Sustainable Wheat (*Triticum aestivum, L.)* Production Using Newly Organic Fertilizers and Bio-Stimulants in Egypt

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ABSTRACT

This study aims to investigate the effect of unveil newly organic fertilizers: a mix of 45% from both plant compost and chicken manure together and 10% Azolla (OFAZ) at 7 t/fed. rate, with foliar spraying on plant or soil fertigation by bio-supplements: YS (yeast extract), CBE (coffee powder, banana peels, and eggshells mix), and lactic acid bacteria (LAC), respectively, at 4 and 6 times per season for enhancing production of wheat variety 'Giza168'. OFAZ, YS, CBC and LAC were offered as bio-friendly fertilizers to increase vegetative and wheat production for sustainable agriculture & food security. Two field experiments were conducted in Nubaria Agricultural Research Station farm, during two winter growing seasons, 2022/2023 and 2023/2024. Eight treatments were applied by 4 replicates and arranged in (RCBD). Vegetative, productivity, and quality parameters were increased in all organic treatments with bio-supplements. Highest significant values were plant length (121.2cm), number of spikes (559.3/m^2), spike length (13cm), 1000-grain weight (57.8g), total yield of grains (3.4 tons fed^{-1}), straw (5.2 tons fed^{-1}), and biological yields (8.6 tons fed^{-1}) at T_6 (OFAZ+YS at 6 times/season as a foliar spraying) more than inorganic treatment (T_1) control. As well as, highest significant values were record of P, K, N, proteins, starch, and carbohydrate %, in grains and straw were exhibited at T_6. From the results obtained, we can be recommended using OFAZ + YS 6 times/season as foliar spray during vegetative growing stage to increase wheat production of grains, straw and their quality, and minimize environmental hazard impact in sandy soil conditions.

Keywords: Agricultural sustainable, Bio-stimulants, Organic fertilizers, Wheat production.

INTRODUCTION

Wheat (*Triticum aestivum L.*) is an important strategic crop in the world. At the same time, it is the major part in the international commerce of grains. It is an important crop in Egypt; increasing its production and quality is a fundamental aim for closing the gap between its production and consumption. So the creation of adequate soil characteristics to increase the wheat expansion cultivation area for achieving high production and quality in Egypt. In the world, the total grain yield and harvesting area were 734.04 million tons and 214.3 million ha, respectively. They were 8.80 million tons and 1.36 million ha, respectively (FAOSTAT, 2024), in Egypt. Different organic sources played pivotal roles in increasing total wheat yield and quality by N, P, and K application, resulting in significant increases in plant length (cm), number of tillers per plant, number of grains/spike, weight of 1000 grains, and total grain and straw yield tons/ha more than inorganic N, P, and K fertilizers. Wheat is the main part of the diet for all people. In addition, wheat is a strategic crop with economic return for Egyptian farmers. The cultivated area was about 3.4 million fed., representing about 51% of total crops in the Nubariya region (Al-Hasany et al., 2019). In Egypt, wheat production is a very important improvement to reduce its import and increase export by obligating farmers to overcome challenges for increasing the production and then needing to use vertical horizontal agriculture for wheat production to achieve the security of food and sustainable agriculture. Wheat productivity is the main task because of its short supply, so about 52% of needed wheat grains come from outside Egypt (EL-Guibali, 2016; Al-Shamary and Huthily, 2019; Seema et al., 2021; Sahra et al., 2022; Hussein et al., 2023).

Azolla is a plant that contains almost all vitamins, minerals, hormones, essential amino acids and proteins, growth regulators, antibiotics, and minerals (phosphorus, zinc, calcium, copper, ferrous, potassium, and magnesium). It contains 25–35% protein, 7–13% amino acids, 10–15% minerals, biopolymers, bioactive substances, and 15% total ash. Azolla has more benefits in the nutritional needs for livestock and fish production by low cost in bio-control, environmental bioremediation, and as a biofertilizer to increase crop production. Azolla application has long been recognized for its benefits in sustainable lifestyles and the enhancement of a bio-based economy. Azolla is an environmentally friendly solution for health and bio-natural resources and is also used as a result of the expanding human population and the increasing consumption for increasing the biotechnological strategies and enhancing the environmental sustainability. Azolla is a well-known biotechnology product with concern for environmental sustainability. Azolla is a genus of 7-9 species of small floating aquatic ferns that are found in the world in two zones of tropical

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or temperate. Azolla species belong to two subgenera: Rhizosperma or Euazolla. However, also, azolla production may be 3 to 11 times more than lucerne plant. It helps the farmers with the reduction of the supplementing expense to enhance the crop production. So that azolla is able to fix the atmospheric nitrogen to supply ammonia in the soil. So that it is rice as an ecofriendly biofertilizer and low cost. Azolla is a beneficial feeding supplement with potential as a biofertilizer for vital components of integrated agriculture. Azolla grows easily in a short period and is produced in a small area. It has a high nutritional composition and plays major roles in the production of bioenergy in agriculture with low-cost and environmentally friendly methods. The goal of this was to attempt to utilize the benefits of Azolla in agriculture, its nutritional composition to enhance the multiple purposes and green approach of Azolla for different applications, and environmental factors to improve the efficiency of Azolla to improve crop production. Azolla contains the essential minerals (calcium, magnesium, iron, and potassium), high quantities of the vitamins (V.A and V. B12), probiotics, biopolymers, and essential amino acids. Soil contains nitrogen, and water retention capacity was low, so azolla is a source of nutrients, leading to enhanced organic fertilizer application to get this around (Chekola et al., 2024; Nayel et al., 2024; and Al-Jabari et al., 2024).

Yeast extract as a foliar application has rates on yield and quality of wheat. Yeast extract is useful for plant nutrition and antimicrobial requirements for good plant growth because the essential amino acids and sugar were produced via fungi, bacteria, organic matter, and root hairs of plants. Yeast extract as a bio-fertilizer in agriculture has received considerable attention because of its bio-activity and safety for humans and the environment (Gomaa et al., 2021, and Abd El Samie et al., 2022). Yeast extract is a new promoter for increasing the growth of different crops. It is a natural, organic source of vegetative growth substrates like riboflavin, thiamine, pyridoxine, niacin, and the vitamins B6, B2, B1, B3, and B12 required for enhancing plant growth and total yield with the lowest cost. As well as yeast with many nutrients from organic fertilizers like carbohydrates, sugars, protein, nucleic acid, amino acids, and lipids had more beneficial effects on green growth, flowering, fruiting, total yield, and chemical components of crops (Abd-El Samie et al., 2022). It is hormonal groups that have been strongly implicated in affecting yield, particularly the grain size, numbers, and total grain yield in tons/fed. Yeast extract is able to regulate the division of cells. differentiation in certain tissues, and participation in many developmental processes like photosynthesis, flowering, partitioning, and senescence of plants (Hammad and Ali, 2014; Miraje and Huthily, 2019; Gomaa et al., 2021; Abd El Samie et al., 2022; Ali et al., 2024).

Lactic acid bacteria (LAC) is contained in milk that is fermented at room temperature (27-30°C) for 10 days, which has more minerals like Fe, Mg, Ca, Zn, and Mn; proteins; amino acids; kazyine; propanine; and vitamins like VD, E, and A. As well as fermented rice with milk, the rice is richer in more minerals, vitamins, and hormones for initial plant growth increasing. So that, LAC is considered Lactic acid bacteria was inoculated into soil with organic materials to enhance the decomposition and release of nutrients and increase the organic matter and humus of the soil. Populations of fungi, actinomycetes, protozoa, and lactobacillus (lactic acid bacteria) were increased in soil rhizosphere and were harmful to plant growth, increasing the total yield and quality of the plant (Higa and Kingo, 1988). Inoculated with lactic acid bacteria, soil leads to providing the recycling plant nutrients, and soil humus formation increased (Okada, 1988) to improve health, welfare, and decrease environmental harm impacts. It has antioxidant properties and is similar to that of brown seaweed extract and produces probiotic species of Lactobacillus to provide direct antioxidant support in plant growth and soil health (Aisha *et al., 2018*; Al Shamary *et al*., 2019; Abd El Samie *et al*., 2022; Ali *et al*., 2024).

CBE is a mixture of coffee grounds, banana peels, and eggshells (1:1:1) and has more benefits for plant growth enhancement, total yield, and quality increase. A mixture of coffee grounds, banana peels, and eggshells offered a promising solution to improve total yield and quality and food security. This study brings the innovation to reimagine kitchen waste for sustainable agriculture, introducing multi-component fertilizer. This study evaluated the influence of coffee grounds, eggshells, and banana peels as an organic fertilizer on the vegetative and total yield of crops (Aboelkheir et al., 2024, and Yang *et al*., 2024). Combining coffee powder, banana peels, and eggshells as biostimulants not only enhances the total yield and quality of plants but also has benefits to improve soil fertility and health. CBE is rich in essential nutrients, vitamins, and hormones as supplements for increasing the plant growth and total yield. Components of eggshells are high in Ca, which is able to neutralize soil pH and improve nutrient availability. Banana peel contains high amounts of K, Mg, and organic matter for plant health. A combination of eggshell and banana peel can improve plant growth in height, total yield, and quality compared to untreated plants. They are able to improve soil structure and nutrient retention for better plant performance. Coffee grounds benefit soil by enhancing a robust and diverse population of beneficial soil microorganisms for enhancing soil and plant health.

Calcium from eggshells enters plants only via the actively growing root hyphal tips. Calcium moves through plants and into fruits along with water by transpiration, and Mg and NH_4^+ can interfere with Ca uptake (Nossier, 2021; Teixeira and Santos, 2022; Nurseha *et al*., 2023). The objective of this study was to evaluate the influence of the mixture of plant compost (45%) and chicken manure (45%) with Azolla (10%) and bio-supplements by yeast extract (YS), CBE, or LAC at two rates, 4 and 6 times per season, as foliar spraying on leaves or soil fertigation, on the growth, grain and straw yields and their qualities under sandy soil conditions.

MATERIAL AND METHODS

Two experimental fields were conducted out on the farm of Nubaria Agricultural Research Station during two winter seasons, 2022/2023 & 2023/2024. This objective to evaluate influence of newly organic fertilizers (OFAZ), which contains 45% of plant compost + 45% of chicken manure + 10% Azolla mixed, with best number of times from foliar spraying on shoot plants by yeast extract (YS) or CBE and best number of times from soil fertigation by lactic acid bacteria (LAC) or CBE on yield and quality of wheat. CBE is containing the mixture of coffee powder, banana peels, and eggshells at (1:1:1, w: w), and its concentration at (5 g/1 L water) was applied as a foliar spraying on plant, or as a soil fertigation only, or together. LAC is product by milk fermentation at room temperature (27-30°C) for 10 days, which was applied only as a soil fertigation. Samples of the soil surface layer (0-30 cm) and OFAZ were collected before cultivation to determine some physico-chemical properties, following the methodology of (Page et al., 1982 and Jones, 2018), were shown in Table (1). Sandy soil is formed from (57.3%), clay (23.1%), and silt (19.6%); it was low in available nitrogen (45.4), phosphorus (3.6), and potassium (140.4) mg/kg as an average from both of two winter seasons, at 2022/2023 & 2023/2024. Physico-chemical properties of OFAZ sample as an organic fertilizer was (total organic matter %= 23.7, organic carbon %= 17.3, ratio of carbon to nitrogen = 4, pH = 7.3 (1:10), E.C. = 5.8 dS m^{-1} (1:10 water extract), percentage of total amounts of phosphorus = 4.9 & potassium = 6.1%) accorded to (Lowther, 1980 and Klute, 1986). A randomized complete block design (RCBD) with 4 replicates was done, with eight treatments as follows: T1 = inorganic of N, P, and K fertilizers at $R_{100\%}$ (control); T2 = OFAZ (the mixture of plant compost and chicken manure at 45% from everyone mixed with 10% of Azolla) was applied at the recommended dose ($R_{100\%}$ = 7 t/fed.); T3 = T2 + LAC (4 times/season) as a soil fertigation only; T4 = T2 + LAC (6 times/season) as a soil fertigation only; T5 = T2 + YS (4 times/season) as a foliar spraying on plants only; T6 = T2 + YS (6 times/season) as a foliar spraying on plants only; T7 = T2 + CBE (4 times/season) as a foliar spraying on plants and a soil fertigation together; T8 = T2 + CBE (6 times/season) as a foliar spraying on plants and a soil fertigation together. Organic fertilizer (OFAZ) was applied in treatments from T_2 to T_8 on the soil surface (0-30 cm) for about 21 days before sowing during both of two winter's seasons, 2022/2023 and 2023/2024. OFAZ was applied prior to sowing and thoroughly mixed into the surface soil during the plowing for 21 days before sowing. The total numbers of experimental plots were 32 plots per season; the plot area was 10.5 m² by width (3.0 m) & length (3.5 m). Wheat variety 'Giza168' was sown on December 9th, 2022/23 and December 11th, 2023/24, and harvested on May 3rd, 2023 and May 7th, 2024. Recommended doses of inorganic N, P, and K fertilizers are as follows: Ammonium nitrate (33.5%) = 200 kg fed. $^{-1}$, Super Calcium Phosphate (15.5%) = 200 kg fed. $^{-1}$ and Potassium Sulphate (48%) = 50 kg fed. $^{-1}$ was applied in the control treatment (T1). A full dose of Super Calcium Phosphate and half dose of Ammonium Nitrate were applied to the soil surface before sowing. The remaining doses from both of the half dose of Ammonium Nitrate and full dose of Potassium Sulfate were added with the next irrigation after sowing by 21 days later. YS, CBE and LAC were applied as a foliar spraying or a soil fertigation; after 21 days from grains germination every 10 days. Grain and straw yields were obtained from the central area, 2.0 m wide & 2.5 m long (5.0 m²) from each experimental unit (plot) to avoid any border effects. Plant samples were taken from the central area per plot to determine the growth, yield, and quality parameters of wheat grains and straw. Data collections were plant height (cm), number of spikes/m^2, spike length (cm), 1000-grain weight (g), total grains and straw yields (tons fed^{-1}), biological yield (tons fed^{-1}), and harvest index (HI %). Percentages of some chemical components in wheat grains like N, P, K, proteins, carbohydrates and starch. Chemical components in straw were (N, P, K, and proteins) determined according to Lowther, 1980) and A.O.A.C., 2000; to determine the above contents. Nitrogen, phosphorus and potassium % were measured accorded to Jackson (1973) and Chapman & Pratt (1978). Carbohydrates and starch of wheat grains were measured accorded to Holm et al., 1986 and Cronin & Smith, 1979.

Table 1. **Physical- chemical properties analyses of the experimental farm in Nubaria Agricultural Research Station in two growing seasons, 2022/2023 and 2023/2024**

Properties		2022/2023	2023/2024
Mechanical analysis and texture	Sand	59.7 %	54.9 %
	Clay	21.9 %	24.3 %
	Silt	18.4 %	20.8 %
	Texture	Sandy-clay-loam	Sandy-clay-loam
Mechanical analysis	pH (1:2.5)	8.1	8.2
	E.C. dS/m	1.47 dS/m	1.38 dS/m
	O.C.%	2.3 %	2.4 %
	O.M.%	0.9 %	1.1 %
	C / N ratio	1:5.2	1:5.3
	CaCO3%	23.0 %	21.6 %
Available Macro-nutrients	Nitrogen (mg/kg)	44.5	46.2
	Phosphorus (mg/kg)	3.5	3.7
	Potassium (mg/kg)	138.2	142.6

All results were analyzed using the statistical SAS program (SAS, 2001), and the means of all treatments were compared by using the Duncan's Multiple Range Test at the 5% level of probability.

RESULTS AND DISCUSSION

1- Growth Parameters

The effect of natural bio-supplements like YS, CBE, and LAC at two rates (4 and 6 times/season) as a foliar spray on plants and as a soil fertigation with OFAZ, which is contains from chicken manure and plant compost at 45% from everyone mixed with 10% of Azolla at the rate of 7 tons fed^{-1} as the recommended dose on the growth parameters was recorded in Table 2. Results show that significant differences were observed between all treatments in studied parameters. which gave mean values of 121.2 cm, 559.3 spikes/m^2, 13.0 cm, and 57.8 g, respectively, for plant height, numbers of spikes/m^2, length of spike and weight of 1000-grain were positively affected in organic treatments (from T_2 to T_8) as compared with control (T_1) in the two growing seasons. The lowest significant values were 57.5 cm, 264.9 spikes/m^2, 6.2 cm, and 27.1g, respectively, as an average from both of two winter growing seasons, 2022/2023 and 2023/2024, at T_1 (control) inorganic N, P, and K fertilizers. These results were in agreement with Abd El-Hadi *et al. (2018),* Al Shamary and Huthily (2019), Gomaa *et al. (2021),* Tombarkiewicz *et al. (2022),* Mohammed and Hasan (2023), Aboelkheir *et al. (2024),* Chekola *et al. (2024),* Nayel *et al. (*2024) and Yang *et al. (2024).* The results in Table (2) show that the foliar spraying and soil fertigation of bio-supplements like YS, CBE, and LAC, in all treatments which caused significantly greater increases in all studied parameters of wheat than in the untreated plants (T1). Yeast extract (YS) was suggested for its beneficial role during plant growth due to its high content of auxin, cytokinin, gibberellin, minerals, carbohydrates, and vitamins (Al-Shamary and Huthily, 2019; Gomaa *et al*., 2021; Abd El Samie *et al*., 2022; and Al-Jabari *et al*., 2024).

2- Yield Parameters

Results in Table (3) revealed that the mixture of chicken manure (45%) and plant compost (45%) mixed with 10% of Azolla (OFAZ) at $R_{100\%}$ (7 t/fed.) gave substantial superiorities in total grain, straw yield, biological yield (tons/fed.), and harvest index (HI %) from T_2 to T_8 treatments more than the untreated plant (T_1) control. The highest significant values at T_6 (OFAZ + YE 6 times/season as a foliar spraying on plants) were 3.4, 5.2, and 8.5 tons/fed., respectively, as an average from both of two winter seasons, 2022/2023 and 2023/2024, respectively. There are nonsignificant differences shown between T_3, T_4, T_6, T7, and T_8 in the harvest index (HI %) from both of two winter seasons, 2022/2023 and 2023/24. Considerable superiorities were evident for T_6 in tables (2 and 3) for the greatest growth and yield parameters. It is obvious from table (3) that also the lowest significant values were 1.2, 2.1, and 3.3 tons/fed. and 39.9%, respectively, as an average from both of two winter seasons, 2022/2023 and 2023/24, in the untreated plant (T_1). All-natural bio-supplements like YS, CBE, and LAC at two rates (4 and 6 times/season) as a foliar spray on plants or as a soil fertigation, respectively, lead to enhanced growth, and increased total grain and straw yield were recorded in Tables (2 and 3) more than untreated control T_1. These results are in agreement with those obtained by Aria (1981), Higa and Kinjo (1988), El-Tohamy *et al. (2015),* Aisha *et al. (2018),* Khairnar and Nair (2019), Abd el Samie *et al. (2022),* Tombarkiewicz *et al. (2022),* Teixeira and Santos (2022), Al-Jabari *et al. (2024),* and Sowell (2024).

Table 2. Effect of Newly Organic-Fertilizer with Bio-supplements on studied vegetative growth parameters of wheat variety 'Giza168' in 2022/2023 and 2023/2024; two growing seasons

T.	Plant length (cm)			Number of Spikes/m^2			Length of Spike (cm)			The weight of 1000 grains (g)		
	2022/2023	2023/2024	Average	2022/2023	2023/2024	Average	2022/2023	2023/2024	Average	2022/2023	2023/2024	Average
T.1	55.0 c	59.9 c	57.5	251.0 h	278.7 h	264.9	5.9 h	6.7 h	6.4	25.9 h	28.2 h	27.1
T.2	60.6 c	66.1 c	63.4	281.9 g	312.9 g	297.4	6.6 g	7.5 g	7.1	29.3 g	31.9 g	31.6
T.3	82.7 abc	94.3abc	88.5	386.9 d	429.4 d	408.2	9.5 d	10.7 d	10.1	40.2 d	43.8 d	42.0
T.4	62.1 c	70.8 c	66.5	429.2 c	476.4 c	452.8	10.5 c	11.9 c	11.2	44.3 c	48.3 c	46.3
T.5	102.0 ab	116.3ab	109.2	477.4 b	529.9 b	503.7	11.7 b	13.2 b	12.5	49.6 b	54.1 b	51.9
T.6	113.3 a	129.1 a	121.2	530.1 a	588.4 a	559.3	12.2 a	13.8 a	13.0	55.3 a	60.2 a	57.8
T.7	67.1 c	74.4 c	70.8	312.5 f	346.9 f	329.7	7.3 f	8.3 f	7.8	32.3 f	35.2 f	33.8
T.8	74.8 bc	83.1 c	78.9	347.6 e	385.9 e	366.8	8.5 e	9.6 e	9.1	36.3 e	39.5 e	37.9
L.S.D. 0.05	31.9	36.4		0.81	0.89		0.36	0.40		0.31	0.33	

T1= Inorganic N, P and K fertilizers at R100% (Control), T2 = OFAZ (45% of plant compost + 45% of chicken manure+ 10% of Azolla) at R100% (7 t/fed.); T3 = T2 + LAC (4 times/season) as a soil fertigation; T4 = T2 + LAC (6 times/season) as a soil fertigation; T5 = T2 + YS (4 times/season) as a foliar spraying on plants; T6 = T2 + YS (6 times/season) as a foliar spraying on plant; T7 = T2 + CBE (4 times/season) as a foliar spraying on plants and a soil fertigation together; T8 = T2 + CBE (6 times/season) as a foliar spraying on plant and a soil fertigation together

Table 3. Effect of Newly Organic-Fertilizer with Bio-supplements on studied yield parameters of wheat variety 'Giza168' in 2022/2023 and 2023/2024; growing seasons

T	Grains yield tons fed.$^{-1}$			Straw yields tons fed. $^{-1}$			The Biological yield tons fed. $^{-1}$			Harvest Index (HI) %		
	2022/2023	2023/2024	Average	2022/2023	2023/2024	Average	2022/2023	2023/2024	Average	2022/2023	2023/2024	Average
T1	1.1h	1.3 h	1.2	1.9 h	2.2 h	2.1	3.1 h	3.5 h	3.3	36.9 d	42.9 d	39.9
T2	1.4 g	1.7 g	1.6	2.3 g	2.6 g	2.5	3.7 g	4.3 g	4.0	38.7 cd	44.9 cd	41.8
T3	2.2 d	2.6 d	2.4	3.2 d	3.6 d	3.4	5.4 d	6.2 d	5.8	41.3 a	47.9 a	44.6
T4	2.5 c	2.8 c	2.7	3.6 c	4.2 c	3.9	6.1 c	7.0 c	6.6	40.4 abc	46.8 abc	43.6
T5	2.7 b	3.1 b	2.9	4.2 b	4.8 b	4.5	6.8 b	7.9 b	7.4	39.0 bc	45.2 bc	42.1
T6	3.1 a	3.6 a	3.4	4.8 a	5.5 a	5.2	7.9 a	9.1 a	8.5	39.6 abc	45.9 abc	42.8
T7	1.7 f	1.9 f	1.8	2.5 f	2.9 f	2.7	4.2 f	4.8 f	4.5	39.7 abc	46.0 abc	42.9
T8	1.9 e	2.2 e	2.1	2.8 e	3.3 e	3.1	4.8 e	5.5 e	5.2	40.6 ab	47.1 a	43.9
L.S.D. 0.05	0.11	0.12		0.11	0.12		0.10	0.12		1.81	2.1	

T1= Inorganic N, P and K fertilizers at R100% (Control), T2 = OFAZ (45% of plant compost + 45% of chicken manure + ١٠ of Azolla) at R100% (7 t/fed.); T3 = T2 + LAC (4 times/season) as a soil fertigation; T4 = T2 + LAC (6 times/season) as a soil fertigation; T5 = T2 + YS (4 times/season) as a foliar spraying on plants; T6 = T2 + YS (6 times/season) as a foliar spraying on plants; T7 = T2 + CBE (4 times/season) as a foliar spraying on plant and a soil fertigation together; T8 = T2 + CBE (6 times/season) as a foliar spraying on plant and a soil fertigation together

3- Quality Parameters in Grains and Straw of Wheat Plants

There were significant variations in grain composition, the percentage of N, P, K, proteins, carbohydrates, and starch between all treatments. These traits record the highest significantly average the highest significantly average values were 3.0, 0.61, 2.8, 17.0, 78.6, and 74.2% (respectively) at T_6 (OFAZ + YS 6 times/season as a foliar spraying on plants). But the lowest significant average values were 1.4, 0.28, 1.1, 6.4, 35.8, and 34.1%, respectively, for the same traits in untreated plants (T_1). It may be because of crop benefits from yeast extract (YS) in the growth stage, which was reflected in all characteristics of plant growth, yield, and quality of wheat grains. This was agreed with the findings of Hammad and Ali (2014); Ismail and Amin (2014), Al-Shamary and Huthily (2019), Nossier (2021), Nurseha *et al. (2023)*, Ali *et al. (*2024) and Yang *et al. (2024)*. As well as, results of wheat straw in the percentage of N, proteins, P, and K in Table 5 cleared that the highest significant average values at T_6 (OFAZ + YS 6 times/season as a foliar spraying on the whole plant) were 1.8, 0.44, 2.1, and 10.8%, respectively, more than the untreated once (T_1). The lowest significantly valued were 0.3, 0.2, 0.7, and 2.0% (respectively) as an average from both of two winter

seasons, 2022/2023 and 2023/2024, in T1. The beneficial impact of the yeast extract was correlated to gibberellins, cytokinins, and auxins; they lead to encouraging the division of plant cells and development with the yeast extraction as a bio-supplement. It is able to produce essential amino acids, nitrogen, mineral components, and vitamins for inducing the powerful growth of crops. El-Tohamy et al. (2015), Aisha et al. (2018), Nossier (2021), Nurseha et al. (2023), Ali et al. (2024) and Yang et al. (2024) all support these findings.

Table 4. **Effect of Newly Organic-Fertilizer with Bio-supplements on studied chemical components of wheat grains, in 2022/2023 and 2023/2024, growing seasons**

T	Grain Wheat								
	Nitrogen%			Proteins%			Phosphorus%		
	2022/2023	2023/2024	Average	2022/2023	2023/2024	Average	2022/2023	2023/2024	Average
T.1	1.03 h	1.8 h	1.4	5.97 h	6.8 h	6.4	0.26 h	0.29 h	0.28
T.2	1.27 g	1.4 g	1.3	7.30 g	8.3 g	7.8	0.31 g	0.35 g	0.33
T.3	1.83 d	2.1 d	1.9	10.57 d	12.1 d	11.8	0.43 d	0.48 d	0.45
T.4	2.07 c	2.4 c	2.2	11.90 c	13.6 c	12.8	0.48 c	0.54 c	0.51
T.5	2.33 b	2.7 b	2.5	13.40 b	15.3 b	14.4	0.53 b	0.59 b	0.56
T.6	2.77 a	3.2 a	3.0	15.90 a	18.1 a	17.0	0.59 a	0.66 a	0.63
T.7	1.43 f	1.6 f	1.5	8.27 f	9.4 f	8.9	0.35 g	0.39 f	0.37
T.8	1.63 e	1.9 e	1.8	9.40 e	10.7 e	10.1	0.38 e	0.43 e	0.41
LSD0.05	0.09	0.10		0.49	0.57		0.01	0.01	

T1= Inorganic N, P and K fertilizers at R100% (Control), T2 = OFAZ (45% of plant compost + 45% of chicken manure + 10% of Azolla) at R100% (7 t/fed.); T3 = T2 + LAC (4 times/season) as a soil fertigation; T4 = T2 + LAC (6 times/season) as a soil fertigation; T5 = T2 + YS (4 times/season) as a foliar spraying on plants; T6 = T2 + YS (6 times/season) as a foliar spraying on plants; T7 = T2 + CBE (4 times/season) as a foliar spraying on plant and a soil fertigation together; T8 = T2 + CBE (6 times/season) as a foliar spraying on plant and a soil fertigation together

Table 5. **Effect of Newly Organic-Fertilizer with Bio-supplements on studied chemical components of wheat grains, in 2022/2023 and 2023/2024, growing seasons**

T	Grain Wheat								
	Potassium%			Carbohydrates%			Starch %		
	2022/2023	2023/2024	Average	2022/2023	2023/2024	Average	2022/2023	2023/2024	Average
T.1	1.0 g	1.1 h	1.1	33.9 h	37.6 h	35.8	32.2 h	36.0 h	34.1
T.2	1.4 f	1.5 g	1.5	38.5 g	42.7 g	40.6	37.4 g	41.9 g	39.7
T.3	1.8 d	1.9 d	1.9	53.6 d	59.5 d	56.6	51.5 d	57.7 d	54.6
T.4	2.0 c	2.2 c	2.1	59.2 c	65.7 c	62.5	57.0 c	63.9 c	60.5
T.5	2.3 b	2.5 b	2.4	65.5 b	72.7 b	69.1	63.5 b	71.2 b	67.4
T.6	2.6 a	2.9 a	2.8	72.8 a	84.4 a	78.6	69.9 a	78.4 a	74.2
T.7	1.5 f	1.6 f	1.6	43.6 f	48.4 f	46.0	41.9 f	46.9 f	44.4
T.8	1.7 e	1.8 e	1.8	47.6 e	52.9 e	50.3	46.1 e	53.0 e	49.6
LSD0.05	0.10	0.11		0.63	0.71		0.66	0.74	

Inorganic N, P and K fertilizers at R100% (Control), T2 = OFAZ (45% of plant compost + 45% of chicken manure +10% of Azolla) at R100% (7 t/fed.); T3 = T2 + LAC (4 times/season) as a soil fertigation; T4 = T2 + LAC (6 times/season) as a soil fertigation; T5 = T2 + YS (4 times/season) as a foliar spraying on plants; T6 = T2 + YS (6 times/season) as a foliar spraying on plants; T7 = T2 + CBE (4 times/season) as a foliar spraying on plant and a soil fertigation together; T8 = T2 + CBE (6 times/season) as a foliar spraying on plant and a soil fertigation together

Table 6. Effect of Newly Organic Fertilizer with Bio-supplements on studied chemical components of wheat straw in, 2022/2023 and 2023/2024, growing seasons

T.	Straw Wheat											
	Nitrogen%			Proteins%			Phosphorus%			Potassium%		
	2022/2023	2023/2024	Average	2022/2023	2023/2024	Average	2022/2023	2023/2024	Average	2022/2023	2023/2024	Average
T.1	0.3 g	0.4 g	0.4	1.9 g	2.1 g	2.0	0.18 h	0.21 h	0.20	0.7 g	0.8 g	0.8
T.2	0.6 f	0.8 f	0.7	3.7 f	4.1 f	3.9	0.21 g	0.24 g	0.23	0.9 f	1.1 f	1.0
T.3	1.1 d	1.2 d	1.1	6.1` d	7.0 d	6.6	0.29 d	0.32 d	0.31	1.3 d	1.5 d	1.4
T.4	1.2 c	1.4 c	1.2	7.1 c	7.9 c	7.5	0.32 c	0.37 c	0.35	1.5 c	1.7 c	1.6
T.5	1.4 b	1.6 b	1.5	8.3 b	9.3 b	8.8	0.36 b	0.40 b	0.38	1.7 b	1.9 b	1.8
T.6	1.8 a	1.9 a	1.9	10.2 a	11.4 a	10.8	0.41 a	0.46 a	0.45	1.9 a	2.2 a	2.1
T.7	0.73 f	0.8 f	0.8	4.2 f	4.7 f	4.5	0.23 f	0.26 f	0.25	1.07 e	1.2 e	1.1
T.8	0.93 e	1.1 e	1.0	5.4 e	6.1 e	5.8	0.26 e	0.29 e	0.28	1.17 e	1.3 e	1.2
L.S.D. 0.05	0.11	0.12		0.59	0.66		0.01	0.02		0.10	0.12	

T1= Inorganic N, P and K fertilizers at R100% (Control), T2 = OFAZ (45% of plant compost + 45% of chicken manure + 10% of Azolla) at R100% (7 t/fed.); T3 = T2 + LAC (4 times/season) as a soil fertigation; T4 = T2 + LAC (6 times/season) as a soil fertigation; T5 = T2 + YS (4 times/season) as a foliar spraying on plants; T6 = T2 + YS (6 times/season) as a foliar spraying on plants; T7 = T2 + CBE (4 times/season) as a foliar spraying on plant and a soil fertigation together; T8 = T2 + CBE (6 times/season) as a foliar spraying on plant and a soil fertigation together

CONCLUSION

The results obtained from the two growing seasons, 2022/2023 and 2023/2024, confirm the importance of the mixture of organic fertilizers (OFAZ), chicken manure (45%), and plant compost (45%) with azolla (10%) to enrich essential amino acids, vitamins, plant regulators, hormones, and all required minerals for a good nutritional plant, enhance the vegetation, and increase total yields of wheat grains and straw and qualities. Results showed a significant superiority of plant height, spike length (cm), number of spikes/m² , 1000-grain weight (g), total grains and straw yield t/fed., biological yield, and harvest index (HI %). Meanwhile, yeast extract (YS) spraying 6 times per season was superior in all characteristics of growth, grain yield and straw, and their qualities. The ultimate goal of this research is to find the best treatment: adding yeast extract 6 times per season as a spray on the whole plants and fertilizing with OFAZ at 7 tons fed^{-1}) to increase all traits of strategic wheat production. They are inexpensive and increase the total yield of grains and straw and quality with the lowest cost. This works to solve the huge amount of addition of inorganic fertilizers in agricultural problems for sustainable agriculture, food security, and decreased environmental hazard impact.

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الملخص العربي

الإنتاج المستدام للقمح (*Triticum aestivum*, L) باستخدام الأسمدة العضوية الحديثة والمحفزات الحيوية في مصر

أمال كرم أبو الجود

تهدف هذة الدراسة إلي الكشف عن أسمدة عضوية جديدة مثل المخلوط المكون من (٤٥٪ من الكمبوست النباتي و ٤٥ % من سبلة الدجاج و ١٠٪ من نبات الأزولا) و المسمي ب (OFAZ) بمعدل٧طن/فدان، مع رشّ النبات ورقيًا أو ري التربة بالمكملات حيوية: مثل YS (مستخلص الخميرة)، وCBE (مخلوط من مسحوق القهوة، وقشور الموزالجاف المطحون، وقشر البيض)، وبكتيريا حمض اللاكتيك (LAC)، بمعدل ٤ أو٦ مرات في الموسم الواحد إما رشا ورقيا أو ريا لتربة، لتعزيز إنتاجية صنف القمح "جيزة ١٦٨". وقد قُدّمت هذه الأسمدة كسماد صديقة للبيئة لزيادة إنتاجية القمح وتحقيق زراعة مستدامة وأمن غذائي. في هذة الدراسة أُجريت تجربتين ميدانيتين في مزرعة محطة بحوث النوبارية الزراعية، خلال موسمين زراعيين ٢٠٢٢/٢٠٢٣ و٢٠٢٣/ ٢٠٢٤. طُبّقت ثماني معاملات بأربع مكررات، ورُتبت في (RCBD). أوضحت النتائج وجود زيادة معنوية للصفات المدروسة في النمو و الإنتاجية والجودة في جميع المعاملات العضوية باستخدام المكملات الحيوية المختلفة مقارنة بالكنترول. وكانت هناك زيادة معنوية في طول النبات (١٢١,٢ سم)، وعدد السنابل (٥٥٩,٣/م²)، وطول السنبلة (١٣ سم)، ووزن الألف حبة (٥٧,٨ جراغ)، والمحصول الكلي للحبوب (٣,٤ طن فدان$^{-1}$)، والقش (٥,٢ طن فدان$^{-1}$)، والمحصول البيولوجي (٨,٥ طن فدان$^{-1}$) عند T6 و هي (YS + OFAZ بمعدل ٦ مرات من مستخلص الخميرة /موسم رشًا ورقيًا) مقارنةً بمعاملة (T1) الكنترول. كما سُجلت أعلى القيم المعنوية لنسب الفوسفور والبوتاسيوم والنيتروجين والبروتينات والنشا والكربوهيدرات في الحبوب والقش عند T6. من نتائج هذة الدراسة يمكن التوصية باستخدام مستخلص الخميرة (YS) ست مرات رشًا ورقيًا على النباتات في الموسم الواحد + OFAZ (مخلوط الاسمدة السابق ذكرة) لتحسين نمو و إنتاجية صنف القمح جيزة ١٦٨ من الحبوب والقش، وتحسين جودتهما، وتقليل آثار المخاطر البيئية تحت ظروف الأراض الرملية.

الكلمات المفتاحية: الزراعة المستدامة، المُحفّزات الحيوية، الأسمدة العضوية، الإنتاج المستدام لمحصول القمح.