

## Influence of different fertility levels on yield and nutrient status in zero till direct-seeded rice cultivation

Birendra Kumar<sup>1</sup>, Ram Swaroop Meena<sup>2</sup>, Supriya<sup>1\*</sup>, Rakesh Kumar<sup>1</sup>, Amresh Chaudhary<sup>3</sup> and Ganesh Patel<sup>3</sup>

<sup>1</sup>ICAR-National Dairy Research Institute, Karnal, Haryana-132001

<sup>2</sup>Institute of Agricultural Sciences (BHU), Varanasi-221005

<sup>3</sup>ICAR-Central Soil Salinity Research Institute, Karnal, Haryana-132001

### Article history:

Received: 06 Aug., 2024

Revised: 05 Dec., 2024

Accepted: 17 Dec., 2024

### Citation:

Kumar B, RS Meena, Supriya, R Kumar, A Chaudhary and G Patel. 2024. Influence of different fertility levels on yield and nutrient status in zero till direct-seeded rice cultivation. *Journal of Cereal Research* **16** (3): 278-286. <http://doi.org/10.25174/2582-2675/2024/154756>

### \*Corresponding author:

E-mail: [supriya.ndri5@gmail.com](mailto:supriya.ndri5@gmail.com)

### Abstract

The conventional methods, along with excessive fertilizer application in the rice-wheat cropping system, commonly result in decreased productivity and environmental pollution. However, employing zero tillage methods that involve retaining surface residues, alongside strategic nutrient management, could potentially enhance productivity and the efficient utilization of water and nutrients in zero-till direct-seeded rice (ZTDSR). Keeping this in mind, the present investigation was conducted at the Agriculture Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India during *kharif* season of 2019-20. The experiment was conducted in Randomised Block Design with four replication and five different nutrient treatment *viz.*, control, 75 % RDF+5 Kg Fe+5 Kg Zn, 100% RDF, 100 % RDF+5Kg Fe+5Kg Zn and 125 % RDF. Urea, diammonium phosphate (DAP), muriate of potash (MOP), Iron sulphate and zinc sulphate were used as source of nitrogen, phosphorus, potassium, iron and zinc. The rice varieties HUR-105 was used as the rate of 30 kg/ha. The application of 100% RDF+ Zn 5kg/ha+ Fe5kg/ha significantly enhanced the yield, nutrient content and uptake in ZT-DSR.

**Key word:** Zero till, DSR, Harvest Index, Micronutrient, Yield

© Society for Advancement of Wheat and Barley Research

## 1. Introduction

Rice (*Oryza sativa* L.) stands as a crucial staple crop universally cultivated and consumed by more than half of the world's population, supporting over 3 billion people in their daily diets (Farooq et al., 2011). Given its status as a primary carbohydrate source, about two-thirds of India's total population relies on rice for 43% of their calorie intake (Mohan et al., 2018). Asian countries dominate rice production, with approximately 90% of the global rice area (143 mha) yielding around 612 million tons (Wang et al., 2012). China leads as the largest global rice producer, contributing over 28% of the total output, followed by India, which ranks as the second-largest producer and consumer of rice. However, challenges like climate change, resource depletion, Greenhouse Gas (GHG) emissions,

and inadequate nutrient practices have stagnated rice crop yields. The traditional method of transplanted and flooded rice (T&FR) farming demands significant labor, energy, and leads to GHG emissions, exacerbating issues of water scarcity and labor shortages. As a solution, Direct Seeded Rice (DSR) cultivation, encompassing approximately 23% of global cultivation, presents itself as a more sustainable and cost-effective approach. In India, DSR covers about 4.95 million hectares, constituting 12% of the nation's rice area and 17% of Asia's direct-seeded rice (Pathak et al., 2011). Nonetheless, this method faces challenges such as poor crop stand and weed infestation, resulting in lower yields compared to transplanted rice. Implementing ZT-DSR enhances labor efficiency and



land productivity while conserving resources such as water requirements and expediting land preparation. Managing nutrients like nitrogen (N), potassium (K), zinc (Zn), and iron (Fe) significantly influences rice yield and quality. While nitrogen plays a crucial role in enhancing yield, deficiencies in micronutrients like Zn and Fe are more common in ZT-DSR, emphasizing the criticality of micronutrient management in this method. Considering these aspects, an investigation focusing on the impact of different fertility levels on ZT-DSR's yield and nutrient status was carried out to ascertain potential improvements in rice cultivation practices.

## 2. Material and Methods

### 2.1 Experimental sites and climate

The experiment was conducted during the *kharif* season of 2019-20 at the Agriculture Research Farm of the Institute of Agricultural Sciences, Banaras Hindu University, located at 25°18'N latitude and 83°31'E longitude, with an elevation of 75.7 meters above sea level, within the Northern Gangetic Alluvial Plains. Area having subtropical climate with annual precipitation in this area totals 1081.5 mm, the maximum and minimum temperatures range between 22°C to 45.4°C and 8.5°C to 28.4°C, respectively and average relative humidity stands at 70%.

### 2.2 Description of cultivar

**HUR-105:** HUR-105, also known as Malviya Sungandha 105, developed in 2008 by Banaras Hindu University, Varanasi, utilizing MPR 7-2 as its parent. Released in 2009, this variety is predominantly grown in the North Eastern Plain Zone and exhibits moderate resistance to common diseases and pests, notably leaf rollers. It is characterized as a photoperiod-insensitive, high-yielding semi-dwarf rice with long-grain and strong aroma. Cultivated mainly in Uttar Pradesh and Bihar, it matures in around 135-140 days, standing at a dwarf height of 79-85 cm. HUR-105 showcases sturdy grains, resistance to lodging, moderate tillering (8-15 tillers), medium broad leaves, and produces long, bold, red grains. Its potential yield reaches 52 to 54 q/ha. Top of Form

### 2.3 Experimental details

A field experiment was conducted during the 2019-20 *kharif* season following a Randomized Block Design with four replications. Each net plot measured 2.4 m x 2.0

m, equaling 4.80 m<sup>2</sup> and a row spacing of 20.0 cm. The recommended fertilizer doses applied were 150:60:60:25:25 (kg/ha) of NPK, Zn, and Fe.

### 2.4 Treatment details

Table 1: Treatments details

| Symbol used | Treatments               |
|-------------|--------------------------|
| T1          | Control                  |
| T2          | 75 % RDF+5 kg Fe+5 kg Zn |
| T3          | 100% RDF                 |
| T4          | 100 % RDF+5kg Fe+5kg Zn  |
| T5          | 125 % RDF                |

### 2.5 Cultural practices

Field preparation skipped ploughing and harrowing to optimize sowing conditions. Treatments were segregated into distinct blocks, employing the zero till direct seeded rice approach. Before sowing, a light pre-sowing irrigation was administered, and weed control in zero till treatments was managed with Glyphosate (1 kg/ha) before seed sowing. The zero till DSR method involved manual line sowing with 20.0 cm row spacing and seedling depth set at 2-3 cm. The rice variety HUM-105 was sown at a rate of 30 kg/ha. Fertilizers 150 kg N, 60 Kg P<sub>2</sub>O<sub>5</sub>, 60 kg K<sub>2</sub>O, 5 kg Zn, and Fe/ha were evenly applied using urea, DAP, muriate of potash, Zinc Sulphate, and ferrous sulphate, respectively. At sowing, half of the nitrogen and full doses of P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O, Zn, and Fe were employed as basal fertilizer. The remaining nitrogen was divided equally and top-dressed at 30 and 60 DAS with urea. Harvesting was timed for full crop maturity, identified by yellowing stems and leaves. Crop yield from each net plot was separately harvested, sun-dried, and taken for individual threshing. Threshing was done plot-wise by hand, followed by cleaning, drying, and weighing the grains separately for each plot. Final yield was computed in kilograms per hectare with a moisture level of 14%.

### 2.6 Yield parameters

The count of panicles was conducted for each meter in both years and then presented as the number per meter. Three panicles were selected from the marked plants within each plot. The length was measured starting from the base of the panicle to the topmost spikelet. The



average panicle length was calculated and expressed in centimeters. The number of spikelets of three panicles from each plot were taken and counted carefully and then averaged to obtain the number of spikelets/panicle.

## 2.7 Yield

Grains from each net plot were individually threshed, winnowed, cleaned, and weighed. Moisture content in harvested grains was determined using a moisture meter. The recorded yield in kg/plot was adjusted to 14% moisture and converted to kg/ha. The dry weight of the straw was determined by deducting the grain yield from the overall biological yield of the crop. Subsequently, the straw yield

per plot was converted into kilograms per hectare (kg/ha). All plant parts above the ground, harvested from the designated net plot area, were gathered, bundled, tagged, and transported to the threshing floor individually. After thorough sun-drying, each bundle was weighed, and subsequently, the biological yield per plot was converted into kilograms per hectare (kg/ha). Harvest index was calculated as per the following formula:

## 2.8 Nutrient content

Nitrogen, Phosphorus, Potassium, content in rice (seed and straw) and weeds were analysed as per standard procedure (Table 2).

Table 2: Methods of plant chemical analysis

| Nutrient      | Analytical method       | References     |
|---------------|-------------------------|----------------|
| Nitrogen      | Micro Kjeldahl method   | Piper (1966)   |
| Phosphorus    | Olsen's Method          | Jackson (1967) |
| Potassium     | Flame photometer method | Jackson (1967) |
| Zinc and Iron | DTPA                    | Lindsay (1978) |

## 2.9 Nutrient uptake (kg/ha)

Nutrient uptake by rice and weeds were calculated in kg/ha in relation to dry matter production/yield (seed or straw) /ha by using the following formula

## 2.10 Statistical analysis

The data was analyzed using the analysis of variance method outlined by Gomez and Gomez (1984). To compare the treatment, mean values, calculations were performed to determine standard error, critical values, and coefficients of variance using the following formulae.

a)  $SEm \pm = EMS/r$

b)  $C.D. = S.E.m \pm \times \sqrt{2} \times \text{error d.f. at } 5\%$

c)  $C.V. (\%) = EMS/GM$

## 3. Results and discussion

### 3.1 Grain yield (Mg/ha)

The application of different fertility levels significantly increases the grain yield of zero till DSR (Table 3 and fig 1). The maximum grain yield (4.54) was observed with

the application of 100% RDF + 5kg Fe + 5 Kg Zn/ha, while it was statistically at par with the application of 125 % RDF (4.40). These yield attributes including significant increase in the test weight of grains (Singh et al., 2014) together resulted in higher grain yield with zero tilled DSR practices. The results are consistent with previous researchers' reports of Wiangsamut et al., 2006 and Kumar et al., 2022. The findings were similar with the findings of Kumar (2020) where Zero tillage + Residue management and Zero tillage increased the grain yield of direct seeded rice to the tune of 14.03 %; 9.27 % and 10.15 %; 6.1 % over Conventional tillage respectively.

### 3.2 Straw yield (Mg/ha)

The application of different fertility levels significantly increases the straw yield of zero till DSR (Table 3 and fig 1). The maximum straw yield (6.72) was observed with the application of 100% RDF + 5kg Fe + 5 Kg Zn/ha, while it was statistically at par with the application of 125 % RDF (6.55). The findings are in line with the Sharma et al., 2007; Zeidan et al., 2010 and Kumar (2020).



Table 3: Effect of different fertility levels on yield and harvest index (HI) of zero-till direct seeded rice

| Treatment               | Grain yield (Mg/ha) | Straw yield (Mg/ha) | Biological yield (Mg/ha) | HI (%) |
|-------------------------|---------------------|---------------------|--------------------------|--------|
| Control                 | 3.06                | 5.20                | 8.26                     | 37.05  |
| 75% RDF+5 Kg Fe+5 Kg Zn | 4.02                | 6.02                | 10.04                    | 40.04  |
| 100% RDF                | 4.05                | 6.15                | 10.20                    | 39.71  |
| 100% RDF+5Kg Fe+5Kg Zn  | 4.54                | 6.72                | 11.26                    | 40.33  |
| 125% RDF                | 4.40                | 6.55                | 10.95                    | 40.20  |
| <b>SEm±</b>             | 0.10                | 0.08                | 0.15                     | 0.58   |
| <b>CD (P=0.05)</b>      | 0.21                | 0.18                | 0.33                     | 1.26   |

### 3.3 Biological yield (Mg/ha)

The application of different fertility levels significantly increases the biological yield of zero till DSR (Table 3 and fig 1). The maximum biological yield (11.26) was observed with the application of 100% RDF + 5kg Fe + 5 Kg Zn/ha, while it was statistically at par with the application of 125 % RDF (10.95). Zinc crucial role in crop growth encompasses photosynthesis, respiration, and various biochemical and physiological activities, contributing significantly to

achieving higher yields (Zeidan et al., 2010). Crop yield in rice relies on shoot dry matter and Harvest Index (HI). Enhanced shoot dry matter accumulation boost yield (Mai et al., 2021). Also, DSR-RT recorded the highest grain and straw yields among rice establishment methods, likely due to increased microbial activity and improved soil structure under reduced tillage compared to conventional tillage (Krauss et al., 2022; Trivedi et al., 2017).

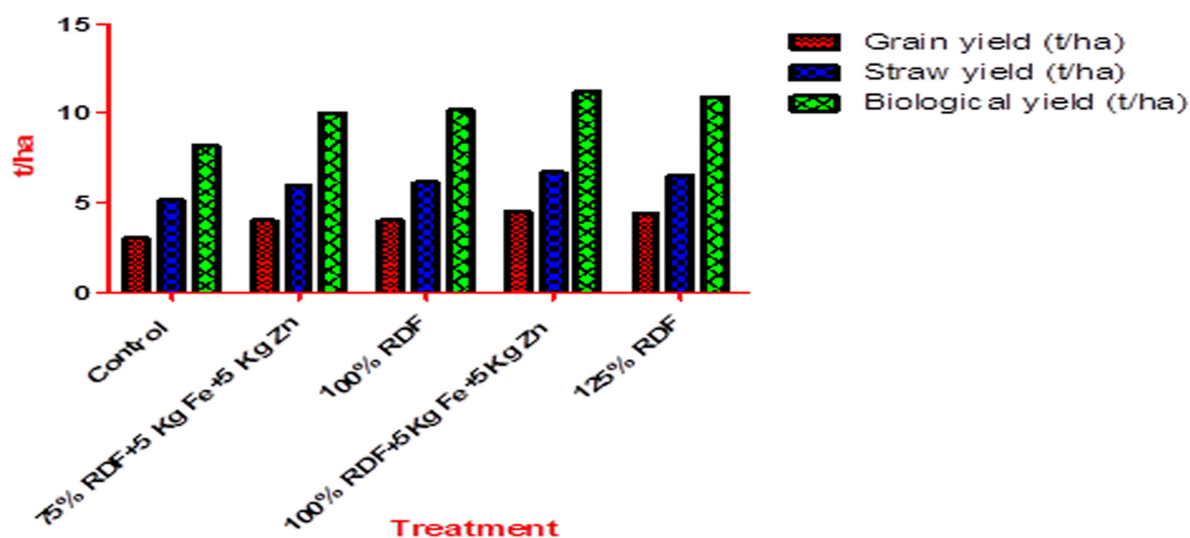


Fig 1: Effect of different fertility levels on yield of zero-till direct seeded rice.

### 3.4 Harvest index (%)

The application of different fertility levels significantly increases the harvest index of zero till DSR (Table 3). The maximum harvest index (40.33) was observed with

the application of 100% RDF + 5kg Fe + 5 Kg Zn/ha, while it was statistically at par with the application of 125 % RDF (40.20).



### 3.5 Nutrient content (%) and their uptake (mg/ha)

#### N, P, K, content (%) in grain and straw

Results indicated that the application of different fertility levels significantly increases the N, P and K content in grain of zero till DSR (Table 4). The maximum N, P and K content in grain (1.36, 0.212 and 0.354) and straw (0.67, 0.102 and 1.63) was observed with the application of 100% RDF + 5kg Fe + 5 Kg Zn/ha, while it was statistically at par with the application of 125 % RDF (1.32, 0.205 and 0.342, 0.65, 0.099 and 1.58, respectively). Furthermore, 75 % RDF + 5kg Fe + 5 Kg Zn/ha and 100 % RDF was also statistically at par. The residue helped in better recycling of nutrients and increased availability of nutrients (Kumar et al., 2021).

### 3.6 Zn and Fe content (%) in grain and straw

Results indicated that the application of different fertility levels significantly increase the Zn and Fe content in grain of zero till DSR (Table 4). The maximum Zn and Fe content in grain (21.78 and 246.00) and straw (65.86 and 265.52) was observed with the application of 100% RDF + 5kg Fe + 5 Kg Zn/ha, while it was statistically at par with the application of 125 % RDF (21.08 and 241.08, 63.83 and 259.33, respectively). Furthermore, 75 % RDF + 5kg Fe + 5 Kg Zn/ha and 100 % RDF was also statistically at par. The results were in consistent with the findings of Meena et al., (2018) where zinc and iron content in grain was enhanced by nitrogen rate and highest zinc content (~ 34 mg /kg) was recorded with 150 kg N/ha, which is 57% higher than control.

Table 4: Effect of different fertility levels on nutrient content (%) in grain and straw of zero-till direct seeded rice

| Treatment               | N     |       | P     |       | K     |       | Zn    |       | Fe     |        |
|-------------------------|-------|-------|-------|-------|-------|-------|-------|-------|--------|--------|
|                         | Grain | Straw | Grain | Straw | Grain | Straw | Grain | Straw | Grain  | Straw  |
| Control                 | 0.90  | 0.43  | 0.136 | 0.068 | 0.234 | 1.08  | 14.38 | 44.38 | 194.08 | 200.26 |
| 75% RDF+5 Kg Fe+5 Kg Zn | 1.20  | 0.59  | 0.185 | 0.090 | 0.311 | 1.43  | 19.18 | 58.30 | 227.72 | 242.55 |
| 100% RDF                | 1.21  | 0.59  | 0.187 | 0.091 | 0.314 | 1.45  | 19.33 | 58.74 | 228.78 | 243.88 |
| 100% RDF+5Kg Fe+5Kg Zn  | 1.36  | 0.67  | 0.212 | 0.102 | 0.354 | 1.63  | 21.78 | 65.86 | 246.00 | 265.52 |
| 125% RDF                | 1.32  | 0.65  | 0.205 | 0.099 | 0.342 | 1.58  | 21.08 | 63.83 | 241.08 | 259.33 |
| SEm±                    | 0.03  | 0.02  | 0.005 | 0.002 | 0.008 | 0.04  | 0.49  | 1.43  | 3.45   | 4.33   |
| CD (P=0.05)             | 0.07  | 0.03  | 0.011 | 0.005 | 0.017 | 0.08  | 1.07  | 3.11  | 7.51   | 9.44   |

### 3.7 N, P, K, uptake (Mg/ha) in grain and straw

Results indicated that the application of different fertility levels significantly increase the N, P, K, uptake in grain and straw of zero till DSR (Table 5). The maximum N, P, K, uptake in grain (61.82, 9.63 and 16.08) and straw (44.96, 6.86 and 109.51) was observed with the application of 100% RDF + 5kg Fe + 5 Kg Zn/ha, while it was statistically at par with the application of 125 % RDF (57.94, 9.01 and 15.07, 42.32, 6.47 and 103.25, respectively). Furthermore, 75 % RDF + 5kg Fe + 5 Kg Zn/ha and 100 % RDF was also statistically at par. The increase in nutrient uptake with the increase in fertility levels could be attributed to the better availability of nutrients and their transport to the plant from the soil, as the nutrient application leads to its enhanced uptake by plant (Kumar et al., 2020).

### 3.8 Zn and Fe uptake (Mg/ha) in grain and straw

Results indicated that the application of different fertility levels significantly increase the Zn and Fe uptake in grain and straw of zero till DSR (Table 5). The maximum Zn and Fe uptake in grain (989.86 and 11176.00) and straw (4425.72 and 17838.98) was observed with the application of 100% RDF + 5kg Fe + 5 Kg Zn/ha, while it was statistically at par with the application of 125 % RDF (927.63 and 10608.78, 4178.40 and 16976.40, respectively). Furthermore, 75 % RDF + 5kg Fe + 5 Kg Zn/ha and 100 % RDF was also statistically at par. Application of fertilizers in combination with Zn and Fe improved various physic-chemical properties resulting in enhanced nutrient absorption or uptake (Hazarika et al., 2018). It was also due to the involvement of N, P and K in growth



and development and the increased availability of Zn and Fe (Meena et al., 2018). Similar results were also reported by Hazarika et al., 2020.

Table 5: Effect of different fertility levels on nutrient uptake by grain and straw of zero-till direct seeded rice

| Treatment               | N (kg/ha) |       | P (kg/ha) |       | K (kg/ha) |        | Zn (g/ha) |         | Fe (g/ha) |          |
|-------------------------|-----------|-------|-----------|-------|-----------|--------|-----------|---------|-----------|----------|
|                         | Grain     | Straw | Grain     | Straw | Grain     | Straw  | Grain     | Straw   | Grain     | Straw    |
| Control                 | 27.55     | 22.46 | 4.17      | 3.56  | 7.16      | 55.99  | 441.15    | 2309.11 | 5948.54   | 10417.46 |
| 75% RDF+5 Kg Fe+5 Kg Zn | 48.20     | 35.23 | 7.45      | 5.43  | 12.53     | 86.35  | 771.74    | 3508.47 | 9160.72   | 14596.00 |
| 100% RDF                | 48.94     | 36.29 | 7.57      | 5.59  | 12.73     | 88.90  | 783.52    | 3611.02 | 9271.35   | 14992.62 |
| 100% RDF+5Kg Fe+5Kg Zn  | 61.82     | 44.96 | 9.63      | 6.86  | 16.08     | 109.51 | 989.86    | 4425.72 | 11176.00  | 17838.98 |
| 125% RDF                | 57.94     | 42.32 | 9.01      | 6.47  | 15.07     | 103.25 | 927.63    | 4178.40 | 10608.78  | 16976.40 |
| SEm±                    | 2.42      | 1.24  | 0.39      | 0.18  | 0.63      | 2.93   | 38.70     | 115.35  | 362.37    | 391.05   |
| CD ( $P=0.05$ )         | 5.27      | 2.70  | 0.84      | 0.39  | 1.37      | 6.39   | 84.33     | 251.32  | 789.53    | 852.03   |

### 3.9 Total NPK uptake (kg/ha) by crop

Results indicated that the application of different fertility levels significantly increase the total NPK uptake of zero till DSR (Table 6). The maximum total NPK uptake (106.78, 16.49 and 125.59) was observed with the application of 100% RDF + 5kg Fe + 5 Kg Zn/ha, while it was statistically at par with the application of 125 % RDF (100.26, 15.48 and 118.32). Furthermore, 75 % RDF + 5kg

Fe + 5 Kg Zn/ha and 100 % RDF was also statistically at par. The maximum total NPK uptake (50.01, 7.73 and 63.16) and total crop micronutrient viz., Zn, Fe, Cu and Mn uptake was found maximum in Zero tillage + Residue management among tillage practices as per findings of Kumar (2020). Also, line with the findings of Dudwal et al., 2023 and Hazarika et al., 2020.

Table 6: Effect of different fertility levels on total nutrient uptake by zero-till direct seeded rice

| Treatment               | N (kg/ha) | P (kg/ha) | K (kg/ha) | Zn (g/ha) | Fe (g/ha) |
|-------------------------|-----------|-----------|-----------|-----------|-----------|
| Control                 | 50.01     | 7.73      | 63.16     | 2750.27   | 16366.01  |
| 75% RDF+5 Kg Fe+5 Kg Zn | 83.43     | 12.88     | 98.88     | 4280.21   | 23756.72  |
| 100% RDF                | 85.22     | 13.16     | 101.63    | 4394.55   | 24263.97  |
| 100% RDF+5Kg Fe+5Kg Zn  | 106.78    | 16.49     | 125.59    | 5415.58   | 29014.98  |
| 125% RDF                | 100.26    | 15.48     | 118.32    | 5106.03   | 27585.18  |
| SEm±                    | 3.59      | 0.56      | 3.52      | 151.44    | 727.30    |
| CD ( $P=0.05$ )         | 7.83      | 1.21      | 7.66      | 329.97    | 1584.65   |

### 3.10 Total Zn and Fe uptake (kg/ha) by plant

Results indicated that the application of different fertility levels significantly increase the total Zn and Fe uptake of zero till DSR (Table 6). The maximum total Zn and Fe uptake (5415.58 and 29014.98) was observed with the

application of 100% RDF + 5kg Fe + 5 Kg Zn/ha, while it was statistically at par with the application of 125 % RDF (5106.03 and 27585.18 and 27585.18). Furthermore, 75 % RDF + 5kg Fe + 5 Kg Zn/ha and 100 % RDF was also statistically at par.



### 3.11 Available nutrient in soil

#### Available NPK (kg/ha)

Results indicated that the application of different fertility levels significantly increase the available NPK in soil after harvest of zero till DSR (Table 7 and fig 2). The maximum available NPK (225.00, 20.20 and 208.00) was observed with the application of 100% RDF + 5kg Fe + 5 Kg Zn/ha, while it was statistically at par with the application of 125 % RDF (218.44, 19.62 and 201.67). Furthermore, 75 % RDF + 5kg Fe + 5 Kg Zn/ha and 100 % RDF was also statistically at par. The findings were similar with the Kumar (2020) where maximum organic carbon content (0.61 %), available N, P, K, (268.82, 37.57, 139.67, kg/ha) & S (15.36 ppm) and micronutrients viz., Zn, Fe, Cu & Mn (0.80, 1.31, 7.52 & 4.02 ppm) in post-harvest soil were found in Zero tillage + Residue management over the rest of the tillage practices. According to the findings of Hazarika et al. (2028) the increase in available phosphorus might be due to the organic acid, which were released during microbial decomposition of organic matter and help in solubility of

native phosphates and as a result of increase in phosphorus was recorded. Also, the higher availability of potassium in soil may be due to beneficial effect of organic manures from residues on the reduction of potassium fixation and release potassium due to interaction of organic with clay. Hazarika et al. (2018) also found that the highest available N, P and K in soil were found in zero tillage.

### 3.12 Available Zn and Fe

Results indicated that the application of different fertility levels significantly increase the available Zn and Fe in soil after harvest of zero till DSR (Table 7 and fig. 2). The maximum available Zn and Fe (0.32 and 13.52) was observed with the application of 100% RDF + 5kg Fe + 5 Kg Zn/ha, while it was statistically at par with the application of 125 % RDF (0.31 and 13.11). Furthermore, 75 % RDF + 5kg Fe + 5 Kg Zn/ha and 100 % RDF was also statistically at par. The higher availability of Zn and Fe in soil may be due to beneficial effect of organic manures from residues on the reduction of Zn and Fe fixation and release due to interaction of organic with clay (Hazarika et al., 2018).

Table 7: Effect of different fertility levels on available nutrient in soil after harvest of zero-till direct seeded rice

| Treatment               | N (kg/ha) | P (kg/ha) | K (kg/ha) | Zn (kg/ha) | Fe (kg/ha) |
|-------------------------|-----------|-----------|-----------|------------|------------|
| Control                 | 155.74    | 14.11     | 141.19    | 0.22       | 9.18       |
| 75% RDF+5 Kg Fe+5 Kg Zn | 200.63    | 18.05     | 184.48    | 0.28       | 11.99      |
| 100% RDF                | 202.03    | 18.18     | 185.84    | 0.29       | 12.08      |
| 100% RDF+5Kg Fe+5Kg Zn  | 225.00    | 20.20     | 208.00    | 0.32       | 13.52      |
| 125% RDF                | 218.44    | 19.62     | 201.67    | 0.31       | 13.11      |
| SEm±                    | 4.60      | 0.40      | 4.44      | 0.007      | 0.29       |
| CD (P=0.05)             | 10.02     | 0.88      | 9.67      | 0.015      | 0.63       |

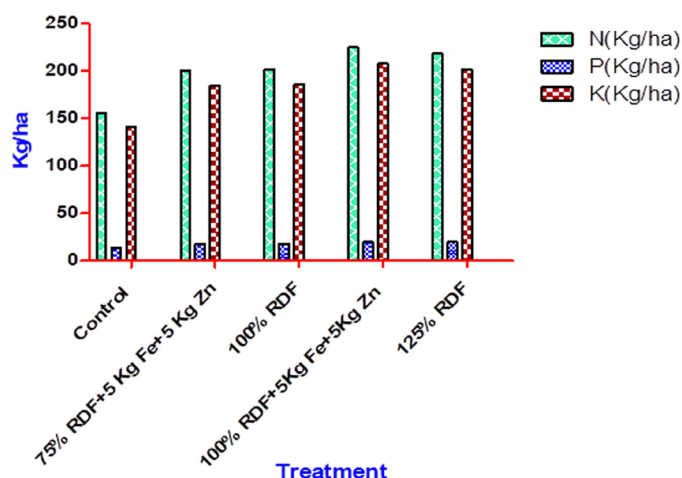


Fig 2: Effect of different fertility levels on available nutrient in soil after harvest of zero-till direct seeded rice.



## Conclusion

The application of 100% RDF+ Zn 5kg/ha+ Fe5 kg/ha was suitable to attain the higher yield, nutrient content and uptake under ZT-DSR. The utilization of macro and micronutrients presents itself as a potential solution to address nutrient deficiencies and conserve resources in direct-seeded rice cultivation, potentially enhancing yields. Furthermore, the findings of this study suggest that transitioning from the conventional transplanting method to Zero-tillage Direct-Seeded Rice (DSR) could result in water and labor savings.

## Author contributions

The conceptualization of research (B.K and R.S.M); Designing of the experiments (B.K. and R.S.M); Execution of field experiments and data collection (B.K); Analysis of data and interpretation (S., R.K. and A.C.); writing–original draft preparation (S., and A.C.); writing–review and editing, (S., B.K., A.C. and R.K); Preparation of the manuscript (A.C. and G.P.).

## Conflict of interest

No

## Declaration

The authors declare no conflict of interest.

## References

1. Dudwal BL, TK Das and SK Dudwa. 2023. Yield and Nutrient Uptake Influenced by Tillage Crop Establishment and Residue Management in Rice-Wheat Cropping System. *International Journal of Economic Plants*. 10(1): 6-11.
2. Farooq M, Siddique KH, Rehman H, Aziz T, Lee DJ and Wahid A. 2011. Rice direct seedling: experiences, challenges and opportunities. *Soil Tillage Research*. 111(2): 87-98.
3. Gomez KA and AA Gomez. 1984. Statistical Procedures for Agricultural Research. John Willey and Sons, Singapore, 680p
4. Hazarika N, MK Sarmah, A Basumatary and R Saikia. 2018. Soil chemical properties as influenced by tillage and nutrient management practices after growing direct seeded sali rice. *International Journal of Chemical Studies*. 6: 2709-2712.
5. Jackson ML. 1967. Soil Chemical Analysis. Prentice Hall of India Private Limited, New Delhi, pp. 111-203.
6. Krauss M, A Berner, F Perrochet, R Frei, U Niggli and P Mader. 2020. Enhanced soil quality with reduced tillage and solid manures in organic farming—A synthesis of 15 years. *Scientific Report*. 10: 4403.
7. Kumar D, A Punetha, PP Verma and RC Padalia. 2022. Micronutrient based approach to increase yield and quality of essential oil in aromatic crops. *Journal of Applied Research on Medicinal and Aromatic Plants*. 26: 100361.
8. Kumar S, SK Verma, A Yadav, S Taria, B Alam and TR Banjara. 2022. Tillage based crop establishment methods and zinc application enhances productivity, grain quality, profitability and energetics of direct-seeded rice in potentially zinc-deficient soil in the subtropical conditions of India. *Communications in Soil Science and Plant Analysis*. 53(9): 1085-1099.
9. Kumar P. 2020. Impact of different tillage and nutrient management strategies on productivity and profitability of direct seeded rice (*Oryza sativa* L.) (Doctoral dissertation, DRPCA, Pusa).
10. Kumar P, A Kumar, AK Rai, RK Yadav, T Damodaran and DK Sharma. 2021. Nutrient and residue management in zero tilled-direct seeded basmati rice (*Oryza sativa*)-wheat (*Triticum aestivum*) system. *The Indian Journal of Agricultural Sciences*. 91(7): 1029-1033.
11. Lindsay WL and W Norvell. 1978. Development of a DTPA soil test for zinc, iron, manganese, and copper. *Soil science society of America journal*. 42(3): 421-428.
12. Mai W, B Abliz and X Xue. 2021. Increased number of spikelets per panicle is the main factor in higher yield of transplanted vs. Direct-seeded rice. *Agronomy*. 11(12): 2479.
13. Meena RP, SK Prasad, A Layek, MK Singh and M Das. 2018. Nitrogen and zinc scheduling for zinc biofortification in direct seeded rice (*Oryza sativa*). *The Indian Journal of Agricultural Sciences*. 88(5): 805-808.



14. Mohan V, R Unnikrishnan, S Shobana, M Malavika, RM Anjana and V Sudha. 2018. Are excess carbohydrates the main link to diabetes & its complications in Asians. *The Indian journal of medical research*. **148**(5): 531.
15. Pathak H, V Singh, A Bhatia and N Jain. 2011. Direct seeding of rice: Potential, performance and problem. *Current advance in agricultural science*. **3**(2): 77-88.
16. Piper CS. 1966. Soil and Plant Analysis. *Academic Press*. New York. pp 47-77.
17. Sharma RP, SK Pathak and RC Singh. 2007. Effect of nitrogen and weed management in direct-seeded rice (*Oryza sativa*) under upland conditions. *Indian Journal of Agronomy*. **52**(2): 114-119.
18. Singh A, VK Phogat, R Dahiya and SD Batra. 2014. Impact of long-term zero till wheat on soil physical properties and wheat productivity under rice-wheat cropping system. *Soil and Tillage Research*. **140**: 98-105.
19. Trivedi P, PM Schenk, MD Wallenstein, BK Singh. 2017. Tiny microbes, big yields: Enhancing food crop production with biological solutions. *Microbial Biotechnology*. **10**: 999-1003.
20. Wang H, O Velarde, S Bona and P Meas. 2012. Pattern of varietal adoption and economics of rice production in Cambodia. Patterns of varietal adoption and economics of rice production in Asia 23-65.
21. Wiangsamut B, CT Mendoza and AT Lafarge. 2006. Growth dynamics and yield of rice genotypes grown in transplanted and direct-seeded fields. *Journal of Agricultural Technology*. **2**(2): 299-316.
22. Zeidan MS, F Manal and HA Hamouda. 2010. Effect of foliar fertilization of Fe, Mn and Zn on wheat yield and quality in low sandy soils fertility. *World Journal of Agricultural Sciences*. **6**(6): 696-699.

