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# The Effect of Integrated Nutrient Management on Growth, Yield Attributes and Yield of Transplanted Rice under Irrigated Condition (*Oryza sativa* L.)

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

The present investigation was carried out in *kharif* season 2022-23 at Agronomy Research Farm of Chandra Bhanu Gupta Krishi Snatakottar Mahavidyalaya, Bakshi ka Talab, Lucknow (U.P). The 8 treatments comprised of T1- RDF(IF), T2- 100% RDF+25 kg ha$^{-1}$ ZnSO4 (B), T3-100% RDF+2 foliar

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spray of ZnSO4, T4- RDF+50 kg ha$^{-1}$ FeSO4 (B),T5-100% RDF+ZnSO4 25 kg ha$^{-1}$ (B) + FeSO4 @ 50 kg ha$^{-1}$ (B), T6- 75% RDF (IF)+25% RDN (FYM), T7- 50% RDF (IF)+50% RDN (FYM),T8- 100% RDF through FYM were laid out in Randomized Block Design (RBD). The soil was silty-loam texture with slightly alkaline pH 8.1, organic carbon 0.70 %, available nitrogen 270.00 kg ha$^{-1}$, available phosphorus 27.0 kg ha$^{-1}$, and available potash 262.0 kg ha$^{-1}$ during 2022-2023. The values of growth contributing characters viz., plant height (cm), number of tillers per m$^2$ (439.73), dry matter accumulation (g m $^{-2}$ ) (829.62), at harvest and significantly highest (6.33) leaf area index (LAI) was recorded under 100% RDF + 2 foliar spray of ZnSO4 and yield attributes and yield like number of effective tillers per m$^{-2}$ (200.66), panicles weight (g)(4.51), length of panicle (cm) (28.33), number of grains panicle$^{-1}$ (175.33), test weight (g) (29.10), grain yield (47.85), straw yield (q ha$^{-1}$ ) (64.75) of rice were significantly higher under T3- 100% RDF + 2 foliar spray of ZnSO4 compared to other treatment. The nitrogen content (%), and its uptake (kg ha$^{-1}$), and protein content (%), and its production (kg ha$^{-1}$) in grain and straw was significantly higher under T3-100% RDF + 2 foliar spray of ZnSO4. The Fe and Zn content (mg kg$^{-1}$) and its uptake (kg ha$^{-1}$) in grain and straw was higher under T3-100% RDF + 2 foliar spray of ZnSO4. Economics analysis viz gross return (123514), net return (84107) and benefit cost ratio (2.13) was recorded highest with T3-100% RDF + 2 foliar spray of ZnSO4 while lowest with T8- 100% RDF through FYM. Thus for obtaining better yield and profit apply T3-100% RDF + 2 foliar spray of ZnSO4.

*Keywords: Integrated nutrient management; growth; yield attributes; yield; transplanted rice.*

## 1. INTRODUCTION

"Rice (*Oryza sativa L.)* belongs to Poaceae (Gramineae) family with chromosome number 2n=24. It is the one of the most important stable food crops in the world. Rice is a crop of wet tropical climate and also grown in humid regions of subtropics. Rice is a C3 plant and self-pollinated crop. Rice is a major source of energy. It's main component is carbohydrate, which is composed of amylose & amylopectin. It constitutes 12% water, 75% - 85% starch & only 7% protein with a full complements of amino acid with very low amount of Phosphorus, Iron & some quantity of Calcium. Rice also provides more than 15 essential vitamins and minerals including, folic acid, B vitamins, potassium, selenium, fibre, iron and zinc. Rice is gluten – free and highly digestible. Rice is an important grain option for those who suffered from celiac disease. Rice provides 35 - 60% of the dietary calories and 50 - 80% of the energy intake of the people in developing countries" [1]. "Rice (*Oryza sativa L*.) is the premier food crop of India and therefore, national food security system largely relies on the productivity of rice in different agro-ecosystems. Among the rice growing countries, India stands first in area (36.95 m ha) and second in production (120.6 m t) next only to China. India ranks first in rice area after China. India occupy the largest rice area of 45 million hectares and produced 111.76 million tonnes with productivity of 25.78 q ha$^{-1}$" [2]. "Uttar Pradesh is the largest rice growing state after West Bengal in India, though the productivity is low. In Uttar Pradesh Rice is grown over an area of 5.68 million hectares with the production of 15.66 million tonnes and productivity of about 2.75 tonnes ha$^{-1}$" [3]. Integrated nutrient management (INM) is a prescription for developing a durable integrated plant nutrient system (IPNS). The INM is a soil fertility and productivity sustaining practice because it enhances the availability of both, applied and native soil nutrients during the growing season of the crops synchronizing the nutrient demand set by the plants both in time and space with supply of the nutrients from the labile soil and applied nutrient pools sustains and enhances chemical, biological and physical soil health and arrests degradation of soil, water and environmental quality by promoting carbon sequestration, minimizing the avoidable leakage of the fertilizer nutrients to the water bodies and atmosphere. There is a vast scope for increasing nutrient supply through use of organic manures viz. FYM, mustard oil cake, green manures. The fertilizer use should be promoted till a full proof low input technology for higher productivity is available. Under the present Indian context, the organic sources of nutrients should be considered as supplements to chemical fertilizers and no their substitutes.

## 2. METHODS AND MATERIALS

The field experiment was carried out during Kharif 2022-23 at Shradhay Bhagwati Singh Agriculture Research Farm, Hajipur, Chandra Bhanu Gupta Krishi Snatakottar Mahavidyalaya, BKT, Lucknow University, Lucknow (U.P.). The

experimental site was well levelled having good soil condition. Geographically, Experimental site falls under sub-tropical zone and is situated at 26.50°C North latitude, 80.52°C East longitudes with an altitude of 123 meters above mean sea level. Nestled on the bank of Gomti river, Lucknow is flanked by Barabanki district on the East, Unnao on the West, Raibareli on the South and Sitapur and Hardoi districts on the North, respectively. The experimental site is situated about 20 kms away from Lucknow city Airforce road on Sitapur highway. The soil of experimental field was slightly alkaline in reaction (8.00 pH), low in organic carbon (0.70%) and available nitrogen (270 kg $ha^{-1}$), medium in phosphorous (27 kg $ha^{-1}$) and potassium (262 kg $ha^{-1}$).

The 8 treatments comprised of RDF(IF), 100% RDF + 25 Kg $ha^{-1}$ $ZnSO_4$ (B), 100% RDF + 2 foliar spray of $ZnSO_4$, RDF+ 50 kg $ha^{-1}$ $FeSO_4$ (B), 100% RDF+ $ZnSO_4$ 25 kg $ha^{-1}$ (B)+ $FeSO_4$ @ 50 kg $ha^{-1}$ (B), 75% RDF(IF)+25% RDN (FYM), 50% RDF(IF) + 50% RDF(IF) +50% RDN (FYM), 100% RDF through FYM were laid out in Randomized Block Design (RBD). The half dose of Nitrogen as per treatment was applied at the time of sowing and rest half does of nitrogen was applied in two splits at the time of first irrigation and second irrigation. Healthy and bold seed of rice variety NDR 2065 @ 40 kg ha $^{-1}$ for transplanting were sown on 18 June 2022 in puddled soil. All improved packages of practices were followed to raise the crop. The data on plant height and tillers were recorded from the area already marked by tagged. Sample for dry matter accumulation was recorded by cutting of plants 25 cm row length. For leaf area index the sample taken for dry matter accumulation, was first used to take leaf area. All the leaves of two hill were separated and grouped into three categories viz. small, medium, large.

The number of leaves of each group was recorded and one representative leave for each category was taken and their length and width were measure and multiplied by number of leaves of each category. The leaf area of all leaves was calculated. The samples were first sun dried and then kept in hot air oven 72°C ± 1°C for 48 hours till the constant weight was achieved. Yield attributes were recorded from 10 panicles selected randomly from each plot. Grain and straw yields of rice were recorded at harvest the harvest index was calculated as grain yield divided by total biological yield and multiplied by hundred. The uptake of nutrients was calculated as nutrient content in grain and straw multiplied by respective yield. Economics of different treatments was worked out on the basis of prevailing market prices. The data so obtained on various parameters were analyzed as per standard statistical procedures. The content of N, P, and K in grain and straw was determined using standard laboratory procedures.

## 3. RESULTS AND DISCUSSION

### 3.1 Growth Attributes

Plant height, number of tillers, leaf area index and dry matter accumulation of rice were affected significantly due to application of 100% RDF through Inorganic fertilizer + 2 foliar spray of $ZnSO_4$ due to different nutrient management practices (Table-1). The maximum plant height (99.18 cm), leaf area index (5.97), number of tillers (367.35 $m^{-2}$) and dry matter accumulation (1215.24 $gm^2$) was recorded significantly with $T_3$ - 100% RDF + 2 foliar spray of $ZnSO_4$ over rest of the treatments. Significant improvement in growth parameters with increasing the levels of nitrogen might be due to increased availability of nitrogen and its uptake by plant increased the metabolic activity and formation of meristematic tissues which improved the cell elongation and cell division which is turn improved the plant height, number of leaves, leaf area/plant and dry matter accumulation of crop. The findings of present investigation are in close proximity of those observed by Suvarna Latha and Sankara Rao [4]; Devi and Manimaran [5]; Moe et al. [6].

### 3.2 Yield Attributes

Yield attributing characters like effective tiller/$m^2$, length of panicle (cm), no. of grain/panicle, grain weight/panicle (g), panicle weight (g)& 1000 grain weight (g) were affected significantly when crop fertilized with 100% RDF + 2 spray of $ZnSO_4$ observed significantly highest no of effective tillers (439.73), panicle length (28.33 cm), No.of grain/panicle (175.33), grain weight/panicle (3.46 g), panicle weight (4.51g), and 1000 grain weight (29.10 g) over rest of the treatments. With the application of $T_3$ (RDF+ 2 foliar spray of $ZnSO_4$) No. of effective tillers was recorded higher which was found at par with the treatment (50% RDF-IF + 50% RDN – FYM ($T_6$) but recorded significantly highest tillers over rest of the treatments. The crop sown with $T_3$ (100% RDF

**Table 1. Growth attributes of rice as affected by different integrated nutrient management**

| Treatments | Number of tillers/$m^2$ | Plant height (cm) | Leaf area index | Dry matter accumulation (g $m^{-2}$) |
|---|---|---|---|---|
| T1-Recommended dose of fertilizer through inorganic fertilizer | 407.00 | 96.68 | 5.55 | 745.77 |
| T2-100%RDF+25kg/haZnSO4 (Basal) | 415.33 | 100.27 | 5.94 | 792.63 |
| T3-100% RDF +2 foliar spray ofZnSO4 (30 and 60 DAT) | 439.73 | 104.97 | 6.33 | 829.62 |
| T4-100% RDF + 50 kg/ha FeSO4 (Basal) | 411.73 | 98.96 | 5.87 | 781.38 |
| T5-100% RDF + ZnSO4@ 25kg/ha(B)+FeSO4@50kg/ha(B) | 418.33 | 100.88 | 5.96 | 803.90 |
| T6-75%RDF(IF)+25%RDN through (FYM) | 410.66 | 97.87 | 5.82 | 780.29 |
| T7-50%RDF(IF)+50%RDN through (FYM) | 435.37 | 102.26 | 6.22 | 819.63 |
| T8-100% RDF through FYM | 402.11 | 93.56 | 5.52 | 730.36 |
| SE(m)± | 3.23 | 0.37 | 0.19 | 4.44 |
| C.D. at 5% | 9.90 | 1.17 | 0.58 | 13.60 |

**Table 2. Yield attributes of rice as influenced by integrated nutrient management**

| Treatments | Effective Tillers/ $m^2$ | Panicle length (cm) | No.of. Grains/ panicle | Grain weight/ panicle (g) | Panicle weight (g) | 1000 grain weight (g) |
|---|---|---|---|---|---|---|
| T1-Recommended dose of fertilizer(RDF)throughinorganic fertilizer | 407.00 | 20.76 | 141.33 | 2.19 | 3.77 | 25.33 |
| T2-100%RDF+25kg/haZnSO4 (Basal) | 415.33 | 22.53 | 162.33 | 2.65 | 3.96 | 27.33 |
| T3-100%RDF+ 2 foliar spray of ZnSO4 (30 & 60DAT) | 439.73 | 28.33 | 175.33 | 3.46 | 4.51 | 29.10 |
| T4-100%RDF+50kg/haFeSO4 (Basal) | 411.73 | 21.90 | 160.33 | 2.60 | 3.86 | 27.17 |
| T5-100%RDF+ZnSO425kg/ha (B)+FeSO4@50kg/ha(B) | 418.33 | 25.23 | 164.33 | 2.72 | 4.04 | 28.33 |
| T6-75%RDF(IF)+25%RDN (FYM) | 410.66 | 21.07 | 157.66 | 2.45 | 3.81 | 26.33 |
| T7-50%RDF(IF)+50%RDN (FYM) | 435.37 | 26.83 | 167.00 | 2.79 | 4.27 | 28.68 |
| 100%RDF through FYM | 402.11 | 19.11 | 126.00 | 2.17 | 3.70 | 22.15 |
| S.E(m)+ | 2.01 | 0.27 | 1.78 | 0.20 | 0.41 | 2.00 |
| C.D. at 5% | 6.18 | 0.82 | 5.47 | 0.61 | 1.27 | 4.35 |

through (IF) + 2 foliar spray of ZnSO4) recorded the significantly higher panicle length (cm), panicle weight (g), numbers of grains $panicle^{-1}$, grains weight $panicle^{-1}$ which might be due to

chemical fertilizers provide readily plant nutrients to crop. Similar responses were also recorded by Krishnakumar et al. [7] and Uma Shankar et al. [8]. This might be due to improvement in nutrient supply system is more with organic manures, which improves the soil physical, chemical and biological properties. Yield is the combine result of all growth and management factors. It is well known fact that grain yield is the function of a greater number of effective tillers per unit area, number of grains per panicle and test weight.

### 3.3 Yield Studies

Crop received 100% RDF-IF+ 2 foliar spray of $ZnSO_4$ ($T_3$) produced significantly highest grain yield (47.85 q/ha), straw yield (64.75q/ha) and total biological yield (112.6 q/ha) as compared to rest of the nutrient management practices. However, the differences between $T_3$ (100% RDF+ 2 foliar spray of $ZnSO_4$) was statistically non-significant over 50% RDF+50% RDN (FYM). Application of 100% RDF+$ZnSO_4$ 25kg/ha + $FeSO_4$ 50 kg/ha produced higher grain yield of (42.15 q/ha), straw yield (59.20q/ha) and total biological yield (101.35q/ha) which was on par with 100% RDF+25kg/ha $ZnSO_4$. As the yield is directly related to all the yield attributing characters which also showed increasing used with this type of nutrient management. $T_3$ (100% RDF through (IF) + 2 foliar spray of $ZnSO_4$) recorded the significantly higher grain yield with 47.85 q $ha^{-1}$, straw yield with 64.75 q $ha^{-1}$ and biological yield with 112.6 q $ha^{-1}$. Similar responses were also recorded by Dikshit and Khatik [8], Uma Shankar et al. [9]; Kumar et al. [10]. It might also due to that the combination of chemical fertilizers and organic manures not only increase the rate of photosynthesis but also increase the translocation of source to sink which resulted in higher grain yield. However, the rate of releasing of nutrients from organic manures is slow in beginning. The effect of INM on harvest index was nonsignificant. The grain, straw, biological yield and harvest index was closely followed by treatment $T_7$ (50% RDF(IF)+50% RDN FYM) This result was closely justified with report of Siavoshi [11]; Yadav and Yadav [12]; Thulasi et al. [13].

### 3.4 Nutrient Uptake

The nitrogen, phosphorus and potassium content (%) in grain and straw was non- significantly affected with the application of 100% RDF + 2 foliar spray of $ZnSO_4$ followed by 50% RDF(IF) + 50% RDN(FYM) and 100% RDF + $ZnSO_4$@25kg/ha(B)+@50kg/ha(B).

Crop fertilized with 100% RDF through FYM produced lowest NPK content (%). Nitrogen, phosphorus and potassium uptake (kg/ha) by grain and straw was recorded highest with the treatment $T_3$ (100% RDF + 2 foliar spray of $ZnSO_4$). In grain N,P,K uptake was found highest with the treatment $T_3$ (100% RDF + 2 foliar spray of $ZnSO_4$). Which was being at par with the treatment $T_7$ (50%RDF(IF)+50%RDN (FYM). N,P uptake by straw was non-significant, while K uptake was found significant and highest value was found significant and highest value was found with the treatment $T_3$ (100% RDF + 2 foliar spray of $ZnSO_4$). However, minimum values was recorded with the application of 100% RDF through FYM ($T_8$). Application of 100% RDF + 2 foliar spray of $ZnSO_4$ recorded maximum content of protein (8.80 % and 3.00%) in grain and straw, respectively followed by 50% RDF through inorganic fertilizer+50% RDN (FYM) and 100% RDF+$ZnSO_4$@25kg/ha(B) + $FeSO_4$@ 50kg/ha (B).

Protein production (q $ha^{-1}$) also exhibited similar trend as in case of protein % and being highest with 100% RDF + 2 foliar spray of $ZnSO_4$ followed by 50% RDF through inorganic fertilizer+ 50% RDN (FYM) and 100% RDF+ $ZnSO_4$@25kg/ha(B)+ $FeSO_4$@50kg/ha(B). Application of 100% RDF + 2 foliar spray of $ZnSO_4$ recorded maximum Fe content (mg/kg) in grain and straw (184 and 418) followed by Recommended dose of fertilizer through inorganic fertilizer and RDF+ $ZnSO_4$@ 25kg/ha(B) + FeSO4@50kg/ha(B). However, crop fertilized with 100% RDF through FYM produced lowest Fe content in grain and straw. Fe uptake in grain was recorded maximum with the application of 100%RDF+2 foliar spray of $ZnSO_4$ and in straw was observed maximum with the application of 100%RDF+2 foliar spray of $ZnSO_4$ Application of 100% RDF through FYM was recorded non-significantly affected Zn content. (mg/kg) and uptake (kg/ha) in grain and straw followed by Recommended dose of fertilizer through inorganic fertilizer. Crop fertilized with 100% RDF through produced lowest Zn content and uptake. Nutrient content (%) in grain and straw and its uptake as affected by

various INM practices. The higher N, P and K content in grains and straw was found higher under treatment T3 (100% RDF through (IF) + 2 foliar spray of ZnSO4) followed by T7 (100% RDF through (IF) + 25% RDN through FYM), the higher content (mg/kg) of N with T3 might might be due to higher availability of nutrients as compared to other treatment Similar responses were observed by Kumar et al. [14]; Kumar et al. [10]; Sultana et al. [15]. The uptake of nitrogen, phosphorus and potassium in grain and straw in rice was recorded significantly higher with the treatment T3 (100% RDF through (IF) + 2 foliar spray of ZnSO4). This result is closely related with finding of Ghose et al. [16] and the uptake of phosphorus and potassium was statistically similar with T7 (50% RDF through (IF) + 50% RDN through FYM). The high uptake of nitrogen with T3 was mainly due to higher grain and straw. These findings are in conformity with the findings of Kumar et al. [10]; and Shrivastava and Singh [17]. The protein content (%) is the function of nitrogen content in grain and multiplied by constant. Hence, higher protein content (%) and its production was found maximum under T3 treatment because of higher grain and straw yield. The higher Fe and Zn content in grain and straw was found maximum when crop was fertilized with 100% RDF + 2 foliar spray of ZnSO4, however, lowest content (mg/kg) was recorded with 100% RDF through FYM. This was because of lower grain and straw yield with their treatment. Contrary to this, the T3 recorded the lowest content (mg/kg) might be due to higher grain and straw yield. The uptake of Zn and Fe was highest with T3 and the lowest being with 100% RDF through FYM. This is because of high grain and straw yield with former treatments.

## 3.5 Economics

The data recorded on the cost of cultivation (Rs/ha), Gross return (Rs/ha), Net return (Rs/ha) and the Benefit: Cost ratio (Rs/Re invested) are presented in table. A perusal of the data indicated that the highest gross return (123514 Rs/ha) net income (Rs 84107) and benefit: cost ratio (2.13) was recorded with T3 which was followed by T4 and T5 for gross income and T2 for net income and benefit: cost ratio. However, the lowest net return and BCR was recorded with T8 . The highest profitability with T3 was mainly due to higher grain and straw yield and lower cost incurred. However, treatment combined with farm yard manure recorded lower profit as compared to inorganic treatment alone was mainly attributed due to low yield and higher cost incurred. The lowest net return (Rs 20218.6) and B:CR (0.29) was recorded with T8

**Table 3. Yield of rice as influenced by different integrated nutrient management**

| Treatments | Grain yield (q/ha) | Straw yield (q/ha) | Total biological yield(q/ha) | Harvest index (%) |
|---|---|---|---|---|
| T1-Recommended dose of fertilizer (RDF) throughinorganic fertilizer | 35.12 | 56.44 | 91.56 | 38.78 |
| T2-100%RDF+25kg/haZnSO4(Basal) | 40.18 | 59.04 | 99.22 | 40.43 |
| T3-100%RDF+2 foliar spray of ZnSO4 (30 &60 DAT) | 47.85 | 64.75 | 112.6 | 42.29 |
| T4-100% RDF+50kg/ha FeSO4(Basal) | 39.21 | 58.58 | 97.79 | 40.09 |
| T5-100%RDF+ZnSO4@25kg/ha(B)+ FeSO4@50kg/ha(Basal) | 42.15 | 59.20 | 101.35 | 41.61 |
| T6-75%RDF(IF)+25%RDN(FYM) | 37.15 | 58.32 | 95.47 | 38.91 |
| T7-50%RDF(IF)+50%RDN(FYM) | 46.79 | 62.42 | 109.21 | 42.84 |
| T8-100%RDF through FYM | 32.44 | 54.79 | 87.23 | 37.18 |
| SE(m)± | 0.96 | 1.10 | 1.27 | 0.81 |
| C.D. at 5% | 2.94 | 3.37 | 3.90 | 2.50 |

**Table 4. NPK content (%) and uptake (kg/ha) in grain and straw as affected by different integrated nutrient management**

| Treatments | NPK content (%) | | | | | | NPK uptake (kg/ha) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grain | | | Straw | | | Grain | | | Straw | | |
| | N | P | K | N | P | K | N | P | K | N | P | K |
| T1-Recommended dose offertilizer through inorganic fertilizer | 1.41 | 0.42 | 0.41 | 0.42 | 0.25 | 1.21 | 52.38 | 16.84 | 15.80 | 26.52 | 15.23 | 71.11 |
| T2-100%RDF+ 25kg/ha ZnSO4(Basal) | 1.42 | 0.51 | 0.42 | 0.44 | 0.30 | 1.25 | 57.69 | 19.81 | 17.27 | 27.15 | 17.71 | 73.80 |
| T3-100%RDF+ 2 Foliar sprayof ZnSO4 (30 DAT & 60 DAT) | 1.51 | 0.55 | 0.46 | 0.48 | 0.32 | 1.27 | 66.99 | 22.45 | 19.65 | 28.71 | 18.72 | 80.93 |
| T4-100%RDF + 50 kg/ha FeSO4 (Basal) | 1.41 | 0.44 | 0.42 | 0.43 | 0.28 | 1.24 | 55.67 | 18.26 | 16.46 | 26.94 | 16.32 | 72.63 |
| T5-100%RDF+ZnSO4@ 25kg/ha(B)+FeSO4@50kg/ha(B) | 1.43 | 0.52 | 0.43 | 0.46 | 0.30 | 1.26 | 59.85 | 20.04 | 17.70 | 27.23 | 17.49 | 74.59 |
| T6-75%RDF(IF)+25% RDN through (FYM) | 1.41 | 0.43 | 0.41 | 0.43 | 0.28 | 1.23 | 53.03 | 17.25 | 15.97 | 26.24 | 16.4 | 71.73 |
| T7-50%RDF(IF)+50% RDN through (FYM) | 1.43 | 0.53 | 0.44 | 0.47 | 0.31 | 1.26 | 65.97 | 21.29 | 19.61 | 27.84 | 18.71 | 76.15 |
| T8-100% RDF through FYM | 1.40 | 0.40 | 0.40 | 0.41 | 0.21 | 1.20 | 49.95 | 15.21 | 14.92 | 26.29 | 15.29 | 69.58 |
| SE(m)+ | 0.17 | 0.05 | 0.07 | 0.06 | 0.05 | 0.22 | 0.76 | 0.92 | 1.03 | 1.10 | 1.21 | 0.98 |
| C.D. at 5% | NS | NS | NS | NS | NS | NS | 2.34 | 2.82 | 3.16 | NS | NS | 3.03 |

**Table. 5 Protein content (%) in grain and straw and its production (kg ha-1) as influenced by different integrated nutrient management**

| Treatments | Proteincontent(%) | | Protein yield(kg/ha) | |
|---|---|---|---|---|
| | Grain | Straw | Grain | Straw |
| T1-Recommended dose of fertilizer through inorganicfertilizer | 8.03 | 2.17 | 299.42 | 164.87 |
| T2-100%RDF+ 25kg/ha ZnSO4 (Basal) | 8.12 | 2.87 | 328.27 | 169.44 |
| T3-100%RDF+ 2 Foliar spray of ZnSO4 (30 DAT & 60DAT) | 8.80 | 3.00 | 382.80 | 179.33 |
| T4-100%RDF + 50 kg/ha FeSO4 (Basal) | 8.10 | 2.87 | 318.38 | 168.12 |
| T5-100%RDF+ZnSO4@25kg/ha(B)+FeSO4@50kg/ha(B) | 8.17 | 2.87 | 342.25 | 169.90 |
| T6-75%RDF(IF)+25%RDN through (FYM) | 8.06 | 2.87 | 303.08 | 165.90 |
| T7-50%RDF(IF)+50%RDN through (FYM) | 8.63 | 2.93 | 377.12 | 173.14 |
| T8-100% RDF through FYM | 8.00 | 2.68 | 285.47 | 163.87 |
| SE(m) ± | 0.64 | 0.77 | 1.49 | 0.62 |
| C.D. at 5% | NS | NS | 4.57 | 1.92 |

**Table 6. Fe, Zn content and uptake in grain and straw as affected by different integrated nutrient management practices**

| Treatments | Fe content(mg/kg) | | Fe uptake(kg/ha) | | Zn content(mg/kg) | | Zn uptake(kg/ha) | |
|---|---|---|---|---|---|---|---|---|
| | Grain | Straw | Grain | Straw | Grain | Straw | Grain | Straw |
| T1-Recommended dose of fertilizer (RDF) throughinorganic fertilizer. | 195 | 419 | 0.626 | 2.36 | 33.18 | 35.10 | 0.106 | 1.98 |
| T2-100% RDF + 25kg/ha ZnSO4 (Basal) | 191 | 416 | 0.767 | 2.45 | 30.00 | 35.00 | 0.120 | 0.206 |
| T3-100% RDF + 2 Foliar spray of ZnSO4 (30DAT and 60DAT) | 184 | 418 | 0.880 | 2.71 | 29.50 | 32.80 | 0.141 | 2.12 |
| T4-100% RDF + 50 kg/ha FeSO4 (Basal) | 190 | 422 | 0.744 | 2.47 | 30.07 | 33.10 | 0.117 | 1.93 |
| T5-100%RDF+ZnSO4@25kg/ha(B)+FeSO4@50kg/ha(B) | 186 | 415 | 0.783 | 2.456 | 29.00 | 33.00 | 0.122 | 0.195 |
| T6-75%RDF(IF)+25% RDN through (FYM) | 205 | 426 | 0.761 | 2.484 | 35.00 | 40.00 | 0.130 | 0.233 |
| T7-50%RDF(IF)+50% RDN through (FYM) | 164 | 383 | 0.767 | 2.390 | 22.00 | 27.00 | 0.102 | 0.168 |
| T8-100% RDF through FYM | 210 | 431 | 0.681 | 2.361 | 35.10 | 30.22 | 0.097 | 1.65 |
| Sem± | 0.87 | 0.79 | - | - | 0.61 | 0.55 | - | - |
| C.D. at 5% | 2.68 | 2.42 | - | - | 1.87 | 1.70 | - | - |

**Table 7. Economics influenced by different integrated nutrient management**

| Treatments | Cost of cultivation | Gross return (Rs/ha) | Net return (Rs/ha) | B:C ratio (Rs/Re invested) |
|---|---|---|---|---|
| T1-Recommended dose ofFertilizer (RDF) throughinorganic fertilizer. | 38867 | 94220.8 | 55353.8 | 1.42 |
| T2-100% RDF+25 kg/ha ZnSO4 (Basal) | 39367 | 105583.2 | 66216.2 | 1.68 |
| T3-RDF+ 2 Foliar spray of ZnSO4 (30 DAT & 60 DAT) | 39407 | 123514 | 84107 | 2.13 |
| T4-RDF+50kg/haFeSO4(Basal) | 39617 | 103420.4 | 63803.4 | 1.61 |
| T5-RDF+ZnSO4@25kg/ha(B) + FeSO4@50kg/ha (B) | 47867 | 109666 | 61799 | 1.29 |
| T6-75%RDF(IF)+25%RDN through (FYM) | 54087 | 99114 | 45027 | 0.83 |
| T7-50%RDF(IF)+50%RDN through (FYM) | 69308 | 120419.6 | 51111.6 | 0.73 |
| T8-100% RDF through (FYM) | 67875 | 88093.6 | 20218.6 | 0.29 |

## 4. CONCLUSION

It can be concluded from the above results that rice crop should be fertilized with 100% RDF + 2 foliar spray of ZnSO4 to obtain maximum yield and highest profit under irrigation condition of central plain zone of UP.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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