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# Response of integrated nutrient management on growth and productivity of wheat (*Triticum aestivum* L.)

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**Abstract**
An agronomic investigation to study the response of integrated nutrient management (INM) in wheat crop. Experiment was conducted during *Rabi* season of year 2020-21 an agricultural Farm at Rama University, Kanpur 209217 (U.P) India. The experiment was laid out in Randomized Block Design with three replications. 13 treatments *viz.* T0 – Control, T1 – 100% RDF, T2 – 75% RDF, T3 – 50% RDF, T4– 100% RDF + Vermicompost@ 5 t ha-1, T5– 75% RDF + Vermicompost@ 5 t ha-1, T6 – 50% RDF + Vermicompost@ 5 t ha-1, T7– 100% RDF + Poultry manure@ 5 t ha-1, T8– 75% RDF + Poultry manure@ 5 t ha-1, T9 – 50%RDF + Poultry manure @ 5t ha-1, T10 – 100%RDF+Azotobacter(seed treatment), T11 – 100% RDF + PSB, T12– 100%RDF+Azotobacter(seed treatment)+PSB. Higher growth attributing characters at different crop stages and yield attributing characters at harvest *viz.* plant height, number of tillers, leaf area index, plant dry matter, length of ear, number of ear, number of grains per ear and test weight were produced with T4– 100% RDF + Vermicompost@ 5 t ha-1treatment. Similarly, higher grain yield, straw yield, biological yield and harvest index & Protein, N, P and K (%) along with gross return, net return and B: C ratio was recorded with T4– 100% RDF + Vermicompost@ 5 t ha-1treatment as compared to all the other treatments in wheat crop.

**Keywords:** INM, growth attribute, vermicompost, wheat and yield

## Introduction
Wheat (*Triticum aestivum* L.) is one of the most significant cereal crops of India. Wheat being an vigour rich winter cereal contributes 35% to the food grain hamper of the country today our country enjoy status of additional in the wheat production alongside the scarcity at the time of sovereignty But in spite of exciting reaching in the recent past intensive hard work are still needed for achieving constant growth in production to fulfill nutritional necessity of ever growing population maintaining buffer stock for food security and sufficient supplies to wheat based food processing industries, by the year 2020 India will have to produce at least 109 million tonnes of wheat to meet the strain of 135 cr. Population which seems to be achieved only through increasing productivity up to 40 q ha$^{-1}$ (DWR 1997B), Wheat is one of the most important staple food crop of India and occupy a notable position among the food grain crops not only in terms and production but also in its elasticity in fulfillment to a wide range of agro-climatic conditions the area production and productivity of wheat in India were 29.8 million ha 111.32 million stonne and 3371 kg ha$^{-1}$ during 2020-2021 (Anonymous 2021) [1]. Wheat includes 12.6-14 g protein, 1.5-1.9 g fat, 68-71 g carbohydrates, 12.2 g dietary fibre, 360 kcal calories, 39 mg calcium, 239 mg magnesium, 842 mg phosphorus, 892 mg potassium, 12.29 mg zinc, and 6.26 mg iron, which is 17-20% of the daily requirement in the human body.

Today most of the farmers are applying higher dose of nitrogen low phosphorus and no Potassic fertilizers at all which grossly imbalance the ratio of N, P and K. Wheat is nutrient exhaustive and has resulted in decline of soil organic carbon and deteriorating soil health in general for sustainability of the system well as the overall soil health, organic source play an important role. Incorporation of organic manure and micro nutrients in combination with inorganic fertilizers improve the productivity of wheat ameliorates and sustains soil health and also economize fertilizers gave higher yield, owing to adequate availability of nutrients (Mundra *et al.* 2003) [4]. To curb this trend of declining yield there is a need to adopt the concept of integrated nutrient management. The appropriate combination of mineral fertilizer, organic manure, compost or bio fertilizers along with incorporation of micronutrients can be feasible and viable to sustain agriculture as a commercial and profitable means ensuring high yield of crop without deterioration in quality of the produce. Now days the soils of the region are deficient in major and micro nutrients this situation arises through the indiscriminate use of chemical fertilizers.

Enhanced use of chemical fertilizers for increasing production has been widely recognized but their indiscriminate use may have adverse effect on soil health, ecology and other natural resources, the high cost of fertilizer also restrict their large scale use, therefore to reduce dependence on chemical fertilizers and maintenance of high production level are vital issue in modern agriculture which is only possible through integrated nutrient management (INM). Use of organic manures in INM helps in mitigating the multiple nutrient deficiencies. Judicious use of FYM with chemical fertilizer improves soil physical, chemical and biological properties and improve the crop productivity (Sharma *et al.* 2006) [11]. Application of organic manure may also improve availability of native nutrients in soil as well as the efficiency of applied fertilizers. The integrated plant nutrition system (IPNS) involves monitoring all the pathways of plant nutrient supply in crops and cropping systems and calls for a judicious combination of fertilizer, bio-fertilizer and organic manures. Organic sources of plant nutrients including growing of legumes in cropping systems, green manures, crop residues, organic manures (FYM, compost, vermicompost, biogas slurry, phosphocompost, bio-compost, press mud, cake, etc.) and biofertilizers.

## Materials and Methods

The field experiment was conducted during *Rabi* season of 2020-2021 at an Agricultural Research Farm, of Rama University, Mandhana, Kanpur Nagar (U.P.) which is situated in the alluvial tract of Indo-Gangatic Plain in central part of Uttar Pradesh between 25026' to 26058' North latitude, 79031' to 31034' East longitude and on the altitude of 125.9 meters. The irrigation facilities are adequately available on this farm. The farm is situated in the main campus of the university. During the cropping season maximum temperature ranges from 17 to 35.10 °C, while the lowest temperature ranges from 6 to 21.70 °C. During the cropping period, relative humidity ranged from 24 to 94 percent. During the trial, average wind speeds ranged from 1.3 to 6.3 km hr$^{-1}$. During the testing period, the trail location got a total of 43.2 mm of rain in one wet day, providing favourable conditions for crop development. The experiment was laid out in Randomized Block Design with three replications. 13 treatments *viz.* T0 - Control, T1 - 100% RDF, T2 - 75% RDF, T3 - 50% RDF, T4- 100% RDF + Vermicompost@ 5 t ha$^{-1}$, T5 - 75% RDF + Vermicompost@ 5 t ha$^{-1}$, T6 - 50% RDF + Vermicompost@ 5 t ha$^{-1}$, T7 - 100% RDF + Poultry manure@ 5 t ha$^{-1}$, T8 - 75% RDF + Poultry manure@ 5 t ha$^{-1}$, T9 - 50% RDF + Poultry manure@ 5 t ha$^{-1}$, T10 - 100% RDF + Azotobacter (Seed treatment), T11 - 100% RDF + PSB, T12 - 100% RDF + Azotobacter (Seed treatment) + PSB. All plots of experiment were equally fertilized with recommended dose of fertilizers (150:60:40 kg ha$^{-1}$ NPK). Urea, di-ammonium phosphate, and murate of potash were the sources of nitrogen, phosphorus, and potassium, respectively. Before 15 days after wheat was sown, farmyard manure according to treatments was evenly applied to the plots. The experimental site's soil had a clay loamy texture, low levels of organic carbon (0.40 percent), available nitrogen (166.53 kg ha$^{-1}$), medium levels of available phosphorus (18.73 kg ha$^{-1}$), and medium levels of available potash (266.27 kg ha$^{-1}$) with a slightly alkaline reaction (8.2 pH).The wheat variety HD-2733 was sown in line at 20 cm row to row distance and seed rate 120.0 kg ha$^{-1}$ was used for sowing of experimental crop and before sowing seed was treated with vitavax @ 2.5 g kg$^{-1}$ of seed. Experimental crop was irrigated as per treatments.

## Results and Discussion

### Effect of INM on growth attributing characters

The data plant height as affected by INM is presented in (Table 1). Tallest plants (24.75 cm) at harvest were recorded with T4 (100% RDF + Vermicompost @ 5t ha$^{-1}$) and minimum plant height (19.45 cm) was recorded under treatment T0 (control). It may be due to the supply of efficient nutrient at critical growth stages and it also has been reported by Ram and Mir (2006) [9] and Chandel *et al.* (2014) [2]. It have fulfill the presence of enough nutrient in the crop root zone, and a relative improvement in plant growth characteristics. Similarly, maximum number of effective tillers at harvest (442.25 m$^{-2}$) were found with T4 (100% RDF + Vermicompost @ 5t ha$^{-1}$) treatment which may be due to sufficient nutrient availability. Such effect of INM on number of tillers was also reported earlier by Rajput *et al.* (2004) [8]. Similar reasons might be responsible for higher LAI with application of (100% RDF + Vermicompost @ 5t ha$^{-1}$) at 60, 90, 120 DAS in comparison to other treatments. The superior vegetative growth and morphological parameters *viz.* plant height, LAI, number of tillers with T4 (100% RDF + Vermicompost @ 5t ha$^{-1}$) were further reflected into higher plant dry matter accumulation at harvest. It is also reported by many researches Nehra *et al.* (2001) [5] and Chandel *et al.* (2014) [2].

**Table 1:** Effect of integrated nutrient management on growth attributing characters of wheat.

| Treatment | Plant height at harvest | Effective tillers at harvest | Dry matter accumulation at maturity | LAI | | |
|---|---|---|---|---|---|---|
| | | | | 30DAS | 60 DAS | 90 DAS |
| T0 - Control | 69.53 | 315.80 | 16.74 | 0.98 | 4.06 | 4.46 |
| T1 - 100% RDF | 90.86 | 398.35 | 21.86 | 1.10 | 4.31 | 4.74 |
| T2 - 75% RDF | 82.33 | 363.20 | 19.80 | 1.20 | 4.93 | 5.42 |
| T3 - 50% RDF | 80.34 | 356.90 | 19.34 | 1.25 | 4.85 | 5.33 |
| T4 - 100% RDF + Vermicompost @5 t ha$^{-1}$ | 101.16 | 442.25 | 24.35 | 1.50 | 6.01 | 6.61 |
| T5 - 75% RDF + Vermicompost @5 t ha$^{-1}$ | 89.10 | 395.40 | 21.46 | 1.13 | 5.38 | 5.91 |
| T6 - 50% RDF + Vermicompost @5 t ha$^{-1}$ | 85.20 | 376.90 | 20.51 | 1.08 | 5.12 | 5.63 |
| T7 - 100% RDF + Poultry manure @5 t ha$^{-1}$ | 98.21 | 432.45 | 23.64 | 1.44 | 5.88 | 6.46 |
| T8 - 75% RDF + Poultry manure @5 t ha$^{-1}$ | 87.17 | 384.40 | 20.99 | 1.04 | 5.23 | 5.75 |
| T9 - 50% RDF + Poultry manure @5 t ha$^{-1}$ | 83.80 | 371.65 | 20.16 | 1.14 | 5.06 | 5.56 |
| T10 - 100% RDF + Azotobacter (seed treatment) | 96.23 | 424.05 | 23.16 | 1.35 | 5.76 | 6.33 |
| T11 - 100% RDF + PSB | 92.63 | 408.16 | 22.29 | 1.33 | 5.55 | 6.10 |
| T12 - 100% RDF + Azotobacter (Seed treatment) | 94.60 | 416.74 | 22.75 | 1.40 | 5.68 | 6.24 |

| | | | | | | |
|---|---|---|---|---|---|---|
| + PSB | | | | | | |
| SE m+ | 1.973 | 6.714 | 0.518 | 0.083 | 0.149 | 0.163 |
| C.D. at 5% | 5.762 | 19.603 | 1.514 | N.S. | 0.436 | 0.476 |

**Effect of INM on yield and yield attributing characters**

Increases in growth-related characters eventually showed up in yield-related characters *viz.* ear length (cm), number of ear $m^{-1}$, number of grains per ear and test weight (Table 2); which were recorded higher (11.95 cm, 442.25, 58.40 and 42.43g respectively) with T4 (100% RDF + Vermicompost @ 5t $ha^{-1}$). The benefits of INM planning on different yield-contributing traits such as *viz.* ear length (cm), number of ear $m^{-1}$, number of grains per ear and test weight and growth characters (plant height, number of tillers, LAI, dry matter accumulation) resulted in Higher grain yield, straw yield, biological yield and harvest index (49.85 q $ha^{-1}$, 84.65 q $ha^{-1}$, 144.50 q $ha^{-1}$ and 38.65% respectively). Effect of INM on yield and yield attributing characters have been also reported by Chandel *et al.* (2014) [2], Patil *et al.* (2008) [6] and Prakash *et al.* (2011) [7].

**Table 2:** Effect of integrated nutrient management on yield and yield attributing characters of wheat.

| Treatments | No. of ear ($m^{-2}$) | Length of ear (cm) | No. of grains (ear$^{-1}$) | Test wt. | Grain yield (q $ha^{-1}$) | Straw yield (q $ha^{-1}$) | Biological yield (q $ha^{-1}$) | Harvest index |
|---|---|---|---|---|---|---|---|---|
| T0 - Control | 315.80 | 8.22 | 40.17 | 36.95 | 38.39 | 64.26 | 102.65 | 37.40 |
| T1 - 100% RDF | 398.35 | 10.73 | 52.44 | 38.10 | 47.85 | 79.73 | 131.93 | 38.05 |
| T2 - 75% RDF | 363.20 | 9.72 | 47.50 | 37.56 | 45.45 | 75.27 | 120.72 | 37.65 |
| T3 - 50% RDF | 356.90 | 9.49 | 46.38 | 37.25 | 44.35 | 73.60 | 117.95 | 37.60 |
| T4 - 100% RDF + Vermicompost @5 t $ha^{-1}$ | 442.25 | 11.95 | 58.40 | 42.43 | 49.85 | 84.65 | 144.50 | 38.65 |
| T5 - 75% RDF + Vermicompost @5 t $ha^{-1}$ | 395.40 | 10.53 | 51.46 | 40.25 | 48.20 | 80.44 | 129.64 | 37.95 |
| T6 - 50% RDF + Vermicompost @5 t $ha^{-1}$ | 376.90 | 10.06 | 49.16 | 38.65 | 47.05 | 77.59 | 124.64 | 37.75 |
| T7 - 100% RDF + Poultry manure @5 t $ha^{-1}$ | 432.45 | 11.60 | 56.68 | 41.85 | 49.25 | 82.84 | 141.09 | 38.45 |
| T8 - 75% RDF + Poultry manure @5 t $ha^{-1}$ | 384.40 | 10.30 | 50.34 | 39.95 | 47.15 | 78.16 | 127.31 | 37.82 |
| T9 - 50% RDF + Poultry manure @5 t $ha^{-1}$ | 371.65 | 9.89 | 48.33 | 38.55 | 46.25 | 76.43 | 122.68 | 37.70 |
| T10 - 100% RDF + Azotobacter (seed treatment) | 424.05 | 11.36 | 55.52 | 41.65 | 48.15 | 82.41 | 138.56 | 38.36 |
| T11 - 100% RDF + PSB | 408.16 | 10.94 | 53.46 | 41.50 | 47.15 | 78.79 | 133.94 | 38.19 |
| T12 - 100% RDF + Azotobacter (Seed treatment) + PSB | 416.74 | 11.16 | 54.54 | 41.75 | 48.75 | 80.35 | 136.60 | 38.25 |
| S.Em+ | 6.714 | 0.150 | 1.063 | 0.179 | 1.294 | 1.480 | 2.899 | 0.106 |
| C.D. at 5% | 19.603 | 0.439 | 3.103 | N.S. | 3.779 | 4.324 | 8.466 | N.S. |

**Effect of INM on quality parameters and economics of wheat**

The data presented in (Table 3), maximum protein content (%) in grain, N content (%) in grain, P content (%) in grain and K content (%) in grain (12.42, 1.74, 0.26 and 0.464% respectively) was recorded under application of (100% RDF + Vermicompost@ 5 t $ha^{-1}$). It might be due to favorable soil condition which enhanced nutrient availability better growth and activity of roots. Similar findings were reported by Singh *et al.* (2010) [12] and Rather *et al.* (2009) [19]. Maximum gross return (122870 Rs $ha^{-1}$), net return (56565 Rs $ha^{-1}$) and benefit cast ratio (1.85) were recorded under application (100% RDF + Vermicompost@ 5 t $ha^{-1}$). Gross return, net return and benefit cast ratio were more due to higher production grain yield of wheat crop. The effect of INM on economics of wheat has been also described earlier by various scientists; Mehadi *et al.* (20011) and Sharma *et al.* (2011).

**Table 3:** Effect of integrated nutrient management on quality parameters and economics of wheat.

| Treatments | Protein content in grain (%) | N content (%) in grain | P content (%) in grain | K content (%) in grain | Cost of cultivation (Rsha$^{-1}$) | Gross return (Rs ha$^{-1}$) | Net return (Rs ha$^{-1}$) | B:C ratio |
|---|---|---|---|---|---|---|---|---|
| T0 - Control | 11.80 | 1.65 | 0.22 | 0.440 | 56305 | 84458 | 28153 | 1.50 |
| T1 - 100% RDF | 12.11 | 1.69 | 0.25 | 0.451 | 65305 | 110440 | 45135 | 1.69 |
| T2 - 75% RDF | 11.80 | 1.65 | 0.24 | 0.440 | 63305 | 99990 | 36685 | 1.58 |
| T3 - 50% RDF | 11.79 | 1.64 | 0.24 | 0.438 | 61305 | 97570 | 36265 | 1.59 |
| T4 - 100% RDF + Vermicompost @5 t $ha^{-1}$ | 12.42 | 1.74 | 0.26 | 0.464 | 66305 | 122870 | 56565 | 1.85 |
| T5 - 75% RDF + Vermicompost @5 t $ha^{-1}$ | 12.01 | 1.68 | 0.25 | 0.448 | 60305 | 108240 | 47935 | 1.79 |
| T6 - 50% RDF + Vermicompost @5 t $ha^{-1}$ | 11.90 | 1.66 | 0.25 | 0.443 | 60305 | 103510 | 43205 | 1.72 |
| T7 - 100% RDF + Poultry manure @5 t $ha^{-1}$ | 12.32 | 1.72 | 0.26 | 0.459 | 66305 | 119350 | 53045 | 1.80 |
| T8 - 75% RDF + Poultry manure @5 t $ha^{-1}$ | 11.70 | 1.63 | 0.24 | 0.435 | 62305 | 105930 | 43625 | 1.70 |
| T9 - 50% RDF + Poultry manure @5 t $ha^{-1}$ | 11.49 | 1.61 | 0.23 | 0.430 | 61305 | 101750 | 40445 | 1.66 |
| T10 - 100% RDF + Azotobacter (seed treatment) | 12.25 | 1.73 | 0.26 | 0.462 | 65305 | 116930 | 51625 | 1.79 |
| T11 - 100% RDF + PSB | 12.21 | 1.71 | 0.25 | 0.456 | 63305 | 112530 | 49225 | 1.78 |
| T12 - 100% RDF + Azotobacter (Seed treatment) + PSB | 12.35 | 1.74 | 0.26 | 0.464 | 62905 | 114950 | 52045 | 1.83 |
| SE m+ | 0.017 | 0.017 | 0.008 | 0.008 | 80.33 | 1117.15 | 798.20 | 0.048 |
| C.D. at 5% | N.S. | N.S. | N.S. | N.S. | 234.53 | 3261.62 | 2330.41 | 0.140 |

## Conclusion

It can be concluded from the present investigation that INM with 100% RDF + Vermicompost@ 5 t $ha^{-1}$increases the growth & yield attributes and yield of wheat. Similarly, maximum protein, N, P and K content in grain along with net return (56565 Rs $ha^{-1}$) and benefit cost ratio (1.85) noticed under the treatment (100% RDF + vermicompost @5 t $ha^{-1}$) followed by treatment (100% RDF + poultry manure @5 t $ha^{-1}$).

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