



# Effect of Inorganic Fertilizers and Organic Manures on Growth and Yield Parameters under Wheat-Maize Cropping Sequence Grown on Normal and Saline-Sodic Inceptisol

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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 study was conducted at PGI Research farm, Department of Soil Science and Agriculture Chemistry, Post Graduate Institute, MPKV., Rahuri during *Rabi-2021* and *Summer-2022*. The experiment consist of eight treatments in wheat crop viz., T<sub>1</sub>: RDN (50% N) + 50% N through FYM, T<sub>2</sub>: RDN (50% N) + 50% N through vermicompost, T<sub>3</sub>: RDN (50% N) + 50% N through poultry manure, T<sub>4</sub>: (50% N) + 50% N through press mud compost, T<sub>5</sub>: (50% N) + 50% N through goat manure, T<sub>6</sub>: (50% N) + 50% N through urban compost T<sub>7</sub>: GRDF (120:60:40 N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O kg ha<sup>-1</sup>) + 10 t FYM ha<sup>-1</sup> and T<sub>8</sub>: absolute control. Whereas, in maize crop treatment from T<sub>1</sub> to T<sub>6</sub> RDN (50% N) is applied with residual N applied to wheat through FYM, vermicompost, poultry manure, goat manure and urban compost, respectively and T<sub>7</sub>: GRDF (120:60:40 N: P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O kg ha<sup>-1</sup>) + 5 t FYM ha<sup>-1</sup> and T<sub>8</sub>: Absolute control. These treatments replicated thrice in Randomized Block Design. In wheat crop, the grain yield, straw yield, test weight, plant height and spike length recorded higher in treatment T<sub>7</sub> (GRDF 120:60:40 N: P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O kg ha<sup>-1</sup> + 10 t FYM ha<sup>-1</sup>) under both normal and saline-sodic Inceptisol (27.87 q ha<sup>-1</sup>, 41.00 q ha<sup>-1</sup>, 43.72 g, 92 cm and 9.92 cm) and (34.43 q ha<sup>-1</sup>, 44.02 q ha<sup>-1</sup>, 42.40 g, 91 cm and 9.82 cm), respectively. Whereas, in succeeding maize crop, the treatment T<sub>7</sub> (GRDF 120:60:40 N: P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O kg ha<sup>-1</sup> + 5 t FYM ha<sup>-1</sup>) recorded highest grain yield, stover yield, test weight, plant height, length of cob and no. of grains per cob in both normal and saline-sodic Inceptisol (64.11 q ha<sup>-1</sup>, 74.23 q ha<sup>-1</sup>, 40.34 g, 237.82 cm, 19.99 cm and 633.02 g) and (52.52 q ha<sup>-1</sup>, 61.82 q ha<sup>-1</sup>, 38.63 g, 226.24 cm, 18.74 cm and 579.48 g), respectively. In wheat crop application of treatment T<sub>7</sub> (GRDF 120:60:40 N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O kg ha<sup>-1</sup> + 10 t ha<sup>-1</sup> FYM) recorded highest total uptake of nitrogen, phosphorous and potassium in both normal and saline-sodic Inceptisol (88.00, 16.00 and 100 N, P and K kg ha<sup>-1</sup>) and (99.36, 17.20 and 103 N, P and K kg ha<sup>-1</sup>), respectively. Whereas in succeeding maize crop, total uptake of nitrogen, phosphorous and potassium recorded highest in treatment T<sub>7</sub> (GRDF (120:60:40 N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O kg ha<sup>-1</sup> + 5 t ha<sup>-1</sup> FYM) in both normal and saline-sodic Inceptisol (107.69, 10.77 and 94.67 N, P and K kg ha<sup>-1</sup>) and (85.85, 8.58 and 75.47 N, P and K kg ha<sup>-1</sup>), respectively.

**Keywords:** Inorganic fertilizer; organic manures; saline-sodic soil; plant height; no. of grains per cob; Uptake of N, P and K.

## 1. INTRODUCTION

The maize-wheat cropping system holds significant importance in addressing local food requirements and ensuring food security for India's ever-growing population. This system, featuring the cultivation of maize (*Zea mays L.*) and wheat (*Triticum aestivum*), is widely recognized as the primary and popular double cropping approach, especially in the irrigated regions of northwestern India [1]. Although maize is traditionally grown during the monsoon season, the maize-wheat combination remains the prevailing maize-based system, covering approximately 1.8 million hectares. This system ranks as the third major crop rotation in India and plays a vital role, contributing 3.0% to the nation's overall food production [2]. Additionally,

it serves as a crucial factor in sustaining the country's food supply.

Chemical fertilizers have the advantage of rapidly restoring soil fertility, as the nutrients they contain become readily available to plants once the fertilizers dissolve in the soil [3]. Consequently, farmers have placed a strong emphasis on the use of chemical fertilizers to boost agricultural productivity [4]. Inorganic fertilizers, being water-soluble and containing all the essential nutrients in readily usable forms, are particularly effective for promoting rapid plant growth. Their quick and efficient action is attributed to their high nutrient content, requiring only small quantities to enhance productivity [5].

Organic fertilizers encompass natural materials derived from both plant and animal sources, such

as livestock manure, green manures, crop residues, household waste, compost, and other organic matter. These materials function directly as sources of essential plant nutrients while also exerting indirect effects on the physical, chemical, and biological characteristics of the soil [4]. Organic manures like farmyard manure (FYM), compost, vermicompost, poultry manure, and goat manure, among others, represent natural products that serve as valuable reservoirs of nutrients and moisture in the soil. Organic manures contribute to the improvement of soil structure and foster the growth and proliferation of beneficial soil microorganisms. This, in turn, increases the availability of nutrients for crop growth and aids in the detoxification of harmful chemicals present in the soil [6-8].

A well-balanced approach involving the combined use of fertilizers and manure stands as a highly effective strategy for preventing the

depletion of organic matter and the rapid deterioration of soil's physical attributes, particularly its structure [9,10]. Integrated nutrient management practices have been developed as efficient methods to rejuvenate both soil's physical properties and chemical fertility while enhancing soil organic matter levels. The introduction of organic matter into the soil leads to an increase in its organic carbon content, which, whether directly or indirectly, impacts on growth and yield parameters of crops [11].

## 2. MATERIALS AND METHODS

The research trials took place at the PGI Research Farm within the Department of Soil Science and Agricultural Chemistry at Mahatma Phule Krishi Vidyapeeth, Rahuri. The experimental plot selected was characterized as a level and uniform area with moderate soil depth, classified as an Inceptisol.

**Table 1. Initial soil properties of normal and saline-sodic Inceptisol**

| Sr. No.  | Soil Properties   | Values      |                   |
|----------|---|-------------|-------------------|
|          |   | Normal Soil | Saline-Sodic Soil |
| <b>A</b> | <b>Chemical Properties</b>  |             |                   |
| 1        | pH (1:2.5)  | 8.32        | 8.41              |
| 2        | EC (dS m <sup>-1</sup> )  | 0.29        | 2.10              |
| 3        | Organic carbon (%)  | 0.42        | 0.46              |
| 4        | Calcium Carbonate (%)   | 8.77        | 11.68             |
| 5        | Available nitrogen (kg ha <sup>-1</sup> )                               | 182.60      | 187.10            |
| 6        | Available phosphorus (kg ha <sup>-1</sup> )                             | 14.16       | 13.11             |
| 7        | Available potassium (kg ha <sup>-1</sup> )                              | 389.60      | 361.30            |
| 8        | DTPA extractable Fe (mg kg <sup>-1</sup> )                              | 4.09        | 4.01              |
| 9        | DTPA extractable Mn (mg kg <sup>-1</sup> )                              | 10.90       | 10.64             |
| 10       | DTPA extractable Zn (mg kg <sup>-1</sup> )                              | 0.323       | 0.307             |
| 11       | DTPA extractable Cu (mg kg <sup>-1</sup> )                              | 0.724       | 2.12              |
| 12       | CEC (cmol (p <sup>+</sup> ) kg <sup>-1</sup> )                          | 57.00       | 52.00             |
| 13       | Exchangeable Na <sup>+</sup> (cmol (p <sup>+</sup> ) kg <sup>-1</sup> ) | 3.84        | 9.68              |
| 14       | ESP (%)   | 6.73        | 18.61             |
| <b>B</b> | <b>Heavy Metals</b>   |             |                   |
| 1        | Pb (mg kg <sup>-1</sup> )   | Traces      | Traces            |
| 2        | Cd (mg kg <sup>-1</sup> )   | Traces      | Traces            |
| 3        | Cr (mg kg <sup>-1</sup> )   | Traces      | Traces            |
| 4        | Ni (mg kg <sup>-1</sup> )   | Traces      | Traces            |
| <b>C</b> | <b>Saturation Paste Extract Analysis For</b>                            |             |                   |
| 1        | pHs   | 8.26        | 8.37              |
| 2        | ECe   | 1.33        | 5.76              |
| 3        | Ca <sup>2+</sup> (meL <sup>-1</sup> )                                   | 7.19        | 24.92             |
| 4        | Mg <sup>2+</sup> (meL <sup>-1</sup> )                                   | 6.80        | 19.41             |
| 5        | Na <sup>+</sup> (meL <sup>-1</sup> )                                    | 0.11        | 11.28             |
| 6        | K <sup>+</sup> (meL <sup>-1</sup> )                                     | 0.15        | 0.16              |
| 7        | CO <sub>3</sub> <sup>2-</sup> (meL <sup>-1</sup> )                      | -           | -                 |
| 8        | HCO <sub>3</sub> <sup>-</sup> (meL <sup>-1</sup> )                      | 5.6         | 9.4               |
| 9        | Cl <sup>-</sup> (meL <sup>-1</sup> )                                    | 5.8         | 24.6              |
| 10       | SO <sub>4</sub> <sup>2-</sup> (meL <sup>-1</sup> )                      | 2.2         | 22.3              |

Geographically, the experimental site was situated at a latitude of 19.034° N and a longitude of 74.064° E, with an elevation of 513 meters above sea level. This region is positioned on the Eastern side of the Western Ghats in Maharashtra. The climate in this area is categorized as a regional steppe climate, characteristic of a semiarid tropical region. It features dry and hot summers, along with cool winters, and falls within the agro-climatic zone known as the "Scarcity zone. The initial status of both normal and saline-sodic Inceptisol is described in Table 1.

"The experiment consists of eight treatments in wheat crop viz., T<sub>1</sub>: RDN (50% N) + 50% N through FYM, T<sub>2</sub>: RDN (50% N) + 50% N through vermicompost, T<sub>3</sub>: RDN (50% N) + 50% N through poultry manure, T<sub>4</sub>: (50% N) + 50% N through press mud compost, T<sub>5</sub>: (50% N) + 50% N through goat manure, T<sub>6</sub>: (50% N) + 50% N through urban compost T<sub>7</sub>: GRDF (120:60:40 N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O kg ha<sup>-1</sup>) + 10 t FYM ha<sup>-1</sup> and T<sub>8</sub>: absolute control" [12]. Whereas, in maize crop treatment from T<sub>1</sub> to T<sub>6</sub> RDN (50% N) is applied with residual N applied to wheat through FYM, vermicompost, poultry manure, goat manure and urban compost, respectively and T<sub>7</sub>: GRDF (120:60:40 N: P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O kg ha<sup>-1</sup>) + 5 t FYM ha<sup>-1</sup> and T<sub>8</sub>: Absolute control. The observations were recorded such as plant height, spike length, grain yield, straw yield and test weight in wheat crops under both normal and saline-sodic Inceptisol and plant height, length of cob and no. of grains per cob, grain yield, stover yield and test weight in maize crop under both normal and saline-sodic Inceptisol. The data were analysed statistically and results were interpreted by using methods suggested by Panse and Sukhatme [13].

### 3. RESULTS AND DISCUSSION

#### 3.1 Effect of Inorganic Fertilizers and Organic Manures on Yield and Plant Growth Parameters of Wheat Crop in Normal and Saline-Sodic Inceptisol

Data on the growth and yield of wheat by the application of various organic manures with inorganic fertilizers and presented in Tables 2 and 3 for normal and saline-sodic soil, respectively.

The treatment T<sub>7</sub>, GRDF (120:60:40 N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O kg ha<sup>-1</sup> + 10 t FYM ha<sup>-1</sup>) recorded significantly the highest values in terms of grain

yield (27.87 kg ha<sup>-1</sup>), straw yield (41 kg ha<sup>-1</sup>), test weight (43.72 g), plant height (92 cm) and spike length (9.92 cm) in normal soil. For grain and straw yield treatment T<sub>3</sub> and T<sub>6</sub> were at par with treatment T<sub>7</sub> and for the test weight and plant height treatments T<sub>3</sub>, T<sub>4</sub> and T<sub>6</sub> while, for spike length treatment T<sub>6</sub> was found to be at par with treatment T<sub>7</sub>.

The treatment T<sub>7</sub>, GRDF (120:60:40 N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O kg ha<sup>-1</sup> + 10 t FYM ha<sup>-1</sup>), also demonstrated superior performance in saline-sodic conditions, with highest values recorded for grain yield (34.43 kg ha<sup>-1</sup>), straw yield (44.02 kg ha<sup>-1</sup>), test weight (42.40 g), plant height (91 cm) and spike length (9.82 cm) in saline-sodic Inceptisol. The treatments T<sub>2</sub>, T<sub>3</sub> and T<sub>6</sub> were found to be at par with treatment T<sub>7</sub> for grain yield and straw yield whereas, for test weight treatment T<sub>4</sub> and T<sub>6</sub> and for spike length treatment T<sub>3</sub> was found to be at par with treatment T<sub>7</sub>.

"The highest yield in wheat crop was observed in treatment T<sub>7</sub>, GRDF (120:60:40 N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O kg ha<sup>-1</sup> + 10 t FYM ha<sup>-1</sup>) for both normal and saline-sodic Inceptisol which might be due to the application of organic with inorganic fertilizers was found to be quite promising not only in maintaining higher productivity as well as in providing greater stability in crop production by synergistic effect of FYM on improving efficiency of optimum dose of NPK" [14]. These results conform with the findings of Singh et al. [15]. Wheat is a moderately salt-tolerant crop and tolerates salt up to many levels and takes nutrients even after high salt concentration it might be one of the reasons for the high grain and straw yield of wheat crop in saline-sodic soil.

#### 3.2 Effect of Inorganic Fertilizers and Organic Manures on Yield and Plant Growth Parameters of Maize Crop in Normal and Saline-Sodic Inceptisol

Significant results were observed for the total yield of maize by the application of inorganic fertilizers and the residual effect of organic manures and presented in Tables 4 and 5 for normal and saline-sodic soil, respectively.

The grain yield (64.11 kg ha<sup>-1</sup>) and stover yield (74.23 kg ha<sup>-1</sup>) along with test weight (40.34 g), plant height (237.82 cm), length of cob (19.99 cm) and number of grains per cob (633.02 g) were significantly higher in treatment T<sub>7</sub>, GRDF (120:60:40 N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O kg ha<sup>-1</sup> + 10 t FYM

ha-1) in normal soil. For grain yield, stover yield, plant height, length of cob and no. of grain per cob treatment T2 and T3 were at par with treatment T7 and for the test weight treatments T2, T3, T4 and T6 were found to be at par with treatment T7.

**Table 2. Effect of inorganic fertilizers and organic manures on yield and plant growth parameters of wheat in normal Inceptisol**

| Tr. No.        | Treatments  | Yield and Plant Growth Parameters |                                   |                 |                   |                   |
|----------------|---|-----------------------------------|-----------------------------------|-----------------|-------------------|-------------------|
|                |   | Normal Soil                       |                                   |                 |                   |                   |
|                |   | Grain Yield (q ha <sup>-1</sup> ) | Straw Yield (q ha <sup>-1</sup> ) | Test Weight (g) | Plant Height (cm) | Spike Length (cm) |
| T <sub>1</sub> | RDN (50% N) + 50% N through FYM   | 24.34                             | 27.61                             | 39.44           | 78                | 6.67              |
| T <sub>2</sub> | RDN (50% N) + 50% N through Vermicompost  | 24.33                             | 32.05                             | 40.67           | 85                | 7.17              |
| T <sub>3</sub> | RDN (50% N) + 50% N through Poultry manure  | 26.33                             | 40.23                             | 41.88           | 85.7              | 7.33              |
| T <sub>4</sub> | RDN (50% N) + 50% N through Press mud compost   | 24.34                             | 28.62                             | 42.34           | 86                | 7.50              |
| T <sub>5</sub> | RDN (50% N) + 50% N through Goat manure   | 23.00                             | 29.65                             | 40.97           | 84                | 6.75              |
| T <sub>6</sub> | RDN (50% N) + 50% N through urban compost   | 27.81                             | 40.00                             | 42.56           | 89                | 9.47              |
| T <sub>7</sub> | GRDF (120:60:40 N: P <sub>2</sub> O <sub>5</sub> : K <sub>2</sub> O kg ha <sup>-1</sup> + 10 t ha <sup>-1</sup> FYM | 27.87                             | 41.00                             | 43.72           | 92                | 9.92              |
| T <sub>8</sub> | Absolute Control  | 11.00                             | 18.07                             | 31.5            | 65                | 4.33              |
|                | <b>SE (m)±</b>  | <b>0.66</b>                       | <b>1.81</b>                       | <b>0.64</b>     | <b>2.14</b>       | <b>0.18</b>       |
|                | <b>CD at 5%</b>   | <b>2.03</b>                       | <b>5.45</b>                       | <b>1.93</b>     | <b>6.4</b>        | <b>0.55</b>       |

**Table 3. Effect of inorganic fertilizers and organic manures on yield and plant growth parameters of wheat in saline-sodic Inceptisol**

| Tr. No.        | Treatments  | Yield and Plant Growth Parameters |                                   |                 |                   |                   |
|----------------|---|-----------------------------------|-----------------------------------|-----------------|-------------------|-------------------|
|                |   | Saline Sodic Soil                 |                                   |                 |                   |                   |
|                |   | Grain Yield (q ha <sup>-1</sup> ) | Straw Yield (q ha <sup>-1</sup> ) | Test Weight (g) | Plant Height (cm) | Spike Length (cm) |
| T <sub>1</sub> | RDN (50% N) + 50% N through FYM   | 25.61                             | 39.04                             | 37.82           | 80                | 6.8               |
| T <sub>2</sub> | RDN (50% N) + 50% N through Vermicompost  | 31.69                             | 40.67                             | 38.97           | 87                | 7.19              |
| T <sub>3</sub> | RDN (50% N) + 50% N through Poultry manure  | 34.17                             | 42.12                             | 40.61           | 86                | 9.40              |
| T <sub>4</sub> | RDN (50% N) + 50% N through Press mud compost   | 30.00                             | 38.67                             | 40.96           | 88                | 7.50              |
| T <sub>5</sub> | RDN (50% N) + 50% N through Goat manure   | 29.78                             | 40.02                             | 39.57           | 86                | 6.75              |
| T <sub>6</sub> | RDN (50% N) + 50% N through urban compost   | 30.99                             | 42.53                             | 40.94           | 89                | 8.17              |
| T <sub>7</sub> | GRDF (120:60:40 N: P <sub>2</sub> O <sub>5</sub> : K <sub>2</sub> O kg ha <sup>-1</sup> + 10 t FYM ha <sup>-1</sup> ) | 34.43                             | 44.02                             | 42.40           | 91                | 9.82              |
| T <sub>8</sub> | Absolute Control  | 16.63                             | 28.81                             | 32.62           | 68                | 5.31              |
|                | <b>SE (m)±</b>  | <b>1.22</b>                       | <b>1.23</b>                       | <b>0.47</b>     | <b>0.15</b>       | <b>0.19</b>       |
|                | <b>CD at 5%</b>   | <b>3.63</b>                       | <b>3.68</b>                       | <b>1.47</b>     | <b>0.45</b>       | <b>0.57</b>       |

**Table 4. Effect of inorganic fertilizers and organic manures on yield and plant growth parameters of maize in normal Inceptisol**

| Tr. No.        | Treatments   | Yield and Plant Growth Parameters |                                    |                 |                   |                    |                          |
|----------------|--|-----------------------------------|------------------------------------|-----------------|-------------------|--------------------|--------------------------|
|                |  | Normal Soil                       |                                    |                 |                   |                    |                          |
|                |  | Grain Yield (q ha <sup>-1</sup> ) | Stover Yield (q ha <sup>-1</sup> ) | Test Weight (g) | Plant Height (cm) | Length of Cob (cm) | No. of Grain Per Cob (g) |
| T <sub>1</sub> | RDN (50% N) + Residual effect of FYM   | 58.41                             | 67.72                              | 36.83           | 188.45            | 17.32              | 520.33                   |
| T <sub>2</sub> | RDN (50% N) + Residual effect of vermicompost  | 62.28                             | 70.44                              | 39.72           | 224.85            | 18.93              | 596.33                   |
| T <sub>3</sub> | RDN (50% N) + Residual effect of poultry manure  | 60.34                             | 69.89                              | 39.16           | 216.71            | 18.72              | 586.78                   |
| T <sub>4</sub> | RDN (50% N) + Residual effect of press mud compost   | 58.66                             | 67.64                              | 37.92           | 198.32            | 17.74              | 533.63                   |
| T <sub>5</sub> | RDN (50% N) + Residual effect of goat manure   | 57.42                             | 66.22                              | 36.14           | 186.45            | 17.25              | 515.36                   |
| T <sub>6</sub> | RDN (50% N) + Residual effect of urban compost   | 59.36                             | 68.44                              | 38.72           | 208.32            | 18.03              | 543.78                   |
| T <sub>7</sub> | GRDF (120:60:40 N: P <sub>2</sub> O <sub>5</sub> : K <sub>2</sub> O kg ha <sup>-1</sup> + 5 t ha <sup>-1</sup> FYM | 64.11                             | 74.23                              | 40.34           | 237.82            | 19.99              | 633.02                   |
| T <sub>8</sub> | Absolute control   | 48.83                             | 58.52                              | 29.84           | 176.35            | 15.79              | 491.19                   |
|                | <b>SE (m)±</b>   | <b>1.45</b>                       | <b>1.72</b>                        | <b>1.13</b>     | <b>6.96</b>       | <b>0.47</b>        | <b>16.07</b>             |
|                | <b>CD at 5%</b>  | <b>4.39</b>                       | <b>5.22</b>                        | <b>3.42</b>     | <b>21.13</b>      | <b>1.44</b>        | <b>48.76</b>             |

The treatment T<sub>7</sub>, GRDF (N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O kg ha<sup>-1</sup> + 10 t FYM ha<sup>-1</sup>), recorded significantly the highest values for grain yield (52.52 kg ha<sup>-1</sup>), stover yield (61.82 kg ha<sup>-1</sup>), test weight (38.63 g), plant height (226.24 cm), length of cob (18.74 cm), and number of grains per cob (579.48 g) in saline-sodic Inceptisol. Treatment T<sub>2</sub> and T<sub>3</sub> were at par with treatment T<sub>7</sub> for grain yield, stover yield, plant height, length of cob and no. of grain per cob and for the test weight treatments T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> and T<sub>6</sub> were found to be at par with treatment T<sub>7</sub>.

The highest yield in maize crop was observed in treatment T<sub>7</sub>, GRDF (120:60:40 N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O kg ha<sup>-1</sup> + 10 t FYM ha<sup>-1</sup>) for both normal and saline-sodic Inceptisol which might be due to improvement of physical and chemical properties of soils that resulted in increased productivity by increasing availability of plant nutrients [16]. Further, the organic matter might have supplied macro and micronutrients and resulted as a chelating agent for enhancing the availability of nutrients in soil. These results conform with the

findings of Urkurkar et al. [17] and Thakur et al. [18].

### 3.3 Effect of Inorganic Fertilizers and Organic Manures on Uptake of Nutrients by Wheat in Normal and Saline-Sodic Inceptisol

The data for the uptake of NPK by wheat by the application of various organic manures with inorganic manures is presented in Table 6. The significantly higher NPK uptake was observed in treatment T<sub>7</sub>, in both normal and saline-sodic Inceptisol (88.00, 16.00 and 100 N, P and K kg ha<sup>-1</sup>) and (99.36, 17.20 and 103 N, P and K kg ha<sup>-1</sup>), respectively, compared to treatment T<sub>8</sub> (Absolute control) which exhibited the lowest uptake.

Analysis of nutrient uptake in normal soil revealed that T<sub>3</sub> and T<sub>6</sub> were found to be at par with treatment T<sub>7</sub> for the uptake of total nitrogen and potassium while, for the uptake of phosphorus treatment T<sub>3</sub> was at par with treatment T<sub>7</sub>. In the case of saline-sodic

**Table 5. Effect of inorganic fertilizers and organic manures on yield and plant growth parameters of maize in saline-sodic Inceptisol**

| Tr. No.        | Treatments   | Yield and Plant Growth Parameters |                                    |                 |                   |                    |                          |
|----------------|--|-----------------------------------|------------------------------------|-----------------|-------------------|--------------------|--------------------------|
|                |  | Saline-Sodic Soil                 |                                    |                 |                   |                    |                          |
|                |  | Grain Yield (q ha <sup>-1</sup> ) | Stover Yield (q ha <sup>-1</sup> ) | Test Weight (g) | Plant Height (cm) | Length of Cob (cm) | No. of Grain Per Cob (g) |
| T <sub>1</sub> | RDN (50% N) + Residual effect of FYM   | 47.18                             | 56.43                              | 34.96           | 184.68            | 16.31              | 476.85                   |
| T <sub>2</sub> | RDN (50% N) + Residual effect of vermicompost  | 50.76                             | 59.52                              | 36.82           | 213.75            | 17.42              | 551.78                   |
| T <sub>3</sub> | RDN (50% N) + Residual effect of poultry manure  | 49.28                             | 58.77                              | 36.23           | 206.23            | 17.33              | 533.63                   |
| T <sub>4</sub> | RDN (50% N) + Residual effect of press mud compost   | 47.54                             | 57.12                              | 35.58           | 197.75            | 16.78              | 496.13                   |
| T <sub>5</sub> | RDN (50% N) + Residual effect of goat manure   | 46.64                             | 55.53                              | 34.37           | 179.46            | 16.08              | 468.86                   |
| T <sub>6</sub> | RDN (50% N) + Residual effect of urban compost   | 49.08                             | 57.28                              | 35.86           | 197.71            | 17.12              | 517.6                    |
| T <sub>7</sub> | GRDF (120:60:40 N: P <sub>2</sub> O <sub>5</sub> : K <sub>2</sub> O kg ha <sup>-1</sup> + 5 t ha <sup>-1</sup> FYM | 52.52                             | 61.82                              | 38.63           | 226.24            | 18.74              | 579.48                   |
| T <sub>8</sub> | Absolute control   | 38.47                             | 49.35                              | 26.49           | 168.45            | 14.23              | 393.74                   |
|                | <b>SE (m)±</b>   | <b>1.12</b>                       | <b>1.39</b>                        | <b>1.05</b>     | <b>6.97</b>       | <b>0.48</b>        | <b>16.07</b>             |
|                | <b>CD at 5%</b>  | <b>3.40</b>                       | <b>4.21</b>                        | <b>3.18</b>     | <b>21.14</b>      | <b>1.44</b>        | <b>48.76</b>             |

**Table 6. Effect of inorganic fertilizers and organic manures on nutrient uptake by wheat in normal and saline-sodic Inceptisol**

| Tr. No.        | Treatments  | Total uptake (kg ha <sup>-1</sup> ) |             |             |                   |             |             |
|----------------|---|-------------------------------------|-------------|-------------|-------------------|-------------|-------------|
|                |   | Normal Soil                         |             |             | Saline-Sodic Soil |             |             |
|                |   | N                                   | P           | K           | N                 | P           | K           |
| T <sub>1</sub> | RDN (50% N) + 50% N through FYM   | 74.44                               | 9.24        | 80.81       | 95.88             | 10.90       | 86          |
| T <sub>2</sub> | RDN (50% N) + 50% N through Vermicompost  | 63.85                               | 10.46       | 84.06       | 77.13             | 15.68       | 88          |
| T <sub>3</sub> | RDN (50% N) + 50% N through Poultry manure  | 86.48                               | 14.00       | 94.10       | 97.59             | 15.39       | 96          |
| T <sub>4</sub> | RDN (50% N) + 50% N through Press mud compost   | 68.01                               | 11.70       | 91.61       | 74.31             | 14.92       | 93          |
| T <sub>5</sub> | RDN (50% N) + 50% N through Goat manure   | 55.68                               | 10.66       | 79.51       | 59.56             | 10.04       | 87          |
| T <sub>6</sub> | RDN (50% N) + 50% N through urban compost   | 85.92                               | 10.40       | 94.7        | 73.20             | 13.41       | 100         |
| T <sub>7</sub> | GRDF (120:60:40 N: P <sub>2</sub> O <sub>5</sub> : K <sub>2</sub> O kg ha <sup>-1</sup> + 10 t FYM ha <sup>-1</sup> ) | 88.00                               | 16.00       | 100         | 99.36             | 17.20       | 103         |
| T <sub>8</sub> | Absolute Control  | 33.06                               | 4.45        | 41.25       | 38.50             | 5.88        | 69.31       |
|                | <b>SE(m)±</b>   | <b>0.94</b>                         | <b>0.66</b> | <b>2.21</b> | <b>1.1</b>        | <b>1.14</b> | <b>3.05</b> |
|                | <b>CD at 5%</b>   | <b>2.82</b>                         | <b>2.03</b> | <b>6.63</b> | <b>3.3</b>        | <b>3.52</b> | <b>9.16</b> |

Inceptisol for total nitrogen uptake treatment T<sub>3</sub> was at par with treatment T<sub>7</sub> and for total phosphorus treatments T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> while, for total potassium uptake treatments T<sub>3</sub> and T<sub>6</sub> were found to be at par with T<sub>7</sub>.

The highest nutrient uptake in the wheat crop was observed in treatment T<sub>7</sub>, GRDF (120:60:40 N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O kg ha<sup>-1</sup> + 10 t FYM ha<sup>-1</sup>) for both normal and saline-sodic Inceptisol which might be due to combined application of organic and inorganic fertilizers due to which availability of

**Table 7. Effect of inorganic fertilizers and organic manures on nutrient uptake by maize in normal and saline-sodic Inceptisol**

| Tr. No.        | Treatments   | Total Uptake (kg ha <sup>-1</sup> ) |             |             |                   |             |             |
|----------------|--|-------------------------------------|-------------|-------------|-------------------|-------------|-------------|
|                |  | Normal Soil                         |             |             | Saline-Sodic Soil |             |             |
|                |  | N                                   | P           | K           | N                 | P           | K           |
| T <sub>1</sub> | RDN (50% N) + Residual effect of FYM   | 96.58                               | 9.66        | 84.90       | 76.09             | 7.61        | 66.89       |
| T <sub>2</sub> | RDN (50% N) + Residual effect of vermicompost  | 102.58                              | 10.26       | 90.18       | 82.15             | 8.22        | 72.22       |
| T <sub>3</sub> | RDN (50% N) + Residual effect of poultry manure  | 100.31                              | 10.03       | 88.18       | 78.98             | 7.96        | 70.26       |
| T <sub>4</sub> | RDN (50% N) + Residual effect of press mud compost   | 98.28                               | 9.83        | 86.40       | 77.04             | 7.70        | 67.73       |
| T <sub>5</sub> | RDN (50% N) + Residual effect of goat manure   | 96.13                               | 9.61        | 84.51       | 74.77             | 7.48        | 65.74       |
| T <sub>6</sub> | RDN (50% N) + Residual effect of urban compost   | 99.33                               | 9.93        | 87.32       | 80.01             | 8.00        | 70.34       |
| T <sub>7</sub> | GRDF (120:60:40 N: P <sub>2</sub> O <sub>5</sub> : K <sub>2</sub> O kg ha <sup>-1</sup> + 5 t ha <sup>-1</sup> FYM | 107.69                              | 10.77       | 94.67       | 85.85             | 8.58        | 75.47       |
| T <sub>8</sub> | Absolute control   | 79.49                               | 7.95        | 69.88       | 61.72             | 6.17        | 54.26       |
|                | <b>SE(m)±</b>  | <b>2.88</b>                         | <b>0.29</b> | <b>2.54</b> | <b>2.28</b>       | <b>0.23</b> | <b>2.01</b> |
|                | <b>CD at 5%</b>  | <b>8.75</b>                         | <b>0.87</b> | <b>7.69</b> | <b>6.93</b>       | <b>0.69</b> | <b>6.09</b> |

nutrients increased during crop growth. The findings are as per those reported by Bahadur et al. [19].

### 3.4 Effect of Inorganic Fertilizers and Organic Manures on Uptake of Nutrients by Maize in Normal and Saline-Sodic Inceptisol

The data for the uptake of NPK by maize by the application of inorganic fertilizers and the residual effect of organic manures is presented in Table 7.

The treatment T<sub>7</sub>, GRDF (120:60:40 N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O kg ha<sup>-1</sup> + 5 t ha<sup>-1</sup> FYM was recorded significantly the highest NPK uptake and the lowest value for the uptake of NPK was recorded for treatment T<sub>8</sub> (Absolute control) in both normal and saline-sodic Inceptisol. In normal soil, treatments T<sub>2</sub>, T<sub>3</sub> and T<sub>6</sub> were found to be at par with treatment T<sub>7</sub> for the uptake of total nitrogen, phosphorus and potassium. However, in the case of saline-sodic Inceptisol for total nitrogen, phosphorus and potassium uptake treatment T<sub>2</sub>, T<sub>3</sub> and T<sub>6</sub> were found to be at par with treatment T<sub>7</sub>.

The highest nutrient uptake in maize crop was observed in treatment T<sub>7</sub>, GRDF (120:60:40 N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O kg ha<sup>-1</sup> + 10 t FYM ha<sup>-1</sup>) for both normal and saline-sodic Inceptisol which might

be due to releasing nutrients from sources and biological activity which resulted in more nutrient uptake. The findings are as per those reported by Prajapati et al. [20]. The higher uptake increased due to better root development which resulted in better absorption of nutrients which led to the yield. The uptake response also shows plant metabolic activity earlier reported similar response in nutrient uptake by Singh et al. [21].

## 4. CONCLUSION

The growth parameters viz. plant height, spike length, test weight, grain and straw yield and total uptake of N, P and K were found to be significantly higher in the treatment GRDF 120:60:40 N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O kg ha<sup>-1</sup> + 10 t ha<sup>-1</sup> FYM under wheat crop in both normal and saline-sodic Inceptisol. The yield in GRDF 120:60:40 N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O kg ha<sup>-1</sup> + 10 t ha<sup>-1</sup> FYM is increased by 23.53 % in saline-sodic soil compared to normal Inceptisol.

Application of GRDF 120:60:40 N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O kg ha<sup>-1</sup> + 5 t ha<sup>-1</sup> FYM was found significantly higher under succeeding maize crop in both normal and saline-sodic Inceptisol in terms of plant height, length of cob, No. of grains per cob, test weight, grain yield, stover yield and total uptake of N, P and K. The treatment RDN 50% N + Residual N is applied to wheat through vermicompost and RDN 50% N + Residual N is applied to wheat through poultry manure was found at par for



maize crop characteristics such as plant height, cob length, grain count, test weight, grain and stover yield, and nutrient uptake in both types of soils.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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