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Effect of Nitrogen Levels and Inoculation of Biofertilizers on Growth and Yield of Wheat

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ABSTRACT

A field experiment titled ”Effect of Nitrogen levels and inoculation of Biofertilizers on growth and yield of Wheat’’ was conducted during *Rabi* 2022-23 at Crop Research Farm, Department ofAgronomy, SHUATS, Prayagraj (U.P). The treatments consists of three different levels of Nitrogen-100%, 75% and 50% with combination of different levels of *Azotobacter* and *Azospirillum*. The experiment was laid out in Randomized Block Design with ten treatments which are replicated thrice.The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 6.9), low in organic carbon (0.112%), available N (278.93 kg/ha), available P (10.8 kg/ha), and available K (206.4 kg/ha). The results obtained that combined application of Nitrogen 100% -150 kg/ha along with Azotobacter10g/kg and Azospirillum10g/kg seed (Treatment-3) significantly increased higher plant height (85.00 cm), number of tillers/hill (8.2), plant dry weight (21.00 g), number of effective tillers/hill (6.03), number of grains/spike (50.06), grain yield (4.96 t/ha) and straw yield (7.00 t/ha).

Key words: *Wheat, Nitrogen, Bio fertilizers, Growth parameters and yield attributes.*

Introduction

Wheat (*Triticumae stivum L.*) one of the main cereals that is widely grown and developed across the world is wheat. It is the third most significant cereal in the world because of its protein-to-carbohydrate ratio, nutritional diversity, and widespread end-product manufacturing. It is grown as a staple food for people and cattle all over the world in different seasons with various local adaptations, although it exhibits the best growth and yields in temperate climate zones. The wheat kernel includes about 12% water, 70% carbohydrates, 14% protein, 2% fat, 1.8 minerals, 2.2 crude fibres, and thiamine, riboflavin, niacin, and vitamin A in only in minute quantity. Hard kinds of wheat with a protein content of 11 to 15 percent and strong gluten (wheat storage protein) are typically produced in dry locations and offer the best flour suitable for producing bread.

The world’s wheat crop was grown on 221.84 million hectares in 2022, with a yield per hectare of 3.51 metric tonnes and a total production of 779.33 million metric tonnes. China is at the top of the production scale for 2022, followed by the European Union, the United States, Australia, India, and Russia (Global Market Analysis, FAS, USDA, 2023). Around 304.47 lakh hectares of wheat have been seeded in India overall (GOI, 2022). India produces about 111.32 million tonnes of wheat overall.

Nitrogen is more essential for vegetative and reproductive period of the wheat crop, when grain yield subsequently exhibits observable changes.

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Wheat grain yield is determined by the weight and number of kernels per unit of surface area. According to Kausar *et al.* (1993), grain weight is a genetically regulated characteristic that is significantly impacted by the environment during the grain-filling stage. In addition to enhancing a crop's leaf area and perhaps improving dry matter output by intercepting more sunlight, nitrogen is essential for the process of grain filling (Green, 1984).

Biofertilizers are preparations of living microorganisms used in a variety of processes, including biological nitrogen fixation, the solubilization of insoluble phosphates and other nutrients, the production of growth hormones, and the control of plant diseases. Azotobacter is a free-living nitrogen-fixing bacterium that can grow well in the rhizosphere zone of several crops, including wheat, maize, rice, sorghum, sugarcane, cotton, etc. It may fix 10–20 kg of nitrogen per hectare over a growing season (Jadhav *et al.,* 1987). Aside from fixing nitrogen, azotobacter also produces and secretes large amounts of physiologically active compounds that help plants expand their roots, such as B vitamins, nicotinic acid, pantothenic acid, biotin, heteroauxins, and gibberellins (Rao, 1986). One of the most significant genera of rhizobacteria that promote plant development and create an associative relationship with plant roots is *Azospirillum*. It aids in the manufacture of plant growth hormones. Under greenhouse and field conditions, it produces highly favourable outcomes.

Materials and Methods

A field experiment was conducted during *Rabi* season of 2022-23 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of the field constituting a part of central Gangetic alluvium is neutral and deep. The soil of the experimental field was sandy loam in texture, nearly neutral in soil reaction (pH 7.8), low level of organic carbon (0.62%), available N (225 Kg/ha), P (38.2 kg/ha), K (240.7 kg/ha) and zinc (2.32 mg/kg). The treatment consists of three different levels Nitrogen@100%, 75%, and 50%with combination of different levels of Azotobacter and Azospirillum. The experiment was laid out in RBD with 10 treatments each replicated thrice. The treatment combinations are T_1: 100%N-150kg/ha + Azotobacter @20g/kg seed, T_2: 100%N-150kg/ha + Azospirillum @20g/kg seed, T_3:100%N-150kg/ha + Azotobacter @10g/kg seed + Azospirillum @10g/kg seed, T_4: 75%N- 112.5kg/ha + Azotobacter @20g/kg seed, T_5:75%N- 112.5kg/ha + Azospirillum @20g/kg seed, T_6: 75%N- 112.5kg/ha + Azotobacter @10g/kg seed + Azospirillum @10g/kg seed, T_7: 50%N- 75kg/ha + Azotobacter @20g/kg seed, T_8: 50%N- 75kg/ha + Azospirillum @20g/kg seed, T_9: 50%N- 75kg/ha + Azotobacter @20g/kg seed + Azospirillum @20g/kg seed, T_{10}: Control (RDF- 150:60:40 kg/ha). The growth parameters and yield, production was recorded at harvest from randomly selected plants in each plot. The data were computed and analysed by following statistical method of Gomez and Gomez (1976).

Results and Disscussion

Growth parameters

Plant height (cm)

The data revealed treatment 3 (100%N - 150kg/ha + Azotobacter @10g + Azospirillum @10g/kg seed) recorded significantly highest plant height (85.00cm). However, treatment 2(100%N-150kg/ha +Azospirillum@20g/kg seed) was statistically at par with the treatment 3 (100%N - 150 kg/ha + Azotobacter @10g+Azospirillum@10g/kg seed).

The increased availability of nitrogen may be the cause of an increase in plant height following the application of N fertilizers (Indra Chaturvedi, 2006) and inoculation of bacterial preparation accelerate plant growth by giving the inoculated plant biologically fixed nitrogen, as well as stimulate plant growth by excreting substances which promote plant growth, such as auxins, kinetin, vitamins, and gibberellins, as also observed by Malik *et al.,* 2005.

Number of tillers/hill

The data revealed that number of tillers/hill (8.2) was recorded significantly higher in treatment 3(100%N – 150kg/ha + Azotobacter @10g + Azospirillum@10g/kgseed). However, treatment 2 (100%N-150kg/ha +Azospirillum@20g/kg seed) and treatment 6 (75%N -112.5 kg/ha+ Azotobacter @10g+Azospirillum@10g/kg seed) were statistically at par with the treatment 3 (100%N - 150kg/ha + Azotobacter @10g + Azospirillum@ 10g/kg seed).

According to Maurya *et al.,* (2019) increased nitrogen doses may have increased cell multiplication and elongation, resulting in an increase in the number of tillers, whereas Me Carty *et al.* (2017) claimed that the inoculation of Azotobacter and PSB solubilized inorganic insoluble phosphates by microorganisms to the production of organic acids, chelates, and other compounds.

Plant dry weight (g/plant)

Results revealed that significant and higher plant dry weight (21.00g), was observed in treatment 3(100%N - 150kg/ha + Azotobacter @10g + Azospirillum@ 10g/kg seed). However, treatment 2 (100%N-150kg/ha + Azospirillum@20g/kg seed) was statistically at par with the treatment 3(100%N - 150 kg/ha + Azotobacter @10g+ Azospirillum@ 10g/kg seed).

According to Singh *et al.* (2019), an adequate supply of nitrogen allowed the plant tissue to expand, increase chlorophyll production, and improve a rapid rate of photosynthetic activity, resulting to a greater accumulation of dry matter. Similar outcomes were seen by Akhthar *et al.* (2018), who found that the injection of biofertilizers increases the activation of hormones which help in shoot and root elongation and high dry matter production.

Yield parameters

Number effective tillers/hill

The data recorded that in treatment 3(100%N - 150kg/ha + Azotobacter @10g+Azospirillum@10g/kgseed) recorded significant and maximum number (6.03). However, treatment 1(100% N- 150 kg/ha + Azotobacter @20g/kg seed), treatment 2(100% N-150 kg/ha + Azospirillum @20g/kg seed) and treatment 4 (75% N- 112.5 kg/ha + Azotobacter @20g/kg seed) were statistically at par with the treatment 3 (100%N - 150kg/ha + Azotobacter @10g+ Azospirillum @ 10g/kgseed).

The increased early vegetative growth in terms of higher leaf area, dry matter accumulation, and strong root systems resulted to more tillers, which in turn significantly increased the number of effective tillers. Similar findings were observed by Devi *et al.* (2011). Similarly increase in effective tillers/ha with the application of biofertilizer might be due it seems owing to increased supply of plant hormones by the microorganisms or by roots as results of reaction to microbial colonization (Avivi and Feldman, 1982).

Number of grains/spike

The data showed that significant and higher number of grains/spike (50.06), was observed in treatment 3(100%N - 150kg/ha + Azotobacter @10g + Azospirillum@ 10g/kgseed).

Though there was significant difference among the treatments. A significant increase in the number of grains or spikes is caused by an increase in higher nitrogen dosages, which leads to the creation of more spikelets. Similar findings were made by Bhatta *et al.* (2020). Similarly, increase in number of grains/spike is might de due to combined application of *Azospirillum*, *Azotobacter* bacteria fix their nitrogen in the soil, helps plants in synthesis of protein, carbohydrates starch and other assimilates. Similar findings were reported by Amit Kumar and Urmila (2018).

Grain Yield (t/ha)

Treatment 3(100%N– 150kg/ha + Azotobacter @10g

Table 1. Effect of Nitrogen levels and inoculation of Bio fertilizers on growth attributes of Wheat

S.No	Treatments	Plant height (cm)	Number of tillers/hill	Plant dry weight (g/plant)
1.	100% N- 150 kg/ha + Azotobacter @20g/kg seed	83.53	7.5	19.96
2.	100%N-150kg/ha + Azospirillum@20g/kg seed	84.80	8.1	20.76
3.	100%N - 150kg/ha + Azotobacter@10g+Azospirillum@10g/kg seed	85.00	8.2	21.00
4.	75% N- 112.5 kg/ha + Azotobacter @20g/kg seed	82.27	6.9	19.30
5.	75%N -112.5 kg/ha + Azospirillum@20g/kg seed	83.47	7.3	19.76
6.	75%N -112.5 kg/ha+ Azotobacter @10g+Azospirillum@10g/kg seed	84.50	8.0	20.32
7.	50% N- 75 kg/ha + Azotobacter @20g/kg seed	80.60	6.2	18.52
8.	50% N -75 kg/ha + Azospirillum@20g/kg seed	81.50	6.5	18.81
9.	50% N -75 kg/ha+ Azotobacter @10g+Azospirillum@10g/kg seed	82.90	7.2	19.60
10.	Control (RDF-150:60:40 NPK kg/ha)	79.63	5.7	18.21
	F-test	S	S	S
	Sem±	0.61	0.07	0.09
	CD at 5%	0.21	0.20	0.27

+ Azospirillum@ 10g/kg seed) recorded significant and maximum grain yield (4.96 t/ha). However, treatment 2 (100%N– 150 kg/ha + Azosprillum @20g/kg seed) was statistically at par with the treatment 3(100%N – 150kh/ha +Azotpbacter @10g+ Azospirillum @ 10g/kg seed).

Higher nitrogen application might have increased photosynthetic activity, increased vegetative growth, and improved yield qualities, all of which may have contributed to the rise in grain production. Similar results have been observed, as stated by Pandey *et al.* (2018). According to Kaur *et al.* (2018) the release of additional plant hormones (auxin, cytokinin, gibberellin, etc.) by the given microorganisms or by the root as a result of reaction to the microbial population may be the cause of the improvement in yield characteristics and yield bybio-fertilizer.

Straw yield (t/ha)

The data revealed that Treatment 3(100%N - 150kg/ha + Azotobacter @10g+Azospirillum@10g/kg seed) recorded significant and maximum straw yield (7.00 t/ha). However, treatment 2 (100% N-150 kg/ha + Azospirillum @20g/kg seed) was statistically at par with the treatment 3 (100%N - 150kg/ha + Azotobacter @10g+Azospirillum@10g/kg seed.

According to Kaur *et al.* (2018) the use of bio-fertilizer increased wheat straw yields as well as growth and yield-attributing characteristics. According to Bhatta *et al.* (2020) greater plant height, the number of green leaves on each hill, and the generation of dry matter all contributed to better straw output. Straw yield is therefore dependent on vegetative growth.

Conclusion

From the results it is concluded that in Wheat crop with the application of 100% N - 150 kg/ha + Azotobacter 10 g/kg seed and *Azospirillum* 10 g/kg seed in treatment 3 recorded highest growth, yield and B.C. ratio. Since the findings are based on one season, further trails are needed to confirm the results.

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Table 2. Effect of Nitrogen levels and inoculation of Bio fertilizers on yield attributes and yield of Wheat

S. No.	Treatments	Number of effective Tillers/hill	Number of grains/ spike	Grain yield (t/ha)	Straw yield (t/ha)
1.	100% N- 150 kg/ha + Azotobacter @20g/kg seed	6.03	47.05	4.63	6.65
2.	100%N-150kg/ha + Azospirillum@20g/kg seed	6.00	48.03	4.73	6.75
3.	100%N - 150kg/ha + Azotobacter@10g+Azospirillum@10g/kg seed	6.03	50.06	4.96	7.00
4.	75% N- 112.5 kg/ha + Azotobacter @20g/kg seed	5.07	49.03	4.44	6.51
5.	75%N -112.5 kg/ha + Azospirillum@20g/kg seed	6.03	47.07	4.51	6.59
6.	75%N -112.5 kg/ha+ Azotobacter @10g+Azospirillum@10g/kg seed	6.00	48.03	4.60	6.96
7.	50% N- 75 kg/ha + Azotobacter @20g/kg seed	5.03	49.05	4.24	6.29
8.	50% N -75 kg/ha + Azospirillum@20g/kg seed	5.07	48.03	4.26	6.31
9.	50% N -75 kg/ha+ Azotobacter @10g+Azospirillum@10g/kg seed	5.06	50.04	4.33	6.42
10.	Control (RDF-150:60:40 NPK kg/ha)	5.03	47.01	3.96	5.99
	F-test	S	S	S	S
	Sem±	0.14	0.34	0.09	0.11
	CD at 5%	0.41	0.12	0.28	0.33

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