their green weight taken.

3.15. Dry matter estimation:

The separated plant parts were placed in an oven for 72 hours at 85^0C and after constant weight, plan samples were taken out of the oven and their dry weight was taken and moisture content (%) determined.

3.15.1. Total dry matter production (TODM): Total dry matter production of each crop was calculated using the following formula:

$$\text{TODM (t/ha)} = \frac{\text{Oven dry weight of plant (gm) X No. of plant per plot X0.01}}{\text{No. of plant dried in oven X Plot size (Sq. m)}}$$

3.16. Nutrient uptake: N, P, K and S uptake (Kg/ha) of different plant samples were calculates from the data of of dry matter yield and nutrient content of different plant samples using the following formula:

$$\textbf{Nutrient uptake (Kg/ha)} = \frac{\text{Percent nutrient content X Total dry matter (Kg/ha)}}{100}$$

3.17. Statistical analysis:

The data of respective variables of yield and yield contributing characteristics were analyzed by MSTAT programme, a so ftware for statistical analyses (MSTAT, 2002) and also by ANOVA developed by SRTI, Iswardi, Bangladesh.

3.18. Economic analysis:

Benefit cost ratio was calculated using gross return, margin and total variable cost.

CHAPTER 4

Results and Discussion

Results of the experiment are reported and discussed in this chapter. Morphological description of study area of Manikganj is presented in table 1 and Kishoreganj in table 1.1 respectively. The results of the initial properties of the soil of Manikganj and Kishoreganj are shown in table 2 and 2.1.Soils of both the sites had low organic matter content, low fertility, poor physical and biological condition.

The properties of poultry litter samples which were used in the experiment are given in appendix Table iv and v. It shows that poultry litter contained considerable amount of macro and micro nutrient with very low heavy metal/toxic element.

4.1 Effect of poultry litter on the growth and yield of jute

Various methods have been adopted to measure the plant growth and yield of jute. The principal measures which are employed for this purpose are increase in length of the stem and base diameter of the plant. The weight of green plants, fibre and stick yield are also considered as yield contributing parameters.

The observatories on the different yield parameters of jute in the years 2004-2005, 2005-2006, 2006-2007, 2007-2008 and average of the four years are presented in the tables 3, 3.1, 3.2, 3.3, 3.4 for Manikganj and 3.5, 3.6, 3.7, 3.8 and 3.9 for Kishoreganj site respectively. Data show that the application of poultry litter singly or in combination with chemical fertilizer at different combinations caused significant changes each year at 5% and 1% level of significant on the height, base diameter, yield of green plants, fibre and stick.

Table 3: Effect of poultry litter on the growth and yield of Jute at Manikganj, 2004-2005.

Treatments	Number plant /plot	Plant height (m)	Base diameter (mm)	Yield of green plant with leaves (t/ha)	Yield of green plant with out leaves (t/ha)	Yield of fibre (t/ha)	Yield of stick (t/ha)
T_1=Control	300	1.10	11.20	35.96	25.96	1.25	2.50
T_2= RDF N 25% from PL	280	1.20	11.46	42.56	33.89	1.49	4.99
T_3= T_2 + 75% RDF	272	2.88	14.45	60.50	50.42	3.30	6.99
T_4= RDF N 50% from PL	288	2.29	13.50	52.20	42.39	2.62	5.25
T_5= T_4 + 50% RDF	268	3.20	16.80	60.53	52.72	3.58	8.45
T_6= RDF N 75% from PL	286	2.39	14.70	50.20	50.40	2.75	5.61
T_7= T_6 + 25% RDF	289	3.00	16.20	66.56	57.45	3.45	7.80
T_8= RDF N 100% from PL	297	2.91	15.75	61.28	51.18	3.35	7.20
T_9= T_8 +100% RDF	305	2.56	16.10	54.43	46.92	2.90	6.48
T_{10}= Sole RDF	275	2.98	16.00	57.50	48.28	3.16	7.25

$LSD_{0.05}$	25.02	0.18	1.26	1.01	1.89	0.53	0.19
$LSD_{0.01}$	3.77	0.24	1.71	1.37	2.58	0.72	0.25

Table 3.1: Effect of poultry litter on the growth and yield of Jute at Manikganj, 2005-2006.

Treatments	**Number plant /plot**	**Plant height (m)**	**Base diameter (mm)**	**Yield of green plant with leaves (t/ha)**	**Yield of green plant with out leaves (t/ha)**	**Yield of fibre (t/ha)**	**Yield of stick (t/ha)**
T_1=Control	283	1.00	10.50	34.98	24.98	1.10	2.40
T_2= RDF N 25% from PL	285	1.10	11.20	42.80	33.69	1.40	4.90
T_3= T_2 + 75% RDF	280	2.82	14.00	57.98	47.37	3.10	7.00
T_4= RDF N 50% from PL	286	2.18	14.00	52.65	42.07	2.50	5.21
T_5= T_4 + 50% RDF	265	3.04	16.40	60.25	51.95	3.50	8.44
T_6= RDF N 75% from PL	280	2.30	14.10	49.68	38.79	2.64	5.36
T_7= T_6 + 25% RDF	294	2.96	15.80	65.90	55.77	3.40	7.70
T_8= RDF N 100% from PL	293	2.83	15.30	59.98	49.66	3.25	7.10
T_9= T_8 +100% RDF	300	2.50	16.00	54.00	46.60	2.88	6.45
T_{10}= Sole RDF	265	2.90	15.85	58.20	47.50	3.05	7.32
$LSD_{0.05}$	10.55	0.11	0.40	1.53	0.33	0.79	0.45
$LSD_{0.01}$	14.39	0.15	0.55	2.09	0.44	1.08	0.62

Table 3.2: Effect of poultry litter on **the growth and yield of Jute at Manikganj, 2006-2007.**

Treatments	**Number plant /plot**	**Plant height (m)**	**Base diameter (mm)**	**Yield of green plant with leaves (t/ha)**	**Yield of green plant with out leaves (t/ha)**	**Yield of fibre (t/ha)**	**Yield of stick (t/ha)**
T_1=Control	296	1.04	11.00	36.00	26.00	1.14	2.58
T_2= RDF N 25% from PL	293	1.30	11.78	43.10	34.88	1.50	4.99
T_3= T_2 + 75% RDF	276	2.97	15.10	62.10	51.95	3.40	7.10
T_4= RDF N 50% from PL	300	2.30	14.30	51.54	42.55	2.63	5.20
T_5= T_4 + 50% RDF	273	3.15	16.75	59.80	51.03	3.63	8.50
T_6= RDF N 75% from PL	290	2.39	14.35	51.20	41.54	2.75	5.58
T_7= T_6 + 25% RDF	292	2.92	15.98	66.88	56.38	3.34	7.69
T_8= RDF N 100% from PL	285	2.89	15.45	61.44	51.60	3.35	7.30
T_9= T_8 +100% RDF	288	2.44	15.98	54.36	43.20	2.87	6.50
T_{10}= Sole RDF	268	2.86	15.60	56.86	45.68	2.99	7.30
$LSD_{0.05}$	16.15	0.07	10.89	1.00	0.39	0.44	0.21
$LSD_{0.01}$	22.03	0.09	14.86	1.37	0.53	0.60	0.28

Table 3.3: Effect of poultry litter on the growth and yield of Jute at Manikganj, 2007-2008.

Treatments	Number plant /plot	Plant height (m)	Base diameter (mm)	Yield of green plant with leaves (t/ha)	Yield of green plant with out leaves (t/ha)	Yield of fibre (t/ha)	Yield of stick (t/ha)
T_1=Control	305	1.09	10.75	36.00	25.99	1.01	2.51
T_2= RDF N 25% from PL	297	1.36	11.56	43.88	35.07	1.60	5.20
T_3= T_2 + 75% RDF	288	2.85	15.30	61.80	50.72	3.32	7.15
T_4= RDF N 50% from PL	304	2.33	14.46	52.50	43.03	2.66	5.35
T_5= T_4 + 50% RDF	269	3.18	16.81	61.00	52.26	3.65	8.52
T_6= RDF N 75% from PL	294	2.44	14.45	51.60	41.60	2.81	5.69
T_7= T_6 + 25% RDF	296	3.00	16.00	66.50	55.77	3.42	7.81
T_8= RDF N 100% from PL	294	2.78	15.30	58.98	48.90	3.20	7.20
T_9= T_8 +100% RDF	310	2.40	15.50	54.28	46.27	2.86	5.86
T_{10}= Sole RDF	280	2.80	15.90	57.30	45.77	2.93	7.32
LSD $_{0.05}$	45.74	0.27	1.10	0.64	0.31	0.64	0.31
LSD $_{0.01}$	62.38	0.37	1.51	0.89	0.43	0.87	0.42

Table 3.4: Average four years effect of poultry litter on the growth and yield of Jute at Manikganj, 2004-05 to 2007-08.

Treatments	Number Plant /plot	Plant height (m)	Base diameter (mm)	Yield of green plant with leaves (t/ha)	Yield of green plant with out leaves (t/ha)	Yield of fibre (t/ha)	Yield of stick (t/ha)
T_1=Control	296.00	0.99	10.86	35.74	25.73	1.12	2.49
T_2= RDF N 25% from PL	288.75	1.24	11.49	42.87	34.38	1.49	5.02
T_3= T_2 + 75% RDF	279.00	2.88	14.71	60.59	50.11	3.28	7.06
T_4= RDF N 50% from PL	294.5	2.27	14.07	52.22	42.51	2.60	5.25
T_5= T_4 + 50% RDF	268.75	**3.14**	**16.69**	60.39	51.99	**3.61**	**7.77**
T_6= RDF N 75% from PL	287.5	2.38	14.40	50.67	40.58	2.73	5.56
T_7= T_6 + 25% RDF	292.75	2.72	16.00	**66.46**	**56.34**	3.40	7.75
T_8= RDF N 100% from PL	292.25	2.85	15.45	60.42	50.33	3.26	7.20
T_9= T_8 +100% RDF	300.75	2.47	15.90	54.31	45.74	2.87	6.32
T_{10}= Sole RDF	272.00	2.88	15.84	57.46	46.80	3.03	7.29
LSD $_{0.05}$	10.10	0.24	261.30	1.23	1.69	0.12	0.18
LSD $_{0.01}$	13.60	0.32	351.89	1.66	2.28	0.16	0.25

The average results at Manikganj site indicate (table 3.4) that the tallest plant (3.14 m), the highest base diameter(16.69mm), yields of fibre(3.61 t/ha)and stick(7.77 t/ha) were obtained with the integrated treatment T_5 (RDF N 50% from PL +50% RDF) and the lowest was obtained with T_1-Control (Without fertilizer) at Manikganj. The yield of

green plants with (66.46 t/ha) and with out leaves (56.34 t/ha) were recorded for T_7 (RDF N 75% from PL + 25% RDF). A standard plant population was observed with different treatments at Manikganj. A positive correlation was observed between plant height and yield of fibre (r^2=0.986) and /stick (r^2=0.873) in fig.1 and fig.1.1 respectively. It was also found that positive correlation between base diameter and yield of fibre (r^2=0.917) and stick (r^2=0.833) in fig.1.2, and fig.1.3 at Manikganj.

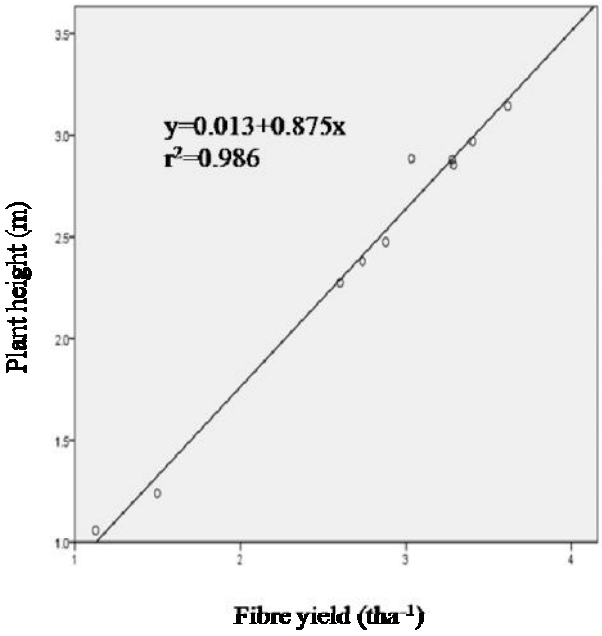

Fig.1. Relationship between plant height and fibre yield at Manikganj

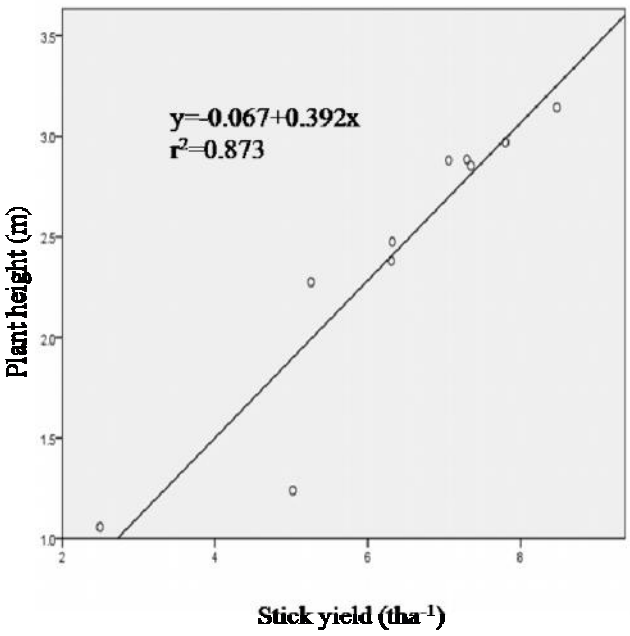

Fig.1.1 Relationship between plant height and stick yield at Manikganj

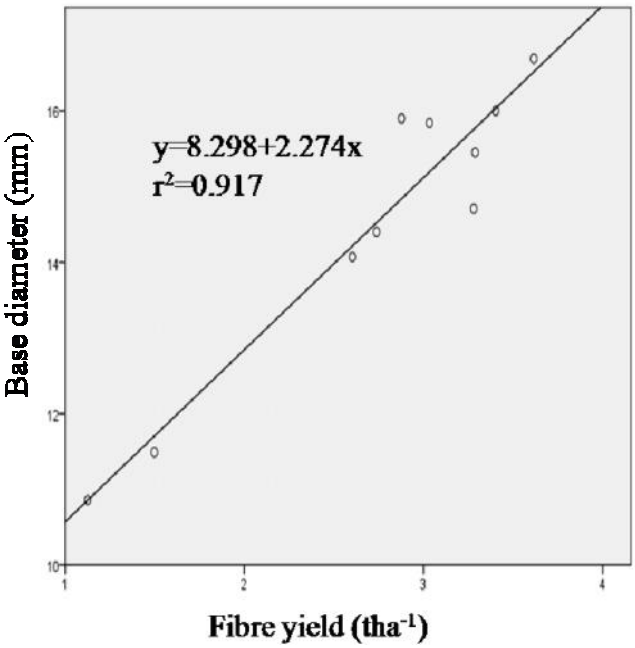

Fig.1.2 Relationship between base diameter and fibre yield at Manikganj

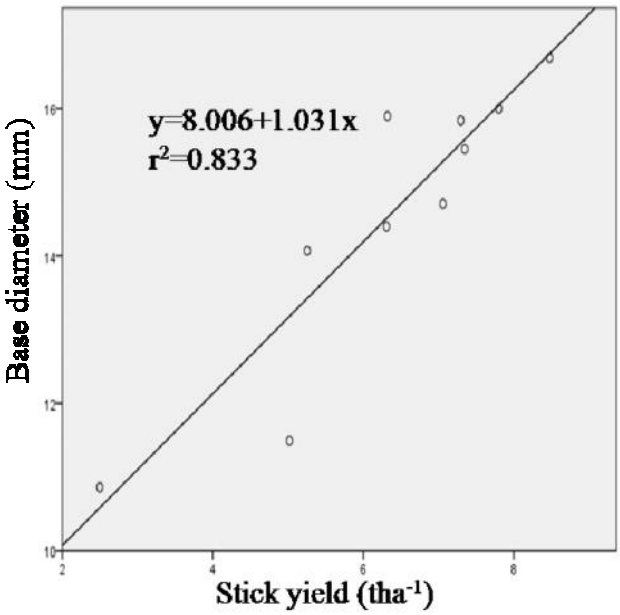

Fig.1.3 Relationship between base diameter and stick yield at Manikganj

Table 3.5: Effect of poultry litter on the growth and yield of Jute at Kishoreganj, 2004-05.

Treatments	Number Plant /plot	Plant height (m)	Base diameter (mm)	Yield of green plant with leaves (t/ha)	Yield of green plant with out leaves (t/ha)	Yield of fibre (t/ha)	Yield of stick (t/ha)
T_1=Control	355	1.30	11.50	36.20	26.20	1.21	2.60
T_2= RDF N 25% from PL	285	1.40	11.52	42.96	34.27	1.57	4.92
T_3= T_2 + 75% RDF	278	3.00	14.56	61.21	52.31	3.34	7.20
T_4= RDF N 50% from PL	298	2.40	14.00	52.70	42.89	2.65	5.45
T_5= T_4 + 50% RDF	280	3.30	17.09	61.98	54.20	3.17	8.30
T_6= RDF N 75% from PL	310	2.45	15.26	51.12	43.00	2.72	8.82
T_7= T_6 + 25% RDF	296	3.09	16.70	68.10	58.60	3.40	7.59
T_8= RDF N 100% from PL	320	2.99	16.10	61.23	51.60	3.23	6.98
T_9= T_8 +100% RDF	350	2.98	16.40	59.50	51.81	2.94	7.10
T_{10}= Sole RDF	320	2.96	16.10	58.52	49.00	3.21	6.98
$LSD_{0.05}$	57.14	0.65	1.04	0.94	0.83	0.30	0.95
$LSD_{0.01}$	77.93	0.89	1.42	1.28	1.13	0.41	1.29

Table 3.6: Effect of poultry litter on the growth and yield of Jute at Kishoreganj, 2005-2006.

Treatments	Number plant /plot	Plant height (m)	Base diameter (mm)	Yield of green plant with leaves (t/ha)	Yield of green plant with out leaves (t/ha)	Yield of fibre (t/ha)	Yield of stick (t/ha)
T_1=Control	340	1.16	11.00	36.00	26.28	1.10	2.49
T_2= RDF N 25% from PL	293	1.40	11.50	43.06	34.10	1.52	4.88
T_3= T_2 + 75% RDF	280	2.85	15.40	61.35	52.00	3.21	6.99
T_4= RDF N 50% from PL	301	2.28	14.09	52.84	42.75	2.55	5.38
T_5= T_4 + 50% RDF	277	3.10	17.21	61.78	45.55	3.50	8.00
T_6= RDF N 75% from PL	305	2.48	15.23	51.23	42.89	2.68	5.86
T_7= T_6 + 25% RDF	290	3.09	16.25	68.00	58.20	3.43	7.66
T_8= RDF N 100% from PL	318	2.93	16.00	60.79	50.62	2.10	6.91
T_9= T_8 +100% RDF	330	2.95	16.35	58.81	51.85	2.90	6.88
T_{10}= Sole RDF	299	2.93	16.21	58.60	49.20	3.15	6.93
$LSD_{0.05}$	58.44	0.62	1.13	1.57	0.77	0.37	0.37
$LSD_{0.01}$	79.70	0.85	1.54	2.15	1.05	0.51	0.50

Table 3.7: Effect of poultry litter on the growth and yield of Jute at Kishoreganj, 2006-2007.

Treatments	Number plant /plot	Plant height (m)	Base diameter (mm)	Yield of green plant with leaves (t/ha)	Yield of green plant with out leaves (t/ha)	Yield of fibre (t/ha)	Yield of stick (t/ha)
T_1=Control	355	1.28	11.20	36.89	26.50	1.17	2.55
T_2= RDF N 25% from PL	290	1.48	12.00	43.15	34.95	1.69	5.20
T_3= T_2 + 75% RDF	288	3.05	15.45	62.72	52.39	3.44	7.31
T_4= RDF N 50% from PL	320	2.45	14.35	53.10	42.90	2.66	5.55
T_5= T_4 + 50% RDF	281	3.25	17.30	61.90	55.00	3.65	8.40
T_6= RDF N 75% from PL	330	2.53	15.40	51.50	42.96	2.76	5.98
T_7= T_6 + 25% RDF	294	2.99	16.35	68.43	58.35	3.46	7.71
T_8= RDF N 100% from PL	332	3.07	16.21	61.84	52.00	3.40	7.15
T_9= T_8 +100% RDF	332	2.91	16.33	58.93	51.75	2.96	7.20
T_{10}= Sole RDF	306	2.87	16.15	58.75	49.52	3.31	7.15
$LSD_{0.05}$	40.02	0.66	0.83	1.38	2.29	0.17	0.32
$LSD_{0.01}$	54.58	0.91	1.13	1.83	3.12	0.23	0.43

Table 3.8: Effect of poultry litter on the growth and yield of Jute at Kishoreganj, 2007-2008.

Treatments	Number plant /plot	Plant height (m)	Base diameter (mm)	Yield of green plant with leaves (t/ha)	Yield of green plant with out leaves (t/ha)	Yield of fibre (t/ha)	Yield of stick (t/ha)
T_1=Control	360	1.35	11.15	36.70	26.57	1.28	2.63
T_2= RDF N 25% from PL	300	1.51	12.23	43.80	35.50	1.72	5.23
T_3= T_2 + 75% RDF	290	2.91	15.50	62.77	52.56	3.46	7.34
T_4= RDF N 50% from PL	331	2.56	15.41	53.60	43.48	2.69	5.61
T_5= T_4 + 50% RDF	286	3.28	17.40	62.00	52.29	3.70	8.45
T_6= RDF N 75% from PL	320	2.57	15.46	51.91	43.16	2.78	6.12
T_7= T_6 + 25% RDF	300	3.12	16.41	68.48	57.50	3.50	7.75
T_8= RDF N 100% from PL	336	2.98	16.30	61.90	52.21	3.38	7.09
T_9= T_8 +100% RDF	345	2.88	16.31	59.01	51.80	2.93	7.05
T_{10}= Sole RDF	300	2.81	16.00	58.56	49.55	3.34	7.23
$LSD_{0.05}$	39.06	0.49	0.68	1.82	1.05	0.40	0.13
$LSD_{0.01}$	53.27	0.66	0.93	2.48	1.44	0.55	0.18

Table 3.9: Average four years effect of poultry litter on the growth and yield of Jute at Kishoreganj, 2004-05 to 2007-08.

Treatments	Number plant /plot	Plant height (m)	Base diameter (mm)	Yield of green plant with leaves (t/ha)	Yield of green plant with out leaves (t/ha)	Yield of fibre (t/ha)	Yield of stick (t/ha)
T_1=Control	352	1.27	11.21	36.45	26.39	1.19	2.57
T_2= RDF N 25% from PL	289	1.46	11.81	43.24	34.71	1.63	5.06
T_3= T_2 + 75% RDF	284	2.95	15.23	62.01	52.32	3.36	7.21
T_4= RDF N 50% from PL	312	2.42	14.46	53.06	42.98	2.64	5.49
T_5= T_4 + 50% RDF	281	**3.23**	**17.25**	61.69	54.76	**3.64**	**8.29**
T_6= RDF N 75% from PL	316	2.50	15.34	51.44	43.00	2.74	5.95
T_7= T_6 + 25% RDF	295	3.07	16.43	59.06	51.80	3.45	7.68
T_8= RDF N 100% from PL	326	2.99	16.15	61.44	51.61	3.28	7.03
T_9= T_8 +100% RDF	354	2.93	16.35	**68.25**	**58.16**	2.93	7.08
T_{10}= Sole RDF	306	2.89	16.12	58.61	49.33	3.25	7.07
LSD $_{0.05}$	13.06	0.11	0.43	0.61	0.59	0.12	0.20
LSD $_{0.01}$	17.58	0.14	0.58	0.82	0.79	0.17	0.27

At the Kishoreganj site also (table 3.9), the maximum height of the plant (3.23 m), base diameter (17.25 mm),yields of fibre (3.64t/ha) and stick (8.29 t/ha) were obtained with T_5. However the yield of green plants with leaves (68.25 t/ha) and green plants without leaves (58.16 t/h) were found with T_9 (RDF N 100 % from PL + 100% RDF). A standard plant population was also found with different treatment at Kishoreganj. Among all the poultry litter only treatments, the highest dose T_8 (RDF N 100 % from PL) contributed maximum growth and yield contributing characteristics compared to T_{10} (Sole RDF application). On the other hand the highest integrated dose T_9 (RDF N 100 % from PL +100% RDF) showed a decreasing the tendency of the yield of fibre and stick production compared to the other integrated treatments such as T_3 (RDF N 25% from PL + 75%RDF), T_5 (RDF N 50% from PL +50%RDF and T_7 (RDF N 75% from PL + 25% RDF), or T_{10} (Sole RDF). On the basis of fibre yield production, the treatments may be arranged in the order of T_5>T_7>T_3>T_8>T_{10}>

T_9>T_6>T_4>T_2>T_1. The present findings indicate that the use of poultry litter in combination with inorganic fertilizer contributed towards a better performance on the yield parameter's of jute. Strong co-relation also showed (fig 1.4 and 1.5,) at Kishoreganj between plant height and fibre (r^2 value 0.964) / stick yield (r^2 value0.874). The co-relation (fig 1.6 and 1.7) between base diameter and fibre /stick yield having r^2 value 0.831 and 0.800 respectively which is significant. It revealed that the yield if jute crop may increase with the increases of plant height and base diameter at both the sites.

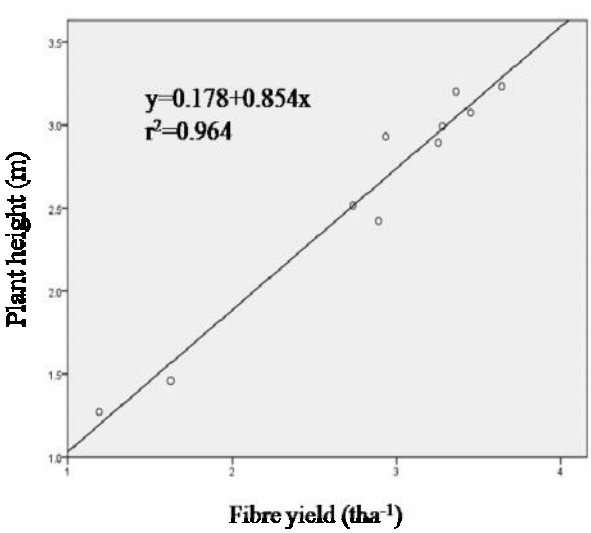

Fig.1.4 Relationship between plant height and fibre yield at Kishoreganj

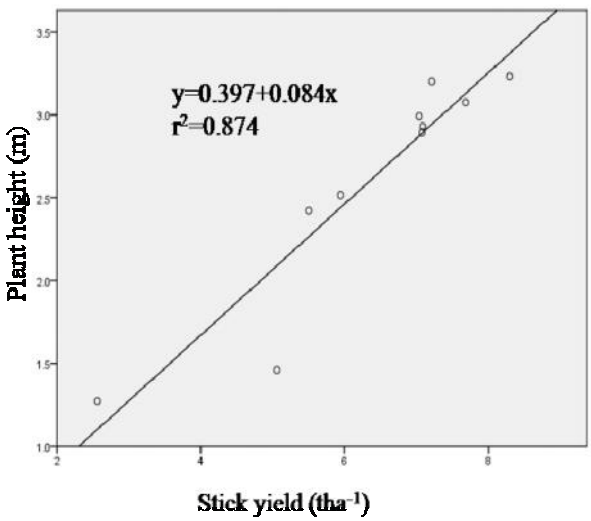

Fig.1.5 Relationship between plant height and stick yield at Kishoreganj

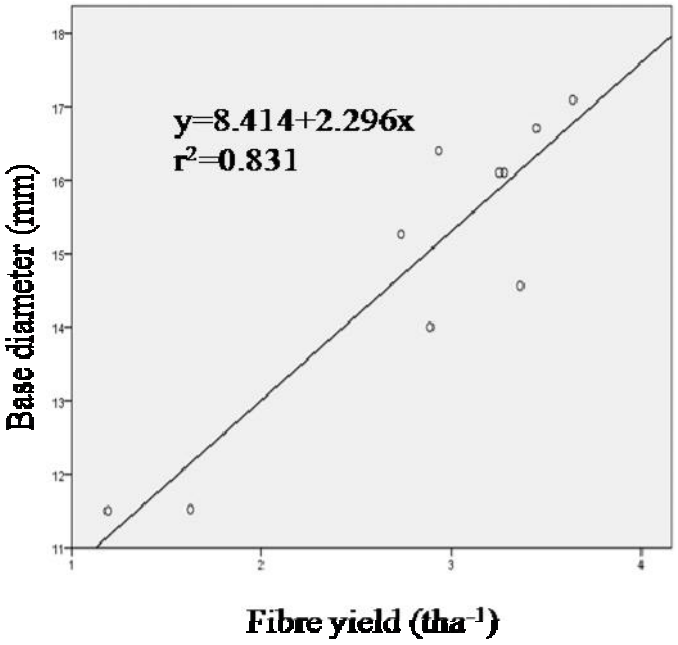

Fig.1.6 Relationship between base diameter and fibre yield at Kishoregnj

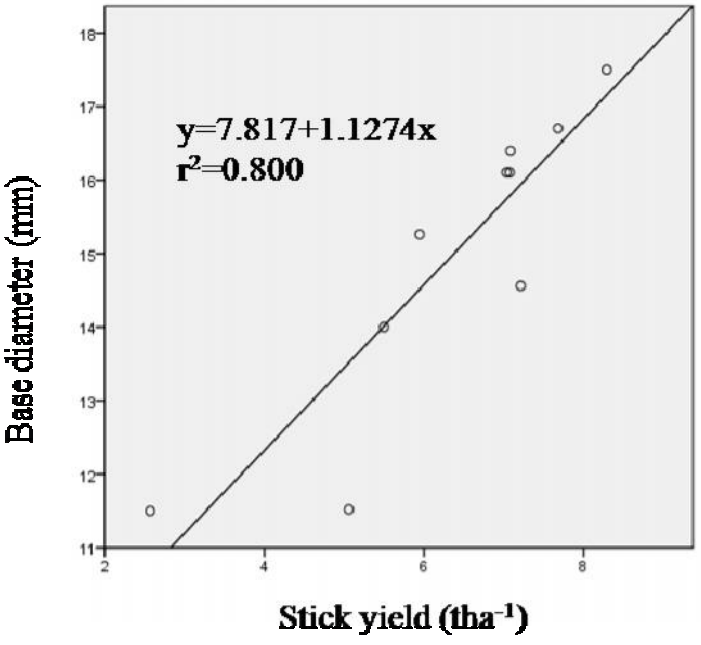

Fig.1.7 Relationship between base diameter and stick yield at Kishoregnj

4. Effect of poultry litter on the dry matter production of jute

Dry matter productions of the different parts of jute plant were measured and are presented in the tables 4 to 4.4 for Manikganj and in the tables 4.5 to 4.9 for Kishoreganj respectively. Leaves shoot and roots were considered as different

parts of jute plant. The effect of different poultry litter treatments on dry matter yield of jute was statistically significant.

Table 4. Effect of poultry litter on the dry matter production of jute at Manikganj, 2004-2005.

Treatments	**Green weight of 5 plants/plot(g)**			**Oven dry weight of 5 plants/plot(g)**			**Oven dry weight (t/ha)**			**Total Dry weight (t/ha)**
	Leaves	Shoots	Roots	Leaves	Shoots	Roots	Leaves	Shoots	Roots	L+S+R
T_1=Control	30.50	190.00	45.50	11.25	90.00	8.75	0.75	6.00	0.58	7.35
T_2=RDFN25%fromPL	57.50	230.00	73.50	24.00	110.00	31.75	1.49	5.6	0.54	7.63
T_3= T_2 + 75% RDF	100.00	400.00	117.00	45.00	195.00	53.00	2.72	6.65	1.91	11.28
T_4= RDF N 50% fromPL	95.05	380.20	113.08	42.53	185.00	51.00	2.72	11.84	3.26	17.82
T_5= T_4 + 50% RDF	98.75	395.00	117.75	44.38	193.00	55.00	2.64	11.49	3.28	17.41
T_6= RDF N 75% from PL	98.00	392.00	118.00	22.00	191.00	53.00	2.80	12.13	3.36	18.29
T_7= T_6 + 25% RDF	107.58	430.32	122.58	48.79	210.00	62.20	3.30	14.23	4.22	**21.75**
T_8= RDF N 100% fromPL	96.53	386.00	112.23	43.25	188.00	51.00	2.84	12.34	3.34	18.52
T_9= T_8 +100% RDF	107.50	430.00	125.50	48.75	210.00	56.00	3.13	13.48	3.60	20.21
T_{10}= Sole RDF	99.00	396.00	117.00	44.50	193.00	53.50	2.67	11.58	3.63	17.88
LSD $_{0.05}$	1.70	2.37	31.61	5.98	1.97	1.70	0.14	1.70	0.25	1.52
LSD $_{0.01}$	2.32	3.23	43.10	8.16	2.68	2.32	0.19	2.32	0.35	2.08

Table 4.1: Effect of poultry litter on the dry matter production of jute at Manikganj, 2005 -2006.

Treatments	**Green weight of 5 plants/plot(g)**			**Oven dry weight of 5 plants/plot(g)**			**Oven dry weight (t/ha)**			**Total Dry weight (t/ha)**
	Leaves	Shoot	Roots	Leaves	Shoots	Roots	Leaves	Shoots	Roots	L+S+R
T_1=Control	35.30	141.25	50.31	12.71	65.62	10.10	0.80	4.13	0.64	5.57
T_2= RDF N 25% from PL	58.20	232.70	74.21	24.20	111.40	32.11	1.53	7.06	2.03	10.62
T_3= T_2 + 75% RDF	102.00	408.10	119.00	46.00	199.00	54.60	2.86	12.38	3.40	18.64
T_4= RDF N 50% from PL	94.90	376.00	112.80	42.44	185.00	51.50	2.70	11.76	3.27	17.73
T_5= T_4 + 50% RDF	98.95	396.10	118.00	44.47	183.00	52.00	2.62	10.78	3.06	16.46
T_6= RDF N 75% from PL	97.75	391.30	117.80	43.88	190.65	54.00	2.73	11.86	3.36	17.95
T_7= T_6 + 25% RDF	107.72	430.82	124.00	48.86	210.40	57.00	3.23	13.75	3.80	**20.78**

T_8= RDF N 100% from PL	96.40	384.00	112.50	43.10	188.00	51.00	2.81	12.24	3.32	18.37
T_9= T_8 +100% RDF	107.00	428.20	123.00	48.50	209.00	56.00	3.19	13.39	3.66	20.24
T_{10}= Sole RDF	101.00	404.35	118.00	45.50	197.18	54.00	2.68	11.61	2.65	16.94
LSD $_{0.05}$	1.67	4.1	3.1	1.70	1.70	1.70	0.17	3.3	0.35	1.62
LSD $_{0.01}$	2.28	5.7	4.2	2.32	2.32	2.32	0.23	4.5	0.48	2.20

Table 4.2: Effect of poultry litter on the dry matter production of jute at Manikganj, 2006-07.

Treatments	**Green weight of 5 plants/plot(g)**			**Oven dry weight of 5 plants/plot(g)**			**Oven dry Weight (t/ha)**			**Total dry weight (t/ha)**
	Leaves	Shoots	Roots	Leaves	Shoots	Roots	Leaves	Shoots	Roots	L+S+R
T_1=Control	35.00	142.00	51.00	12.50	67.00	10.60	0.82	4.41	0.70	5.93
T_2= RDF N 25% from PL	57.98	232.00	73.98	24.00	111.00	32.00	1.56	7.23	2.08	10.87
T_3= T_2 + 75% RDF	102.30	404.00	119.30	46.10	197.00	54.40	2.83	12.08	3.34	18.25
T_4= RDF N 50% from PL	95.00	382.00	113.00	42.50	185.00	51.00	2.83	12.33	3.40	18.56
T_5= T_4 + 50% RDF	98.89	395.20	117.90	44.20	192.00	54.00	2.68	11.65	2.76	18.09
T_6= RDF N 75% fromPL	97.60	390.00	117.60	43.70	190.00	53.80	2.82	12.24	3.47	18.53
T_7= T_6 + 25% RDF	105.70	422.60	120.70	47.85	206.00	55.00	3.10	13.37	3.57	20.03
T_8= RDF N 100%fromPL	95.50	382.00	112.00	42.75	186.00	51.00	2.71	11.78	3.23	17.72
T_9= T_8 +100% RDF	103.10	142.00	120.00	46.00	200.00	55.00	2.94	12.80	3.52	19.26
T_{10}= Sole RDF	101.30	400.00	119.00	45.00	194.00	54.50	2.68	11.55	3.25	17.48
LSD $_{0.05}$	1.70	62.37	1.70	1.67	28.74	1.97	0.16	1.55	0.17	1.43
LSD $_{0.01}$	2.32	85.06	3.32	2.28	39.19	2.68	0.22	2.11	0.23	1.95

Table 4.3: Effect of poultry litter on the dry matter production of jute at Manikganj, 2007-08.

Treatments	**Green weight of 5 plants/plot(g)**			**Oven dry weight of 5 plants/plot(g)**			**Oven dry weight (t/ha)**			**Total dry weight (t/ha)**
	Leaves	Shoots	Roots	Leaves	Shoots	Roots	Leaves	Shoots	Roots	L+S+R
T_1=Control	35.20	140.82	50.40	12.70	65.50	17.20	0.85	4.44	1.17	6.47
T_2= RDF N 25% from PL	57.89	231.60	73.93	23.96	110.80	31.98	1.58	7.31	2.11	11.00
T_3= T_2 + 75% RDF	101.70	406.82	118.80	46.00	198.38	54.45	2.94	12.70	3.48	19.12
T_4= RDF N 50% from PL	95.81	386.20	113.85	42.95	188.30	51.93	2.90	12.72	3.51	19.13
T_5= T_4 + 50% RDF	99.10	396.45	118.30	44.60	193.28	54.21	2.67	11.55	3.24	17.46
T_6= RDF N 75% from PL	98.25	393.20	118.25	44.14	191.70	54.13	2.88	12.52	3.54	18.94
T_7= T_6 + 25% RDF	104.80	419.60	119.85	47.50	204.85	54.92	3.12	13.47	3.61	20.20
T_8= RDF N 100% from PL	94.70	378.90	110.75	42.40	184.50	50.38	2.77	12.05	3.55	18.37
T_9= T_8 +100% RDF	102.80	411.30	119.80	46.50	200.62	54.95	3.20	13.82	3.79	20.18
T_{10}= Sole RDF	100.90	403.60	118.90	45.47	196.82	54.30	3.83	12.25	3.39	18.47
LSD $_{0.05}$	1.70	125.67	44.01	1.70	4.80	1.70	0.16	1.53	0.56	1.53
LSD $_{0.01}$	2.32	171.40	60.02	2.32	6.54	2.32	0.22	2.08	0.77	2.08

Table 4.4: Average of four years on the effect of poultry litter on dry matter production of jute at Manikganj, 2004-05 to 2007-08

Treatments	Green weight of 5 plants/plot(g)			Oven dry weight of 5 plants/plot(g)			Oven dry weight (t/ha)			Total dry weight (t/ha)
	Leaves	**Shoots**	**Roots**	**Leaves**	**Shoots**	**Roots**	**Leaves**	**Shoots**	**Roots**	**L+S+R**
T_1=Control	34.00	153.51	49.30	12.29	72.03	11.66	0.80	4.74	0.77	6.31
T_2= RDF N 25% from PL	57.89	231.57	73.90	24.04	11.08	31.96	1.53	6.80	1.69	10.02
T_3= T_2 + 75% RDF	101.49	404.72	168.02	45.77	19.73	54.11	2.83	10.95	3.03	16.81
T_4= RDF N 50% from PL	95.18	381.10	113.18	42.60	18.58	51.36	2.78	12.16	3.36	18.30
T_5= T_4 + 50% RDF	98.92	395.68	117.99	44.41	190.32	53.80	2.65	11.37	3.08	17.10
T_6= RDF N 75% fromPL	97.89	391.62	117.91	45.38	190.83	53.73	2.80	12.19	3.42	18.41
T_7= T_6 + 25% RDF	106.45	425.83	121.53	47.41	207.81	55.48	3.13	13.51	3.61	**20.54**
T_8= RDF N 100%fromPL	95.78	382.72	111.86	42.88	186.63	50.84	2.77	12.10	3.36	18.23
T_9= T_8 +100% RDF	105.10	420.37	122.32	47.43	204.91	57.29	3.16	13.55	3.83	20.25
T_{10}= Sole RDF	100.54	400.99	118.22	45.11	195.25	54.12	2.71	11.74	3.23	17.68
LSD $_{0.05}$	1.70	1.70	1.70	1.70	1.70	1.62	0.17	1.53	0.17	1.62
LSD $_{0.01}$	2.32	2.32	2.32	2.32	2.32	2.20	0.23	2.09	0.23	2.20

At Manikganj site all the treatments enhanced the dry matter yield over control. Higher rate of dry matter yield production was obtained with the treatments of combined application of poultry litter and inorganic fertilizer. Sole application of poultry litter also contributed to dry meter yields which were closely comparable to RDF. The highest dry matter yield (20.54 t/ha) was recorded for T_7 (RDF N 75% from PL+25% RDF) and the lowest (6.31t/ha) for T_1 (control) which was increased 225.52% dry matter yield over control.

Table 4.5: Effect of poultry litter on the dry matter production of jute at Kishoreganj, 2004-05.

Treatments	Green weight of 5 plants /plot(g)			Oven dry weight of 5 plants/plot(g)			Oven dry weight (t/ha)			Total dry weight (t/ha)
	Leaves	Shoots	Roots	Leaves	Shoots	Roots	Leaves	Shoots	Roots	L+S+R
T_1=Control	42.00	170.00	58.00	16.00	80.21	12.50	1.26	6.33	0.99	8.58
T_2= RDF N 25% from PL	60.10	240.40	76.30	30.15	115.21	50.50	1.91	7.30	3.20	12.41
T_3= T_2 + 75% RDF	104.00	416.00	121.00	47.20	203.20	56.12	2.92	12.55	3.47	18.94
T_4= RDF N 50% from PL	98.20	392.80	116.40	44.10	191.10	53.56	2.92	12.66	3.55	19.13
T_5= T_4 + 50% RDF	98.80	395.50	117.80	44.42	192.55	55.90	2.76	11.98	3.48	18.22
T_6= RDF N 75% fromPL	100.00	420.00	119.00	45.20	205.00	54.50	3.11	14.12	3.75	20.98
T_7= T_6 + 25% RDF	106.40	450.00	121.40	48.25	220.25	55.70	3.17	14.49	3.66	21.32
T_8= RDF N 100%fromPL	97.00	388.00	113.00	43.20	189.20	51.50	3.07	13.45	3.66	20.18
T_9= T_8 +100% RDF	106.40	425.00	122.60	48.40	207.50	56.36	3.76	16.14	4.38	24.28
T_{10}= Sole RDF	102.00	411.00	119.00	46.00	200.58	58.50	3.27	14.26	4.16	21.69
LSD $_{0.05}$	2.02	2.53	1.62	1.94	1.70	31.14	0.08	0.14	0.08	0.09
LSD $_{0.01}$	2.76	3.45	2.20	2.65	2.32	42.47	0.11	0.19	0.11	0.13

Table 4.6: Effect of poultry litter on the dry matter production of jute at Kishoreganj, 2005-06.

Treatments	Green weight of 5 plants/plot(g)	Oven dry weight of 5 plants/plot(g)	Oven dry weight (t/ha)	Total dry

										weight (t/ha)
	Leaves	Shoots	Roots	Leaves	Shoots	Roots	Leaves	Shoots	Roots	L+S+R
T_1=Control	35.20	141.80	52.20	12.55	74.00	20.40	0.95	5.59	1.54	8.03
T_2= RDF N 25% from PL	57.45	229.00	73.50	25.20	110.50	31.80	1.64	7.19	2.07	10.90
T_3= T_2 + 75% RDF	101.70	404.40	118.55	45.90	198.50	54.28	0.01	12.35	3.38	15.74
T_4= RDF N 50% from PL	97.45	389.80	114.40	43.70	190.90	57.50	2.92	12.77	3.85	35.23
T_5= T_4 + 50% RDF	100.00	400.54	119.20	45.20	194.27	55.60	2.78	11.96	3.42	18.16
T_6= RDF N 75% from PL	97.20	391.50	117.20	43.78	199.75	55.60	2.97	13.54	3.77	20.28
T_7= T_6 + 25% RDF	106.00	424.25	120.90	48.20	207.14	55.26	3.11	13.35	3.56	20.02
T_8= RDF N 100%fromPL	96.70	393.40	112.70	43.80	192.00	51.40	3.10	13.57	3.63	20.30
T_9= T_8 +100% RDF	102.95	410.80	121.00	46.50	201.00	56.60	3.41	14.74	4.15	22.30
T_{10}= Sole RDF	100.30	401.40	118.15	45.18	196.70	54.50	3.00	13.07	3.62	19.69
LSD $_{0.05}$	1.78	1.87	1.70	1.62	1.62	1.70	0.80	1.43	0.94	1.62
LSD $_{0.01}$	2.43	2.54	2.32	2.21	2.20	2.32	1.10	1.95	1.29	2.21

Table 4.7: Effect of poultry litter on the dry matter production of jute at Kishoreganj, 2006-07.

Treatments	**Green weight of 5 plants/plot(g)**			**Oven dry weight of 5 plants/plot(g)**			**Oven dry weight (t/ha)**			**Total dry weight (t/ha)**
	Leaves	Shoots	Roots	Leaves	Shoots	Roots	Leaves	Shoots	Roots	L+S+R
T_1=Control	35.35	141.30	50.37	12.70	65.68	19.20	1.00	5.18	1.51	7.69
T_2= RDF N 25% from PL	58.00	232.10	74.20	24.70	111.15	32.10	1.59	7.16	2.07	10.82
T_3= T_2 + 75% RDF	102.10	406.40	119.10	46.05	198.20	54.60	2.95	12.68	3.49	19.12
T_4= RDF N 50% from PL	94.81	379.85	112.83	42.46	184.93	51.42	3.02	13.15	3.66	19.83
T_5= T_4 + 50% RDF	100.50	300.90	120.00	45.00	150.92	55.00	2.80	9.39	3.42	15.61
T_6= RDF N 75% from PL	97.80	391.10	117.81	43.91	190.60	53.91	3.22	13.97	3.95	20.36
T_7= T_6 + 25% RDF	105.95	423.80	120.95	47.58	206.91	55.48	3.11	13.52	3.62	20.25
T_8= RDF N 100%fromPL	96.00	385.85	116.41	43.10	187.95	53.21	3.18	13.87	3.93	20.98
T_9= T_8 +100% RDF	104.10	416.45	121.30	47.05	203.25	55.66	3.47	15.00	4.11	22.58
T_{10}= Sole RDF	100.56	402.26	118.48	45.00	196.23	54.20	3.06	13.34	3.69	20.09
LSD $_{0.05}$	12.55	1.70	53.35	1.70	1.70	1.08	0.94	1.62	1.21	1.71
LSD $_{0.01}$	17.12	2.32	72.76	2.32	2.32	1.48	1.29	2.20	1.65	2.33

Table 4.8: Effect of poultry litter on the dry matter production of jute at Kishoreganj, 2007-08

Treatments	**Green weight of 5 plants/plot(g)**			**Oven dry weight of 5 plants/plot(g)**			**Oven dry weight (t/ha)**			**Total dry weight (t/ha)**
	Leaves	Shoots	Roots	Leaves	Shoots	Roots	Leaves	Shoots	Roots	L+S+R

T_1=Control	36.00	144.40	51.45	13.00	67.20	20.72	1.04	5.38	1.66	8.08
T_2= RDF N 25% from PL	59.45	237.95	75.45	24.73	113.98	32.73	1.65	7.60	2.18	11.43
T_3= T_2 + 75% RDF	103.42	413.70	120.43	46.72	201.85	55.22	3.01	13.00	3.56	19.57
T_4= RDF N 50% from PL	96.28	385.25	114.30	43.15	187.63	52.13	3.17	13.80	3.83	20.80
T_5= T_4 + 50% RDF	99.70	398.86	118.75	44.85	144.43	54.38	2.85	9.18	3.46	15.49
T_6= RDF N 75% from PL	98.60	394.50	118.20	44.35	192.30	54.26	3.15	10.27	3.86	17.28
T_7= T_6 + 25% RDF	104.90	419.70	120.00	47.50	204.85	55.20	3.16	13.65	3.68	20.49
T_8= RDF N 100%fromPL	96.80	387.39	112.82	43.45	188.70	51.42	3.24	14.08	3.84	21.16
T_9= T_8 +100% RDF	103.45	413.86	120.45	46.73	201.95	55.23	3.58	15.48	4.23	23.29
T_{10}= Sole RDF	100.60	402.48	118.65	45.30	196.25	54.33	3.02	13.08	3.62	20.44
LSD $_{0.05}$	1.61	1.70	1.70	1.70	1.70	9.93	0.18	1.54	1.62	1.64
LSD $_{0.01}$	2.20	2.32	2.32	2.32	2.32	13.54	0.24	2.11	2.20	2.24

Table 4.9: Average of four years on the effect of poultry litter on dry matter roduction of jute at Kishoreganj, 2004-05 to 2007-08.

Treatments	**Green weight of 5 plants/plot(g)**			**Oven dry weight of 5 plants/plot(g)**			**Oven dry weight (t/ha)**			**Total dry weight (t/ha)**
	Leaves	Shoots	Roots	Leaves	Shoots	Roots	Leaves	Shoots	Roots	L+S+R
T_1=Control	37.12	143.74	53.01	13.56	71.78	18.21	1.06	5.62	1.43	8.11
T_2= RDF N 25% from PL	58.75	149.38	74.86	26.20	112.71	36.79	1.97	8.46	2.77	13.20
T_3= T_2 + 75% RDF	102.81	234.49	119.77	44.97	200.45	55.06	2.84	12.65	3.48	18.97
T_4= RDF N 50% from PL	96.69	386.93	114.78	43.35	188.64	53.65	3.00	13.09	3.72	19.81
T_5= T_4 + 50% RDF	99.70	373.95	118.94	44.87	170.55	55.22	2.79	10.62	3.45	16.86
T_6= RDF N 75% from PL	98.41	464.53	118.06	44.31	194.24	54.47	3.11	12.79	3.83	19.73
T_7= T_6 + 25% RDF	105.82	429.44	120.82	47.88	209.79	55.41	3.14	13.73	3.63	20.50
T_8= RDF N 100%fromPL	96.63	388.67	113.74	43.39	189.47	51.89	3.14	13.74	3.78	20.66
T_9= T_8 +100% RDF	104.23	416.33	121.34	47.17	203.43	55.97	3.55	15.32	4.21	**23.08**
T_{10}= Sole RDF	100.87	404.29	118.58	45.38	159.71	55.39	3.08	13.43	3.77	20.28
LSD $_{0.05}$	216.09	1.70	1.70	1.76	62.51	1.70	1.43	1.72	1.32	1.70
LSD $_{0.01}$	294.71	2.32	2.32	2.41	85.25	2.32	1.94	2.35	1.80	2.32

Similar trends of results were also observed at Kishoreganj site. Higher rate of dry matter yield was obtained with the integrated treatments of poultry litter and inorganic fertilizer. Sole application of poultry litter also contributed to good amount as compared to sole inorganic fertilizer application. The treatment T_8 (where 100% RDF N from poultry litter was applied) yielded 20.66 t/ha whereas the sole inorganic fertilizer application T_{10} produced 20.28 t/ha at Kishoreganj site. Maximum dry matter yield (23.08 t/ha) was found with T_9 and the lowest (8.11t/ha) with T_1 (table 4.9) at Kishoreganj. Hence dry matter yield was increased 184.60% with T_9 over Control.

At both the sites (Manikganj and Kishoreganj) the total dry matter production (table 4.4 and 4.9) of jute, was influenced by different levels of poultry litter. The highest dry matter accumulation was obtained with T_7 (RDF N 75% from PL+ 25% RDF) and T_9 (RDF N 100% from PL+100% RDF) at Manikganj and Kishoreganj respectively where the maximum

green plants yield with and without leaves were also attained. The integrated treatments also produced near about equal amount of total dry matter which is statistically similar.

4.3 Effect of poultry litter on the nutrient content in plant parts and uptake by the jute Plant

The nutrient content and nutrient uptake due to poultry litter incorporation in jute at Manikganj in different years are presented in the tables 5 to 5.4. The average nutrient NPK and S contents of leaves varied between 2.05 to 2.58%, 0.31 to 0.55%, 1.60 to 2.56% and 0.09 to 0.17% respectively (table 5.4). Average nutrient content of NPK and S in shoot, was lower than leaves but higher than that of roots. The ranges of NPK and S in shoot were 0.56 to 1.34%, 0.15 to 0.27%, 0.88 to1.23% and 0.06 to 0.13% respectably. In root the values were 0.40 to 0.87%, 0.21 to0.41%, 0.51 to 0.67% and 0.05 to 0.07% respectably. The highest content of N (2.58%) and K (2.56%) were found in leaves with T_7 and P (0.55%) and S (0.17%) with T_9.

Nutrient uptake was higher in all the treatments over control at Manikganj. The highest uptake of N (272.60 Kg/ha), P (64.78 Kg/ha), K (275.52 Kg/ha) and S (23.28 Kg/ha) were found with integrated treatment T_9 (RDF N 100% from PL +100% RDF) at Manikganj. The second highest uptake of N (230.12 Kg/ha) for T_6, P(60.75 Kg/ha)for T_{10}, K(232.17Kg/ha) for T_6 and S (21.78 Kg/ha) for T_7. Considerable nutrients were taken up by the treatments. The N uptake ranges between 59.36 to 272.60 Kg/ha, for-P 13.13 to 64.78 Kg/ha, for K 62.36 to 275.52 Kg/ha and for S- 4.53 to 23.28 Kg/ha at Manikganj. Lowest S was taken up by T_1 (Control).

The N and K uptake increased proportionately, maintained a regular sequence with treatments and displayed a positive correlation (r^2 value 0.994) at Manikganj (fig.2).

Table 5. Effect of poultry litter in nutrient content in different parts of jute plant and nutrient uptake at Manikganj 2004-05

Treatments	Plant parts	Nutrient %				Uptake of nutrient Kg/ha			
		N	P	K	S	N	P	K	S
T_1.Control	Leaves	2.00	0.32	2.00	0.09	15.00	2.40	15.00	0.68
	Shoot	0.84	0.16	0.86	0.06	37.03	9.00	51.00	3.00
	Root	0.40	0.18	0.44	0.05	2.32	1.04	2.55	0.29
	Total					**54.35**	**12.44**	**68.55**	**3.97**
T_2 =RDF N 25% from PL	Leaves	2.14	0.33	2.12	0.11	31.89	4.92	31.59	1.64
	Shoot	0.87	0.22	0.96	0.08	75.74	12.32	53.76	4.48
	Root	0.45	0.25	0.50	0.06	2.43	1.05	2.70	0.32
	Total					**110.06**	**18.29**	**88.05**	**6.44**
T_3=T_2+75%RDF	Leaves	2.50	0.43	2.47	0.14	68.00	11.70	67.18	3.81
	Shoot	0.89	0.15	1.02	0.09	86.72	9.98	67.83	5.99
	Root	0.47	0.32	0.56	0.08	8.28	6.11	10.70	1.53
	Total					**78.79**	**27.79**	**145.71**	**11.33**
T_4= RDF N 50% from PL	Leaves	2.18	0.37	2.09	0.12	59.30	10.06	56.85	3.26
	Shoot	0.83	0.20	1.00	0.07	151.19	23.68	118.40	8.29
	Root	0.51	0.29	0.52	0.06	16.63	9.45	16.95	1.96
	Total					**227.12**	**43.19**	**192.2**	**13.51**
T_5=T_4+50% RDF	Leaves	2.41	0.51	2.50	0.12	63.62	13.46	66.00	3.17
	Shoot	0.66	0.17	1.08	0.07	34.68	19.53	124.09	81.04
	Root	0.52	0.32	0.54	0.06	17.06	10.50	17.71	1.97
	Total					**115.36**	**43.49**	**207.8**	**86.18**
T_6=RDF N 75% from PL	Leaves	2.12	0.47	2.52	0.13	59.26	13.16	70.56	0.64
	Shoot	0.92	0.21	1.10	0.08	131.56	25.46	133.43	9.70
	Root	0.48	0.27	0.57	0.07	16.13	9.07	19.15	2.35
	Total					**206.95**	**47.69**	**223.14**	**12.69**
T_7=T_6+RDF 25%	Leaves	2.57	0.51	2.54	0.18	80.44	15.96	71.50	5.63
	Shoot	0.77	0.19	1.09	0.12	3.85	25.61	146.93	16.18
	Root	0.52	0.35	0.60	0.08	18.72	12.60	21.60	2.88
	Total					**95.31**	**54.17**	**240.03**	**24.69**
T_8= RDF N100% from PL	Leaves	2.15	0.43	2.56	0.14	61.06	12.21	72.70	3.98
	Shoot	0.98	0.25	1.12	0.12	24.05	30.85	138.29	20.98
	Root	0.47	0.37	0.65	0.06	15.70	12.36	1.67	2.00
	Total					**100.81**	**55.42**	**212.66**	**26.96**
T_9=T_8+100%RDF	Leaves	2.48	0.54	2.59	0.17	81.84	17.82	85.47	5.61
	Shoot	0.79	0.22	1.10	0.13	166.95	31.31	156.53	18.50
	Root	0.55	0.38	0.72	0.07	23.21	16.04	30.83	2.95
	Total					**272.00**	**65.17**	**272.83**	**27.06**
T_{10}=RDF sole	Leaves	2.50	0.42	2.43	0.17	66.75	11.21	64.88	4.54
	Shoot	0.51	0.18	0.93	0.09	126.26	20.84	107.69	10.42
	Root	0.41	0.22	0.63	0.07	17.42	7.99	22.87	2.54
	Total					**210.43**	**40.04**	**195.44**	**17.5**

Table 5.1. Effect of poultry litter in nutrient content in different parts of jute plant and nutrient uptake at Manikganj 2005-06.

Treatments	Plant parts	Nutrient %				Uptake of nutrient Kg/ha			
		N	P	K	S	N	P	K	S
T_1-Control	Leaves	2.07	0.30	2.01	0.10	16.56	2.40	16.08	0.80
	Shoot	0.81	0.17	0.88	0.08	31.75	7.02	36.34	3.20
	Root	2.42	0.19	0.47	0.07	2.69	1.22	3.01	0.45
	Total					**51.00**	**10.64**	**55.43**	**4.45**
T_2 =RDF N 25% from PL	Leaves	2.12	0.32	2.13	0.12	32.44	4.90	32.59	1.84
	Shoot	0.86	0.20	0.98	0.10	72.99	14.12	69.19	7.06
	Root	0.43	0.24	0.51	0.08	8.73	4.87	10.35	1.62
	Total					**114.16**	**23.89**	**112.13**	**10.52**
T_3=T_2+75%RDF	Leaves	2.84	0.42	2.50	0.15	70.93	12.01	17.50	4.29
	Shoot	0.86	0.17	1.08	0.07	31.83	24.76	121.32	12.38
	Root	0.45	0.30	0.60	0.06	15.30	10.20	20.40	2.04
	Total					**118.06**	**46.97**	**159.22**	**18.71**
T_4= RDF N 50% from PL	Leaves	2.20	0.35	2.11	0.13	59.40	9.45	27.00	3.51
	Shoot	0.81	0.22	1.09	0.09	158.46	25.87	128.18	10.58
	Root	0.47	0.27	0.53	0.07	15.37	8.83	17.33	2.29
	Total					**233.23**	**44.15**	**172.51**	**16.38**
T_5=T_4+50% RDF	Leaves	2.83	0.50	2.52	0.14	62.36	13.10	66.02	3.67
	Shoot	0.68	0.19	1.10	0.08	72.77	20.48	118.58	8.62
	Root	0.49	0.30	0.55	0.05	14.99	9.18	16.83	1.53
	Total					**150.12**	**42.76**	**201.43**	**13.82**
T_6=RDF N 75% from PL	Leaves	2.14	0.49	2.54	0.14	58.42	3.38	69.34	3.82
	Shoot	0.88	0.22	1.11	0.07	65.46	26.09	131.65	8.30
	Root	0.50	0.23	0.59	0.06	116.50	7.59	19.47	1.98
	Total					**240.38**	**37.06**	**220.46**	**14.1**
T_7=T_6+RDF 25%	Leaves	2.55	0.53	2.54	0.16	81.35	16.91	81.03	5.10
	Shoot	0.79	0.18	1.12	0.10	27.14	24.75	154.00	13.75
	Root	0.51	0.33	0.61	0.09	18.67	12.08	22.33	3.29
	Total					**127.16**	**53.74**	**257.36**	**22.14**
T_8= RDF N100% from PL	Leaves	2.18	0.41	2.57	0.13	61.26	11.52	72.22	3.65
	Shoot	0.95	0.26	1.15	0.14	73.75	31.82	140.76	17.14
	Root	0.45	0.38	0.68	0.04	14.94	12.65	22.58	0.33
	Total	2.55				**149.95**	**55.99**	**235.56**	**21.12**
T_9=T_8+100%RDF	Leaves		0.55	2.58	0.19	82.37	17.77	83.33	6.14
	Shoot	0.89	0.20	1.20	0.15	187.58	26.78	160.68	20.09
	Root	0.52	0.39	0.70	0.08	19.76	14.82	26.00	3.04
	Total					**289.71**	**59.37**	**270.01**	**29.27**
T_{10}=RDF sole	Leaves	2.50	0.44	2.42	0.16	67.54	11.79	64.86	4.29
	Shoot	0.48	0.15	0.96	0.11	112.11	17.42	343.66	12.77
	Root	0.50	0.24	0.64	0.06	13.25	6.36	16.96	1.59
	Total					**192.90**	**35.57**	**425.48**	**18.65**

Table 5.2. Effect of poultry litter in nutrient content in different parts of jute plant and nutrient uptake at Manikganj 2006-07.

Treatments	Plant parts	Nutrient %				Uptake of nutrient Kg/ha			
		N	P	K	S	N	P	K	S
T_1-Control	Leaves	2.20	0.28	0.20	0.11	18.04	2.30	18.04	0.90
	Shoot	0.93	0.24	0.96	0.10	38.43	10.58	42.34	4.41
	Root	0.41	0.26	0.59	0.06	2.87	1.82	4.13	0.42
	Total					**59.36**	**14.7**	**64.51**	**5.73**
T_2=RDF N 25% from PL	Leaves	2.12	0.40.	2.05	0.13	33.07	6.24	39.00	2.03
	Shoot	0.94	0.21	1.30	0.09	52.39	15.18	93.99	6.51
	Root	0.45	0.23	0.58	0.07	9.36	4.78	12.06	14.56
	Total					**94.82**	**26.20**	**145.05**	**14.27**
T_3=T_2+75%RDF	Leaves	2.58	0.53	2.50	0.16	73.01	15.00	70.75	4.53
	Shoot	0.98	0.19	1.26	0.08	16.91	22.95	152.21	9.66
	Root	0.51	0.28	0.73	0.07	17.03	9.35	24.38	2.34
	Total					**106.95**	**47.3**	**247.34**	**16.53**
T_4= RDF N 50% from PL	Leaves	2.10	0.45	2.19	0.14	59.43	12.74	61.98	3.96
	Shoot	0.91	0.24	1.27	0.11	102.00	29.59	156.59	13.56
	Root	0.48	0.25	0.63	0.08	16.32	8.50	21.42	2.72
	Total					**177.75**	**50.83**	**239.99**	**20.24**
T_5=T_4+50% RDF	Leaves	2.59	0.49	2.57	0.16	69.41	13.13	68.88	4.29
	Shoot	0.70	0.18	1.21	0.12	78.79	20.97	140.97	13.98
	Root	0.50	0.40	0.62	0.04	13.80	11.04	17.11	1.10
	Total					**162.00**	**45.14**	**226.89**	**19.37**
T_6=RDF N 75% from PL	Leaves	2.04	0.54	2.62	0.15	57.53	15.23	73.88	4.23
	Shoot	0.93	0.14	1.42	0.12	158.71	17.14	173.81	14.69
	Root	0.40	0.31	0.67	0.08	13.88	10.76	23.25	2.78
	Total					**230.12**	**43.13**	**270.94**	**21.7**
T_7=T_6+RDF 25%	Leaves	2.64	0.55	2.60	0.17	83.08	17.05	80.60	5.27
	Shoot	0.84	0.14	1.42	0.11	8.99	18.72	189.85	14.71
	Root	0.62	0.34	0.68	0.10	22.13	12.14	24.28	3.57
	Total					**114.20**	**47.91**	**294.73**	**23.55**
T_8= RDF N100% from PL	Leaves	2.03	0.39	2.64	0.15	55.01	10.57	71.64	4.07
	Shoot	1.01	0.33	1.48	0.10	64.57	38.87	174.34	11.78
	Root	0.52	0.36	0.65	0.05	16.80	11.63	21.00	1.12
	Total					**136.38**	**61.07**	**266.98**	**16.97**
T_9=T_8+100%RDF	Leaves	2.36	0.59	2.66	0.18	69.38	17.35	78.20	5.29
	Shoot	0.75	0.24	1.48	0.11	143.53	30.72	189.44	14.08
	Root	0.55	0.37	0.62	0.09	19.26	13.02	21.82	3.17
	Total					**232.17**	**61.09**	**289.46**	**22.54**
T_{10}=RDF sole	Leaves	2.36	0.34	2.53	0.15	63.25	9.11	67.80	4.02
	Shoot	0.66	0.17	1.05	0.10	144.14	19.64	121.28	11.55
	Root	0.52	0.26	0.53	0.05	16.90	8.45	1.33	0.13
	Total					**224.29**	**37.2**	**190.41**	**15.7**

Table 5.3. Effect of poultry litter in nutrient content in different parts of jute plant and nutrient uptake at Manikganj 2007-08.

Treatments	Plant parts	Nutrient %				Uptake of f nutrient Kg/ha			
		N	P	K	S	N	P	K	S
T_1-Control	Leaves	1.92	0.34	2.02	0.07	16.51	2.92	17.39	0.60
	Shoot	0.88	0.19	0.82	0.05	51.77	8.44	36.41	2.22
	Root	0.38	0.21	0.54	0.02	4.45	2.46	6.32	0.23
	Total					**72.73**	**13.82**	**60.12**	**3.05**
T_2=RDF N 25% from PL	Leaves	2.28	0.43	2.22	0.10	36.02	6.79	35.08	1.56
	Shoot	0.91	0.20	1.02	0.07	75.90	14.62	74.56	5.12
	Root	0.44	0.25	0.54	0.06	9.28	5.28	11.39	1.27
	Total					**121.20**	**26.69**	**121.03**	**7.95**
T_3=T_2+75%RDF	Leaves	2.46	0.45	2.51	0.13	72.32	13.23	73.79	3.82
	Shoot	2.66	0.58	0.98	0.03	34.28	73.66	124.46	3.81
	Root	0.50	0.32	0.62	0.06	17.40	11.14	21.58	2.09
	Total					**124.00**	**98.03**	**219.83**	**9.72**
T_4= RDF N 50% from PL	Leaves	2.15	0.44	2.23	0.12	62.35	12.76	64.67	3.48
	Shoot	0.91	0.22	1.14	0.11	134.55	27.94	144.78	13.97
	Root	0.45	0.76	0.57	0.04	15.80	26.68	20.01	1.40
	Total					**212.70**	**67.38**	**229.46**	**18.85**
T_5=T_4+50% RDF	Leaves	2.53	0.51	2.54	0.19	67.55	13.62	67.82	5.07
	Shoot	0.60	0.17	1.02	0.09	88.60	19.64	117.81	10.40
	Root	0.52	0.32	0.59	0.08	16.85	10.37	19.12	2.59
	Total					**173.00**	**43.63**	**204.75**	**18.06**
T_6=RDF N 75% from PL	Leaves	2.20	0.46	2.51	0.14	63.36	13.25	72.29	4.83
	Shoot	0.93	0.25	1.02	0.09	164.45	31.30	127.70	11.24
	Root	0.43	0.32	0.56	0.07	15.22	11.33	19.82	2.48
	Total					**243.03**	**55.88**	**219.81**	**18.55**
T_7=T_6+RDF 25%	Leaves	2.54	0.53	2.58	0.15	79.25	16.54	80.50	4.68
	Shoot	0.70	0.17	1.17	0.08	21.75	22.90	157.60	10.78
	Root	0.53	0.32	0.61	0.04	19.13	11.55	22.02	1.44
	Total					**120.13**	**50.99**	**260.12**	**16.9**
T_8= RDF N100% from PL	Leaves	2.23	0.52	2.30	0.14	61.77	14.40	63.71	3.88
	Shoot	0.99	0.26	1.03	0.03	78.50	31.33	124.12	3.62
	Root	0.51	0.32	03.57	0.10	18.11	11.36	20.24	20.24
	Total					**158.38**	**57.09**	**208.07**	**27.74**
T_9=T_8+100%RDF	Leaves	2.57	0.55	2.62	0.15	82.24	17.60	83.84	4.80
	Shoot	0.74	0.30	1.15	0.10	191.03	41.46	158.93	13.82
	Root	0.55	0.38	0.66	0.03	20.85	14.40	25.01	1.14
	Total					**294.12**	**73.46**	**267.78**	**19.76**
T_{10}=RDF sole	Leaves	2.46	0.41	2.55	0.14	69.62	11.60	72.17	3.96
	Shoot	0.62	0.14	1.19	0.09	127.87	17.15	145.78	12.25
	Root	0.49	0.27	0.56	0.04	16.61	9.15	18.98	1.36
	Total					**214.10**	**37.9**	**236.93**	**17.57**

Table 5.4. Four years average effect of poultry litter in nutrient content in different parts of jute plant and nutrient uptake at Manikganj 2004-05 to 2007-08.

Treatments	**Plant parts**	**Nutrient %**				**Uptake of nutrient Kg/ha**			
		N	P	K	S	N	P	K	S
T_1-Control	Leaves	2.05	0.31	2.05	0.09	16.51	2.50	16.61	0.74
	Shoot	0.86	0.19	0.88	0.07	39.78	9.01	41.77	3.45
	Root	0.40	0.21	0.51	0.05	3.07	1.62	3.98	0.34
	Total					**59.36**	**13.13**	**62.36**	**4.53**
T_2=RDF N 25% from PL	Leaves	2.16	0.37	2.13	0.11	33.29	3.09	32.71	1.76
	Shoot	0.89	0.20	1.06	0.08	69.45	14.09	72.34	5.75
	Root	0.43	0.24	0.53	0.06	7.32	4.11	9.01	1.13
	Total					**110.06**	**21.29**	**114.06**	**8.64**
T_3=T_2+75%RDF	Leaves	2.50	0.45	2.49	0.14	71.00	12.96	70.73	4.10
	Shoot	1.34	0.27	1.08	0.06	21.45	31.63	118.22	7.17
	Root	0.47	0.30	0.62	0.06	14.50	9.26	19.00	2.03
	Total					**106.95**	**53.85**	**107.95**	**13.3**
T_4= RDF N 50% from PL	Leaves	2.15	0.40	2.15	0.12	60.13	11.23	60.10	3.55
	Shoot	0.86	0.22	1.12	0.09	136.71	26.75	136.79	15.41
	Root	0.87	0.39	0.56	0.06	15.86	13.37	18.90	2.09
	Total					**212.70**	**51.35**	**215.79**	**21.05**
T_5=T_4+50% RDF	Leaves	2.47	0.50	1.60	0.15	65.78	13.34	67.24	4.05
	Shoot	0.66	0.17	1.11	0.09	68.77	20.18	67.24	10.23
	Root	0.50	0.33	0.57	0.05	15.57	10.31	17.73	1.78
	Total					**150.12**	**43.83**	**152.21**	**16.06**
T_6=RDF N 75% from PL	Leaves	2.12	0.45	2.54	0.14	59.62	12.69	71.45	4.12
	Shoot	0.91	0.20	1.16	0.09	155.04	10.03	140.30	9.19
	Root	0.45	0.26	0.59	0.07	15.46	9.17	20.42	2.39
	Total					**230.12**	**31.89**	**232.17**	**15.7**
T_7 =T_6+RDF 25%	Leaves	2.58	0.53	2.56	0.16	81.04	16.61	80.41	5.17
	Shoot	0.77	0.17	1.20	0.10	13.49	22.97	16.18	13.85
	Root	0.54	0.33	0.62	0.07	19.67	12.09	22.56	2.76
	Total					**114.20**	**51.67**	**119.15**	**21.78**
T_8= RDF N100% from PL	Leaves	2.14	0.43	2.51	0.14	59.64	12.15	69.92	3.88
	Shoot	1.00	0.27	1.19	0.09	60.34	33.28	47.36	11.81
	Root	0.48	0.41	0.63	0.06	16.40	11.99	21.39	1.80
	Total					**136.38**	**57.42**	**138.67**	**17.49**
T_9=T_8+100%RDF	Leaves	2.48	0.55	1.70	0.17	78.67	17.63	82.62	3.09
	Shoot	0.79	0.24	1.23	0.13	172.53	32.58	167.02	17.6
	Root	0.54	0.38	0.67	0.06	20.80	14.57	25.88	2.59
	Total					**272.60**	**64.78**	**275.52**	**23.28**
T_{10}=RDF sole	Leaves	2.46	0.40	2.48	0.15	66.66	36.12	67.30	4.19
	Shoot	0.56	0.15	1.03	0.09	124.03	18.18	121.55	11.74
	Root	0.49	0.24	0.59	0.05	19.74	6.45	24.38	2.65
	Total					**210.43**	**60.75**	**213.23**	**18.58**

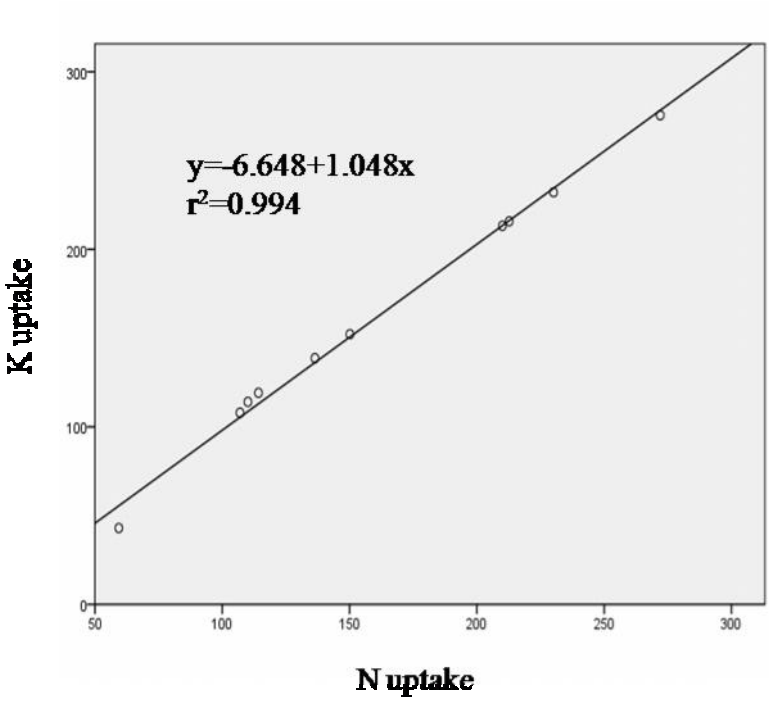

Fig.2. N and K relation in Jute at Manikganj

At Kishoreganj site the nutrient content and uptake in jute with various poultry litter treatments in different years are presented in tables 5.5 to 5.9. The nutrient NPK and S content of leaves (table 5.9) ranged between 2.08 to 2.56%, 0.34 to 0.56%, 2.08 to 2.57% and 0.06 to 0.073%. respectively. Average nutrient content of NPK and S in shoot was lower than leaves but higher than roots. The range of NPK and S in shoot was 0.79 to 0.94%, 0.26 to 0.39%, 0.80 to1.53% and 0.045 to 0.056% respectively. In root it was 0.39 to 0.48%, 0.15 to0.24%, 0.52 to 0.82% and 0.03 to 0.072% for N, P, K and S respectively. In leaves, the highest contents of N (2.56%),P(0.56%), K(2.57%) and S (0.073%) were found with T_9 (RDF N100% from PL +100%RDF). Uptake of K found increased with the increasing doses of and complied a proportionate sequence (r^2 value 0.894) at Kishoreganj (fig 2.1)

Table 5.5. Effect of poultry litter in nutrient content in different parts of jute plant and nutrient uptake with different treatments of poultry litter at Kishoreganj ,2004-05.

Treatments	Plant parts	Nutrient %				Uptake of nutrient Kg/ha			
		N	P	K	S	N	P	K	S
T_1.Control	Leaves	2.16	0.38	2.11	0.061	27.22	4.79	26.59	0.77
	Shoot	0.86	0.28	0.82	0.048	54.44	17.72	51.91	3.03
	Root	0.38	0.20	0.54	0.024	3.76	1.98	5.35	0.24
	Total					**85.42**	**24.49**	**83.85**	**4.04**
T_2 =RDF N 25% from PL	Leaves	2.32	0.39	2.12	0.065	44.31	7.45	40.49	1.24
	Shoot	0.82	0.30	0.58	0.052	59.86	21.90	62.05	3.80
	Root	0.42	0.16	0.54	0.037	13.44	5.12	17.28	1.18
	Total					**117.61**	**34.47**	**119.82**	**6.22**
T_3 =T_2+75%RDF	Leaves	2.54	0.51	2.51	0.070	74.17	14.89	73.29	2.04
	Shoot	0.91	0.29	1.22	0.052	114.21	36.40	153.11	6.53
	Root	0.48	0.12	0.78	0.072	16.66	4.16	27.07	2.69
	Total					**204.97**	**55.45**	**253.65**	**11.26**
T_4= RDF N 50% from PL	Leaves	2.42	0.42	2.22	0.065	70.60	12.26	64.82	1.90
	Shoot	0.84	0.33	0.83	0.051	106.34	41.78	105.08	6.46
	Root	0.40	0.23	0.50	0.052	14.20	8.17	17.75	1.49
	Total					**191.20**	**62.21**	**187.65**	**9.85**
T_5=T_4+50% RDF	Leaves	2.52	0.55	2.52	0.070	69.55	15.18	69.55	1.93
	Shoot	0.87	0.31	1.15	0.050	104.23	37.14	137.77	5.11
	Root	0.45	0.17	0.68	0.063	15.66	5.92	23.68	2.19
	Total					**189.44**	**58.24**	**231.00**	**10.11**
T_6 =RDF N 75% from PL	Leaves	2.42	0.41	2.25	0.065	75.26	14.93	79.93	2.05
	Shoot	0.83	0.35	0.93	0.051	117.20	49.42	131.32	7.20
	Root	0.42	0.18	0.53	0.039	15.75	6.75	19.88	1.46
	Total					**208.21**	**71.10**	**231.13**	**10.71**
T_7 =T_6+RDF 25%	Leaves	2.51	0.54	2.54	0.071	79.57	17.12	80.52	2.25
	Shoot	0.94	0.39	1.10	0.049	136.21	56.51	159.39	7.10
	Root	0.48	0.25	0.74	0.068	17.57	9.15	27.08	2.49
	Total					**233.35**	**82.78**	**266.99**	**11.84**
T_8= RDF N100% from PL	Leaves	2.39	0.48	2.57	0.066	73.37	14.73	78.90	2.05
	Shoot	0.93	0.31	1.10	0.055	125.09	41.70	147.95	7.40
	Root	0.53	0.24	0.77	0.039	19.40	8.78	28.28	1.43
	Total					**217.86**	**85.21**	**255.03**	**10.88**
T_9 =T_8+100%RDF	Leaves	2.62	0.55	2.62	0.076	98.51	20.68	98.51	2.86
	Shoot	0.94	0.38	1.21	0.069	151.72	61.33	195.29	9.85
	Root	0.50	0.27	0.81	0.068	21.90	11.83	35.48	2.98
	Total					**172.13**	**93.84**	**329.28**	**15.69**
T_{10}=RDF sole	Leaves	2.50	0.49	2.54	0.067	81.75	16.02	83.06	2.19
	Shoot	0.90	0.29	1.07	0.051	128.34	41.35	152.58	7.27
	Root	0.44	0.15	0.75	0.066	18.30	6.24	31.20	2.75
	Total					**228.39**	**63.61**	**266.84**	**12.21**

Table 5.6. Effect of poultry litter in nutrient content in different parts of jute plant and nutrient uptake at Kishoreganj, 2005-06.

Treatments	Plant parts	Nutrient %				Uptake of nutrient Kg/ha			
		N	P	K	S	N	P	K	S
T_1-Control	Leaves	2.05	0.31	2.08	0.058	19.48	2.94	19.26	0.55
	Shoot	0.78	0.22	0.77	0.050	43.60	12.30	43.04	2.80
	Root	0.40	0.11	0.49	0.032	6.16	1.69	7.55	0.49
	Total					**09.24**	**16.93**	**70.35**	**3.34**
T_2=RDF N 25% from PL	Leaves	2.13	0.33	2.10	0.060	34.93	5.41	34.44	0.98
	Shoot	0.81	0.23	0.81	0.051	51.34	16.54	58.24	2.37
	Root	0.41	0.18	0.52	0.033	8.49	3.73	10.76	0.68
	Total					**94.76**	**25.68**	**103.49**	**4.03**
T_3=T_2+75%RDF	Leaves	2.40	0.50	2.49	0.071	68.64	14.30	71.21	2.03
	Shoot	0.81	0.31	1.13	0.051	100.04	38.29	139.55	6.30
	Root	0.42	0.16	0.73	0.065	14.19	5.41	24.67	2.20
	Total					**182.87**	**58.00**	**235.43**	**10.53**
T_4= RDF N 50% from PL	Leaves	2.40	0.35	2.18	0.061	70.08	10.22	63.66	1.78
	Shoot	0.82	0.26	0.87	0.052	104.71	33.20	111.10	5.64
	Root	0.44	0.17	0.54	0.038	16.94	6.55	20.79	1.46
	Total					191.73	49.97	195.55	9.88
T_5 =T_4+50% RDF	Leaves	2.43	0.51	2.51	0.066	67.55	14.18	89.78	1.83
	Shoot	0.83	0.30	1.11	0.046	99.27	35.88	132.76	5.50
	Root	0.41	0.15	0.72	0.065	14.02	5.13	24.62	2.22
	Total					**180.84**	**55.19**	**247.16**	**9.53**
T_6 =RDF N 75% from PL	Leaves	2.40	0.39	2.21	0.064	71.28	11.58	65.64	1.90
	Shoot	0.82	0.28	0.86	0.055	111.03	37.91	116.44	7.45
	Root	0.41	0.22	0.51	0.040	15.46	8.29	19.23	1.51
	Total					**197.77**	**57.78**	**201.31**	**10.86**
T_7 =T_6+RDF 25%	Leaves	2.52	0.55	2.53	0.071	78.37	17.11	78.68	2.21
	Shoot	0.90	0.36	1.10	0.051	120.15	48.06	146.85	6.81
	Root	0.44	0.21	0.70	0.063	14.78	7.06	23.52	2.12
	Total					**213.30**	**72.23**	**249.05**	**11.14**
T_8= RDF N100% from PL	Leaves	2.42	0.44	2.55	0.068	75.02	13.64	79.05	1.74
	Shoot	0.86	0.35	1.10	0.056	116.70	47.50	149.27	7.60
	Root	0.41	0.20	0.73	0.043	14.88	7.26	26.50	1.56
	Total					**206.60**	**68.40**	**254.82**	**10.90**
T_9=T_8+100%RDF	Leaves	2.53	0.57	2.53	0.071	86.27	19.44	86.27	2.42
	Shoot	0.93	0.36	1.14	0.054	137.08	53.06	168.04	7.95
	Root	0.42	0.23	0.82	0.070	17.43	9.55	34.03	2.91
	Total					**240.78**	**82.05**	**288.34**	**13.28**
T_{10}=RDF sole	Leaves	2.50	0.53	2.52	0.071	75.00	15.90	75.60	2.13
	Shoot	0.91	0.31	1.12	0.049	118.94	40.52	146.38	6.40
	Root	0.42	0.16	0.71	0.067	15.20	5.79	25.70	2.42
	Total					**209.14**	**62.21**	**247.68**	**10.95**

Table 5.7. Effect of poultry litter in nutrient content in different parts of jute plant and nutrient uptake at Kishoreganj, 2006-07.

Treatments	**Plant parts**	**Nutrient %**				**Uptake of nutrient Kg/ha**			
		N	P	K	S	N	P	K	S
T_1.Control	Leaves	2.03	0.33	2.05	0.061	20.30	3.30	2.50	0.61
	Shoot	0.76	0.25	0.78	0.052	39.37	12.95	4.40	2.69
	Root	0.42	0.14	0.50	0.034	6.34	2.11	7.55	0.51
	Total					**66.01**	**18.36**	**68.45**	**1.81**
T_2=RDF N 25% from PL	Leaves	2.15	0.36	2.11	0.061	34.19	5.72	33.55	0.97
	Shoot	0.80	0.25	0.80	0.050	57.28	17.19	57.28	3.58
	Root	0.43	0.17	0.50	0.035	8.60	35.50	10.30	0.72
	Total					**100.07**	**26.41**	**101.13**	**5.27**
T_3=T_2+75%RDF	Leaves	2.38	0.52	2.50	0.072	7.21	15.34	73.75	2.12
	Shoot	0.80	0.33	1.10	0.053	101.44	41.84	139.48	6.72
	Root	0.43	0.14	0.74	0.067	**15.00**	**4.90**	**25.83**	**2.33**
	Total					186.65	62.08	239.06	11.17
T_4= RDF N 50% from PL	Leaves	2.38	0.37	2.20	0.063	71.88	11.17	66.44	1.90
	Shoot	0.80	0.28	0.85	0.050	105.20	36.82	111.78	6.58
	Root	0.42	0.16	0.52	0.040	15.37	5.86	19.03	1.46
	Total					**192.45**	**53.85**	**197.25**	**9.94**
T_5=T_4+50% RDF	Leaves	2.40	0.50	2.50	0.068	67.20	14.00	70.00	1.90
	Shoot	0.85	0.52	1.10	0.045	79.64	29.98	103.07	4.22
	Root	0.43	0.13	0.70	0.064	14.71	4.45	23.94	2.19
	Total					**161.55**	**48.43**	**197.01**	**8.31**
T_6=RDF N 75% from PL	Leaves	2.41	0.04	2.20	0.066	77.60	12.88	70.84	2.13
	Shoot	0.84	0.30	0.85	0.053	117.35	41.91	118.75	7.40
	Root	0.40	0.20	0.52	0.038	15.80	7.90	20.54	1.50
	Total					**210.75**	**62.69**	**210.13**	**11.03**
T_7=T_6+RDF 25%	Leaves	2.50	0.53	2.55	0.070	77.75	16.48	79.31	2.18
	Shoot	0.92	0.33	1.11	0.050	124.38	44.62	150.07	6.76
	Root	0.43	0.23	0.72	0.064	15.57	8.33	26.06	2.32
	Total					**217.7**	**69.43**	**255.44**	**11.25**
T_8= RDF N100% from PL	Leaves	0.41	0.46	2.56	0.067	76.64	14.63	81.41	2.13
	Shoot	0.88	0.33	1.12	0.057	122.06	45.77	155.34	7.90
	Root	0.44	0.22	0.75	0.041	17.29	8.65	29.48	1.61
	Total					**215.99**	**69.05**	**266.23**	**11.64**
T_9=T_8+100%RDF	Leaves	2.50	0.56	2.50	0.073	86.75	19.43	86.75	2.53
	Shoot	0.95	0.37	1.16	0.056	142.50	55.50	174.00	8.40
	Root	0.46	0.25	0.80	0.068	18.91	10.28	32.88	2.79
	Total					**248.16**	**85.21**	**293.63**	**13.72**
T_{10}=RDF sole	Leaves	2.48	0.51	2.50	0.073	75.89	15.61	76.50	2.20
	Shoot	0.89	0.33	1.11	0.050	118.73	44.02	148.07	6.67
	Root	2.43	0.17	0.73	0.068	15.87	6.27	26.94	2.51
	Total					**210.49**	**65.90**	**251.51**	**11.38**

Table 5.8. Effect of poultry litter in nutrient content in different parts of jute plant and nutrient uptake at Kishoreganj 2007-08.

Treatments	Plant parts	Nutrient %				Uptake of nutrient Kg/ha			
		N	P	K	S	N	P	K	S
T_1-Control	Leaves	2.08	0.34	2.10	0.063	21.63	3.54	21.84	0.66
	Shoot	0.78	0.30	0.83	0.058	41.96	16.14	44.65	3.12
	Root	0.39	0.16	0.55	0.032	6.47	2.65	9.13	0.53
	Total					**70.06**	**22.33**	**75.62**	**4.31**
T_2=RDF N 25% from PL	Leaves	2.14	0.35	2.19	0.071	35.31	5.77	36.13	1.17
	Shoot	0.83	0.36	0.94	0.055	63.08	27.36	71.44	4.18
	Root	0.44	0.17	0.57	0.038	9.59	3.70	12.42	0.82
	Total					**107.98**	**36.83**	**199.99**	**6.17**
T_3=T_2+75%RDF	Leaves	2.45	0.54	2.52	0.073	73.74	16.25	75.85	2.19
	Shoot	0.85	0.32	1.47	0.061	110.5	41.6	191.1	7.93
	Root	0.46	0.21	0.73	0.073	16.37	7.47	25.98	2.59
	Total					**200.61**	**65.32**	**292.93**	**12.71**
T_4= RDF N 50% from PL	Leaves	2.40	0.44	2.30	0.067	76.08	13.94	72.91	2.12
	Shoot	0.86	0.41	0.99	0.056	118.68	56.58	136.62	7.72
	Root	0.40	0.18	0.70	0.047	15.32	6.89	26.81	1.80
	Total					**210.08**	**77.41**	**236.34**	**11.64**
T_5=T_4+50% RDF	Leaves	2.42	0.52	2.56	0.076	68.97	14.82	72.96	2.16
	Shoot	0.86	0.38	1.25	0.041	78.94	34.88	114.75	3.76
	Root	0.48	0.22	0.76	0.058	16.60	7.61	26.29	2.00
	Total					**164.51**	**57.27**	**214**	**7.92**
T_6=RDF N 75% from PL	Leaves	2.43	0.47	2.34	0.067	76.54	14.80	73.71	2.11
	Shoot	0.87	0.31	0.90	0.061	89.34	31.83	92.43	6.26
	Root	0.46	0.24	0.61	0.035	17.75	9.26	23.54	1.35
	Total					**183.63**	**55.89**	**189.68**	**9.72**
T_7=T_6+RDF 25%	Leaves	2.50	0.63	2.77	0.080	79	19.90	87.53	2.52
	Shoot	0.90	0.36	1.34	0.050	122.85	49.14	182.91	6.82
	Root	0.49	0.27	0.79	0.080	1.80	9.93	29.07	2.94
	Total					**203.65**	**78.97**	**299.51**	**12.28**
T_8= RDF N100% from PL	Leaves	2.49	0.48	2.58	0.060	80.67	15.55	8.35	1.94
	Shoot	0.91	0.32	1.32	0.056	57.72	128.12	185.85	7.88
	Root	0.43	0.29	0.87	0.042	16.51	11.13	33.40	1.61
	Total					**154.9**	**154.8**	**227.6**	**11.43**
T_9=T_8+100%RDF	Leaves	2.60	0.57	2.63	0.074	93.08	20.40	94.15	2.64
	Shoot	0.96	0.45	1.30	0.055	148.60	69.66	201.24	8.51
	Root	0.55	0.24	0.85	0.083	23.26	10.15	35.95	3.51
	Total					**264.94**	**100.21**	**331.34**	**14.66**
T_{10}=RDF sole	Leaves	2.50	0.56	2.51	0.073	75.5	16.91	75.80	2.20
	Shoot	0.90	0.40	1.26	0.050	117.72	52.32	164.80	6.54
	Root	0.49	0.23	0.80	0.066	17.73	8.32	28.96	2.38
	Total					**210.95**	**77.55**	**289.56**	**11.08**

Table 5.9. Four years average effect of poultry litter in nutrient content in different parts of jute plant and nutrient uptake at Kishoreganj, 2004-05 to 2007-08.

Treatments	Plant parts	Nutrient %				Uptake of nutrient Kg/ha			
		N	P	K	S	N	P	K	S
T_1.Control	Leaves	2.08	0.34	2.08	0.060	21.94	3.58	21.99	0.64
	Shoot	0.79	0.26	0.80	0.052	44.69	14.72	44.93	2.91
	Root	0.39	0.15	0.52	0.030	5.66	2.18	7.45	0.44
	Total					**72.29**	**20.48**	**74.37**	**3.99**
T_2 =RDF N 25% from PL	Leaves	2.18	0.35	2.13	0.064	42.83	7.03	41.79	1.25
	Shoot	0.81	0.28	0.85	00.52	68.86	23.88	71.61	4.39
	Root	0.42	0.17	0.53	0.035	11.71	4.69	14.64	0.98
	Total					**123.4**	**35.6**	**128.04**	**6.62**
T_3=T_2+75%RDF	Leaves	2.44	0.51	2.50	0.071	69.30	14.69	71.08	2.02
	Shoot	0.82	0.31	1.23	0.054	104.68	39.53	155.85	6.87
	Root	0.44	0.15	0.74	0.069	15.47	5.49	25.90	2.41
	Total					**189.45**	**59.71**	**252.83**	**11.3**
T_4= RDF N 50% from PL	Leaves	2.40	0.39	2.22	0.064	72.12	11.89	66.90	1.92
	Shoot	0.82	0.32	0.88	0.052	108.42	42.09	116.07	6.85
	Root	0.42	0.18	0.56	0.041	15.42	6.68	21.05	1.55
	Total					**195.96**	**60.66**	**204.02**	**10.32**
T_5=T_4+50% RDF	Leaves	2.44	0.52	2.52	0.070	68.31	14.55	70.57	1.95
	Shoot	0.85	0.32	1.15	0.045	90.49	34.52	121.92	4.85
	Root	0.44	0.16	0.71	0.062	15.24	5.77	24.63	2.15
	Total					**174.04**	**54.84**	**217.12**	**8.95**
T_6=RDF N 75% from PL	Leaves	2.41	0.42	2.23	0.065	75.16	13.23	70.04	2.84
	Shoot	0.84	0.31	1.53	0.056	107.24	39.66	112.11	6.98
	Root	0.43	0.21	0.54	0.038	16.46	8.33	20.78	1.45
	Total					**198.86**	**61.22**	**202.93**	**14.27**
T_7=T_6+RDF 25%	Leaves	2.50	0.56	2.55	0.073	78.67	17.65	81.50	2.39
	Shoot	0.91	0.36	1.18	0.050	125.65	49.44	168.66	6.86
	Root	0.46	0.24	0.73	0.068	12.63	8.70	26.76	2.49
	Total					**216.95**	**75.79**	**276.92**	**11.74**
T_8= RDF N100% from PL	Leaves	2.44	0.46	2.56	0.065	76.84	14.62	61.80	2.05
	Shoot	0.89	0.32	1.17	0.055	105.34	65.74	160.86	7.49
	Root	0.44	0.23	0.78	0.041	16.81	8.94	29.50	1.55
	Total					**198.99**	**89.3**	**252.16**	**11.09**
T_9=T_8+100%RDF	Leaves	2.56	0.56	2.57	0.073	90.97	19.96	91.24	2.59
	Shoot	0.94	0.39	1.53	0.056	144.00	59.79	184.30	8.55
	Root	0.48	0.24	0.82	0.072	20.30	10.41	34.50	3.05
	Total					**255.27**	**90.16**	**310.04**	**14.19**
T_{10}=RDF sole	Leaves	2.50	0.53	2.51	0.070	77.00	16.55	77.54	2.17
	Shoot	0.90	0.32	1.41	0.050	93.32	46.59	152.90	6.71
	Root	0.44	0.17	0.74	0.066	16.75	6.66	28.15	2.51
	Total					**187.07**	**69.8**	**258.59**	**11.39**

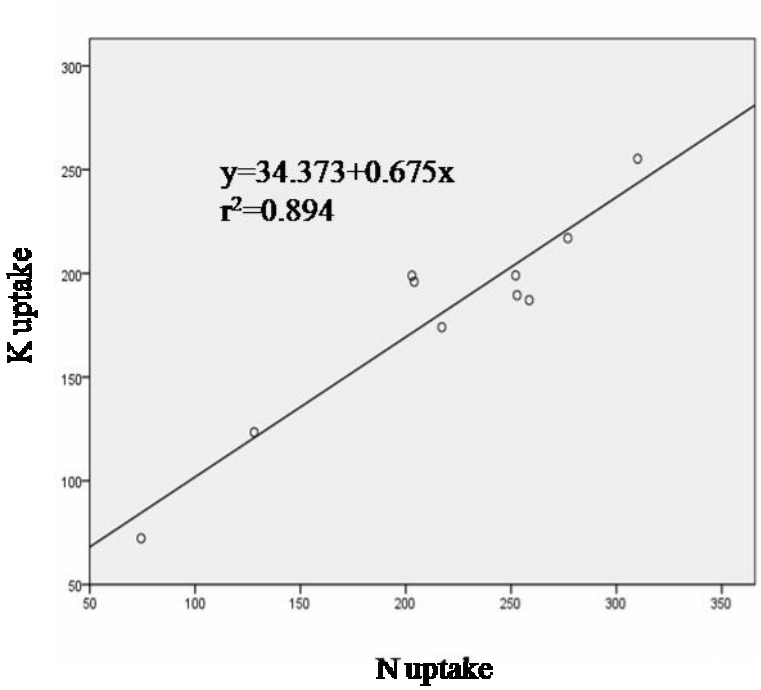

Fig.2.1 N and K relation in Jute at Kishoreganj

Results at both the places indicated that the application of poultry litter with and without inorganic fertilizer at different combinations remitted in significant changes in nutrient contents and uptake. All the treatments showed higher nutrient content and uptake over control. Effect of poultry litter on nutrient content in different parts of jute plants was pronounced. Higher amounts of NPK and S content were found in leaves than in the shoot and root in all the treatments. In the experimental site of Manikganj the nutrient content in leaves was to be the found highest N (2.58%), P (53%), K (2.56%) with T_7 and S(0.17%) with T_9 respectively. In shoot the highest N (1.34%) and P (0.27%) were found with T_3, K (1.23%) and S (0.13%) with T_9.

In the root the highest content of N (0.87%) and P (0.39%) were found with T_4, K (67%) with T_9 and S (0.07%) with T_7. At Kishoreganj site the highest content of nutrients in leaves *viz*. N (2.56%), K (2.57%) and S (0.073%) were with T_9. Both the treatment T_7 and T_9 gave the highest P (0.56%) in leaves. In the shoot the highest N (0.94%), P (0.39%), K (1.53%) and S(0.56%) were with T_9.

The highest uptake of nutrients was with integrated treatment T_9 (RDF N 100% from PL+100% RDF) at both the locations. At Kishoreganj, the amount of N uptake was 255.27Kg/ha, for P the value being 90.16, Kg/ha and for K 310.04 Kg/ha respectively found with the integrated treatment T_9 (RDF N 100 % from PL +100% RDF) at Kishoreganj.

On the other hand the highest uptake of S (14.27 Kg/ha) found with T_6 which was closer to the findings of T_9 (S uptake 14.19 Kg/ha). Uptake of K was higher than N in T_9. At Kishoreganj a large amount of nutrients were taken up by the treatments. The N uptake ranges between 72.29 to 255.27 Kg/ha, for P- 20.48 to 90.16 Kg/ha, for K -74.37 to 310.04 Kg/ha and for S -3.05 to 14.19 Kg/ha. The lowest uptake of N, P, K and S was found with T_1.

4.4 Effect of poultry litter on the nutrient contents of post harvest soil

Soil pH, organic matter, N, P, K, S, Zn, B, Pb and As of soils were determined each year after harvest the crops. The results of Manikganj site are presented in tables 6 to 6.5. The range of C/N ratio of the treated plots was 9.45 to 9.71 at Manikganj, the value being larger (9.89) for control T_1. In Manikganj the maximum amount of OM(1.39%),and N (0.084%) were found with T_5 (RDF N 50% from PL+50% RDF), K(0.16meq/100g), S(10.43ppm) and Zn(0.72ppm) with T_7 (RDF N 75% as PL+ 25% RDF) but P(15.50ppm) with T_9 (RDF N 100% from PL+100%RDF).The results also showed that all the treatments increased the percentage of nutrients compared to initial soil value (table 6.5).

[4]

The integrated treatment T_7 (RDF N 75% from PL + 25% RDF) was contributed 28.32% OM, 29.23% N, 45.45% K, 30.38% S, 13 .13% Zn and 15.92% B over initial soil nutrient status. However 55% P, 5.23% Pb and 7.18% As were obtained with maximum dose of integrated treatment T_9 (RDF N 100% from PL + 100% RDF) compared to initial soil value. According to the higher percentage of the organic matter which was found at Manikganj with different treatments could be arranged with following sequence:

$T_7 > 7_9 > T_5 > T_8 > T3 > T_6 > T_{10} > T_4 > T_2 > T_1$.

Table 6: Effect of poultry litter on the nutrient status of post harvest soil at Manikganj, 2004 to 2005.

Treatment	pH	OC %	OM %	Total N%	C/N ratio	P ppm	K meq/ 100gm	S ppm	Zn ppm	B Ppm	Pb ppm	As Ppm
T_1=Control	6.50	0.67	1.15	0.066	10.15	10	0.112	8.02	0.622	0.272	0.212	0.325
T_2= RDF N 25% from PL	6.52	0.69	1.18	0.071	9.72	11	0.126	8.55	0.625	0.278	0.215	0.328
T_3= T_2 + 75% RDF	6.49	0.76	1.30	0.080	9.50	13	0.130	9.56	0.656	0.284	0.217	0.332
T_4= RDF N 50% from PL	6.54	0.73	1.26	0.076	9.60	12	0.129	9.10	0.648	0.281	0.216	0.335
T_5= T_4 + 50% RDF	6.52	0.78	1.34	0.082	9.51	14	0.153	10.0	0.668	0.285	0.217	0.335
T_6= RDF N 75% from PL	6.53	0.74	1.27	0.077	9.61	13	0.144	9.67	0.659	0.284	0.218	0.336
T_7= T_6 + 25% RDF	6.48	0.79	1.36	0.084	9.40	15	0.156	10.40	0.710	0.309	0.219	0.339
T_8= RDF N 100%fromPL	6.57	0.77	1.32	0.080	9.62	14	0.145	10.20	0.700	0.303	0.223	0.338
T_9= T_8 +100% RDF	6.56	0.80	1.37	0.082	9.76	16	0.148	10.31	0.712	0.305	0.224	0.341
T_{10}= Sole RDF	6.58	0.74	1.28	0.077	9.61	12	0.141	9.50	0.648	0.281	0.213	0.327

$LSD_{0.05}$	0.09	0.09	0.08	0.04	0.05	0.03	0.01	2.79	0.02	0.04	0.00	0.00
$LSD_{0.01}$	0.13	0.12	0.11	0.05	0.07	0.04	0.01	3.81	0.03	0.05	0.00	0.00

Table 6.1: Effect of poultry litter on the nutrient status of post harvest soil at Manikganj, 2005-06

Treatment	pH	OC %	OM %	Total N%	C/N ratio	P ppm	K meq/ 100 gm	S ppm	Zn ppm	B ppm	Pb Ppm	As Ppm
T_1=Control	6.48	0.66	1.13	0.067	9.85	9	0.114	8.15	0.620	0.270	0.214	0.321
T_2= RDF N 25% from PL	6.57	0.72	1.24	0.071	10.14	10	0.123	8.61	0.628	0.284	0.216	0.325
T_3= T_2 + 75% RDF	6.53	0.75	1.29	0.078	9.61	14	0.130	9.60	0.660	0.284	0.219	0.329
T_4= RDF N 50% from PL	6.58	0.70	1.20	0.073	9.58	11	0.127	9.18	0.650	0.280	0.215	0.334
T_5= T_4 + 50% RDF	6.56	0.76	1.30	0.080	9.50	13	0.150	10.20	0.671	0.290	0.220	0.337
T_6= RDF N 75% from PL	6.51	0.71	1.22	0.074	9.59	13	0.142	9.87	0.663	0.287	0.220	0.336
T_7= T_6 + 25% RDF	6.57	0.77	1.32	0.082	9.39	14	0.154	10.45	0.714	0.313	0.222	0.337
T_8= RDF N 100%fromPL	6.55	0.76	1.30	0.079	9.62	15	0.144	10.23	0.712	0.300	0.221	0.340
T_9= T_8 +100% RDF	6.58	0.77	1.32	0.079	9.74	15	0.147	10.33	0.714	0.301	0.222	0.345
T_{10}= Sole RDF	6.59	0.71	1.22	0.074	9.59	13	0.142	9.52	0.650	0.284	0.215	0.325
$LSD_{0.05}$	0.08	0.09	0.06	0.03	0.09	0.32	0.00	0.02	0.02	0.04	0.01	0.01
$LSD_{0.01}$	0.11	0.12	0.08	0.05	0.12	0.43	0.00	0.03	0.03	0.05	0.01	0.01

Table 6.2: Effect of poultry litter on the nutrient status of post harvest soil at Manikganj, 2006-07

Treatment	pH	OC %	OM %	Total N%	C/N ratio	P ppm	K meq/ 100gm	S ppm	Zn ppm	B ppm	Pb Ppm	As ppm
T_1=Control	6.52	0.68	1.17	0.070	9.71	11	0.118	8.21	0.623	0.273	0.212	0.322
T_2= RDF N 25% from PL	6.55	0.71	1.22	0.073	9.73	12	0.125	8.58	0.625	0.281	0.214	0.327
T_3= T_2 + 75% RDF	6.58	0.77	1.32	0.080	9.62	14	0.132	9.62	0.664	0.288	0.216	0.330
T_4= RDF N 50% from PL	6.62	0.73	1.25	0.074	9.86	12	0.128	9.15	0.652	0.285	0.213	0.331
T_5= T_4 + 50% RDF	6.55	0.79	1.36	0.083	9.51	14	0.152	10.23	0.674	0.296	0.214	0.334
T_6= RDF N 75% from PL	6.53	0.74	1.27	0.076	9.73	12	0.143	9.84	0.665	0.291	0.217	0.334
T_7= T_6 + 25% RDF	6.59	0.79	1.36	0.084	9.40	14	0.158	10.41	0.712	0.315	0.219	0.336
T_8= RDF N 100%fromPL	6.52	0.78	1.34	0.081	9.62	13	0.147	10.20	0.712	0.315	0.220	0.343
T_9= T_8 +100% RDF	6.61	0.80	1.37	0.082	9.75	15	0.150	10.30	0.713	0.312	0.220	0.344
T_{10}= Sole RDF	6.62	0.73	1.25	0.075	9.73	13	0.144	9.55	0.652	0.278	0.211	0.323
$LSD_{0.05}$	0.07	0.08	0.08	0.03	0.06	3.12	0.01	0.02	0.03	0.00	0.11	0.01
$LSD_{0.01}$	0.09	0.11	0.11	0.04	0.08	4.25	0.02	0.03	0.04	0.00	0.14	0.01

Table 6.3: Effect of poultry litter on the nutrient status of post harvest soil at Manikganj, 2007-08.

Treatment	pH	OC %	OM %	Total N%	C/N ratio	P ppm	K meq/ 100gm	S ppm	Zn ppm	B ppm	Pb Ppm	As ppm
T_1=Control	6.55	0.66	1.13	0.067	9.85	11	0.120	8.23	0.622	0.271	0.210	0.324
T_2= RDF N 25% from PL	6.56	0.71	1.22	0.073	9.72	11	0.130	8.64	0.624	0.283	0.213	0.326
T_3= T_2 + 75% RDF	6.60	0.79	1.36	0.082	9.63	15	0.140	9.66	0.667	0.291	0.216	0.332
T_4= RDF N 50% from PL	6.58	0.73	1.25	0.075	9.73	13	0.131	9.21	0.653	0.288	0.214	0.333

T_5= T_4 + 50% RDF	6.62	0.81	1.39	0.085	9.52	15	0.155	10.26	0.676	0.302	0.215	0.336
T_6= RDF N 75% fromPL	6.57	0.72	1.24	0.074	9.72	13	0.146	10.08	0.662	0.295	0.215	0.337
T_7= T_6 + 25% RDF	6.63	0.82	1.41	0.086	9.53	16	0.157	10.46	0.714	0.317	0.216	0.339
T_8= RDF N 100%fromPL	6.55	0.81	1.39	0.083	9.76	14	0.150	10.40	0.711	0.315	0.218	0.341
T_9= T_8 +100% RDF	6.65	0.82	1.41	0.084	9.76	16	0.152	10.38	0.715	0.313	0.221	0.343
T_{10}= Sole RDF	6.70	0.74	1.27	0.077	9.61	14	0.148	9.60	0.650	0.285	0.213	0.325
$LSD_{0.05}$	0.10	0.07	0.08	0.04	2.80	0.03	0.01	0.02	1.31	0.00	0.01	0.00
$LSD_{0.01}$	0.14	0.09	0.11	0.05	3.82	0.04	0.01	0.03	1.79	0.00	0.01	0.01

Table 6.4: Average four years effect of poultry litter on the nutrient status of post harvest soil at Manikganj, 2004-05 to 2007-08

Treatment	pH	OC %	OM %	Total N%	C/N ratio	P ppm	K meq/ 100gm	S ppm	Zn ppm	B ppm	Pb ppm	As ppm
T_1=Control	6.51	0.66	1.14	0.067	9.89	10.25	0.12	8.20	0.63	0.271	0.212	0.323
T_2= RDF N 25% from PL	6.55	0.70	1.21	0.072	9.64	11.00	0.13	8.60	0.63	0.281	0.214	0.326
T_3= T_2 + 75% RDF	6.55	0.76	1.31	0.080	9.59	14.00	0.14	9.61	0.67	0.286	0.217	0.330
T_4= RDF N 50% from PL	6.58	0.72	1.24	0.074	9.69	12.00	0.13	9.16	0.66	0.283	0.214	0.333
T_5= T_4 + 50% RDF	6.56	0.78	**1.39**	**0.084**	9.50	14.00	0.15	10.09	0.67	0.293	0.216	0.335
T_6= RDF N 75% fromPL	6.54	0.73	1.25	0.075	9.66	12.75	0.15	9.87	0.67	0.289	0.217	0.335
T_7= T_6 + 25% RDF	6.56	0.79	1.36	0.083	9.45	14.75	**0.16**	**10.43**	**0.72**	**0.313**	0.219	0.337
T_8= RDF N 100%fromPL	6.54	0.68	1.33	0.080	9.65	14.00	0.15	10.26	0.71	0.308	0.220	0.340
T_9= T_8 +100% RDF	6.60	0.79	1.36	0.082	9.71	**15.50**	0.15	10.33	0.71	0.307	**0.221**	**0.343**
T_{10}= Sole RDF	6.62	0.73	1.25	0.075	9.63	13.00	0.15	10.14	0.65	0.284	0.213	0.325
LSD $_{0.05}$	0.09	0.09	0.07	0.01	0.03	0.03	0.02	0.25	0.02	0.06	0.02	0.02
LSD $_{0.01}$	0.12	0.12	0.10	0.02	0.04	0.04	0.02	0.34	0.02	0.08	0.02	0.02

Table 6.5: Percent increment of nutrient after 4 years application of poultry litter at Manikganj over the initial soil nutrient value.

Treatments	OC	OM	Total N	P	K	S	Zn	B	Pb	As
T_1=Control	6.45	7.55	3.07	2.50	9.09	2.50	1.61	0.37	0.95	0.93
T_2= RDF N 25% from PL	12.90	14.15	10.76	10.00	18.18	7.50	1.61	4.07	1.90	1.87
T_3= T_2 + 75% RDF	22.58	23.58	23.08	40.00	27.27	20.13	8.06	5.92	3.33	3.12
T_4= RDF N 50% from PL	16.13	16.98	13.84	20.00	18.18	14.50	6.46	4.81	1.90	4.06
T_5= T_4 + 50% RDF	25.81	26.42	27.69	40.00	36.36	26.13	8.06	8.52	2.85	4.68
T_6= RDF N 75% fromPL	17.74	17.92	15.38	27.50	36.36	23.38	8.06	7.03	3.33	4.68
T_7= T_6 + 25% RDF	27.42	**28.32**	**29.23**	47.50	**45.45**	**30.38**	**16.13**	**15.92**	4.28	5.31
T_8= RDF N 100%fromPL	9.68	25.47	23.07	40.00	36.36	28.25	14.52	14.07	4.76	6.25
T_9= T_8 +100% RDF	27.42	28.30	24.61	**55.00**	36.36	29.13	16.13	13.70	**5.23**	**7.18**
T_{10}= Sole RDF	17.74	17.92	15.38	30.00	36.36	26.75	4.84	5.18	1.42	1.56

The nutrient status of post harvest soil at Kishoreganj is presented in tables 6.6 to 6.11. In the experimental site at Kishoreganj the range of C/N ratio 9.61 to 9.88 with the fertilized plot and maximum (9.93) with unfertilized T_1 (control). At Kishoreganj site highest OM (1.52%), N(0.090%),K(0.155meq/100g),S (16.32ppm) and Zn (0.729ppm) found with T_7(RDF N 75% from PL + 25% RDF)but P(24.50ppm) with T_4 (RDF N 50% as PL). In the table 6.11 it observed that the treatments showed higher percentage of nutrients compare to initial soil value at Kishoreganj. The OM, N, P, K and S were increased 26.66%, 27.03% ,41.70%,29.16% and 48.35% respectively with T_7 (RDF N 75% from PL+ 25% RDF) compared to initial soil nutrient status. In case of B, Pb and As were found in very low percentage over initial soil value at Kishoreganj.

The organic matter was increased in different parentage for the treatments at Kishoreganj compared to initial soil value. The order of sequence of increased percent of organic matter for treatments may be arrange as follows:
$T_7>T_5>T_8>T_6>T_9>T_3>T_4>T_{10}>T_2>T_1$.

Table 6.6: Effect of poultry litter on the nutrient status of post harvest soil at Kishoreganj, 2004 to 2005.

Treatment	pH	OC %	OM %	Total N%	C/N ratio	P ppm	K meq/ 100gm	S ppm	Zn ppm	B ppm	Pb Ppm	As ppm
T_1=Control	5.42	0.71	1.22	0.073	9.73	11	0.123	11.00	0.710	0.361	0.246	0.390
T_2= RDF N 25% from PL	5.44	0.73	1.26	0.075	9.73	13	0.128	12.00	0.716	0.365	0.261	0.395
T_3= T_2 + 75% RDF	5.45	0.78	1.34	0.081	9.63	16	0.135	14.00	0.722	0.370	0.263	0.397
T_4= RDF N 50% from PL	5.50	0.76	1.31	0.077	9.87	14	0.13	12.60	0.720	0.368	0.262	0.396
T_5= T_4 + 50% RDF	5.51	0.82	1.41	0.086	9.53	17	0.158	16.00	0.727	0.374	0.263	0.398
T_6= RDF N 75% fromPL	5.48	0.79	1.36	0.080	9.88	15	0.147	14.80	0.723	0.371	0.265	0.399
T_7= T_6 + 25% RDF	5.53	0.84	1.45	0.087	9.66	18	0.162	16.20	0.730	0.377	0.267	0.400
T_8= RDF N 100%fromPL	5.54	0.81	1.40	0.082	9.88	16	0.150	15.00	0.726	0.373	0.266	0.408
T_9= T_8 +100% RDF	5.56	0.79	1.36	0.081	9.75	17	0.152	16.40	0.729	0.380	0.268	0.410
T_{10}= Sole RDF	5.45	0.74	1.28	0.075	9.87	14	0.150	13.00	0.724	0.364	0.263	0.406
LSD $_{0.05}$	0.04	0.04	0.04	0.02	0.04	0.04	0.03	0.03	0.02	0.15	0.03	0.11
LSD $_{0.01}$	0.06	0.05	0.05	0.03	0.05	0.06	0.04	0.04	0.03	0.21	0.04	0.15

Table 6.7: Effect of poultry litter on the nutrient status of post harvest soil at Kishoreganj, 2005 to 2006.

Treatment	pH	OC %	OM %	TotalN %	C/N ratio	P ppm	K meq/100gm	S ppm	Zn ppm	B ppm	Pb ppm	As Ppm
T_1=Control	5.45	0.70	1.20	0.071	9.86	12	0.123	11.20	0.700	0.363	0.261	0.385
T_2= RDF N 25% from PL	5.47	0.74	1.28	0.074	10.00	13	0.124	12.10	0.714	0.364	0.263	0.394
T_3= T_2 + 75% RDF	5.46	0.80	1.37	0.080	10.00	15	0.130	13.80	0.723	0.372	0.262	0.396
T_4= RDF N 50% from PL	5.53	0.78	1.34	0.079	9.87	14	0.152	12.80	0.719	0.366	0.264	0.398
T_5= T_4 + 50% RDF	5.55	0.85	1.46	0.088	9.77	16	0.152	16.40	0.724	0.376	0.265	0.401
T_6= RDF N 75% from PL	5.53	0.82	1.41	0.081	10.12	15	0.158	15.00	0.721	0.370	0.266	0.403
T_7= T_6 + 25% RDF	5.57	0.87	1.50	0.089	9.76	16	0.153	16.50	0.727	0.375	0.270	0.402
T_8= RDF N 100%fromPL	5.55	0.81	1.40	0.083	9.76	15	0.151	15.10	0.724	0.375	0.269	0.405
T_9= T_8 +100% RDF	5.56	0.80	1.38	0.082	9.75	16	0.153	16.00	0.726	0.377	0.272	0.408
T_{10}= Sole RDF	5.58	0.76	1.31	0.076	10.00	13	0.148	13.30	0.722	0.366	0.265	0.404
LSD $_{0.05}$	0.02	0.02	0.06	0.02	0.03	0.03	0.04	0.25	0.03	0.03	0.00	0.00
LSD $_{0.01}$	0.02	0.03	0.09	0.03	0.03	0.04	0.05	0.34	0.04	0.04	0.00	0.00

Table 6.8: Effect of poultry litter on the nutrient status of post harvest soil at Kishoreganj, 2006 to 2007

Treatment	pH	OC %	OM %	Total N%	C/N ratio	P ppm	K meq/100gm	S ppm	Zn ppm	B ppm	Pb ppm	As Ppm
T_1=Control	5.40	0.71	1.22	0.073	9.73	12	0.120	11.00	0.714	0.360	0.263	0.382
T_2= RDF N 25% from PL	5.48	0.76	1.31	0.078	9.74	12	0.121	12.20	0.718	0.362	0.265	0.396
T_3= T_2 + 75% RDF	5.50	0.81	1.40	0.085	9.53	16	0.127	13.60	0.725	0.374	0.266	0.401
T_4= RDF N 50% from PL	5.56	0.80	1.38	0.082	9.76	15	0.146	13.00	0.721	0.365	0.268	0.405
T_5= T_4 + 50% RDF	5.53	0.87	1.50	0.092	9.45	17	0.150	16.00	0.726	0.372	0.270	0.408
T_6= RDF N 75% from PL	5.50	0.84	1.45	0.086	9.76	16	0.148	14.00	0.724	0.372	0.268	0.405
T_7= T_6 + 25% RDF	5.55	0.88	1.52	0.093	9.46	17	0.151	16.00	0.728	0.374	0.272	0.404
T_8= RDF N 100%fromPL	5.57	0.83	1.43	0.085	9.76	15	0.150	15.00	0.727	0.375	0.271	0.409
T_9= T_8 +100% RDF	5.58	0.84	1.45	0.086	9.77	17	0.153	15.70	0.730	0.376	0.275	0.413
T_{10}= Sole RDF	5.57	0.78	1.34	0.079	9.90	14	0.144	13.50	0.721	0.362	0.264	0.401
LSD $_{0.05}$	0.02	0.03	0.03	0.02	0.04	0.03	0.03	3.42	0.03	0.03	0.00	0.07
LSD $_{0.01}$	0.02	0.05	0.04	0.03	0.06	0.03	0.04	4.66	0.03	0.04	0.00	0.09

Table 6.9: Effect of poultry litter on the nutrient status of post harvest soil at Kishoreganj, 2007 to 2008

Treatment	pH	OC %	OM %	Total N%	C/N ratio	P ppm	K meq/100gm	S ppm	Zn ppm	B ppm	Pb ppm	As Ppm
T_1=Control	5.43	0.72	1.24	0.071	10.14	13	0.121	11.30	0.712	0.361	0.261	0.380
T_2= RDF N 25% from PL	5.45	0.78	1.34	0.080	9.75	13	0.125	12.50	0.719	0.365	0.264	0.393
T_3= T_2 + 75% RDF	5.49	0.84	1.45	0.087	9.66	17	0.128	13.80	0.727	0.376	0.266	0.400
T_4= RDF N 50% from PL	5.51	0.81	1.40	0.083	9.76	15	0.151	13.30	0.723	0.370	0.267	0.402
T_5= T_4 + 50% RDF	5.50	0.90	1.55	0.094	9.57	17	0.153	16.30	0.729	0.375	0.268	0.405
T_6= RDF N 75% from PL	5.55	0.86	1.48	0.088	9.77	15	0.150	14.30	0.727	0.370	0.271	0.407
T_7= T_6 + 25% RDF	5.49	0.92	1.58	0.096	9.58	18	0.155	16.40	0.730	0.380	0.274	0.403
T_8= RDF N 100%fromPL	5.54	0.87	1.50	0.089	9.76	16	0.152	14.80	0.729	0.379	0.273	0.413
T_9= T_8 +100% RDF	5.51	0.88	1.52	0.090	9.77	18	0.151	16.00	0.733	0.382	0.277	0.414
T_{10}= Sole RDF	5.57	0.76	1.30	0.077	9.87	15	0.146	14.00	0.724	0.364	0.262	0.400
LSD $_{0.05}$	0.04	0.02	0.02	0.02	0.04	1.75	0.03	425.15	0.02	0.03	0.01	0.16
LSD $_{0.01}$	0.05	0.03	0.03	0.03	0.05	2.38	0.04	579.84	0.03	0.03	0.01	0.22

Table 6.10: Average four years effect of poultry litter on the nutrient status of post harvest soil at Kishoreganj, 2004-05 to 2007-08

Treatment	pH	OC %	OM %	Total N%	C/N ratio	P ppm	K meq/ 100gm	S ppm	Zn ppm	B ppm	Pb ppm	As ppm
T_1=Control	5.43	0.71	1.22	0.072	9.93	12.00	0.121	11.12	0.709	0.36	0.26	0.384
T_2= RDF N 25% from PL	5.46	0.76	1.30	0.077	9.80	12.75	0.122	12.2	0.716	0.37	0.27	0.394
T_3= T_2 + 75% RDF	5.48	0.81	1.39	0.083	9.70	16.00	0.130	13.8	0.724	0.38	0.27	0.398
T_4= RDF N 50% from PL	5.53	0.79	1.36	0.080	9.81	**24.5**	0.1 44	12.92	0.720	0.37	0.27	0.400
T_5= T_4 + 50% RDF	5.53	0.86	1.48	0.089	9.65	16.75	0.153	16.17	0.726	0.38	0.27	0.403
T_6= RDF N 75% from PL	5.52	0.83	1.43	0.084	9.88	15.25	0.150	15.02	0.721	**0.46**	0.27	0.403
T_7= T_6 + 25% RDF	5.54	0.88	**1.52**	**0.090**	9.61	17.00	**0.155**	**16.32**	**0.729**	0.38	0.28	0.402
T_8= RDF N 100%fromPL	5.55	0.83	1.44	0.085	9.79	15.5	0.150	14.97	0.726	0.38	0.28	0.408
T_9= T_8 +100% RDF	5.56	0.83	1.43	0.085	9.76	17.00	0.152	16.02	0.728	0.38	0.28	**0.411**
T_{10}= Sole RDF	5.55	0.76	1.31	0.076	9.91	14.00	0.147	13.45	0.722	0.37	0.27	0.402

$LSD_{0.05}$	0.02	0.03	0.03	0.02	0.02	0.02	0.03	0.16	NS	NS	NS	0.15
$LSD_{0.01}$	0.02	0.05	0.04	0.02	0.03	0.02	0.04	0.22				0.21

Table 6.11: Percent increment of nutrient after 4 years application of poultry litter at kishoreganj over the initial soil nutrient value.

Treatments	OC	OM	Total N	P	K	S	Zn	B	Pb	As
T_1=Control	1.43	1.67	1.40	4.35	0.83	1.09	1.29	2.86	1.96	1.05
T_2= RDF N 25% from PL	8.57	8.33	4.05	6.25	1.66	10.90	0.84	2.78	3.85	3.68
T_3= T_2 + 75% RDF	15.71	15.83	13.52	33.36	8.33	25.45	1.97	5.56	3.85	4.74
T_4= RDF N 50% from PL	12.86	13.33	13.52	20.85	19.99	17.45	1.40	2.78	3.85	5.26
T_5= T_4 + 50% RDF	22.86	23.33	27.03	33.36	27.49	46.99	2.25	2.78	3.85	6.05
T_6= RDF N 75% fromPL	18.56	19.16	13.52	27.11	24.99	36.54	1.54	5.56	3.85	6.05
T_7= T_6 + 25% RDF	25.71	**26.66**	27.03	**41.70**	**29.16**	**48.35**	**2.53**	5.56	7.69	5.79
T_8= RDF N 100%fromPL	18.57	20.00	27.03	29.19	24.7.9	36.08	2.25	5.56	7.69	7.37
T_9= T_8 +100% RDF	18.57	19.16	27.03	41.70	26.66	45.63	2.67	5.56	7.69	8.15
T_{10}= Sole RDF	8.57	9.16	13.52	16.68	22.49	22.27	1.69	2.78	3.85	5.79

Both the sites the significant effect of poultry litter was observed to enhance the soil nutrient status. The organic matter content in the soil was very low in the control. It significantly increased in the soils treated with poultry litter. The treatment both sole poultry litter and integrated treatments were increased OC, OM, N, P, K and S over initial nutrient status. The status of Pb, B and As increased slightly which was statistically not significant and found very below to allowable limit. Narrower C/N ratio found with the treated plots. Study indicated that poultry litter is a good contributor to soil fertility and no adverse effect occurred by the little bit presence Pb and As in poultry litter.

4.5 Effect of poultry litter on physical propertiesof post harvest soil

After four years field experiments the soil physical properties of different poultry litter treatments were measured. The results of Manikganj and Kishoreganj were presented in tables 7 and 7.1 respectively. In Manikganj site it was observed that most reduced bulk density (1.16 g/cm^3) at 0-15cm depth, highest pore space (57.35%) and particle density(2.72 g/cm^3) found with T_7 (RDF N 75% from poultry litter +25%RDF). Maximum water retentive characteristics (41.35 V %) found with T_9 (RDF N 100% from poultry litter +100%RDF). Both the treatments T_7 and T_9 contributed to obtain most reducing percentage of sand (34%) at Manikganj. Percent of silt found highest rate (49%) with T_9 and clay (18%) with both T_5 and T_7. The co-ralation between bulk density and maximum water retentive characteristics was positive having r^2 value 0.807(fig 2.2) at Manikganj.

Table 7: Four years effect of poultry litter on soil physical properties of post harvest soil of jute at Manikganj (2004-05 to 2007-08).

Treatment	**Bulk density (g/cm^3) 0 -15cm**	**Bulk density (g/cm^3) 15cm-30cm**	**Maximum water retentive characteristics V%**	**Pore space %**	**Sand %**	**Silt %**	**Clay %**	**Textural class**	**Particle density (g/cm^3)**
T_1-Control	1.46	1.48	33.48	40.65	50	36	14	Silt loam	2.46
T_2=RDF N25% from PL	1.44	1.49	34.00	44.19	48	37	15	Silt loam	2.58
T_3=T2+75%RDF	1.30	1.42	38.00	50.94	42	42	16	Silt loam	2.65
T_4=RDFN50% from PL	1.41	1.47	35.20	45.77	46	40	14	Silt loam	2.60
T_5=T4+50% RDF	1.25	1.40	40.80	53.70	35	47	**18**	Silt loam	2.70
T_6=RDF N75% RDF from PL	1.37	1.45	39.10	48.50	45	43	12	Silt loam	2.66
T_7=T6+25%RDF	**1.16**	**1.39**	41.20	**57.35**	**34**	48	**18**	Silt loam	**2.72**
T_8=RDF N 100 from PL	1.30	1.40	40.78	49.10	37	47	16	Silt loam	2.55
T_9=T8+100%RDF	1.26	1.38	**41.35**	50.78	**34**	**49**	14	Silt loam	2.56
T_{10}= RDF (sole)	1.41	1.45	34.70	46.18	46	42	12	Silt loam	2.62
LSD $_{0.05}$	0.15	0.14	1.94	1.70	1.70	1.70	1.70	-	0.11
LSD $_{0.01}$	0.21	0.19	2.65	2.32	2.32	2.32	2.32	-	0.15

In Kishoreganj site it was observed that most reduced bulk density(1.09 g/cm^3) at 0-15cm depth, highest pore space (57.35%) and particle density (2.78g/cm^3) found with T_7 (RDF N 75% from poultry litter + 25%RDF).Maximum water retentive characteristics (41.19 V%) found with T_9 (RDF N 100% from poultry litter + 100% RDF). The treatments T_5 and T_7 gave most reducing percentage of sand (20%) at Kishoreganj where as initial value was 28%. Silt percentage found highest (58%) with T_9 and clay (23%) with T_5 at Kishoreganj. It was observed from the result (fig 2.3) that relation of bulk density and maximum water retentive characteristics indicating positive correlation (r^2 value 0.888) at kishoreganj

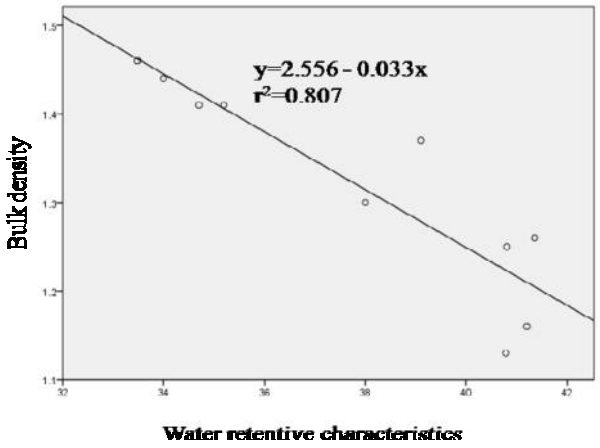

Fig. 2.2 Relationship between bulk density and Maximum water retentive characteristics at Manikganj

.Table 7.1: Four years effect of poultry litter on soil physical properties of post harvest Soil of the experimental site at Kishoreganj (2004-05 to 2007-08).

Treatment	**Bulk density (g/cm^3) 0 -15cm**	**Bulk density (g/cm^3) 15cm-30cm**	**Maximum Water retentive characteristics V%**	**Pore pace %**	**Sand %**	**Silt %**	**Clay %**	**Textural class**	**Particle density (g/cm^3)**
T_1-Control	1.43	1.46	31.00	45.83	29	54	18	Silt loam	2.64
T_2=RDF N25% from PL	1.40	1.44	32.40	47.17	28	56	16	Silt loam	2.65
T_3=T2+75%RDF	1.15	1.28	35.58	57.09	24	54	22	Silt loam	2.68
T_4=RDFN50% from PL	1.35	1.40	32.50	49.25	25	56	19	Silt loam	2.66
T_5=T4+50% RDF	1.15	1.30	40.70	58.18	**20**	57	**23**	Silt loam	2.75
T_6=RDF N75% RDF from PL	1.32	1.35	34.10	51.11	25	55	20	Silt loam	2.70
T_7=T6+25%RDF	**1.09**	**1.26**	41.13	57.19	**20**	**58**	22	Silt loam	**2.78**
T_8=RDF N 100 from PL	1.20	1.29	40.85	55.28	23	57	20	Silt loam	2.68
T_9=T8+100%RDF	1.10	1.27	**41.19**	**58.95**	23	**58**	19	Silt loam	2.68
T_{10}= RDF (sole)	1.39	1.43	32.00	47.74	27	56	17	Silt loam	2.60
LSD $_{0.05}$	0.15	0.16	2.95	1.70	3.28	1.70	1.70	-	0.12
LSD $_{0.01}$	0.21	0.22	3.97	2.32	4.47	2.32	2.32	-	0.16

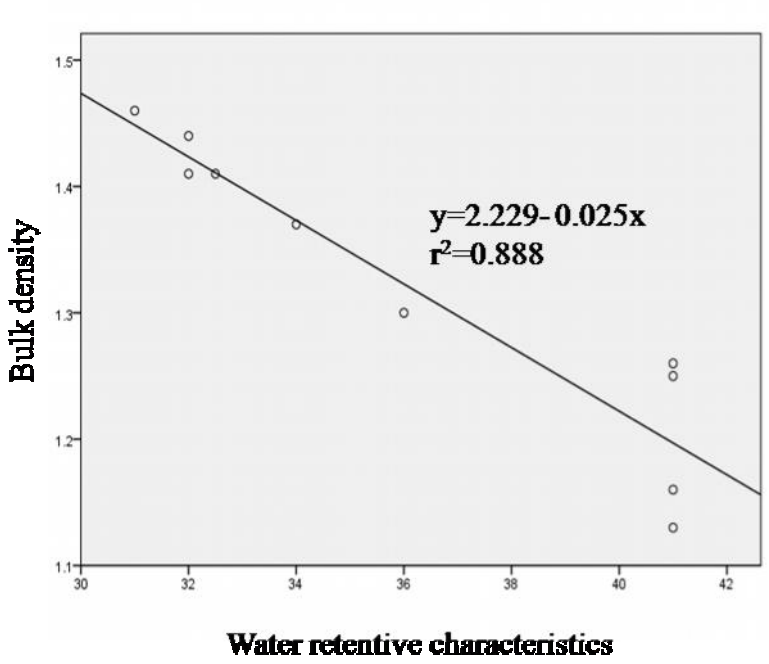

Fig. 2.3 Relationship between bulk density and Maximum water retentive characteristics at Kishoregnj

At both sites of the study area, poultry litter improved soil physical properties by reducing soil bulk density and increasing pore space, particle density and maximum water retentive characteristics over initial soil value. Incorporation of poultry litter also improved the soil textural class by reducing the percentage of sand. Integrated use of poultry litter and inorganic fertilizer performed better than sole application of poultry litter and inorganic fertilizer. Study revealed that the poultry litter acted as a good conditioner of improving the soil physical, chemical and biological properties.

4.6. Effect of poultry litter on bacterial population of post harvest soil

Average four years result of bacterial population due to incorporation of poultry litter at Manikganj and Kishoreganj has been presented in the tables 8 and 8.1. Results of showed that different treatments affected significantly on bacterial population. It increased with all the treated plots compare to initial soil value. Bacterial population was found higher with the integrated treatment of poultry litter and inorganic fertilizer than sole inorganic fertilizer and poultry litter application. Highest population found with T_7 (RDF N 75% from PL + 25% RDF) both at Kishoreganj (56 X 10^5) and

Manikganj (59 X 10^5). Among all the treatments, the control plot T_1 (with out fertilizer) showed the minimum count of bacterial population over treated plots.

Table 8: Effect of poultry litter on bacterial population (X10^5) of year wise post harvest soil and average of 4 years (2004-05 to 2007-08) at Manikganj.

Treatments	2004-05	2005-06	2006-07	2007-08	average of 4 years (2004-05 to 2007-08)
T_1-Control	32	34	31	32	32
T_2=RDF N25% from PL	40	38	41	43	41
T_3=T2+75%RDF	54	55	58	59	57
T_4=RDFN50% from PL	42	44	46	46	45
T_5=T4+50% RDF	57	55	58	60	58
T_6=RDF N75% RDF from PL	43	45	47	50	46
T_7=T6+25%RDF	**58**	**56**	**60**	**62**	**59**
T_8=RDF N 100 from PL	46	45	48	50	47
T_9=T8+100%RDF	45	47	48	51	48
T_{10}= RDF (sole)	33	36	34	32	34
LSD $_{0.05}$	3.23	3.09	3.36	3.97	5.12
LSD $_{0.01}$	4.41	4.22	4.59	4.05	6.90

Table 8.1: Effect of poultry litter on bacterial population ($X10^5$) of year wise post harvest soil and average of 4 years (2004-05 to 2007-08) at Kishoreganj.

Treatments	2004-05	2005-06	2006-07	2007-08	average of 4 years (2004-05 to 2007-08)
T_1-Control	35	34	31	32	33
T_2=RDF N25% from PL	32	37	35	40	36
T_3=T2+75%RDF	51	54	56	57	55
T_4=RDFN50% from PL	40	36	41	43	40
T_5=T4+50% RDF	53	35	55	52	54
T_6=RDF N75% RDF from PL	43	41	43	46	43
T_7=T6+25%RDF	**53**	**54**	**57**	**60**	**56**
T_8=RDF N 100 from PL	54	52	55	55	54
T_9=T8+100%RDF	48	51	56	54	52
T_{10}= RDF (sole)	32	35	37	33	34
$LSD_{0.05}$	3.14	2.69	1.70	1.94	5.59
$LSD_{0.01}$	4.28	3.67	2.32	2.65	3.70

The efficiencies of different treatments (four years average)with respect to population of bacteria at Manikganj followed the sequence of T_7> T_8 >T_3>T_9>T_8 >T_6>T_4>T_2>T_{10}>T_1. The treatments at Kishoreganj site may be arranged for the population of bacteria (four years average) T7>T_3>T_5>T_8>T_9>T_6>T_4>T_2>T_{10}>T_1. The results revealed that poultry litter significantly improves the bacterial population.

4.7. Effect of poultry litter on fibre quality

The quality of fibre was measured in different parameters such as lusture, fineness and bundle strength.

The results of Manikganj are presented in tables 9 to 9.4.It showed that the application of poultry litter sole or inorganic fertilizer caused significant changes on the lusture, fineness and bundle strength every year. It appears from the results (table 9.4.) that maximum lusture (36.75%) and most fine fibre (23.95 μ) were obtained with T_5 (50% RDF N from PL+ 50% RDF).But bundle strength was found highest (10.19 Ibs/mg) with T_7 (RDF N 75% from PL + 25% RDF) at Manikganj. From table 9.4, it was evident that, integrated treatments enhanced the fiber quality than sole application poultry litter and inorganic fertilizer. Among the treatments lowest performance was observed with T_1. At Manikganj (table 9.4) the sequence of lusture was T_5>T_7>T_3>T_9>T_6>T_8>T_4>T_{10}>T_2>T_1, fineness T_5>T_6>T_7>T_3>T_4>T_2>T_8>T_1> T_9>T_{10} and bundl estrength T_7>T_5>T_9>T_{10}>T_8>T_3>T_6>T_4>T_2>T_1.

Table 9: Effect of poultry litter on different parameters of fibre quality at Manikganj 2004- 05.

Treatments	**Lusture %**	**Fineness µ**	**Bundle strength Ibs/mg**
T_1-Control	17	35.00	8.45
T_2=RDF N25% from PL	20	30.00	8.52
T_3=T2+75%RDF	33	25.50	9.30
T_4=RDFN50% from PL	25	26.00	8.88
T_5=T4+50% RDF	37	23.50	10.00
T_6=RDF N75% RDF from PL	32	24.20	9.20
T_7=T6+25%RDF	36	23.60	10.10
T_8=RDF N 100 from PL	35	34.00	9.50
T_9=T8+100%RDF	37	38.00	9.80
T_{10}= RDF (sole)	28	37.70	9.60
LSD $_{0.05}$	2.53	1.21	0.95
LSD $_{0.01}$	3.45	1.66	1.29

Table 9.1: Effect of poultry litter on different parameters of fibre quality at Manikganj 2005- 06.

Treatments	**Lusture %**	**Fineness µ**	**Bundle strength Ibs/mg**
T_1-Control	16	35.40	8.30
T_2=RDF N25% from PL	23	30.10	8.50
T_3=T2+75%RDF	36	25.20	9.35
T_4=RDFN50% from PL	30	26.30	9.10
T_5=T4+50% RDF	35	24.20	10.20
T_6=RDF N75% RDF from PL	34	24.50	9.23
T_7=T6+25%RDF	35	24.76	10.21
T_8=RDF N 100 from PL	33	34.60	9.56
T_9=T8+100%RDF	34	37.70	9.87
T_{10}= RDF (sole)	25	38.71	9.55
LSD $_{0.05}$	1.70	0.25	0.68
LSD $_{0.01}$	2.32	0.34	0.93

Table 9.2: Effect of poultry litter on different parameters of fibre quality at Manikganj 2006- 07.

Treatments	**Lusture %**	**Fineness µ**	**Bundle strength Ibs/mg**
T_1-Control	19	34.80	8.36
T_2=RDF N25% from PL	25	29.70	8.47
T_3=T2+75%RDF	34	25.00	9.40
T_4=RDFN50% from PL	32	26.42	9.00
T_5=T4+50% RDF	37	24.00	9.90
T_6=RDF N75% RDF from PL	36	24.53	9.00
T_7=T6+25%RDF	36	24.65	10.23
T_8=RDF N 100 from PL	31	34.40	9.60
T_9=T8+100%RDF	33	37.50	9.84
T_{10}= RDF (sole)	27	38.50	9.78
LSD $_{0.05}$	1.94	0.94	0.78
LSD $_{0.01}$	2.65	1.29	1.06

Table 9.3: Effect of poultry litter on different parameters of fibre quality at Manikganj 2007- 08.

Treatments	**Lusture %**	**Fineness µ**	**Bundle strength Ibs/mg**
T_1-Control	17	35.00	8.40
T_2=RDF N25% from PL	26	29.50	8.51
T_3=T2+75%RDF	36	25.00	9.43
T_4=RDFN50% from PL	35	26.20	9.30
T_5=T4+50% RDF	38	24.10	10.20
T_6=RDF N75% RDF from PL	36	24.42	9.15
T_7=T6+25%RDF	38	24.80	10.21
T_8=RDF N 100 from PL	35	34.20	9.55
T_9=T8+100%RDF	35	38.00	10.00
T_{10}= RDF (sole)	28	39.00	9.76
LSD $_{0.05}$	1.70	1.09	0.57
LSD $_{0.01}$	2.32	1.49	0.78

Table 9.4: Averge 4 years effect of poultry litter on different parameters of fibre quality at Manikganj 2004-05 to 2007-08.

Treatments	Lusture %	Fineness µ	Bundle strength Ibs/mg
T_1-Control	17.25	35.05	8.38
T_2=RDF N25% from PL	23.50	29.83	8.50
T_3=T2+75%RDF	34.75	25.18	9.37
T_4=RDFN50% from PL	30.50	26.23	9.07
T_5=T4+50% RDF	**36.75**	**23.95**	10.08
T_6=RDF N75% RDF from PL	34.50	24.41	9.15
T_7=T6+25%RDF	36.25	24.45	**10.19**
T_8=RDF N 100 from PL	33.50	34.30	9.55
T_9=T8+100%RDF	34.75	37.80	9.88
T_{10}= RDF (sole)	27.00	38.48	9.67
LSD $_{0.05}$	3.13	0.48	0.14
LSD $_{0.01}$	4.21	0.65	0.19

The results of Kishoreganj are presented in tables 9.5 to 9.9. Every year incorporation of poultry litter showed significant influences on the lusture, fineness and bundle strength. The table 9.9 displayed that highest value of lusture (34.12%) and bundle strength were achieved (11.67 Ibs/mg) with T_7 (RDF N 75% from PL + 25% RDF) at Kishoreganj. The least fine fibre (20.25µ) was obtained with T_5 (50% RDF from PL+ 50% RDF) at Kishoreganj. Results pointed out that all the treatments increased the different parameters of fibre quality over T_1 and integrated treatments performed better at Kishoreganj. Among the treatments the sequence of lusture was $T_7>T_5>T_9>T_8>T_3>T_6>T_{10}>T_4>T_2>T_1$, fineness $T_5>T_7>T_6>T_3>T_4>$
$T_2>T_8>T_1>T_9>T_{10}$ and bundle strength $T_7>T_5>T_6>T_9>T_8>T_{10}>T_3>T_4>T_2>T_1$in Kishoreganj.

Table 9.5: Effect of poultry litter on different parameters of fibre quality at Kishoreganj 2004-05.

Treatments	Lusture %	Fineness µ	Bundle strength Ibs/mg
T_1-Control	14.00	36	10.00
T_2=RDF N25% from PL	14.50	28	10.50
T_3=T2+75%RDF	30.00	25	10.75
T_4=RDFN50% from PL	22.00	27	10.60
T_5=T4+50% RDF	33.00	22	11.20
T_6=RDF N75% RDF from PL	28.00	23	11.00
T_7=T6+25%RDF	33.20	22	11.50
T_8=RDF N 100 from PL	32.80	32	1080
T_9=T8+100%RDF	33.10	37	11.30
T_{10}= RDF (sole)	26.00	41	11.00
LSD $_{0.05}$	3.13	5.26	0.14
LSD $_{0.01}$	4.27	7.17	0.19

Table 9.6: Effect of poultry litter on different parameters of fibre quality at Kishoreganj 2005-06.

Treatments	Lusture %	Fineness µ	Bundle strength Ibs/mg
T_1-Control	15.00	38	9.80
T_2=RDF N25% from PL	16.00	30	10.60
T_3=T2+75%RDF	29.00	24	10.65
T_4=RDFN50% from PL	23.00	25	10.62
T_5=T4+50% RDF	34.00	20	11.45
T_6=RDF N75% RDF from PL	30.00	24	11.30
T_7=T6+25%RDF	35.00	21	11.70
T_8=RDF N 100 from PL	33.00	35	11.00
T_9=T8+100%RDF	33.00	39	11.40
T_{10}= RDF (sole)	26.50	40	10.80
$LSD_{0.05}$	0.22	3.00	0.15
$LSD_{0.01}$	0.30	4.09	0.21

Table 9.7: Effect of poultry litter on different parameters of fibre quality at Kishoreganj 2006-07.

Treatments	Lusture %	Fineness µ	Bundle strength Ibs/mg
T_1-Control	17.00	34	10.20
T_2=RDF N25% from PL	19.00	27	10.80
T_3=T2+75%RDF	31.00	22	11.20
T_4=RDFN50% from PL	25.00	23	10.90
T_5=T4+50% RDF	33.50	20	11.52
T_6=RDF N75% RDF from PL	29.65	21	11.35
T_7=T6+25%RDF	34.00	20	11.72
T_8=RDF N 100 from PL	33.20	33	11.20
T_9=T8+100%RDF	33.08	40	11.00
T_{10}= RDF (sole)	28.00	42	11.20
$LSD_{0.05}$	0.95	3.14	0.28
$LSD_{0.01}$	1.30	4.28	0.38

Table 9.8: Effect of poultry litter on different parameters of fibre quality at Kishoreganj 2007-08.

Treatments	Lusture %	Fineness µ	Bundle strength Ibs/mg
T_1-Control	14.00	32	10.30
T_2=RDF N25% from PL	20.00	29	11.00
T_3=T2+75%RDF	32.00	23	11.50
T_4=RDFN50% from PL	26.00	22	11.20
T_5=T4+50% RDF	34.20	19	11.60
T_6=RDF N75% RDF from PL	30.20	22	11.45
T_7=T6+25%RDF	34.30	22	11.76
T_8=RDF N 100 from PL	33.15	32	11.30
T_9=T8+100%RDF	33.21	41	10.80
T_{10}= RDF (sole)	28.20	39	11.00
LSD $_{0.05}$	1.91	2.53	0.83
LSD $_{0.01}$	2.61	3.45	1.14

Table 9.9: Averge 4 years effect of poultry litter on different parameters of fibre quality at Kishoreganj 2004-05 to 2007-08.

Treatments	Lusture %	Fineness µ	Bundle strength Ibs/mg
T_1-Control	15.00	35.00	10.08
T_2=RDF N25% from PL	17.38	28.50	10.72
T_3=T2+75%RDF	30.50	23.50	11.02
T_4=RDFN50% from PL	24.00	24.25	10.83
T_5=T4+50% RDF	33.68	**20.25**	11.44
T_6=RDF N75% RDF from PL	29.47	22.50	11.27
T_7=T6+25%RDF	**34.12**	21.25	**11.67**
T_8=RDF N 100 from PL	33.03	33.00	11.07
T_9=T8+100%RDF	33.14	39.25	11.12
T_{10}= RDF (sole)	27.17	40.50	11.00
LSD $_{0.05}$	1.86	2.31	0.53
LSD $_{0.01}$	2.51	3.12	0.71

Study indicates that the application of poultry litter improved the different physico-mechanical properties of fibre quality *viz.* Lusture, fineness and bundle strength. It is the general agreement that higher value of lusture, bundle strength and lower value of fineness indicate super grade of fibre which found due to poultry litter incorporation. Integrated treatments showed improve fibre quality than sole application of poultry litter and inorganic fertilizer. Study revealed that utilization of poultry litter along with inorganic fertilizer a good technique to obtain quality fibre. Findings created a new approach for ascertaining quality of fibre.

4.8. Cost and return analysis

Cost and return analysis was done considering the variable cost of fertilizer, seed, labour, price of fibre and stick. The cost and return analysis of Manikganj and Kishoreganj site have been presented in tables 10 to 10.9.Every year recorded the benefit cost ratio. The total variable cost was found to be the highest with T_9 using the highest dose of poultry litter

and inorganic fertilizer. Average of four years cost and return analysis (tables 10.4 and 10.9) showed that the highest gross return, gross margin as well as benefit cost ratio was obtained with T_5 (RDF N 50% from PL + 50% RDF) and lowest with control T_1. Highest benefit cost ratio was 5.05 at Kishoreganj and 5.20 at Manikganj.

Table 10: Cost and return analysis due to poultry litter application at Manikganj , 2004-2005

Treatments	Gross return (Tk/ha)	Variable cost (Tk/ha)	Gross margin (Tk/ha)	Benefit cost ratio (BCR)
T_1-Control	26250/-	13020/-	13230.00	2.02
T_2=RDF N25% from PL	35310/-	13341.43	21968.57	2.65
T_3=T2+75%RDF	70080/-	15579.85	54500.15	4.50
T_4=RDFN50% from PL	55040/-	13662.86	41377.14	4.03
T_5=T4+50% RDF	79460/-	15155.14	64304.86	5.24
T_6=RDF N75% RDF from PL	57970/-	13984.29	43985.71	4.15
T_7=T6+25%RDF	74250/-	14730.43	59519.57	5.04
T_8=RDF N 100 from PL	71300/-	14305.72	56994.28	4.98
T_9=T8+100%RDF	62860/-	17290.28	45569.72	3.64
T_{10}= RDF (sole)	52420/-	16004.56	36415.44	3.28

Input cost: Urea = Tk. 5.60/ kg,TSP= Tk 12.50/ kg, MoP= Tk. 11.40/kg,Gypsum= Tk. 5.00/kg , Jute seed= Tk.70/ kg,Poultry litter = 0.30/ kg, Per labour wage = Tk 70/day Output price: Fibre= Tk 17/kg, Stick= Tk 2.00/kg

Table 10.1: Cost and return analysis due to poultry litter application at Manikganj 2005-2006

Treatments	Gross return (Tk/ha)	Variable cost (Tk/ha)	Gross margin (Tk/ha)	Benefit cost ratio (BCR)
T_1-Control	30100.00	13020.00	17080.00	2.31
T_2=RDF N25% from PL	42000.00	13343.00	28657.00	3.15
T_3=T2+75%RDF	85500.00	15581.42	69918.58	5.49
T_4=RDFN50% from PL	67900.00	13666.00	54234.00	4.97
T_5=T4+50% RDF	99680.00	15158.28	84522.00	6.58
T_6=RDF N75% RDF from PL	71440.00	13989.00	57451.00	5.11
T_7=T6+25%RDF	93600.00	14735.14	78864.86	6.35
T_8=RDF N 100 from PL	88950.00	14312.00	74638.00	6.22
T_9=T8+100%RDF	79140.00	17296.56	61843.44	4.58
T_{10}= RDF (sole)	84790.00	16004.56	68785.44	5.30

Input cost: Urea = Tk. 6.25/ kg,TSP= Tk 12.50/ kg, MoP= Tk. 14.40/kg,Gypsum= Tk. 6.50/kg , Jute seed= Tk.80/ g,Poultry litter = 0.30/ kg, Per labour wage = Tk 70/day Output price: Fibre= Tk 23.00/kg, Stick= Tk 2/kg

Table 10.2: Cost and return analysis due to poultry litter application at Manikganj 2006-2007

Treatments	Gross return (Tk/ha)	Variable cost (Tk/ha)	Gross margin (Tk/ha)	Benefit cost ratio (BCR)
T_1-Control	33240.00	20640.00	12600.00	1.61
T_2=RDF N25% from PL	47725.00	20941.34	26783.66	2.28
T_3=T2+75%RDF	97400.00	23179.76	74220.24	4.20
T_4=RDFN50% from PL	74125.00	21242.68	52882.32	3.49
T_5=T4+50% RDF	107965.00	22734.96	85230.04	4.75
T_6=RDF N75% RDF from PL	78575.00	21544.02	57030.98	3.65
T_7=T6+25%RDF	98240.00	22290.16	75949.84	4.41
T_8=RDF N 100 from PL	96975.00	21845.36	75129.64	4.44
T_9=T8+100%RDF	83695.00	24829.92	58865.08	3.37
T_{10}= RDF (sole)	88515.00	23624.56	64890.44	3.75

Input cost: Urea = Tk. 6.30/ kg,TSP= Tk 18.00/ kg, MoP= Tk. 11.40/kg,Gypsum= Tk.6.00/kg , Jute seed= Tk.80/ kg,Poultry litter = 0.30/ kg, Per labour wage = Tk 112.00/day
Output price: Fibre= Tk 23.50/kg, Stick= Tk 2.50/kg,

Table 10.3: Cost and return analysis due to poultry litter application at Manikganj 2007-2008

Treatments	Gross return (Tk/ha)	Variable cost (Tk/ha)	Gross margin (Tk/ha)	Benefit cost ratio (BCR)
T_1-Control	32080.50	20700.00	11380.50	1.55
T_2=RDF N25% from PL	53880.00	21211.37	32668.63	2.54
T_3=T2+75%RDF	102701.00	24868.88	77832.12	4.13
T_4=RDFN50% from PL	81263.00	21722.74	59540.26	3.74
T_5=T4+50% RDF	114557.50	24161.07	90396.43	4.75
T_6=RDF N75% RDF from PL	86020.50	22234.11	63786.39	3.87
T_7=T6+25%RDF	106906.00	23453.28	83452.72	4.56
T_8=RDF N 100 from PL	99760.00	22745.48	77014.52	4.39
T_9=T8+100%RDF	87723.00	27622.14	60100.86	3.18
T_{10}= RDF (sole)	93161.50	25576.66	67584.84	3.64

Input cost: Urea = Tk. 11.60/ kg, TSP= Tk 18.00/ kg, MoP= Tk. 16.50/kg,Gypsum= Tk. 6.00/kg , Jute seed= Tk.90/ kg,Poultry litter = 0.50/ kg, Per labour wage = Tk112.00/day
Output price: Fibre= Tk 25.50/kg, Stick= Tk 2.50/kg,

Table 10.4: Average 4 years Cost and return analysis due to poultry litter application at Manikganj 2004-05 to2007-08

Treatments	Gross return (Tk/ha)	Variable cost (Tk/ha	Gross margin (Tk/ha)	Benefit cost ratio (BCR)
T_1-Control	30417.63	16845.00	13572.63	1.81
T_2=RDF N25% from PL	44728.75	17209.29	27519.46	2.60
T_3=T2+75%RDF	88920.25	19802.48	69117.77	4.50
T_4=RDFN50% from PL	59582.00	17573.57	42008.43	3.39
T_5=T4+50% RDF	100415.63	19302.36	81113.27	5.20
T_6=RDF N75% RDF from PL	73501.38	17937.86	55563.52	4.10
T_7=T6+25%RDF	93249.00	18802.25	74446.75	4.96
T_8=RDF N 100 from PL	89246.25	18302.74	70944.11	4.88
T_9=T8+100%RDF	78354.50	21759.73	56594.77	3.60
T_{10}= RDF (sole)	79721.63	20302.59.	59419.04	3.93

Table 10.5: Cost and return analysis due to poultry litter application at Kishoreganj 2004-2005

Treatments	Gross return (Tk/ha)	Variable cost (Tk/ha	Gross margin (Tk/ha)	Benefit cost ratio (BCR)
T_1-Control	25750.00	13020.00	12730.00	1.98
T_2=RDF N25% from PL	36530.00	13326.82	23203.18	2.74
T_3=T2+75%RDF	71180.00	15565.23	55614.77	4.57
T_4=RDFN50% from PL	55950.00	13633.64	42316.36	4.10
T_5=T4+50% RDF	79670.00	15125.92	64544.08	5.27
T_6=RDF N75% RDF from PL	57880.00	13940.46	43939.54	4.15
T_7=T6+25%RDF	72980.00	14686.60	58293.40	4.97
T_8=RDF N 100 from PL	68870.00	14247.28	54622.72	4.83
T_9=T8+100%RDF	64180.00	17231.83	46948.17	3.72
T_{10}= RDF (sole)	68530.00	16004.55	52525.45	4.28

Input cost: Urea = Tk. 5.60/ kg,TSP= Tk 12.50/ kg, MoP= Tk. 11.40/kg,Gypsum= Tk. 5.00/kg , Jute seed= Tk.70/ kg,Poultry litter = 0.30/ kg, Per labour wage = Tk 70/day
Output price: Fibre= Tk 17/kg, Stick= Tk 2.00/kg.

Table 10.6: Cost and return analysis due to poultry litter application at Kishoreganj 2005-2006

Treatments	Gross return (Tk/ha)	Variable cost (Tk/ha	Gross margin (Tk/ha)	Benefit cost ratio (BCR)
T_1-Control	30280.00	13080.00	17200.00	2.31
T_2=RDF N25% from PL	44720.00	13401.40	31318.60	3.34
T_3=T2+75%RDF	87810.00	15997.33	71812.67	5.49
T_4=RDFN50% from PL	69410.00	14810.60	54599.40	4.69
T_5=T4+50% RDF	96500.00	16541.20	79958.80	5.83
T_6=RDF N75% RDF from PL	73360.00	14044.29	59315.71	5.22
T_7=T6+25%RDF	94210.00	14909.59	79300.41	6.32
T_8=RDF N 100 from PL	85120.00	14365.75	70754.25	5.93
T_9=T8+100%RDF	80460.00	17826.97	62633.03	4.51
T_{10}= RDF (sole)	86310.00	16541.22	69768.78	5.52

Input cost: Urea = Tk. 6.25/ kg,TSP= Tk 12.50/ kg, MoP= Tk. 14.40/kg,Gypsum= Tk. 6.50/kg , Jute seed= Tk.80/ kg,Poultry litter = 0.30/ kg, Per labour wage = Tk 70/day Output price: Fibre= Tk 23.00/kg, Stick= Tk 2/kg,

Table 10.7: Cost and return analysis due to poultry litter application at Kishoreganj 2006-2007

Treatments	Gross return (Tk/ha)	Variable cost (Tk/ha	Gross margin (Tk/ha)	Benefit cost ratio (BCR)
T_1-Control	33870.00	20640.00	1230.00	1.64
T_2=RDF N25% from PL	52715.00	20942.70	31772.30	2.52
T_3=T2+75%RDF	99115.00	23575.70	75539.30	4.20
T_4=RDFN50% from PL	76385.00	21245.40	55139.60	3.60
T_5=T4+50% RDF	106775.00	23000.74	83774.26	4.64
T_6=RDF N75% RDF from PL	79810.00	21548.10	58261.90	3.70
T_7=T6+25%RDF	100585.00	22425.77	78159.23	4.48
T_8=RDF N 100 from PL	97775.00	21850.80	75924.20	4.47
T_9=T8+100%RDF	87560.00	25361.46	62198.54	3.45
T_{10}= RDF (sole)	95660.00	24150.66	71509.34	3.96

Input cost: Urea = Tk. 6.30/ kg, TSP= Tk 18.00/ kg, MoP= Tk. 11.40/kg,Gypsum= Tk. 6.00/kg, Jute seed= Tk.80/ kg,Poultry litter = 0.30/ kg, Per labour wage = Tk 112.00/day Output price: Fibre= Tk 23.50/kg, Stick= Tk 2.50/kg,

Table 10.8: Cost and return analysis due to poultry litter application at Kishoreganj 2007-2008

Treatments	**Gross return (Tk/ha)**	**Variable cost (Tk/ha)**	**Gross margin (Tk/ha)**	**Benefit cost ratio (BCR)**
T_1-Control	39279.00	20700.00	18579.00	1.90
T_2=RDF N25% from PL	57021.00	21268.19	35752.81	2.68
T_3=T2+75%RDF	106753.00	24925.69	81827.31	4.28
T_4=RDFN50% from PL	82754.50	21836.38	60918.12	3.79
T_5=T4+50% RDF	115660.00	24274.71	91385.29	4.76
T_6=RDF N75% RDF from PL	86329.00	22404.57	63924.43	3.85
T_7=T6+25%RDF	108800.00	23623.74	85176.26	4.60
T_8=RDF N 100 from PL	104084.00	22972.76	81111.24	4.53
T_9=T8+100%RDF	92736.50	27849.76	64886.74	3.33
T_{10}= RDF (sole)	103412.00	25577.00	77835.00	4.04

Input cost: Urea = Tk. 11.60/ kg,TSP= Tk 18.00/ kg, MoP= Tk. 16.50/kg,Gypsum= Tk. 6.00/kg , Jute seed= Tk.90/ kg,Poultry litter = 0.50/ kg, Per labour wage = Tk.112.00/day Output price: Fibre= Tk 25.50/kg, Stick= Tk 2.50/kg,

Table 10.9: Avrage 4 years Cost and return analysis due to poultry litter application at Kishoreganj 2004-2009.

Treatments	**Gross return (Tk/ha)**	**Variable cost (Tk/ha**	**Gross margin (Tk/ha)**	**Benefit cost ratio (BCR)**
T_1-Control	32294.75	16860.00	15434.75	1.92
T_2=RDF N25% from PL	47746.50	17234.78	30511.72	2.77
T_3=T2+75%RDF	91214.50	20016.00	71198.50	4.56
T_4=RDFN50% from PL	71124.88	17881.51	53243.37	3.98
T_5=T4+50% RDF	99651.25	19735.64	79915.61	5.05
T_6=RDF N75% RDF from PL	74344.75	17984.36	56360.39	4.13
T_7=T6+25%RDF	94143.75	18911.43	75232.32	4.97
T_8=RDF N 100 from PL	88962.25	18359.15	70603.10	4.85
T_9=T8+100%RDF	81234.12	22067.50	59166.62	3.68
T_{10}= RDF (sole)	88478.00	20568.36	67909.64	4.30

Benefit cost ratio recorded higher with all the treatments over the control (T_1). Considering the benefit cost ratio treatments may be arranged at Manikganj in the order of $T_5>T_7>T_8>T_3>T_6>T_{10}>T_9>T_4>T_2>T_1$ and at Kishoreganj $T_5>T_7>T_8>T_3>T_{10}>T_6>T_4>T_9>T_2>T_1$. The integrated treatments displayed higher benefit cost ratio in comparison to sole application of poultry litter. Study noticed that all the integrated treatments showed beneficial for jute cultivation.

CHAPTER 5

GENERAL DISCUSSION

Growth and yield

From the average results at Manikganj site it appear (table 3.4) that the tallest plant (3.14m), highest base diameter(16.69mm), yield of fibre (3.61 t/ha) and stick (7.77 t/ha) were obtained with the integrated treatments T_5 (RDF N 50% from PL +50%RDF) and lowest with T_1-Control (Without fertilizer). The yield of green plants with (66.46 t/ha**)** and without leaves (56.34 t/ha**)** was recorded highest with T_7 (RDF N 75% from PL + 25% RDF).

Results for Kishoreganj site showed that the maximum height of the plant (3.23 m), base diameter (17.25 mm), yield of fibre (3.64t/ha) and stick (8.29 t/ha) were achieved also with T_5. But the yield of green plants with leaves (68.25 t/ha) and green plants without leaves (58.16 t/h) were found with T_9 (RDF N 100% from PL+ 100%RDF). Among the sole poultry litter treatments, the highest dose T_8 (RDF N 100 % from PL) contributed maximum growth and yield contributing characteristics which was also over the T_{10} (Sole RDF application). But highest integrated dose T_9 (RDF N 100 % from PL +100% RDF) showed a decreasing rate of the yield of fibre and stick compared to other integrated treatments T_3 (RDF N 25% from PL + 75%RDF), T_5 (RDF N 50% from PL +50%RDF), T_7 (RDF N 75% from PL + 25% RDF) and T_{10} (Sole RDF). On the basis of fibre yield production the treatments may be arranged in the order $T5>T_7>T_3>T_8>T_{10}>T_9>T_6>T_4>T_2>T_1$. The treatments of poultry litter with or without inorganic fertilizer increased the yield of jute over control. Findings indicate that combined use of poultry litter and inorganic fertilizer is better for obtaining higher yield. These observations are in agreement with the findings of the following scientists:

Gani *et al.,* (1999) observed that the average data for plant height, yield of green plants and fibre of jute were significantly different between poultry litter incorporation and control. Arunah *et al.,* (2006), Yayock and Awoniyi(1974) found that poultry manure was superior in promoting growth, highest grain and stalk yield of sorghum. Charls *et al.,* (2005) stated that application of broiler litter resulted in higher rate of plant height and 30 to 50% cotton lint yield. Giardini *et al.,* (1992) reported an increased yield of onion bulbs due to poultry manure, which produced yields of more than 35 t ha^{-1}. Oikeh and Asiegbu, (1993) obtained highest tomato growth and yields with poultry manure. Jayanthi (1995) reported that application of poultry manure resulted higher plant height, grain and straw yield of rice. Nakamoto *et al.,* (1994) reported that application of 25% recommended commercial fertilizer with 75% poultry manure was superior and concluded that poultry manure has potential for supplementing or replacing inorganic fertilizer in sweet corn production. Obi and Ebo (1995) found that average maize grain yield was significantly improved due to 100% poultry manure and also with 50% poultry manure + 50% inorganic fertilizer. Ayeni and Adetunji, (2010) also reported

that integrated use of poultry manure and mineral fertilizer increased plant height, grain yield, stover yield and root dry matter of maize crop.

Supreme dose of poultry litter and inorganic fertilizer treatment T_9 produced the lower growth and yield but enhanced the green plant yield at Kishoreganj. This could be related to the findings that excessive nitrogen and manure application to reduce fruit number and yield but enhances green plant yields of pepper (Fowzy *et al.,* 2012). Oyewole and Mera, 2010 also observed increased green plant of roselly *(Hibiscas sabdariffa* L.*)* due to excessive nitrogen and manure application. Olasantn (1991) also found that fruit yield of tomato plant was reduced at higher N application rates. The present findings in T_9 are a case of nutrient imbalance in jute with a large N supplied from poultry litter and inorganic fertilizer.

Ali *et al*., (2009) reported that in a Cauli flower- Stem amaranthus-Jute cropping pattern the highest jute fibre yield was obtained with 50% chemical fertilizer + 50% poultry manure and 100% poultry manure (equal to RDF N) and concluded that this combination is also promising for jute cultivation. Present findings showed higher yield with integrated use of poultry litter and inorganic fertilizer application. It can be said that the addition of NPK fertilizer to poultry manure aided mineralization of nutrients in poultry manure that resulted in enhanced supply of nutrients, resulting for higher plant growth and yield. This study agrees with the findings of Makinde *et al*., (2001) who reported that the most satisfactory method of increasing maize yield was by a judicious combination of organic wastes and inorganic fertilizer. Qian and Schoenau (2002), and Okwugwu and Alleh (2003) reported that high and sustained crop yield could be achieved with a judicious and balanced NPK fertilizer treatments combined with organic matter amendments. Ayoola and Adeniyan (2006) reported that nutrients from mineral fertilizers enhance the establishment of crops, while those from mineralization of organic manure promoted yield when both fertilizers were combined. The combined application also increased tomato fruit yield compared with pig manure or NPK fertilizer treatments alone (Giwa, 2004). Adeniyan and Ojeniyi (2005) also observed that integrated application of poultry manure and NPK fertilizer increased maize yield compared with poultry manure or fertilizer application alone.

The total dry matter yield of jute

All the poultry litter treated plots whether sole application or combined with inorganic fertilizer progressively increased total dry matter yield of jute and lowest with control. Total dry matter was significantly superior with T_7 (RDF N 75% as PL+ 25% RDF) at Manikganj and with T_9 (RDF N 100% from PL+100% RDF) at Kishoreganj respectively where maximum green plants yield with and without leaves were obtained. Increasing rates of poultry litter applications resulted in significant increase of dry matter yield. The integrated treatments produced higher amount of total dry matter compared to sole application of litter. The results are consistent with the findings of those Girma *et al.*, (2005) who also attained total dry matter yield of cowpea significantly superior with poultry manure treated soils over the control. Hossain *et al.,* (2012) found higher rate of total dry matter of maize crop with same nature of treatments, poultry manure

alone and 25% NPK +75% poultry manure. Haruna *et al.,* (2011) reported higher yield of Sesam (*Semaum indicum* L.) with different levels of poultry manure application alone or in combined with mineral fertilizer. He also obtained the maximum dry matter with integrated combination dose of poultry manure, nitrogen and phosphorus (15 t/ha PM, 60 Kg N/ha and 23.20 Kg P /ha).

Effect of Poultry litter on the nutrient content of various plant parts and uptake of nutrients by the jute plant

Results showed that application of poultry litter with and without inorganic fertilizer at different combinations caused significant changes in nutrient contents and uptake at both the places. All the treatments showed higher nutrient content and uptake over control. Effect of poultry litter on nutrient content in different parts of jute plants was pronounced.

At Manikganj site the nutrient NPK and S content of leaves varied between 2.05 to 2.58%, 0.31 to 0.55%, 1.60 to 2.56% and 0.09 to 0.17%. Average nutrient content of NPK and S observed in shoot was lower than leaves but higher than that in roots. The ranges of NPK and S in shoot were 0.56 to 1.34%, 0.15 to 0.27%, 0.88 to1.23% and 0.06 to 0.13%. In root it was 0.40 to 0.87%, 0.21 to 0.41%, 0.51 to 0.67% and 0.05 to 0.07% with different treatments. Highest content of N (2.58%) and K (2.56%) were found in leaves with T_7 but P (0.55%) and S (0.17%) with T_9 over T_{10} (Sole RDF) which exhibits a marked variation.

At Kishoreganj site the nutrient NPK and S content in jute with leaves ranged from 2.08 to 2.56%, 0.34 to 0.56%, 2.08 to 2.57% and 0.06 to 0.073%. Average nutrient content of NPK and S in shoot were lower than that in the leaves but higher than roots. The ranges of NPK and S in shoot were 0.79 to 0.94%, 0.26 to 0.39%, 0.80 to1.53% and 0.045 to 0.056%. In root it was 0.39 to 0.48%, 0.15 to 0.24%, 0.52 to 0.82% and 0.03 to 0.072% with different treatments. In leaves, the highest content of N (2.56%), P (0.56%), K (2.57%) and S (0.073%) were found with T_9 (RDF N 100% from PL +100%RDF) over the T_{10} (Sole RDF).

The uptake of nutrients was found to be the highest with integrated treatment T_9 (RDF N 100 % from PL +100% RDF) at both the locations Kishoreganj and Manikganj.

At the Kishoreganj, amount of uptake of N was -255.27 kg/ha, P -90.16 kg/ha, K-310.04 kg/ha and S-14.19 Kg/ha. At the Manikganj site the uptake of N was -206.89 kg/ha, P -64.78kg/ha,K-275.52 kg/ha and S-23.28 Kg/ha. Uptake of K was higher than N in T_9. The uptake of nitrogen at Kishoreganj was in the range of 72.29 Kg N/ha to 255.27 kg N /ha, P-20.48 kg/ha to 90.16 kg/ha, K-74.37 kg/ha to 310.04 kg/ha and S-3.99 kg/ha to 14.19 Kg/ha. Nutrient uptake range at Manikganj was N -100.38 Kg/ha to 206.89 kg/ha, P -13.13 kg/ha to 64.78kg/ha,K-62.36 kg /ha to 275.52 kg/ha and S-4.53 kg/ha to 23.28 Kg/ha. The range indicates that the Kishoreganj site soils are more fertile than the soils of Manikganj site soils. These findings are in consent with the following research workers:

Akanni, (2005) obtained incremental N P K Ca and Mg content and uptake by tomato and its leaves due to application of poultry manure. Alam (2007) found similar nutrient concentration and uptake in different plant parts of jute with

combined use of organic and inorganic fertilizer. Adeniyan and Ojeniyi (2005) reported that the increased availability of nutrients due to application of poultry manure expectedly led to increased content and uptake of NPK Ca and Mg in Maize plant. The nutrient concentration in plant parts and uptake by Jute plant which is presented in this study is comparable to other research on cotton by Tewolde *et al.,* (2005). Olasantan (1991) observed poultry litter increased uptake of NPK and S by tomato plant. Ayeni *et al*., (2008) showed that poultry manure increased uptake of N, P, K, Ca, Mg, Zn, Fe and Cu by maize grown. This is consistent with the present study that poultry litter enhanced nutrient uptake (status) of jute in addition to increasing nutrient status in soil.

Soil chemical properties

Generally the pH of the treated soil with poultry litter was found neutral to slightly acidic, which agreed with the results of Lopwez- Masquera *et al.,* (2008) on the pH of chicken manure applied soil.

There was a general increase in soil organic carbon and other nutrients with the application of poultry litter compared to the inorganic fertilizer and control. Soil organic carbon tended to be higher because the poultry litter was applied continuously for four years.The higher contents of N, P, K, S, Zn and B in the treated soil were found as the high organic carbon contents were observed. This agreed with the report of Grich (1990) that organic manure is a store house of plant nutrients and contributor of major and minor elements which plays a key role in sustaining desirable soil physical condition. Soil organic matter was enhanced with the application of poultry litter with or without inorganic fertilizer and decreased with sole inorganic fertilizer application. Results are in agreement with findings of Ullah *et al.,* (2008) from a field study that soil organic matter was decreased by sole chemical fertilizer application but was increased with all types of poultry manure application and that was recorded the highest was recorded with combined application. The result is further supported by the findings of Wells *et al.,* (2000).

The C/N ratio was lower in applied poultry litter which was probably due to higher mineralization rate of C or higher N contents in the PL. Study showed narrower C/N ratio with the treated plots compared to T_1(Control). Titiloye (1992) stated from his experience that low C/N ratio have faster decomposition of poultry manure and thereby enhanced more and quick release of N, P and other nutrients. He also observed lower C/N ratio with combined poultry manure and inorganic fertilizer than sole poultry manure application and control (T_1). Similar observation was made by Yadav, and Jha, (1988).

In this study an increase in N levels (10.76-29.23%) at Manikganj and (13.52-23.08%) Kishoreganj with respect to control were observed. Similar result was found to Chescheir *et al.,* (1986) who observed 17-38% N increase over control due to addition of chicken manure in a sandy loam soil.

The results of present study indicated increased available P with application rate of poultry litter. This is because concentration of P in soils is influenced by, besides the mineralogical composition of the parent material, anthropogenic

sources like addition of fertilizers and poultry manure (organic matter) to improve soil fertility (Brady and Weil 1996; Duncan 2005; Agbede *et al*., 2008). There were significant increases of available P with increasing application rate due to the addition of the poultry litter in all treated plots. In all cases the results shows substantial gains for the available N and P with the addition of poultry manure. Statistical analysis showed that increase of P and N concentration due to poultry manure addition was significant at 5% and 1% levels. This is in agreement with another study (Adeniyan and Ojeniyi, 2005) where P was significantly increased by poultry manure application. The exchangeable K also increased significantly with the applied poultry litter both at Manikganj (18.18-45.45%) and Kishoreganj (1.66-29.16%) over initial soil value. A similar observation was made by Kingery *et al.,* (1993) who reported that using of poultry manure improves the content of K in soil. Duncan, (2005) also stated, if applied, poultry litter acted as a good soil amendments and increased the presence of K in soil. The rate of S also increased with the poultry litter incorporation is this work. These findings are in conformity with the observation of the research workers Ayeni (2011) and Mba and Anikwes (2000) who also observed that combined use of poultry manure and mineral fertilizer increased S content in soil. The micronutrient Zn and B were increased with the addition of poultry litter. Ayeni and Adetunji (2010) conducted a field experiment and found increased micronutrient Zn, B and Mn with poultry manure, they also reported higher rate of micronutrient obtained with the combined incorporation of poultry manure and NPK fertilizer. The results micronutrient was in this study are also in line with that observed by Kayodi and Agboola (1983).

The increased levels of various nutrients are due to the richness of the poultry manure with the nutrient elements studied. The status of Pb and As were not statistically increased and found below the allowable limit as the poultry litter used in the experiment contained very low amount of Pb and As.

Peryea and Kammereck (1997) suggested that the continued land application of As or heavy metal containing (above critical range) poultry litter could be detrimental to soil. Mamun (2007) observed that there was very little concentration of As (below allowable limit) in soil with the different level of poultry manure application (5 to 10 t/ha PM) during the production of Kalmi sak, rather he found that for any concentration of As in soil, the poultry manure /cow dung application in soil decreased the As accumulation in roots and shoots of Kalmi. The probable cause may be that the As forms stable complex with organic matter.

Findings revealed that N, P, K and S progressively increased with the addition of poultry litter and integrated use of poultry litter and inorganic fertilizer and a decreased trend was observed with sole inorganic fertilizer application. Babul *et al.,* (2007) observed similar trend of upgraded nutrient status after harvest of sugarcane with the integrated application of poultry manure along with inorganic fertilizer.

The present study indicated that poultry litter is a good contributor to soil fertility and no adverse effect occurred in soil by the use of poultry litter as it contained an in significant of Pb and As. It becomes clear that the source of poultry litter is important before it is applied to soil.

Effect of poultry litter on post harvest soil physical properties

Compared with control and initial soil value, the application of poultry litter and combined effect of poultry litter +NPKS fertilizer improved soil physical conditions. Yearly application of poultry litter had cumulative positive effect on soil physical properties. At both sites of study this is confirmed by the fact that soil bulk density reduced while pore space, particle density and maximum water retentive characteristics increased with poultry litter treated plots. Poultry litter also reduced the percent of sand and increased the percent of silt and clay. The cumulative effect of poultry litter on soil physical properties could be related to the observation of Gupta *et a*l., (1997) about poultry litter who mentioned that it is very rich animal manure and causes considerable increase in soil OM. As because positive influence of OM (poultry litter) the physical properties were progressively improved. The poultry litter contributed to was manure and led to improvement of soil physical properties. It has stabilized soil structure thereby reducing soil bulk density, increasing pore space, and infiltration rate and water retention. The increased pore space and water retention have enhanced root growth, water and nutrient uptake, apart from the fact that nutrient released from poultry litter had direct effect on growth and yield of jute.

Incorporation of poultry litter also improved the soil textural class by reducing the percentage of sand. The lowest of sand at Kishoreganj was recorded at T_5 (20%) and T_7 (20%). Integrated use of poultry litter and inorganic fertilizer performed better than sole application of poultry litter and inorganic fertilizer. These findings are evidence that poultry litter favored to improve soil physical properties. The favorable soil physical condition adduced to poultry litter is consistent with earlier findings of Weil and Kroontye (1979); Khaleel *et al*.,(1981); Paglil *et al.,(*1987), Mbagwu(1987,1992), Obi and Ebo,(1995) and Akanni *et al*., (2005)

Effect of poultry litter on bacterial population of post harvest soil

Average four years result of bacterial population due to incorporation of poultry litter at Manikganj and Kishoreganj showed that it has affected significantly the bacterial population. The bacterial population increased with all the treated plots compared to initial soil value (tables 8 and 8.1) and control.

This result was in the line with the results of Maguire *et al*. (2006) and reported that application of poultry litter to soil increased the bacterial population which are also responsible for soil fertility. In this study, as poultry litter was applied bacterial population was increased which ultimately caused better mineralization and nutrient release. This indicates that no significant toxicity effect occurred due to poultry litter application. The present findings are in the agreement with those of Kaur *et al*., (2005) who observed the same results that received poultry litter for 7 years.

Cook and Allen (1992) reported that the soil microbial biomass and soil respiration become high in poultry litter amended soil may have been due to a greater labile fraction of organic matter and the labile fraction of organic matter is

most degradable and therefore, the most susceptible to mineralization which act as an immediate energy source for bacteria causing a greater proliferation of the bacterial population. Marin,(2004) reported, that higher N and P content in poultry litter and inorganic fertilizer when combinedly use in soil , the nutrients might have increased quantity of soil bacteria. The results also agreed with Alam (2007) who found highest population of bacteria with integrated organic manure and chemical fertilizer and least with control.

Effect of poultry litter on fibre quality

Fibre quality is an important factor while producing jute for marketing purpose. Lusture, fineness and bundle strength are the primary parameters for the jute quality assessment. High value lusture and bundle strength and low value fineness are considered as good quality fibre.

The results at both the sites showed that the application of poultry litter sole or with inorganic fertilizer caused significant changes on the lusture, fineness and bundle strength every year. Among the treatments lowest performance was observed with T_1. Results pointed out that all the treatments increased the different parameters of fibre quality over T_1 and integrated treatments performed better at Kishoreganj. From the results of Manikganj and Kishoreganj it become evident that integrated treatments enhanced the fiber quality compared to sole application of poultry litter and inorganic fertilizer.

Sheikh *et al*., (2004) observed improved quality of various components of mustard crop with poultry manure.

Tewolde *et al.,* (2007) found increased fibre quality of cotton with broiler litter. They observed significant effect of broiler litter alone or combined with mineral N on the quality parameter of cotton such as fibre length, strength, micronaire (measures fibre fineness), color(lusture) and other quality characteristics. Similar findings of different quality parametrs of cotton with broiler litter was reported by Sistani *et al., (*2004). Pimpini *et al*., (1992) observed that addition of poultry manure and mineral fertilizer enhanced the quality parameters of onion, potato and tomato.

Present findings are also supported by the observation of Gani *et al*., (2002), who found increased physico- mechanical characteristics (quality of fibre) of jute fibre with the application of water hyacinth (organic source) over the chemical fertilizer and control. They also reported highest quality of fibre obtained with joint application of water hyacinth and chemical fertilizer.

Similar observation was made by Taher *et al*., (2009). They found the highest lusture value (22.10%) and bundle strength (10.40 ibs/mg) with rice straw 5 t/ha + ½ dose of chemical fertilizer over control and sole chemical fertilizer application. Finest fibre (33.20µ) was found with the rice straw 3 t/ha + ½ RDF treatment.

The present results also indicate that the sole chemical fertilizer application may not be possible to maintain the quality of fibre, it may be needed to an integration of organic matter and chemical fertilizer application in soil to enrich the fibre quality.

Study indicates that the application of poultry litter improved the different physico-mechanical properties of fibre quality *viz.* lusture, fineness and bundle strength. It is the general agreement that higher value of lusture, bundle strength and lower value of fineness indicate super grade of fibre which was found due to poultry litter incorporation. Integrated treatments showed improve fibre quality than sole application of poultry litter and inorganic fertilizer. Study revealed

that utilization of poultry litter along with inorganic fertilizer is a good technique to obtain quality fibre. The present findings has ushered a new approach for ascertaining quality of fibre.

The present work confirms that poultry litter when used with inorganic fertilizer ensures availability of nutrients including micronutrients. Also the need for inorganic fertilizer can be reduced for jute production. Utilization of poultry litter acted as improver of soil physical and biological condition. Present work also shows that use of poultry litter with inorganic fertilizer was more effective in terms of fibre quality and fibre performance.

Mean of four years cost and return analysis showed that benefit cost ratio (BCR) was higher with the fertilized treatments over the control (T_1). The highest BCR was obtained with T_5 (RDF N from PL + 50% inorganic fertilizer). The 2nd highest value was recorded for T_7 (RDF N 75% from PL +25% inorganic fertilizer). Integrated treatments of poultry litter and inorganic fertilizer contributed higher BCR compared to single application either of poultry litter or inorganic fertilizer. Results indicates that T_5 (RDF N 50% from PL +50% RDF) is optimum dose for jute to get a good return. Taher *et al.,* (2009) reported that 50% N as rice straw and 50% inorganic fertilizer gave highest benefit cost ratio of jute. The result is in consistent with Anonymous (2005-06), it stated that 50% inorganic fertilizer along with 50% poultry manure gave highest BCR in cauliflower- stem amaranth- jute copping pattern.

It is recommended to use the integrated doses: T_7 (RDF N 25% from PL +75% RDF), T_5 (RDF N 50% from PL+50% RDF) and T_3 (RDF N 25% from PL + 75% RDF) of maximum benefit for jute cultivation.

CHAPTER 6

Summary and conclusion

Low organic matter content remains prime constraints to sustainable agricultural production of Bangladesh. Moreover occasional fertilizer crisis and price hike impair crop production.

The conventional sources of organic materials such as cow dung, rice straw, wheat straw, husking materials, tree leaves, weeds etc. which could build organic matter in soil are being used as fuel, fodder and other purposes. For these reasons addition of organic materials to soil through farmyard manure, compost and organic residues has been reduced considerably even though there is a little or no opportunity for green manuring practices due to intensive cropping pattern. But there is a scope to use other non conventional sources of organic materials such as poultry litter, sewage sludge, city waste compost, industrial waste, saw dust, forest litter and kitchen garbage etc. Among these, poultry litters most available and a huge accumulation in Bangladesh and poultry industry is gradually increasing day by day science 1980 which is extended in rural areas rapidly. Under such a situation, an attempt has been made to supplement the nutrients through poultry litter use on jute crop in two important Agro Ecological Zones (AEZ) of Bangladesh. These are Young Bramahputtra and Jamuna Floodplain (AEZ-8) and Old Bramahputtra Floodplain (AEZ-9). The location of the sites were Central Research Station, Manikgnj and Kishoreganj Regional Station of Bangladesh Jute Research Institute.Experiments were carried out at both the sites during the year 2004-05 to 2007-08 under Sonatala and Silmondi soil series of Bangladesh.

The soil of the Manikganj experimental field represents the Non Calcareous Grey Flood Plain Soil(General Soil Type) which belongs to Agro Ecological Zone No.8(Young Bramahputtra and Jamuna Floodplain)and the soil of Kishoreganj field is Dark Gray Floodplain soils (General Soil Type) under Agro Ecological Zone No.9(Old Bramahputtra Floodplain). The treatments were T_1- Control (Without fertilizer), T_2-RDF N 25% from poultry litter(PL), T_3-RDF N 25% from PL + 75% RDF, T_4-RDF N 50% from PL, T_5-RDF N 50% from PL +50% RDF, T_6-RDF N 75% from PL, T_7-RDF N 75% from PL + 25% RDF, T_8-RDF N 100 % from PL, T_9- RDF N 100 % from PL +100% RDF and T_{10}-Sole RDF(Recommended dose of inorganic fertilizer N_{90}-P_{10}-K_{30}-S_{20} Kg^{-ha} respectively). The objectives of the research work were**:** (1) to study the effect of poultry litter on the growth and yield of jute. (2) to study the effect of poultry litter on soil properties(physical ,chemical and biological) (3) to study the effect of poultry litter on the reduction of chemical fertilizer for jute cultivation.(4) to study the integrated effect of poultry litter and inorganic fertilizer on fibre quality and (5) to make a integrated fertilizer recommendation for jute crop.

The experiments were laid out in a randomized block design having three replications. It was conducted in kahrif-1 season. The fertilizer doses were determined by soil chemical test basis and of the fertilizer recommendation guide (2005) was used to calculate the amount required. Fertilizer was applied to the soil according to treatment design. During

the study weeding, thinning and all the intercultural practices were done properly as and when necessary. After 120 days of sowing jute plants were harvested.

The initial soil samples and post harvest soil samples were collected (each year) and processed for physical, chemical and microbiological analysis. The plant samples were taken every year for determining the dry matter production, nutrient content in different parts of jute plant and nutrient uptake capacity. The findings showed that application of graded doses of poultry litter increased the different growth parameters such as plant height, base diameter and yield of jute significantly. The integrated dose of poultry litter and inorganic fertilizer produced higher rate of plant height, base diameter, green weight with and without leaves, yield of fibre and stick over the sole application of poultry litter and recommended dose of inorganic fertilizer.

The tallest plant, highest base diameter, yield of green plants, fibre and stick was found with the integrated treatments T_5 (RDF N 50% from PL +50% RDF) and lowest with T_1-Control (Without fertilizer). Among the sole poultry litter treatments, the highest dose T_8 (RDF N 100 % from PL) contributed maximum growth and yield contributing characteristics which was also over the T_{10} (Sole RDF application). But highest integrated dose T_9 (RDF N 100 % from PL +100% RDF) showed a decreasing rate of growth and yield parameters compared to other integrated treatments T_3 (RDF N 25% from PL + 75% RDF), T_5=RDF N 50% from PL + 50%RDF and T_7 (RDF N 75% from PL + 25% RDF) and T_{10} (Sole RDF). On the basis of the observations the treatments may be arranged in the order of $T_5>T_7>T_3>T_8>T_{10}>T_9>T_6>T_4>T_2>T_1$.

At both the sites the total dry matter production in jute over time was influenced by different levels of poultry litter and was statistically significant. Leaves, shoot and roots were considered as different parts of jute plant to estimate the total dry matter of jute plants. All the plots treated with or with out poultry litter increased the total dry matter yield of jute over control. Highest dry matter accumulation was obtained at Manikganj (20.54 t/ha) and at Kishoreganj (23.08 t/ha) with T_9 (N 100% RDF from PL+100% RDF) where maximum green plants yield with and without leaves were obtained. The other integrated treatments also produced near about equal amount of total dry matter were found withT_7 and T_9 which is statistically similar. Sole application of poultry litter treatment T_8 (N 100% RDF) also contributed good amount as compare to sole inorganic fertilizer application T_{10} (Sole RDF).

Effect of poultry litter on nutrient content in different parts of jute plants was pronounced. Higher rate of NPK and S content found in leaves than the shoot and root in all the treatments.

In Manikganj site the nutrient content in leaves was found highest, N (2.58%) and K (2.56) with T_7 as well as P (0.55%) and S (0.17%) with T_9 respectively .In shoot the highest content of N (1.34%) and P (0.27%) found with T_3, K (1.23%) and S (0.13%) with T_9. In the root foud the highest content N (0.87%) with T_4, P (0.41%) was with T_8, K (0.67%) with T_9 and S (0.07%) with T_7. At Kishoreganj site the highest content of nutrients in leaves such as N (2.56%), K (2.57%) and S(0.073%) were found with T_9. Both the treatments T_7 and T_9 gave the highest P (0.56%) in leaves. The highest nutrient

content in shoot like N (0.94%), P (0.39%), K (1.53%) and S (0.056%) were with T_9. The uptake of nutrients were to be the found highest with integrated treatment T_9 (RDF N 100 % from PL +100% RDF) at both the locations. At Kishoreganj, the highest amount of uptake of N -255.27 kg/ha, P -90.16 kg/ha, K-310.04 kg/ha and S-14.27 Kg/ha were in T_9. At Manikganj site the highest uptake of N -272.60 kg/ha, P -64.78kg/ha, K-275.52 kg/ha and S-23.28 Kg/ha with the same treatment T_9. Uptake of K was higher than N in T_9. The uptake of nitrogen at Kishoreganj was in the range of 72.29 Kg N/ha to 255.27 kg N /ha, P-20.48 kg/ha to 90.16 kg/ha, K-74.37 kg/ha to 310.04 kg/ha and S-3.99 kg/ha to 14.19 Kg/ha. Nutrient uptake range at Manikganj was N -100.38 Kg/ha to 272.60 kg/ha, P -13.13 kg/ha to 64.78kg/ha,K-62.36 kg /ha to 275.52 kg/ha and S-4.53 kg/ha to 23.28 Kg/ha.

Addition of poultry litter increased bacterial population with all the treated plots compared to initial soil value. Bacterial population was found higher with the integrated treatment of poultry litter and inorganic fertilizer than sole inorganic fertilizer and poultry litter application. Highest population was found with T_7 (RDF N 75% as PL + ¼ RDF) both at Kishoreganj (56 X 10^5) and Manikganj (59 X 10^5). Among all the treatments, the control plot T_1 (with out fertilizer) showed the minimum count of bacterial population over treated plots. The results revealed that poultry litter significantly improves the bacterial population.

Poultry litter enhanced the soil nutrient status. The organic matter content in the soil was very low in the control. It was significantly increased in the soils treated with poultry litter. The treatments with either both sole poultry litter or integrated, increased OM, N, P, K and S over initial nutrient status. The status of Pb, B and As increased slightly which was statistically not significant and quite below to the allowable limit. Narrower C/N ratio was found in the treated plots. The range of C/N ratio in the treated plots was 9.45 to 9.71 at Manikganj, and the largest (9.89) was with the control T_1. In the site of Manikganj the highest OM (1.39%), N (0.084%) were found with T_5 (RDF N 50% as Pl+50% RDF), K (0.16meq/100g), S (10.43ppm) and Zn (0.72ppm) with T_7 (RDF N 75% from PL+25% RDF) but P (15.50ppm) with T_9 (RDF N 100% from PL+100%RDF). In the experimental site at Kishoreganj the range of C/N ratio was 9.61 to 9.88 with the fertilized plot and the maximum (9.93) was with unfertilized T_1 (control). At Kishoreganj site the highest OM(1.52%), N(0.090%), K(0.155meq/100g), S(16.32ppm) were found with T_7 and Zn(0.729ppm) with T_9 where as P(24.50ppm) was found with T_4 (RDF N 50% from PL). Study indicated that poultry litter is a good contributor to soil fertility and no adverse effect occurred due to the presence of Pb and As in the poultry litter.

Poultry litter improved soil physical properties by reducing soil bulk density and increasing pore space, particle density and maximum water retentive characteristics over initial soil value at both sites. Incorporation of poultry litter also improved the soil textural class by reducing the percentage of sand. The maximum reduction of soil bulk density was found with T_7 (RDF N 75% from PL + 25%RDF) in 0-15 cm depth at Kishoreganj (1.09 g/cm^3) while the initial soil value was 1.41 g/cm^3 and at Manikganj site the value was decreased to 1.16 g/cm^3 from 1.45 g/cm^3. The highest particle density (2.78g/cm^3) and maximum water retentive characteristics (45.10V %) at Kishoreganj site was found with T_7 and

pore space (58.95%) with T_9 (RDF N 100 % from PL +100% RDF). At Manikganj site the pore space (57.35%) and particle density (2.72 g/cm^3) were found to be the highest with T_7 and the maximum water retentive characteristics(41.35 V%)with T_9. The present study has shown that poultry litter acted as a good conditioner for improving the soil physical, chemical and biological properties.

Application of poultry litter improved the different physico-mechanical parameters of fibre quality *viz:* lusture, fineness and bundle strength of jute. It is the general agreement that higher value of lusture, bundle strength and lower value of fineness indicate super grade of fibre. The lusture and bundle strength were increased and fineness reduced with all the treatments over control. Integrated treatments showed improved fibre quality than sole application of poultry litter and inorganic fertilizer. Best quality fibre was found at both the sites.

Benefit cost ratio was recorded higher with all the treatments over control. The integrated treatments displayed higher benefit cost ratio in comparison to sole application of poultry litter. Mean of four years cost and return analysis showed that the highest gross return, gross margin as well as benefit cost ratio was obtained with T_5 (RDF N 50% from PL + 50%RDF) and lowest with control T_1. The maximum benefit cost ratio for Manikganj was 5.20 and for Kishoreganj it was 5.05 respectively. Study focused that all the integrated treatments are economically beneficial for jute cultivation.

Suggestions

It could be suggested from the experiment that whereever possible poultry litter should be given priority to be used in jute cultivation as there is scarcity of cow dung in the country. However, further field trials are needed with other jute varieties and allied fibre crop Kenaf and Mesta in different AEZ in Bangladesh. Moreover, the possibility of toxic element and heavy metals addition are also underlined.

Conclusions

From the above findings the following conclusion are made:

►Poultry litter incorporated with inorganic fertilizer produce taller plant and higher base diameter as compared to sole poultry litter and inorganic fertilizer incorporation.

►Yield of green plants, fibre and stick increases with incorporation of poultry litter alone or along with inorganic fertilizer as compared to control.

►The fibre quality enhances with combined use of poultry litter and inorganic fertilizer as compared to either sole application of poultry litter or sole application of inorganic fertilizer.

►Good economic return comes and 25 to 50% chemical fertilizer are saved with integrated use of poultry litter and inorganic fertilizer as compared to sole application of poultry litter or sole application inorganic fertilizer.

►Soil health is improved with combined use of poultry litter and inorganic fertilizer or only poultry litter incorporation as compare to initial soil status.

►In general, the findings of the experiments showed that poultry litter can profitably be used as a complementary source of chemical fertilizer. This will undoubtedly reduce the consumption of costly chemical fertilizer and thereby minimize the production cost of jute. As a result this will give our country an opportunity to save foreign currency by low import of chemical fertilizer.

►On the other hand various problems which it create in the environment is also reduced by the utilization in crops cultivation. Findings also pinpointed that poultry litter appears an alternative source of organic materials for crop production. The research indicates that poultry litter is a valuable fertilizer whose use needs to be encouraged.

Recommendation

In spite of the immense scope and prospectus, no systematic activities has so far been undertaken to improve the production of jute in our country. In order to bring a positive change in the production of jute, the following recommendations are made on the basis of the findings of current study:

1) In jute cultivation suggested to use are of the following integrated doses: T_3 -RDF N 25% from PL + 75% RDF (1.19 t PL / ha +75% inorganic fertilizer), T_5 -RDF N 50% from PL + 50% RDF (2.38 t PL/ ha +50% inorganic fertilizer, and T_7 -RDF N 75% from PL + 25% RDF (3.57 t PL/ ha + 25% inorganic fertilizer).
2) For maximum benefit of jute cultivation emphasis is to be given to use the treatment T_5- RDF N 50% from PL +50% RDF (2.38 t PL / ha + 25% inorganic fertilizer) is an effective dose for improving all parameters related to jute production.
3) Efforts may be given to make the farmers aware of the appropriate fertilizer management practices on jute cultivation and to provide them necessary training and other technical assistance for this purpose.
4) Jute growers should be trained on improved and proper management practices of jute so that they can effectively carryout their role on the improvement of future production target for jute.
5) Treatment: T_5 (RDF N 50% from poultry litter + 50% RDF) an effective dose for jute cultivation.
6) Research activities may be undertaken to develop fertilizer dose, method and time of fertilizer application and selection of fertilizer including other intercultural operations to increase yield per unit area.
7) Proper publicity or extension work for appropriate fertilizer management on jute is needed.
8) Attention should be given to produce and use diversified product.
9) It is needed to include jute in cropping pattern and use alternative organic materials for sustaining soil nutrients.

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Appendices

Appendix Table i: Input cost and output price of different years 2004 to 2008.

Year	Input cost							Output price	
	Fertilizer TK./Kg								
	Urea	TSP	MoP	Gypsum	Poultry litter	Jute seed TK./Kg	Per labour wage TK./day	Fibre TK./Kg	Stick TK./Kg
2004-2005	5.60	12.50	11.40	5.00	0.30	70.00	70.00	17.00	2.00
2005-2006	6.25	12.50	14.40	6.50	0.30	80.00	70.00	23.00	2.00
2006-2007	6.30	18.00	11.40	6.00	0.30	80.00	112.00	23.50	2.50
2007-2008	11.60	18.00	16.50	6.00	0.50	90.00	112.00	25.55	2.50

Source: BJRI News Letter and Annual Report, 2004 to 2008.

Appendix Table ii: Maximum allowable concentration of As, Cd, Pb and Zn in soil and irrigation water.

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Parameter	Concentration in soil *	Concentration in water mg/L **
As	5-6 mg/Kg	0.01
Cd	0.05 mg/m^3 (USA)	0.005
Pb	0.1 mg/m^3 (Germany)	2.0
Zn	35-88 mg/Kg	5.0

Source: * Kannan, 1997, ** Goel, 1997
Appendix -3

Appendix Table iii: Maximum allowable limits of different toxic metals in chemical and Organic fertilizers

SI. NO.	Toxic metal	Chemical fertilizer[1] (ppm)	Organic fertilizer[2] (ppm)
1.	Arsenic (As)	50	20
2.	Cadmium(Cd)	10	5
3.	Lead (Pb)	100	30
4.	Mercury (Hg)	5	0.1
5.	Chromium (Cr)	500	50
6.	Nickel (Ni)	50	30
7.	Zinc (Zn)	NA*	0.1
8.	Copper (Cu)	NA*	0.05

*NA: Not applicable

Source: [1]Fertiulizer (Management) Regulation, 2007; Published in Bangladesh Gazette on 30 May 2007; & [2]কৃষি মন্ত্রনালয় প্রজ্ঞাপন নং: কৃম/ উপ-২/সার-১/ ২০০৮/১৫৬; তাং: ০২এপ্রিল ২০০৮ (Ministry of Agriculture Circular noMOA/Sub-2/Fertilizer-1/2008/156 Dt.02.April 2008)

Appendix Table iv: Nutrient content in poultry litter applied in the experimental plot at Manikganj

Year	**Moisture**	**pH**	**OC**	**OM**	**Total N**	**C:N** ratio	**P**	**K**	**Ca**	**Mg**	S	Zn	B	Pb
	%		%	%	%		%	%	%	%	%	ppm	ppm	ppm
2004 to2005	20.00	7.20	19.94	34.35	2.10	9.50	0.92	0.99	1.20	0.46	1.20	166	1.00	0.97
2005 to2006	21.00	6.65	19.87	34.24	2.09	9.51	1.03	1.02	1.08	0.38	0.98	182	1.08	0.71
2006 to2007	18.00	6.70	21.30	36.70	2.24	9.51	0.98	1.20	1.10	0.40	1.15	185	1.06	0.60
2007 to2008	19.00	6.80	20.89	36.00	2.20	9.50	1.10	1.08	1.07	0.42	1.08	220	1.10	0.73
Average 4 years	19.50	6.84	20.50	35.32	2.16	9.51	1.01	1.07	1.11	0.42	1.11	188.25	1.06	0.76

Appendix Table v: Nutrient content in poultry litter applied in the experimental plot at Kishoreganj,

Year	**Moisture**	**pH**	**OC**	**OM**	**Total N**	**C:N** ratio	**P**	**K**	**Ca**	**Mg**	**S**	**Zn**	**B**	**Pb**
	%		%	%	%		%	%	%	%	%	ppm	ppm	ppm
2004 to2005	19.00	6.50	15.58	26.84	2.20	7.08	0.77	0.97	1.20	0.50	1.13	160	1.80	1.10
2005 to2006	20.00	6.20	14.75	25.41	2.10	7.02	0.99	0.98	1.09	0.49	1.62	190	1.65	0.99
2006 to2007	19.30	6.67	15.83	27.32	2.23	7.09	0.82	1.09	1.10	0.38	0.98	210	1.85	1.11
2007 to2008	18.00	7.40	14.25	24.35	1.98	7.20	0.86	0.98	0.99	0.42	2.10	155	1.20	1.00
Average 4 yers	19.08	6.69	15.12	26.00	2.13	7.09	0.86	1.01	10.95	0.44	1.46	178.75	1.63	1.05

Appendix vi. Lay out of the experiment