

**“ASSESSMENT OF UREA BRIQUETTE
APPLICATION FOR MAXIMIZATION OF RICE
YIELD AND NITROGEN USE EFFICIENCY IN
INCEPTISOL”**

M.Sc. (Ag) Thesis

By

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SOIL SCIENCE AND AGRICULTURAL CHEMISTRY**

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INDIRA GANDHI KRISHI VISHWAVIDYALAYA
RAIPUR (Chhattisgarh)**

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INCEPTISOL”**

Thesis

Submitted to the

Indira Gandhi Krishi Vishwavidyalaya, Raipur

By

NISHA YADU

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THE DEGREE OF**

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In

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CERTIFICATE - I

This is to certify that the thesis entitled “Assessment of urea briquette application for maximization of rice yield and Nitrogen use efficiency in *Inceptisol*” submitted in partial fulfillment of the degree of **Master of Science in Agriculture** of the Indira Gandhi Krishi Vishwavidyalaya, Raipur, is a record of the bonafide research work carried out by **Nisha Yadu** under my guidance and supervision. The subject of the thesis has been approved by student’s Advisory Committee and Director of Instructions.

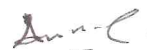
No part of the thesis has been submitted for any other degree or diploma or certificate course. All the assistance and help received during the course of the investigations have been duly acknowledged.


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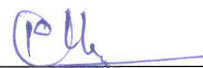
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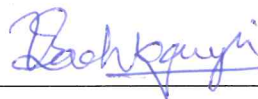
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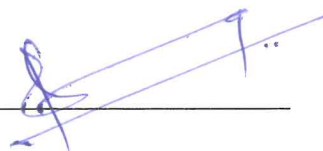
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Member (Shri Vinay Bachkaiya)



Member (Dr. Satish Verma)



Member (Dr. R.R. Saxena)



CERTIFICATE- II

This is to certify that the thesis entitled "**Assessment of urea briquette application for maximization of rice yield and Nitrogen use efficiency in Inceptisol**" submitted by **Nisha Yadu** to the Indira Gandhi Krishi Vishwavidyalaya, Raipur, in partial fulfillment of the requirements for the degree of **Master of science in Agriculture in the Department of Soil Science and Agricultural Chemistry** has been approved by the external evaluator and Student's Advisory Committee after oral examination, under the chairmanship of Head of the Department.

Date 9/11/21

Signature of Head of the Department

(Name.....Koshlendera Tedi.....)

Major Advisor

Dean/Faculty Dean

Approved/Not approved

Director of Instruction

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Nisha Yadu

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LIST OF SYMBOLS AND ABBREVIATIONS

ABBREVIATIONS	DESCRIPTIONS
%	Per cent
@	At the rate of
cm	Centimeter
dS/m	Deci Simens per meter
<i>et al</i>	Et alii (and other)
Fig	Figure
ha	Hectare
<i>i.e.</i> ,	id est (that is)
K	Potassium
kg	Kilogram
kg/ha	kilogram per hectare
m	Meter
mg/kg	Milligram per kilogram
min.	Minimum
max.	Maximum
N	Nitrogen
NH ₄ ⁺ -N	Ammonical nitrogen
NO ₃ -N	Nitrate nitrogen
NUE	Nitrogen use efficiency
cm	Centimeter
P	Phosphorus
t/ha	Tonne per hectare
°C	Degree Celsius
Viz.	Namely
UB	Urea briquette
USG	Urea super granule
SEm±	Standard error of mean

THESIS ABSTRACT

a Title of the Thesis : "Assessment of urea briquette application for maximization of rice yield and Nitrogen use efficiency in *Inceptisol*"

b Full Name of the Student : Nisha Yadu

c Major Subject : Soil Science and Agricultural Chemistry

d Name and Address of the Major Advisor : Dr. Anurag, Professor

Department of Soil Science and Agricultural Chemistry, College of Agriculture, IGKV, Raipur (C.G.)

e Degree to be awarded : M.Sc. (Ag) Soil Science and Agricultural Chemistry

Signature of the Student

Signature of the Major Advisor

Date: _____

Signature of the Head of the Department

ABSTRACT

The field experiment entitled "Assessment of urea briquette application for maximization of rice yield and Nitrogen use efficiency in *Inceptisol*" was conducted during *kharif*-2020 at Krishi Vigyan Kendra, Mahasamund, Chhattisgarh. The experiment was comprised of eight treatments involving different levels of nitrogen application through urea briquette and prilled urea viz T₁: N₀:P₆₀:K₄₀ T₂: N₇₅(UB)

T₃: N₁₀₀(PU) T₄: N₁₀₀(UB) T₅: N₁₂₅(PU) T₆: N₁₂₅(UB) T₇: N₁₅₀(PU) T₈: N₁₅₀ (UB)) and conducted in block randomized design with three replications Rice was used as test crop with cultivar “Rajeshwari”. Different nitrogen levels applied through placement of urea briquette and prilled urea broadcasted, phosphorus and potash @ 60 kg P₂O₅ ha⁻¹ and 40 kg K₂O ha⁻¹ respectively applied commonly in each plot. Data on yield and yield attributing parameters of rice crop was recorded and soil and plant samples were analyzed for various physico chemical properties.

The soil of experiment site was sandy loam in texture with pH (6.1), electrical conductivity (0.11 dSm⁻¹), organic carbon (0.41%), available N (137.98), available phosphorus (12.46) and available potassium (238.88) kg ha⁻¹.

The results of field experiment revealed that the yield and yield contributing characters of rice cultivar “Rajeshwari” were significantly influenced by different levels of applied nitrogen through urea briquette (UB) and prilled urea (PU). Application of urea briquette @ 150 kg N ha⁻¹ showed significant higher yield attributing parameters viz, plant height, effective tillers⁻¹ and number filled grains panicle⁻¹ as compared to other treatments.

Grain and straw yields of rice were significantly increased by different levels of applied nitrogen through urea briquette and prilled urea and grain yield ranged from 32.66 to 68.77 q ha⁻¹ and straw yield ranged from 38.11 to 89.87 q ha⁻¹ under treatment (T₁) N₀ to (T₈)150 kg N ha⁻¹(UB). Among different treatments, urea briquette @ 150 kg N ha⁻¹(UB) produced significantly highest grain and straw yield of rice as compared to levels of applied nitrogen 75,100 &125 kg ha⁻¹. Urea briquette induces minimum losses and higher availability of N resulted higher biomass production of the crop.

Application of different levels of nitrogen (@ 75,100,125 & 150 kg N ha⁻¹) showed significant effect on uptake of nitrogen, phosphorus and potassium by rice crop. The highest total N, P and K uptake were recorded 105.35, 19.18, 122.48 kg ha⁻¹ respectively under applied nitrogen @ 150 kg ha⁻¹ under treatment (T₈) and lowest N, P & K uptake 48.27, 7.75, 55.93 kg ha⁻¹ were obtained under treatment (T₁) N₀:P₆₀:K₄₀ respectively.

Overall nitrogen use efficiency (%) decreased with increasing levels of applied nitrogen from 125 to 150 kg N ha⁻¹. The highest NUE (39.22%) was recorded through urea briquette applied N @125 kg ha⁻¹ under treatment (T₆) and the lowest (28.67 %) noted under treatment (T₃) applied N @ 100 kg ha⁻¹ through prilled urea respectively.

After harvest of rice crop different physico-chemical properties of soil were analyzed and the findings revealed that soil pH, EC and organic carbon were not significantly influenced with levels of applied nitrogen through UB and PU. Available nitrogen content increased and phosphorus and potassium decreased in soil with increased levels of applied nitrogen irrespective UB and PU. The highest available nitrogen (180.33 kg ha⁻¹) recorded under applied N 150 kg ha⁻¹ through UB.

As per the above detailed findings it is clear that application of 150 kg N ha⁻¹ level of nitrogen applied through UB performed best yield and growth parameters of rice due to higher nutrient uptake and availability of nutrients in soil.

शोध सारांश

क) शोध का शीर्षक	: "इसेप्टीसाल में यूरिया बिकेट प्रयोग का धान की अधिकतम उपज एवं नत्रजन उपयोग दक्षता का आंकलन"
ख) छात्रा का पूरा नाम	: निशा यदु
ग) मुख्य विषय	: मृदा विज्ञान एवं कृषि रसायन
घ) मुख्य सलाहकार का नाम एवं पता	: डॉ. अनुराग प्राध्यापक इंदिरा गांधी कृषि विश्वविद्यालय, रायपुर
इ) प्रदान की जाने वाली उपाधि	: स्नातकोत्तर (कृषि) मृदा विज्ञान एवं कृषि रसायन


मुख्य सलाहकार के हस्ताक्षर


छात्रा के हस्ताक्षर

दिनांक:.....


विभागाध्यक्ष के हस्ताक्षर

सारांश

वर्तमान शोध शीर्षक खरीफ 2020 में "इसेप्टीसाल में यूरिया बिकेट प्रयोग का धान की अधिकतम उपज एवं नत्रजन उपयोग दक्षता का आंकलन" कृषक परिक्षेत्र के अन्तर्गत कृषि विज्ञान केन्द्र महासमुन्द छत्तीसगढ़ में प्रयोग किया गया था। जिसमें यूरिया बिकेट और प्रिल्ड यूरिया के माध्यम से नत्रजन स्तरों का कुल आठ उपचारों के रूप में $T_1:N_0P_{60}K_{46}$, $T_2:N_{75}(UB)$, $T_3:N_{100}(PU)$, $T_4:N_{100}(UB)$, $T_5:N_{125}(PU)$, $T_6:N_{125}(UB)$, $T_7:N_{150}(PO)$, $T_8:N_{150}(UB)$ तीन प्रतिकृतियों में याछच्छिक रूप से धान फसल किस्म राजेश्वरी का उपयोग परीक्षण में किया गया था। यूरिया बिकेट और प्रिल्ड यूरिया ब्रॉडकास्ट तथा विभिन्न नत्रजन स्तर, स्फुर और प्रोटाश @ 60 kg और 40 kg प्रति हेक्टेयर गणना कर समान रूप से सभी प्लाट्स में डाले गए। धान की फसल की उपज एवं वृद्धाकारक, मापदण्ड आकड़े एकत्रित कर

विभिन्न भौतिक रासायनिक गुणों के लिए मिट्टी और पौधों के नमूने का विषलेक्षण किया गया।

प्रयोग स्थल की मिट्टी पी.एच (6.1), विद्युत चालकता 10.11 डिस्मीमेंस पर मीटर कार्बनिक कार्बन (0.41 %) उपलब्ध नत्रजन (137:98). उपलब्ध स्फुर (12:46) और उपलब्ध पोटैश (238:88) प्रति हेक्टेयर के साथ बनावट में रेतीली दोमट पाई गई।

प्रक्षेत्र प्रयोग के परिणामों से पता चला कि धान (राजेश्वरी) की उपज और उपज में योगदान करने वाले कारक यूरिया ब्रिकेट (यूबी) और प्रिल्ड यूरिया (पीयू) के माध्यम से लागू नत्रजन के विभिन्न स्तरों से काफी प्रभावित थे। यूरिया ब्रिकेट @ 150 कि.ग्रा. नत्रजन प्रति हेक्टेयर का उपयोग उपज एवं उपज को प्रभावित करने वाले मापदंड अधिकतम प्राप्त हुए जैसे पौधों की उचाई प्रभावी कंसे $^{-1}$ संख्या से भरे अनाज बालि $^{-1}$ में अन्य उपचारों की तुलना में उच्चतम पाए गए।

यूरिया ब्रिकेट और प्रिल्ड यूरिया के माध्यम से प्रयुक्त नत्रजन के विभिन्न स्तरों द्वारा धान के अनाज और पुआल में वृद्धि। नत्रजन प्रयोग स्तर 0–150 kg अनाज की उपज 32.66 से 68.77 क्विंटल प्रति हेक्टेयर और पुआल की उपज 38.11 से 89.87 क्विंटल प्रति हेक्टेयर तक थी। यूरिया ब्रिकेट 150 किग्रा. नत्रजन प्रति हेक्टेयर के प्रयोग से अन्य नत्रजन के स्तरों की तुलना में धान की उच्चतम अनाज एवं पुआल की उपज प्राप्त हुई उपरोक्त परिणामों के अनुसार संभवतः ब्रिकेट यूरिया से नत्रजन को न्यूनतम नुकसान होकर धान की फसल में उच्च उपलब्धता प्रदान की गई। जिससे यूरिया ब्रिकेट से इसेप्टीसाल मृदा में नत्रजन उपयोग दक्षता के साथ धान फसल का उच्च उत्पादन प्राप्त हुआ।

नाइट्रोजन के विभिन्न स्तरों (75, 100, 125, और 150 किग्रा नत्रजन प्रति हेक्टेयर) के अनुप्रयोग ने धान की फसल द्वारा नत्रजन, स्फुर और पोटैश के अवशोषण पर महत्वपूर्ण प्रभाव दिखाया। प्रयुक्त नत्रजन स्तर @ 150 किग्रा प्रति हेक्टेयर के तहत उच्चतम फुल नत्रजन स्फुर पोटैश के अवशोषण क्रम T:105.35, 19.18, 122.48 किग्रा प्रति हेक्टेयर दर्ज किया गया और न्यूनतम नत्रजन स्फुर एवं पोटैश के अवशोषण 48.27, 7.75, 55.93 किग्रा प्रति हेक्टेयर T₁:N₀P₆₀K₄₆ प्राप्त किया गया।

कुल नत्रजन उपयोग दक्षता (%) प्रयोग नत्रजन के 125 से 150 किग्रा नत्रजन प्रति हेक्टेयर के बढ़ते स्तर के साथ घट गई। उच्चतम नत्रजन उपयोग दक्षता (39.22%) यूरिया

बिक्रेट के माध्यम से दर नत्रजन 125 किग्रा प्रति हेक्टेयर और सबसे कम (28.67%) क्रमशः नत्रजन 100 किग्रा प्रति हेक्टेयर के साथ पिल्ड यूरिया के माध्यम से पाई गई।

धान की फसल की बाद मिट्टी के विभिन्न भौतिक रासायनिक गुणों का विश्लेषण किया गया और पाया गया कि मिट्टी पी.एच, ईसी और कार्बनिक कार्बन यूरिया बिक्रेट और पिल्ड यूरिया के माध्यम से लागू नत्रजन स्तरों से सार्थक रूप से प्रभावित नहीं थे। मृदा में यूरिया बिक्रेट एवं पिल्ड यूरिया द्वारा लागू नत्रजन 150 किग्रा प्रति हेक्टेयर के तहत अधिकतम उपलब्ध नत्रजन 180.33 किग्रा प्रति हेक्टेयर दर्ज किया गया।

उपयोग प्रयोग प्रक्षेत्र परिणामों से यह पता चला की यूरिया बिक्रेट के माध्यम से प्रयोग किए गए नत्रजन 150 किलोग्राम प्रति हेक्टेयर के कारण धान की सर्वोत्तम उपज और वृद्धि मानकों का प्रदर्शन किया।

CHAPTER – I

INTRODUCTION

Nitrogen is the most important and yield limiting nutrient in irrigated rice production. Current high yields of irrigated rice are associated with large applications of fertilizers and particularly nitrogen is the main driving force to produce large rice yields under irrigated and other farming situations. N fertilizer management is critical for rice production. As nitrogenous fertilizers are usually broadcast as prills in paddy fields prior to transplanting followed by one or more top dressing within the period from transplanting to flowering. Such practices are inefficient because only about one-third of the fertilizer nitrogen is used by the plants and remaining lost through gaseous losses, runoff, and leaching or is immobilized in the soil. One means to reduce nitrogen losses and improve fertilizer efficiency may be use of urea briquettes (UB) in place of prilled urea (PU).

Urea briquette fertilizer is a simple physical modification of ordinary urea fertilizer. It consists of large discrete particles of urea containing 46% nitrogen. Urea briquette weight may vary considerably, but the general range that has been evaluated is 1-3 grams per particle. The shape of the granules depends on the production process used. Urea briquette prepared by any one of the melt-type granulation processes is nearly spherical, but they may vary in size and weight. Those prepared by briquetting are pillow shaped, oblong, or oblate, with broken edges due to webbing, and they are reasonably uniform in size and weight. Urea briquette can save 30% N compared to Prilled Urea (PU), increases absorption rate, improves soil health and ultimately increases rice yield.

Studies shown that the placement of urea pellets at a depth of 3-4 cm is better than surface fertilization. Application of 65 kg N/ha of briquette urea improved soil properties and rice productivity over 80 kg N/ha of prilled urea (Derrick et al., 2017). Deep placement of USG fertilizer released NH_4^+ -N slowly and steadily as compared to prilled urea in soil and found that one time application of USG better than three times broadcast application of PU (Rahman and Samanta, 2016). Therefore urea briquette application in paddy crop may sensitized for adoption by rice farmers,

India has the largest rice area in Asia, 43.77 million ha, accounting 29.4 percent of the global rice area with production of 116.4 mt (Annual report, department of agriculture, cooperation & farmers welfare 2019-20). Indian rice productivity is still well below the world's average yield of 4.36 t ha⁻¹. Chhattisgarh is traditionally known as the rice bowl of India and occupies an area of 3.7mha and recorded production of 8.34mt with average productivity of 2.18t ha⁻¹ (Department of agriculture Raipur 2018-19). The availability of nitrogen is a determinant factor for production and productivity of rice crop.

Urea briquette technology represents a possible alternative to increase rice yields and to reduce the nitrogen loss associated with broadcasted urea (Bautista et al., 2001). Urea agglomerates increase the grain yield of rice from 0.23 to 1.48 t ha as compared with SSP and granulated urea and the Urea-DAP agglomerates placed in a deep layer increased the grain yield of rice from 11% to 86% (Kadam et al., 2001). Grain and straw yield of the rice responded significantly to applied nitrogen through prilled urea (PU), deep placement of USG and foliar application of N. Among different methods of N application USG recorded significantly highest rice yield (Aktar et al., 2018). The highest grain yield was observed with urea briquette as compared to PU (Derrick et al., 2017).

Efficient management of fertilizer nitrogen is critical for rice production as the complex nature of N transformation in soils and various losses led to low N use efficiency and increase in fertilizer cost. N use efficiency defined as the ratio of grain yield to supplied N is a key parameter for evaluating a crop cultivar and consists of the efficiency of N uptake and NUE (Macale and Velk, 2004). N uptake efficiency is the accumulation of N relative to its source, while N physiological use efficiency represents grain yield relative to the accumulation of nitrogen. The lower N use efficiency of fertilizers is a result of multiple loss mechanisms such as volatilization and denitrification and a major problem in rice crop. Nearly 30-40 per cent of applied nitrogen is actually utilized by the crop even with the best agronomic practices and strictly controlled conditions the recovery of nitrogen seldom exceeds 50-60 percent. Hence, evaluation of urea briquette in farmer's fields as compared to prilled urea may be a good intervention for efficient utilization of applied nitrogen for maximization of yield of rice crop.

Keeping the aforesaid views into consideration, the present investigation entitled “**Assessment of urea briquette application for maximization of rice yield and Nitrogen use efficiency in *Inceptisol***” was conducted during *kharif* season, 2020 at KVK, Research Farm, Mahasamund with following objectives:

- ❖ To study the response of urea briquette with different Nitrogen levels on rice yield and its attributes
- ❖ To study the effect of urea briquette on nitrogen uptake, nitrogen use efficiency and soil properties

CHAPTER – II

REVIEW OF LITERATURE

An effort has been made in this section to present some research work done related to present study entitled “**Assessment of urea briquette application for maximization of rice yield and Nitrogen use efficiency in *Inceptisol***” in different rice growing areas of the world including India and Chhattisgarh. The literature on the aspects is reviewed under following heads:

2.1 Effect of urea briquette levels on rice yield and its attributes

2.2 Effect of urea briquette levels on nutrient uptake, nitrogen use efficiency and soil properties

2.1 Effect of urea briquette levels on rice yield and its attributes

Baral *et al.* (2020) carried a field experiment was conducted at the Regional Agricultural Research Station, Banke, Nepal, during the rainy seasons of 2017 and 2018 to study the effects of nitrogen application method on NUE and grain yields across different varieties. out a field experiment consisting of three rice varieties- Arize 6444, Radha-4, and Sukkha Dhan-3 with five nitrogen fertilizer treatments in sub-plots, and repeated thrice. The treatments were with control, broadcast prilled urea (@ 78 kg N ha⁻¹ and (@ 100 kg N ha⁻¹ and urea briquette (@ 78 kg N ha⁻¹ and 100 kg N ha⁻¹. The hybrid variety (Arize 6444) increased grain yield by 23% compared to Sukkha Dhan-3 (4.9 Mg ha⁻¹). Deep-placed briquetted urea increased grain yield by 21–23% (6.7 Mg ha⁻¹) compared to broadcast and deep-placed prilled urea. A higher grain yield for briquetted urea positively correlated ($r = 0.43$) with the number of tillers hill⁻¹.

Aktar *et al.* (2018) conducted an experiment during 2015-16 to study the effect of deep placement and foliar application of urea fertilizer on BRRI dhan29 rice cultivar at the AFL, Bangladesh Agricultural University, Mymensingh, consisting 12 treatments T₀ (No N application), T₁ [140 kg N/ha (as prilled urea)], T₂ (1.8 g 1-USG + 5 foliar spray @ 1% N solution), T₃ (1.8 g 1-USG + 5 foliar spray @ 1.5% N solution), T₄ (1.8 g 1-USG + 5 foliar spray @ 2% N solution), T₅

(1.8 g 2-USG), T₆ (2.7 g 1-USG), T₇ (2.7 g 1-USG + 3 foliar spray @ 1% N solution), T₈ (2.7 g 1-USG + 3 foliar spray @ 1.5% N solution), T₉ (2.7 g 1-USG + 3 foliar spray @ 2% N solution), T₁₀ (1.8 g 2-USG + 3 t/ha cowdung), T₁₁ (2.7 g 1-USG + 3 t ha⁻¹ cowdung). They reported that application of prilled urea (PU), deep placement of USG and foliar application of N responded significantly on grain and straw yield of rice and recorded highest grain yield (4.8 t ha⁻¹) in T₈ which was at par with the yield (4.7 t/ha) of T₃ and lowest under T₀.

Bandaogo *et al.* (2018) carried out fields and pot experiments in Burkina Faso, West Africa during wet and dry season of 2012 and 2013 for evaluating the method of fertilizer N application with prilled urea (PU) broadcasted and briquettes (urea supergranules – USGs) placed deeply into the soil at 5–7 cm used fertilizer N rate @ 52 kg N in irrigated rice systems. They reported significantly higher rice yields in USG-plots and cultivar NERICA 62N responded more to USG as compared with FKR 19 shown higher tillers and panicles numbers and significantly higher yields.

Datta *et al.* (2017) carried out a rice experiment to study the effect of different fertilizers on greenhouse gas emissions and grain yield. T₁: control (N₀), T₂: broadcasted ammonium sulphate, T₃: prilled urea, and T₄: deep placement of urea briquettes were the four treatments in the experiment. Plots treated with UB achieved higher yields than plots treated with PU treatments.

Derrick *et al.* (2017) compared the effect of prilled and briquette urea on soil quality and rice production in Ntende marshland, Rugarama sector of Gatsibo District. They reported that the highest grain yield was observed in plots treated with urea in briquette form with 7.34 per hectare compared to those where urea was applied in prilled form with 5.81 and the lowest yield recorded in control plots with 3.16 t ha⁻¹ and suggested that application of urea briquette in paddy plantation should be sensitized.

Chowdhury *et al.* (2016) conducted an experiment to study the effect of six nitrogen levels, viz. USG 1.8 g 4 hills⁻¹ (55 kg ha⁻¹) and USG 2.7 g 4 hill⁻¹ (80 kg N ha⁻¹, 0, 30, 60, 90 kg N ha⁻¹) on the yield of three fine aromatic rice varieties

viz. Kalizira, Binadhan-13 and dhan34 BRRI. They reported that the yield of aromatic rice was significantly affected by variety, nitrogen level and their interaction and Binadhan-13 yielded the maximum yield of grain (3.33 t ha^{-1}), followed by BRRI dhan34 (3.16 t ha^{-1}) and Kalizira yielded the minimum yield of grain (2.11 t ha^{-1}). They recorded 4 hill⁻¹, the tallest plant (140.3 cm), the maximum number of successful tillers hill⁻¹ (11.40), grains panicle⁻¹ (152.8) and grain yield (3.32 t ha^{-1}) were obtained with USG 1.8 g and the minimum values were found at 0 kg N ha⁻¹.

Islam *et al.* (2016) conducted field experiments during four consecutive rice growing seasons in 2012–2013 and studied the effects of fertilizer treatments i.e deep placed urea briquettes and NPK briquettes (NPK), broadcast prilled urea (PU) and a without N on floodwater ammonium concentration, rice yields and N use efficiency under two water regimes, continuous standing water and alternate wetting and drying (AWD). They reported that the deep placement of fertilizer above 52 and 78 kg N ha⁻¹ had no significant effects on grain yields but reduced N recovery during the wet and dry seasons respectively. The differences in grain yields among deep placed and PU treatments were not significant, deep placement of 30 % less N.

Rahman and Samanta (2016) assessed the comparative advantages of prilled urea (PU) and urea super granule (USG) with different nitrogen levels (N₁-70, N₂-100 and N₃-130% of the recommended dose) on rice during 2015-16 at BINA Farm Dumki, Bangladesh. They reported that the higher yield attributing characters (plant height, effective tiller panicle⁻¹, panicle length from USG × N₁(75%), USG, N₂ (100% N) and USG N₃(130%) produced the highest grain ($3.60, 3.64, 3.78 \text{ t ha}^{-1}$) and straw yield ($3.55, 3.45, 3.70 \text{ t ha}^{-1}$) respectively. Deep placement of USG fertilizer released NH₄⁺-N slowly and steadily as compared to prilled urea in soil. They found that one time fertilizer application of USG better than three times broadcast application of PU in terms of crop yield, nitrogen status in different depth of soil and labour costs.

Shukla *et al.* (2015) studied the performance of rice varieties in relation to nitrogen level under irrigated conditions at the, JNKVV, Rewa (M.P) during kharif

season, comprising three levels of nitrogen (40, 80 and 120 kg ha⁻¹) and seven rice varieties viz; Aditaya, Dantensavari, IET 21288, Jaldidhan, Varalu, IET 21296, and IET 21278. They found that application of 120 kg N ha⁻¹ significantly superior to 40 kg N ha⁻¹ and produced highest grain and straw yield 49.88 q ha⁻¹ & 93.10 q ha⁻¹ respectively. Among different rice varieties, Dantensavari with applied 120 N kg ha⁻¹ produced the highest grain yield (58.39 q ha⁻¹), followed by IET 21278 (56.78 q ha⁻¹).

Banerjee *et al.* (2011) studied the response planting geometry and different applied nitrogen levels, on hybrid rice and reported significant increase on yield and different yield contributing characters viz. number of effective tillers m², length of panicle, filled grains panicle⁻¹ and 1000 grain weight with the increasing applied nitrogen level from 50 to 150 kg ha⁻¹.

Islam *et al.* (2011) conducted field experiments with fertilizer treatments using deep placed urea briquettes and NPK briquettes (NPK), broadcast prilled urea (PU) and a control (without N) during four consecutive rice growing seasons in 2012–13. They reported that deep placed fertilizer treatments irrespective of N rates and water regimes reduced floodwater ammonium similar to the control treatment, while broadcast PU treatment caused floodwater ammonium to increase as N rates increased. Deep placement of fertilizer above 52 and 78 kg N ha⁻¹ during the Aus–Aman seasons (wet seasons) and during the Boro season (dry season), respectively, had no

Metwally *et al.* (2011) studied the effect of different levels of nitrogen viz. 0, 50, 100, 150, 200, 250, 300, 350, and 400 kg N ha⁻¹ on Egyptian hybrid rice 1 ‘H1’ at the Experimental Farm of Rice Research and Training Center, Sakha, Kafer El-Sheikh, Egypt and noted that the significant increase in grain yield and their attributes with levels of applied nitrogen and the maximum grain yield and nutrient use efficiencies were obtained at @ 200 kg N ha⁻¹.

Gautam *et al.* (2008) A field investigation was conducted at the Indian Agricultural Research Institute’s Research Farm during the kharif (wet) seasons of 2002 and 2003 in a split plot design with three varieties (PRH-10, Pusa Sugandh-3 and Pusa

Basmati-1), consisting three levels of nitrogen (0, 80 and 160 kg N ha⁻¹). The research results indicated that aromatic rice hybrid PRH-10 produced 33 and 6%, respectively, more grain yield than that of PusaSugandh-3 and Pusa Basmati-1. The appreciable higher grain yield of PRH-10 over Pusa Sugandh-3 and Pusa Basmati-1 was due to considerable improvement in most of the yield attributing characters. Wider plant spacing of 20 and application of 160 kg N ha⁻¹ recorded significantly higher hulling, milling and head rice recovery compared to closer spacing and zero nitrogen application.

Hossain *et al.* (2008) assessed the effect of different levels of nitrogen on the output of four genotypes of rice, during the transplanted aman (monsoon) season. BRRI dhan38, Kalizira, Badshabhog, and Tulsimala were included in the aromatic rice varieties, while nitrogen was added at 30, 60, 90 and 120 kg ha⁻¹. The output of various varieties was distinct. All the yield attributing parameters differed significantly. The maximum number of grains panicle⁻¹ was produced (135.90) by Kalizira. BRRI dhan 38 gave the maximum grain yield (4.00 t ha⁻¹) among the varieties. The aromatic rice varieties were also significantly affected by distinct nitrogen rates. All components of the yield were substantially increased to 90 kg N ha⁻¹. The higher grain yield (3.62 t ha⁻¹) of 60 kg N ha⁻¹ was nevertheless observed. The plant characteristics and yield parameters of aromatic rice were also influenced by the combination of varieties and nitrogen values, which ultimately affected the yield, and it was observed that the BRRI dhan 38 variety in combination was more sensitive to nitrogen to produce better yields.

Maksoud *et al.* (2008) conducted an experiment to study the effect of nitrogen fertilizer levels application @ 40 and 60 kg in splits and applied at two, three, and four equal doses on the growth and yield of three cultivars of rice viz; Giza 178, Sakha 103 and Sakha 104. They reported that the rice cultivars differed in their growth, grain yield and yield components and observed that rice cultivar Sakha 103 superior over Sakha 104 and nitrogen levels from 40 to 60 kg ha⁻¹ increased the most yield components which led to significant enhance in grain yield ha⁻¹ and N splitting showed significant increase on yield and yield attributes.

Bharadwaj *et al.* (2007) conducted an experiment to evaluate the effect of fifteen fertilizer dose combinations in two rice varieties (one hybrid and one inbred) on the yield. They reported that the yield of grain and straw was higher in the PSD-1 hybrid rice cultivar compared to the Saket-4 inbred cultivar. hybrid rice cultivar PSD-1 recorded the higher grain yield (5.5 t ha^{-1}) with applied N 200 P 34.4 K 66.6 Zn 10 kg ha^{-1} while the inbred cultivar Saket-4 recorded the highest yield with applied N 150 P 34.4 K 66.6 Zn 10 kg ha^{-1} .

Zaidi *et al.* (2007) performed a study to assess the impact of different doses of nitrogen, viz. 0, 50, 100 and 150 kg N ha^{-1} on yield of hybrid rice cultivars (PHB-71, KRH-2, NDRH-2). They found that increasing the amount of nitrogen resulted in significant increases in grain yield, straw yield, panicles m^2 , and panicle weight with each increase in N levels up to 150 kg N ha^{-1} .

Manzoor *et al.* (2006) conducted an experiment with nine various N levels, i.e. 0, 50, 75, 100, 125, 150, 175, 200 and 225 kg ha^{-1} on yield and yield parameters of Super Basmati rice variety. They recorded highest rice yield (4.24 t ha^{-1}) with 175 kg N/ha of nitrogen application and also yield attributes viz, number of grains panicle⁻¹ (130.2), weight of 1000 grains (22.92g) whereas the higher plant height (139.8 cm), number of active tillers hill⁻¹ (23.42) and panicle length (29.75 cm) found with applied N @ 225 kg ha^{-1} .

Bhagat *et al.* (2005) conducted a field experiment during Kharif season of 2009 and 2010 on lateritic soils to study different crop establishment methods and fertilizer sources on growth attributes and yield of rice. They reported that for growing kharif rice under upland situation, crop need to be established by transplanting method and amended with urea-DAP briquettes (@ $168.75 \text{ kg ha}^{-1}$) produced higher yield.

Pillai (2004) conducted a field experiment during kharif 2003 with Hybrid rice var. Sahyadri on lateritic soil at the research farm, Department of Soil Science and Agricultural Chemistry, Dapoli and reported that deep UB-DAP placement was more successful in improving yield characters such as plant height, number of leaves, and dry matter accumulation, tiller count, panicle weight and increased the

grain yield from 29.63 to 63.22 q ha⁻¹ as compared to the broadcast application of N @ 150 kg ha⁻¹ + SSP @ 50 kg ha⁻¹.

Shivay *et al.* (2003) conducted a field experiment during the kharif season of 2000-01 to study the effect of planting geometry and nitrogen levels on growth, yield attributes, yield and nitrogen-use efficiencies of 'PRH 10' scented hybrid rice (*Oryza sativa* L.) at Indian Agricultural Research Institute, New Delhi, . They reported that each unit increase in N level shown significant increase in yield and yield-attributing characters of rice. The maximum grain yield (65.5 q/ha) was recorded with highest level of applied N.

Singh and Singh (2003) conducted field experiments during 2005–2007 at Ludhiana and Gurdaspur on sandy loam soil & clay loam soil respectively for evaluating the relative performance of NCU vis-à-vis ordinary urea as a source of N for transplanted wetland rice. They reported that the application of NCU @120 kg N ha⁻¹ produced significantly higher grain yield than the yield obtained with ordinary urea.

Kadam J.R (2001) reported that Deep placement of urea briquette (UB) by hand after conventional line transplanting at the rate of one UB near the centre of each four rice hills and at soil depth of 7-10 cm reduces nitrogen losses and increases fertilizer use efficiency, but is a time consuming and labour intensive process. A two-row prototype urea briquette applicator was designed, developed and evaluated under simulated condition of system of rice intensification technique (25 cm × 25 cm) in the field of ICAR-IARI in 2013-14. Row-to-row spacing was 50 cm as the distance between two furrow openers. The mechanical urea briquette applicator recorded average distance of placement of 51.44 cm in the row, depth of placement of 7.66 cm, draft of 92.41 N, field capacity of 0.05 ha/h, field efficiency of 69% and field machine index of 69.6% during the operation in the field at forward speed of 0.87 km/h.

2.2 Effect of urea briquette levels on nutrient uptake, use efficiency and soil properties.

Roy *et al.* (2018) conducted field experiment during kharif 2017 at the research farm, IGKV, Raipur (C.G) and studied the impact of use of urea briquettes in combination with organics in irrigated rice cultivation system with treatments involving application of urea briquettes, urea, briquettes of urea + FYM, urea + vermicompost and urea + neem cake as source of nitrogen along with varying doses of phosphorus and potassium. They reported that the addition of organics in urea briquettes and deep placement of briquettes exhibited higher nitrogen, phosphorus and potassium use efficiency may slow release of nitrogen, reduction in losses and thereby higher nutrients uptake and higher yield. They found Urea+FYM briquette most suitable among different sources of fertilizer nitrogen for irrigated rice and shown higher NUE as compared to recommended dose of fertilizers and also influenced the available N,P,K in soil at harvest.

Yao *et al.* (2018) conducted a field experiment during the 2014–2016 rice growing seasons in the Taihu Region, China with five treatments (two surface split broadcasting treatments as a current traditional practice with 300 kg N ha⁻¹ (CT) and a reduced N practice with 225 kg N ha⁻¹ (RN), two one-time urea deep placement (UDP) a current traditional practice under UDP (CTDP) and a reduced N practice under UDP (RNDP), and a CK treatment with no urea). They reported the deep placement of urea could supply a higher NH₄⁺-N concentration in the soil during the early growth stage and prolong the duration of N availability for 2 months; as a result, UDP remarkably increased the N uptake by 28% compared with surface broadcasting treatments in the 3 years. The UDP treatments significantly increased the yield and NRE by 10% and 55% under favorable weather conditions (2015 and 2016 rice seasons), respectively. The RNDP treatment obtained the lowest N surplus (36 kg N ha⁻¹), and the plant 15N uptake was 62% higher and the 15N loss was 38% lower with RNDP than surface broadcasting

Sampat *et al.* (2017) conducted a field experiment on a sandy clay loam soil at college farm of Professor Jayashankar Telangana State Agricultural

University, Rajendranagar, Hyderabad, Rajendranagar, Hyderabad, Telangana during the kharif seasons of 2014 and 2015 to determine the nutrient uptake of rice varieties as influenced by the combination of plant densities and fertilisers under late sown conditions on a sandy, clay loam soil. According to the researchers, MTU 1010 performed superior than Pradyumna and Rajendra in terms of nutrient uptake as well as yield.

Huda *et al.* (2016) conducted an experiment during four consecutive rice growing seasons, at Bangladesh agricultural university to study the effect of deep placement of urea briquette and NPK briquette compared to broadcast prilled urea at different N rates. Across season UB, and NPK significantly increased grain yield and N recovery compared to broadcast prilled urea.

Paul *et al.* (2016) conducted an experiment at Bangladesh Agriculture University to examine the impact of different levels of nitrogen and varieties on the growth output of transplanted aman rice. The experiment includes four different varieties and four different nitrogen levels. BRRIdhan34 fertilised with two pellets of USG, one at 10 DAT and the other at 45 DAT, performed slightly better.

Das *et al.* (2015) conducted an experiment during boro season of 2016 to study the effect of deep placement of N fertilizers on N use efficiency and yield of BRRI dhan29 under alternate wetting and drying (AWD) condition at the Soil Science Field Laboratory of Bangladesh Agricultural University, Mymensingh. They reported significant response to the application of PU, USG and NPK briquettes on N uptake, N use efficiency and apparent N recovery by BRRI dhan29. The maximum N use efficiency of 28.88% was noted in USG, 78 kg N/ha followed by USG, 104 kg N/ha with the value of 26.46% and the minimum value of 17.55% was observed in PU, 130 kg N/ha. The results revealed that the deep placement of N fertilizers accelerated the N uptake; N recovery and N use efficiency by BRRI dhan29.

Gaihre *et al.* (2015) assessed the impact of N-P-K briquette and urea briquette (UB) with prilled urea from 2009 to 2012 in 115 farmer's fields across

eight districts in Bangladesh. They reported higher grain yields with UB and NPK briquette over prilled urea in all rice growing seasons and years of study.

Darade and Bankar (2009) A field experiment was conducted during kharif season of 2006 at Agronomy Farm, College of Agriculture, Dapoli, on clay lateritic loam soil. And found that deep placement of urea-DAP briquettes (@ 114 kg N + 25.4 kg P) + 50 kg K₂O ha⁻¹ resulted in substantially higher nitrogen, phosphorus, and potassium uptake (118, 29.0, and 95.58 kg ha⁻¹, respectively) and grain yield (70.22 q ha⁻¹) than RDF (150:75:50 kg NPK ha⁻¹). Thus the result revealed that the briquettes enhances nutrient uptakes.

Gewaily *et al.* (2018) conducted field experiments during the growing seasons of 2016 and 2017 and evaluated the effectiveness of various N fertiliser rates on N use efficiency of newly released Sakha 108 and some promising GZ9399-4-1-1-3-2-2, GZ10101-5-1-1-1, and GZ10154-3-1-1-1 rice varieties for nitrogen application @ 55, 110, 165, and 220 kg N ha⁻¹. They observed agronomical efficiency (AE) varied significantly among rice cultivars ranging from 3.63 to 32.9 kg of grain yields per kg of applied nitrogen in 2016 and 2017, and 2.72 - 34.12 kg of grain yields per kg of applied N in 2017. Cultivar GZ9399 recorded the highest AE value for applied nitrogen fertiliser dose @ 165 kg N ha⁻¹ among rice cultivars.

Pan *et al.* (2017) found that deep placement of nitrogenous fertilisers increased grain yield and nitrogen usage efficiency (NUE) as well as enhanced nitrogen recovery efficiency as compared to surface broadcasting.

Hasan *et al.* (2016) conducted an experiment at the Regional Agricultural Research Station, Banke, Nepal, during the rainy seasons of 2017 and 2018 to study the effects of nitrogen application method on NUE and grain yields across different varieties. The field experiment was laid out in a split-plot design, consisting of three rice varieties—Arize 6444, Radha-4, and Sukkha Dhan-3—as the main plots and five fertilizer treatments in sub-plots, and replicated thrice. The five fertilizer treatments included control (0 kg N ha⁻¹), broadcast prilled urea at 78 kg N ha⁻¹ and 100 kg N ha⁻¹, and deep placement of prilled urea and

briquetted urea at 78 kg N ha⁻¹. Both rice variety and fertilizer treatment had a significant ($p < 0.05$) effect on grain yield. The hybrid variety (Arize 6444) increased grain yield by 23% compared to Sukkha Dhan-3 (4.9 Mg ha⁻¹). Deep-placed briquetted urea increased grain yield by 21–23% (6.7 Mg ha⁻¹) compared to broadcast and deep-placed prilled urea. A higher grain yield for briquetted urea positively correlated ($r = 0.43$) with the number of tillers per hill. Deep-placed briquetted urea increased NUE (apparent N recovery, agronomic NUE, partial factor productivity of N, and physiological efficiency by 44%, 40%, 34%, and 3%, respectively), while reducing ammonia volatilization by 57% compared to the current recommended rate of broadcast prilled urea. Our results confirm that deep placement of briquetted urea significantly increases grain yields and NUE of rainfed rice.

Haque *et al.* (2016) conducted field experiment during the rainy season of 2014 and assessed growth, yield and nitrogen use efficiency of a new rice variety (BUDhan 1) with applied 6 fertilizer N levels (0, 20, 40, 60, 80 and 100 kg N ha⁻¹) at BSMRAU, Gazipur, Bangladesh. They reported the highest grain yield (5.36 t-1) and nitrogen use efficiency (344.50 kg grain/kg N applied) with applied nitrogen dose @ 60 kg ha⁻¹ and concluded that application of the intermediate level of nitrogen was economical and environment-friendly for the cultivation of new rice variety.

Islam *et al.* (2016) conducted field experiments during four consecutive rice growing seasons in 2012–2013 and studied the effects of fertilizer treatments i.e deep placed urea briquettes and NPK briquettes (NPK), broadcast prilled urea (PU) and a without N on floodwater ammonium concentration, rice yields and N use efficiency under two water regimes, continuous standing water and alternate wetting and drying (AWD). They reported that the deep placement of fertilizer above 52 and 78 kg N ha⁻¹ had no significant effects on grain yields but reduced N recovery during the wet and dry seasons respectively. The differences in grain yields among deep placed and PU treatments were not significant, deep placement of 30 % less N compared to broadcast PU significantly increased N recovery (30–35 % vs. 48–55%).

Chatterjee *et al.* (2015) conducted an experiment with seven different treatments of manual and mechanical mode of application in field in consecutive wet (2015) and dry (2016) seasons. Three row briquette applicator (TRBA) and top dressing applicator (TDA) were used in combination for basal and top dressing application along with prilled urea broadcasting and without application as well. They reported the use of TRBA at basal with first top dressing by TDA and manual placement of urea briquette at second top dressing (TRBA + TDA) yielded highest @ 6.71 t ha⁻¹ and 5.47 t ha⁻¹ in the wet and dry seasons, respectively, suitable method of application of urea briquette in flooded rice (*Oryza sativa* L.) not only increased nitrogen use efficiency, but at the same time sustain yield.

Wang *et al.* (2015) examine mechanical hill direct seeded rice with deep N fertiliser placement (MHDSR-NF) as an alternative to traditional transplanted flooded rice (CTFR) in two rice cultivars in south China. They found that nitrogen use efficiency and nitrogen agronomic efficiency (NAE) had increased with deep N fertiliser placement (MHDSR-NF).

Naznin *et al.* (2013) studied the effects of prilled urea (PU), urea super granules (USG), and NPK briquette on yield, nitrogen usage efficiency (NUE) using rice cultivar BR22 at Bangladesh. They found that using USG and NPK briquettes should be practice in order to obtain higher N use efficiency.

Islam *et al.* (2011) conducted field experiments with fertilizer treatments using deep placed urea briquettes and NPK briquettes (NPK), broadcast prilled urea (PU) and a control (without N) during four consecutive rice growing seasons in 2012–13. Although the differences in grain yields among deep placed and PU treatments were not significant, deep placement of 30 % less N compared to broadcast PU significantly increased N recovery (30–35 % vs. 48–55 %).

Rahman *et al.* (2007) An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during T. Aman season, 2002 to study the effect of different level of nitrogen on growth and yield of transplant aman rice. The experiment included four treatments viz. 0, 60, 80 and 100 kg N ha⁻¹. Nitrogen level significantly influenced growth and yield

components. The highest number of effective tillers hill⁻¹ (9.20), maximum grains panicle⁻¹ (100.80) and highest grain yield (5.34 t ha⁻¹) were obtained with 80 kg N ha⁻¹. The highest straw yield (6.98 t ha⁻¹) was obtained at the highest nitrogen level (100 kg N ha⁻¹). The highest harvest index (44.50%) was observed at 80 kg N ha⁻¹. Results showed that 80 kg N ha⁻¹ was optimum to produce maximum yield of transplant aman rice cv. BRRI dhan32.

Bautista *et al.* (2001) reported that deep placement of nitrogenous fertilizer is an alternative for increasing the N use efficiency of wetland rice besides minimizing the adverse effects of fertilizers on the environment. They also emphasized the development of machines for the placement of N materials (granular, USG or agglomerate, liquid N) for a better acceptance of deep placement in the rice-growing countries of Asia.

Derrick *et al.* (2017) reported that since the application of 65 Kg N ha⁻¹ of briquette urea improved soil properties and rice productivity over 80 Kg N ha⁻¹ of prilled urea.

CHAPTER-III

MATERIALS AND METHODS

The present study entitled “Assessment of urea briquette application for maximization of rice yield and Nitrogen use efficiency in *Inceptisol*” was undertaken during *kharif* seasons of 2020 at the Research farm, Krishi Vigyan Kendra, Mahasamund, (Chhattisgarh). The details of experiment with prevailing weather conditions and materials used and procedures adopted during the course of investigation are briefly presented in following sub heads:

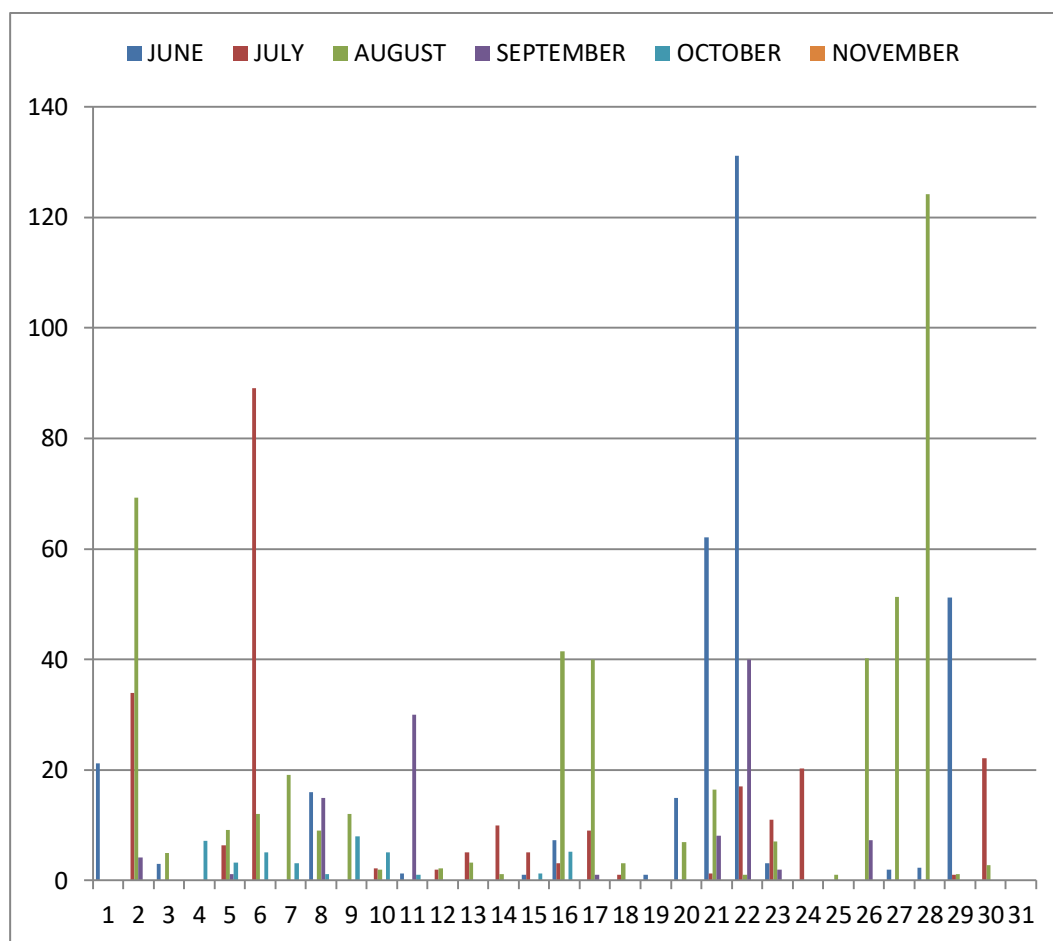
3.1 Geographical situation

An experiment was conducted at Krishi Vigyan Kendra, Research Farm, Mahasamund (Chhattisgarh) which is located at about 55 km away from the district headquarter, Raipur. It has an average elevation of 318 metres (1043 feet) Mahasamund district covers an area of 3902.39 km² in the central eastern part of Chhattisgarh. The district lies between 20°47' to 21°31'30" latitude and 82°00' and 83°15'45" longitude.

3.2 Climate and weather

The general climate of this region is dry and sub humid rainfall varies from 1200-1400 mm annually in which maximum is received during the rainy season (June to September). The pattern of rainfall varies considerably from year to year during the rainy season. The temperature reaches as high as 48 ° C during the summer months and decreases to 5°C during december to January. Below are the weekly averages of rainfall observations during the investigation period depicted in Fig no. 3.1

Fig 3.1: Weekly rainfall data during the crop growth period, Kharif 2020



3.3 Soil of experimental site

Surface soil samples (0-15 cm) of experimental field were collected with the help of auger and representative samples after air dried, grounded and passed through 2 mm sieve analyzed for various physico-chemical properties are presented in Table 3.1. As per analyzed samples, soil characterized sandy loam in texture locally known as “Matasi” and designated in order *Inceptisol*. The initial physico chemical properties of soil is depicted below in table 3.1 respectively.

Table 3.1: Initial physico-chemical properties of experimental soil

S.No.	Properties	Values	Method of estimation
1	pH (1:2.5)	6.1	Glass electrode pH meter (piper,1967)
2	EC (ds m ⁻¹)	0.11	Solubridge conductivity method (Black,1965)
3	Organic carbon (%)	0.41	Rapid titration method (Walkley and Black,1934)
4	Texture(%)	Sand-60 Silt -22 Clay-18	International pipette method (Black,1965)
5	Available N(kg ha ⁻¹)	137.98	Alkaline permanganate method (Subbiah and Asija,1956)
6	Available P (kg ha ⁻¹)	12.46	Sodium bicarbonate method (Olsen et al, 1954)
7	Available K(kg ha ⁻¹)	238.88	Ammonium acetate method (Hanway and Heidel,1952)

3.4 Experimental details

Season	Kharif, 2020
Soil order	<i>Inceptisol</i> (Matasi)
Crop	Rice (CV- Rajeshwari)
Plot Size	96 m ² (16m × 6 m)
Spacing	15 X 15 cm
Design	Randomized Block Design
Replications	3
Total no. of treatments	8
RDF	N:P:K @100:60:40 kg ha ⁻¹

3.5 Treatment details (levels of UB &PU)

Table 3.2: Treatment details

S.No.	Treatments	Treatment details
T ₁	N ₀ :P ₆₀ :K ₄₀	0:60:40 (N:P ₂ O ₅ :K ₂ O)
T ₂	N ₇₅ (UB)	75 kg N ha ⁻¹ urea briquette
T ₃	N ₁₀₀ (PU)	100 kg N ha ⁻¹ prilled urea
T ₄	N ₁₀₀ (UB)	100 kg N ha ⁻¹ urea briquette
T ₅	N ₁₂₅ (PU)	125 kg N ha ⁻¹ prilled urea
T ₆	N ₁₂₅ (UB)	125 kg N ha ⁻¹ urea briquette
T ₇	N ₁₅₀ (PU)	150 kg N ha ⁻¹ prilled urea
T ₈	N ₁₅₀ (UB)	150 kg N ha ⁻¹ urea briquette

Where, UB=Urea briquette @(75,100,125,150)kg ha⁻¹ and PU= Prilled urea
@(100, 125, 150) kg ha⁻¹P and K commonly applied @ 60 & 40 Kg/h in each plots

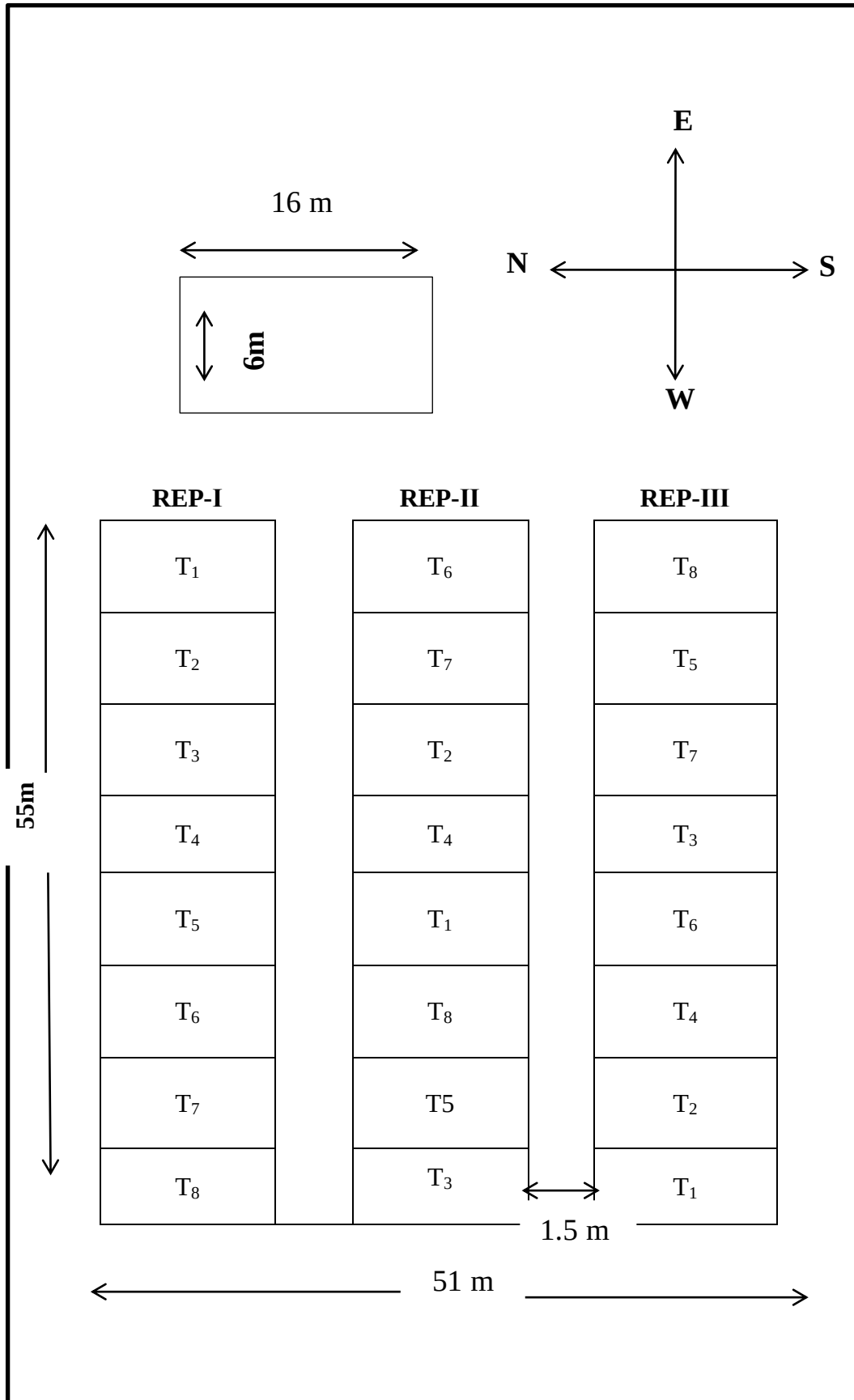
3.6 Field preparation

Firstly the field was prepared by ploughing with two passes of cultivator and one time by rotavator then field was irrigated to fill 5-10 cm water in field for puddling. Thereafter, puddling was done with two passes of tractor drawn puddler and then field was levelled by leveller. Bunds were made all around the field to control the water in plots.

3.7 Layout plan

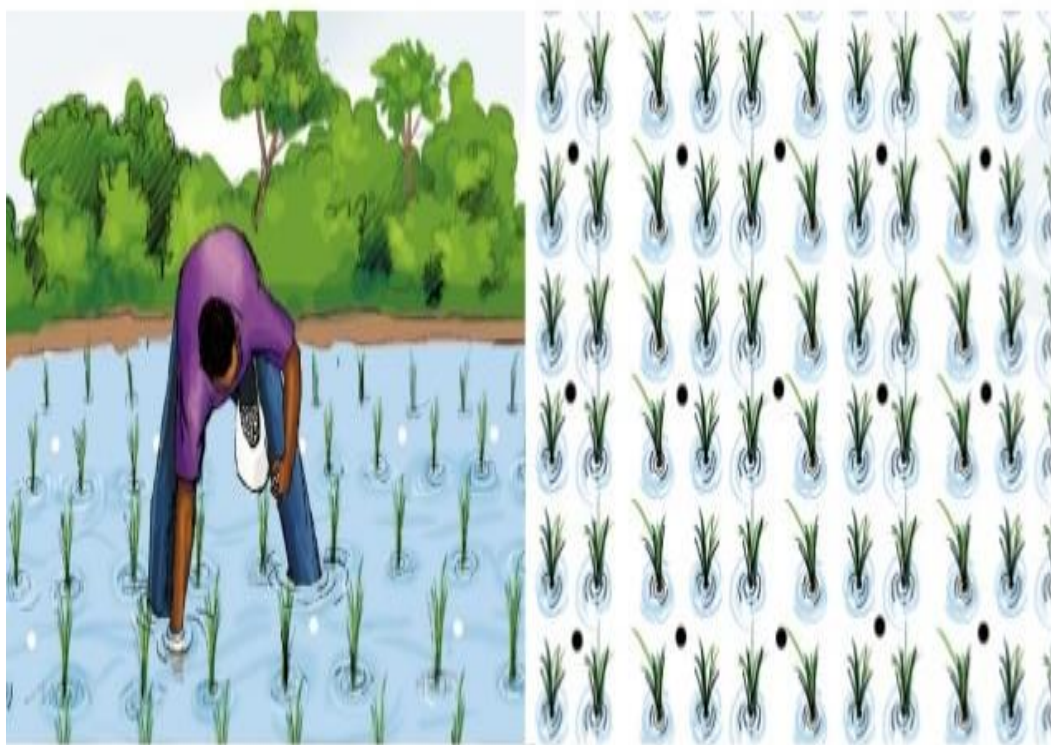
Experiment was laid out with eight treatments through urea briquette and prilled urea and allocated randomly comprising total 24 plots in three replications. These treatment were arranged in a proper layout following the randomized block design and depicted in Fig 3.2

Fig 3.2 Layout of experiment field



3.8 Application of Urea Briquette and P&K Fertilizers

Urea briquette contains 46 per cent nitrogen having weight approx. 1.0 g each briquette and was applied manually 10 DAT placed at centre of four hills @ 1 UB in treatments T₂, T₄, T₆, T₈. The recommended dose of phosphorus and potassic fertilizer @ 60 kg P₂O₅ ha⁻¹ and 40 kg K₂O ha⁻¹ were applied through SSP and MOP commonly at the time of rice transplanting to each plot.



3.9 Cultural operations

The cultural operations performed during field experiment is given in Table 3.3

Table 3.3: Cultural operation during kharif 2020

S.no.	Field operations	Date
1	Collection of soil samples	10-07-2020
2	Land preparation and leveling	12-07-2020
3	Layout of field	14-07-2020
4	Transplanting	17-07-2020
5	UB & PU application	27-07-2020
6	1 st hand weeding	25-08-2020
7	2 nd hand weeding	28-09-2020
8	Harvesting	30-10-2020
9	Collection of soil samples after harvest	3-11-2020

3.10 Crop establishment and planting density

Rice crop was established by transplanting method on puddled field. Rice nursery was established 25 days before transplanting of rice crop. Rice was transplanted at spacing of 15 x 15 cm on puddled field. Two to three seedlings were transplanted at each hill on a shallow depth.

3.11 Harvesting and Threshing

Harvesting and threshing of rice was done manually after physiological maturity of the crop with sickle.

3.12 Observations recorded

Field observations were recorded like plant height (cm) effective tillers hill⁻¹, number of grains panicle⁻¹, test weight (g) and grain and straw yield (q ha⁻¹) during crop season of experiment.

3.12.1 Plant height (cm)

Five hills were randomly selected from each plot and plant height in (cm) was recorded at 60 and 90 DAT.

3.12.2 Number of effective tillers hill⁻¹

Five hills were randomly selected from each plot and effective tillers hill⁻¹ was recorded at 90 DAT.

3.12.3 Number of grains panicle⁻¹

Ten plants have been picked at random and filled grains have been removed and counted. The mean value was measured and noted as filled grains panicle⁻¹.

3.12.4 Test weight (g)

Grain samples were taken from the threshed and cleaned produce of each treatment and 1000 grains were counted and were dried in oven at 60°C temperature for 48 hours. After drying, they were weighed and mean weight of 1000 grains was noted as test weight.

3.12.5 Grain and straw yield (q ha⁻¹)

From each treatment, sun dried produce were tied in bundles and weighed to determine the weight of dry matter produce (grains + straw). The grains obtained from each treatment after threshing and winnowing were weighed and recorded in q ha⁻¹. The straw weight was obtained by subtracting the grain weight from the bundle weight.

3.12.6 Sampling of plant at harvest

Plant samples (straw and grain) were collected randomly from each treatment combination of all three replications. These samples were collected at the time of harvesting of crop for further chemical analysis.

3.13 Collection of soil samples

Surface soil samples (0-15 cm) were collected before and after the field experiment and analyzed for different physico-chemical properties of soil.

3.14 Soil analysis

3.14.1 pH

Soil pH was determined in 1:2.5 soil-water suspension after stirring for 30 minutes, by glass electrode pH meter as suggested by Piper (1967).'

3.14.2 Electrical conductivity (dSm^{-1})

The soil sample used for pH determination was allowed to settle down for 4 hours then conductivity of supernatant liquid was determined by Salt-bridge as described by Black (1965).

3.14.3 Organic carbon (%)

Organic carbon was determined by Walkley and Black rapid titration method (1934).

3.14.4 Available Nitrogen (kg h^{-1})

To estimate the available nitrogen, alkaline potassium permanganate method was adopted as described by Subbiah and Asija (1956) .

3.14.5 Available phosphorus (kg h^{-1})

Available phosphorus was estimated from the soil with 0.5M NaHCO_3 . Quantitative determination of phosphorus in soil given by Olsen et al. (1954) and expressed in kg ha^{-1}

3.14.6 Available potassium (kg h^{-1})

Available potassium was determined by extracting soil with neutral normal ammonium acetate solution. The estimation of potassium is carried out by Flame photometer as described by Jackson (1967).

3.15 Plant analysis:

Nitrogen content (%)

Nitrogen content of plant samples was determined using salt mixture method as described by Chapman and Pratte (1961). 0.25gm uniform prepared plant sample was taken in digestion tube. Salt mixture (K_2SO_4 and $CuSO_4 \cdot 5H_2O$ in the ratio of 10:1) was added in the tube. 5ml of concentrated H_2SO_4 acid and material was digested at $400^\circ C$ in digestion block till the material becomes colorless. Then the nitrogen in digested material was distilled by automatic KEL plus.

Phosphorus and Potassium content (%)

Digestion:

In the digestion tube, 1 gram of grain and straw samples were taken and 10 ml was added. Di-acid mixture (concentrated HNO_3 & $HClO_4$ in 9:4 ratio). The substance was digested in KEL plus digestion block at $250^\circ C$ until the content became colorless. It was moved to 100 ml of volumetric flask. by repeatedly washing with distilled water, the volumetric flask made up the volume up to the level. For the estimation of P and K content analysis, this digested material was used for following P & K contents as given below:

Phosphorus content (%)

Phosphorus content in plant was estimated by vanadomolybdo- phosphoric acid yellow color complex as described by Jackson (1967). 10 ml of an aliquot was taken in that 10 ml of vanado – molybdate yellow reagent was added and volume was made up to 50 ml. After half an hour colour intensity was measured with the help of spectrophotometer at 420nm.

Potassium content (%)

Method to determine the Potassium content was described by chapman and Pratt (1961) an aliquot of 5 ml was taken and made up to volume of 25 ml in volumetric flask and estimated in flame photometer.

3.16 Nutrient Uptake:

N, P and K uptake by rice crop were calculated from their respective concentration of straw and grain of the crop.

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Yields (kg ha}^{-1}\text{)} \times \text{content (\%)}}{100}$$

3.17 Nitrogen Use Efficiency (NUE)

It can be calculated by following formula:

$$\text{NUE (\%)} = \frac{\text{Uptake from treated plot} - \text{Uptake from controlled plot}}{\text{Total nitrogen applied}} \times 100$$

3.18 Statistical analysis

The statistical analysis of data collected through various observations of different parameters of rice on different dates was carried out in split plot design with two levels each replicated three times as described by Gomez and Gomez (1984). Test of significance of the treatments were computed with the critical difference at 5 % level of significance.

CHAPTER- IV

RESULT AND DISCUSSION

The results obtained from the present investigation entitled “**Assessment of urea briquette application for maximization of rice yield and Nitrogen use efficiency in *Inceptisol***” have been presented in this chapter. The result of various observations recorded on crop and soil parameters were analyzed and presented in form of tables and figures with reasons for significant variations discussed under following sub-heads:

4.1 Effect of different levels of nitrogen applied through urea briquette and prilled urea on yield and yield attributes of rice

4.2 Effect of different levels of nitrogen applied through urea briquette and prilled urea on N P & K content, uptake and nitrogen use efficiency of rice

4.3 Effect of different levels of nitrogen applied through urea briquette and prilled Urea on Physico-chemical properties of soil after harvest of rice

4.1 Effect of different levels of nitrogen applied through urea briquette and prilled urea on yield attributes and yields of rice

4.1.1 Plant height (cm)

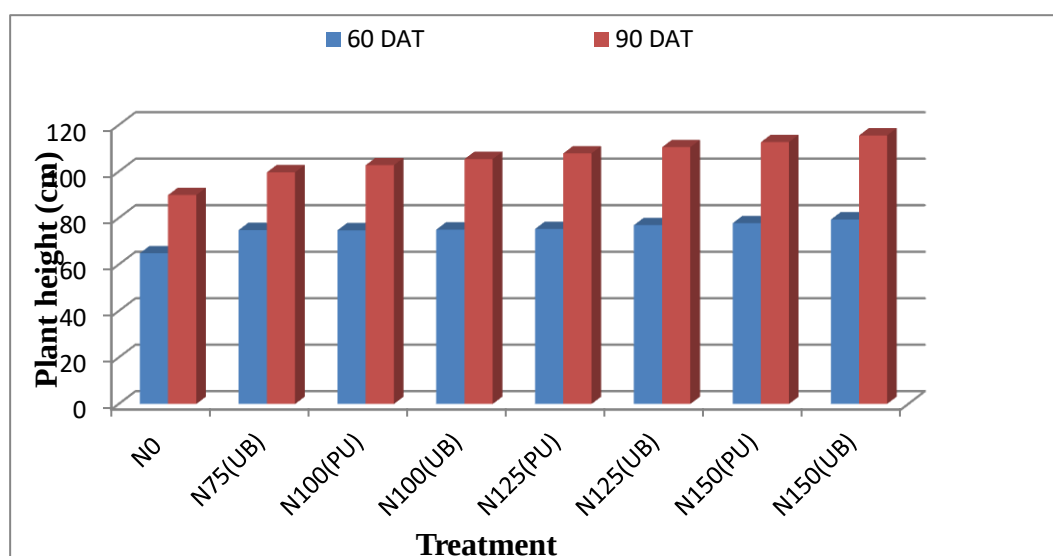
The plant height of rice recorded was significantly influenced at 60 DAT and 90 DAT by different levels of urea application as presented in Table 4.1 and Fig 4.1. Significantly highest plant height (79.40 and 115.55 cm) was recorded with applied 150 kg N ha⁻¹ as urea briquette and the lowest (64.86 and 89.88cm) were observed under T₁(N₀:P₆₀:K₄₀) at 60 DAT and 90 DAT respectively. The height of rice influenced by different levels of urea application followed T₈>T₇>T₆>T₅>T₃>T₄>T₂>T₁ in 90 DAT. Urea application in the form of urea briquette (UB) i.e. T₂, T₄, T₆ and T₈ shown significantly higher plant height than prilled urea applied as basal and over T₁(N₀:P₆₀:K₄₀) both at 60 DAT and 90 DAT. The significant difference in plant heights between different levels of applied urea briquettes (UB) as compared to prilled urea may due to reduction in losses of

nitrogen from root zones. These results are in full conformity with the findings by Pillai (2004) and Bhagat *et al.* (2005).

Table 4.1: Effect of different levels of nitrogen applied through urea briquette and prilled urea on plant height of rice

Treatment		Plant height (cm)	
		60DAT	90DAT
T ₁	N ₀ : P ₆₀ : K ₄₀	64.86	89.88
T ₂	N ₇₅ (UB)	74.83	99.68
T ₃	N ₁₀₀ (PU)	74.73	102.74
T ₄	N ₁₀₀ (UB)	75.03	105.37
T ₅	N ₁₂₅ (PU)	75.32	107.82
T ₆	N ₁₂₅ (UB)	76.94	110.48
T ₇	N ₁₅₀ (PU)	77.79	112.67
T ₈	N ₁₅₀ (UB)	79.40	115.55
SEm±		0.24	0.55
CD (p = 0.05)		0.72	1.67

Fig. 4.1: Effect of different levels of nitrogen applied through urea briquette and prilled urea on plant height of rice



4.1.2 Number of Effective tillers hill⁻¹

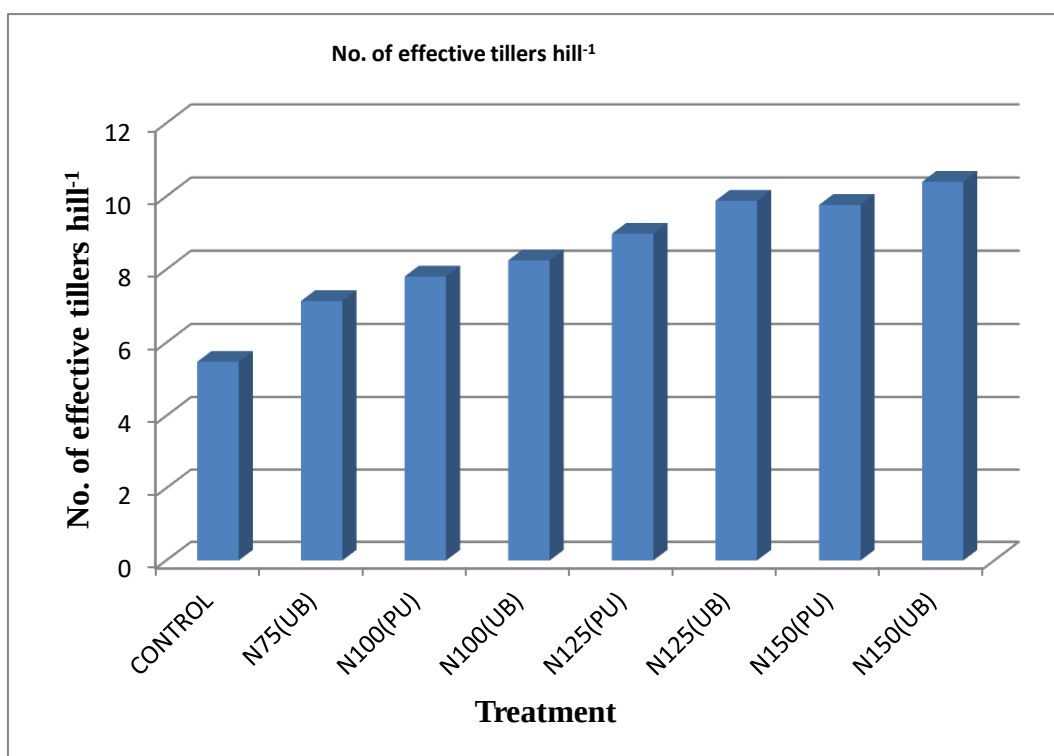
The data presented in Table 4.2 and Fig 4.2 showed significantly higher number of effective tillers hill⁻¹ i.e 10.40 under applied nitrogen level @ 150 kg ha⁻¹ as UB (T₈) at 90 DAT was at par with applied treatments 125 kg ha⁻¹ as UB (T₆) and 150 kg ha⁻¹ as PU (T₇) as compared to the other treatments and the lowest (5.48 hill⁻¹) effective tillers recorded under N₀:P₆₀:K₄₀ (T₁) The increased effective tillers with applied urea briquettes might be due to steady and increased availability of nitrogen which improves more tillering and effective tillers hill⁻¹

The result is in full concurrence with the findings of Kamal *et al.* (1991), Pandey (1996) and Jaiswal (2001) as reported with increase in nitrogen dose applied as UB placement increased number of tillers.

Table 4.2: Effect of different levels of nitrogen applied through urea briquette and prilled urea on effective tillers hill⁻¹ of rice

Treatment		Number of effective tillers hill ⁻¹
T ₁	N ₀ : P ₆₀ : K ₄₀	5.48
T ₂	N ₇₅ (UB)	7.14
T ₃	N ₁₀₀ (PU)	7.81
T ₄	N ₁₀₀ (UB)	8.25
T ₅	N ₁₂₅ (PU)	8.98
T ₆	N ₁₂₅ (UB)	9.88
T ₇	N ₁₅₀ (PU)	9.77
T ₈	N ₁₅₀ (UB)	10.40
SEm±		0.21
CD (p = 0.05)		0.63

Fig 4.2: Effect of different levels of nitrogen applied through urea briquette and prilled urea on effective tillers hill⁻¹ of rice



4.1.3 Number of filled grains panicle⁻¹

Data presented in Table 4.3 and illustrated in Fig 4.3 shows that number of filled grains panicle⁻¹ of rice was significantly influenced by different levels of applied nitrogen through UB and PU. As per recorded data higher filled grains panicle⁻¹ were found higher under applied urea briquette treatments in order $T_8 > T_6 > T_4 > T_2$ as compared to applied prilled urea (i.e. $T_7 > T_5 > T_3$) treatments. The maximum filled grains panicle⁻¹ (145.77) was observed under applied nitrogen @ 150 kg ha⁻¹ (T_8) through UB and the lowest filled grains panicle⁻¹ (99.66) was recorded under $N_0 : P_{60} : K_{40}$ (T_1). Higher number of filled grain might be the result of constant availability of nitrogen with other nutrients.

4.1.4 Test weight (g)

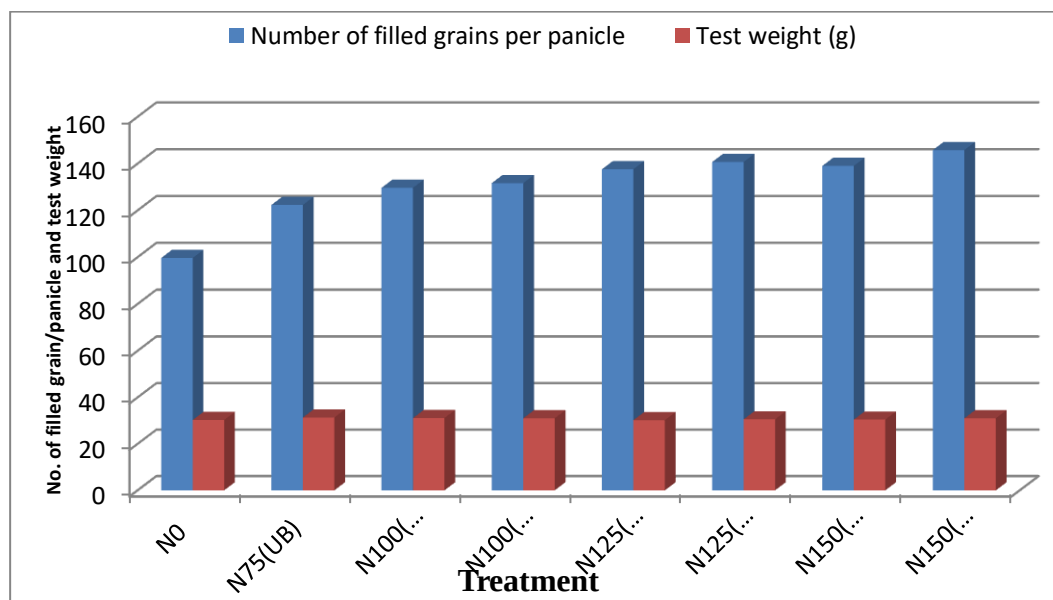
Data presented in Table 4.3 and Fig. 4.3 shows non-significant variation in test weight of rice with different levels of nitrogen applied through urea briquettes and prilled urea. However the highest test weight of rice was recorded under applied 150 kg ha⁻¹ N through UB (T_8) followed by T_3 , T_4 , and T_8 and the lowest

with applied N₀ : P₆₀: K₄₀ (T₁). The similar findings was observed by Rahman *et al.*(2009) who reported non-significant influence of urea-N and manures on test weight of BRRI dhan 29. Hassan *et al.* (2002) showed that different levels of USG did not have any significant effect on 1000 grain weight.

Table 4.3: Effect of different levels of nitrogen applied through urea briquette and prilled urea on filled grains panicle⁻¹ and test weight of rice

	Treatment	Number of filled grains panicle ⁻¹	Test weight (g)
T ₁	N ₀ : P ₆₀ : K ₄₀	99.66	30.26
T ₂	N ₇₅ (UB)	122.33	31.33
T ₃	N ₁₀₀ (PU)	129.66	31.10
T ₄	N ₁₀₀ (UB)	131.66	31.00
T ₅	N ₁₂₅ (PU)	137.59	30.20
T ₆	N ₁₂₅ (UB)	140.67	30.54
T ₇	N ₁₅₀ (PU)	139.00	30.43
T ₈	N ₁₅₀ (UB)	145.77	31.00
	SEm±	0.98	0.29
	CD (p = 0.05)	2.98	NS

Fig 4.3: Effect of different levels of nitrogen applied through urea briquette and prilled urea on filled grainspanicle⁻¹ and test weight of rice



4.1.5 Grain yield (q ha⁻¹)

Data presented in Table 4.4 and in Fig 4.4 shows the significant variations on grain yield of rice with different levels of applied nitrogen through urea briquette and prilled urea. The grain yield ranged from 32.36 to 68.77 among the nitrogen levels. Significantly highest grain yield (68.77 q ha⁻¹) was recorded applied nitrogen @ 150 kg ha⁻¹ through urea briquette (T₈) and the lowest yield (32.36 q ha⁻¹) obtained under applied fertilizer nutrients i.e N₀ : P₆₀ : K₄₀ (T₁). When compared among different treatments of urea briquette and prilled urea treatments, it was observed that treatments of urea briquette i.e T₈ > T₆ > T₄ gave more grain yield than treatments of prilled urea i.e T₇ > T₅ > T₃. Prilled urea tends to increase various losses of nitrogen thereby decreasing its availability and hence records lower yield as compared with urea briquettes which induces slow release of nutrient reducing the losses and thereby higher nutrient uptake and produces higher yield. These results are in conformity with the findings of Kadam J.R (2001) that the placement of urea briquette enhance grain yield of rice over split application. The Urea-DAP briquette increased grain yield of rice from 11 to 86 per cent and gross yield 9 to 62 percent than prilled urea. Similarly, Kapoor et al.

(2008) observed that significantly higher grain yield was observed with deep placement of NPK briquette compared to broadcast applications.

4.1.6 Straw yield (q ha^{-1})

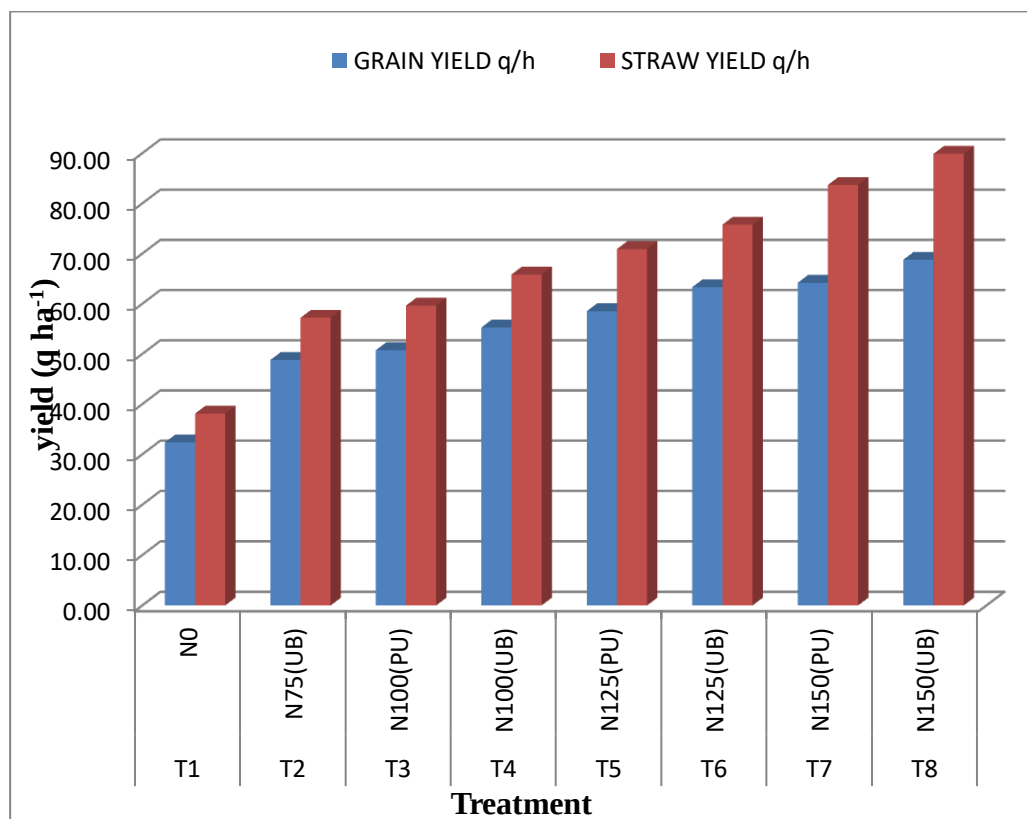
Response of different levels of nitrogen applied through urea briquette and prilled urea on straw yield of rice is presented in Table 4.4 and illustrated in Fig 4.4 which shows the significant variations on straw yield of rice. The straw yield ranged from 38.11 to 89.87 among the nitrogen levels. Among the nitrogen levels significantly highest straw yield (89.87 q ha^{-1}) was recorded under applied nitrogen @ 150 kg ha^{-1} through urea briquette (T_8) and the lowest yield (38.11 q ha^{-1}) obtained under applied fertilizer nutrients i.e $N_0 : P_{60} : K_{40}$ (T_1)

Hence urea briquette makes availability of nitrogen for longer period which enhances vegetative growth. El-Rewainy (2002), Meena *et al.* (2003) and Elbadry *et al.* (2004), and observed similar view on straw yield due to nitrogen applied through urea briquettes.

Table 4.4: Effect of different levels of nitrogen applied through urea briquette and prilled urea on grain and straw yield of rice

	Treatment	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
T_1	$N_0 : P_{60} : K_{40}$	32.36	38.11
T_2	N_{75} (UB)	48.78	57.20
T_3	N_{100} (PU)	50.75	59.64
T_4	N_{100} (UB)	55.26	65.82
T_5	N_{125} (PU)	58.52	70.90
T_6	N_{125} (UB)	63.30	75.75
T_7	N_{150} (PU)	64.18	83.67
T_8	N_{150} (UB)	68.77	89.87
	SEm$\pm$	1.37	1.37
	CD (p = 0.05)	4.09	4.18

Fig 4.4: Effect of different levels of nitrogen applied through urea briquette and prilled urea on grain and straw yield of rice



4.2 Effect of different levels of nitrogen applied through urea briquette and prilled urea on Nutrients content, uptake (N, P & K).

4.2.1 Nitrogen content (%)

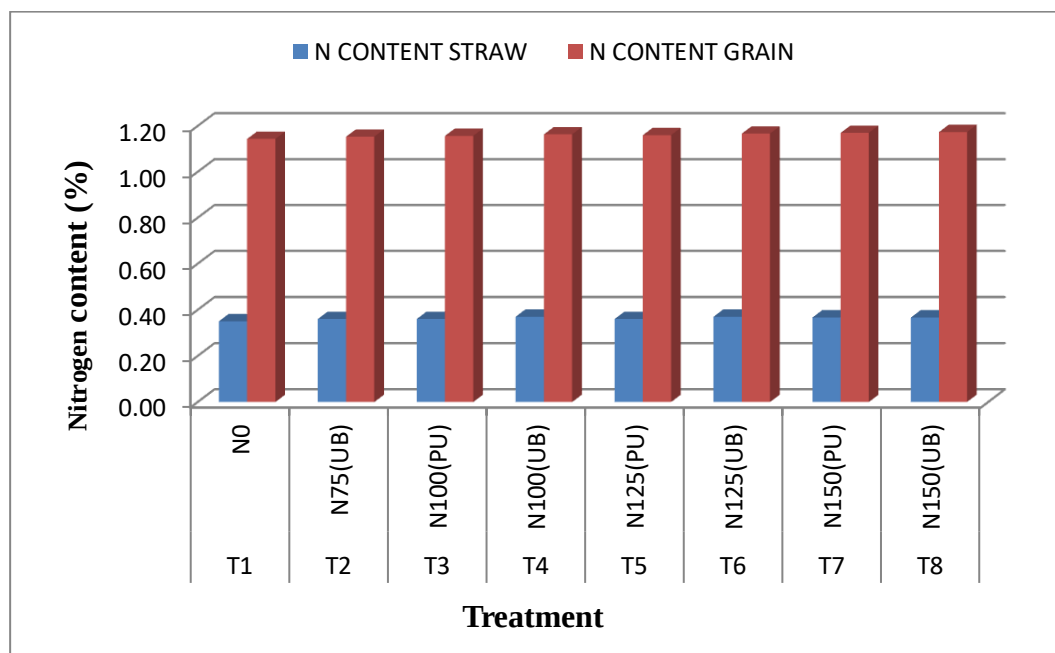
Grain and straw samples were analyzed for nitrogen content (%) and data are presented in Table 4.5 and in Fig 4.5. The findings revealed that none of the treatments of different levels of nitrogen applied through urea briquette and prilled urea gave significant effect on N content in grain and straw of rice. Though nitrogen content in grains ranged from 1.14-1.17 and in straw 0.35-0.37 in different treatments levels of nitrogen. The maximum N content in grain was noted under T₈ and T₇ followed by T₄, T₅, and T₆. However, in case of N content in straw, the highest value was observed under T₄ and T₆ followed by T₃, T₅, T₇ and T₈. The lowest N content in grain and straw noted under treatment T₁. Similar results, were also reported by Sharma et al. (2012) and Bora et al.(2018). The

effect of different levels of nitrogen for N content of grain and straw were found to be non-significant.

Table 4.5: Effect of different levels of nitrogen applied through urea briquette and prilled urea on Nitrogen content (%) of rice

Treatments		Nitrogen Content (%)	
		Grain	Straw
T ₁	N ₀ : P ₆₀ : K ₄₀	1.14	0.35
T ₂	N ₇₅ (UB)	1.15	0.36
T ₃	N ₁₀₀ (PU)	1.15	0.36
T ₄	N ₁₀₀ (UB)	1.16	0.37
T ₅	N ₁₂₅ (PU)	1.16	0.36
T ₆	N ₁₂₅ (UB)	1.16	0.37
T ₇	N ₁₅₀ (PU)	1.17	0.36
T ₈	N ₁₅₀ (UB)	1.17	0.36
SEm±		0.00	0.00
CD (p = 0.05)		NS	NS

Fig 4.5: Effect of different levels of nitrogen applied through urea briquette and prilled urea on nitrogen content (%) of rice



4.2.2 Phosphorus content (%)

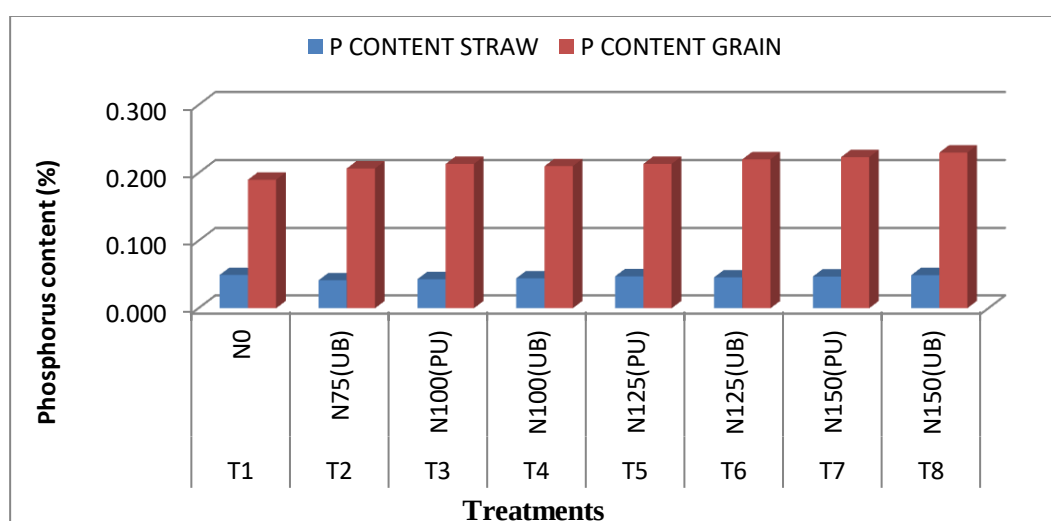
Grain and straw samples were analyzed for phosphorus content (%) and data are presented in Table 4.6 and in Fig 4.6. The findings revealed that none of the treatments of different levels of nitrogen applied through urea briquette and prilled urea gave significant effect on P content in grain and straw of rice. Though phosphorus content in grains ranged from 0.19-0.23 and in straw 0.40-0.49 in different treatments levels of nitrogen. The maximum P content in grain was noted under T₈ and T₇ followed by T₆, T₅, T₄, T₃, T₂. However, in case of P content in straw, the highest value was observed under T₈ and T₇, T₅ followed by T₆, T₄, T₃ and T₂. The lowest P content in grain and straw noted under treatment T₁.

Similar results were also reported by Sharma *et al.* (2012) and Bora *et al.* (2018). The effect of different levels of nitrogen for phosphorus content of grain and straw were found to be non-significant.

Table 4.6: Effect of different levels of nitrogen applied through urea briquette and prilled urea on phosphorus content (%) of rice

Treatment		Phosphorus Content (%)	
		Grain	Straw
T ₁	N ₀ : P ₆₀ : K ₄₀	0.19	0.040
T ₂	N ₇₅ (UB)	0.20	0.041
T ₃	N ₁₀₀ (PU)	0.21	0.043
T ₄	N ₁₀₀ (UB)	0.21	0.044
T ₅	N ₁₂₅ (PU)	0.21	0.047
T ₆	N ₁₂₅ (UB)	0.22	0.046
T ₇	N ₁₅₀ (PU)	0.22	0.047
T ₈	N ₁₅₀ (UB)	0.23	0.049
	SEm±	0.00	0.00
	CD (p = 0.05)	NS	NS

Fig 4.6: Effect of different levels of nitrogen applied through urea briquette and prilled urea on phosphorus content(%) of rice



4.2.3 Potassium content (%)

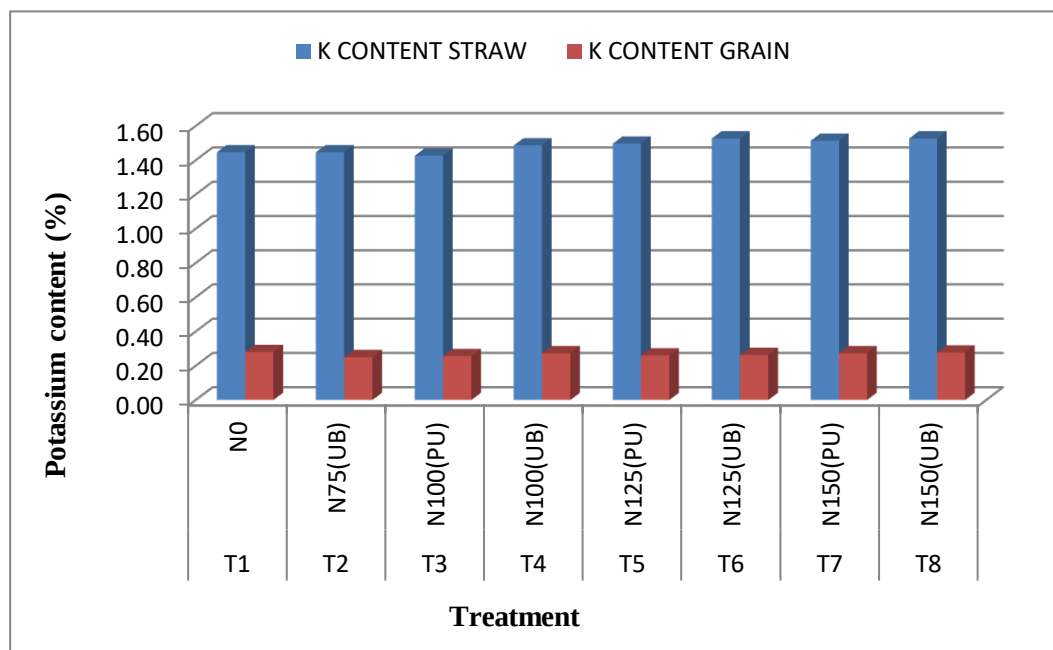
Grain and straw samples were analyzed for potassium content (%) and data are presented in Table 4.7 and in Fig 4.7. The findings revealed that none of the treatments of different levels of nitrogen applied through urea briquette and prilled urea gave significant effect on K content in grain and straw of rice. Though potassium content in grains ranged from 0.22-0.27 and in straw 1.44-1.52 in different treatments levels of nitrogen. The maximum K content in grain was noted under T₈ and T₇ followed by T₆, T₅, T₄, T₃, T₂. However, in case of K content in straw, the highest value was observed under T₈, T₆ followed by T₇, T₅, T₄, T₂ and T₃. The lowest K content in grain and straw noted under treatment T₁.

Similar results were also reported by Sharma *et al.* (2012) and Bora *et al.* (2018). The effect of different levels of nitrogen for phosphorus content of grain and straw were found to be non-significant.

Table 4.7: Effect of different levels of nitrogen applied through urea briquette and prilled urea on potassium content of rice (%) of rice

Treatment		Potassium Content	
		Grain	Straw
T ₁	N ₀ : P ₆₀ : K ₄₀	0.22	1.40
T ₂	N ₇₅ (UB)	0.23	1.44
T ₃	N ₁₀₀ (PU)	0.25	1.42
T ₄	N ₁₀₀ (UB)	0.25	1.48
T ₅	N ₁₂₅ (PU)	0.26	1.49
T ₆	N ₁₂₅ (UB)	0.26	1.52
T ₇	N ₁₅₀ (PU)	0.27	1.51
T ₈	N ₁₅₀ (UB)	0.27	1.52
SEm±		0.00	0.02
CD (p = 0.05)		NS	NS

Fig 4.7: Effect of different levels of nitrogen applied through urea briquette and prilled urea on Potassium content of rice



4.2.4 Nitrogen uptake (kg ha^{-1})

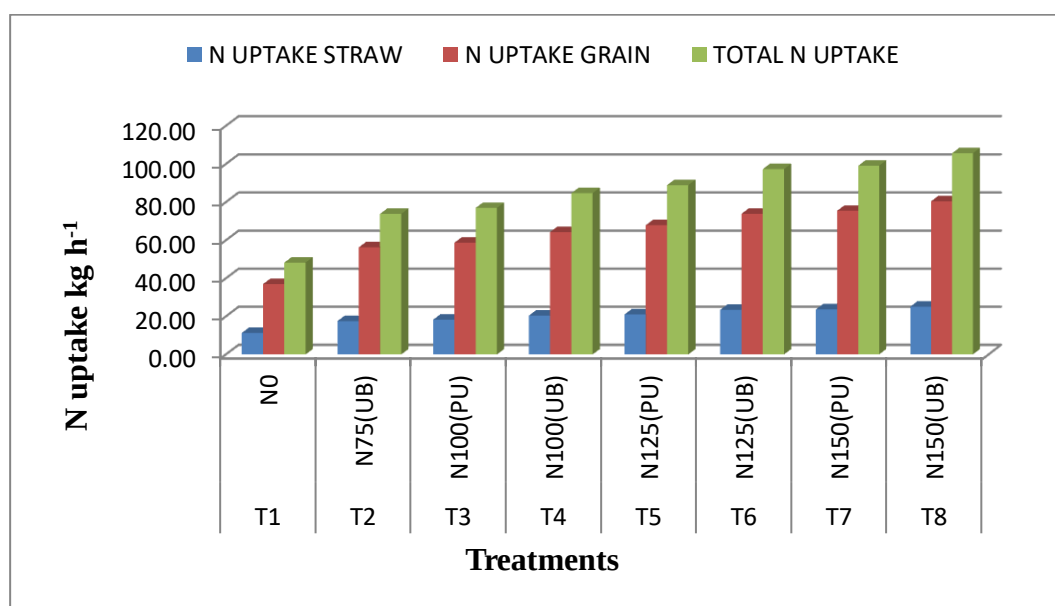
The data presented in Table 4.8 and in Fig 4.8 shows significant result on N uptake by rice as influenced by different levels of nitrogen applied through urea briquette and prilled urea. The results revealed that significantly highest N uptake in grain (80.21 kg ha^{-1}), straw (25.14 kg ha^{-1}) and their total ($105.36 \text{ kg ha}^{-1}$) was recorded under treatment @ 150 kg N ha^{-1} UB (T8) whereas the lowest value of N uptake in grain, straw and in their total was noted under $\text{N}_0\text{:P}_{60}\text{:K}_{40}$ (T₁) However, in case of straw comparable N uptake was also noted under treatment @ 150 kg N ha^{-1} PU (T₇).

The increased N uptake by grain and straw of rice might be due to increased availability of N in soil due to deep placement of UB at proper depth resulted in higher uptake. These findings are supported by Roy *et.al.* (2018).

Table 4.8: Effect of different levels of nitrogen applied through urea briquette and prilled urea on Nitrogen uptake (kg ha^{-1}) of rice

Treatments		Nitrogen uptake (kg ha^{-1})		
		Grain	Straw	Total
T ₁	N ₀ : P ₆₀ : K ₄₀	36.97	11.30	48.27
T ₂	N ₇₅ (UB)	56.26	17.55	73.82
T ₃	N ₁₀₀ (PU)	58.69	18.25	76.95
T ₄	N ₁₀₀ (UB)	64.30	20.39	84.70
T ₅	N ₁₀₀ (PU)	67.88	21.01	88.90
T ₆	N ₁₂₅ (UB)	73.85	23.45	97.30
T ₇	N ₁₅₀ (PU)	75.08	23.65	98.73
T ₈	N ₁₅₀ (UB)	80.21	25.14	105.36
SEm±		1.66	0.51	1.85
CD (p = 0.05)		5.04	1.55	5.63

Fig 4.8: Effect of different levels of nitrogen applied through urea briquette and prilled urea on Nitrogen uptake (kg ha^{-1}) of rice



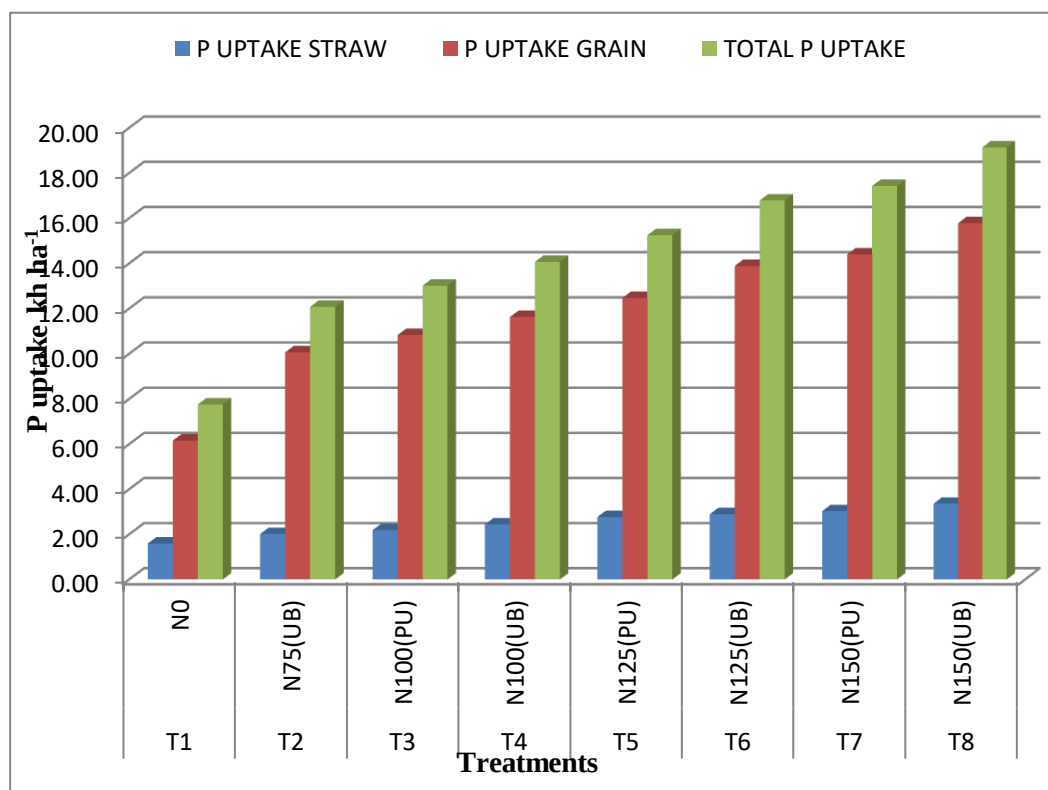
4.2.5 Phosphorus uptake (kg ha^{-1})

The data presented in Table 4.9 and in Fig 4.9 shows significant result on P uptake by rice as influenced by different levels of nitrogen applied through urea briquette and prilled urea. The results revealed that significantly highest P uptake in grain (15.83 kg ha^{-1}), straw (3.36 kg ha^{-1}) and their total (19.19 kg ha^{-1}) was recorded under treatment @ 150 kg N ha^{-1} (T_8) whereas the lowest value of P uptake in grain (6.16 kg ha^{-1}), straw (1.60 kg ha^{-1}) and their total (7.76 kg ha^{-1}) was noted under $N_0:P_{60}:K_{40}$ (T_1). However, in case of grain comparable P uptake was also noted under treatment T_7 . Similar results were also reported by Darade and Bankar (2009).

Table 4.9: Effect of different levels of nitrogen applied through urea briquette and prilled urea on Phosphorus uptake (kg ha^{-1}) of rice

Treatments		Phosphorus uptake (kg ha^{-1})		
		Grain	Straw	Total
T_1	$N_0:P_{60}:K_{40}$	6.16	1.60	7.76
T_2	N_{75} (UB)	10.06	2.02	12.08
T_3	N_{100} (PU)	10.83	2.19	13.01
T_4	N_{100} (UB)	11.63	2.44	14.07
T_5	N_{125} (PU)	12.48	2.77	15.25
T_6	N_{125} (UB)	13.89	2.90	16.79
T_7	N_{150} (PU)	14.34	3.03	17.37
T_8	N_{150} (UB)	15.83	3.36	19.19
SE m($\pm$)		0.51	0.10	0.52
CD ($p = 0.05$)		1.55	0.33	1.58

Fig 4.9: Effect of different levels of nitrogen applied through urea briquette and prilled urea on Phosphorus uptake (kg ha^{-1}) of rice



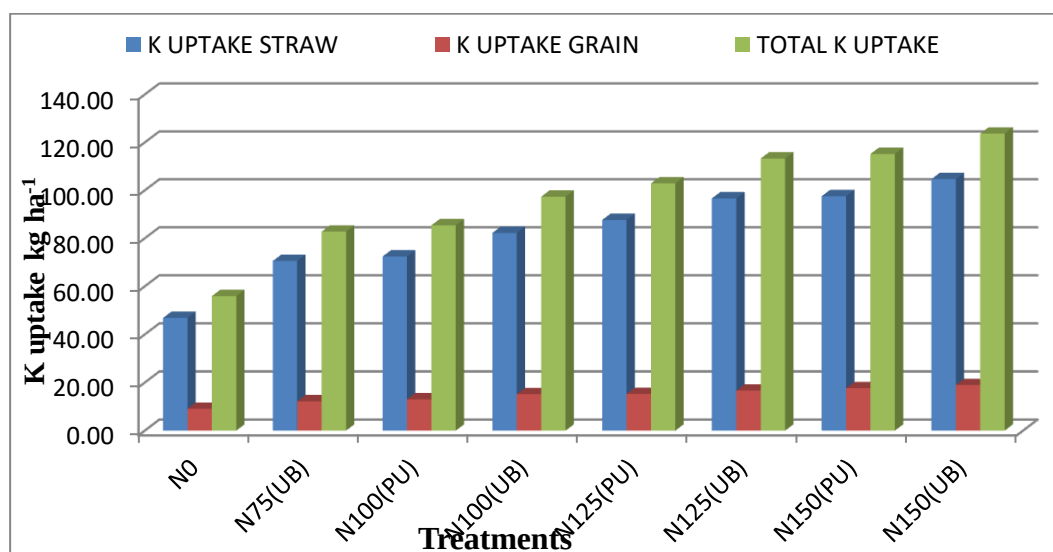
4.2.6 Potassium uptake (kg ha^{-1})

The data presented in Table 4.10 and in Fig 4.10 shows significant result on K uptake by rice as influenced by different levels of nitrogen applied through urea briquette and prilled urea. The results revealed that significantly highest K uptake in grain (19.02 kg ha^{-1}), straw ($104.70 \text{ kg ha}^{-1}$) and their total ($122.48 \text{ kg ha}^{-1}$) was recorded under treatment @ 150 kg N ha^{-1} (T₈) whereas the lowest value of K uptake in grain (9.06 kg ha^{-1}), straw (46.87 kg ha^{-1}) and their total (55.93 kg ha^{-1}) was noted under $\text{N}_0:\text{P}_{60}:\text{K}_{40}$ (T₁). However, in case of grain comparable K uptake was also noted under treatment T₇, T₆, T₅, T₄, T₃, T₂. Similar results were also reported by Darade and Bankar (2009).

Table 4.10: Effect of different levels of nitrogen applied through urea briquette and prilled urea on Potassium uptake (kg ha^{-1}) of rice

Treatments		Potassium uptake (kg ha^{-1})		
		Grain	Straw	Total
T ₁	N ₀ : P ₆₀ : K ₄₀	9.06	46.87	55.93
T ₂	N ₇₅ (UB)	12.21	70.54	82.75
T ₃	N ₁₀₀ (PU)	13.02	72.42	85.44
T ₄	N ₁₀₀ (UB)	15.13	82.23	97.36
T ₅	N ₁₂₅ (PU)	15.25	87.65	102.90
T ₆	N ₁₂₅ (UB)	16.63	96.67	113.30
T ₇	N ₁₅₀ (PU)	17.54	97.58	115.12
T ₈	N ₁₅₀ (UB)	19.02	104.70	122.48
SEm $\pm$		2.62	0.66	2.91
CD (p = 0.05)		7.95	2.00	8.84

Fig 4.10: Effect of different levels of nitrogen applied through urea briquette and prilled urea on Potassium uptake (kg ha^{-1}) of rice



4.2.7 Nitrogen use efficiency.

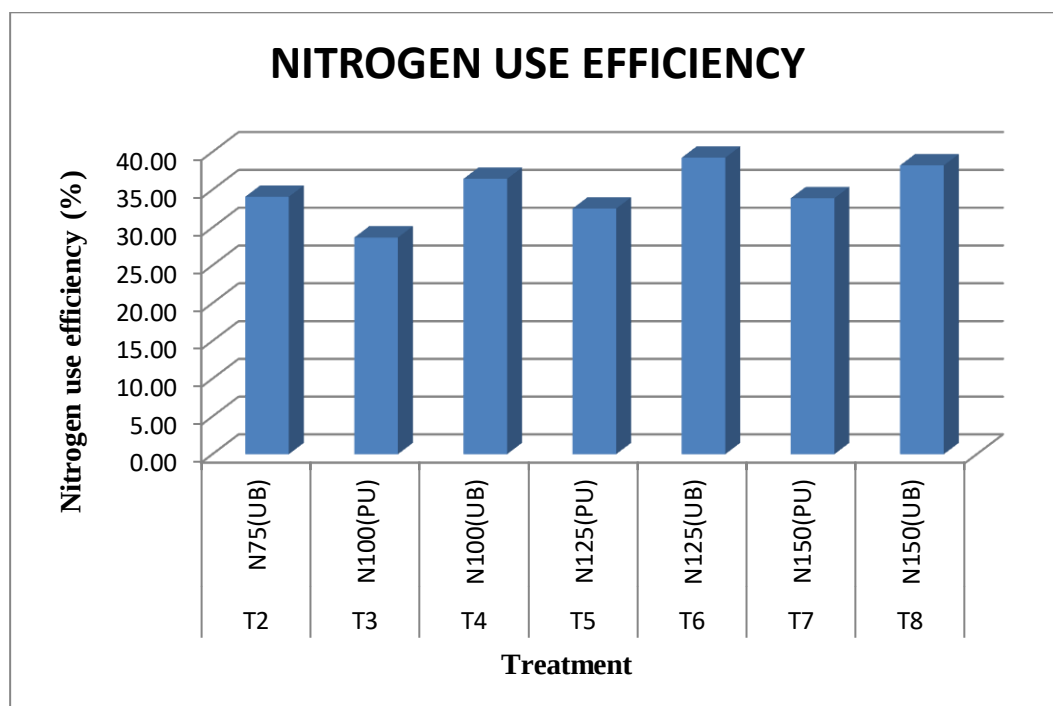
Nitrogen use efficiency (NUE) represents the response of rice plant in terms of grain yield to applied nitrogenous fertilizer. The data on NUE presented in Table 4.11 and in Fig 4.11 shows that the highest value of NUE (39.22 %) was recorded in treatment 125 kg N ha⁻¹ UB (T₆) followed by treatment @150 kg N ha⁻¹ UB (T₈) i.e 38.06% and lowest in treatment @ 100 kg N ha⁻¹ PU (T₃) i.e 28.68%. The NUE of different levels of nitrogen application is arranged in descending order as follows T₆> T₈>T₄>T₂>T₇>T₅>T₃. The treatments in which UB is placed observed to be more efficiently used nitrogen than other method of urea application.

These results indicate that application of urea briquettes in rice field decrease the losses of N which leads to efficient uptake and utilization of applied N. Similar findings were reported by Jena *et al.* (2003) that urea briquettes significantly improved NUE of rice and reduced volatilization loss of ammonia relative to the application of PU. Savant and Stangel (1990) also reported that the agronomic performance and NUE of deep placed USG was found to be superior to that of two or three split applications of urea through RDF.

Table 4.11: Effect of different levels of nitrogen applied through urea briquette and prilled urea on Nitrogen Use Efficiency (%) of rice

Treatments		Nitrogen Use Efficiency (%)
T ₂	N ₇₅ (UB)	34.06
T ₃	N ₁₀₀ (PU)	28.68
T ₄	N ₁₀₀ (UB)	36.43
T ₅	N ₁₂₅ (PU)	32.50
T₆	N₁₂₅(UB)	39.22
T ₇	N ₁₅₀ (PU)	33.63
T ₈	N ₁₅₀ (UB)	38.06

Fig. 4.11: Effect of different levels of nitrogen applied through urea briquette and prilled urea on Nitrogen Use Efficiency (%) of rice



4.3 Effect of different levels of nitrogen applied through urea briquette and prilled urea on Physico-chemical properties of soil after harvest of rice crop

4.3.1 Soil pH

The results on soil pH is recorded after harvest and presented in Table 4.12 and in Fig. 4.12. Soil pH differed non-significantly. The pH ranged from 6.07-6.27. The highest pH was found in treatment 150 kg N ha⁻¹UB (T₈) i.e 6.27 and the lowest pH was recorded in 75 kg N ha⁻¹ UB (T₂) i.e 6.07. The effect of nitrogen levels on pH was found to be non-significant, Similar results were also reported by Sikdar *et al.* (2008), Srivastava *et al.* (2014), kumar *et al.* (2017).

4.3.2 Electrical conductivity

The results on soil EC is recorded after harvest and presented in Table 4.12 and in Fig. 4.12. Soil EC differed non-significantly. The soil EC differed non-significantly, and ranged from 0.11 to 0.16 ds m⁻¹. The highest EC found in treatment 150 kg N ha⁻¹UB (T₈) i.e 0.16 and lowest in treatment N₀ (T₁) i.e 0.11. The effect of nitrogen levels for EC was found to be differed non-significantly,

similar results were also reported by Sikdar *et al.* (2008), Srivastava *et al.* (2014), kumar *et al.* (2017).

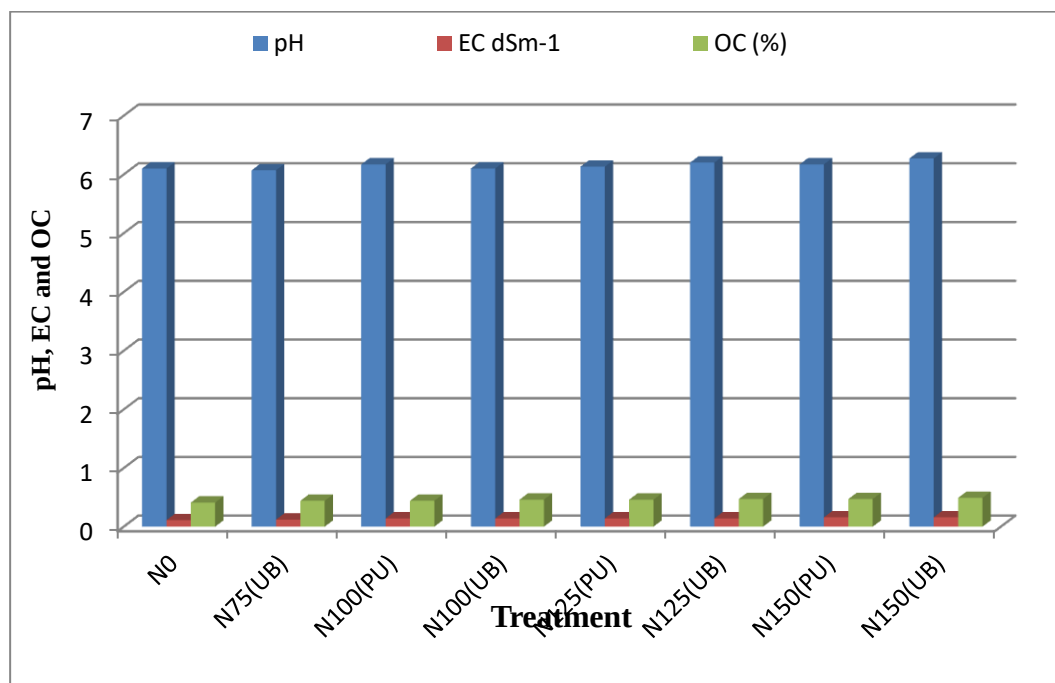
4.3.3 Organic carbon

The results on soil OC is recorded after harvest and presented in Table 4.12 and in Fig. 4.12. Soil OC differed non-significantly. The soil OC differed non-significantly, and ranged from 0.41 to 0.49 (%). The highest OC found in treatment 150 kg N ha⁻¹UB (T₈) i.e 0.49 and lowest in treatment N₀ (T₁) i.e 0.41. Similar results were also reported by Sikdar *et al.* (2008), Srivastava *et al.* (2014), kumar *et al.* (2017).

Table 4.12: Effect of different levels of nitrogen applied through urea briquette and prilled urea on pH, EC and OC of rice after harvest

	Treatments	pH	EC dSm ⁻¹	OC (%)
T1	N ₀ : P ₆₀ : K ₄₀	6.10	0.11	0.41
T2	N ₇₅ (UB)	6.07	0.12	0.44
T3	N ₁₀₀ (PU)	6.17	0.14	0.44
T4	N ₁₀₀ (UB)	6.10	0.14	0.46
T5	N ₁₂₅ (PU)	6.13	0.14	0.46
T6	N ₁₂₅ (UB)	6.20	0.14	0.47
T7	N ₁₅₀ (PU)	6.17	0.16	0.47
T8	N ₁₅₀ (UB)	6.27	0.16	0.49
	SEm±	0.03	0.01	0.01
	CD (P=0.05)	NS	NS	NS

Fig. 4.12: Effect of different levels of nitrogen applied through urea briquette and prilled urea on pH, EC and OC of rice after harvest



4.3.4 Effect on available NPK (Kg ha^{-1}) in soil after harvest

Data presented in Table 4.13 and in Fig 4.13 indicates the status of nutrients in soil after harvest. The data illustrates that available N (kg ha^{-1}) in soil at harvest was significantly affected by different levels of nitrogen. The available N in soil ranged from 137.18 to 180.33. The highest value ($180.33 \text{ kg ha}^{-1}$) of available N recorded under 150 kg N ha^{-1} (T_8) and lowest ($137.18 \text{ kg ha}^{-1}$) under T_1 (N_0).

Available P (kg ha^{-1}) in soil at harvest was also found significantly influenced by different levels of nitrogen. The available P in soil ranged from 15.05 to 16.92. The highest value (16.92 kg ha^{-1}) of available P recorded under T_1 (N_0) and lowest (15.05 kg ha^{-1}) under 125 kg N ha^{-1} UB (T_6).

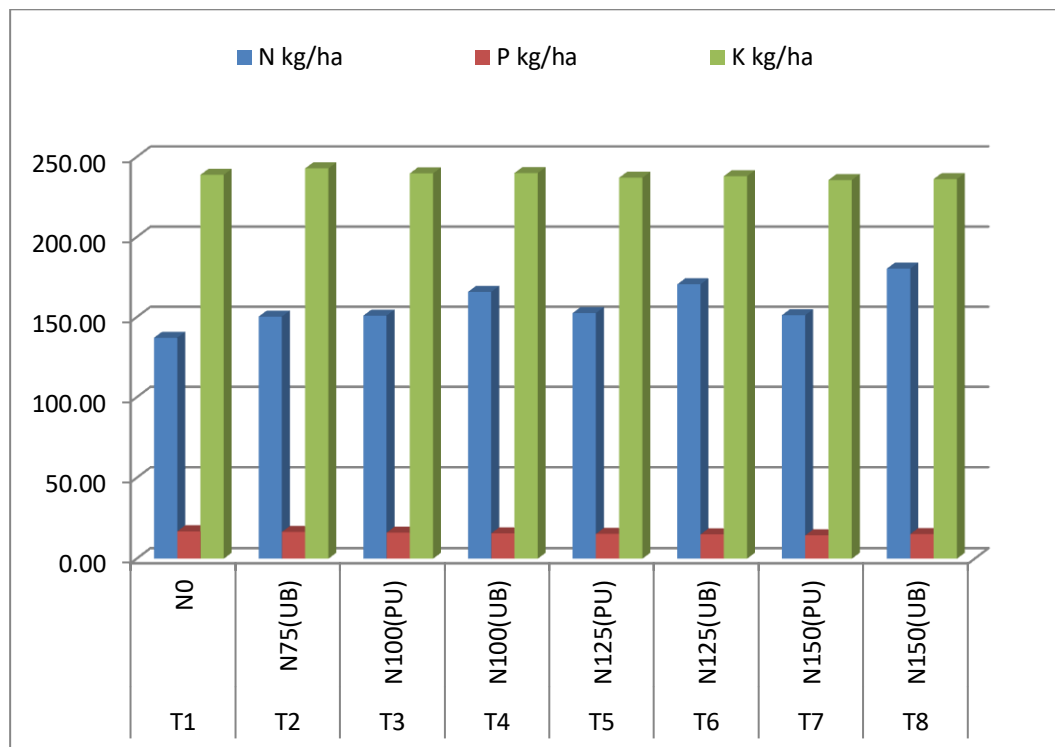
Similarly available K (kg ha^{-1}) in soil at harvest found significantly influenced by different levels of nitrogen application. The available K in soil ranged from 235.67 to 242.91. The highest value ($242.91 \text{ kg ha}^{-1}$) of available K was recorded under

treatment under 75 kg N ha⁻¹ UB (T₂) and lowest value (235.67 kg ha⁻¹) under treatment 150 kg N ha⁻¹ PU (T₇).

Table 4.13: Effect of different levels of nitrogen applied through urea briquette and prilled urea on N, P and K in soil after harvest

Treatments		Available Nutrients (kg ha ⁻¹)		
		N	P	K
T ₁	N0 : P60: K40	137.18	16.92	238.88
T ₂	N75 (UB)	150.39	16.54	242.91
T ₃	N100(PU)	151.00	16.10	239.78
T ₄	N100(UB)	165.81	15.72	240.00
T ₅	N125(PU)	152.59	15.32	237.09
T ₆	N125(UB)	170.56	15.05	238.07
T ₇	N150(PU)	151.30	15.07	235.67
T ₈	N150(UB)	180.33	15.25	236.22
	SEm±	1.09	0.12	0.81
	CD (p = 0.05)	3.33	0.36	2.47

Fig. 4.13: Effect of different levels of nitrogen application on available N P and K (kg ha^{-1}) in soil after harvest



CHAPTER-V

SUMMARY AND CONCLUSION

A field experiment was conducted at Krishi Vigyan Kendra, Mahasamund, (Chhattisgarh), on “Assessment of urea briquette application for maximization of rice yield and Nitrogen use efficiency in *Inceptisol*” during kharif-2020 in randomized block design with three replications. The experiment was comprised of eight treatments consist of different levels of nitrogen (N_0 , 75 kg N ha⁻¹, 100 kg N ha⁻¹, 125 kg N ha⁻¹ and 150 kg N ha⁻¹) combined with different levels of urea application i.e. broadcasting and manual application of urea briquettes. The result were recorded from the experiment during various crop growth stages and soil parameters were recorded before showing, during crop growth and after harvesting of crop. The major findings are highlighted below:

1. The experimental soil was sandy loam in texture pH (6.1) slightly acidic in reaction, the value of electrical conductivity (0.11 ds m⁻¹) and low in organic carbon (0.41 %). Available nitrogen, phosphorus and potassium status in soil was 137.98, 12.26 and 238.88 kg ha⁻¹ respectively.
2. All the yield attributing parameters plant height(cm), effective tillers hill⁻¹, number of filled grains panicle⁻¹ and test weight (g) were significantly influenced by N levels of urea application. The treatment which was treated with urea briquette @ 150 kg N ha⁻¹ applied through UB was found superior than other treatments.
3. Yield of rice i.e. (grain and straw yield q ha⁻¹) was also significantly influenced by different N levels of urea application through urea briquette and prilled urea. The highest grain (68.77 q ha⁻¹) and straw (89.87 q ha⁻¹) yield is recorded under treatment applied 150 kg N ha⁻¹(UB) which is found significantly higher than other treatments.
4. Total nitrogen, phosphorus and potassium uptake by the rice plant was also significantly responded by different N levels of urea application through urea briquette and prilled urea. Treatment under 150 kg N ha⁻¹ (UB) recorded significantly higher uptake of N, P and K than other treatments. The

results revealed that significantly highest N uptake in grain (80.21 kg ha^{-1}), straw (25.14 kg ha^{-1}) and their total ($105.36 \text{ kg ha}^{-1}$) was recorded under treatment T_8 (150 kg N ha^{-1}) whereas the lowest value of N uptake in grain, straw and in their total was noted under T_1 ($N_0:P_{60}:K_{40}$). Similarly highest P uptake in grain (15.83 kg ha^{-1}), straw (3.36 kg ha^{-1}) and their total (19.19 kg ha^{-1}) was recorded under treatment T_8 (150 kg N ha^{-1}) whereas the lowest value of P uptake in grain (6.16 kg ha^{-1}), straw (1.60 kg ha^{-1}) and their total (7.76 kg ha^{-1}) was noted under T_1 ($N_0:P_{60}:K_{40}$). And in K significantly highest K uptake in grain (19.02 kg ha^{-1}), straw ($104.70 \text{ kg ha}^{-1}$) and their total ($122.48 \text{ kg ha}^{-1}$) was recorded under treatment T_8 (150 kg N ha^{-1}) whereas the lowest value of K uptake in grain (9.06 kg ha^{-1}), straw (46.87 kg ha^{-1}) and their total (55.93 kg ha^{-1}) was noted under T_1 ($N_0:P_{60}:K_{40}$).

5. Overall nitrogen use efficiency (%) decreased with increasing levels of applied nitrogen from 125 to 150 kg N ha^{-1} . The highest NUE 39.22(%) was recorded through urea briquette applied N @ 125 kg ha^{-1} and the lowest 28.67 (%) noted with applied N @ 100 kg ha^{-1} through prilled urea respectively.
6. Soil analysis at harvest shows significant influence by different N levels of urea application through urea briquette and prilled urea on available NPK. Available nitrogen content increased and phosphorus and potassium decreased in soil with increased levels of applied nitrogen irrespective to UB and PU. The highest available nitrogen $180.33 \text{ kg ha}^{-1}$ recorded under applied N 150 kg ha^{-1} through UB.

Conclusion

Based on the above experimental field study and results following conclusion can be drawn:

1. Among different levels of applied nitrogen, urea briquette placement @ 150 kg N ha^{-1} had improved rice grain yield and yield attributing parameters viz., plant height⁻¹, effective tillers⁻¹, panicle⁻¹, grains panicle⁻¹ etc. as compared to broadcasted prilled urea and other levels of applied N.

2. Application of urea briquette @ 150 kg N ha⁻¹ showed higher uptake of nitrogen ,phosphorus and potassium rice as compared to broadcasted prilled urea and other levels of applied N. Overall higher NUE found with urea briquette than prilled urea application and the highest NUE recorded @125 kg N ha⁻¹ through applied UB and the lowest with applied PU @100 kg N ha⁻¹ respectively.
3. Soil physico-chemical properties after harvest of rice crop like pH, EC OC was not affected with applied nitrogen levels through UB & PU whereas available nitrogen in soil improved and more in applied UB as compared to PU plots whereas available P and K status decreased with increased applied N levels.

Suggestions for future work

1. Detailed research work should be carried out using higher levels of nitrogen through different sources in order to maximize productivity under different agro-ecological conditions at farmer's field with economics.
2. Possibility of integrating other sources of nutrients in the form of briquette or super granule may be worked out for increasing nutrient use efficiency.



Urea briquette application



Experimental field

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