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Influences of nutrient alteration by organic and inorganic sources on protein content, their yield and economics of the transplanted rice (*Oryza sativa* L.)

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Abstract
A field study was undertaken at Agronomy Research Farm of Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) during *Kharif* season of year 2018, to evaluate the effects of integrated nutrient management on protein content, their yield and economics of transplanted rice (*Oryza sativa* L.). This experiment was laid out in randomized block design (RBD) with eight treatments *viz*.- T_1- Control, T_2- RDF 100% (150:60:60:20 NPK and zinc sulphate), T_3- RDF 75% + 25% N through poultry manure, T_4- RDF 75% + 25% N through FYM, T_5- RDF 75% + 25% N through pressmud, T_6- RDF 50% + 50% N through poultry manure, T_7- RDF 50% + 50% N through FYM, T_8- RDF 50% + 50% N through pressmud, respectively and replicated three times in the field. The study of the data of the experiment showed that the protein content was non-significant, however, yield of protein of transplanted rice were significantly influenced through different INM practices during the experiment and economics were also differed with integration of chemical fertilizers and organic manures.
Further results indicated that the protein content in grains of transplanted rice was found maximum under treatment T_2 [RDF 100% (150:60:60:20 NPK and zinc sulphate)], while, this data was non-significant. However, significantly maximum protein yield (314.99 kg ha^{-1}) was recorded under treatment T_2 [RDF 100% (150:60:60:20 NPK and zinc sulphate)], which remained at par with treatment T_3 (RDF 75% + 25% N through poultry manure) (298.07 kg ha^{-1}). Maximum gross return (Rs. 84199 ha^{-1}), net return (Rs. 43644 ha^{-1}) and B: C ratio (Rs. 1.08 ha^{-1}) were also obtained under T_2 treatment [RDF 100% (150:60:60:20 NPK and zinc sulphate)].

Keywords: Rice, integrated nutrient management (INM), protein content, protein yield, economics

1. Introduction

Rice (*Oryza sativa* L.) is one of the most major and reliable food crops in existence. Rice belongs to the Poaceae family. Rice productivity depends on the crop growing range being successfully completed and the effective developmental activities for individual plants, which fully utilize the genetic potential of the cultivar and are well integrated with the essential components for success and sustainability of rice production. For 40% of the world's population, it serves as their primary source of calories (Virdia and Mehta, 2009) [25]. Since the world population is expanding at an alarming rate, there is no longer space to expand the net cultivable area for food production. Utilizing high yielding rice cultivars' production potential through agronomic management is one way to feed the world's expanding population. Because of this, fertilizers have significantly aided in the astounding rise in rice yield. However, using fertilizers carelessly while producing crops has led to the destruction of lands due to low yields and subpar output.

Protein is very important constituent of our nutrition and the yield of protein by any crop is related with the content of protein and their economic yield (like- grain yield in cereals and pulse crops and leaf yield in leafy vegetable crops etc.). It has been proved by many researches that the content of protein in rice grains were significantly affected by the nutrient management. So far, for increasing the content of the protein integration of nutrient through inorganic chemical fertilizers and organic manures is very important aspect in rice crop. Chaudhary *et al*. (2005) [4] reported that the protein content and yield of the rice crop in the rice-wheat crop system in the north-western Himalaya were considerably impacted by the use of numerous organic manures and inorganic synthetic fertilizers.

Production rose throughout the 1960s Green Revolution era caused by an uptick in rice-wheat acreage regarding overall system performance. However, in existence currently not much more land available, and urbanization is quickly displacing traditional farming.

As a result, increasing production per harvested area will be predominantly required to meet future food demand (Ladha *et al*., 2000) [11]. According to Satyanarayana *et al*. (2002) [19], using synthetic fertilizer to maintain cultivation was observed to boost merely yield temporarily and has a negative impact on the soil over the long run. However, rice fields treated with organic manure alone continuously, saw poor yields and low N and K contents at the mid-tillering stage of the plant's growth (Javier *et al*., 2004) [9]. It also means that the growth of rice involves synchronized nourishment control. It is advised to employ a combination of biodegradable manures and inorganic fertilizers to address slight secondary and micronutrient shortage issues, boost the beneficial effects of applied nutrients and enhance soil physical conditions (Gill and Walia, 2014) [7].

To increase crop yields, inorganic fertilizers and plant protection products were used blindly, causing to an inequality in the N: P: K fertilizer ratio, and this in turn brought to a decline in the physiological, chemical-based and biological state of the soils used to grow wheat and rice. The sustainability of the wheat-rice system of cultivation is currently being questioned in light of stagnating or declining growth rates rice and wheat yields in various states, including Punjab, Haryana, Eastern Uttar Pradesh, Madhya Pradesh, Bihar, Himachal Pradesh and Jammu & Kashmir (Mahajan and Gupta, 2009 [14]; Ladha *et al.*, 2000 [11]). (INM) is one of the best and most versatile techniques for using nutrients from both synthetic and organic origins boost the yields of crop without reducing fertility of soil. For optimum growth, rice plants require a enough supply of nutrients from various sources. Local resources including manure, soil organic material, minerals from the soil, with moisture provide these nutrients, to attain high and sustainable yields, nevertheless the amount usually provided is inadequate. The quantity provided can frequently be insufficient to generate high and durable yields, though. Nevertheless, given the fact that low levels of nutrients present, it's possible that organic manures alone won't be enough to suit the plant's necessities. Therefore, combining organic manures with fertilizers that are synthesized are required to ensure that the soil is adequately provided containing every plant nutrient in its easily accessible form as well as to preserve healthy soil in order to produce the highest possible yields (Lakshmi *et al.*, 2012) [12]. The decline in soil fertility is a significant barrier to increased agricultural output. higher levels of land use without proper and balanced synthetic fertilizer use and short to no organic manure use has severely degraded our soils' fertility, which has led to stagnant or even declining crop output. Manures, bio fertilizers and other integrated chemical and organic sources, along with their effective management, not only support s both the physical and biological health of the soil as well as partially satisfy crops' need for chemical fertilizer (Babu *et al*., 2007) [2]. According to Farouque and Takeya (2007) [6], the INM's (integrated nutrient management) purpose is to utilize all the primary sources nutrition for plants wisely and effectively. The major components of the INM system include fertilizers, farmyard waste, compost, green manure, farm waste or recyclable materials and bio fertilizers. As a result of regulating the nutrient supply as well as minimizing nutrient losses to the ecosystem, INM had been demonstrated to significantly increase rice yields (Parkinson *et al*., 2013) [17]. Chicken faeces are used as an organic fertiliser known as poultry manure, particularly for soils with low nitrogen content. It has the greatest amount of nitrogen, phosphorus and potassium of all animal manures. Nitrogen, potassium, phosphorus, calcium, magnesium, sulphur, manganese, copper, zinc, chlorine, boron, iron and molybdenum are all present in poultry manure. As it provides all necessary plant nutrients and boosts the activity of soil microorganisms, the usage of manure from farmyards (FYM) significant field crops' natural source of manure that is organic (Sutaliya and Singh, 2005)[23]. As an organic waste product from sugar factories, pressmud is a useful source of organic manure for soil application. It has numerous admirable qualities and has positive effects on the soil's biological, chemical, and physical characteristics. Additionally, it increases the efficiency with which chemical fertilisers are used. According to Kumawat and Jat (2005)[10] pressmud is a useful organic manure to use with field crops.

2. Material and Methods

2.1 Site of experiment

This field trial was carried out at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya (Uttar Pradesh).

The experimental location is located on the university's main campus, 42 kilometres from the Ayodhya headquarters along the Ayodhya-Raibarelly route.

2.2 Geographical situation and climatic condition

Geographically, experimental site (Kumarganj) is located at $24^0$40' to $26^0$47' North latitude and in the Indo-gangetic regions of Uttar Pradesh, the location is $81^0$12' east longitude and 113 metres above mean sea level.

The district Ayodhya experiences a sub-humid climate with average annual precipitation of 1143 mm, about 90% of which falls between mid-June and the end of September. May and June are the hottest month. The area is coming under a subtropical region that experiences frigid winters and hot, dry summers. Rainfall is more frequently confined to the months of July through September, with intermittent winter and summer torrential downpour. The distribution of rainfall is not uniformly during crop season. The winter months are colder, and there may be some frost at this time. Summer is a dry, scorching time that commences in April and continues for until the commencement of the monsoon. The experimental field had excellent irrigation and drainage systems and was levelled quite adequately.

2.3 Weather condition during crop season

The data during the crop period, meteorological observations included the weekly pattern of rainfall, peak and smallest temperatures, relative humidity, speed of the wind, mean evaporation rate, and sunlight hours have been recorded from the meteorological observatory situated at University main campus, Kumarganj. During the crop period in 2018, there was a total of 956 millimetre of rainfall. In contrast to the maximum temperature of (27.9^{0}C) in the month of June in 2018, a minimum temperature of 20^{0}C was recorded in the month of October in 2018. In August of 2018, when it reached 92.4%, the relative humidity was at its greatest.

2.4 Edaphic conditions

With the aid of a soil auger, soil samples were randomly taken from 10 different locations within the experimental field in order to assess the physico-chemical properties of the soil and its fertile grade. Table-1 contains a list of the results gathered resulting from the mechanical and chemical analyses. The study of data reveals that the texture of the soils of the experimental field comprised silty loam with ideal bulk density and optimum field capacity and infiltration rate. The chemical reaction of the soil was saline in nature. The soil had medium levels of phosphate and potassium but was poor in organic carbon and nitrogen.

2.5 Description of variety

The rice variety NDR-2065 (IET 17476) is released from NDUAT, Kumarganj, Ayodhya, U.P., in year 2011 which is suitable for irrigated eco-system. This semi-dwarf cultivar has long, angular grains and stands between 105 and 110 cm tall height. It is resistant to sheath rot and moderate resistant to bacterial leaf blight (BLB), sheath blight and brown spot. The duration of variety is 120-125 days this produces an average of 50-55 quintals per hectare. The variety matures in about 120-125 days and yields 50-55 quintals on average per hectare.

2.6 Experimental details and methodology

This field trial was carried out in Randomized Block Design (R.B.D.), with eight different treatment combinations and three replications. Treatments consists of T_1- Control, T_2- RDF 100% (150:60:60:20 NPK and zinc sulphate), T_3- RDF 75% + 25% N through poultry manure, T_4- RDF 75% + 25% N through FYM, T_5- RDF 75% + 25% N through pressmud, T_6- RDF 50% + 50% N through poultry manure, T_7- RDF 50% + 50% N through FYM, T_8- RDF 50% + 50% N through pressmud, respectively. The treatments throughout the plots were all assigned at random. FYM, Poultry manure and press mud as per treatment were consistently implemented in the plots before 15 days of transplanting of rice seedling, to the depth of 10-15 cm and followed by submergence. One-third dose of nitrogen (through urea), total dose of Phosphorus and Potash were applied as basal application before puddling and incorporated in 15 cm deep in the soil, urea was used to apply the remaining amount of nitrogen in two split portions, throughout the tillering and panicle initiation stages, respectively. Seedlings placed into the field were 25 days old. At a depth of 3 cm, one seedling hill^{-1} was transplanted. The planting was done at a distance of 20 x 10 cm spacing.

Table 1: Physical and chemical characteristics of experimental soil before trial (2018)

Particulars	Values	Methods employed
A. Physical Properties		
Sand (%)	26.87	Bouyoucus hydrometer method (Bouyoucus, 1936) [3]
Silt (%)	50.31	
Clay (%)	23.02	
Texture class	Silt loam	Triangular method (Lyon *et al.*, 1952) [13]
Field capacity (%)	22.91	Gravimetric method
Bulk density (gm cm^{-3})	1.37	Soil core method
Infiltration rate (mm hr^{-1})	2.13	Double ring Infiltrometer
B. Chemical Properties		
Soil pH	8.46	1:2.5 Soil water suspension method (Jackson, 1973) [8]
Soil Organic carbon (%)	0.24	Walkley and black rapid titration method (Walkley and Black, 1947) [26]
Soil EC (dSm^{-1} at 250c)	0.34	Electrical conductivity bridge method
Available soil N (kg ha^{-1})	165.37	Alkaline permanganate method (Subbiah and Asija, 1956) [22]
Available soil P (kg ha^{-1})	15.45	Olsen's method (Olsen *et al.*, 1954) [16]
Available soil K (kg ha^{-1})	262.73	Flame photometer method (Jackson, 1973) [8]

2.7 Protein content in grains (%)

After determining the total nitrogen content, the percentage of protein in grains was estimated by multiplying the value by a factor of 6.25 (AOAC, 1970) [1].

2.8 Protein yield (kg ha^{-1})

The protein yield, which is expressed as kg ha^{-1}, was computed through the multiplication of the protein content (%) of rice crop grains by the grain yield of the rice crop.

2.9 Cost of cultivation (Rs. ha^{-1})

The cost for cultivating various treatments has been determined by taking into account all the costs and multiplying them by the average cost associated with the various processes and inputs used. For each treatment combination, the cost of cultivation was determined accordingly.

2.10 Gross return (Rs. ha^{-1})

Grain and straw yields under various treatment combinations were multiplied by the prevailing market prices for determining gross return. For the purpose of determining the gross return, the monetary values of the grain and straw were combined.

2.11 Net returns (Rs. ha^{-1})

Net return has been determined by subtracting the cultivation expanses from the gross return of the individual integrated nutrient management treatment combinations.

Net return = Gross return - Cost of cultivation

2.12 Benefit- cost ratio

Benefit-cost ratio was determined by dividing the net return by the cultivation expenses of the individual integrated nutrient management treatment combinations.

$$\text{B:C ratio} = \frac{\text{Net return (Rs. ha}^{-1})}{\text{Cost of cultivation (Rs.ha}^{-1})}$$

3. Results and Discussion

3.1 Protein content in grains (%)

The protein content in grains of transplanted rice was not considerably impacted by various INM interventions. But it was clearly reveals from data demonstrated treatment T_2-

RDF 100% (150:60:60:20 NPK and zinc sulphate) (7.18%) produced rice grains with the highest level of protein content in grains of rice and minimum under treatment T_1- control (7.09%). It was discovered that the differences caused on by various treatments were not substantial. It might due to the levels of nitrogen were non-significant in grains of rice and after multiplying the factor by the nitrogen concentration of rice grains, the protein content was computed. Choudhary *et al*. (2005) [4] and Mishra *et al*. (2021) [15] reported the related reports as well from their experiment that the inorganic treatment resulted in maximum protein content in rice grains and lowest in control treatment.

Table 2: Impact of integrated nutrient management on protein content (%) and protein yield (kg ha^{-1}) of rice crop

Symbol	Treatments	Protein content in grain (%)	Protein yield (kg ha^{-1})
T_1	Control	7.09	144.49
T_2	RDF 100% (150:60:60:20 NPK and Zinc sulphate)	7.18	314.99
T_3	RDF 75% + 25% N through Poultry manure	7.16	298.07
T_4	RDF 75% + 25% N through FYM	7.13	264.45
T_5	RDF 75% + 25% N through Pressmud	7.15	272.49
T_6	RDF 50% + 50% N through Poultry manure	7.12	246.49
T_7	RDF 50% + 50% N through FYM	7.11	225.74
T_8	RDF 50% + 50% N through Pressmud	7.11	241.60
SEm ±		0.15	8.03
C.D.		NS	24.58

3.2 Protein yield (kg ha^{-1})
The study of the data revealed that the yield of protein of transplanted rice was significantly maximum in treatment T_2 [RDF 100% (150:60:60:20 NPK and zinc sulphate)] (314.99 kg ha^{-1}) which remained at par with T_3 (RDF 75% + 25% N through poultry manure) (298.07). While, the minimum protein yield was observed under control treatment (T_1) (144.49 kg ha^{-1}). It was because the protein yield was calculated after multiplying the protein content in rice grains and grain yield of rice crop and grain yield was maximum in T_2 and minimum under T_1 treatment. That is why the protein yield was maximum under T_2 treatment and minimum under treatment T_1. Choudhary *et al*. (2005) [4] found the similar results from there two years of experiments and a finding that the usage of sole inorganic synthetic fertilizers obtained the maximum protein yield of rice crop, both the years in their research.

3.3 Cost of cultivation (Rs. ha^{-1})
The perusal of data reveals that the highest cost expenses of Rs. 47495 ha^{-1} was recorded under treatment T_6 (RDF 50% + 50% N through poultry manure), which was followed by treatment T_2 [RDF 100% (150:60:60:20 NPK and zinc sulphate)] (Rs. 40555 ha^{-1}). Control treatment (T_1) had the minimum cost of cultivation, it was because, no fertilizers or manures was used in this treatment, so there were no costs of fertilizers inputs in control treatment. While, treatment T_6 had the maximum cost of cultivation, because in this treatment there was many chemical fertilizers and poultry manure were used to provide the nitrogen, phosphorus and potassium to transplanted rice crop and the costs of these inputs were expansive which resulted in the maximum cost of cultivation. Venkatesha *et al.* (2015) [24] also investigated that the maximum cultivation costs were seen in treatments that having the integration of organic manure with inorganic fertilizers.

3.4 Gross return (Rs. ha^{-1})
The examination of data of gross revenue shows that maximum gross returns was recorded under treatment T_2- RDF 100% (150:60:60:20 NPK and zinc sulphate) (Rs. 84199 ha^{-1}) which was followed by treatment T_3 (RDF 75% + 25% N through Poultry manure) (Rs. 80277 ha^{-1}). However, the minimum gross returns were obtained with treatment T_1- - control (Rs. 39971 ha^{-1}). Treatment T_2 received the maximum gross return, because the gross returns of transplanted rice were calculated after selling the outputs (Grain and straw yield) in the market and treatment T_2 obtained the maximum grain and straw yield. So, the maximum grain and straw yield gave the maximum money returns from the market and T_2 resulted in maximum gross returns. While, the control treatment recorded the minimum outputs (Grain and straw yield) and it received minimum money returns from selling grain and straw yield of transplanted rice in the market. So, control treatment (T_1) resulted in minimum gross returns from transplanted rice. Srinivasarao *et al*. (2020) [21] also found the similar results in their research that the use of 100% RDF along with organic manure and bio-fertilizers gave the maximum gross returns.

Table 3: Impact of integrated nutrient management on economics of different treatment combinations

Symbol	Treatments	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B : C ratio
T_1	Control	34436	39971	5535	0.16
T_2	RDF 100% (150:60:60:20 NPK and Zinc sulphate)	40555	84199	43644	1.08
T_3	RDF 75% + 25% N through Poultry manure	44025	80277	36252	0.82
T_4	RDF 75% + 25% N through FYM	43525	71576	28051	0.64
T_5	RDF 75% + 25% N through Pressmud	43461	73498	30037	0.69
T_6	RDF 50% + 50% N through Poultry manure	47495	66966	19471	0.40
T_7	RDF 50% + 50% N through FYM	46495	61873	15378	0.33
T_8	RDF 50% + 50% N through Pressmud	46367	65941	19574	0.42

3.5 Net returns (Rs. ha^{-1})
The study of the data shows that the highest net return of Rs. 43644 ha^{-1} was produced with treatment T_2- RDF 100% (150:60:60:20 NPK and Zinc sulphate) from transplanted rice, which was followed by treatment T_3 (RDF 75% + 25% N through Poultry manure) (Rs. 36252 ha^{-1}). However,

minimum net returns from transplanted rice were found under the treatment T_1- control (Rs. 5535 ha^{-1}). Treatment T_2 received the maximum net returns for transplanted rice, it was because the net return of transplanted rice was computed after deducting the cultivation cost from the gross returns from each treatment's unique application combinations and the gross return was maximum in treatment T_2 in comparison to the cost of cultivation in this treatment, which further resulted in maximum net returns of transplanted rice in this treatment (T_2). While, control treatment (T_1) gave the minimum net return because this treatment received the minimum gross return in comparison to cost of cultivation in control treatment, which resulted in minimum net returns of transplanted rice in control treatment (T_1). Singh *et al.* (2004) [20], and Patro *et al.* (2011) [18] claimed that the use of 100% RDF gave the similar findings related to this research.

3.6 Benefit- cost ratio

The perusal of data disclosed the best benefit-cost ratio of transplanted rice was noted under treatment T_2- RDF 100% (150:60:60:20 NPK and zinc sulphate) (Rs. 1.08) which was followed by treatment T_3 (RDF 75% + 25% N through Poultry manure) (0.82). However, minimum B: C ratio from transplanted rice was obtained under the treatment T_1- control (0.16). Treatment T_2 and T_1 recorded the highest and lowest B: C ratio of transplanted rice crop. It was because the net return was divided by the cost of cultivation for each of the various treatment combinations to determine the benefit-cost ratio and the treatment T_2 had the maximum net returns in comparison to the lower cost of cultivation in this treatment which further resulted in highest B: C ratio of transplanted rice crop. While, control treatment had the minimal net returns in comparison to higher cost of cultivation in this treatment which resulted in lowest B: C ratio of transplanted rice crop. Dass *et al.* (2009) [5] and Patro *et al.* (2011) found the similar findings from there research. They also reported that the 100% RDF from chemical fertilizers gave the maximum B: C ratio of rice crop.

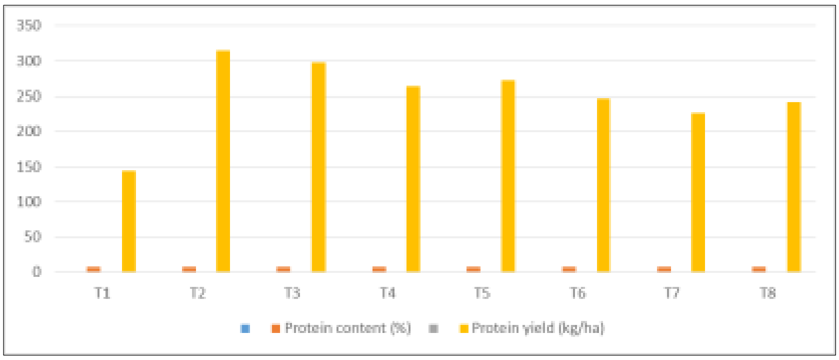

Fig 1: Impact of integrated nutrient management on protein content (%) and protein yield (kg ha^{-1}) of rice crop

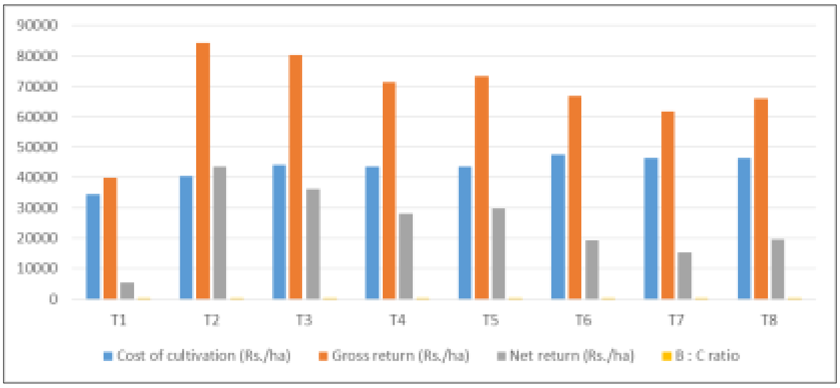

Fig 2: Impact of integrated nutrient management on economics of different treatment combinations

Conclusion

This study emphasises the significance of managing nutrients in transplanted rice crop through the integration of the inorganic chemical fertilizers and organic manures. The outcomes of this field study showed that the protein content in grains of transplanted rice and yield of protein of transplanted rice was significantly affected. However, economics of the transplanted rice was also differed with integrated nutrient management. This study concludes that the farmers can practice the integrated nutrient management for transplanted rice crop. However, farmers can use the recommended dose of nutrients could be provided by the inorganic chemical fertilizers for getting higher protein content in grains of transplanted rice, protein yield from transplanted rice and for obtaining maximum gross returns, net returns and benefit-cost ratio form transplanted rice crop.

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