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# Improvement of productivity and profitability in wheat by nitrogen and bio-fertilizer in north western plain zone

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## Abstract
A field experiment was conducted during winter (*Rabi*) season of 2019-20 at Agricultural Research Farm, Department of Agronomy, R.B.S. College, Bichpuri, Agra (U.P.) the investigation entitled effect of bio fertilizers on nitrogen use efficiency and productivity of wheat (*Triticum aestivum* L.). The variables involve in this study four nitrogen levels *viz.* $N_1$ (60 kg ha$^{-1}$) $N_2$ (90 kg ha$^{-1}$), $N_3$ (120 kg ha$^{-1}$) $N_4$ (150 kg ha$^{-1}$) was sown with three biofertilizers such as (Control-$B_0$, *Azotobacter* -$B_1$, and *Azospirillum*-$B_2$). Thus in all 12 treatments combinations were compared in a Split plot design having cultivars sown in main plots nitrogen levels and sub plot in biofertilizers with four replications. The experimental results revealed that wheat crop nitrogen levels $N_4$ (150 kg ha$^{-1}$) + $B_2$ (*Azospirillum*) obtained significantly higher grain yield (54.71 q ha$^{-1}$) and straw yield (91.04 q ha$^{-1}$) followed by nitrogen levels $N_1$, $N_2$, $N_3$ and Bio-Fertilizer levels $B_0$ (control), $B_1$ (*Azotobacter*).

**Keywords:** Bio-fertilizers, growth, nitrogen and wheat

## Introduction
Wheat (*Triticum aestivum* L.) is the world's most widely produced food crop. It is consumed in different forms by over a billion people globally (Iftikhar *et al*., 2002) [2]. Based on current production levels, the world's wheat needs are estimated to be about 1090 million tons by 2050. To meet this demand, developing countries must increase their wheat output by 77%, with vertical growth accounting for more than 80% of the increase (Paroda, *et al*. 2018) [4]. With an estimated global production of 765.98 million tonnes in 2015, wheat ranked third in the world after rice (740.08 million tonnes) and maize (1010.61 million tonnes). When it comes to carbohydrates, minerals, and proteins, wheat is an excellent food source. Among other cereal grains, it is distinct in that its flour, when mixed with water, makes a cohesive dough mass that is versatile enough to be formed into a wide variety of shapes. (Statistical Overview of Agriculture, 2017) [1].
Reducing the amount of N fertilizer applied is necessary, as is looking for genotypes that have higher N usage efficiency from an agronomic or strict physiological standpoint. In order to reduce N fertilizer usage without lowering yield, wheat cultivars' efficiency in using N has grown in importance (Laghari *et al*., 2016) [3]. One of the biggest obstacles to raising the commercial yield of crops is the current increase in fertilizer prices. Therefore, measures to reduce its losses and improve its economic utilization are required. On the other hand, enhanced cultivars that have been chosen for high yields under high nutrient input circumstances are frequently generated without taking into account their capacity to grow and yield under low soil nutrient status. Due to advancements in national research development, rising chemical fertilizer prices, and growing focus on sustainable agricultural systems, there is currently a greater emphasis on biofertilizer (Yosefi, *et al*. 2011) [6]. By fixing atmospheric nitrogen, both in conjunction with plant roots and independently, biofertilizers (*Azotobacter* and *Azospirillum*) solubilize insoluble soil phosphates and generate plant growth components in the soil, so

contributing significantly to improved soil fertility. In actuality, they are being encouraged to take use of the biological mechanism of nutrition mobilization that is already there (Venkatashwarlu, 2008) [5]. Numerous scholars have evaluated the function and significance of biofertilizers in sustainable crop production; nevertheless, due to a number of obstacles, Asia has never seen the level of advancement in the technology of producing biofertilizers that is desired. It is acknowledged that biofertilizers are a crucial part of sustainable agriculture. The most effective way to combat unchecked soil degradation and the threatened viability of agriculture in India's tropical regions - especially those affected by dry, semiarid, and subhumid climates - is to stop the loss of soil organic matter.

## Materials and Methods

The field experiment was conducted at the Agricultural Research Farm, Department of Agronomy, R.B.S. College, Bichpuri, Agra (U.P.) during the winter (Rabi) season of 2019–20. With a pH of 7.89, organic carbon percentage of 0.37, accessible nitrogen of 172.65 kg ha$^{-1}$, $P_2O_5$ of 25.20 kg ha$^{-1}$, and potash of 215.80 kg ha$^{-1}$, the soil had a sandy loam texture. With 12 treatments, the experiment was set up using a "split plot design." Nitrogen levels (60, 90, 120, and 150 kg ha$^{-1}$) in the main plot and bio-fertilizers (Control, *Azotobacter*, and *Azospirillum*) in four-replication subplots. One-third of the nitrogen as per treatment through urea and the remaining portion were administered at sowing time, together with the full dosages of phosphorus (60 kg $P_2O_5$ ha$^{-1}$) and potash (40 kg $K_2O$ ha$^{-1}$) through DAP and MOP, respectively, as basal doses. Following the first and second irrigations, a top dressing of urea was used to apply two split doses of the third nitrogen.

## Results and Discussion

### Yield attributes

In case of wheat the main yield contributing characters are length of spike, number of spikelets spike-1 number of grains spike-1, grain weight spike-1 and 1000 grain weight. The variations in these yield attributes due to treatment effect were measured and results so obtained were subjected to statistical analyses. The data pertaining to the main effects of all yield attributes have been summarized in Table 1.

### Length of spike

Table 1 shows that nitrogen application levels had a significant impact on spike length; however, spike length increased with increasing levels of nitrogen application up to 150 kg N ha$^{-1}$. Maximum spike length (9.11 cm), which was comparable to 120 kg N ha$^{-1}$, was substantially greater than that of 60 and 90 kg N ha$^{-1}$, but minimum spike length (8.51 cm) was obtained at 60 kg N ha$^{-1}$. The effect of bio-fertilizers clearly shown that the duration of the spike changed greatly as a result of different bio-fertilizers. The longest spike length was reported with *Azospirillum* (B2), which was 3.58 percent longer than the Control Bio- Fertilizers (B0). However, the variation in length of spike with *Azotobacter* (B1) and *Azospirillum* (B2) bio-fertilizers was marginal and could not cross the level of significance.

### Number of spikelets spike$^{-1}$

The data summarized in Table 1 revealed that the level of nitrogen had significant effect on number of spikes plant$^{-1}$. Application of 150 Kg N ha$^{-1}$ resulted significantly higher number of spikes plant$^{-1}$ over all other levels of nitrogen tested in the experiment. The lowest numbers of spikes plant$^{-1}$ were noticed with the application of 60 Kg N ha$^{-1}$ ($N_1$). The magnitude of increase in number of spikes plant$^{-1}$ with the application of 150 Kg N ha$^{-1}$ was to the tune of 13.26, 10.07 and 6.19 per cent over $N_1$, $N_2$ and $N_3$, respectively. Effect of bio-fertilizers indicate that the variations in number of spikelets spike$^{-1}$ of wheat were significantly affected due to bio-fertilizers. Wheat crop sown on *Azotobacter* ($B_1$) and *Azospirillum* ($B_2$) bio-fertilizers were statistically at par with respect to number of spikelets spike$^{-1}$ but had significantly higher number of spikelets spike$^{-1}$ by 2.59 and 3.68 per cent than that of bio-fertilizers of Control ($B_0$), respectively.

**Table 1:** Yield attributes of wheat as influenced by nitrogen levels and Bio- Fertilizers

| Treatments | | Spike Length (cm) | No. of spikelets spike$^{-1}$ | No. of grains spike$^{-1}$ | Grains weight spike$^{-1}$ (g) | 1000 grain weight (g) |
|---|---|---|---|---|---|---|
| **Nutrient levels** | | | | | | |
| 60 | $N_1$ | 8.51 | 15.15 | 41.71 | 1.90 | 39.40 |
| 90 | $N_2$ | 8.60 | 16.25 | 43.42 | 2.00 | 41.53 |
| 120 | $N_3$ | 9.11 | 17.20 | 45.23 | 2.10 | 42.82 |
| 150 | $N_4$ | 9.91 | 19.67 | 47.68 | 2.14 | 43.86 |
| SEm ± | | 0.15 | 0.41 | 0.92 | 0.04 | 0.13 |
| CD at 5% | | 0.51 | 1.17 | 2.81 | 0.09 | 0.33 |
| **Bio- Fertilizers** | | | | | | |
| Control | $B_0$ | 8.66 | 15.57 | 47.75 | 1.94 | 38.78 |
| *Azotobacter* | $B_1$ | 8.91 | 16.11 | 49.41 | 2.02 | 41.72 |
| *Azospirillum* | $B_2$ | 8.97 | 17.27 | 51.45 | 2.10 | 42.80 |
| SEm ± | | 0.19 | 0.20 | 1.12 | 0.03 | 0.13 |
| CD at 5% | | 0.55 | 0.71 | 3.21 | 0.09 | 0.37 |

### Number of grains spike$^{-1}$

Table 1 clearly shows that varied nitrogen levels had a substantial influence on the number of grains spike$^{-1}$. The number of grains spike$^{-1}$ grew noticeably with every increase in nitrogen application level up to 150 kg N ha$^{-1}$. A further rise in nitrogen level raised the number of grains spike$^{-1}$ somewhat, but not significantly. The percentage increase in the number of grains spike$^{-1}$ with 120 kg N ha$^{-1}$ was 10.21. It was discovered that differences in the number of grains spike$^{-1}$ owing to varied row spacing were substantial when using bio-fertilizers. Every increase in bio-fertilizers greatly increases the number of grains spike$^{-1}$. However, *Azospirillum* ($B_2$) had the most grains spike$^{-1}$ compared to Control ($B_0$) and *Azotobacter* ($B_0$), with a difference of 7.75 and 4.13 percent, respectively.

### Grain weight spike$^{-1}$

Based on the analysis of Table 1, it can be observed that applying 150 kg N ha$^{-1}$ resulted in grain weight spike$^{-1}$ that was

6.13 and 4.0 percent greater than applying 90 and 120 kg N ha$^{-1}$, respectively. Grain weight spike$^{-1}$ rose somewhat when nitrogen levels were raised from 60 to 120 kg N ha$^{-1}$, but the difference was not significant enough to be considered significant. The effects of several biofertilizers show that spike$^{-1}$ in grain weight changes dramatically. While there was little difference in the grain weight spike$^{-1}$ between *Azotobacter* ($B_1$) and *Azospirillum* ($B_2$) biofertilizers, the grain weight spike$^{-1}$ for both biofertilizers was substantially greater than that of *Azotobacter* ($B_1$), by 8.25 and 4.12 percent, respectively.

**1000-Grains weight**

The results presented in Table-1 showed that the weight of 1000 grains was significantly impacted by nitrogen levels. With each increment in the nitrogen application dose, the weight of the 1000 grains grew noticeably. The experiment's results showed that the application of 150 kg N ha$^{-1}$ produced a much greater 1000 grain weight than any of the other nitrogen levels studied. Applying 60 kg of N ha$^{-1}$ ($N_1$) resulted in the lowest grain weight of 1000. The weight of 1000 grains increased by 3.53 and 0.78 percent, respectively, at the 150 kg N ha$^{-1}$ ($N_4$) level compared to the 90 kg N ha$^{-1}$ ($N_2$) and 120 kg N ha$^{-1}$ ($N_3$) levels. The results demonstrated that the weight of 1000 grains was significantly impacted by several biofertilizers. Although there was no difference between the two biofertilizers, $B_2$ (*Azospirillum*) and $B_1$ (*Azotobacter*), they both reported considerably greater 1000-grain weights than $S_1$ (16.0 cm), by 2.44 and 2.25 percent, respectively.

**Yield (q ha$^{-1}$)**

**Biological yield (q ha$^{-1}$)**

When nitrogen was applied at higher levels up to 150 kg N ha$^{-1}$ the biological yield (q ha$^{-1}$) increased significantly. Compared to 90 and 120 kg N ha$^{-1}$, respectively, there was a significant increase in total biological yield of 23.62 and 18.19 percent with 150 kg N ha$^{-1}$. The impact of biofertilizers shows that they had a considerable influence on biological yield (q ha$^{-1}$). The highest biological yield (149.21q ha$^{-1}$) obtained by *Azospirillum* ($B_2$) biofertilizers was much greater than that of Control ($B_0$) and *Azotobacter* ($B_2$) biofertilizers by 17.29 and 14.44 percent, respectively. *Azotobacter* biofertilizers also produced a 2.49 percent increase in biological yield ha$^{-1}$ above Control ($B_0$).

**Table 2:** Biological, Grain and Straw yields of wheat and harvest index as influenced by nitrogen levels and Bio- Fertilizers

| Treatments | | Biological yield (q ha$^{-1}$) | Grain yield (q ha$^{-1}$) | Straw yield (q ha$^{-1}$) | Harvest index (%) |
|---|---|---|---|---|---|
| **Nutrient levels** | | | | | |
| 60 | $N_1$ | 106.31 | 35.37 | 70.94 | 33.27 |
| 90 | $N_2$ | 118.84 | 42.21 | 76.63 | 35.51 |
| 120 | $N_3$ | 130.77 | 49.65 | 81.12 | 37.96 |
| 150 | $N_4$ | 142.29 | 54.24 | 88.05 | 38.11 |
| SEm ± | | 0.71 | 0.81 | 0.39 | 0.71 |
| CD at 5% | | 1.31 | 2.67 | 1.31 | 2.11 |
| **Bio- Fertilizers** | | | | | |
| Control | $B_0$ | 127.21 | 40.30 | 79.68 | 31.67 |
| *Azotobacter* | $B_1$ | 137.38 | 49.62 | 85.76 | 36.11 |
| *Azospirillum* | $B_2$ | 149.21 | 55.18 | 94.03 | 36.98 |
| SEm ± | | 1.02 | 0.94 | 0.45 | 0.84 |
| CD at 5% | | 1.89 | 2.68 | 1.29 | 2.40 |

**Grain yield (qha$^{-1}$)**

The information compiled in Table 2 showed that grain production was significantly impacted by the amount of nitrogen present. Grain yield was substantially greater when 150 kg N ha$^{-1}$ was applied than when any other nitrogen quantity was examined during the experiment. When 60 kg N ha$^{-1}$ ($N_1$) was applied, the lowest grain production was observed. When 150 kg of N ha$^{-1}$ was applied, grain yield increased by 19.26, 11.07, and 9.19 percent relative to N1, $N_2$, and $N_3$, respectively. The yield of grains was significantly impacted by the use of biofertilizers. The wheat crop that was grown at the of *Azospirillum* ($B_2$) had the maximum grain yield. The bio-fertilizers of *Azospirillum* resulted in a significant increase in grain production compared to Control ($B_0$) and *Azotobacter* ($B_2$), measuring 16.10 and 6.90 percent, respectively.

**Straw yield (qha$^{-1}$)**

A review of the data indicated that nitrogen levels had a substantial influence on straw output. The table also showed that applying 150 kg N ha$^{-1}$ (N4) generated the most straw and that this amount of nitrogen was much superior to other levels of nitrogen. The increase in straw production with 150 kg N ha$^{-1}$ over 60, 90, and 120 kg N ha$^{-1}$ was 36.81, 29.61, and 23.63 percent, respectively. The effect of bio-fertilizers on straw yield was substantial. Maximum straw yield was recorded when wheat crop was grown at *Azospirillum* ($B_2$) bio-fertilizers, which was 18.01 and 19.39% greater than Control and *Azotobacter* Bio-Fertilizers, respectively.

**Harvest index (%)**

On the harvest index, varying nitrogen application amounts had a major impact with 150 kg N ha$^{-1}$ ($N_4$), the maximum harvest index was observed, much higher than 90 kg N ha$^{-1}$ ($N_2$) and 120 kg N ha$^{-1}$ ($N_3$) amounts of nitrogen. The harvest index was dramatically impacted by the use of biofertilizers. On the other hand, compared to the statistically equivalent Bio- Fertilizers of Control ($B_0$) and *Azospirillum* ($B_2$), the crop cultivated at *Azotobacter* Bio- Fertilizers ($B_1$) had a significantly higher harvest index.

In summary

**Conclusion**

According to the experimental results, applying 150 kg N ha$^{-1}$ of wheat nitrogen ($N_4$) resulted in a considerably greater grain production (54.24 q ha$^{-1}$), followed by N3, N2, and $N_1$. Compared to other biofertilizer and nitrogen levels, a combination of 150 kg N ha$^{-1}$ ($N_4$) and *Azospirillum* ($B_2$) may be used to meet the requirement for grain production.

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