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Effect of Biofertilizers as a Partial Substitute for Mineral Fertilizers on Growth, Yield and Quality of Some Bread Wheat Varieties

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ABSTRACT

Recently, productivity of wheat is has been compromised due to low soil fertility despite the excessive use of mineral fertilizers. So, natural resources must be managed well by sustainable agriculture. Biofertilizers are a valuable alternative approach due to their potential for reducing mineral fertilizers and increasing yield. Two field experiments were conducted at Sids Agricultural Research Station, Beni-Suef Governorate, during 2021/2022 and 2022/2023, to study the effect of biofertilizers application with NPK at 25, 50, 75 and 100% of the recommended dose on growth, productivity and quality of three bread wheat varieties. (i.e., Sids 14, Sakha 95 and Misr 3). The results revealed significant differences among varieties, fertilization treatments, individual or combined, and their interactions for yield-contributing characteristics. Sids 14 variety recorded the highest values of number of tillers/plant, yield and its components and chemical properties. The treatment of 75% NPK+Bio. achieved the highest values in all traits studied except plant height. The interaction of Sids 14 variety with 75% NPK+Bio. showed the highest values of number of tillers/plant, yield and its components and chemical characters. From these results it could be economically recommend application biofertilizers along with 75% from recommended quantity of NPK on Sids 14 variety to achieve the maximum productivity of crop wheat..

KEYWORDS: Wheat, varieties, biofertilizers, NPK, growth, yield and chemical analysis.

1. INTRODUCTION

Bread wheat (*Triticum aestivum* L.) is a major cereal crop in Egypt. Its grains supply about 70% of calories and 80% of the protein in the human diet (Abd El-Samie et al. 2018 and Taha et al., 2016). In 2023, cultivated area in Egypt was 3.3 million feddan, produced 9.7 million tons (FAO, 2024). This amount covers less than 55% of the local consumer demand, a deficit estimated at 45% of wheat grains (Saad et al., 2022). The main objective of the Egyptian Government is to reduce the gap between production and consumption by increasing the productivity and quality of wheat varieties using appropriate biofertilizers which considered one of the main driving factors, supplemented with minerals fertilizers (Muslim et al., 2024).

Wheat growers select varieties depending on their production capacity, maturity, grains hardiness, straw strength, spike length, plant height, lodging resistance, grains size and weight, bread quality and other improved properties to be taken into consideration. They also pay special attention to new promising varieties, characterized by early maturing and high yielding ability. Choosing a wheat variety at the right time best ensures that optimal flowering and consequently, maximum yield (Saad et al., 2022).

Mineral fertilizers are foremost nutrient required for crop plants, especially the three most critical macro nutrients for biological development and growth are nitrogen (N), phosphate (P) and potassium (K). N is required for chlorophyll, amino acids and nucleic acids and the energy transfer molecule (Werner and Newton, 2005). P is essential in photosynthesis, signal transduction, chemical production and respiration (Raghothama, 2015). K is a vital cation for several core metabolic processes such as photosynthesis and the production of proteins (Macik et al. 2020). Despite this, the use excessive for mineral fertilizers may results in environmental damage, such as air pollution, climate change and nutrient enrichment. Therefore, NPK use efficiency should be evaluated in order to maximize the benefit of this fertilizers for maximizing productivity and minimizing environmental pollution (Saad et al., 2022).

Curiously, biofertilizers mitigate the environmental pollution and improve the effectiveness of NPK, which has positive effects on healthy plants soil and enhancing it sustainability. As a result, bio fertilizers (i.e., fertilizers derived from microorganisms) are regarded as essential for long-term agricultural sustainability. Plant growth can be encouraged by using biofertilizers, that increase plants availability and acquisition of nutrients. biofertilizers are non-hazardous inputs, thereby conserving chemicals and protecting soil health and crop quality. Productivity can be enhanced by the application of biofertilizers, a novel tool for agricultural development that is sustainable (Muslim et al., 2024).

Therefore, this study aims to that use of biofertilizers along with different rates of NPK in sole and combined application treatments of some bread wheat varieties., to improve the growth and grain yield and its long term impact on wheat crop under conditions of Middle Egypt.

2. MATERIAL AND METHODS

2.1.Experimental site and plant materials:

The present study was carried out at Sids Agricultural Research Station, Beni-Suef Governorate, Middle Egypt, during the two successive growing seasons 2021/2022 and 2022/2023 to study the effect of bio and mineral fertilizers on growth, productivity and quality of some bread wheat varieties.

2.2.Applied treatments and experimental design:

The experimental material used in this study included as follow:

A) Three bread wheat varieties:

1) Sids 14.
2) Sakha 95.
3) Misr 3.

Grains of these varieties were provided through the Wheat Department, Field Crops Institute Research, Agriculture Research Center. Grains were sown on 5 December and 29 November in the first and second seasons, respectively with a rate, 50 kg/fed. and the preceding crop was maize (*Zea mays*, L.) in two growing seasons.

B) Five fertilization treatments:

1) 100% NPK.
2) Bio. alone.
3) 75% NPK+Bio.
4) 50% NPK+Bio.
5) 25% NPK+Bio.

The full dose of mineral fertilizers (100% NPK) added according to the recommendations of the Ministry of Agriculture and Land Reclamation [*i.e.,* 100 kg/fed. calcium superphosphate (15.5% P_2O_5), 175 kg/fed. urea (46% N) and 50 kg/fed. potassium sulfate (48% K_2O)]. Nitrogen fertilizer was added in 2 equal doses, directly before the first and the second irrigation while, phosphate fertilizer was added during soil preparation and potassium fertilizer was given before the second irrigation.

Grains spray with Arabic Gum solution (16%) as a sticking agent, after than grains inoculated with the tested powder of biofertilizer mixture(Biogen; nitrogen fixing

bacterium namely, *Azotobacter*), (Potasiomag; potassium dissolving bacterium namely, *Bacillus*) and (Phosphorein; facilitating phosphorus bacterium namely, *Pseudomonas*) and added at rate of ^00 g/fed. Inoculated grains were allowed to dry before sowing (Allen, 1971). While, at 60 days after sowing, Biohumein (multimicrobial biofertilizer; nitrogen, phosphate and potassium) was added sprayed next to the plants at a rate 10 l/fed.

The experiment was layed out in a split-plot design in randomized complete blocks with three replicates, where varieties were randomly distributed in the main plots while, fertilization treatments were randomly located in the split-plots. The size of each plot was 10.5 m2 (3.5 m long and 3.0 m wide). All the culture practices were applied as usually done in the ordinary wheat fields, except for the variables under study. The soil of the experimental site was analyzed in both seasons according to Klute (1986) and Page et al. (1982) and results were recorded in (Table 1).

2.3.Studied Parameters:

2.3.1. Determination of growth traits:

When plants were 120 days-old, wheat plants (n=10) were carefully removed from each experimental plot and dipped in a bucket of water. Plants were shaken gently to remove all adhering soil particles and plant height was measured in cm. using a meter scale. Number of tillers/plant was counted. The plants were weighted in g. using a digital balance to record their fresh weights and then placed in an oven at 70 °C for 48 h. The dried plants were weighed in g. using a digital balance to record their dry weights.

Table 1. Physical and chemical properties of soil samples obtained from the experimental location of Sids Agricultural Research Station.

Properties	Unit	Value
Physical analysis:		
Clay	%	82.5
Silt		15.0
Sand		2.5
Texture grade		Clay
Chemical analysis:		
pH	-	8.1
E.C$_e$	(ds/m)	2.26
N	mg/kg soil	83
P		9.74
K		449.5
Fe		0.642
Zn		0.040
Cu		0.152
Mn		0.266

2.3.2. Determination of yield and its components

At harvest, all yield components, i.e. spike length (cm), number of spikes/plant, 1000-grain weight (g) and grain yield (ton/fed.) were measured.

2.3.3. Determination of chemical properties:

The content of total protein in grains was assayed with the near infrared reflectance spectroscopy (NIRS) method using an Inframatic 9200 apparatus, A.O.A.C. (1995). To, assess the percentage of nitrogen (N), phosphorus (P) and potassium (K) in wheat leaves were dried and grounded to powdered form. N was determined according to (Hafez and Mikkelsen, 1981). P and K were assessed using a Perkin-Elmer Atomic Absorption and Flame Photometer (Paeg et al., 1982).

2.4.Statistical analysis:

The data obtained were subjected to statistical analysis according to the procedures

outlined by Snedecor and Cochran (1981). Means values of the studied characters were compared by L.S.D. test at 5% level of significance using GenStat program version (2019).

3. RESULTS AND DICSUSSION

3.1.Growth attributes:

Data presented in (Table 2) revealed significant differences among the studied varieties of number of tillers/plant. Meanwhile, there were no significant differences of plant height, fresh weight/plant and dry weight/plant in the two growth seasons. Sids 14 variety recorded the highest values of number of tillers/plant (10.07 and 10.37). However, Misr 3 variety recorded the highest values of plant height (113.01 and 108.93 cm), fresh weight/plant (9.85 and 10.09 g) and dry weight/plant (1.97 and 2.02 g) in the two studied seasons, respectively. The existed differences among varieties may be attributed to the differences in their genetical constitution and consequently its interaction with environmental prevailing conditions causing of changes in the relative performance for growth and development of varieties. The obtained results are in agreement with those of Seleiman and Abd El-Aal (2018), Abd El-Khalik et al. (2021), Sayed et al. (2021), Saad e al (2022) and Abd El-Lateef et al. (2023).

On the other hand, all growth studied characteristics were significantly affected by applying different treatments of bio and mineral fertilizers during the both growing seasons (Table 2). The treatment of 75% NPK+Bio. achieved the maximum averages of number of tillers/plant (11.25 and 11.55), fresh weight/plant (10.81 and 11.05 g) and dry weight/plant (2.16 and 2.21 g). Meanwhile, the maximum averages of plant height (126.39 and 122.39) were achieved by the treatment of 100% NPK in the first and second seasons, respectively.

Table 2. Main effects of wheat varieties and fertilization treatments on growth characters during 2021/2022 and 2022/2023 seasons.

Characters / Factors		Plant height (cm)	Number of tillers /plant	Fresh weight /plant (g)	Dry weight /plant (g)
2021/2022 Season					
Varieties (V)	**Sids 14**	109.67	10.07	9.69	1.94
	Sakha 95	107.50	9.54	9.48	1.90
	Misr 3	113.01	9.35	9.85	1.97
LSD $_{0.05}$ for V		10.61	0.50	1.19	0.27
Fertilization treatments (F)	**100% NPK**	126.39	9.97	10.79	9.24
	Bio. alone	83.06	8.97	8.07	1.61
	75% NPK + Bio.	122.78	11.25	10.81	2.16
	50% NPK + Bio.	115.28	9.55	9.70	1.94
	25% NPK + Bio.	102.50	8.54	9.00	1.80
LSD $_{0.05}$ for F		5.37	0.57	1.11	0.21
2022/2023 Season					
Varieties (V)	**Sids 14**	105.77	10.37	9.93	1.99
	Sakha 95	103.57	9.84	9.72	1.94
	Misr 3	108.93	9.65	10.09	2.02
LSD $_{0.05}$ for V		10.65	0.47	1.17	0.24
Fertilization treatments (F)	**100% NPK**	122.39	10.27	11.03	2.19
	Bio. alone	79.06	9.27	8.31	1.66
	75% NPK + Bio.	118.78	11.55	11.05	2.21
	50% NPK + Bio.	111.39	9.85	9.94	1.99
	25% NPK + Bio.	98.83	8.84	9.24	1.85
LSD $_{0.05}$ for F		5.38	0.51	1.11	0.22

These results in may be due to the biofertilizers positive role in increasing NPK use efficiency and reducing its application doses and enhances buds activity, improves the efficiency of roots to absorb water and nutrients, achieved good vegetative growth of wheat plants and increase in dry matter in leaves, which is reflected positively in increase growth attributes in wheat plants. Similar results were obtained by Taha et al. (2016) and Saad et al. (2022). In order, El-Khateeb and Metwaly (2019) found that biofertilizers mixed with 100 % nitrogen produced taller plants than biofertilizers mixed with 50 % nitrogen or used alone. However Gautam et al. (2024) found that using biofertilizers with 50% NPK resulted in higher plant heights than using the stipulated NPK.

Respecting, the interaction between the two factors tested for plant height, number of tillers/plant, fresh weight/plant and dry weight/plant, data obtained in the two seasons are presented in (Table 3). The illustrated finding indicates that the two variables in the study, significantly affected on all growth traits by interaction in combination of wheat varieties with fertilization treatments. The interaction of Sids 14 variety with 75% NPK+Bio. recorded the highest values of number of tillers/plant (11.64 and 11.94). On the other hand, the highest values of fresh weight/plant (11.03 and 11.27 g) and dry weight/plant (2.21 and 2.25 g) were recorded by the interaction of Misr 3 variety with 75% NPK+Bio., and the highest values of plant height (128.33 and 124.33 cm) were recorded the interaction of Misr 3 variety with 100% NPK in the two seasons, respectively. This finding are conceded with those obtained by Mahdi (2015), Seleiman et al. (2021) and Saad et al. (2022).

3.2.Yield and its components:

Results in Table (4) declared that the differences among the tested varieties were significant in all yield characteristics under study in both seasons. Sids 14 variety was superior than Sakha 95 and Misr 3 varieties for yield and its components in the first and second seasons. The mean values for Sids 14 variety in respect to number of spikes/plant, spike length, 1000 grain weight and grain yield/fed. were 9.34, 10.20 g, 51.21 g and 3.64 ton in the first season, respectively. The corresponding values in the second season were 9.64, 10.50 g, 54.00 g and 4.12 ton. The probable reason for this differences significant in yield and its components might be varieties have different yield potential due to genetic make-up difference and its adaptability with environment condition. These results agreed with those obtained by Mahdi (2015), Abd El-Hadi et al. (2018), Abd El-Khalik et al. (2021), Sayed et al. (2021) Seleiman et al (2021), Saad e al (2022) andAbd El-Lateef et al. (2023).

In connection with, the effect of fertilization treatments on yield and its components, data collected in the two seasons are recorded in Table (4). This effect was significantly on all yield traits studied during the two seasons. Means comparison of yield and its components indicated that the treatment of 75% NPK+Bio. recorded the highest mean values for number of spikes/plant (10.52 and 10.82), spike length (11.38 and 11.68 cm), 1000 grain weight (49.57 and 52.40 g) and grain yield/fed. (3.66 and 4.09 ton) in the respective studying seasons. This trend of significant values of yield and its components may be attributed to that the use of 75% NPK was enough for the supply of plant requirement and grain fullness with application of biofertilizers which are considered as the most important alternative to the conventional fertilizers, due to their increase in potential roles of crop production, reducing the use of chemical fertilizers and mitigating the adverse impacts of the soil. Similar results were obtained by Muslim et al. (2024). In respect, Taha et al. (2016) discovered that when biofertilizers was applied at 75% NPK from the recommended dose, the maximum grain production was achieved. Grain yields were boosted when biofertilizers and NPK fertilizer were provided together rather than separately or with only half of the required NPK dosage, according to Behera and Rautaray (2010).

Concerning, the interaction between the studied variables for yield and its components, data obtained in the two seasons are presented in Table (5). The illustrated results indicated that the study variables, significantly affected on all yield characteristics by acting in combination of varieties with fertilization treatments. The maximum values of yield and its components obtained to the interaction of Sids 14 variety

Table 3. Interaction effects of wheat varieties and fertilization treatments on growth characters during 2021/2022 and 2022/2023 seasons.

Characters / Factors		Plant height (cm)	Number of tillers /plant	Fresh weight /plant (g)	Dry weight /plant (g)
2021/2022 Season					
Varieties (V)	**Fertilization (F)**				
Sids 14	**100% NPK**	127.55	9.97	11.02	2.19
	Bio. alone	80.00	9.54	7.75	1.55
	75% NPK + Bio.	123.33	11.64	10.77	2.15
	50% NPK + Bio.	116.67	9.60	9.70	1.94
	25% NPK + Bio.	100.00	9.60	9.20	1.84
Sakha 95	**100% NPK**	123.33	9.80	10.69	2.13
	Bio. alone	80.00	9.40	8.11	1.62
	75% NPK + Bio.	121.67	10.90	10.64	2.13
	50% NPK + Bio.	112.50	9.70	9.49	1.90
	25% NPK + Bio.	100.00	7.90	8.49	1.70
Misr 3	**100% NPK**	128.33	10.14	10.65	2.12
	Bio. alone	89.17	7.97	8.36	1.67
	75% NPK + Bio.	123.33	11.22	11.03	2.21
	50% NPK + Bio.	116.67	9.34	9.93	1.99
	25% NPK + Bio.	107.55	8.10	9.30	1.86
LSD $_{0.05}$ for V x F		11.56	0.94	1.93	0.43
2022/2023 Season					
Sids 14	**100% NPK**	123.50	10.27	11.26	2.23
	Bio. alone	76.00	9.84	7.99	1.60
	75% NPK + Bio.	119.33	11.94	11.01	2.20
	50% NPK + Bio.	112.67	9.90	9.94	1.99
	25% NPK + Bio.	96.50	9.90	9.44	1.89
Sakha 95	**100% NPK**	119.33	10.10	10.93	2.17
	Bio. alone	76.00	9.70	8.35	1.67
	75% NPK + Bio.	117.67	11.20	10.88	2.18
	50% NPK + Bio.	108.83	10.00	9.73	1.95
	25% NPK + Bio.	96.00	8.20	8.73	1.75
Misr 3	**100% NPK**	124.33	10.44	10.89	2.16
	Bio. alone	85.17	8.27	8.60	1.72
	75% NPK + Bio.	119.33	11.52	11.27	2.25
	50% NPK + Bio.	112.67	9.64	10.17	2.03
	25% NPK + Bio.	104.00	8.40	9.54	1.91
LSD $_{0.05}$ for V x F		11.89	0.93	1.59	0.39

Table 4. Main effects of wheat varieties and fertilization treatments on yield and its components during 2021/2022 and 2022/2023 seasons.

Factors	Characters	Number of spikes/ plant	Spike length (cm)	1000 grain weight (g)	Grain yield/ fed. (ton)
		2021/2022 Season			
Varieties (V)	**Sids 14**	9.34	10.20	51.21	3.64
	Sakha 95	8.81	9.67	48.92	2.61
	Misr 3	8.62	9.48	45.26	2.56
LSD $_{0.05}$ for V		0.51	0.52	1.93	1.01
Fertilization treatments (F)	**100% NPK**	9.24	10.10	48.47	2.99
	Bio. alone	8.24	9.10	47.64	2.53
	75% NPK + Bio.	10.52	11.38	49.57	3.66
	50% NPK + Bio.	8.82	9.68	48.64	2.91
	25% NPK + Bio.	7.81	8.67	47.30	2.57
LSD $_{0.05}$ for F		0.57	0.56	1.37	0.41
		2022/2023 Season			
Varieties (V)	**Sids 14**	9.64	10.50	54.01	4.12
	Sakha 95	9.11	9.97	51.65	3.03
	Misr 3	8.92	9.78	48.01	3.00
LSD $_{0.05}$ for V		0.53	0.49	1.91	1.07
Fertilization treatments (F)	**100% NPK**	9.54	10.40	51.22	3.44
	Bio. alone	8.54	9.40	50.39	2.97
	75% NPK + Bio.	10.82	11.68	52.41	4.09
	50% NPK + Bio.	9.12	9.98	51.38	3.43
	25% NPK + Bio.	8.11	8.97	50.01	2.98
LSD $_{0.05}$ for F		0.59	0.63	1.33	0.45

with 75% NPK+Bio., in the first and second seasons. These values were 10.91 and 11.21 for number of spikes/plant, 11.77 and 12.07 g for spike length, 54.11 and 57.08 g for 1000 grain weight and 4.32 and 4.79 ton for grain yield/fed., during both seasons in the study, respectively. These results agreed with those obtained by Mahdi (2015), Seleiman et al. (2021) and Saad et al. (2022).

3.3.Chemical properties:

Results in Table (6) revealed that the differences among the studied varieties were not significant of P % and protein %, whereas there were significant differences of N % and K % in the first and second seasons. Sids 14 variety recorded the highest percentages of N (3.33 and 4.06 %), P (0.39 and 0.44 %), K (3.67 and 4.36 %) and protein (9.60 and 9.90 %) compared to the other tested varieties under the study during the two seasons, respectively. From these data it is clear that varieties may interact to the environmental conditions prevailing causing their differences during grain filling stage, nutrient concentration and protein composition. Similar results were obtained by Mahdi (2015), Seleiman et al. (2021) and Saad et al. (2022).

In this context, Application of biofertilizers combined with mineral fertilizers significantly changed all chemical properties during the two studied seasons (Table 6). Treated wheat plants with 75% NPK+Bio. achieved the highest percentages of N, P, K and protein in both seasons. These percentages were (4.08 and 4.52 %) for N, (0.46 and 0.51 %) for P, (4.46 and 4.86 %) for K and (10.59 and 10.89 %) for protein in the first and second seasons, respectively. This result reveals that biofertilizers are extremely advantageous in enriching soil fertility and fulfilling plant nutrient requirements especially nitrogen by supplying the organic nutrients through microorganism and their byproducts. The obtained results are in agreement with those of Taha et al. (2016) who found that the percentages of protein, N, P and K were greater with 75% NPK+Bio,

Table 5. Interaction effects of wheat varieties and fertilization treatments on yield and its components during 2021/2022 and 2022/2023 seasons.

Factors	Characters	Number of spikes/ plant	Spike length (cm)	1000 grain weight (g)	Grain yield/ fed. (ton)
		2021/2022 Season			
Varieties (V)	**Fertilization (F)**				
Sids 14	**100% NPK**	9.24	10.10	51.21	3.74
	Bio. alone	8.81	9.67	49.81	3.39
	75% NPK + Bio.	10.91	11.77	54.11	4.32
	50% NPK + Bio.	8.87	9.73	50.55	3.54
	25% NPK + Bio.	8.87	9.73	50.36	3.19
Sakha 95	**100% NPK**	9.07	9.93	48.92	2.64
	Bio. alone	8.67	9.53	48.15	2.17
	75% NPK + Bio.	10.17	11.03	50.19	3.21
	50% NPK + Bio.	8.97	9.83	49.28	2.68
	25% NPK + Bio.	7.17	8.03	46.92	2.35
Misr 3	**100% NPK**	9.41	10.27	45.62	2.59
	Bio. alone	7.24	8.10	44.95	2.03
	75% NPK + Bio.	10.49	11.35	44.41	3.45
	50% NPK + Bio.	8.61	9.47	46.08	2.53
	25% NPK + Bio.	7.37	8.23	44.64	2.17
LSD $_{0.05}$ for V x F		0.94	0.97	2.76	1.41
		2022/2023 Season			
Sids 14	**100% NPK**	9.54	10.40	54.01	4.26
	Bio. alone	9.11	9.97	52.63	3.75
	75% NPK + Bio.	11.21	12.07	57.08	4.79
	50% NPK + Bio.	9.17	10.03	53.21	4.21
	25% NPK + Bio.	9.17	10.03	53.07	3.60
Sakha 95	**100% NPK**	9.37	10.23	51.65	3.05
	Bio. alone	8.97	9.83	50.68	2.63
	75% NPK + Bio.	10.47	11.33	52.90	3.61
	50% NPK + Bio.	9.27	10.13	52.05	3.09
	25% NPK + Bio.	7.47	8.33	49.64	2.79
Misr 3	**100% NPK**	9.71	10.57	48.01	3.02
	Bio. alone	7.54	8.40	47.68	2.53
	75% NPK + Bio.	10.79	11.65	47.21	3.88
	50% NPK + Bio.	8.91	7.77	48.88	3.03
	25% NPK + Bio.	7.67	8.53	47.32	2.55
LSD $_{0.05}$ for V x F		0.91	0.92	2.71	1.28

Table 6. Main effects of wheat varieties and fertilization treatments on chemical properties during 2021/2022 and 2022/2023 seasons.

Factors	Characters	N (%)	P (%)	K (%)	Protein (%)
		2021/2022 Season			
Varieties (V)	**Sids 14**	3.33	0.39	3.67	9.60
	Sakha 95	3.09	0.36	3.43	9.51
	Misr 3	3.23	0.38	3.49	9.49
LSD $_{0.05}$ for V		0.03	0.05	0.02	0.41
Fertilization treatments (F)	**100% NPK**	3.48	0.42	3.89	10.30
	Bio. alone	2.48	0.32	3.00	8.39
	75% NPK + Bio.	4.08	0.46	4.46	10.59
	50% NPK + Bio.	3.15	0.35	3.15	9.59
	25% NPK + Bio.	2.88	0.34	3.14	8.80
LSD $_{0.05}$ for F		0.05	0.03	0.06	0.69
		2022/2023 Season			
Varieties (V)	**Sids 14**	4.06	0.44	4.36	9.90
	Sakha 95	4.05	0.42	4.17	9.81
	Misr 3	3.81	0.43	4.26	9.79
LSD $_{0.05}$ for V		0.07	0.03	0.03	0.37
Fertilization treatments (F)	**100% NPK**	4.24	0.45	4.35	10.60
	Bio. alone	3.49	0.38	3.89	8.69
	75% NPK + Bio.	4.52	0.51	4.86	10.89
	50% NPK + Bio.	3.78	0.40	4.13	9.89
	25% NPK + Bio.	3.61	0.39	4.09	9.10
LSD $_{0.05}$ for F		0.05	0.07	0.04	0.73

In order, Rana et al. (2012) reported that enhancement of 18.6% in protein content with biofertilizers inoculation in wheat grains.

For, the interaction effect between the two factors under the study was significant on all chemical properties in both seasons (Table 7). Results indicated that the interaction of Sids 14 variety with 75% NPK+Bio. achieved the highest values for nitrogen percentage (4.18 and 4.75 %), phosphorus percentage (0.51 and 0.53 %), potassium percentage (4.95 and 4.96 %) and protein percentage (10.87 and 11.17 %), in the two seasons, respectively. Results are in line with results of Mahdi (2015), Seleiman et al. (2021) and Saad et al. (2022).

4. CONCLUSION

Decisively, the use of biofertilizers became important to minimize the environmental pollution, resulting from using mineral fertilizers and to improve the yield and quality of wheat varieties. Application of biofertilizers combined with NPK significantly increased all characters except plant height. Sids 14 variety exhibited the highest values in the most traits. In conclusion, we can economically recommended application biofertilizers along with 75% NPK on Sids 14 variety to achieve the maximum yield and quality of grains wheat.

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Table 7. Interaction effects of wheat varieties and fertilization treatments on chemical properties during 2021/2022 and 2022/2023 seasons.

Factors / Characters		N (%)	P (%)	K (%)	Protein (%)
		2021/2022 Season			
Varieties (V)	**Fertilization (F)**				
Sids 14	**100% NPK**	3.68	0.46	3.99	10.33
	Bio. alone	2.84	0.31	3.13	8.43
	75% NPK + Bio.	4.18	0.51	4.95	10.87
	50% NPK + Bio.	3.84	0.35	3.18	9.50
	25% NPK + Bio.	3.09	0.33	3.08	8.87
Sakha 95	**100% NPK**	3.53	0.38	3.85	10.30
	Bio. alone	3.10	0.32	3.01	8.37
	75% NPK + Bio.	3.99	0.46	4.05	10.57
	50% NPK + Bio.	3.12	0.33	3.12	9.60
	25% NPK + Bio.	2.72	0.33	3.11	8.70
Misr 3	**100% NPK**	3.24	0.43	3.83	10.27
	Bio. alone	2.51	0.34	2.86	8.37
	75% NPK + Bio.	4.08	0.40	4.40	10.33
	50% NPK + Bio.	3.49	0.37	3.14	9.67
	25% NPK + Bio.	2.84	0.35	3.23	8.83
LSD $_{0.05}$ for V x F		0.07	0.07	0.09	1.15
		2022/2023 Season			
Sids 14	**100% NPK**	4.64	0.45	4.65	10.63
	Bio. alone	3.15	0.39	3.90	8.73
	75% NPK + Bio.	4.75	0.53	3.96	11.17
	50% NPK + Bio.	3.79	0.42	4.16	9.80
	25% NPK + Bio.	4.11	0.41	4.15	9.17
Sakha 95	**100% NPK**	4.63	0.43	4.17	10.60
	Bio. alone	3.82	0.38	3.82	8.67
	75% NPK + Bio.	4.30	0.52	4.71	10.87
	50% NPK + Bio.	3.69	0.39	4.05	9.90
	25% NPK + Bio.	3.51	0.41	4.10	9.00
Misr 3	**100% NPK**	3.46	0.47	4.25	10.57
	Bio. alone	3.51	0.38	3.96	8.67
	75% NPK + Bio.	4.51	0.49	4.90	10.63
	50% NPK + Bio.	3.85	0.40	4.17	9.67
	25% NPK + Bio.	3.22	0.39	4.00	9.13
LSD $_{0.05}$ for V x F		0.13	0.11	0.06	1.19

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الملخص العربي

تأثير الأسمدة الحيوية كبديل جزئي للأسمدة المعدنية على نمو وإنتاجية وجودة بعض أصناف قمح الخبز

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في الأونة الأخيرة تأثرت إنتاجية القمح بشكل واضح بسبب انخفاض خصوبة التربة علي الرغم من استخدام الأسمدة المعدنية بكميات كبيرة. لذا، لابد من ادارة الموارد الطبيعية بشكل جيد من خلال الزراعة المستدامة. وتعتبر الأسمدة الحيوية نهجا بديلا قيما نظرا لقدرتها على تقليل الأسمدة المعدنية وزيادة المحصول. اجريت تجربتان حقليتان في محطة سدس للبحوث الزراعية – محافظة بني سويف خلال موسمي الدراسة ٢٠٢١/٢٠٢٢ و ٢٠٢٢/٢٠٢٣ لدراسة تأثير استخدام الأسمدة الحيوية مع الأسمدة المعدنية بنسبة ٢٥ ، ٥٠ ، ٧٥ ، ١٠٠٪ من الجرعة الموصى بها على نمو وإنتاجية وجودة ثلاثة أصناف من قمح الخبز (سدس ١٤ – سخا ٩٥ – مصر ٣). كشفت النتائج عن وجود فروق معنويه بين الأصناف ومعاملات التسميد منفردة أو مجتمعة وتفاعلاتها فيما يتعلق بالصفات المساهمة في المحصول. سجل صنف سدس ١٤ أعلى قيم لعدد الأفرع/نبات والمحصول ومكوناتها والصفات الكيميائية. حققت المعامله 75% NPK+Bio. أعلى القيم في جميع الصفات المدروسة عدا ارتفاع النبات. أظهر التفاعل الصنف سدس ١٤ مع 75% NPK+Bio. أعلي القيم لعدد الأفرع/نبات والمحصول ومكوناتها والصفات الكيميائية. من هذه النتائج يمكن التوصية اقتصاديا بتطبيق الأسمدة الحيوية مع ٧٥٪ من الكمية الموصى بها من الاسمده المعدنيه على صنف سدس ١٤ لتحقيق أقصى إنتاجية لمحصول القمح.