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Productivity of Some Winter Wheat (*Triticum aestivum* L.) Varieties through Integrated Application of Vermicompost and Biochar in Sandy Soil

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THE INCREASED productivity of cereals in sufficient quantities for the population is one of the largest problems currently facing farmers. Therefore, the aim of this study is to improve grain yield productivity of some common wheat varieties by adding biochar and vermicompost under sandy soil conditions. Two field experiments were carried out in Wadi El-Natrun, El-Beheira, Governorate, Egypt, during the winter seasons of 2020-2021 and 2021-2022. The experience was designed with a completely randomized split-plot with three replications. The main plot was planted with some winter wheat (*Triticum aestivum* L) varieties, while fertilizer rates were assigned to the subplots. Results have shown that the treatments of biochar and vermicompost significantly increased all the yield metrics and chemical constituents compared to the control treatment in sandy soil conditions. The Skaha-95 variety considerably exceeded the Giza-171 variety on grain and straw yields and the percentage of nutritional values of the dry wheat grain, that is, NPK%, total proteins, and carbohydrates. Increasing the fertilizer rate from 1200 to 2400 kg/ha caused a significant increase in plant height (cm), number of grain/spike, 100 grain weight (g), grain and straw yields (ton/ha), NPK%, proteins, and total carbohydrates in the grains. In general, the maximum average values of all the parameters of our study were obtained from the variety Skaha-95 when the plants were fertilized by mixing (1200 biochar + 1200 vermicompost kg/ha). According to the results, mixing rates of biochar and vermicompost fertilizers might be an alternative for improving wheat productivity and quality metrics in sandy soil environments.

Keywords: Biochar, Sandy soil, Vermicompost, Wheat (*Triticum aestivum* L.) varieties.

Introduction

Common wheat (*Triticum aestivum* L) is one of the world's most significant strategic agricultural commodities and stable foods. At the same time, it plays a major part in international food grain commerce. Bread wheat is the most important crop in Egypt, occupying 1.5 million hectares and representing nearly half of the total cultivated area during the winter season. Egypt consumes the equivalent of 20 million metric tons of wheat per year, and less than half of this amount is met from domestic production, the remaining share being covered by imports (Nasr & Sewilam, 2016). Increasing wheat productivity is a fundamental aim to close the gap between wheat consumption and production. As a result, it is critical to create adequate soil conditions for improved wheat crop expansion to achieve not only production but also quality (Gadisa & Mekonnen, 2021). In Egypt, the wheat crop is important and essential in the country's food, so it is necessary to improve and increase productivity.

Both biochar and vermicompost are excellent sources of organic fertilizers that can enhance the

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yield and quality of crops grown in sandy soils. Biochar is produced by burning biomass and is rich in nutrients. It can also improve soil structure. Vermicompost is a type of compost created by the decomposition of organic matter by earthworms. Organic matter provides essential nutrients to crops, which, in turn, increase their yield (Wu et al., 2019).

Nutrients may be supplied through vermicompost, while charcoal preserves them for crop use. The findings are also being utilized to confirm the effectiveness of the two organic soil amendments on crop yield (Cao et al., 2021). Since any further increase in biochar did not result in a commensurate advantage, the usage of combinations may be limited to a 50% incorporation level. Mustafa et al. (2022) observed that vermicompost can be a good organic fertilizer in cereal cultivation, improving the effect of the soil and balancing plant nutrients in its structure.

This is consistent with El-Naggar et al. (2018), who illustrated that, organic fertilizers include dissolved organic carbon (O.C.) and organic matter (O.M.) accessible to soil microorganisms, and that the availability of O.M. for plant development is dependent on the amount applied to the soil. Thus, the use of vermicompost in agricultural production is economically beneficial for farmers, reduces production costs, and increases profitability (Ehlinaz & Orhan, 2021).

This is consistent with De-Jesus Duarte et al. (2019), who discovered that biochar aids in nutrient retention but cannot operate as a sole source of nutrients. Biochar works with other soil components, such as soil bacteria, to enhance overall soil dynamics, which are the circumstances under which plants develop over time. This provides for enhanced plant nutrition, development, and production, as well as overall advantages to agricultural soil productivity (Khan et al., 2021).

Improving soil health characteristics, reducing climate change, and increasing crop productivity are all top priorities for biochar (Ahmad et al., 2021). For example, it has been noted that in arid climates, soil ventilation, water retention, and soil microbial activity have all improved (Diatta et al., 2020). By regulating nitrate leachate and carbon sequestration in soil layers, it also has a positive impact on reducing losses (Gul et al., 2015).

Gebremedhin et al. (2015) indicated that biochar has a high cation exchange capacity, which permits it to retain positive ions in an exchangeable state. These positive ions, which are vital nutrients like ammonium or potassium cations, are utilized by plants, when they are required. This is because when traditional fertilizers are applied to poor soils, nutrients are frequently lost due to leaching, weeds, or microbial activity before crops can absorb them.

In addition, it reduces environmental pollutants and serves as an environmentally friendly substitute for chemical fertilizers. Therefore, the application of biochar can reduce nitrogen losses (Dominguez et al., 2019). The main targets of the field experiment were to study the effect of vermicompost and biochar addition on wheat yield and quality in sandy soils.

Materials and Methods

Experimental site

The current study was conducted at the Wadi El-Natrun farm in El-Beheira, Egypt, during the winters of 2020–2021, and 2021–2022, to determine the impact of biochar and vermicompost fertilizer applications on the grain yield and quality of wheat crops grown in sandy soil conditions.

Soil sample and analysis

Before each planting season, a demonstrative soil sample from the experimental field was collected to evaluate its physical and chemical characteristics. The Klute method's (1982) results for the chemical characteristics of irrigation water and the physico-chemical characteristics of the soil are shown in Tables 1, and results for the chemical analysis of vermicompost and biochar are seen in Table 2

Experimental design

The design of the study was a split-plot design with three replicates in a randomized complete block configuration. Wheat varieties were assigned to the main plots, while fertilizer rates were assigned to the subplots.

The field trials were carried out in both seasons using a drip irrigation system with drippers spaced 30 cm a part (2L/h). The grains were sown in hills that were spaced 10 cm apart on plots that measured 45m^2 and had five ridges (15m long and 0.6m width). The irrigation system was irrigated at (5-7) day intervals, added once before sowing at 10 days.

TABLE 1. Physical and chemical properties of the experimental site before sowing and irrigation water

Soil of experience			Irrigation water		
Determination		Percentage	Determination		Percentage
Mechanical analysis	Sand	84.20	Chemical analysis	pH	8.15
	Silt	7.50		EC ($ds.m^{-1}$)	0.87
	Clay	8.30	Soluble cations (mg/L)	K^+	3.21
	Textural class	Sandy		Na^+	5.12
Chemical analysis	pH	0.45		Mg^{++}	4.42
	EC ($ds.m^{-1}$)	8.90		Ca^{++}	6.35
	Organic matter	0.09	Soluble anions (mg/L)	$CO_3^=$	0.00
	$CaCO_3$	3.38		HCO_3^-	5.35
Available nutrients	Nitrogen	0.05		Cl^-	0.55
	Phosphorus	0.11		$SO_4^=$	13.20
	Potassium	0.80			

TABLE 2. Chemical analysis of vermicompost and biochar

Parameters	Vermicompost	Biochar
Moisture (%)	22.68	3.60
pH	8.00	9.15
EC (dSm^{-1})	1.13	1.87
Carbon (%)	17.55	21.20
Nitrogen (%)	1.23	0.55
Phosphorus (%)	0.32	0.22
Potassium (%)	1.33	1.41
Calcium (%)	5.80	4.40
Magnesium (%)	3.70	2.60

Agricultural practices

Wheat grains (Sahka-95 and Giza-171) were sown on October 25th in both seasons at a rate of 144kg/ha (ha= 10000m^2). Wheat grains were obtained from the Wheat Research Institute, Agricultural Research Centre. A rate of 120 kg K_2O/ha and 144 kg P_2O_5/ha of phosphorus and potassium were used. A single superphosphate application of phosphorus (15.5% P^2O_5) was made before sowing. Potassium sulfate (48% K_2O) was applied after 45 days of sowing. Half the amount of nitrogen recommended for wheat was added at a rate of 108kg N/ha of ammonium nitrate fertilizer (33.5% N) with the first irrigation of wheat. Weeds were controlled twice during both growing seasons, 25 and 50 days after planting. Pest control and other cultural practices have been applied as recommended by Egypt's Ministry of Agriculture.

Treatments

Vermicompost and biochar were added to the grown wheat before sowing at the following rates:

1. Control (R_1)= without biochar or vermicompost fertilizer
2. Biochar (R_2)=1200kg/ha
3. Biochar (R_3)=2400kg/ha
4. Vermicompost (R_4)=1200kg/ha
5. Vermicompost (R_5)=2400kg/ha.
6. Mixture (50%) (R_6)=600 +600kg/ha.
7. Mixture (50%) (R_7)=1200 +1200kg/ha.

Yield and its components

At harvest time, a random of 10 randomly plants were between from the middle ridges of each plot to determine plant height (cm), number of grains/spike and 100-grain weight (g). All plant of each plot were harvested to estimate, seed yield (ton/ha), straw yield (ton/ha) as well as:

- Biological yield (ton/ha) = grain yield + straw yield and

- Harvest Index (%)= grain yield/biological yield *100

Chemical analysis

According to A.O.A.C. (2000), the amounts of total nitrogen and soluble carbohydrates in grains were estimated. The amount of crude protein was assessed by multiplying the N% by 5.75 to A.A.C.C. (2000). Carter & Gregorich (2008) method for estimating phosphorus levels using a spectrophotometer1720 UV. According to Motsara & Roy (2008), K^+ concentrations were measured using Jenway PFP7 and PFP7/C emission flame light meter.

Statistical analyses

The data were statistically evaluated using analysis of variance (ANOVA), mean comparisons with COSTAT, and the least significant differences (LSD) at a level of 5% to determine differences between means. Statistical software for Windows version 6.1 was used for the calculations (StatSoft Inc., 2001).

Results

Yield components

Variety differences

The data in Table 3 shows the average performance of two common wheat cultivars (Sakha-95 and Giza-171) for growth parameters such as plant height (cm), number of grains/spike, and weight of 100 grains (g) over the 2020-2021 and 2021-2022 seasons. The statistics demonstrate that there were substantial differences in plant height between the two cultivars during both seasons. In the first and second seasons, however, there were substantial differences between the two varieties in the attributes tested, favoring the Sakha-95 cultivar.

TABLE 3. Effect of biochar, vermicompost, and mixture treatments on yield components of two common wheat varieties

Varieties	Treatments	2020/2021			2021/2022		
		Plant height (cm)	Number of grains/spike	100-grain weight (g)	Plant height (cm)	Number of grains/spike	100-grain weight (g)
Giza-171	R_1	84.33	62.67	6.17	88.33	66.67	6.45
	R_2	92.33	74.00	7.42	97.33	78.00	7.76
	R_3	93.67	76.33	7.68	98.67	81.33	8.04
	R_4	94.00	73.33	7.48	99.00	77.33	7.83
	R_5	95.00	75.33	7.65	100.00	79.67	8.01
	R_6	96.00	77.00	7.71	100.33	82.00	8.07
	R_7	97.67	78.00	8.31	103.00	84.00	8.70
Mean		**93.29**	**73.81**	**7.49**	**98.09**	**78.43**	**7.84**
Sakha- 95	R_1	85.67	64.00	6.42	89.33	68.00	6.72
	R_2	93.33	75.00	7.31	98.33	79.33	7.65
	R_3	94.00	76.67	7.82	99.00	81.67	8.19
	R_4	95.00	74.33	7.54	99.00	78.33	7.89
	R_5	95.67	77.33	8.05	100.33	82.33	8.43
	R_6	99.33	78.00	7.68	103.00	84.33	8.04
	R_7	103.67	80.00	8.48	107.00	87.00	8.88
Mean		**95.24**	**75.05**	**7.61**	**99.43**	**80.14**	**7.97**
LSD $_{0.05}$	Var.	1.67	1.14	0.03	1.14	1.62	0.03
	Treat.	0.99	0.97	0.15	1.01	0.95	0.16
	Var.* Treat.	1.56	ns	0.23	1.46	ns	0.24

R_1= Control (without fertilizer) R_2= Biochar (1200kg/ha) R_3= Biochar (2400kg/ha)
R_4= Vermicompost (1200kg/ha) R_5= Vermicompost (2400kg/ha). R_6= Mixture 50% (600+600kg/ha).
R_7= Mixture 50% (1200 +1200kg/ha). Var. = Varieties Treat.=Treatments

Furthermore, in both seasons, the variety Sakha-95 outperformed the variety Giza-171 in terms number of grains/spike, and 100 grains by weight. The disparities in performance for growth qualities between the two cultivars may be linked to their genetic background, which had a significant effect in this respect. Some wheat varieties differ in their growth features, such as plant height, number of grains per spike, and weight per 100 grains. Gerema (2020) demonstrates that plant varieties differences in their growth and development and that these changes are due to the plant's morphological, physiological, and biochemical processes.

Effect of treatments

All characteristics evaluated were substantially altered by fertilizer treatments, including no fertilizer as a control, vermicompost, biochar, and a combination of vermicompost and biochar fertilizer in both seasons. According to the findings shown in Table 3, in all seasons, the application of the vermicompost and biochar treatments generated the highest significant values for all characteristics evaluated compared to the control treatment.

The findings revealed that fertilizer rates had a considerable impact on the components of wheat yield. Where the greatest rate provided plant height, number of grains/spike, and weight of 100 grains with a 50% combination (R_7), followed by the same rate of vermicompost and biochar. This impact might be attributed to the high density of the features investigated, which increases element absorption and reduces the chance of fertilizer leaching. These findings were congruent with the findings of Agegnehu et al. (2017), who discovered that high yield and high fertilization efficiency were achieved by boosting element absorption and accumulation in late growth phases of high yield.

The superiority of the growth traits of wheat plants undergoing the combination treatment mixture (R_7) may be owing to the inclusion of some essential macroelements, microelements, and biological fertilizers (some beneficial bacteria, such as nitrogen-fixing bacteria, phosphate solubilizing bacteria, and potassium). El-Naggar *et al*., (2018) found comparable results.

Effect of interaction

Data in Table 3 showed that combining biochar and vermicompost added productive advantages to the wheat varieties used over adding them alone especially the combined treatment mixture 50 % (R_7). Also, in the same Table it shows that all the yield measurements of common wheat varieties were significantly affected by the different fertilizers added during both seasons, except the number of grains per spike, which was not significant during either of the two seasons. El-Naggar et al. (2018) discovered equivalent findings. The treatment produced their maximum values of 100 grains and their grain yield per hectare when treated with the combined processing mixture of 50 % in both seasons. Nevertheless, the bottommost values of the same respective treatments for the weight of 100 grains when not treated with fertilizer (control treatment) in the two seasons.

Grain and straw yield

Variety differences

The results in Table 4 and Figs. 1, 2 demonstrate the average performance of the two wheat varieties (Giza-171 and Sakha-95) for the variables evaluated, namely grain and straw yield (ton/ha), and biological yield (ton/ha), as well as harvest index (%), throughout both seasons. The statistics demonstrate that there were substantial differences in grain and straw production, biological yield, and harvest index between the two cultivars during the two seasons.

However, there were substantial variations in the features analyzed between the two cultivars in favor of the Sakha 95 variety in both seasons. Furthermore, in both seasons, the variety Sakha 95 outperformed the Giza-171 variety in terms of grain and straw production and biological yield, as well as harvest index. Khan *et al*., (2021) reported similar results.

Effect of treatments

It is obvious from the results (Table 4 and Figs. 1, 2) that the application of biochar and vermicompost treatments significantly increased grain yield, straw yield, biological yield and harvest index compared to no fertilizer in both seasons. The data also indicate that vermicompost treatments significantly produced higher grain and straw yield, biological yield and harvest index followed by biochar and control.

TABLE 4. Effect of biochar, vermicompost, and mixture treatments on grain and straw yield, biological yield, and harvest index for common wheat varieties

Varieties	Treatments	2020/2021				2021/2022			
		Grain yield (ton/ha)	Straw yield (ton/ha)	Biol. yield (ton/ha)	Harvest index (%)	Grain yield (ton/ha)	Straw yield (ton/ha)	Biol. yield (ton/ha)	Harvest index (%)
Giza-171	R_1	4.22	2.88	7.10	59.44	4.37	3.12	7.49	58.34
	R_2	5.30	3.14	8.44	62.80	5.50	3.41	8.91	61.73
	R_3	5.42	3.24	8.66	62.59	5.62	3.53	9.15	61.42
	R_4	5.50	3.46	8.96	61.38	5.69	3.77	9.46	60.15
	R_5	5.45	3.43	8.88	61.37	5.64	3.72	9.36	60.26
	R_6	5.59	3.48	9.07	61.63	5.78	3.79	9.57	60.40
	R_7	5.69	3.67	9.36	60.79	5.90	4.08	9.98	59.12
Mean		**5.31**	**3.33**	**8.64**	**61.43**	**5.50**	**3.63**	**9.13**	**60.20**
Sakha- 95	R_1	4.34	3.31	7.65	56.73	4.49	3.48	7.97	56.34
	R_2	5.76	3.60	9.36	61.54	5.98	3.94	9.92	60.28
	R_3	5.66	3.74	9.40	60.21	5.86	4.08	9.94	58.95
	R_4	5.86	3.98	9.84	59.55	6.07	4.34	10.41	58.31
	R_5	5.83	3.94	9.77	59.67	6.05	4.27	10.32	58.62
	R_6	5.93	4.01	9.94	59.66	6.14	4.37	10.51	58.42
	R_7	6.12	4.22	10.34	59.19	6.34	4.75	11.09	57.17
Mean		**5.64**	**3.83**	**9.47**	**59.51**	**5.85**	**4.18**	**10.02**	**58.30**
LSD $_{0.05}$	Var.	0.12	0.02	0.13	0.53	0.13	0.02	0.15	0.55
	Treat.	0.08	0.15	0.15	1.19	0.09	0.17	0.16	1.21
	Var.* Treat.	0.09	ns	ns	ns	0.10	ns	ns	ns

ns= non significant ha= hectare

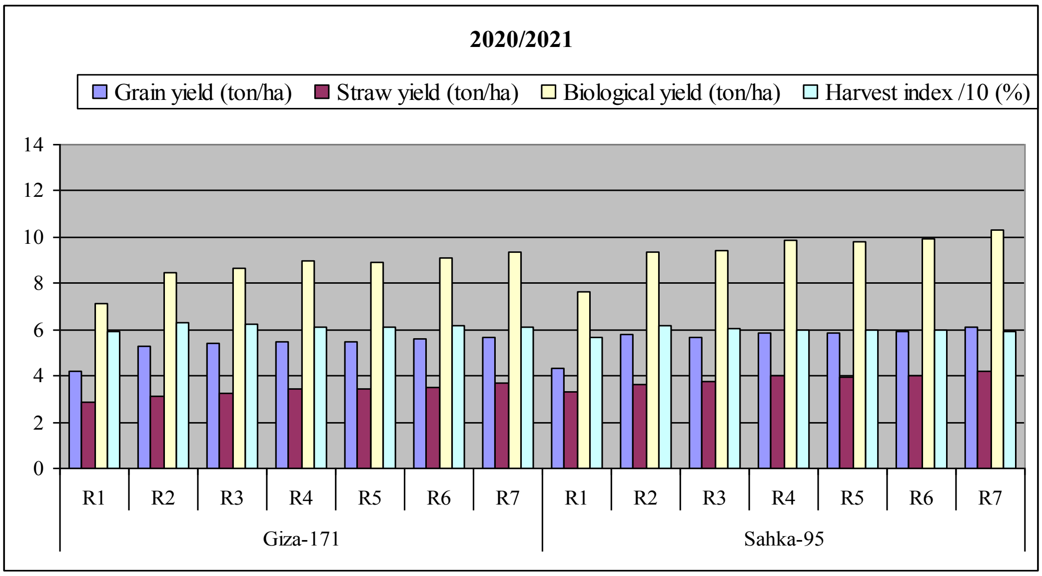

Fig. 1. Effect of biochar, vermicompost and mixture treatments on grain and straw yield, biological yield and harvest index for common wheat varieties in the first season [R_1= Control (without fertilizer), R_2= Biochar (1200kg/ha), R_3= Biochar (2400kg/ha), R_4= Vermicompost (1200kg/ha), R_5= Vermicompost (2400kg/ha), R_6= Mixture 50% (600+600kg/ha), R_7= Mixture 50% (1200 +1200kg/ha)]

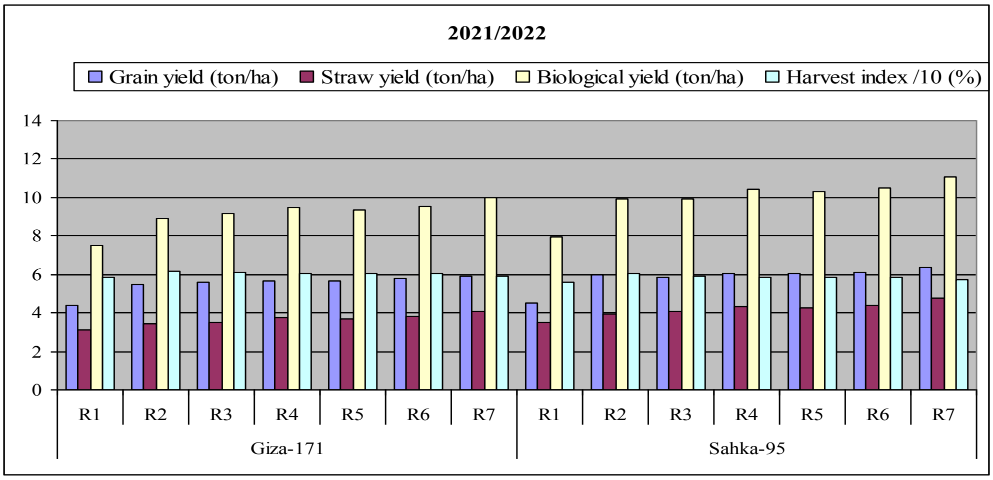

Fig. 2. Effect of biochar, vermicompost and mixture treatments on grain and straw yield, biological yield and harvest index for common wheat varieties in the second season

From the findings (Table 4 and Figs. 1, 2), it can be observed that grain and straw yield increased significantly with increasing fertilizer application rate and that the highest values of grain and straw yield, and biological yield were obtained by fertilizer application at a rate of 2400kg/ha. This response pattern occurred with all the biochar and vermicompost studied.

Effect of interaction

The relation effect of varieties with rates has no significant impact on straw yield, biological yield and harvest index in the first and second seasons, except for the grain yield, which is significant during the two seasons. Vermicompost improved biological yield in the first and second years compared to control, respectively. Similarly, grain yield showed the largest increase in the first and second years when the mixture rate (R_7) (1200+1200kg/ha) of biochar and vermicompost was incorporated.

Grain quality

Variety differences

The data represented in Table 5 indicated that there were significant differences between the two wheat varieties in the quality of the grains, i.e., phosphorus, potassium, crude protein, and total percentages of carbohydrates, during the two seasons. In addition, we can observe that the variety Sakha-95 has exceeded the Giza-171 variety in each of the percentages of phosphorus, potassium crude protein, and total carbohydrates during the two seasons.

The advantage of cultivar Sakha-95 in such grain quality attributes may be related to an increase in its accumulation of dry matter, grain weight, and metabolite translocation. In this regard, other studies have discovered differences in the protein and carbohydrate composition of different common wheat types. As a result, Gerema (2020) demonstrates that plant species vary in their growth and development and that these variances are due to the plant's chemical and biochemical processes.

Many researchers have found that the percentage of protein in grain yield of wheat has increased with increasing biochar rates (Khan et al., 2021). In addition, researchers have found that the percentages of carbohydrates in wheat grains were also increased by the application of vermicompost and biochar fertilizers (Dawar et al., 2022). As for vermicompost and biochar fertilizer rates, it is clear from the data in the same Table that gradual and significant increases in phosphorus%, potassium%, crude protein%, and total carbohydrate% have resulted as fertilizer rates increased up to 2400kg/ha.

Effect of treatments

Regarding the effect of adding fertilizer treatments on wheat grains Table 5, shows that phosphorus, potassium, crude protein, and total carbohydrate percentages have increased significantly due to the increase in the rates adding biochar and vermicompost. in addition, the results have shown that the mixture treatment (R_7) of biochar and vermicompost fertilizers produced the supreme significant values of phosphorus %, potassium %, crude protein %, and total carbohydrate %, compared with control treatment (no fertilizers) in both seasons.

TABLE 5. Effect of biochar, vermicompost, and mixture treatments on macro nutrients, protein and total carbohydrates for common wheat grains

Varieties	Treatments	2020/2021				2021/2022			
		P	K	Protein	T. Carb	P	K	Protein	T. Carb
		%							
Giza-171	R_1	0.26	1.11	9.51	58.07	0.29	1.18	9.91	59.23
	R_2	0.36	1.52	11.81	59.93	0.40	1.61	12.27	61.13
	R_3	0.36	1.61	11.92	61.71	0.40	1.71	12.38	62.94
	R_4	0.35	1.53	11.44	61.03	0.38	1.63	11.90	62.26
	R_5	0.37	1.60	11.62	61.90	0.41	1.70	12.08	63.14
	R_6	0.34	1.65	11.86	61.96	0.38	1.75	12.32	63.20
	R_7	0.39	1.70	12.09	62.95	0.43	1.80	12.55	64.58
Mean		**0.35**	**1.53**	**11.46**	**61.08**	**0.38**	**1.63**	**11.92**	**62.35**
Sakha- 95	R_1	0.33	1.20	10.43	61.33	0.36	1.27	10.83	61.74
	R_2	0.45	1.68	12.96	63.59	0.50	1.78	13.47	64.87
	R_3	0.45	1.78	13.07	65.48	0.50	1.89	13.59	66.79
	R_4	0.44	1.69	12.57	64.77	0.48	1.79	13.09	66.07
	R_5	0.47	1.76	12.77	65.69	0.52	1.87	13.28	67.00
	R_6	0.43	1.82	13.01	65.75	0.47	1.93	13.53	67.07
	R_7	0.49	1.87	13.30	67.45	0.54	1.99	13.82	68.34
Mean		**0.44**	**1.69**	**12.59**	**64.87**	**0.48**	**1.79**	**13.09**	**65.98**
LSD $_{0.05}$	Var.	0.005	0.01	0.01	0.36	0.002	0.01	0.01	0.43
	Treat.	0.01	0.04	0.09	0.76	0.01	0.05	0.10	0.81
	Var.* Treat.	ns	ns	0.11	ns	ns	ns	0.13	ns

P=Phosphorus K=Potassium T.carb=Total carbohydrates

Based on the results in the Table 5, the height resulting from chemical analysis of common wheat grains obtained by adding biochar with vermicompost, this effect may be due to the delayed in fertilizer loss and increased efficiency and macro and micro-nutrients that led to raised the absorption of availability of minerals in plants and therefore the grains quality (Mahmoud & Gad, 2020).

Effect of interaction

The data on all the quality characteristics of the grains studied here in the wheat grains have not been significantly interacted with by the different fertilizer rates actions during both seasons, except for the crude protein percentage, which was significant during both seasons. This may be due to the accumulation of more nutrients with these treatments (Ali et al., 2017).

Economic feasibility

Biochar and vermicompost are commercially viable biofuels that can be used in agriculture. As a result, biochar production has the potential to enhance soil qualities while also creating new revenue streams. The total production revenue (straw and grain) for cultivars varies, as indicated in Table 6. The results showed that, when compared to the control, the higher fertilizer rate resulted in the highest common wheat production. Furthermore, wheat cultivars were altered by addition, with Sahka-95 being the most associated, followed by Giza-171.

In general, the field study reveals that biochar and vermicompost fertilization are economically feasible in wheat production. The Sahka-95 common wheat variety produced a wheat yield of up to 44472 L.E./ha at a mixture (50%), and the control produced up to 36744 L.E./ha, while the Giza-171 variety produced up to 40344 L.E./ha and the control produced up to 14490 L.E./ha.

TABLE 6. Economic feasibility of biochar, vermicompost, and mixture fertilizers on the yield of common wheat varieties in sandy soil average of two years.

Varieties	Fertilizers types	Fert. amount (kg/ha)	Price (L.E.)	Grain yield (ton/ha)	Price (L.E)	Straw yield (ton/ha)	Price (L.E)	Total yield income	Net (L.E.)
Giza 171	Control	0.00	0.00	4.30	25800	3.00	9000	34800	34800
	Biochar	2400	4800	5.47	32820	3.34	10008	42828	38028
	Vermicompost	2400	6000	5.57	33420	3.60	10800	44220	38220
	Mixture (50 %)	2400	5400	5.74	34440	3.77	11304	45744	40344
Sakha 95	Control	0.00	0.00	4.42	26520	3.41	10224	36744	36744
	Biochar	2400	4800	5.81	34860	3.84	11520	46380	41580
	Vermicompost	2400	6000	5.95	35700	4.13	12384	48084	42084
	Mixture (50 %)	2400	5400	6.14	36840	4.34	13032	49872	44472

Biochar=2.00 L.E/kg Vermicompost =2.5.00 L.E/kg Grain= 6.00 L.E/kg Straw= 3.00 L.E/kg

Furthermore, biochar and vermicompost improve soil biological properties by increasing variety and establishing a favorable habitat for soil microbial populations. Biochar's resistance to chemical and biological processes increases its long-term agronomic and environmental advantages. Zheng *et al*., (2017) found that in the current study, the addition of biochar and vermicompost had a greater impact on wheat growth. The increased growth of biochar-treated plants compared to control plants might be attributed to the biochar's porosity, which allowed more water to be retained in the soil. Another theory is that the ash concentration of char makes more nutrients, notably phosphorus, accessible to biochar-treated plants. Many authors, including Singh (2017) and Kamaleshwaran & Elayaraja (2021), have reported on the favorable effects of biochar created from waste.

Discussion

Addition of biochar and vermicompost is a new strategy for improving productivity and efficiency of crop wheat. Because, Biochar and vermicompost can generate a balanced plant interaction condition that increases wheat productivity which could be beneficial for wheat producers. Where, the fertility of most soils decreases when there is not enough organic carbon in the soil. Where, a large amount of crop wheat is lost when cultivated in low-fertility soil. Consequently, biochar and vermicompost are considered among the most important organic fertilizers that increase soil fertility, in addition to improving the absorption of nitrogen, phosphorus and potassium. Higher soil organic matter on the other hand, enhances the activity of soil microbes and improves nutritional availability for plants (Fatima et al., 2021).

Biochar and vermicompost also promote plant growth through the availability of nutrients such as P, K, Ca, and Mg in an easily accessible and absorbable thus improving plant photosynthesis. Increased photosynthetic rate and carbohydrate production, which increases plant height, the number of grains per spike, weight at 100 grains, yield in grains, and yield in the straw of wheat (Liu et al., 2016; Mahmoud & Gad, 2020; Khan et al., 2021).

According to the results of this study the Sakha-95 variety was superior to the Giza-171 variety in terms of grain and straw yield, biological yield, harvest index as well as protein and carbohydrates percentage. Also, the study showed that the treatment of the mixture of biochar and vermicompost in a ratio of 50% (1200+1200kg/ha) is better than the other treatments in terms of plant height, number of grain per spike, weight of 100 grains grain and straw yield as well as protein and total carbohydrates. May be the mixture of biochar and vermicompost contains organic carbon and microorganisms helpful to the soil and incessant and offer of macro and micro-nutrients and growth stimulators such as auxins, Gibberellins, Cytokinins and phosphate, enzyme and vitamins. Consequently, the photosynthesis content is augmented and the growth of crops, results in high-grain proteins and total carbohydrates (Haghparast et al., 2014; Zaremanesh et al., 2017).

Therefore, integrated use of biochar and vermicompost fertilizer is found to be better in improving productivity of wheat and quality parameters. Where, the present finding has demonstrated the impact of combined application of biochar and vermicompost in improving the quality parameters of wheat.

Conclusion

Biochar and vermicompost aid plant development by potentially providing nutrients and which enhances photosynthesis, or by supplying plant growth elements such as P, K, Ca, and Mg in a readily accessible and absorbable form at the plant. Therefore, increasing the rate of photosynthesis in the plant leads to increases plant height, the number of grains per spike, the weight of 100 grains, grains and straw yield in addition to protein, and total carbohydrates.

On the other hand, using a fertilizer mixture is the best way to boost wheat production and quality metrics. But farmers perceive the expense of adding biochar and vermicompost to be expensive, but the cost is offset by an increase in grain output and the preservation of high levels of organic content in the soil for several years. As a result, further study is needed to determine the long-term consequences of using biochar and vermicompost in sandy soil, particularly in Egypt

List of abbreviations

N	Nitrogen	pH	hydrogen ion buffer
P	Phosphorus	Na	Sodium
K	Potassium	Mg	Magnesium
Ca	Calcium	CO_3	Carbon trioxide or carbonate
T. Cab.	Total carbohydrates	HCO_3	Carbon trioxide or carbonate bicarbonate
O.M	Organic matter	Cl	Chloride
L.E.	Egyptian pound	SO_4	Sulphate
E.C	Electrical conductivity	O.C	Organic carbon
ha	Hectare		

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إنتاجية بعض أصناف القمح الشتوي (*Triticum aestivum* L.) من خلال إضافة السماد الدودي والفحم الحيوي في الأرض الرملية

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تَعد زيادة إنتاجية الحبوب بكميات كافية للسكان واحدة من أكبر المشاكل التي تواجه المزارعين حالياً. لذلك، فإن الهدف من هذه الدراسة هو تحسين إنتاجية محصول الحبوب لبعض أصناف القمح عن طريق إضافة الفحم الحيوي والسماد الدودي تحت ظروف الأرض الرملية. تم إجراء تجربتين حقليتين في وادي النطرون، محافظة البحيرة، مصر، خلال موسمي الشتاء 2021-2020، 2022-2021. تم تصميم التجربة بالقطع المنشقة العشوائية مع ثلاث مكررات متماثلة. زرعت القطع الرئيسية بصنفي القمح الشتوي (*Triticum aestivum* L.)، بينما تم تخصيص معدلات الأسمدة للقطع الفرعية.

أظهرت النتائج أن كل معاملات الفحم الحيوي والسماد الدودي زادت بشكل كبير من جميع مقاييس المحصول والمكونات الكيميائية مقارنة بمعاملة الكنترول تحت ظروف الأرض الرملية. تفوق صنف سخا-95 بشكل كبير صنف جيزة-171 في محصول الحبوب، القش والنسبة المئوية للمكونات الكيميائية لحبوب القمح، وكذلك النيتروجين-الفسفور-البوتاسيوم، والبروتينات، والكربوهيدرات الكلية.

أدت زيادة معدل التسميد من 1200 إلى 2400 كجم/هكتار إلى زيادة كبيرة في ارتفاع النبات (سم)، عدد الحبوب/السنبلة، ووزن 100 حبة (جم)، ومحصول الحبوب والقش (طن/هكتار)، النيتروجين-الفسفور-البوتاسيوم، والبروتينات، الكربوهيدرات الكلية في الحبوب. بشكل عام ، تم الحصول على أفضل النتائج لجميع معاملات الدراسة من الصنف سخا-95 عندما تم التسميد عن طريق الخلط (1200 كجم/هكتار من سماد الفحم الحيوي + 1200 كجم/هكتار من السماد الدودي)

وفقا للنتائج المتحصل عليها قد تكون معدلات خلط أسمدة الفحم الحيوي والسماد الدودي بديلاً جيداً لتحسين إنتاجية القمح ومقاييس الجودة في الأرض الرملية.