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# Productivity of maize and wheat influenced by long term application of fertilizer and manure under maize-wheat system in alfisol of Jharkhand

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**Abstract**
Maize (*Zea mays* L.) - Wheat (*Triticum aestivum* L.) is the third most important cropping system in India and is practiced on 1.8 million hectares. The present investigation was carried out during two consecutive years of 2020-22 under the ongoing permanent manurial trial with different nutrient management practices (inorganic and integrated nutrient management) under maize-wheat system since 1983-84 at Birsa Agricultural University, Kanke, Ranchi to study the influence of long-term application of fertilizer and manure under maize-wheat system on the productivity of crops. The experimental soil was loam in texture (42.4 % sand, 23.4 % silt and 34.2% clay) with slightly acidic (6.5) in reaction having low organic carbon (4.1 g/kg soil) and available nitrogen (255.0 kg/ha), medium in available phosphorous (12.50 kg/ha) and available potash (195.0 kg/ha) consisting 11.13 ppm available iron, 18.65 ppm available manganese and 3.85 ppm available zinc. Twelve treatments consisted, $T_1$: $N_0P_0K_0$ to maize fb $N_0P_0K_0$ to wheat; $T_2$: 50% RDF to maize fb50% RDF to wheat; $T_3$: 50 % RDF to maize fb100% RDF to wheat; $T_4$: 75% RDF to maize fb75% RDF to wheat ; $T_5$: 100% RDF to maize fb100% RDF to wheat; $T_6$: 50%N through FYM+ 50% RDF through chemical to maize fb 100% RDF through chemical to wheat; $T_7$:25% N through FYM+ 75% RDF through chemical to maize fb75% RDF through chemical to wheat; $T_8$: 50%N through cut paddy straw+ 50% RDF through chemical to maize fb 100% RDF through chemical to wheat; $T_9$: 25% N through cut paddy straw+ 75% RDF through chemical to maize fb75% RDF through chemical to wheat; $T_{10}$: 50%N through green k*aranj* leaves + 50% RDF through chemical to maize fb100% RDF through chemical to wheat; $T_{11}$: 25%N through green k*aranj* leaves + 75% RDF through chemical to maize fb75% RDF through chemical to wheat and $T_{12}$: Farmer's Practice– urea @ 50kg /ha to both crops laid out in randomized block design and replicated thrice. Results showed that application of 50%N through FYM along with 50% RDF through chemical fertilizer to maize fb 100% RDF through chemical fertilizer to wheat produced maximum and significantly higher grain yield (46.92 and 47.96 q/ha of maize and wheat respectively) than other nutrient management practices except application of25%N through FYM along with 75% RDF through chemical fertilizer to maize fb 75% RDF through chemical fertilizer to wheat (45.04 and 45.53 q/ha of maize and wheat, respectively)owing to higher yield attributing characters of maize, grains/line (31.47), grains/cob (394) and 1000 grain weight (331.24 g) and of wheat effective tillers /$m^2$ (362), grains/spike (46), and 1000 grain weight (40.99 g).

**Keywords:** cropping system, farm yard manure, integrated nutrient management, manurial trial and recommended dose of fertilizer

## Introduction
Maize–wheat cropping system is one of the major cropping systems in India, covering around 1.8 million hectares mainly in Indo-Gangetic Plains contributes about sizeable share in national food basket. Increasing the nutrients have played a major role in enhancing the supply of food to a continually growing population. However, over application of inorganic fertilizers causes imbalances of nutrients and have contributed to the degradation of soils including soil fertility depletion. Intensive and multiple cropping systems require judicious application of chemical, organic and bio-fertilizers for yield sustainability and improved soil health (Jat *et al.*, 2013) [4]. Integrated nutrient management (INM) is the feasible solution for sustaining the crop productivity of maize and wheat as nutrient requirements of both the crops are high and have shown superior response towards higher levels of nutrient application (Sharma *et al.*, 2020) [1]. Farmyard manure (FYM), Green manure (GM), crop residues are important and renewable organic sources of nutrients. Large quantities of organic matter are available with the farmers which can be utilized as complementary source to chemical fertilizers.

Furthermore, the use of inorganic nutrient sources coupled with organic sources is a feasible approach for higher agricultural productivity and monitoring soil health (Kumar *et al.*, 2021) [2]. The utilization of well-decomposed farmyard manure (FYM) in soil management practices is a well-known practice for enhancing crop yield, soil organic matter, promoting soil microbial activities, promoting friendly soil environment (Kundu *et al.*, 2006) [3] and increasing the plant-available macro and micronutrients in soil. Besides improving the nutrient availability, organic manures also affect the soil physical and biological characteristics as well as possessing residual effects on the succeeding crops.

## Materials and Methods

A field experiment was conducted at Agronomical farm of Birsa Agricultural University, Kanke, Ranchi during *kharif* and *rabi* seasons of two consecutive years, 2020-22. The present experiment is a long term being conducted since *Kharif* 1983 with maize-wheat cropping system. The experimental soil was loam in texture (42.4 % sand, 23.4 % silt and 34.2% clay) with slightly acidic (6.5) in reaction having low organic carbon (4.1 g/kg soil) and available nitrogen (255.0 kg/ha), medium in available phosphorous (12.50 kg/ha) and available potash (195.0 kg/ha) consisting 11.13 ppm available iron, 18.65 ppm available manganese and 3.85 ppm available zinc.

Altogether 12 treatments in maize-wheat cropping system were $T_1$: $N_0P_0K_0$to maize fb $N_0P_0K_0$to wheat; $T_2$: 50% RDF to maize fb50% RDF to wheat; $T_3$: 50 % RDF to maize fb100% RDF to wheat; $T_4$: 75% RDF to maize fb75% RDF to wheat; $T_5$: 100% RDF to maize fb100% RDF to wheat; $T_6$: 50%N through FYM+ 50% RDF through chemical to maize fb 100% RDF through chemical to wheat; $T_7$: 25%N through FYM+ 75% RDF through chemical to maize fb75% RDF through chemical to wheat; $T_8$: 50%N through cut paddy straw+ 50% RDF through chemical to maize fb 100% RDF through chemical to wheat; $T_9$: 25%N through cut paddy straw+ 75% RDF through chemical to maize fb75% RDF through chemical to wheat; $T_{10}$: 50%N through green k*aranj* leaves + 50% RDF through chemical to maize fb100% RDF through chemical to wheat; $T_{11}$: 25%N through green k*aranj* leaves + 75% RDF through chemical to maize fb75% RDF through chemical to wheat and $T_{12}$: Farmer's Practice– urea @ 50kg /ha to both crops laid out in randomized block design and replicated thrice. Recommended dose of fertilizer for both component crops were @ 100 kg N, 50 Kg $P_2O_5$ and 25 kg $K_2O$ /ha. "Suwan Composit$^{-1}$" maize and "K 9107" wheat was the test crop variety.

## Results and Discussion

### Yield attributes

### Maize

#### Grains per row

The effect of inorganic fertilizer alone or its integration with organic sources on number of grains per row (pooled data) of maize was found to be significant (Table-1). Average number of grains per row varied from 14.58 to 31.47. Maximum and higher grains per row (31.47) was recorded in the cropapplied with 50% N through FYM+50% RDF through chemical fertilizer than crop receiving no fertilizer (14.6) and farmer's practice (20.3).

#### Grains per cob

Grains per cob varied from 134.69 to 394.34. Grains per cob (394.34) was recorded maximum and significantly higher with crop receiving 50% N through FYM+50% RDF through chemical fertilizer (394.34) than crop with sub optimal doses of fertilizer (134.69 to 327.51).

#### 1000 - grain weight

The effect of inorganic fertilizer alone or its integration with organic sources on 1000 - grain weight of maize was found to be significant. 1000- grain weight of maize varied from 281.24 to 331.24 g (Table-1). The heavier grain (331.24 g) was recorded in treatment with 50% N through FYM+50% RDF through chemical fertilizer. The lowest weight was observed in control ($N_0P_0K_0$) followed by farmer's practice (281.24 g and 294.01g, respectively)

### Wheat

#### Effective tillers per $m^2$

Effective tillers per $m^2$differed significantly due to nutrient management practices. Data also revealed that level of application of inorganic fertilizers and organic sources applied in maize crop, significantly influenced the number of effective tillers per $m^2$ in wheat. The number of effective tillers per $m^2$ varied from 180 to 362. The highest number of effective tillers per $m^2$ (362.23) was recorded in treatment with 50% N through FYM+50% RDF through chemical fertilizer to maize fb 100% RDF through chemical fertilizer to wheatwhich was statistically *at par* with all the treatments except control, 50% RDF through chemical fertilizer and farmer's practice.

#### Grains per spike

Grains per spike differed significantly due to nutrient management practices. Number of grains spike varied from 23.9 to 45.8. Maximum and higher number of grains per spike was recorded in treatment receiving 50% N through FYM along with 50% RDF through chemical to maize fb 100% RDF through chemical fertilizer to wheat (45.8) than other nutrient management practices except 100% RDF through chemical fertilizer to both crops and 25% N through FYM+75% RDF through chemical fertilizer to maize fb 75% RDF through chemical fertilizer to wheat.

#### 1000- Grain weight

Data revealed that level of application of inorganic fertilizers and organic sources in maize and wheat crop, significantly influenced 1000-grain weight of wheat. Mean thousand grain weight of wheat varied from 33.2 to 42.3 g. Highest and significantly higher thousand grain weight was recorded in treatment receiving 50% N through FYM along with 50% RDF through chemical fertilizer to maize and 100% RDF through chemical fertilizer to wheat than all other sub optimal doses of fertilizer.

**Table 1:** Effect of long-term application of fertilizer and manure on yield attributes of maize and wheat under maize-wheat cropping system (pooled data of 2 years).

| Treatment | | Maize | | | Wheat | | |
|---|---|---|---|---|---|---|---|
| Maize | Wheat | Grains/ row | Grains/ cob | 1000 grain wt(g) | Effective tillers/$m^2$ | Grains/spike | 1000 grain wt. (g) |
| $T_1$.$N_0P_0K_0$ | $N_0P_0K_0$ | 14.58 | 134.69 | 281.24 | 180.27 | 23.93 | 33.11 |
| $T_2$.50%RDF | 50%RDF | 28.34 | 312.66 | 296.53 | 288.20 | 35.03 | 35.40 |
| $T_3$.50%RDF | 100%RDF | 28.86 | 324.17 | 299.11 | 307.35 | 37.10 | 35.66 |
| $T_4$. 75%RDF | 75%RDF | 28.32 | 327.51 | 300.76 | 313.85 | 38.43 | 35.96 |
| $T_5$.100%RDF | 100%RDF | 29.23 | 355.72 | 321.14 | 338.60 | 41.70 | 40.54 |
| $T_6$.50%N (FYM) + 50% RDF | 100%RDF | 31.47 | 394.34 | 331.24 | 362.23 | 45.82 | 40.99 |
| $T_7$.25%N (FYM) + 75% RDF | 75%RDF | 30.99 | 381.24 | 325.34 | 354.06 | 43.77 | 40.69 |
| $T_8$.50%N (CPS) + 50% RDF | 100%RDF | 30.30 | 369.61 | 319.34 | 337.16 | 39.45 | 40.29 |
| $T_9$.25%N (CPS) + 75% RDF | 75%RDF | 29.46 | 344.44 | 312.94 | 318.60 | 37.27 | 38.39 |
| $T_{10}$.50%N (GKL) + 50% RDF | 100%RDF | 29.96 | 361.25 | 318.44 | 333.87 | 38.07 | 39.95 |
| $T_{11}$.25%N (GKL) + 75% RDF | 75%RDF | 29.08 | 339.47 | 306.60 | 316.76 | 39.23 | 38.01 |
| $T_{12}$.Farmer's practice (urea @ 50kg/ha) | Farmer's practice (urea @ 50kg/ha) | 20.26 | 197.91 | 294.01 | 191.18 | 26.23 | 33.64 |
| SEm± | | 1.72 | 19.25 | 11.67 | 19.34 | 2.39 | 1.43 |
| CD at 5% | | 5.03 | 56.47 | 34.22 | 56.72 | 7.02 | 4.19 |
| CV (%) | | 10.78 | 10.41 | 6.54 | 11.04 | 11.03 | 6.56 |

DAS:- Days after sowing; CPS:- Cut paddy straw; GKL:- Green karanj leaves FYM- Farmyard manure

## Maize

### Grain yield

Grain yield of maize in maize-wheat system influenced significantly by nutrient management practices (Table-2). Grain yield of maize produced with application of 50% N through FYM+50% RDF through chemical fertilizer to maize fb 100% RDF through chemical fertilizer to wheat(46.9 q/ha) being like 100% RDF through chemical fertilizer to both crops (43.3 q/ha) and 25% N through FYM+75% RDF through chemical fertilizer to maize fb 75% RDF through chemical fertilizer to wheat (45.4 q/ha) recorded higher yield than all other nutrient management practices owing to more grains/cob, grins/row and heavier grain.

### Straw yield

Pooled data on straw yield of maize revealed that nutrient management practices (inorganic fertilizer and in combination with organic sources) significantly influenced the straw yield of maize. The highest straw yield (70.53 q/ha) was obtained in treatment receiving 50% N through FYM+50% RDF through chemical fertilizer to maize fb 100% RDF through chemical fertilizer to wheat. It was significantly higher than all other nutrient management practices except 100% RDF through chemical fertilizer to both crops (63.8 q/ha) and 25% N through FYM+75% RDF through chemical fertilizer to maize fb 75% RDF through chemical fertilizer to wheat100%RDF (65.2q/ha).

## Wheat

### Grain yield

Grain yield of wheat in maize-wheat system influenced significantly by nutrient management practices (Table-2). Grain yield of wheat produced with application of 50% N through FYM+50% RDF through chemical fertilizer to maize fb 100% RDF through chemical fertilizer to wheat(47.96 q/ha) being like 100% RDF through chemical fertilizer to both crops (43.69 q/ha) and 25% N through FYM+75% RDF through chemical fertilizer to maize fb 75% RDF through chemical fertilizer to wheat (45.53 q/ha) recorded higher yield than all other nutrient management practices owing to more effective tillers/$m^2$ (362.2), grains/spike (45.8) and heavier grain (41 g).

### Straw yield

Pooled data on straw yield of wheat have been presented in Table-2. Data revealed that level of application of inorganic fertilizers and organic sources in *kharif* crop, significantly influenced straw yield in *rabi* crop of wheat. Straw yield varied from 29.91 to 82.28 q/ha. The highest straw yield (82.28 q/ha) was recorded in treatment receiving 50% N through FYM+50% RDF through chemical fertilizer to maize fb 100% RDF through chemical fertilizer to wheat. It was similar to all other integrated nutrient management practices as well as 100% RDF to both cropsbut significantly higher than rest of the treatments.

**Table 2:** Effect of long-term application of fertilizer and manure on grain yield of maize and wheat under maize-wheat system (pooled data of 2 years).

| Treatment | | Maize(q/ha) | | Wheat(q/ha) | |
|---|---|---|---|---|---|
| Maize | Wheat | Grain | Straw | Grain | Straw |
| $T_1$.$N_0P_0K_0$ | $N_0P_0K_0$ | 9.01 | 20.42 | 10.1 | 29.91 |
| $T_2$.50%RDF | 50%RDF | 25.81 | 48.77 | 24.46 | 61.93 |
| $T_3$.50%RDF | 100%RDF | 26.9 | 51.08 | 32.37 | 67.91 |
| $T_4$. 75%RDF | 75%RDF | 28.53 | 53.32 | 35.26 | 69.7 |
| $T_5$.100%RDF | 100%RDF | 43.33 | 63.83 | 43.69 | 78.03 |
| $T_6$.50%N (FYM) + 50% RDF | 100%RDF | 46.92 | 70.53 | 47.96 | 82.28 |
| $T_7$.25%N (FYM) + 75% RDF | 75%RDF | 45.04 | 65.19 | 45.53 | 78.73 |
| $T_8$.50%N (CPS) + 50% RDF | 100%RDF | 38.78 | 60.66 | 41.69 | 76.28 |
| $T_9$.25%N (CPS) + 75% RDF | 75%RDF | 36.3 | 57.85 | 38.41 | 73.25 |

| | | | | | |
|---|---|---|---|---|---|
| $T_{10}$.50%N (GKL) + 50% RDF | 100%RDF | 37.64 | 59.04 | 39.38 | 75.71 |
| $T_{11}$.25%N (GKL) + 75% RDF | 75%RDF | 30.65 | 55.15 | 36.69 | 72.49 |
| $T_{12}$.Farmer's practice (urea @ 50kg/ha) | Farmer's practice (urea @ 50kg/ha) | 11.74 | 21.61 | 14.76 | 47.11 |
| SEm± | | 2.08 | 3.06 | 2.18 | 4.18 |
| CD at 5% | | 6.1 | 8.97 | 6.39 | 12.27 |
| CV (%) | | 11.36 | 10.13 | 11.04 | 10.69 |

DAS:-Days after sowing; CPS:- Cut paddy straw; GKL:- Green karanj leaves FYM- Farmyard manure

## Conclusion

It may be concluded that substitution of 50% N through FYM + 50% RDF through chemical fertilizer to maize and 100% RDF through chemical fertilizer to wheat in maize–wheat cropping system was found best for higher crop production and can be recommended for farmers.

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