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# Impact of Nitrogen Nutrition through Organic and Inorganic Sources of Fertilizer on Growth Phenology and Yield of Wheat (*Triticum aestivum* L.)

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**Abstract**

The field experiment was conducted at wheat research farm of CCS Haryana Agriculture University during *Rabi* season of 2019-20 to study nitrogen nutrition through organic and inorganic source of fertilizer on growth phenology, yield and quality of wheat (*Triticum aestivum* L.) The experiment was laid out in randomized block design with three replications containing 16 treatments combination i.e $T_1$-Control; $T_2$-100% RDN through urea; $T_3$-100% RDN through FYM; $T_4$-100% RDN through vermicompost; $T_5$-50% RDN through urea+ 50% RDN through FYM; $T_6$-50% RDN through urea+ 50% RDN through vermicompost; $T_7$-25% RDN through urea+ 75% RDN through FYM; $T_8$-25% RDN through urea 75% RDN through vermicompost; $T_9$-100% RDN through urea + *Azotobacter*; $T_{10}$-100% RDN through FYM + *Azotobacter*; $T_{11}$-100% RDN through vermicompost + *Azotobacter*; $T_{12}$-50% RDN through urea+ 50% RDN through FYM + *Azotobacter*; $T_{13}$-50% RDN through urea+ 50% RDN through vermicompost + *Azotobacter*; $T_{14}$-25% RDN through urea+ 75% RDN through FYM + *Azotobacter*; $T_{15}$-25% RDN through urea+ 75% RDN through vermicompost + *Azotobacter*; $T_{16}$- *Azotobacter*. Treatment $T_{9,}$ 100% nitrogen nutrition through chemical fertilizer (urea) with seed treatment of *Azotobacter* has taken significantly maximum days to emergence (5.3). Days taken to 50% spike emergence (94.7) and days taken to maturity (148.0) respectively. Similarly $T_9$ had significantly higher grain yield (5640 kg/ha), hectoliter weight (83.167 kg/ha), grain appearance score (7.933 scale/10) and protein content (12.90 %) of wheat during the research period respectively.

***Keywords*:** organic and inorganic nitrogen nutrition, growth phenology, *Azotobacter*.

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## 1. Introduction

Wheat (*Triticum aestivum* L.) is one of the world's leading cereal crop, which can be grown in wide range of altitudes and latitudes. Wheat is one of the good sources of carbohydrates and unique protein, which is consumed as human food as well as animal feed. It is the staple food of nearly 35% of world population. Globally wheat was grown in around 215.45 million hectares during 2018-19, holding the highest position in acreage among all other crops with yearly production of 370.84 million tonnes with the yield of 3390 kg/ha (USDA, 2020). Wheat cultivation has also been sign of green revolution, self-sufficiency in food and sustained production (Alam *et al*., 2013). India is the second largest producer of wheat next to China, which produces about 107.59 million tons of wheat from an area of 29.6 million hectare with an average productivity of 3508 kg $ha^{-1}$. The states which produce significant amount of wheat are Haryana, Uttar Pradesh, Punjab, Rajasthan, Gujarat, Madhya Pradesh, Bihar and Maharashtra. Haryana produces 12.57 million tons of wheat from 2.55 million hectare in year 2018-19, with an average productivity of 4925 kg $ha^{-1}$ (Anonymous, 2020). Because of complex genome nature of wheat it has wider adaptability, therefore, it is grown from temperate irrigated to dry and high rainfall areas and from warm humid to dry cold environmental conditions and being a $C_3$ type crop, it thrives well in cool environment (Anonymous, 2015). Wheat is cultivated principally in two seasons in the world *viz*., winter and spring. Winter wheat is cultivated in temperate zones *viz*., Europe, USA and Russian Federation etc. which withstand frozen status during early stages of its life cycle, while spring wheat is grown in Asia and parts of USA, which do not undergo freezing temperature. Winter wheat matures in 240-300, days while spring wheat matures in 100-150 days depending upon temperature. Wheat can be grown from below sea level depth up to 5000 meter altitude and in areas where the precipitation prevails between 300-1130 mm annually (Bhardwaj *et al*., 2010). Due to intensive cropping, where food grain production and fertilizer application run parallel, soil is degrading day by day with respect to soil fertility and productivity. Meanwhile, agriculture becomes more intensive and chemical dependent, therefore soil toxicities and nutrient imbalance threaten sustainable production. Therefore, we have to consider about the low-cost and easily available alternative source of nitrogen, which not only supply the nitrogen to the soil but also develop the physico-chemical properties of the soil. Thus, demand for fertilizers can be lowered by supplementing the nutrients through organic manures and biofertilizers. To overcome the problem

 

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of nutrient deficiency and to increase wheat yield, the farmers are using chemical fertilizers. However, the chemical fertilizers are costly and the small farmers cannot afford to use these fertilizers in appropriate amount and balanced proportion. Under such condition integrated use of chemical and organic fertilizer can play an important role to maintain soil fertility and crop productivity. Nitrogen is one of the most important nutrients applied to crop for higher yield and quality, but its balanced use is a key point for healthy environment and higher land effectiveness, which can be attain through integrated nitrogen management (Iqbal *et al*., 2012). Biofertilizers are a good approach to increase crop productivity. Nowadays, the biofertilizers are used to supply the important nutrients to the plant and significantly increase its productivity. These are eco-friendly, cost effective, provides the natural environment to the plant, boost the protection system of the plant, and protect the plant from drought, acidity, and other unfavorable conditions (Nosheen *et al*., 2020).

## 2. Materials and Methods

The field experiment was conducted at wheat research farm of CCS Haryana Agriculture University during *Rabi* season of 2019-20 to study the economics of wheat under integrated nitrogen management. The experiment was laid out in randomized block design with three replications containing 16 treatments combination *i.e.* $T_1$-Control; $T_2$-100% RDN through urea; $T_3$- 100% RDN through FYM; $T_4$-100% RDN through vermicompost; $T_5$-50% RDN through urea+ 50% RDN through FYM; $T_6$-50% RDN through urea+ 50% RDN through vermicompost; $T_7$-25% RDN through urea+ 75% RDN through FYM; $T_8$-25% RDN through urea 75% RDN through vermicompost; $T_9$-100% RDN through urea + *Azotobacter*; $T_{10}$-100% RDN through FYM + *Azotobacter*; $T_{11}$-100% RDN through vermicompost + *Azotobacter*; $T_{12}$-50% RDN through urea+ 50% RDN through FYM + *Azotobacter*; $T_{13}$-50% RDN through urea+ 50% RDN through vermicompost + *Azotobacter*; $T_{14}$-25% RDN through urea+ 75% RDN through FYM + *Azotobacter*; $T_{15}$-25% RDN through urea+ 75% RDN through vermicompost + *Azotobacter*; $T_{16}$- *Azotobacter*. The initial status of soil fertility was 130:17:250 kg NPK $ha^{-1}$ with 0.37 percent organic carbon. The wheat variety WH 1184 used for sowing at the rate of 120 kg/ha. Both the FYM and vermicompost were analyzed for available nitrogen and were made to percent RDN. The FYM and vermicompost were broadcasted as per treatments. Half dose of nitrogen through urea was applied before sowing as per treatments, along

 

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with full dose of P, K and Zn, and second half dose after first irrigation. All the agronomic operation were equally done for all the treatments. The only differences among the treatments were the rate and source of nitrogen nutrition. The phonological days were counted from days of sowing and the protein content of wheat was calculated by multiplying the nitrogen content of wheat by 6.25.

## 3. Results and Discussion

### 3.1. Growth phenology

Growth is an irreversible process by which a plant increases in size or dry weight or volume. Plants receive energy for their growth from sunlight through photosynthesis process. However, utilization of manufactured energy by crop depends upon the development stage and environmental conditions and also photosynthate formation rate in somewhat temperature related. The data presented in Table 1 indicated that days taken to emergence of wheat was not influenced significantly by any of the treatments. Days taken to 50% Spike emergence days was significantly lower in control treatment as compared to rest of treatment. The maximum days taken to 50% spike emergence was recorded in 100% RDN through urea + *Azotobacter* (94.7 days) which was statistically at par with 100% RDN through urea alone. Nutrition of nitrogen through organic source i.e. FYM or vermicompost resulted in significantly earlier emergence of spikes as compared to nitrogen nutrition through chemical fertilizer *i.e* urea. Decrease in contribution of nitrogen through urea in combination with organic source nitrogen nutrition decreased number of days to spike emergence significantly with decrease in N nutrition through chemical fertilizer (urea). Seed treatment with *Azotobacter* irrespective of the integrated nitrogen management failed to produce significant variation in days taken to 50% spike emergence. Seed treatment with *Azotobacter* delayed 50% spike emergence significantly as compared to control treatment but it was significantly lower than integrated use of RDN through urea with FYM or vermicompost at either of the integrated nitrogen management treatment. Nitrogen nutrition either through urea or FYM or vermicompost resulted in increase in days taken to maturity of wheat crop significantly over control treatment. Nitrogen nutrition through any of the organic source *i.e* FYM or vermicompost resulted in significantly earlier maturity of wheat as compared to nitrogen nutrition through chemical fertilizers (urea). Integration of organic source of nitrogen nutrition *i.e* 50:50 or 25:75 with chemical fertilizer resulted in significantly earlier maturity of wheat as compared to alone

 

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100% RDN nutrition through urea. Seed treatment of wheat with *Azotobacter* in either of the integrated nutrient treatments failed to produce significant variation in maturity of wheat as compared to no *Azotobacter* seed treatment in the respective integrated nitrogen management treatment. Nitrogen nutrition 100% through vermicompost + *Azotobacter* delayed the wheat maturity as compared to 100% RDN through vermicompost alone. Sarwar *et al*. (2007) also reported that nitrogen availability was 40 only percent for manure. No much difference in maturity was recorded if nitrogen supply was 50% through urea + 50% FYM/vermicompost as compared to the same treatment combination with *Azotobacter* seed treatment which might be due to no significant supply of nitrogen by *Azotobacter*. However, it improved the nutrient (nitrogen) availability.

**Table 1. Effect of integrated nitrogen management on phenology of wheat (*Triticum aestivum* L.)**

| **Treatments** | **Days taken to** | | |
|---|---|---|---|
| | **Emergence** | **50% spike emergence** | **Maturity** |
| $T_1$: Control | 5.1 | 77.7 | 132.0 |
| $T_2$: 100% RDN through urea | 5.0 | 94.3 | 148.3 |
| $T_3$: 100% RDN through FYM | 5.1 | 87.0 | 141.3 |
| $T_4$: 100% RDN through vermicompost | 5.2 | 90.3 | 143.3 |
| $T_5$: 50% RDN through urea+ 50% RDN through FYM | 5.0 | 91.7 | 144.3 |
| $T_6$: 50% RDN through urea+ 50% RDN through vermicompost | 5.1 | 92.3 | 145.7 |
| $T_7$: 25% RDN through urea+ 75% RDN through FYM | 5.1 | 88.0 | 143.0 |
| $T_8$: 25% RDN through urea+ 75% RDN through vermicompost | 5.2 | 87.3 | 144.0 |
| $T_9$: 100% RDN through urea + *Azotobacter* | 5.3 | 94.7 | 148.0 |
| $T_{10}$: 100% RDN through FYM + *Azotobacter* | 5.2 | 87.3 | 142.0 |
| $T_{11}$: 100% RDN through vermicompost + *Azotobacter* | 5.1 | 91.7 | 144.0 |
| $T_{12}$: 50% RDN through urea+ 50% RDN through FYM + *Azotobacter* | 5.2 | 92.0 | 145.0 |

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| | | | |
|---|---|---|---|
| $T_{13}$: 50% RDN through urea+ 50% RDN through vermicompost + *Azotobacter* | 5.0 | 93.0 | 146.0 |
| $T_{14}$: 25% RDN through urea+ 75% RDN through FYM + *Azotobacter* | 5.1 | 88.7 | 143.3 |
| $T_{15}$: 25% RDN through urea+75% RDN through vermicompost+*Azotobacter* | 5.1 | 89.0 | 143.7 |
| $T_{16}$: *Azotobacter* | 5.1 | 88.0 | 136.0 |
| SE(m) ± | 0.9 | 1.0 | 1.0 |
| CD at 5% | NS | 2.1 | 2.4 |

**3.2 Yield studies**

Among different treatments highest grain yield was recorded in 100% RDN through urea + *Azotobacter* which was 22, 22.8, 29.9 and 25.1 percent higher than $T_5$ (50% RDN through urea + 50% RDN through FYM), $T_6$ (50% RDN through urea + 50% RDN through vermicompost), $T_7$ (25% RDN through urea + 75% RDN through FYM), and $T_8$ (25% RDN through urea + 75% RDN through vermicompost). No significant variation in grain yield of wheat was recorded at the same proportion *i.e* 50:50 or 25:75 ratio of chemical fertilizer and organic fertilizer if organic source was FYM or vermicompost, however, higher proportion of urea *i.e.* 50% RDN produced significantly higher grain yield as compared to 25% proportion. Treatment having 50% RDN through urea + 50% RDN through vermicompost produced 3 percent higher grain yield as compared to 25% RDN through urea + 75% RDN through vermicompot. Nutrition of 100% RDN in wheat through chemical fertilizer recorded 28.58 and 27.79 percent higher grain yield as compared to FYM and vermicompost, respectively. Seed treatment of wheat with *Azotobacter* along with 50% RDN through urea + 50% RDN through FYM or vermicompost improved the grain yield by 458 and 288 kg/ha, respectively over no inoculation. Similarly, *Azotobacter* seed treatment had positive impact on wheat grain yield at different combination of chemical fertilizer and organic sources (FYM or vermicompost). Nitrogen nutrition 100% through urea produced 23.74 percent higher grain yield as compared to $T_{15}$ (25% RDN through urea + 75% RDN through vermicompost + *Azotobacter*).

 

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**Table 2: impact of nitrogen nutrition on yield and quality of wheat**

| **Treatments** | **Grain yield (kg/ha)** | **Hectoliter weight (kg/ha)** | **Grain appearance score (10 scale)** | **Protein content (%)** | **Protein Yield (kg/ha)** |
|---|---|---|---|---|---|
| $T_1$: Control | 3911 | 77.207 | 6.167 | 7.48 | 383.05 |
| $T_2$: 100% RDN through urea | 5600 | 83.167 | 7.700 | 12.89 | 721.84 |
| $T_3$:100% RDN through FYM | 4000 | 79.933 | 6.667 | 12.00 | 480.00 |
| $T_4$: 100% RDN through vermicompost | 4044 | 80.300 | 6.700 | 12.08 | 488.62 |
| $T_5$: 50% RDN through urea+ 50% RDN through FYM | 4400 | 82.133 | 6.967 | 11.73 | 516.18 |
| $T_6$: 50% RDN through urea+ 50% RDN through vermicompost | 4355 | 82.267 | 7.333 | 11.79 | 513.69 |
| $T_7$: 25% RDN through urea+ 75% RDN through FYM | 4177 | 81.167 | 6.933 | 9.79 | 312.55 |
| $T_8$: 25% RDN through urea+ 75% RDN through vermicompost | 4222 | 81.167 | 7.067 | 11.64 | 491.63 |
| $T_9$: 100% RDN through urea + *Azotobacter* | 5640 | 83.167 | 7.933 | 12.90 | 727.56 |
| $T_{10}$: 100% RDN through FYM +*Azotobacter* | 4133 | 80.900 | 6.700 | 11.23 | 464.18 |
| $T_{11}$: 100% RDN through vermicompost +*Azotobacter* | 4266 | 80.067 | 6.767 | 11.11 | 474.03 |
| $T_{12}$: 50% RDN through urea+ 50% RDN through FYM +*Azotobacter* | 4502 | 83.067 | 7.500 | 11.77 | 529.86 |
| $T_{13}$: 50% RDN through urea+ 50% RDN through vermicompost +*Azotobacter* | 4688 | 83.100 | 7.533 | 11.88 | 556.81 |
| $T_{14}$: 25% RDN through urea+ 75% RDN through FYM +*Azotobacter* | 4211 | 80.067 | 7.000 | 11.71 | 492.97 |
| $T_{15}$: 25% RDN through urea+75% RDN through vermicompost+*Azotobacter* | 4271 | 81.700 | 7.100 | 11.69 | 499.19 |
| $T_{16}$: *Azotobacter* | 4044 | 79.200 | 6.300 | 10.46 | 422.90 |
| SEm ± | 136 | 0.480 | 0.334 | 0.647 | 8.333 |
| CD at 5% | 296 | 1.392 | 0.970 | 1.87 | 24.18 |

 

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## 4. Conclusion

Among different treatments highest grain yield was recorded in 100% RDN through urea + *Azotobacter* than $T_5$ (50% RDN through urea + 50% RDN through FYM), $T_6$ (50% RDN through urea + 50% RDN through vermicompost), $T_7$ (25% RDN through urea + 75% RDN through FYM), and $T_8$ (25% RDN through urea + 75% RDN through vermicompost). No significant variation in grain yield of wheat was recorded at the same proportion *i.e* 50:50 or 25:75 ratio of chemical fertilizer and organic fertilizer if organic source was FYM or vermicompost, however, higher proportion of urea *i.e* 50% urea produced significantly higher grain yield as compared to 25% proportion. Treatment having 50% RDN through urea + 50% RDN through vermicompost produce 3 percent higher grain yield as compared to 25% RDN through urea + 75% RDN through vermicompost. Seed treatment of wheat with *Azotobacter* along with 50% RDN through urea + 50% RDN through FYM or vermicompost improved the grain by 458 and 288 kg/ha, respectively or no inoculation.

Days taken to emergence of wheat was not influenced significantly by any treatments.

Days taken to 50% spike emergence was significantly higher in control treatment as compared to rest of treatment. The maximum days taken to 50% spike emergence was recorded in 100% RDN through urea + *Azotobacter* (94.4 days) which was statistically at par with 100% urea alone. Nutrition of nitrogen through organic source i.e. FYM or vermicompost resulted in significantly earlier emergence of spikes as compared to nitrogen nutrition through chemical fertilizer *i.e.* urea.

Nitrogen nutrition through FYM or vermicompost resulted in significantly earlier maturity of wheat as compared to nitrogen nutrition through chemical fertilizers (urea) integration of organic source of nitrogen nutrition *i.e* 50:50 or 25:75 with chemical fertilizer resulted in significantly earlier maturity of wheat as compared to alone 100% N nutrition through urea. Seed treatment of wheat with *Azotobacter* in either of the integrated nutrient treatments failed to produce significant variation in maturity of wheat as compared to no *Azotobacter* seed treatment in the respective integrated nitrogen treatment. 100% nitrogen nutrition through vermicompost + *Azotobacter* delayed the wheat maturity as compared to 100% RDN through vermicompost alone.

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### Brief bibliography of the author

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