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Applications of Chemical and Biofertilizers on Yield, and Wheat (*Triticum Aestivum* L.) Quality

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Abstract. *To reduce using conventional fertilizer and enhance wheat cultivation sustainability while recorded high production and quality. The study investigated the applications of integrated traditional and biofertilizers on yield and bread wheat grain quality. Eco-friendly biofertilizers are an essential component of agriculture sustainability and a promising alternative to conventional nitrogen fertilizers. Impacts of four fertilizer treatments consisted of, i.e., T1 Control recommended 75 kg Nitrogen/fed, T2 50 kg Nitrogen /fed + 10 kg/fed blue-green algae, T3 Azotobacter 10 kg/fed + 50 kg Nitrogen /fed and T4 50 kg N/fed + 10 kg blue-green algae + 10 kg Azotobacter. Randomized Complete Block Design (RCBD) was used with three replications and observed that T4 recorded the early days to 50% heading and early days to maturity compared to T1 Control recommended 75 kg N/fed. Plant height and flag leaf area recorded significant increase values under T4. Number of grains per spike, number of spike/square meter, spike length, 1000-grain weight, and grain yield recorded increases under 450 kg N/fed + 10 Kg blue-green algae + 10 Kg Azotobacter. Crude protein enhanced under plants received 50 Kg N/fed + 10 Kg blue-green algae + 10 Kg Azotobacter in comparison to the control. In conclusion, for sustainable wheat cultivation, the integrated application of biofertilizers and conventional significantly increases wheat yield and enhances grain quality under experimental conditions. Thus, the use of biofertilizer led to a significant increase in soil fertility, yield, and wheat grain quality.*

Keywords: Wheat, Nitrogen, Blue Green Algae, Azotobacter, Yield And Quality.

INTRODUCTION

Wheat (Triticum aestivum L.) is most principal and significant cereal crop worldwide accounts 33.5% of total world grain productions and the straw of wheat is the main source of forage. [1] noticed that increasing production of wheat by raising land productivity area units and area cultivated for closing the production-consumption gap. The most widely cultivated staple cereal crop for guaranteeing the food security of the world's expanding population is bread wheat. Wheat supplies 19 percentage calories of dietary and proteins supply 25 percentage along worldwide promote health diets with a wealth of additional nutrients [2].

Given global population is expected to grow about 10 billion people by 2050 and steadily decline the farmland, so there is a need to boost food production. Though, recently indicated trends progress toward wheat high-yielding may fall short of meeting the demand impending [3]. Enhancing the genetic potential of wheat productivity remains the primary objective for all wheat breeding programs. Chemical fertilizers diminished soil fertility, making it unsuitable for cultivating cultivated plants. [4] reported that nitrogen fertilizer. Nitrogen is a necessary nutrient for proper growth wheat and high yield. Nitrogen fertilizer losses are higher in arid environments, which has a negative impact on wheat growth in these areas. Because of the high expense of chemical fertilizers, biofertilizers is the most important and had important role in sustainability and productivity of management health of soil in terms of solubilizing nutrients and stimulating growth wheat crop. Use of biofertilizer in protect agriculture the environment as eco-friendly and economical for farmers [5]. [6] noticed using biofertilizers could enhance environmental restoration by enabling agriculture. [7] recommended that grain quality be improved by combining nitrogen and biofertilizers, which will conserve the environment without having any detrimental effects. However, there is limited information available and further research is necessary. Biofertilizers inoculation is limit and reduces the need of mineral fertilizers and promotes a useful tool for soil development in less contaminated areas, lowering agricultural expenses, and increasing crop output by giving them access to readily available nutrients and compounds that promote growth [8]. By producing and boost growth hormones such indole acetic acid and such auxins, gibberellins, plus cytokinin, Azotobacter inoculation helps to improve agricultural yield by promoting root growth and nutrient adsorption. Whereas, Azotobacter applied alone was effective in promoting the physiological parameters. [9] 50% mineral nitrogen + biofertilizer with azotobacter also resulted in higher values of physiological parameters traits comparing with (100% nitrogen and uninoculated), but the differences among the two treatments almost did not attain the differences statistically. Because of its numerous metabolic processes, free-living, conventional nitrogen-fixing bacteria diazotrophic azotobacter is crucial to the cycle of nitrogen [10]. Vitamins like thiamine and riboflavin can be produced by Azotobacter. Blue green algae (Cyanobacteria) play an important role in nourishing the soil with nitrogen and substances growth-promoting auxins, IAA, and GA3, which accelerate plant growth. By making the soil more fertile, cyanobacteria can boost crop yields and development contribute an eco-friendly agro-ecosystem that guarantees economic viability. Inoculating wheat seed with several types of biofertilizer has been shown to increase crop yields [11]. In smart agricultural the improved wheat varieties and grain quality is the key to agricultural progress. So, scientists are working to increase wheat yield under various situations while paying less attention to its quality attributes. However, the quality of wheat grains impact on the quality of bread. Grain yield significantly increased because of the increase in number of spikes per unit area. Seed quality is important as yield and the quality of wheat is a genetic factor. Wheat seed quality associate germination, protein content, and thousands of grain weight. Therefore, this work aimed to investigate the response of wheat crop under mineral and biofertilizers as azotobacter, and cyanobacteria - blue-green algae in respect to, yield, and enhance wheat seed quality.

MATERIALS AND METHODS

Experimental work was conducted at Education College for Pure Sciences laboratories Agricultural Research Station, identified among 30° 58′ 56″ N Latitude and 30° 57′ 8″ E Longitude during 2022/2023 seasons of growing to study effects of conventional fertilizer and biofertilization on wheat grain yield and quality seed of wheat crop in clay soil. Statistical design was a RCBD, in three replicates. The area of plot was 8.4 m2 i.e. 2.4 in width and 3.5 m2 in length. Samples of soil were collected at the depth of (0-30 cm) in all plots. Samples were allowed to dry under shade, then ground and sieved to pass through a sieve 2 mm. Soil samples were analyzed for some chemical properties according to [12] noticed in Table 1. Grains planted on mid-November with 50 kg fed-1 seeding. Experiment included four fertilizer treatments, i.e.

T1 Control recommended nitrogen 75 Kg N/fed
T2 50 Kg N / fed + 10 Kg /fed blue-green algae
T3 50 Kg N /fed+ 10 Kg fed azotobacter
T4 50 Kg N/fed + 10 Kg blue-green algae + 10 Kg azotobacter

Table 1. Physical and conventional properties of the soils experimental in 2022/2023

Characters.	**Values.**
Soil depth	0-30 cm
Soil type	Clay
Size particle distribution %	
Sand (coarse).	8.90
Fine sand	15.33
Silt.	27.86
Clay.	47.91
PH Potential of Hydrogen	8.13
Electrical Conductivity; EC. Ds/cm	0.91
NPK available. mg/kg	
Nitrogen Available. mg/kg	34.05
Phosphorus Available. mg/kg	2.75
Available Potassium. mg/kg	315.71
Organic Matter	1.35
SAR. Sodium Adsorption Ratio.	3.28

OM=organic matter, C. sand= corease sand, F. sand= fine sand SAR based on the US Salinity Lab.

The biofertilizer was distributed to the experimental plots before Al-Mohayah irrigating. Nitrogen in the form of urea was added, while phosphate fertilizer at the rate of 100 kg calcium superphosphate fed-1. (15.5 kg P2O5) was applied during preparation of seedbed.

Maize was preceding crop. Recommended and normal agronomic practices of wheat were followed until harvest. NPK in the experiment were Nitrogen, superphosphate, and potassium sulfate. Two doses of nitrogen fertilizer were added (20 days firstly and 50 days from sowing). Wheat plants were harvested on May and the grains were separated from straw and weighed.

1. Days to heading: were recorded from the sowing date to 50 % of days which plant showing full ear-head emergence.
2. Days to maturity: were recorded from sowing date to the maturity of physiological phase.
3. (FLA) Flag leaf area (Cm2) was recorded by multiplying flag leaf length and flag leaf width times 0.75 (FLL × FLW × 0.75) [13] and [14].
4. (PH) Plant height. (cm) was recorded after physiological stage from distance base to the top of the spike [15].
5. Spikes No/m-2 was measured as numbers of tillers in fertile counting spikes per meter.
6. Grain No / spike it was recorded as grains number per spike collected.
7. Thousands grain weight (g) random 1000 grains sample, handly counted and weighted.
8. (GY) Grain yield Plants in square meter harvested and threshed at 14% moisture the grain yield was weight and the average were taken [15].
9. Crude protein content the grains from each treatment were dried at 105 oC and grinned into a fine powder, estimated regarding to the improved Kjeldahl method (N×5.70) [16].
10. Chlorophyll and carotenoids were estimated by adopting the method of [17]. Basically, fresh leaves 0.5 g mashed in a pestle and mortar with 10 cm3 of acetone 85% and some transparent sand, then 3000 r. p. m. centrifuged. Evacuated supernatant was to a 50 cm3 conical via filter paper, and filled the flasc was with 85% to 50 milliliters. After that calculated the pigment concentrations by µg/ml:
    Chlorophyll a = 10.3 E. 663 - 0.918 E. 644.
    Chlorophyll b = 19.7 E. 644 - 3.87 E. 663.
11. Carotenoids = 4.2 E. 542.5 – (0.0264 Chlorophyll a + 0.4260 Chlorophyll b)
12. (DH) Dehydrogenase activities were set according to [18].
13. Statistical analysis
    RCBD in 3 replicates of statistical ANOVA among means of difference as described by [19]. Among treatment means were compared using (LSD) at a 5% of probability [20].

RESULTS AND DISCUSSIONS

A. Results

Data presented in Table 2 elucidated that T4: 50 Kg N/fed + 10 Kg blue-green algae + 10 Kg azotobacter recorded early heading (98 days), early days to maturity (143.7 days), increased flag leaf area (43 cm2) to different treats.

Table 2. Nitrogen mineral and biofertilizer, impacts on days to heading, days to maturity, area of flag leaf and plant heights during 2022/2023 season.

Biofertilizer	Days to 50% heading	Days to maturity	Flag leaf area (cm2)	Plant height
	2022/2023	2022/2023	2022/2023	2022/2023
T1	102.0A	153.3A	37.0D	110.0A
T2	98.7B	148.0B	38.7C	103.0B
T3	97.3B	145.7BC	40.3B	104.0B
T4	98.3B	143.7C	43.0A	108.0A
F. test	**	**		**
LSD at 0.05	2.21	3.194	1.597	2.514

T1 Control recommended N 75 Kg N/fed, T2 50 Kg N / fed + 10 Kg /fed blue-green algae, T3 50 Kg N /fed+ 10 Kg fed Azotobacter, and T4 50 Kg N/fed + 10 Kg blue-green algae + 10 Kg Azotobacter

Table 3 showed the impact of integrated biofertilizers and conventional fertilizers (chemical) on wheat yield attributes regarding number of grains per spike, number of spikes per square meter spike length, thousands grain weight and grain yield. Results indicated significant increase in mentioned characteristics when using T4 50 Kg N/fed + 10 Kg blue-green algae + 10 Kg Azotobacter followed by T3 50 Kg N /fed+ 10 Kg fed Azotobacter.

Table 3. Nitrogen synthetic and biofertilizer, impacts on grains number/spike, spike number/m2, spike length, 1000 grain weight and yield during 2022/2023 season.

	grains number/ spike	spike number/m2	Spike length	1000-Grain weight	Grain yield, Kg/ fed
Biofertilizer	2022/2023	2022/2023	2022/2023	2022/2023	2022/2023
T1	59.0AB	306.3D	12.3B	40.7D	3088.3C
T2	51.7C	330.3C	12.6AB	42.6C	3054.2C
T3	54.7BC	342.7B	12.8A	44.5B	3501.1B
T4	60.3A	368.0A	12.9A	46.3A	4318.2A
F. test	**	**	*	**	**
LSD at 0.05	5.1154	5.4613	0.4380	1.64	313.9

Fed=4200m2. T1 Control recommended N 75 Kg N/fed, T2 50 Kg N / fed + 10 Kg /fed blue-green algae, T3 50 Kg N /fed+ 10 Kg fed Azotobacter, and T4 50 Kg N/fed + 10 Kg blue-green algae + 10 Kg Azotobacter

As shown in Table 4 the protein quality enhanced under T4 50 Kg N/fed + 10 Kg blue-green algae + 10 Kg Azotobacter followed by T3 50 Kg N /fed+ 10 Kg fed Azotobacter, in comparing to control T1. On the other hand, high chlorophyll and carotenoid showed boost and improvement when plants receiving the integrated chemical and biofertilizers at T4 50 Kg N/fed + 10 Kg blue-green algae + 10 Kg Azotobacter.

Table 4. Effect of chemical nitrogen and biofertilizer, on protein percentage, chlorophyll a, chlorophyll b, and carotenoid in 2022/2023 season.

	Protein (%)	Chl. a mg/g fw.	Chl. b mg/g fw.	Carotenoid mg/g fw.
Biofertilizer	2022/2023	2022/2023	2022/2023	2022/2023
T1	12.923B	1.77C	1.450C	0.633B
T2	13.030B	1.78BC	1.510B	0.850A
T3	13.133B	1.83B	1.547B	0.873A
T4	14.200A	1.95A	1.597A	0.910A
F test	**	**	**	**
LSD at 0.05	0.304	0.050	0.044	0.077

T1 Control recommended N 75 Kg N/fed, T2 50 Kg N / fed + 10 Kg /fed blue-green algae, T3 50 Kg N /fed+ 10 Kg fed Azotobacter, and T4 50 Kg N/fed + 10 Kg blue-green algae + 10 Kg Azotobacter

Data collected in Table 5 showed highly significant differences regarding soil biological activity through dehydrogenase activity. The Dehydrogenase activity significantly increased over the control in each tested treatment. In additions, 103. mg µgTPFg-1 dry soil recorded highest due to plants received T4 50 Kg N/fed + 10 Kg blue-green algae + 10 Kg Azotobacter.

Table 5. Dehydrogenase activity as affected by integrated fertilizers

Biofertilizer treatments	Dehydrogenase activity µgTPFg-1 dry soil
T1	18.70 D
T2	81.67 C
T3	94.00 B
T4	103.00 A
F test	**
LSD at 0.05	1.7768

T1 Control recommended N 75 Kg N/fed, T2 50 Kg N / fed + 10 Kg /fed blue-green algae, T3 50 Kg N /fed+ 10 Kg fed Azotobacter, and T4 50 Kg N/fed + 10 Kg blue-green algae + 10 Kg Azotobacter

B. Discussions

Biofertilizers are a cultivation technique to crop productivity enhancement by promoting nutrition and growth in wheat cultivation [21]. Before stem elongation, azotobacter and blue green algae were effectively utilized in the open field. The current work used biofertilizers as seed inoculants, which is less expensive than canopy spraying, to investigate their potential agronomic effects. Using this application strategy, occupy the root surface and intercellularly the interior plant tissues of plant organs, and enhance the plant roots beginning with the first rootlet of the sprouting seeds, therefore contributing to improve plant nutrition and growth [22]. The biofertilizers and inoculants azotobacter and cyanobacteria (blue green algae) increased wheat yield attributes and yield, soil boost nutrient balance. In addition, increase activity of microbial in rhizosphere and less pollution [23]. [24] noticed to using cyanobacteria could enhanced biological activity in clay loamy soil. The biological activity of the soil was positively enhanced by dual inoculation with both cyanobacteria and azotobacter paired with half nitrogen dose only, notably at the second stage [25] hence, this treatment resulted in dehydrogenase activity and soil microbial improvement. [26] proved that dual inoculation with azotobacter and cyanobacteria combined with a 1/4 nitrogen dose increased significantly the soil's biological activity and increased yield of wheat, improve soil nutrient balance. Results showed that inoculation of wheat seed by integrated azotobacter with N mineral 25 Kg or blue green algae with 50 kg per fed increment the yield and its attributes and enhanced the wheat seed quality. Application of biofertilizer integrated with chemicals recorded the tallest plants. Also, recorded, the highest grains number of spikes. This finding agreed with [27]. [5] indicated that the biofertilizers could reduce chemical fertilizers, and risks of environmental, in additions, enhance soil fertility, and promote agriculture. Biofertilizers alone or in combination with mineral fertilizers were positive, the biofertilizer increased yield and yield components of wheat. It is important to note here the response of crop yield and its related characters to the application of biofertilizer and mineral nitrogen may be attributed to the increase of the nutrient availability in the soil solution. In addition, blue green algae might improve the soil in terms of chemical and physical features. Furthermore, cyanobacteria beneficial and effective as soil amendment and it increased its organic matter and reduced environmental pollution. These results agreed with the findings of [28] and [27]. Growth increases resulted to applied microbes and solubilizing activity of nutrients, as well as the generation of growth-promoting compounds like IAA (indole-3-acetic acid). (PGPR) Plant Growth Promoting Rhizobacteria can affect plant senescence by producing the enzyme ACC-deaminase; 1-aminocyclopropane-1-carboxylate and toxins such as rhizobitoxine, which inhibit ethylene synthesis [29]. [30] showed that the differences in plant responses can be related to the microbial makeup of the biofertilizers, as triple N primarily growth stimulated of roots, whereas Rhizosum N and P.K boosted the uptake of low-mobile nutrients such as Ca, K, and Zn, largely through improved growth. Boosted the protein quality with all of the biofertilizers tested could be attributed to fixation of nitrogen and nutrient-solubilizing contribution of the microorganisms used, to changes in the bacterium groups during grain feeding.

CONCLUSIONS

According to the results of this investigation. It can be concluded that the application of nitrogen with either blue green algae or azotobacter had a significant effect on wheat yield, as well as seed quality, chlorophyll a, chlorophyll b, and carotenoid. Hence, it is imperative to popularize the use of biofertilizers in combination with nitrogen fertilizers, to maintain high grain yield and reducing environmental pollution and the costs of production. It is highly suggested for future studies to use nano-biofertilizers (NBFs), which are an emerging branch in agricultural science and represent a viable route for sustainable farming.

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