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# Effect of Nitrogen Management through Different Sources on Growth and Yield of Organic Wheat (*Triticum aestivum* L.)

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**Abstract**

An experiment was carried out at research farm- career point university, Kota (Rajasthan) during *rabi* 2023-24 to study on Effect of Nitrogen Management through Different Sources in Organic Wheat (*Triticum aestivum* L.). The experiment comprises nine treatments with three replications were laid out in randomized block design. The objective of the experiment was to select appropriate dose and source of nitrogen to crop to achieve higher productivity under vertisols of Rajasthan. The soil of the experimental field was clay loam in texture, medium in available nitrogen and phosphorous, high in available potassium and alkaline in reaction. Growth parameters *viz*., plant height and dry matter production, yield attributes *viz*., number of effective tillers $m^{-1}$ row length, length of ear, grains $ear^{-1}$ and test weight, grain, straw and biological yield, were recorded significantly higher under application of 120 kg N $ha^{-1}$ through vermicompost ($T_2$) over rest of the treatment which was remained at par with application of 120 kg N $ha^{-1}$ through FYM ($T_3$) and application of 120 kg N $ha^{-1}$ through castor cake ($T_4$).

**Keywords:** Wheat, Vermicompost, Castor cake, FYM

## I Introduction

Organic farming is a production system which avoids the use of synthetic fertilizers, pesticides and growth regulators (Reddy *et al.*, 2005). Organic farming systems often include recycled organic manure as fertilizer and bio control measures for plant protection. The global area under organic agriculture is about 74.9 million hectare and world organic market

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is now 120.6 billion US$ (FiBL and IFOAM 2021). In India, about 4.33 million ha area is under organic cultivation and total production of certified organic products is 3.49 MMT (APEDA, 2021). India is fastly growing base for production and supply of organically produced agricultural products to the world market.

**II Literature Review:**

Use of organic manures including farmyard manure, vermicompost, goat manure, green manure, cakes and poultry litter might be a substitute of the chemical fertilizers use for crop production (Sarwar *et al.*, 2008). Organic agriculture minimizes environmental pollution and the use of non-conventional natural resources. It conserves soil fertility and soil erosion through implementation of appropriate conservation principles (Trewavas, 2001). Several reasons like limited land holdings, poor economic condition of farmers, rise in input costs *etc* have been attributed for the need of organic farming (Sharma, 2002).

Wheat (*Triticum aestivum* L.) belongs to family "Poaceae" and genus "Triticum". It is a crop of temperate zone with cool winters and hot summers being very conducive for its growth. Among the food crops, wheat is one of the most abundant sources of energy and protein for the world population and for food security enhancement in production is essential. It is necessary to sustain the wheat crop production for meet the demand of wheat in India as well as world (Sharma *et al.*, 2008). Wheat is generally grown in organic farming systems (Burnett and Rutherglen, 2008). In India, total area under wheat cultivation is 30.55 million ha with 107.18 million tons production and average yield of 35.08 q $ha^{-1}$ in 2019-20. In Rajasthan, area under wheat cultivation is 3.93 million ha with production of 10.92 million tons and average yield is 35.01 q $ha^{-1}$ (FAI, 2019).

The excessive use of fertilizers and pesticides over the last 50 years has helped make good progress earlier, but in recent decades the decline in the growth and stagnation in crop yields, creating big problems and the chain of many problems, has been addressed. A number of deleterious effects on the soil, water and air have been caused by the indiscriminately used fertilizers and pesticides. This has declined soil productivity by deteriorating soil health as regards soil fertility and microbial activity. Despite the numerous benefits of organic farming and organic foods, organic inputs do not produce immediate results, especially in soils with a high C: N ratio. Compost, FYM, vermicompost, crop residues, green manures, green leaf manuring in crop rotation and biofertilizers are used to increase soil organic carbon, provide all essential plant nutrients and improve soil properties. Organic nutrient management plays a key role in protecting soil quality through soil organic matter, beneficial microbes and enzymes. Long-term organic material addition to soil increased organic matter, crop yields and soil biological activity (Collins *et al*., 1992).

## III Methodology

**Methods and Materials** An investigation was carried out at Research Farm- Career Point University, Kota (Rajasthan), which is placed in the South-East part of Rajasthan at an altitude of 579.5 metre above mean sea level and at 24º35 °C N latitude and 73º42 °C E longitude. The experimental site's soil type was clay-loam, and it had a reaction-friendly pH of 7.5 and good drainage capabilities. The soil had low levels of accessible potassium (235 kg/ha) and phosphorus (155 kg/ha) and was found to have low levels of organic carbon (0.29%) and available nitrogen (112 kg/ha). Three replications of the experiment were employed, and the RBD (Randomized Block Design) method was used to build it up. The present experiment consisting of eight treatment combinations was laid out in Randomized Block Design. The experiment was involved nine treatments N equivalent to 120 kg $ha^{-1}$ through FYM, N equivalent to 120 kg $ha^{-1}$ through vermicompost, N equivalent to 120 kg $ha^{-1}$ through castor cake, N equivalent to 90 kg $ha^{-1}$ through FYM + NPK consortium (Seed treatment), N equivalent to 90 kg $ha^{-1}$ through vermicompost + NPK consortium (Seed treatment), N equivalent to 90 kg $ha^{-1}$ through castor cake + NPK consortium (Seed treatment), N equivalent to 90 kg $ha^{-1}$ through FYM + NPK consortium (Soil application), N equivalent to 90 kg $ha^{-1}$ through vermicompost + NPK consortium (Soil application) and N equivalent to 90 kg $ha^{-1}$ through castor cake + NPK consortium (Soil application).

The experimental field was prepared by ploughing with tractor drawn disc plough followed by cross harrowing and planking to get well-pulverized soil tilth. In the experiment, wheat crop was sown on 20$^{th}$ November, 2023. A uniform seed rate of 100 kg $ha^{-1}$ was used at inter row spacing of 22.5 cm. In order to obtain uniform plant stand, seeds were weighed for each plot separately. Sowing was done manually in furrows followed by irrigation. In wheat, six irrigations were applied in both the years at critical growth stages, *i.e*., at crown root initiation, tillering, late jointing, flowering, milking and dough stages of wheat.

Number of plants 0.5 $m^{-1}$ row length was recorded from five randomly selected places for wheat crop in each experimental unit at 20 DAS and at harvest. These were averaged and number of plants 0.5 $m^{-1}$ row length was worked out for wheat crop. Height of these five plants was measured at 30, 60, 90 DAS and at harvest from the base of the plant to the top of the main shoot by metre scale and their mean was expressed as cm. Dry matter accumulation (g plant$^{-1}$) was recorded at 30, 60, 90 DAS and at harvest and plants were uprooted randomly from sample rows of each plot. After removal of the root portion, the samples were first air-dried for some days and finally dried in an electric oven at 70$^0$C till a constant weight was achieved. The weight was recorded and expressed as g plant$^{-1}$. The number of effective tillers (m$^{-1}$ row length) of five plants randomly selected from each plot was counted at harvest and average number of effective tillers m$^{-1}$ row length was worked out. Number of grains ear$^{-1}$ was counted from the five selected (tagged) plant's spike and their mean was taken. The length of ear of each plant was measured from the five selected (tagged) plants and their mean was taken and expressed in cm. Samples were drawn randomly from produce of each plot and one thousand seeds were counted from each sample and weighed to record test weight. After threshing and winnowing of the seeds from each net plot were weighed in kg plot$^{-1}$ and converted in kg ha$^{-1}$ for grain yield. Straw yield was obtained by subtracting the grain yield (kg ha$^{-1}$) from biological yield (kg ha$^{-1}$). At maturity completely, dried biomass *i.e.* grain and straw from each net plot harvested were weighed and computed for biological yield as kg ha$^{-1}$. The harvest index was calculated by using following formula and expressed as percentage (Singh and Stoskoff, 1971).

$$\text{HI (\%)} = \frac{\text{Economic yield (kg ha}^{-1}\text{)}}{\text{Biological yield (kg ha}^{-1}\text{)}} \times 100$$

Data from an experiment performed in RBD were evaluated using a standard procedure recommended by Panse and Sukhatme (1985). The 'F' (variance) test and calculating C. D. at a 5% level of significance were used to determine whether there was a significant difference between the treatments.

## IV Results and Discussion

**Growth parameters** The pant height and dry matter accumulation were the growth metrics of wheat that were impacted by the various nutrient management practices (Table 1-4). Our observations of plant height included measurements of dry matter accumulation periodical intervals of at 30, 60, 90 DAS as well as at harvest. At 20 DAS, there were no discernible variations caused by intercrops in terms of plant height. Results presented in Table 4.1 to 4.3 revealed that application of N equivalent to 120 kg ha$^{-1}$ through vermicompost ($T_2$) recorded tallest plant at 60, 90 DAS and harvest and highest dry matter accumulation at 60, 90 DAS and harvest of wheat which was significantly higher over rest of the treatments but remained at par with application of N equivalent to 120 kg $ha^{-1}$ through FYM ($T_1$) and N equivalent to 120 kg $ha^{-1}$ through caster cake ($T_3$).

Increase in plant height in treatment $T_2$ (N equivalent to 120 kg $ha^{-1}$ through vermicompost) might be due to basal application of vermicompost supply macro as well as micro nutrients through organic source, which improve soil physical and biological properties and increase the availability of nutrients and solubilizing them. Thus, favourable influence of nutrients to produce larger cells with thinner cell walls and its contribution in cell division and cell elongation which improved vegetative growth and ultimately increased the plant height of soybean. These are in conformity with the results of Dekhane *et al*. (2017), Jain *et al*. (2021) and Chauhan *et al*. (2022).

The higher root length might be due to significant increase in organic matter content in the soil with the application of organic manure which improved the favourable effect on modifying the soil environment physically and hold more water and nutrients, better aeration and enhanced microbial activities, resulting ultimately into higher root length.

Secondly, it might be due to that increase in the root length with application of vermicompost which had accelerated various metabolic processes and resulted in increasing root growth. This clearly indicated that addition of organic manures to the soil increased the availability of nutrients considerably resulting in a positive effect on growth parameters viz. root length.

Increase in dry matter accumulation in treatment $T_2$ (N equivalent to 120 kg $ha^{-1}$ through vermicompost) might be due to application of vermicompost supplied all essential nutrients, growth hormones and enzymes to plant, which favours rapid cell division and elongation and ultimately results into more development of plant and higher dry matter accumulation. These results are in concurrence with the findings of Dekhane *et al*. (2017), Jain *et al*. (2021), Chauhan *et al*. (2022) and Chaudhary *et al*. (2023).

**Yield attributes**

Data presented in Table 4 indicate that yield attributes *viz*., number of effective tillers $m^{-1}$ row length at harvest, number of grains $ear^{-1}$, length of ear and test weight of wheat significantly increased due to application of nitrogen through organic sources during experimentation. Application of N equivalent to 120 kg $ha^{-1}$ through vermicompost ($T_2$) recorded maximum yield attributes *viz*., number of effective tillers $m^{-1}$ row length, number of grains $ear^{-1}$, length of ear and test weight of wheat which was significantly higher over rest of the treatments but remained at par with application of N equivalent to 120 kg $ha^{-1}$ through

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FYM ($T_1$) and N equivalent to 120 kg ha$^{-1}$ through caster cake ($T_3$). Increase in yield attributes *viz*., number of effective tillers m$^{-1}$ row length at harvest, number of grains ear$^{-1}$, length of ear and test weight in application of N equivalent to 120 kg ha$^{-1}$ through vermicompost ($T_2$) might be due to application of vermicompost delayed leaf senescence and this might be the reason for increased seed weight.

Secondly, better growth and development of crop plants due to nitrogen supply might have increased the supply of assimilates to seed, which ultimately gained more weight. This was perhaps due to a continuous supply of nitrogen to the crop at all stages of crop growth, as slow release nutrients might have increase grain weight (Chaudhary, 2016).

As vermicompost supplies essential plant nutrients, vitamins, growth hormones and enzymes, this leads to more production of spikelets ear$^{-1}$ in wheat. Vermicompost also improves soil physical condition, which further improved the absorption of nutrients which results into tissue differentiation from somatic to reproductive meristematic activity and increase in development of floral primordial, resulting in higher number of spikelets ear$^{-1}$. These results are in conformity to those reported by Jat *et al*. (2018), Kumar *et al*. (2020a) and Game *et al*. (2022), Chauhan *et al*. (2022).

**Yield**

The grain, straw and biological yield was significantly influenced by the organic manure application (Table 5). Maximum grain, straw and biological yield (4255, 5140 and 9395 kg ha$^{-1}$, respectively) produced with the application of N equivalent to 120 kg ha$^{-1}$ through vermicompost ($T_2$) which was significantly higher grain, straw and biological yield over rest of the treatments except application of N equivalent to 120 kg ha$^{-1}$ through FYM ($T_1$) and N equivalent to 120 kg ha$^{-1}$ through caster cake ($T_3$). Vermicompost application might have increased activities of N fixing bacteria and increased rate of humification. Humic acid in vermicompost might have enhanced the availability of both added and native nutrients in soil and as a result improved growth, yield attributes and yield of the crop significantly.

Secondly, vermicompost also supply phosphorus which increased availability of phosphorus in soil, which is a major structural element of cell and helped in cell elongation, higher availability of photosynthesis, metabolites and nutrients to develop reproductive structures which promote to increased growth parameters and lead to higher yield attributes and yields of linseed crop. These results are in close accordance with those reported by Dekhane *et al*. (2017), Jat *et al*. (2018), Kumar *et al*. (2020a), Game *et al*. (2022), Chauhan *et al*. (2022) and Chaudhary *et al*. (2023a). However, data clearly showed that different organic

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sources of nitrogen remained akin to harvest index (Table 4.4) and they had no any significant influence on harvest index. It may be due to balance distribution of assimilates to both sink and vegetative growth which ultimately similar harvest index.

**Table 1 Effect of nitrogen management through various sources on plant population of wheat.**

| Treatments | Plant population (0.5 $m^{-1}$ row length) | |
|---|---|---|
| | 20 DAS | Harvest |
| N equivalent to 120 kg $ha^{-1}$ through FYM ($T_1$) | 11.12 | 9.71 |
| N equivalent to 120 kg $ha^{-1}$ through vermicompost ($T_2$) | 11.48 | 9.89 |
| N equivalent to 120 kg $ha^{-1}$ through castor cake ($T_3$) | 11.51 | 10.02 |
| N equivalent to 90 kg $ha^{-1}$ through FYM + NPK consortium (Seed treatment) ($T_4$) | 11.64 | 10.30 |
| N equivalent to 90 kg $ha^{-1}$ through vermicompost + NPK consortium (Seed treatment) ($T_5$) | 11.45 | 9.88 |
| N equivalent to 90 kg $ha^{-1}$ through castor cake + NPK consortium (Seed treatment) ($T_6$) | 11.57 | 9.95 |
| N equivalent to 90 kg $ha^{-1}$ through FYM + NPK consortium (Soil application) ($T_7$) | 11.50 | 9.96 |
| N equivalent to 90 kg $ha^{-1}$ through vermicompost + NPK consortium (Soil application) ($T_8$) | 11.48 | 9.89 |
| N equivalent to 90 kg $ha^{-1}$ through castor cake + NPK consortium (Soil application) ($T_9$) | 12.24 | 10.75 |
| **SEm ±** | **0.54** | **0.56** |
| **CD (5%)** | **NS** | **NS** |
| **CV** | **8.10** | **9.60** |

**Table 2 Effect of nitrogen management through various sources on plant height of wheat**

| Treatments | Plant height (cm) | | | |
|---|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS | Harvest |
| N equivalent to 120 kg $ha^{-1}$ through FYM ($T_1$) | 28.77 | 62.13 | 77.84 | 87.10 |
| N equivalent to 120 kg $ha^{-1}$ through vermicompost ($T_2$) | 29.35 | 63.29 | 79.24 | 88.59 |
| N equivalent to 120 kg $ha^{-1}$ through castor cake ($T_3$) | 28.31 | 61.83 | 77.64 | 87.11 |
| N equivalent to 90 kg $ha^{-1}$ through FYM + NPK consortium (Seed treatment) ($T_4$) | 28.40 | 51.50 | 65.32 | 74.65 |
| N equivalent to 90 kg $ha^{-1}$ through vermicompost + NPK consortium (Seed treatment) ($T_5$) | 28.00 | 50.69 | 64.36 | 73.94 |

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| | | | | |
|---|---|---|---|---|
| N equivalent to 90 kg ha$^{-1}$ through castor cake + NPK consortium (Seed treatment) ($T_6$) | 28.26 | 51.22 | 64.81 | 74.07 |
| N equivalent to 90 kg ha$^{-1}$ through FYM + NPK consortium (Soil application) ($T_7$) | 28.11 | 53.92 | 68.03 | 77.56 |
| N equivalent to 90 kg ha$^{-1}$ through vermicompost + NPK consortium (Soil application) ($T_8$) | 28.05 | 54.60 | 68.86 | 78.28 |
| N equivalent to 90 kg ha$^{-1}$ through castor cake + NPK consortium (Soil application) ($T_9$) | 27.92 | 53.24 | 67.45 | 76.72 |
| **SEm ±** | **1.19** | **2.38** | **2.82** | **3.44** |
| **CD (5%)** | **NS** | **7.13** | **8.45** | **10.31** |
| **CV** | **7.26** | **7.37** | **6.94** | **7.47** |

**Table 3 Effect of nitrogen management through various sources on dry matter accumulation of wheat**

| **Treatments** | **Dry matter accumulation (g plant$^{-1}$)** | | | |
|---|---|---|---|---|
| | **30 DAS** | **60 DAS** | **90 DAS** | **Harvest** |
| N equivalent to 120 kg ha$^{-1}$ through FYM ($T_1$) | 4.36 | 10.88 | 73.74 | 78.34 |
| N equivalent to 120 kg ha$^{-1}$ through vermicompost ($T_2$) | 4.45 | 11.07 | 75.00 | 79.60 |
| N equivalent to 120 kg ha$^{-1}$ through castor cake ($T_3$) | 4.29 | 10.83 | 73.40 | 78.00 |
| N equivalent to 90 kg ha$^{-1}$ through FYM + NPK consortium (Seed treatment) ($T_4$) | 4.30 | 9.15 | 60.97 | 65.57 |
| N equivalent to 90 kg ha$^{-1}$ through vermicompost + NPK consortium (Seed treatment) ($T_5$) | 4.24 | 9.02 | 60.10 | 64.70 |
| N equivalent to 90 kg ha$^{-1}$ through castor cake + NPK consortium (Seed treatment) ($T_6$) | 4.28 | 9.10 | 60.67 | 65.27 |
| N equivalent to 90 kg ha$^{-1}$ through FYM + NPK consortium (Soil application) ($T_7$) | 4.26 | 9.54 | 63.60 | 68.20 |
| N equivalent to 90 kg ha$^{-1}$ through vermicompost + NPK consortium (Soil application) ($T_8$) | 4.25 | 9.65 | 64.35 | 68.95 |
| N equivalent to 90 kg ha$^{-1}$ through castor cake + NPK consortium (Soil application) ($T_9$) | 4.23 | 9.43 | 62.87 | 67.47 |
| **SEm ±** | **0.18** | **0.39** | **2.71** | **2.75** |
| **CD (5%)** | **NS** | **1.16** | **8.12** | **8.25** |
| **CV** | **7.26** | **6.81** | **7.10** | **6.75** |

**Table 4 Effect of nitrogen management through various sources on yield attributes of wheat**

| **Treatments** | **Yield attributes** |
|---|---|

| | Effective tillers ($m^{-1}$ row length) | Number of grains ear$^{-1}$ | Length of ear | Test weight (g) |
|---|---|---|---|---|
| N equivalent to 120 kg ha$^{-1}$ through FYM ($T_1$) | 69.74 | 38.74 | 10.36 | 50.72 |
| N equivalent to 120 kg ha$^{-1}$ through vermicompost ($T_2$) | 71.00 | 39.44 | 10.54 | 51.56 |
| N equivalent to 120 kg ha$^{-1}$ through castor cake ($T_3$) | 69.40 | 38.56 | 9.81 | 50.50 |
| N equivalent to 90 kg ha$^{-1}$ through FYM + NPK consortium (Seed treatment) ($T_4$) | 56.97 | 31.65 | 8.04 | 42.22 |
| N equivalent to 90 kg ha$^{-1}$ through vermicompost + NPK consortium (Seed treatment) ($T_5$) | 56.10 | 31.17 | 7.91 | 41.63 |
| N equivalent to 90 kg ha$^{-1}$ through castor cake + NPK consortium (Seed treatment) ($T_6$) | 56.67 | 31.48 | 8.00 | 42.02 |
| N equivalent to 90 kg ha$^{-1}$ through FYM + NPK consortium (Soil application) ($T_7$) | 59.60 | 33.11 | 8.41 | 43.97 |
| N equivalent to 90 kg ha$^{-1}$ through vermicompost + NPK consortium (Soil application) ($T_8$) | 60.35 | 33.53 | 8.52 | 44.47 |
| N equivalent to 90 kg ha$^{-1}$ through castor cake + NPK consortium (Soil application) ($T_9$) | 58.87 | 32.71 | 8.31 | 43.48 |
| SEm ± | 2.71 | 1.58 | 0.37 | 1.84 |
| CD (5%) | 8.12 | 4.74 | 1.11 | 5.50 |
| CV | 7.56 | 7.93 | 7.25 | 6.97 |

**Table 5 Effect of nitrogen management through various sources on yield of wheat.**

| Treatments | Yield | | | Harvest index (%) |
|---|---|---|---|---|
| | Grain | Straw | Biological | |
| N equivalent to 120 kg ha$^{-1}$ through FYM ($T_1$) | 4173 | 5039 | 9211 | 45.30 |
| N equivalent to 120 kg ha$^{-1}$ through vermicompost ($T_2$) | 4255 | 5140 | 9395 | 45.29 |
| N equivalent to 120 kg ha$^{-1}$ through castor cake ($T_3$) | 4150 | 4980 | 9130 | 45.45 |
| N equivalent to 90 kg ha$^{-1}$ through FYM + NPK consortium (Seed treatment) ($T_4$) | 3321 | 3986 | 7307 | 45.45 |
| N equivalent to 90 kg ha$^{-1}$ through vermicompost + NPK consortium (Seed treatment) ($T_5$) | 3263 | 3916 | 7179 | 45.46 |
| N equivalent to 90 kg ha$^{-1}$ through castor cake | 3302 | 3962 | 7264 | 45.46 |

| | | | | |
|---|---|---|---|---|
| + NPK consortium (Seed treatment) ($T_6$) | | | | |
| N equivalent to 90 kg ha$^{-1}$ through FYM + NPK consortium (Soil application) ($T_7$) | 3498 | 4196 | 7694 | 45.46 |
| N equivalent to 90 kg ha$^{-1}$ through vermicompost + NPK consortium (Soil application) ($T_8$) | 3548 | 4255 | 7804 | 45.47 |
| N equivalent to 90 kg ha$^{-1}$ through castor cake + NPK consortium (Soil application) ($T_9$) | 3448 | 4138 | 7586 | 45.46 |
| **SEm ±** | **183** | **219** | **399** | **0.36** |
| **CD (5%)** | **550** | **658** | **1197** | **NS** |
| **CV** | **8.68** | **8.63** | **8.58** | **1.39** |

**V Conclusion**

organic farming presents a sustainable approach to agriculture that emphasizes the avoidance of synthetic fertilizers, pesticides, and growth regulators. With a global area of approximately 74.9 million hectares dedicated to organic agriculture and a market value of $120.6 billion USD, the significance of organic farming is increasingly recognized worldwide. In India, where 4.33 million hectares are under organic cultivation, there is a growing base for the production and supply of organically produced agricultural products to the global market.

Organic farming relies on the use of organic manures such as farmyard manure, vermicompost, and green manure, which serve as substitutes for chemical fertilizers. By minimizing environmental pollution and conserving soil fertility and erosion, organic agriculture contributes to the sustainable management of natural resources.

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