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Effect of Nitrogen Management on Growth Attributes and Yield Attributes of Wheat

Rashmi R. Vishwajna [a++*], Victor Debbarma [a#] and Mahesh Namdev Shingare [a++]

[a] *Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India.*

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

A field experiment was conducted during *rabi* 2022-23 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P) to determine the "Effect of Nitrogen management on growth and yield of wheat". There were nine treatments each replicated thrice and the experiment was laid out in Randomized Block Design. The results showed that treatment 6 (75% N through urea + 25 % N through poultry manure) recorded significantly higher plant height (119.20 cm), maximum number of tillers/ m^2 (214), higher plant dry weight (64.34 g), highest Crop growth rate during the interval of 50-75 DAS (35.73 $g/m^2/day$), maximum number of effective tillers/ m^2 (144.5), maximum number of grains/ spike (53.33) and highertest weight (97.71 g) compared to other treatments.

[++]*M.Sc. Scholar;*
[#]*Assistant Professor;*
**Corresponding author: E-mail: rrvishwajna99@gmail.com;*

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1. INTRODUCTION

Wheat, the country's second-largest cereal crop, is crucial for the country's food and nutritional security. About 20% of the world's population, or close to 55%, gets their calories from wheat. In North India, where people like chapatti, it is one of the main food grains consumed there and a staple diet. Wheat is a self-pollinating, long-day, winter crop that is a member of the Poaceae family of plants. It is grown for both grain and feed purposes to meet the needs of both people and animals. The insufficient levels and timing of fertilizers, the soil's deficiency in organic matter and nitrogen, and alkalinity are all contributing factors to the decreased productivity.

The total area of wheat cultivation around the world is 221.91 million hectares, the total production was 781.01 million metric tons, and the productivity per hectare was 3.52 metric tons [1]. The total sown area under wheat crop in India is around 31.61 million hectares. The total wheat production in India is around 109.52 million tons and productivity of 3464 kg/ hectare. Total area under wheat in Uttar Pradesh is 9.85 million hectares which is 31.16% of total area under wheat cultivation in India. Total wheat production in Uttar Pradesh is 35.50 million tons and productivity is 3604 kg/ hectare [2].

Insufficient nitrogen has a remarkable impact on grain yield and factors that affect yield by influencing biomass synthesis and how well the plant uses solar energy [3]. The varying soil and climatic circumstances that affect how nitrogen components behave in the root zone and how they interact with plants may cause variations in nitrogen accessibility and its relevance to plants [4]. Additionally, the introduction of new cultivars with varying dietary requirements has upset suggestions for nitrogen fertilizers for wheat crops. The need to increase wheat yields has spurred forward-thinking farmers to work diligently on farm management tasks. It should be remembered that the optimal level of nitrogen application should be low for cultivars that respond poorly to its application and that the rate of nitrogen should be high for varieties that respond well to its application and produce more, as this will prevent the varieties' yield potential from being maximized. However, there are situations when applying too much nitrogen causes toxicity, stunts plant growth by making it more prone to lodging, and contaminates the environment through nitrate leaching [5] as well as ammonia volatilization [6]. One of the most popular fertilisers with nitrogen is urea. The primary component of protein, amino acids, and chlorophyll, nitrogen is crucial for the production of wheat [7]. Due to nitrogen application levels that were below and beyond the recommended range, respectively, dwarfed wheat growth and lodging were observed [8].

Nitrogen increases the number of spikes and contributes more to the components of the yield [9], increased leaf area index and grain yield [10]. According to studies on synthetic nitrogen fertilizers that depleted soil nitrogen, inorganic N fertilizers, particularly those in the form of ammonium, lowered the mass of organic carbon due to increased microbial consumption and decreased total nitrogen in the soil as a result of increased grain uptake of nitrogen. Chaudhary et al. [11] have stated that the main issues with using commercial fertilizer alone are its high cost, soil degradation, and environmental damage.

Vermicompost is a byproduct of the co-action of earthworms and microorganisms in the bio-oxidation and stabilization of organic material. While earthworms are crucial drivers of the process, modifying the substrate and changing biological activity, microorganisms are still in charge of biologically degrading organic waste [12]. If used in the right proportions with synthetic fertilizers, vermicompost could be a source of nutrients for field crops. *Vermicompost* treatment has been shown to increase the growth and productivity of grains and legumes, according to prior researchers [13]. *Vermicompost* contains cytokinins, auxins, and gibberellins, which are biologically active growth-promoting compounds, in addition to a significant amount of nutrients and a large number of beneficial microorganisms. For a good qualitative and quantitative yield, it can be used alone or in conjunction with other organic and inorganic fertilizers.

In addition to being a rich source of macro (N, P, K) and micro (S, Fe) nutrients, poultry dung also improves the health of the soil. It provides organic matter for the soil, enhances soil biological activity, and increases the soil's capacity to hold water. Because poultry manure has a higher mineralization level than other natural manures, when it is put to the soil for plant uptake, it easily releases its nutrients.

Applying poultry manure to soil improves its carbon content, water holding capacity, soil agglomeration, and bulk density. Poultry manure contains 3-5% nitrogen; 1.5-3.5% phosphorus, 1.5-3% potassium, considerable number of micronutrients and its pH is 6-7 [14]. When applied to cereals along with urea, poultry manure has a greater positive impact on yield components than other organic manures [15]. Utilizing both poultry manure and urea together promotes soil restoration and is more cost-effective than applying urea alone [16]. It has been noted that increasing nitrogen use efficiency boosts yield and activates the low affinity nitrogen uptake transport mechanism, which allows for passive nitrogen uptake and high production [17]. Keeping the above points in view the experiment was carried out to determine the “Effect of nitrogen management in growth and yield of wheat”.

2. MATERIALS AND METHODS

A field experiment was conducted during *rabi* 2022-23 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P) on the topic “Effect of nitrogen management on growth and yield of wheat”, to study the response of nitrogen through urea along with combination of *vermicompost* and poultry manure. The soil of experimental plot was sandy loam in texture, soil pH was 8.0, low in organic carbon (0.62%), available N (225 kg/ha), available P (38.2 kg/ha) and available K (240.7 kg/ha). There were 9 treatments, each being replicated thrice and laid out in Randomized Block Design. The treatment combinations were 100% N through urea, 75% N through urea + 25% N through *vermicompost*, 50% N through urea + 50% N through *vermicompost*, 25% N through urea + 75% N through *vermicompost*, 100% N through *vermicompost*, 75% N through urea + 25% N through poultry manure, 50% N through urea + 50% N through poultry manure, 25% N through urea + 75% N through poultry manure, 100% N through poultry manure. The data recorded on different aspects of crop such as, growth attributes and yield attributes were subjected to statistical analysis by analysis of variance method [18].

3. RESULTS AND DISCUSSION

3.1 Growth attributes Plant height (cm)

Significant and higher plant height (119.20 cm) was recorded in treatment 6 (75% N through urea + 25% N through poultry manure). However, treatment 7 (50% N through urea + 50% N through poultrymanure) was found to be statistically at par with treatment 6 (75% N through urea + 25% N through poultry manure). Significant and higher plant height was recorded with 75% N through urea might bedue to more nitrogen applied, plant cells grow bigger and contain more protein, which improves leaf area and photosynthesis rate and, ultimately, causes the plant to grow taller. Similar results were reported by Wysocki et al. [19]. Further, increase in plant height with application of 25% N through poultry manure may be due to the buildup of nitrogen together with other assimilates and the increased availability of nitrogen for cell elongation, development, photosynthesis, and metabolism. Similar results were reported by Haberle et al*.* [20].

3.2 Number of Tillers / m^2

Significant and higher number of tillers / m^2 (214.0) was recorded in treatment 6 (75% N through urea + 25% N through poultry manure). However, treatment 2 (75% N through urea + 25% N through *vermicompost*) and treatment 7 (50% N through urea + 50% N through poultry manure) were found to be statistically at par with treatment 6 (75% N through urea + 25% N through poultry manure). Significant and higher number of tillers/ m^2 was recorded with 75% N through urea might be due to nitrogen levels were increased, which increased tiller output from the main stem and decreased tiller mortality. Similar results were also reported by Rahman et al*.* [21]. Further, increase in number of tillers/ m^2 with application of 25% N through poultry manure may be due to enhanced nutrient availability and ease of uptake by receiving plants, which sped up plant growth and development and ultimately led to the production of more tillers/ m^2. Similar results were also reported by Enujeke [22].

3.3 Plant Dry Weight (g)

Significant and higher plant dry weight/ plant (64.34 g) was recorded in treatment 6 (75% N through urea + 25% N through poultry manure). However, treatment 7 (50% N through urea + 50% N throughpoultry manure) was found to be statistically at par with treatment 6 (75% N through urea + 25% N through poultry manure). Significant and higher plant dry weight was recorded with 75% N through urea might be due to nitrogen increases leaf area, speeds up

Table 1. Effect of nitrogen management on growth attributes of wheat

S. No.	Treatments	Plant height (cm)	Number of tillers/ m^2	Plant dry weight (g)	Crop growth rate (g/m^2/day)
1.	100% N through urea	108.20	189.3	54.67	32.07
2.	75% N through urea + 25 % N through *vermicompost*	113.20	213.0	61.21	37.03
3.	50% N through urea + 50% N through *vermicompost*	114.80	204.0	59.06	34.17
4.	25% N through urea + 75% N through *vermicompost*	109.20	190.7	57.53	32.91
5.	100 % N through *vermicompost*	110.50	180.0	52.00	31.29
6.	75% N through urea + 25 % N through poultry manure	119.20	214.0	64.34	35.73
7.	50% N through urea + 50% N through poultry manure	116.20	213.7	64.00	35.16
8.	25% N through urea + 75 % N through poultry manure	114.00	200.0	58.31	34.20
9.	100 % N through poultry manure	106.20	180.0	53.46	33.33
	F – Test	S	S	S	NS
	SEm (±)	1.02	0.34	0.72	1.19
	CD (p=0.05)	3.08	1.03	2.17	-

Table 2. Effect of nitrogen management on yield attributes of wheat

S. No.	Treatments	Number of effective tillers/ m^2	Number of grains/ spike	Test weight (g)
1.	100% N through urea	119.8	45.00	87.90
2.	75% N through urea + 25 % N through *vermicompost*	140.5	52.33	94.38
3.	50% N through urea + 50% N through *vermicompost*	134.5	50.00	93.00
4.	25% N through urea + 75% N through *vermicompost*	121.2	46.67	89.25
5.	100 % N through *vermicompost*	110.5	42.00	84.00
6.	75% N through urea + 25 % N through poultry manure	144.5	55.33	97.71
7.	50% N through urea + 50% N through poultry manure	144.2	54.67	96.93
8.	25% N through urea + 75 % N through poultry manure	130.5	49.40	90.51
9.	100 % N through poultry manure	110.0	43.33	85.53
	F – Test	S	S	S
	SEm (±)	0.23	0.68	0.27
	CD (p=0.05)	0.69	2.05	0.82

photosynthesis, produces assimilates more quickly, and accelerates the production of plant dry matter, increasing plant dry weight. Similar results were reported by Rahman et al. [21]. Further increase in plant dry weightwith application of 25% N through poultry manure may be due to the addition of N increased the number of photosynthetic pigments and chlorophyll in wheat, which raised the plant's net photosynthetic rate and raised the dry matter of the plant. Similar results were reported by Iqra et al. [23].

3.4 Crop Growth Rate (g/m^2/day)

At 50-75 DAS, highest crop growth rate (35.73 g/m^2/day) was recorded in treatment 7 (50% N through urea + 50% N through poultry manure), though there was no significant difference among the treatments. Significant and higher crop growth rate was recorded with 75% N through urea might be due to optimal nutrient use to optimize plant nutrient uptake and the distribution of assimilates to different plant sections, which enhanced plant biomass and raised CGR. Similar results were reported by Wang et al. [24].

3.5 Yield Attributes

3.5.1 Number of effective tillers/ m^2

Significantly higher number of effective tillers/ m^2 (14.45) was recorded in treatment 6 (75% N throughurea + 25% N through poultry manure). However, treatment 7 (50% N through urea + 50% N throughpoultry manure) was found to be statistically at par with treatment 6 (75% N through urea + 25% N through poultry manure). Significant and higher number of effective tillers/ m^2 was recorded with 75% N through urea might be due to more leaves produced by an increase in nitrogen led to higher rates of photosynthesis, assimilation, metabolic activity, and cell division, which in turn produced a considerable rise in the number of productive tillers/m^2. Similar results were reported by Chauhan et al. [25]. Further, increase in number of tillers/ m^2 with application of 25% N through poultry manure may be due to availability of both macronutrients and micronutrients, increasing the number of productive tillers/m^2. Similar results were reported by Muhammad et al. [26].

3.5.2 Number of grains/ spike

Significantly higher number of grains/ spike (55.33) was recorded in treatment 6 (75% N through urea + 25 % N through poultry manure). However, treatment 7 (50% N through urea + 50 % N through poultry manure) was found to be statistically at par with treatment 6 (75% N through urea + 25 % N through poultry manure). Significant and higher number of grains/ spike was recorded with 75% N through urea might be due to increased dry matter, improved photosynthetic rate as a result of higher nitrogen dose, more assimilates produced and transported to fill the seeds. Similar results were reported Imbad et al. [27] Further increase in number of grains/ spike along with application of 25% N through poultry manure may be due to higher nitrogen rate caused a rise in dry matter, which in turn caused more grain partitioning and an increase in number of grains/spikes. Similar results were reported by Muhammad et al. [26].

3.5.3 Test weight (g)

Significantly higher test weight (97.71 g) was recorded in treatment 6 (75% N through urea + 25 % Nthrough poultry manure). However, treatment 7 (50% N through urea + 50% N through poultry manure) was found to be statistically at par with treatment 6 (75% N through urea + 25% N through poultry manure). Significant and higher test weight was recorded with 75% N through urea might be due to because of the massive accumulation of proteins and other nutrients that were stored in the seed, the weight of thousand grain weight rose. Similar results were reported by Azam et al. [28]. Further increase in test weight along with application of 25% N through poultry manure may be due to A-type starch granules have more amylose, which makes grain rounder and bolder for more starch to accumulate in, increasing grain weight. The accumulation of A-type starch granules is increased by adequate nitrogen, and A- type starch granules have more amylose. Similar results were recorded by Wei et al. [29].

4. CONCLUSION

It is concluded that in wheat with the combination of 75% N through urea along with 25% N through poultry manure (treatment 6) higher plant height, plant dry weight, more number of tillers/ m^2, higher CGR, more number of effective tillers/ m^2, grains/ spike and test weight was observed.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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