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EFFECT OF MINERAL, ORGANIC AND BIO FERTILIZATION ON WHEAT PRODUCTION IN TWO DIFFERENT SOILS

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ABSTRACT: Biological experiment was conducted in the clay and sandy soils to study the effect of inorganic, organic and bio fertilization on growth and yield components as well as N, P and K-uptake by wheat plants. Ammonium sulphate (N) was added at the rates of 25 [50% the recommended dose (RD)] and 50 (100% RD) mg N kg^{-1} soil, while ordinary superphosphate (P_1) and rock phosphate (P_2) were applied at the rates of 9.72 (50% RD) and 19.44 (100% RD mg P kg^{-1} soil. Potassium sulphate (K_1) and feldspar (K_2) were added at the rates of 20.8 (50% RD) and 41.5 (100% RD) mg K kg^{-1} soil. The organic materials *i.e.* clover straw (CS), sunflower seed teflon (ST) and banana peel (BP) were added at a rate of (0.5%). Some wheat grains were inoculated by biofertilizers *i.e.* nitrobein (nit), phosphate dissolving bacteria (PDB) and potassiumage (Pot). The results showed that the treatments of [50% RD (NP_1K_1) + CS + ST + BP + Nit + PDB + Pot] gave the greatest values of the straw and grains dry weight, biological yield and harvest index, N-uptake by grains and P- and K- uptake by straw and grains if compared to the other treatments in both soils under study. Wherease the highest 1000 grains weight was observed with the treatment of [50% RD (NP_2K_2) + CS + ST + BP + Nit + PDB + Pot] in the clayey soil and [50% RD (NP_1K_1) + CS + ST + BP] in the sandy soil compared to the other treatments. The greatest values of N- uptake by straw were recorded with treatments of [50% RD (NP_1K_1) + CS + ST + BP] in the clayey soil and [50% RD (NP_1K_1) + CS + ST + BP + Nit + PDB + Pot] in the sandy soil compared to the other treatments. Finally, it could be concluded that the use of 50% of the recommend dose of the most mineral fertilizers (NP_1K_1) mixed with organic materials (CS + ST + BP) and biofertilizers (Nit + PDB + Pot) may reduce the mineral fertilization (NP_1K_1) dose, production cost and environmental contamination.

Key words: Mineral fertilizers, organic materials, biofertilizers.

INTRODUCTION

Wheat (*Triticum aestivum*, L.) is considered one of the most important cereal crops in Egypt. The amount needed from it is greater than that locally produced.

Most of the Egyptian soils suffer from lack of available nutrients content, due to increase pH values and low in organic matter content. The shortage and high costs of mineral fertilizers and pollution factor have been focused attention on organic fertilizations source of plant nutrients (**Parsons, 1985; Chen and Avnimelech, 1986**).

Also, application of 40 mg N kg^{-1} soil of mineral N fertilizer mixed with *Azotobacter* + *Azospirillum* in presence of humic acid (50 L $fad.^{-1}$) realized the greater values of grain and straw yields, N, P and K uptake by wheat (**El-Hamdi *et al.*, 2012**).

The application of organic residues and bio-fertilizers are considered as promising practices of improving the nutritive and productive capacities of such soils either directly or indirectly (**El-Sirafy *et al.*, 2012**).

In view of the economical and environmental problems of using chemical fertilizers, utilization of organic manures and biofertilizers, will not

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only result in increasing soil fertility and crop production through its nutritional supply, but would also help in solving sanitary and environmental problems as well as save foreign currency for Egypt. Pot experiment was carried out under greenhouse condition to study the effect of mineral, organic and biofertilization on wheat crop yield and some nutrients uptake by plants grown on clayey and sandy soils. However, the present work objectives are to produce a clean and safe foods, reduce the quantity of mineral fertilizers (NPK) and production cost. As well as reduce the environmental contamination and soil salinity.

MATERIALS AND METHODS

Materials

Soil Sampling

Samples of two different soil types were collected from the surface soil (0-30 cm) as follows:

1. A clay soil from Hihia District, Sharkia Governorate,
2. A sandy soil from the farm of the Faculty of Agriculture at El-Khattara District, Sharkia Governorate.

Soil samples were air dried, crushed, sieved through 2 mm plastic screen, throughly mixed and stored in plastic bags for analysis and experimental work.

Physical and chemical characteristics of the studied soils were done according to the method described by **Black *et al.* (1965)** as shown in Table 1.

Mineral fertilizers (NPK)

Inorganic fertilizers which used in this work were ammonium sulphate (20.5%N) as source of nitrogen, ordinary superphosphate (P_1, 6.6% P) and rock phosphate (P_2,13.1 % P) as source of phosphorus and potassium sulphate (K_1, 33.1% K) and feldspar (K_2, 9.96% K) as source potassium.

Organic manures

Three types of organic manure *i.e.*, clover straw (CS), sunflower teflon (ST) and banana peel (BP) residues were used in this work.

Some characteristics of organic wastes were determined according to **Black *et al.* (1965)** and tabulated in Table 2.

Biofertilizers

Nitrobein (Nit) a commercial fertilizer contains nonsymbiotic N_2- fixing bacteria (*Azotobacter, Achromobacter* 10^6cell g^{-1}beat), it has an effective role of increasing nitrogen for plants. Phosphorein a commercial fertilizer contains P- dissolving bacteria (PDB) (*Bacillus megatherium* 10^6cell g^{-1}beat), which dissolves the unavailable P forms to available P forms. Potassiumag a commercial fertilizer contains K-bearing minerals dissolving bacteria, which dissolves the K-silicate minerals to available K forms. All the biofertilizers obtained from the Soil Microbiology Unit of the Soil, Water and Environment Research Institute of the Agriculture Research center, Giza, Egypt.

Biological Greenhouse Experiment

Pot experiment was carried out under greenhouse condition at the experimental farm, Faculty of Agriculture, Zagazig University during the winter growing season, 2017. The applied mineral fertilizers in this work are ammonium sulphate as source of nitrogen at rates of 25 mg N kg^{-1} soil [50% of the recommended dose (RD)] and 50 mg N kg^{-1} soil (100% RD) and ordinary superphosphate (P_1) and rock phosphate (P_2) as source of phosphorus at rates of 9.72 mg P kg^{-1} soil (50% RD) and 19.44 mg P kg^{-1} soil (100% RD) as well as potassium sulphate (K_1) and feldspar (K_2) as source of potassium at rates of 20.8 mg K kg^{-1} soil (50% RD) and 41.5 mg K kg^{-1} soil (100% RD). The organic amendments *i.e.* clover straw (CS), sunflower seed teflon (ST) and banana peel (BP) were added at the rate of (0.5%).

100 g of each nitrobein (nit), phosphate dissolving bacteria (PDB) and potassiumage (pot) as biofertilizers were mixed throughly with some wetted wheat grains by liquid gum after that the inoculation grains were left for half an hour before sowing.

This experiment was conducted to study the effect of mineral, organic and biofertilization on yield and some macronutrients (NPK) uptake by wheat plants grown on clayey and sandy soils.

Table 1. Some physical and chemical properties of the investigated soils

Soil characteristic	Soil location		Soil characteristic	Soil location	
	Hihia	El-khattara		Hihia	El-khattara
Soil particle size			pH^{*}	8.2	8.37
distribution			EC^{**},dSm^{-1}	2.1	0.78
Sand (%)	30.6	83.31	Soluble ions, mmolc l^{-1}		
Silt (%)	20.3	6.59	Ca^{++}	7.9	2.46
Clay (%)	49.1	10.1	Mg^{++}	6.1	0.88
Textural class	Clay	Sand	Na^{+}	6.9	3.51
Field capacity (%)	32.3	10.2	K^{+}	0.2	0.95
$CaCO_3$ (gkg^{-1})	10.0	3.0	CO_3^{-}	Nil	-
Organic matter (gkg^{-1})	16.2	3.24	HCO_3^{-}	3.8	2.04
			CL^{-}	10.9	4.13
			SO_4^{-}	6.4	1.63

* Soil-water suspension 1:2.5 ** soil paste extract

Table 2. Some characteristics of organic residues

Organic residue	Characteristics						
	EC* dsm^{-1}	pH**	OM gkg^{-1}	Total N gkg^{-1}	Total P gkg^{-1}	Total K gkg^{-1}	C/N ratio
Clover straw (CS)	0.877	6.2	352.6	61.3	3.01	5.90	3.30
Sunflower seed teflon (ST)	0.009	7.8	485.0	46.1	6.04	11.1	6.03
Banana peel (BP)	0.017	5.2	435.2	36.7	2.03	31.4	6.81

* Organic material – water extract (1: 5)**organic material – water suspension (1: 5)

The experimental treatments were as follow:

- Control
- 100% RD (N P_1 K_1).
- 100% RD (N P_2 K_2).
- 50% RD (N P_1 K_1) +Nit +PDB +Pot.
- 50% RD (N P_2 K_2) +Nit +PDB +Pot.
- 50% RD (N P_1 K_1) +CS + ST + BP.
- 50% RD (N P_2 K_2) + CS + ST + BP.
- 50% RD (N P_1 K_1) + CS + ST + BP + Nit + PDB + Pot.
- 50% RD (N P_2 K2) +CS + ST + BP + Nit + PDB +Pot.

Plastic pots of internal dimensions 20 x 25cm were filled with five kilograms of the soils under investigation. Before planting, the treatments of organic amendments (clover straw, sunflower seeds Teflon and banana peel), phosphatic fertilizers (Superphosphate and rock phosphate) as well as potassium fertilizers (potassium sulphate and feldspar) were thoroughly mixed with the soil samples at the previosly mentioned rates and replicated four times. A randomized complete block design was used. The rates of ammonium sulphate were added after planting. The applied nitrogen rates were divided into three doses, the first dose was applied after planting (15 days) and the second and third doses were added at tillering and booting stages after 45 and 70 days, respectively. Twenty grains of wheat cultivar (*Triticum aestivum*) Misr-1 were seeded per pot. The pots were daily weighed and the soil moisture content was adjusted nearly the field capacity. After germination, plants were thinned to ten plants. The plants were cut off from each pot after 150 days from sowing. Plant samples were dried at 70°C for 72 hours, weighed, grund and analyzed for total nitrogen, phosphorus and potassium. After harvesting, plants were separated into straw and grains. Yield and yield components were recorded. Yield quality expressed as grain protein content in grains was calculated by multiplying N% × 5.7 (**Bishni and Hughes, 1979**) and harvest index = [grains / (grains + straw) × 100] was also calculated. Statistical analysis was carried out according to **Snedecor and Cochran (1990)**.

RESULTS AND DISCUSSION

Straw and Grains Dry Weight

Results in Table 3 show that all the treatments in both clayey and sandy soils realized beneficial increase in the straw and grains dry weight compared to the control treatment. This result may be due to improve hydophysical and chemical properties of the clayey and sandy soils by addition of mineral, organic and biofertilizers to both soils under study. These findings are in agreement with those obtained by **Merwad (2013), Ademba *et al*. (2015), Fouda (2017) and Abd El-Satar (2018)**.

Irrespective of the control treatment, the straw dry weight values ranged between 20.0 and 23.9 (g pot^{-1}) for clayey soil and between 13.3 and 23.5 (g pot^{-1}) for sandy one. The lowest straw dry weight value was obtained with the treatment of 100% RD (NP_2K_2) in the clayey soil and [50% RD (NP_2K_2) + Nit + PDB + Pot] treatment in the sandy soil, while the greatest one was observed with the treatment of [50% RD (NP_1K_1) + CS + ST + BP +Nit + PDB + Pot], when applied to the two soils under study. The values of grains dry weight ranged between 14.9 and 25.9 (g pot^{-1}) for clayey soil and between 10.2 and 20.3 (g pot^{-1}) for sandy soil. The lowest grains dry weight values were found with the treatment of 100% RD (NP_2K_2) in the clay soil and [50% RD (NP_2K_2) + Nit + PDB + Pot] in the sandy soil, while the highest one was recorded with the treatment of [50% RD (NP_1K_1) + CS + ST + BP + Nit + PDB + Pot] in both soils under study. These findings are in agreement with those obtained by **Hassan *et al.* (2002), Merwad (2013) and Abd El-Satar (2018)** who reported that organic residues added to soil not only increase the soil nutrients content, but also enhance growth and activate soil biota, which considerably increase dissolving of insoluble nutrients compounds in soil.

Hassan *et al.* (2002) and Abd El-Satar (2018) found that the combination of PDB with organic materials proved to have a synergistic effect in lowering the pH of the soils.

In general, application of [100% RD (NP_1K_1)] treatment to the used soils show favourable effect on straw and grains dry weight if compared to [100% RD (NP_2K_2)] one. This may be due to the solubility and availability of chemical P and K fertilizers. Also this is actually due to their difference in phosphorus and potassium forms and consequently availability to plants, **Dahdouh *et al.* (2004) and Merwad (2013)**.

Also, in both soils under study, the beneficial effect on straw and grains dry weight was observed with the [50% RD (NP_1K_1) + Nit + PDB + Pot), (50% RD (NP_1K_1) + CS + ST + BP] and [50% RD (NP_1K_1) + CS + ST + BP + Nit + PDB + Pot) treatments as compared to (50% RD (NP_2K_2) + Nit + PDB + Pot), (50% RD (NP_2K_2) + CS + ST + BP) and (50% RD (NP_2K_2) + CS + ST + BP + Nit + PDB + Pot) ones, respectively.

Table 3. Effect of inorganic, organic and biofertilization on straw and grains dry weight (g pot^{-1}) of wheat plants grown on two different soils

Treatment	Clayey soil		Sandy soil	
	Straw dry weight	Grains dry weight	Straw dry weight	Grains dry weight
Control	15.1	10.1	11.7	8.6
100% RD (NP_1K_1)	20.4	15.5	15.5	14.2
100% RD (NP_2K_2)	20.0	14.9	13.7	11.1
50% RD (NP $_1K_1$) + Nit+ PDB + pot	20.9	18.3	14.6	13.3
50% RD (NP $_2K_2$) + Nit+ PDB + pot	20.6	17.3	13.3	10.2
50% RD (NP_1k_1)+ C5+ST +BP	23.7	22.2	22.3	18.9
50% RD (NP_2k_2)+ C5+ST +BP	21.6	20.7	20.5	17.1
50% RD (NP_1K_1) + CS+ST+BP + Nit+PDB+Pot	23.9	25.9	23.5	20.3
50%RD (NP_2K_2)+ CS+ ST + BP+ Nit+PDB+Pot	22.2	23.4	21.2	18.6
LSD 0.05	1.8	3.2	2.3	2.8

N: Ammonium Sulphate; K_1: Potassium sulphate; P_1: Ordinary Super Phosphate
K_2: Feldspar; P_2: Rock Phosphate; ST: Sun Flower seed teflon
CS: Clover straw; BP: Banana Peel; Nit: Nitrobein
PDB: Phosphate dissolving bacteria; Pot: Potassiumage

From the results presented in Table 3 results showed that application of [50% RD (NP_1K_1) + Nit + PDB + Pot], [50% RD (NP_1K_1) + CS + ST + BP] and [50% RD (NP_1K_1) + CS + ST + BP + Nit + PDB + Pot] gave the favourable effect on straw and grains dry weight as compared to the treatment of mineral fertilization (NP_1K_1) applied at the rate of 100% RD to the two tested soils. These results are in agreement with those obtained by **Abdo *et al.* (2010), Merwad (2013), Ali (2017) and Abd El-Satar (2018)**.

Also, the treatments of [50% RD (NP_2K_2) + CS + ST + BP] and [50% RD (NP_2K_2) + CS + ST + BP + Nit + PDB + Pot] showed the same effect on the straw and grains dry weight when compared to the solely treatment of [100% RD (NP_2K_2)], except for the treatments of [50% RD (NP_1K_1) or (NP_2K_2) + Nit + PDB + Pot] in sandy soil which gave lower values of straw and grain dry weights than that of [100% RD (N P_1 K_1)] or [100% RD (NP_2K_2)] treatments.

Regarding to the effect of either singly NPK fertilization or combined with organic and biofertilization on straw and grains dry weight, the trends were in the following ranking: 50% RD (NP_1K_1) + CS + ST + BP + Nit + PDB + Pot> 50% RD (NP_2K_2) + CS + ST + BP + Nit + PDB + Pot > 50% RD (NP_1K_1) + CS + ST + BP > 50% RD (NP_2K_2) + CS + ST + BP > 50% RD (NP_1K_1) + Nit + PDB + Pot > 50% RD (NP_2K_2) + Nit + PDB + Pot >100% RD (NP_1K_1) > 100% RD (NP_2K_2) in the clayey soil and 50% RD (NP_1K_1) + CS + ST + BP + Nit + PDB + Pot > 50% RD (NP_1K_1) + CS + ST + BP > 50% RD (NP_2K_2) + CS + ST + BP + Nit + PDB + Pot > 50% RD (NP_2K_2) + CS + ST + BP >100% RD ($N_1P_1K_1$) > 50% RD (NP_1K_1) + Nit + PDB + Pot > 100% RD (NP_2K_2) > 50% RD (NP_2K_2) + Nit + PDB + Pot in the sandy soil.

In general, the favourable effect of various chemical fertilizers (NP_1K_1) or (NP_2K_2) applied either individualy or combined with organic and biofertilization on straw and grains yield was more pronounced in the clayey soil than in the sandy one, which may be related to the high ammonia loss by volatilization from ammonicial nitrogen fertilizer as well as the low nutrients content in sandy soil. These findings are in agreement with those obtained by **Ali (2017) and El-Sayed (2017)**.

The Biological Yield and Weight of 1000 Grains

Results in Table 4 show that all the treatments in both clayey and sandy soils gave benfecial increase in the straw and grains dry weights compared to the control treatment. These findings are in agreement with those obtained by **Merwad (2013), Ademba *et al.* (2015), Fouda (2017) and Abd El-Satar (2018)**.

Irrespective of the control treatment, the biological yield values ranged between 34.9 and 49.8 (g pot^{-1}) for clayey soil and between 23.5 and 43.8 (g pot^{-1}) for sandy soil. The lowest biological yield value was obtained either with the treatment of [100 % RD (NP_2K_2)] in the clayey soil or [50% RD (NP_2K_2) + Nit + PDB + Pot] treatment in the sandy soil, while the greatest one was observed with the treatment of [50% RD (NP_1K_1) + CS + ST + BP + Nit + PDB + Pot], when applied to the two soils under study.

The values of 1000 - grain weight ranged between 36.0 and 42.8 g for clayey soil and between 30.4 and 44.0 g for sandy soil. The lowest 1000-grain weight values was found with the treatment of [100% RD (NP_2K_2)] in both soils, while the highest one was recorded with either the treatment of [50% RD (NP_2K_2) + CS + ST + BP + Nit + PDB + Pot] in the clay soil or the treatment of [50% RD (NP_1K_1) + CS + ST + BP] in the sandy soil. These findings are similar with those obtained by **Hassan *et al.* (2002), Merwad (2013)**.

Hassan *et al.* (2002) and Mansour *et al.* (2009) found that the combination of biofertilization with organic residues proved to have a synergistic effect in reduction of the soil pH.

Generally, application of [100% RD (NP_1K_1)] treatment to both soils show favourable effects on biological yield and 1000- grain weight if compared to [100% RD (NP_2K_2)] one. This result is according with that obtained by **Dahdouh *et al.* (2004) and Merwad (2013)**. Also, in both soils under study, the beneficial effect on biological yield was observed with the [50% RD (NP_1K_1) + Nit +PDB + Pot], [50% RD (NP_1K_1) + CS + ST + BP] and [50% RD (NP_1K_1) + CS + ST + BP + Nit + PDB + Pot] treatments as compared to the [50% RD (NP_2K_2) + Nit + PDB + Pot], [50% RD (NP_2K_2) + CS + ST + BP] and[50% RD (NP_2K_2) + CS + ST + BP + Nit + PDB + Pot] ones, respectively.

In the clayey soil , the favourable effect on 1000-grain weight was found with the [50% RD (NP_2K_2) + Nit + PDB + Pot], [50% RD (NP_2K_2) + CS + ST + BP] and [50% RD (NP_2K_2) + CS + ST + BP + Nit + PDB + Pot] treatments as compared to the [50% RD (NP_1K_1) + Nit + PDB + Pot], [50% RD (NP_1K_1) + CS + ST + BP] and [50% RD (NP_1K_1) + CS + ST + BP + Nit + PDB + Pot] ones.

In the sandy soil, the beneficial effect on 1000 - grain weight was found with the [50% RD (NP_1K_1) + Nit + PDB + Pot] and [50% RD (NP_1K_1) + CS + ST + BP] treatments as compared to the [50% RD (NP_2K_2) + Nit + PDB + Pot] and [50% RD (NP_2K_2) + CS + ST + BP] ones, while the beneficial effect on 1000 grain weight was recorded with the [50% RD (NP_2K_2) + CS + ST + BP + Nit + PDB + Pot] treatment as compared to the [50% RD (NP_1K_1) + CS + ST + BP + Nit + PDB + Pot] one.

Generally, the favourable effect of various chemical fertilizers (NP_1K_1) or (NP_2K_2) applied either individual or combined with organic and biofertilization on biological yield and 1000 grain weight was more pronounced in the clay soil than in the sandy one, except the treatments of (100% RD (NP_1K_1), (50% RD (NP_1K_1) + CS + ST + BP) and (50% RD (NP_2K_2) + CS + ST + BP) in the clayey soil. These findings are in agreement with those obtained by **Ali (2017) and El-Sayed (2017)**.

Yield Efficiency and Protein Content

Results in Table 5 show that all the treatments in both clay and sandy soils achieved beneficial increase in the harvest index and protein content compared to the control treatment. These findings are in agreement with those obtained by **Merwad (2013), Ademba *et al.* (2015), Fouda (2017) and Abd El-Satar (2018)**.

Regardles of the control treatment, the harvest index values ranged between 42.7 and 52.0% for clayey soil and between 43.4 and 47.8% for sandy soil. The lowest harvest index value was obtained with either the treatment of [100% RD (NP_2K_2)] in the clayey soil or the

Table 4. Effect of inorganic, organic and biofertilization on biological yield (g pot^{-1}) and 1000 grain weight (g) of wheat plants grown on two different soils

Treatment	Clayey soil		Sandy soil	
	Biological yield	1000 grain weight	Biological yield	1000 - grain weight
Control	25.2	34	20.3	28
100% RD (NP_1K_1)	35.9	38	29.7	40
100% RD (NP_2K_2)	34.9	36	24.8	30.4
50% RD (NP $_1K_1$) + Nit+ PDB + pot	39.2	42.0	27.9	34.0
50% RD (NP $_2K_2$) + Nit+ PDB + pot	37.9	42.3	23.5	32.0
50% RD (NP_1k_1)+ C5+ST +BP	45.9	41.0	41.2	44.0
50% RD (NP_2k_2)+ C5+ST +BP	42.3	42.2	37.6	43.0
50% RD (NP_1K_1) + CS+ST+BP+ Nit+ PDB+Pot	49.8	42.0	43.8	38.0
50%RD (NP_2K_2)+ CS+ST+ BP+ Nit+PDB+Pot	45.6	42.8	39.8	40
LSD 0.05	3.1	3.3	3.1	6.3

N: Ammonium Sulphate; K_1: Potassium sulphate; P_1: Ordinary Super Phosphate
K_2: Feldspar; P_2: Rock Phosphate; ST: Sun Flower seed teflon
CS: Clover straw; BP: Banana Peel; Nit: Nitrobein
PDB: Phosphate dissolving bacteria; Pot: Potassiumage

Table 5. Effect of inorganic, organic and biofertilization on harvest index (%) and protein content (%) of wheat plants grown on two different soils

Treatment	Clayey soil		Sandy soil	
	Harvest index (%)	Protein content (%)	Harvest index (%)	Protein content (%)
Control	40.1	17.7	42.4	11.9
100% RD (NP_1K_1)	43.2	18.0	47.8	13.1
100% RD (NP_2K_2)	42.7	18.2	44.8	14.3
50% RD (NP $_1K_1$) + Nit+ PDB + pot	46.7	18.1	47.7	15.4
50% RD (NP $_2K_2$) + Nit+ PDB + pot	45.6	18.2	43.4	15.5
50% RD (NP_1k_1)+ CS+ST +BP	48.4	19.4	45.9	16.0
50% RD (NP_2k_2)+ CS+ST +BP	45.1	19.7	45.5	16.1
50% RD (NP_1K_1) + CS+ST+BP+ Nit+ PDB+Pot	52.0	20.1	46.3	16.3
50%RD (NP_2K_2)+ CS+ ST+ BP+ Nit+ PDB+Pot	51.3	21.1	46.7	16.6
LSD 0.05	5.1	0.2	6.7	0.3

N: Ammonium Sulphate; K_1: Potassium sulphate; P_1: Ordinary Super Phosphate
K_2: Feldspar; P_2: Rock Phosphate; ST: Sun Flower seed teflon
CS: Clover straw; BP: Banana Peel; Nit: Nitrobein
PDB: Phosphate dissolving bacteria; Pot: Potassiumage

treatment of [50% RD (NP_2K_2) + Nit + PDB + Pot] in the sandy soil, while, the greatest one was observed with either the treatment of [50% RD (NP_1K_1) + CS + ST + BP + Nit + PDB + Pot] in the clayey soil or [100% RD (NP_1K_1)] in the sandy one. The values of protein content ranged between 18.0 and 21.1% for clayey soil and between 13.1 and 16.6% for sandy soil. The lowest protein content value was found with the treatment of [100% RD (NP_1K_1)] in both soils under study, while the highest one was recorded with the treatment of [50% RD (NP_2K_2) + CS + ST + BP + Nit + PDB + Pot] in both soils. These findings are in similar with those obtained by **Hassan *et al.* (2002), Merwad (2013) and Abd El-Satar (2018)**.

In general, application of [100% RD (NP_1K_1)] treatment to the used soils appeared favourable effects on harvest index as compared to [100% RD (NP_2K_2)] one and the treatment of [100% RD (NP_2K_2)] to the used soils show favourable effects on protein content if compared to [100% RD (NP_1K_1)] one. This finding is in agreement with that obtained by **Awadalla *et al*. (2012)**.

In the clayey soil, the favourable effect on harvest index was observed with the [50% RD (NP_1K_1)+Nit + PDB + Pot], [50% RD (NP_1K_1)+ CS + ST + BP] and [50% RD (NP_1K_1) + CS+ST + BP+ Nit + PDB + Pot] treatments as compared to the [50% RD (NP_2K_2) + Nit + PDB + Pot, [50% RD (NP_2K_2) + CS + ST + BP] and [50% RD (NP_2K_2) + CS + ST + BP + Nit + PDB + Pot] ones, respectively.

In the sandy soil, the favourable effect on harvest index was noticed with the [50% RD (NP_1K_1)+Nit+PDB+Pot] and [50% RD (NP_1K_1) + CS + ST + BP] treatments as compared to the [50% RD (NP_2K_2) + Nit + PDB + Pot] and [50% RD (NP_2K_2) + CS + ST + BP] ones, while the beneficial effect on harvest index was recorded with the[50% RD (NP_2K_2) + CS + ST + BP + Nit + PDB + Pot] treatment as compared to the [50% RD (NP_1K_1) + CS + ST + BP + Nit + PDB + Pot] ones.

Also, in both soils under study, the beneficial effect on protein content was observed with the [50% RD (NP_2K_2) + Nit + PDB + Pot], [50% RD (NP_2K_2) + CS + ST + BP] and [50% RD (NP_2K_2) + CS + ST + BP + Nit + PDB + Pot] treatments if compared to the [50% RD (NP_1K_1) + Nit + PDB + Pot], [50% RD (NP_1K_1) + CS + ST + BP] and [50% RD (NP_1K_1) + CS + ST + BP + Nit + PDB + Pot] ones.

Generally, the favourable effect of various chemical fertilizers (NP_1K_1) or (NP_2K_2) applied either individual or combined with organic and biofertilizers on harvest index was more pronounced in the clayey soil than in the sandy one, except the treatments of control, [50% RD (NP_1K_1) + Nit + PDB + Pot] and [50% RD (NP_2K_2) + CS + ST + BP] Protein content was more pronounced in the clayey soil than in the sandy soil. These findings are in accordance with those obtained by **Ali (2017) and El-Sayed (2017)**.

N- Uptake by Straw and Grains

Results in Table 6 illustrate that all the treatments in both clayey and sandy soils gave beneficial increase in N- uptake by straw and grains compared to the control treatment. These findings are in agreement with those obtained by **Esmat and Noufal (2007), El-Sayed *et al.* (2006), El-Shouny *et al.* (2008) and Abd El-Satar (2018)**.

Irrespective of the control treatment, N- uptake by straw values ranged between 430 and 690 (mg pot^{-1}) for clayey soil and between 173 and 313 (mg pot^{-1}) for sandy soil. The lowest N- uptake by straw value was obtained with either the [100% RD (NP_2K_2)] treatment in the clay soil or the [50% RD (NP_2K_2)+ Nit + PDB + Pot] treatment in the sandy soil, while the greatest one was observed with either the treatment of [50% RD (NP_1K_1) + CS + ST + BP] in the clay soil or the [50% RD (NP_1K_1) + CS + ST + BP + Nit + PDB + Pot] treatment in the sandy soil. The values of N- uptake by grains ranged between 469 and 911 (mg pot^{-1}) for clayey soil and between 276 and 579 (mg pot^{-1}) for sandy soil.

The lowest N- uptake by grains value was found with either the treatment of [100% RD (NP_2K_2)] in the clayey soil or the [50% RD (NP_2K_2) + Nit + PDB + Pot] treatment in the sandy soil, while the highest one was recorded with the treatment of [50% RD (NP_1K_1) + CS + ST + BP + Nit + PDB + Pot] in both soils under study. These findings are similar with those obtained by **El-Sayed *et al.* (2006), Merwad (2013) and Abd El-Satar (2018)**.

Table 6. Effect of organic, inorganic and biofertilization N-uptake (mgpot^{-1}) by straw and grains of wheat plants grown on two different soils

Treatment	Clayey soil		Sandy soil	
	N-uptake by straw	N-uptake by grains	N-uptake by straw	N-uptake by grains
Control	319	313	129	180
100% RD (NP_1K_1)	571	488	217	326
100% RD (NP_2K_2)	430	469	192	277
50% RD (NP $_1K_1$) + Nit+ PDB + pot	608	567	206	359
50% RD (NP $_2K_2$) + Nit+ PDB + pot	577	554	173	276
50% RD (NP_1k_1)+CS +ST +BP	690	755	312	531
50% RD (NP_2k_2)+ CS+ST +BP	540	714	283	484
50% RD(NP_1K_1) + CS+ST+BP+ Nit+ PDB+Pot	598	911	313	579
50%RD(NP_2K_2)+CS+ST+ BP+Nit+ PDB +Pot	555	866	303	541
LSD 0.05				

N: Ammonium Sulphate; K_1: Potassium sulphate; P_1: Ordinary Super Phosphate
K_2: Feldspar; P_2: Rock Phosphate; ST: Sun Flower seed teflon
CS: Clover straw; BP: Banana Peel; Nit: Nitrobein
PDB: Phosphate dissolving bacteria; Pot: Potassiumage

Generally, application of (100% RD (NP_1K_1) treatment to both soils showed favourable effects on N- uptake by straw and grains if compared to [100% RD (NP_2K_2)] one. These results are accordance with those obtained by **Dahdouh *et al*. (2004) and Merwad (2013)**.

Also, in both soils under study, the beneficial effect on N- uptake by straw and grains was observed with the [50% RD (NP_1K_1) + Nit + PDB + Pot], [50% RD (NP_1K_1) + CS + ST + BP] and [50% RD (NP_1K_1) + CS + ST + BP + Nit + PDB + Pot] treatments as compared to the [50% RD (NP_2K_2) +Nit + PDB + Pot], [50% RD (NP_2K_2) + CS + ST + BP] and [50% RD (NP_2K_2) + CS + ST + BP + Nit + PDB + Pot] ones, respectively.

Generally, the favourable effect of various chemical fertilizers (NP_1K_1) or (NP_2K_2) applied either individual or combined with organic and biofertilizers on N- uptake by straw and grains was more pronounced in the clayey soil than in the sandy one. These findings are in agreement with those obtained by **Ali (2017) and El-Sayed (2017)**.

P- Uptake by Straw and Grains

Results in Table 7 show that all the treatments in both clay and sandy soils gave beneficial increase in P-uptake values by straw and grains compared to the control treatment. These findings are in agreement with those obtained by **Zaghloul and El-Kherbawy (2008) and Silber *et al.* (2010)**.

Regardless of the control treatment, P- uptake by straw ranged between 40 and 71.7 (mg pot^{-1}) for clayey soil and between 26.6 and 47 (mg pot^{-1}) for sandy soil. The lowest P- uptake value by straw was obtained with the [50% RD (NP_2K_2) + Nit + PDB + Pot] treatment in both soils under study, while the highest one was recorded with the treatment of [50% RD (NP_1K_1) + CS + ST + BP + Nit + PDB + Pot] in both soils under study. The values of P- uptake by grains ranged between 89.4 and 207.2 (mg pot^{-1}) for clayey soil and between 51.0 and 101.5 (mg pot^{-1}) for sandy soil. The lowest P-uptake by grains value was found with the treatment of [100% RD (NP_2K_2)] in both soils under study, while the highest one was recorded with the treatment of

Table 7. Effect of inorganic, organic and bio- fertilization on P-uptake (mg pot^{-1}) by straw and grains of wheat plants grown on two different soils

Treatment	Clayey soil		Sandy soil	
	P-uptake by straw	P-uptake by grains	P-uptake by straw	P-uptake by grains
Control	30.2	40.4	23.4	17.2
100% RD (NP_1K_1)	40.8	93.0	31.0	71.0
100% RD (NP_2K_2)	40.2	89.4	27.4	51.0
50% RD (NP $_1K_1$) + Nit+ PDB + pot	41.8	121.5	29.2	66.5
50% RD (NP $_2K_2$) + Nit+ PDB + pot	40.0	91.5	26.6	55.5
50% RD (NP_1k_1)+ C5+ST +BP	71.1	155.4	44.6	94.5
50% RD (NP_2k_2)+ C5+ST + BP	64.8	144.9	41.0	85.5
50% RD (NP_1K_1) + CS+ST+BP+ Nit+ PDB + Pot	71.7	207.2	47.0	101.5
50%RD (NP_2K_2)+ CS+ST+BP+ Nit+ PDB+ Pot	66.6	187.2	42.4	93.0
LSD 0.05	0.3	0.2	0.2	0.2

N: Ammonium Sulphate; K_1: Potassium sulphate; P_1: Ordinary Super Phosphate
K_2: Feldspar; P_2: Rock Phosphate; ST: Sun Flower seed teflon
CS: Clover straw; BP: Banana Peel; Nit: Nitrobein
PDB: Phosphate dissolving bacteria; Pot: Potassiumage

[50% RD (NP_1K_1) + CS + ST + BP + Nit + PDB + Pot] in both soils under study. These findings are in harmony with those obtained by **Omar *et al.* (2012), Mostafa *et al.* (2007) and Al-Oud (2011)**.

Generally, application of [100% RD (NP_1K_1)] treatment to both soils showed favourable effects on P- uptake by straw and grains if compared to [100% RD (NP_2K_2)] one. These results are in accordance with those obtained by **El-Shouny *et al.* (2008)**. Also, in both soils under study, the beneficial effect on P-uptake by straw and grains was observed with the [50% RD (NP_1K_1) + Nit + PDB + Pot], [50% RD (NP_1K_1) + CS + ST + BP] and [50% RD (NP_1K_1) + CS + ST + BP + Nit + PDB + Pot] treatments as compared to the [50% RD (NP_2K_2) + Nit + PDB + Pot], [50% RD (NP_2K_2) + CS + ST + BP] and[50% RD (NP_2K_2) + CS + ST + BP + Nit + PDB + Pot] ones, respectively.

Generally, the favourable effect of various chemical fertilizers (NP_1K_1) or (NP_2K_2) applied either individual or combined with organic and biofertilizers on P- uptake by straw and grains was more pronounced in the clayey soil than in the sandy one. These findings are in agreement with those obtained by **El-Shouny *et al.* (2008)**.

K- Uptake by Straw and Grains

Results in Table 8 indicate that all the treatments in both clayey and sandy soils gave beneficial increase in K-uptake by straw and grains compared to the control treatment. These findings are in agreement with those obtained by **Mostafa *et al.* (2007) and Esmat and Noufal (2007)**.

Regardles of the control treatment, K- uptake by straw values ranged between 226 and 621 (mg pot^{-1}) for clayey soil and between 66.5 and 305(mg pot^{-1}) for sandy one. The lowest K-uptake value by straw was obtained with the [50% RD (NP_2K_2) + Nit + PDB + Pot] treatment in both soils under study, while the highest one was recorded with the treatment of [50% RD (NP_1K_1) + CS + ST + BP + Nit + PDB + Pot] in both soils under study.

The values of K-uptake by grains ranged between 89.4 and 155.4 (mg pot^{-1}) for clayey soil and between 30.6 and 81.2 (mg pot^{-1}) for sandy soil. The lowest K- uptake values by grains were found with either the treatment of [100% RD (NP_2K_2)] in the clayey soil or the [50% RD (NP_2K_2) + Nit + PDB + Pot] treatment in the sandy soil, while the highest one was recorded with the treatment of [50% RD (NP_1K_1)

Table 8. Effect of inorganic, organic and bio- fertilization on K-uptake (mg pot^{-1}) by straw and grains of wheat plants grown on two different soils

Treatment	Clayey soil		Sandy soil	
	K-uptake by straw	K-uptake by grains	K-uptake by straw	K-uptake by grains
Control	90.6	60.6	35.1	25.8
100% RD (NP_1K_1)	388	93.0	204	42.6
100% RD (NP_2K_2)	387	89.4	109	33.3
50% RD (NP $_1K_1$) + Nit+ PDB + pot	271	109.8	160	39.9
50% RD (NP $_2K_2$) + Nit+ PDB + pot	226	103.8	66.5	30.6
50% RD (NP_1k_1)+ CS+ST +BP	521	133.2	246	56.7
50% RD (NP_2k_2)+ CS+ST +BP	518	124.2	245	51.3
50% RD (NP_1K_1) + CS+ST+ BP+ Nit + PDB+Pot	621	155.4	305	81.2
50%RD (NP_2K_2)+ CS+ST+ BP+ Nit+ PDB +Pot	488	140.4	233	74.4
LSD 0.05	0.2	0.2	0.1	0.3

N: Ammonium Sulphate; K_1: Potassium sulphate; P_1: Ordinary Super Phosphate
K_2: Feldspar; P_2: Rock Phosphate; ST: Sun Flower seed teflon
CS: Clover straw; BP: Banana Peel; Nit: Nitrobein
PDB: Phosphate dissolving bacteria; Pot: Potassiumage

+ CS + ST + BP + Nit + PDB + Pot] in both soils under study. These findings are in agreement with those obtained by **Khalil *et al.* (2000) and Ismail *et al.* (2006)**.

Generally, application of [100% RD (NP_1K_1)] treatment to both soils show favourable effects on K-uptake by straw and grains if compared to [100% RD (NP_2K_2)] one. This results are in accordance with that obtained by **Nassar (2007) and Abd Alla (2004)**.

Also, in both soils under study, the beneficial effect on K- uptake by straw and grains was observed with the [50% RD (NP_1K_1) + Nit + PDB + Pot], [50% RD (NP_1K_1) + CS + ST + BP] and [50% RD (NP_1K_1) + CS + ST + BP + Nit + PDB + Pot] treatments as compared to the [50% RD (NP_2K_2) + Nit + PDB + Pot], [50% RD (NP_2K_2) + CS + ST + BP] and [50% RD (NP_2K_2) + CS + ST + BP + Nit + PDB + Pot] ones, respectively.

Generally, the favourable effect of various chemical fertilizers (NP_1K_1) or (NP_2K_2) applied either individual or combined with organic and bio fertilization on K- uptake by straw and grains was more pronounced in the clay soil than in the sandy one. These findings are in agreement with those obtained by **Nassar *et al.* (2006) and Yang *et al.* (2006)**.

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تأثير التســميد المعدني والعضـوي والحيوي على إنتاجية القمح في تربتين مختلفتيــن

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أجريت تجربة أصص في صوبة كلية الزراعة – جامعة الزقازيق لدراسة تأثير التسميد المعدني والعضوي والحيوي علي نمو ومكونات إنتاج نبات القمح وامتصاص عناصر النيتروجين والفوسفور والبوتاسيوم، أضيف سماد كبريتات الأمونيوم (N) كمصدر للنيتروجين بمعدل ٢٥ ملليجرام ن كجم$^{-1}$ تربة (٥٠% من الجرعة الموصى بها)، ٥٠ ملليجرام ن كجم$^{-1}$ (١٠٠% من الجرعة الموصي بها) وسماد سوبر فوسفات العادى (P_1) وصخر الفوسفات (P_2) كمصدر للفوسفور بمعدل ٩.٧٢ ملليجرام فو كجم$^{-1}$ تربة (٥٠% من الجرعة الموصي بها)، ١٩,٤٤ملليجرام فو كجم$^{-1}$ تربة (١٠٠% من الجرعة الموصى بها) وكبريتات البوتاسيوم (K_1) والفلسبار (K_2) كمصدر للبوتاسيوم بمعدل ٢٠.٨ ملليجرام بو كجم$^{-1}$ تربة (٥٠% من الجرعة الموصى بها)، ٤١.٥ ملليجرام بو كجم$^{-1}$ تربة (١٠٠% من الجرعة الموصى بها)، كما أضيفت للتربتين تحت الدراسة مواد عضوية مختلفة منها قش البرسيم (CS) وتفلون ودوار الشمس (ST) وقشر الموز (BP) كمصادر للمادة العضوية بمعدل (٠.٥%) كما لقحت كمية معينة من حبوب القمح بأسمدة حيوية مختلفة منها النيتروبين (nit) بكتريا مثبتة للنيتروجين الجوى والفوسفورين (PDB) بكتريا مذيبة للفوسفور والبوتاسيوماج (Pot) بكتريا مذيبة لسيلكات البوتاسيوم، أوضحت النتائج أن إضافة كبريتات الأمونيوم مع سماد السوبر فوسفات العادي وكبريتات البوتاسيوم بمعدل ٥٠% من الجرعة الموصي بها مخلوطة مع قش البرسيم، تفلون بذور دوار الشمس، قشر الموز وفي وجود البكتريا المثبتة للنيتروجين الجوى والمذيبة للفوسفور والمذيبة لسليكات البوتاسيوم أعطت أعلى قيم من الوزن الجاف للقش والحبوب والمحصول البيولوجى ومعامل الحصاد وكمية النيتروجين الممتصة بالحبوب وكمية الفوسفور والبوتاسيوم الممتصة بالقش والحبوب إذا ما قورنت بباقى المعاملات فى التربتين تحت الدراسة، بينما كانت أعلى قيم فى وزن ١٠٠٠ حبة عند معاملة التربة الطينية بكبريتات الأمونيوم وصخر الفوسفات والفلسبار بمعدل ٥٠% من الجرعة الموصى بها مخلوطة مع قش البرسيم، تفلون بذور دوار الشمس، قشر الموز فى وجود البكتريا المثبتة للنيتروجين الجوى والمذيبة للفوسفور والمذيبة لسليكات البوتاسيوم وأيضا عند معاملة التربة الرملية بكبريتات الأمونيوم والسوبر الفوسفات العادى وكبريتات البوتاسيوم بمعدل ٥٠% من الجرعة الموصى بها مخلوطة مع قش البرسيم، تفلون بذور دوار الشمس، قشر الموز إذا ما قورنت بالمعاملات الأخرى فى التربتين كما وجد أن أعلى قيم للنيتروجين الممتص بالقش تم الحصول عليها عند معاملة التربة الطينية بكبريتات الأمونيوم وسوبر الفوسفات العادى وكبريتات البوتاسيوم بمعدل ٥٠% من الجرعة الموصى بها مخلوطة مع قش البرسيم، تفلون بذور دوار الشمس، قشر الموز وأيضا عند معاملة التربة الرملية بكبريتات الأمونيوم وسوبر الفوسفات العادى وكبريتات البوتاسيوم بمعدل ٥٠% من الجرعة الموصى بها مخلوطة مع قش البرسيم، تفلون بذور دوار الشمس، قشر الموز فى وجود بكتريا المثبتة للنيتروجين الجوى والمذيبة للفوسفور والمذيبة لسليكات البوتاسيوم مقارنة بالمعاملات الأخرى تحت الدراسة، وفى النهاية يمكن استنتاج أن استخدام الأسمدة المعدنية العادية (NP_1K_1) مخلوطة مع المواد العضوية (BP + ST+ CS) والأسمدة الحيوية (Pot + PDB + Nit) قد تقلل من جرعة التسميد المعدنى (NP_1K_1) مما يقلل من تكلفة الإنتاج وكذا تقليل التلوث البيئى.

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