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REDUSING MINERAL FERTILIZERS DOSE OF WHEAT PLANT USING BIOFERTILIZERS: CHEMICAL COMPOSITION AND USE EFFICIENCY OF FERTILIZERS

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ABSTRACT

Pot and field experiments were conducted at the Agric. Exp. Station of El-Mansoura Univ. During the winter season of (2008- 2009) and (2009-2010); respectively to investigate the possibility of partial or entirely substituting bio and organic fertilizers for cultivation of wheat plants instead of inorganic fertilizer. Forty treatments were arranged in split-split block design which were the simple possible combination between, two treatments of farmyard manure; with (FYM) and without it (0) were arranged as main plots. Four treatments of NPK fertilizers at rates of 0, 50, 75 and 100% from the recommended doses by the Ministry of Agriculture and land reclamation (MALR) for wheat plants were randomly located as sup-plots. Wheat seeds were inoculated with biofertilizers and devoted as sub-sub plots as five treatments including; Control, cerealin, phosphoren, K-mg and a mixture of them at rate of 1:1:1.

The obtained results indicated that:

- Adding farmyard manure in both years of the experiment significantly increased the average values of N, P and K% in the leaves, straw and grains and their uptake by wheat plant than those obtained for the untreated plants.
- Increasing NPK- applied level from 50 to 75% and, furtherly to 100% RD significantly increased the aforementioned traits. The highest mean values for the previously mentioned traits were found to be associated with the addition of 100% RD-NPK.
- Inoculation of wheat seedlings with single or mixed biofertilizers was responsible for the statistically increase in the previously mentioned traits. Always, the mixed biofertilizers was pronounced and associated with the heighest mean values for all aforementioned traits.
- Co-inoculation of wheat seeds with (Cerealin), (Phosphoren) and (K-Mg) in single form or as a mixture in combination with the ra tes of NPK-applied in the presence and absence of FYM significantly resulted in high N and P contents in the leaves, straw and grains of wheat plant than those obtained for the untreated plants. In addition, the heighest mean values for the previously mentioned traits were connected with the treatment of 75 % RD + FYM + Mix during both season of the experimentation. On the contrary of this trend, the differences between the values of K% in the grains of wheat plant did not reach the level of significance during both seasons of the experiment.
- However, at any fertilization treatment the use efficiency of N, P and K appeared higher for the plants treated with N, P and K fertilizers at rate of 50% RD in combination with inoculation wheat seeds with the mixture of biofertilizers in the presence of FYM at rate of 20 m^3/fed.

Thus, it could be recommended that inoculation of wheat seeds with the mixture of biofertilizers combined with N, P and K fertilization at the rates of 57, 11

and 14 kg.fed^{-1} respectively, and farmyard manure ; 20m^3.fed^{-1} are considered as the most suitable treatment for realizing the highest economic yield for wheat.

INTRODUCTION

Wheat occupies about 33% of the total winter crop area in Egypt and in the major stable crop, consumed mainly as bread. More than one-third of the daily caloric intake of Egyptian consumers and 45% of their total daily protein consumption is derived from wheat. (Kherallah *et al.,* 2000).

As the universe is going now on the way of clean agriculture and minimizing pollution effects, organic and biofertilizers became of the best management products to improve soil characteristics and productivity. They are considered as the most important factor in reducing the application of the inorganic fertilizers; consequently, reduce the adverse environmental impact of chemicals. The organic acids produced by microbial colonization on the mineral surfaces greatly accelerated the release of mineral elements to solution from feldspar sample. Microbes can enhance mineral dissolution rate by producing and excreting metabolic by-products that interact with the mineral surface. Complete microbial respiration and degradation of particulate and dissolved organic carbon can elevate carbonic acid concentration at mineral surfaces, in soils and in ground water. Micro-organisms can secrete growth promoting substances, e.g., indole acetic acid, gibberellins, cytokinins like substances and auxins. Biofertilization technology has taken a part to minimize production costs and at the same time, avoid the environmental hazards. (Khafagy 1999, Galal *et al.* 2001, Abdel-Malek, 2005, Aziz, 2007, Abbasdokht, 2008, Mohd and Zaki, 2009 and El-Sirafy, 2010).

Microbial inoculation of cereal crop by certain free living N2 fixing bacteria; bacteria solubilizing phosphorous and potassium had a greater important as a new technology, as it minimize the amount of applied chemical fertilizer and reduce the costs of crop production as well as reduce soil pollution. Several free-living bacteria species can fix atmospheric nitrogen such as *Azotobacter* and *Azospirillum* which are prepaired in commercial packets as a biofertilization, such as cerealin and phosphorein which contain bacteria solubilizing soil phosphorus and K-MAG which contain bacteria solubilizing silicate. (El-Zeky, 2005).

The aim of this study:

This investigation has been conducted to evaluate the effect of using biofertilizers composed of active strains of a symbiotic N_2-fixer (Cerealin), phosphate dissolving bacteria (Phosphoren) and potassium releaser silicate bacteria (K-mg) in the presence and absence of FYM on the productivity of wheat for diminishing the adverse evolved from the continues application of chemical fertilizers in high doses and replacing it (at least partially) with biofertilizers cultivation management which so called clean agriculture.

MATERIALS AND METHODS

Pot and field experiments were conducted at the Agric. Exp. Station of El-Mansoura Univ. During the winter season of (2008- 2009) and (2009-2010); receptivity to investigate the possibility of partial or entirely substituting bio and organic fertilizers for cultivation of wheat plants instead of inorganic fertilizer. Forty treatments were arranged in split-split block design which were the simple possible combination between, two treatments of farmyard manure; with (FYM) and without it (0) were arranged as main plots. Four treatments of NPK fertilizers at the rates of 0, 50, 75 and 100% from the recommended doses by the Ministry of Agriculture and land reclamation (MALR) for wheat plants were randomly located as sub-plots. Wheat seeds were inoculated with biofertilizers and devoted as sub-sub plots as five treatments including; control, cerealin, phosphoren, K-mg and a mixture of them at rate of 1:1:1.

Pot experiment: 120 large plastic pots (30 cm. diameter and 40 cm. depth) were used. Each pot was filled with 20 kg air dried soil taken from the surface layer of a private farm near El-Mansoura city. Half of the experimental pots were mixed with farmyard manure at rate of 20 $m^3.fed^{-1}$ as recommended by (MALR) for wheat plants. Each pot recived about 280 gm. On 21th November 2008; 15 seeds of wheat per pot were sown. Three weeks later the plants were thinned to the most suitable ten plants per pot. Throughout the experiment, irrigation was carried at 50% of water holding capacity by watering to the constant weight.

Field experiment: A field experiment was carried out at the farm of Agriculture Fac. El-Mansoura Univ., during the winter season of (2009-2010)**.** The plot area was 6 m^2 (2x3m). Each plot consisted of five rows, 3 m long and 40 cm wide. Wheat seeds cv. Gemmeza10 were planted on 22th November 2009 in hills 20 cm apart on the middle of raw. Two weeks later; plants were thinned to 2 plants per hill. Thus, the plant population could be estimated as about 100000 plants per feddan. Then irrigation was carried out at field capacity. Common agriculture practices known for wheat commercial production were applied as recommended by (M.A.L.R). After that farmyard manure was added to each plot two weeks before sowing wheat seeds, each plot received 20 kg farmyard manure as recommended dose (20 m3/fed) that was equal 14 ton /fed. The soil was analyzed for some physico-chemical properties as shown at Table (1).

Seeds of wheat (*Triticum aestivum L*); variety of Gemmeza10 were divided into equal parts and coated with biofertilizers; cerealin, phosphoren, K-mg and a mixture of them at the rate of 1:1:1. Also, the untreated seeds were studied as a control treatment.

Ripe farmyard manure (FYM) as a source of organic manure was taken from the station of animal production, Faculty of Agriculture, Mansoura University. Before sowing FYM was added at the rate of (20 m^3. fed^{-1}) and irrigated with water at the saturation percentage. Then, left for a month to elucidate the damage on seeds and their roots resulted from the heat of decomposition.

Table (1): Pysical and chemical properties of the used soil during both seasons of 2008 and 2009.

Soil characters		2008-2009	2009-2010
Mechanical analysis (%)	Coarse sand	1.9	1.7
	Fine sand	19.7	15.2
	Silt	28.3	27.4
	Clay	50.1	55.7
	Texture class	Clayey	Clayey
E.C. dS.m^{-1}(1:5)		0.82	1.03
pH (1:2.5)		7.89	8.03
S.P. %		56	61
O.M. %		1.48	1.64
T. $CaCO_3$ %		1.93	1.77
Available (mg/kg)	N	32	46
	P	3.8	3.4
	K	218	225

Table (2): **Some chemical properties of organic manure during both seasons of 2008 and 2009.**

Seasons	O.M%	O.C%	N%	C/N	P%	K%	pH 1:5	E.C ds.m^{-1}
2008-2009	49.3	28.7	1.58	18.2	0.38	1.16	7.62	4.08
2009-2010	46.7	27.2	1.55	17.5	0.41	1.09	7.75	4.06

Urea (46 % N), super phosphate (15.5 % P_2O_5) and potassium sulphate (48 % K_2O) were the respective of N, P and K sources. Four treatments of N, P and K fertilizers at rates of 0, 50, 75 and 100 % from the recommended doses for wheat plants i.e. 75, 15 and 18 kg.fed^{-1} for N, P and K, respectively were used. Treatments of N, P and K fertilizers were divided into two equal doses .The first dose was added after 21 days from sowing and the other two weeks later.

At boating stage (60 days after sowing) six plants were randomly taken from each treatment during both seasons. Plant samples were oven dried at 70^{0}c tell constant weight, the dried plant samples were thoroughly ground and stored for chemical analysis of N, P and K%.

Representative samples of wheat plants were randomly taken from each treatment at harvesting stage (150 days after sowing); separated into grains and straw. Grinned to fine powder then 0.2 gm was wet digested with a mixture of sulfuric Perchloric acid for the different analysis of N, P and K%.

- Mechanical analysis was determined following the international pipette method *(Kilmer and Alexander 1949)*, using NH_4OH as a depressing agent.
- Total carbonate was determined using Collin's calcimeter method *(Piper 1950).*
- Organic matter content was determined using Walkely's rapid titration method (Jackson 1967).
- Available N was measured using the conventional method of Kjeldahl as described by Bremner and Mulvany (1982).

- Available P was extracted with 0.5 M ($NaHCO_3$) adjusted at pH of 8.5 and was determined at a wavelength 660 nm by Spectrophotometer as described by Olsen and Sommers (1982).
- Available K was determined by extracting with ammonium acetate at pH 7 and measured using a flam photometer according to Black (1965)**.**

The oven dried materials of leaves and fruits as well as farmyard manure were ground and wet digested by a sulfuric-percloric acid mixture as described by Peterburgski (1968).

The total N, P and K were determined using the following methods:

- Total nitrogen (%) was determined according to the methods described by Pregle (1945), using micro-Kjeldahl.
- Total phosphorus (%) was determined calorimetrically using the chlorostannus reduce molybdo phosphoric blue colour method in sulphoric system as described by Jackson (1967).
- Potassium (%) was determined using a flame photometer according to Black (1965).
- N, P and K uptake values were calculated by multiplying the percentage of such elements by dry weight of plant.
- N, P, K use efficiency were calculated as grain yield (kg-g) produced due to adding units of fertilizer as following equation:

  - NUE, PUE, KUE = Grain yield /units of N, P, K applied level.

Appropriate analyses of variance were performed using MSTAT-C software *(*Freed, 1988). Mean of treatments were compared using new list significant differences (NLSD) as described by; Waller and Duncan; 1969.

RESULTS

Nitrogen, Phosphorus and Potassium contents:

Data presented in Tables (3, 4 and 5) indicated the average values of N, P and K % in leaves straw and grains of wheat plant as influenced by farmyard manure, NPK-fertilization and bio-inoculation for wheat seeds in the two seasons of 2008-2009 and 2009-2010.

Concerning the effect of FYM data at Tables (3, 4 and 5), reveal that; using FYM in both seasons increased the average values of N, P and K % in leaves, straw and grains of wheat than those obtained for the untreated plants.

Data in the same Tables also showed that; increasing NPK fertilization from 50% to 75% RD significantly increased the average values of N, P and K% in the leaves, straw and grains of wheat plants as compared to the control treatment. Raising the rate of N, P and K-applied from 75 to 100% RD tended to increase the values of aforementioned traits, but rate of increases had no significant effect between the values of these parameters. On other words, the heighest values of these parameters were happened for the plants treated with N, P and K fertilizers at the rate of 75% RD. this was the same during both seasons of the experiment.

The different comparisons tabulated in tables (3, 4 and 5) indicated that; inoculation wheat seeds with single or mixed biofertilizers was responsible for statistically increased in N, P and K % in leaves, straw and grains. The highest mean values for the previously mentioned traits were found to be associated with using mixed biofertilizer (Cerealin + phosphorin + K-Mag). Such effect was happened during both seasons of the experiments.

Table 3: N% in leaves, straw and grains of wheat plants as affected by FYM, NPK-fertilization and bio-fertilization in the two seasons of 2009 and 2010.

Char. / Treat.	N% (leaves)	N% (straw)	N% (grain)
First season (pot exp.)			
A- FYM			
Without	3.25	1.02	3.01
With	3.65	1.17	3.22
L.S.D at 5%	**0.95**	**0.27**	**0.06**
B- N, P and K			
0%	2.85	0.92	2.28
50% RD	3.86	1.09	3.35
75% RD	4.17	1.22	3.64
100% RD	4.19	1.26	3.71
L.S.D $_{at\ 5\%}$	**0.04**	**0.06**	**0.17**
C- Bio-fertilization			
Mix	4.09	1.20	3.46
Cerealin	3.90	1.14	3.26
Phosphorene	3.75	1.10	3.11
K-Mag	3.55	1.05	2.98
Control	3.26	1.00	2.74
L.S.D $_{at\ 5\%}$	**0.08**	**0.02**	**0.16**
Second season (field exp.)			
A- FYM			
Without	3.00	0.94	2.81
With	3.73	1.10	3.34
L.S.D $_{at\ 5\%}$	**0.45**	**0.08**	**0.13**
B- N, P and K			
0%	2.61	0.85	2.44
50% RD	3.54	1.01	3.00
75% RD	3.72	1.14	3.27
100% RD	3.79	1.16	3.28
L.S.D $_{at\ 5\%}$	**0.17**	**0.03**	**0.02**
C- Bio-fertilization			
Mix	3.54	1.11	3.10
Cerealin	3.42	1.06	2.93
Phosphorene	3.33	1.02	2.78
K-Mag	3.27	0.98	2.66
Control	3.06	0.93	2.55
L.S.D at 5%	**0.16**	**0.04**	**0.04**

Table 4: P% in leaves, straw and grains of wheat plants as affected by FYM, NPK-fertilization and bio-fertilization in the two seasons of 2009 and 2010.

Char. / Treat.	P% (leaves)	P% (straw)	P% (grain)
First season (pot exp.)			
A- FYM			
Without	0.328	0.106	0.208
With	0.358	0.112	0.340
L.S.D at 5%	**0.006**	**0.004**	**0.017**
B- N, P and K			
0%	0.224	0.072	0.178
50% RD	0.329	0.107	0.268
75% RD	0.406	0.129	0.326
100% RD	0.413	0.129	0.324
L.S.D at 5%	**0.019**	**0.002**	**0.003**
C- Bio-fertilization			
Mix	0.391	0.124	0.312
Cerealin	0.357	0.114	0.287
Phosphorene	0.346	0.109	0.273
K-Mag	0.320	0.102	0.257
Control	0.301	0.096	0.242
L.S.D at 5%	**0.017**	**0.008**	**0.012**
Second season (field exp.)			
A- FYM			
Without	0.430	0.132	0.351
With	0.492	0.150	0.460
L.S.D at 5%	**0.050**	**0.007**	**0.047**
B- N, P and K			
0%	0.366	0.085	0.296
50% RD	0.452	0.137	0.346
75% RD	0.556	0.169	0.402
100% RD	0.571	0.170	0.438
L.S.D at 5%	**0.020**	**0.002**	**0.050**
C- Bio-fertilization			
Mix	0.530	0.163	0.418
Cerealin	0.490	0.148	0.377
Phosphorene	0.460	0.140	0.353
K-Mag	0.429	0.131	0.327
Control	0.397	0.122	0.302
L.S.D at 5%	**0.016**	**0.012**	**0.001**

Data presented in Tables (6, 7 and 8) indicated the interaction effect between the rates of NPK – applied combined with co-inoculation with Cerealin, phosphorin , K-Mag and Mix treatments in the presence or absence of FYM on the average values of N,P,K % in the leaves, straw and grain yield of wheat plant during both seasons of 2009 and 2010.

It could be observed that; except for the mean values of K% which had no significance differences in the grains of wheat plant during both seasons of the investigation. An application of NPK at rate of 75% + Mix of (Cerealin, phosphorin & K-Mag) + FYM gave the highest values of N, P & K% in the leaves, straw and grain yield of wheat plant during both seasons of 2008-2009 and 2009-2010. The highest values in the 1st season were 4.32,

1.37 & 3.85% for N% and 0.475, 0.150 & 0.457% for P% in the leaves, straw and grains, respectively. Such effect for K% were 3.98 and 1.44% for the leaves and straw, respectively. The same trend was realized in the 2nd season of 2009-2010.

Table 5: K% in leaves, straw and grains of wheat plants as affected by FYM, NPK-fertilization and bio-fertilization in the two seasons of 2009 and 2010.

Char. / Treat.	K% (leaves)	K% (straw)	K% (grain)
First season (pot exp.)			
A- FYM			
Without	2.29	0.95	1.12
With	3.16	1.15	1.33
L.S.D at 5%	**0.070**	**0.01**	**0.06**
B- N, P and K			
0%	1.97	0.76	0.89
50% RD	2.75	1.05	1.22
75% RD	3.10	1.20	1.40
100% RD	3.14	1.22	1.40
L.S.D at 5%	**0.06**	**0.04**	**0.02**
C- Bio-fertilization			
Mix	3.02	1.17	1.36
Cerealin	2.81	1.08	1.27
Phosphorene	2.69	1.04	1.21
K-Mag	2.60	1.00	1.18
Control	2.51	0.95	1.11
L.S.D at 5%	**0.05**	**0.01**	**0.01**
Second season (field exp.)			
A- FYM			
Without	2.63	1.21	1.22
With	3.90	1.38	1.71
L.S.D at 5%	**0.01**	**0.09**	**0.17**
B- N, P and K			
0%	2.36	0.94	1.06
50% RD	3.26	1.30	1.46
75% RD	3.73	1.48	1.67
100% RD	3.75	1.50	1.68
L.S.D at 5%	**0.04**	**0.03**	**0.02**
C- Bio-fertilization			
Mix	3.63	1.44	1.61
Cerealin	3.38	1.34	1.51
Phosphorene	3.23	1.28	1.44
K-Mag	3.13	1.24	1.41
Control	2.96	1.18	1.33
L.S.D at 5%	**0.01**	**0.01**	**0.01**

Nitrogen, Phosphorus and Potassium uptake (mg/plant):

Listed data presented in Tables (9 and 10) reflect the effect of farmyard manure, NPK-fertilization and bio-inoculation on N, P & K uptakes (mg/plant) of wheat plants and its interaction during the two seasons of 2008-2009 and 2009-2010.

Data illustrated that adding of farmyard manure in both years of the experiment significantly increased the average values of N, P and K uptakes of wheat plants than those obtained for the untreated plants.

Table 6: Effect of interaction between FYM, NPK-fertilization and bio-fertilization on N% in leaves, straw and grains of wheat plants during both seasons of 2009 and 2010.

Char. / Treat.		N% (leaves)		N% (straw)		N% (grain)	
		0	FYM	0	FYM	0	FYM
First season (pot exp.)							
0%	Mix	2.84	3.11	1.00	1.18	2.53	2.68
	Cerealin	2.63	2.94	0.92	1.05	2.33	2.52
	Phosphorene	2.46	2.76	0.86	0.98	2.12	2.28
	K-Mag	2.37	2.67	0.78	0.89	2.00	2.16
	Control	2.29	2.57	0.69	0.79	1.91	2.05
50% RD	Mix	3.69	4.14	1.10	1.27	3.41	3.68
	Cerealin	3.51	3.95	1.06	1.22	3.24	3.50
	Phosphorene	3.33	3.73	1.03	1.18	3.20	3.46
	K-Mag	3.26	3.66	0.96	1.10	3.02	3.27
	Control	3.17	3.57	0.92	1.05	2.91	3.15
75% RD	Mix	3.86	4.32	1.19	1.37	3.57	3.85
	Cerealin	3.77	4.20	1.17	1.35	3.47	3.75
	Phosphorene	3.62	4.07	1.13	1.30	3.33	3.59
	K-Mag	3.57	4.01	1.11	1.28	3.28	3.54
	Control	3.51	3.95	1.09	1.25	3.20	3.45
100% RD	Mix	2.78	3.12	1.13	1.30	3.49	3.76
	Cerealin	3.69	4.14	1.10	1.27	3.39	3.66
	Phosphorene	3.62	4.07	1.08	1.24	3.30	3.56
	K-Mag	3.56	3.99	1.06	1.22	3.24	3.50
	Control	3.53	3.96	1.02	1.17	3.21	3.47
L.S.D at 5%		0.03		0.01		0.04	
Second season (field exp.)							
0%	Mix	2.56	3.23	0.94	1.11	2.33	2.78
	Cerealin	2.42	3.05	0.84	0.99	2.18	2.60
	Phosphorene	2.27	2.86	0.79	0.92	1.99	2.36
	K-Mag	2.19	2.76	0.71	0.84	1.88	2.24
	Control	2.12	2.67	0.63	0.75	1.79	2.13
50% RD	Mix	3.40	4.30	1.01	1.19	3.20	3.82
	Cerealin	3.24	4.09	0.97	1.15	3.04	3.62
	Phosphorene	3.07	3.87	0.94	1.11	3.00	3.59
	K-Mag	2.99	3.79	0.88	1.03	2.83	3.38
	Control	2.93	3.69	0.84	0.99	2.73	3.26
75% RD	Mix	3.56	4.49	1.09	1.28	3.34	3.99
	Cerealin	3.45	4.35	1.08	1.26	3.25	3.88
	Phosphorene	3.34	3.21	1.04	1.22	3.12	3.72
	K-Mag	3.30	4.16	1.02	1.20	3.07	3.67
	Control	3.24	4.09	1.00	1.17	3.00	3.58
100% RD	Mix	3.57	4.51	1.04	1.22	3.26	3.90
	Cerealin	3.40	4.30	1.01	1.19	3.17	3.79
	Phosphorene	3.34	4.21	0.99	1.17	3.09	3.68
	K-Mag	3.29	4.15	0.97	1.15	3.04	3.62
	Control	3.26	4.11	0.94	1.10	3.01	3.60
L.S.D at 5%		0.06		0.08		0.12	

Table 7: Effect of interaction between FYM, NPK-fertilization and bio-fertilization on P% in leaves, straw and grains of wheat plants during both seasons of 2009 and 2010.

Char.		P% (leaves)		P% (straw)		P% (grain)	
Treat.		0	FYM	0	FYM	0	FYM
First season (pot exp.)							
0%	Mix	0.249	0.243	0.075	0.077	0.146	0.234
	Cerealin	0.220	0.236	0.071	0.075	0.139	0.227
	Phosphorene	0.214	0.230	0.071	0.073	0.136	0.221
	K-Mag	0.207	0.222	0.069	0.071	0.131	0.213
	Control	0.204	0.218	0.066	0.070	0.129	0.210
50% RD	Mix	0.400	0.429	0.129	0.137	0.253	0.413
	Cerealin	0.329	0.352	0.106	0.112	0.208	0.340
	Phosphorene	0.274	0.340	0.102	0.108	0.200	0.328
	K-Mag	0.295	0.317	0.095	0.101	0.186	0.305
	Control	0.269	0.289	0.087	0.092	0.170	0.278
75% RD	Mix	0.442	0.475	0.142	0.150	0.279	0.457
	Cerealin	0.420	0.451	0.134	0.143	0.265	0.435
	Phosphorene	0.385	0.412	0.124	0.131	0.243	0.398
	K-Mag	0.373	0.401	0.120	0.127	0.236	0.386
	Control	0.338	0.362	0.109	0.116	0.213	0.349
100% RD	Mix	0.431	0.463	0.139	0.147	0.272	0.445
	Cerealin	0.409	0.439	0.131	0.140	0.259	0.423
	Phosphorene	0.393	0.522	0.127	0.135	0.248	0.407
	K-Mag	0.361	0.387	0.116	0.122	0.228	0.373
	Control	0.350	0.375	0.113	0.119	0.221	0.362
L.S.D at 5%		0.008		0.002		0.002	
Second season (field exp.)							
0%	Mix	0.299	0.338	0.090	0.103	0.242	0.313
	Cerealin	0.289	0.329	0.088	0.100	0.234	0.307
	Phosphorene	0.275	0.320	0.086	0.097	0.229	0.299
	K-Mag	0.272	0.310	0.084	0.094	0.220	0.288
	Control	0.268	0.303	0.082	0.093	0.217	0.284
50% RD	Mix	0.527	0.598	0.161	0.182	0.427	0.558
	Cerealin	0.434	0.491	0.131	0.149	0.351	0.458
	Phosphorene	0.418	0.474	0.127	0.143	0.338	0.443
	K-Mag	0.389	0.441	0.118	0.135	0.314	0.412
	Control	0.355	0.403	0.108	0.122	0.287	0.376
75% RD	Mix	0.582	0.661	0.177	0.201	0.471	0.617
	Cerealin	0.554	0.628	0.168	0.191	0.447	0.587
	Phosphorene	0.507	0.574	0.154	0.174	0.410	0.537
	K-Mag	0.492	0.558	0.149	0.169	0.398	0.521
	Control	0.445	0.504	0.136	0.154	0.360	0.472
100% RD	Mix	0.576	0.657	0.173	0.196	0.469	0.617
	Cerealin	0.539	0.611	0.164	0.187	0.437	0.571
	Phosphorene	0.518	0.588	0.158	0.182	0.419	0.549
	K-Mag	0.475	0.539	0.144	0.164	0.385	0.503
	Control	0.461	0.522	0.140	0.159	0.373	0.489
L.S.D at 5%		0.009		0.006		0.004	

Data at the same table reveal that; increasing NPK applied level from 50 to 75% RD significantly increased N, P and K uptakes by wheat plants. The highest mean values were 806.9, 67.0 &599.9 (mg/plant) in the first season and 985.8, 147.3 & 988.5 (mg/plant) in the second season for

nitrogen, phosphorus and potassium uptakes, respectively were recorded for the plants treated with N, P & K fertilizers at the rate of 75% RD.

Table 8: Effect of interaction between FYM, NPK-fertilization and bio-fertilization on K% in leaves, straw and grains of wheat plants during both seasons of 2009 and 2010.

Treat.	Char.	K% (leaves)		K% (straw)		K% (grain)	
		0	FYM	0	FYM	0	FYM
First season (pot exp.)							
0%	Mix	1.82	2.47	0.75	0.90	0.89	1.04
	Cerealin	1.69	2.35	0.71	0.86	0.84	1.01
	Phosphorene	1.64	2.28	0.69	0.83	0.81	0.95
	K-Mag	1.59	2.22	0.67	0.80	0.79	0.94
	Control	1.53	2.13	0.64	0.77	0.75	0.90
50% RD	Mix	2.67	3.70	1.12	1.35	1.30	1.55
	Cerealin	2.27	3.14	0.95	1.15	1.12	1.33
	Phosphorene	2.22	3.08	0.93	1.12	1.09	1.30
	K-Mag	2.18	3.03	0.91	1.10	1.09	1.30
	Control	2.35	2.81	0.85	1.02	0.99	1.16
75% RD	Mix	2.86	3.98	1.20	1.44	1.40	1.66
	Cerealin	2.76	3.83	1.14	1.38	1.36	1.59
	Phosphorene	2.56	3.54	1.07	1.28	1.27	1.51
	K-Mag	2.50	3.47	1.05	1.26	1.24	1.48
	Control	2.33	3.23	0.97	1.17	1.15	1.37
100% RD	Mix	2.81	3.90	1.18	1.42	1.40	1.66
	Cerealin	2.70	3.76	1.12	1.36	1.33	1.58
	Phosphorene	2.59	3.60	1.08	1.30	1.27	1.51
	K-Mag	2.43	3.39	1.02	1.23	1.21	1.44
	Control	2.38	3.30	0.99	1.19	1.18	1.40
L.S.D at 5%		0.03		0.01		N.S	
Second season (field exp.)							
0%	Mix	2.05	3.04	0.94	1.08	0.94	1.33
	Cerealin	1.96	2.89	0.91	1.04	0.91	1.28
	Phosphorene	1.90	2.82	0.88	1.00	0.88	1.24
	K-Mag	1.84	2.73	0.85	0.97	0.85	1.19
	Control	1.77	2.62	0.82	0.92	0.81	1.15
50% RD	Mix	3.09	4.57	1.43	1.62	1.41	1.98
	Cerealin	2.62	3.88	1.21	1.38	1.21	1.70
	Phosphorene	2.56	3.80	1.19	1.35	1.18	1.66
	K-Mag	2.52	3.74	1.16	1.33	1.18	1.66
	Control	2.34	3.47	1.09	1.23	1.07	1.52
75% RD	Mix	3.30	4.90	1.53	1.74	1.51	2.11
	Cerealin	3.19	4.72	1.46	1.66	1.48	2.07
	Phosphorene	2.96	4.37	1.37	1.54	1.37	1.93
	K-Mag	2.89	4.28	1.34	1.52	1.34	1.88
	Control	2.69	3.99	1.24	1.41	1.24	1.75
100% RD	Mix	3.25	4.82	1.51	1.71	1.51	2.11
	Cerealin	3.13	4.63	1.44	1.64	1.44	2.02
	Phosphorene	2.99	4.44	1.38	1.56	1.37	1.93
	K-Mag	2.81	4.18	1.30	1.48	1.31	1.84
	Control	2.75	4.07	1.27	1.44	1.28	1.79
L.S.D at 5%		0.02		0.03		N.S	

Results in Table (11) showed that inoculation wheat seeds with single or mixed biofertilizers (Cerealin, phosphorin, K-Mag) significantly increased the contents of N, P&K uptake (mg/plant) compared with the uninoculated plants. For example ; the rate of increases over the uninoculated plants for phosphorus uptake were accounted to be 28.8, 19.7, 8.7 & 46.5% in the first season and 44.3, 29.5, 15.2 & 63.1% in the second season for the treatments of Cerealin, phosphorin, K-Mag and Mix, respectively. The same trend was happened for N and K uptakes during both seasons of the experimentation.

Table 9: N, P and K uptake (mg/plant) of wheat plants as affected by FYM, NPK-fertilization and bio-fertilization in the two seasons of 2009 and 2010.

Char. / Treat.	N uptake (mg/plant)	P uptake (mg/plant)	K uptake (mg/plant)
First season (pot exp.)			
A- FYM			
Without	516.43	52.12	363.88
With	692.04	67.88	599.14
L.S.D at 5%			
B- N, P and K			
0%	376.77	29.61	260.43
50% RD	691.71	58.96	492.80
75% RD	806.90	78.56	599.85
100% RD	805.32	79.38	603.51
L.S.D $_{at\ 5\%}$			
C- Bio-fertilization			
Mix	675.26	64.55	498.60
Cerealin	699.27	64.01	503.83
Phosphorene	645.00	59.51	462.68
K-Mag	598.53	53.95	438.36
Control	607.34	56.08	467.61
L.S.D $_{at\ 5\%}$			
Second season (field exp.)			
A- FYM			
Without	654.00	93.74	573.34
With	1018.29	134.32	1064.70
L.S.D $_{at\ 5\%}$			
B- N, P and K			
0%	561.15	78.69	507.40
50% RD	863.76	110.29	795.44
75% RD	985.80	147.34	988.45
100% RD	1027.09	154.74	1016.25
L.S.D $_{at\ 5\%}$			
C- Bio-fertilization			
Mix	750.48	112.36	769.56
Cerealin	848.16	121.52	838.24
Phosphorene	789.21	109.02	765.51
K-Mag	739.02	96.95	707.38
Control	792.54	102.82	766.64
L.S.D at 5%			

Statistical analysis of the data in Table (10) clearly showed that co-inoculation of wheat plants with biofertilizer either in single form or as a mixture combined with the rates of NPK-fertilization in the presence and absence of FYM significantly increased the average values of N, P & K uptakes as compared to the control treatment.

Table 10: Effect of interaction between FYM, NPK-fertilization and bio-fertilization on N, P and K uptake (mg/plan) of wheat plants during both seasons of 2009 and 2010.

Treat.	Char.	N uptake (mg/plant)		P uptake (mg/plant)		K uptake (mg/plant)	
		0	FYM	0	FYM	0	FYM
First season (pot exp.)							
0%	Mix	379.14	495.73	33.24	38.73	242.97	393.72
	Cerealin	332.96	442.47	27.85	35.52	213.95	353.68
	Phosphorene	291.02	389.71	25.32	32.48	194.01	321.94
	K-Mag	270.42	364.46	23.62	30.30	181.42	303.03
	Control	252.82	337.70	22.52	28.65	168.91	279.88
50% RD	Mix	654.61	877.68	70.96	90.95	473.66	784.40
	Cerealin	593.54	798.69	55.63	71.17	383.86	634.91
	Phosphorene	533.80	712.80	43.92	64.97	355.87	588.59
	K-Mag	512.15	685.52	46.34	59.37	342.48	567.52
	Control	483.43	652.24	41.02	52.80	358.38	513.39
75% RD	Mix	716.80	956.45	82.08	105.17	531.10	881.17
	Cerealin	684.63	902.16	76.27	96.87	501.22	822.68
	Phosphorene	630.60	847.78	67.07	85.82	445.95	737.38
	K-Mag	613.68	824.06	64.12	82.41	429.75	713.09
	Control	593.54	798.69	57.16	73.20	394.00	653.11
100% RD	Mix	508.74	680.47	78.87	100.98	514.23	850.59
	Cerealin	654.61	877.68	72.56	93.07	478.98	797.12
	Phosphorene	630.60	847.78	68.46	108.73	451.18	749.88
	K-Mag	610.18	816.35	61.88	79.18	416.50	693.59
	Control	600.10	802.69	59.50	76.01	404.60	668.91
L.S.D at 5%		12.25		0.85		2.45	
Second season (field exp.)							
0%	Mix	467.97	748.39	54.66	78.31	374.74	704.37
	Cerealin	418.90	668.26	50.03	72.08	339.28	633.20
	Phosphorene	367.74	587.44	44.55	65.73	307.80	579.23
	K-Mag	341.86	547.86	42.46	61.54	287.22	541.91
	Control	320.33	511.31	40.49	58.02	267.45	501.73
50% RD	Mix	825.86	1327.41	128.01	184.60	750.56	1410.76
	Cerealin	749.74	1202.05	100.43	144.30	606.27	1140.33
	Phosphorene	672.64	1075.47	91.58	131.72	560.90	1056.02
	K-Mag	638.37	1032.40	83.05	120.13	538.02	1018.78
	Control	612.08	978.59	74.16	106.88	488.83	920.24
75% RD	Mix	904.95	1446.68	147.94	212.97	838.86	1578.78
	Cerealin	850.43	1358.07	136.56	196.06	786.34	1473.58
	Phosphorene	797.26	741.19	121.02	132.54	706.55	1009.03
	K-Mag	777.48	1242.59	115.92	166.67	680.88	1278.44
	Control	749.74	1202.05	102.97	148.13	622.47	1172.66
100% RD	Mix	897.14	1431.93	144.75	208.60	816.73	1530.35
	Cerealin	825.86	1327.41	130.92	188.62	760.28	1429.28
	Phosphorene	797.26	1274.37	123.65	177.99	713.71	1343.99
	K-Mag	772.82	1236.29	111.58	160.57	660.07	1245.22
	Control	758.60	1212.86	107.27	154.04	639.93	1201.06
L.S.D at 5%		8.20		1.25		3.15	

In this regard, the most suitable treatment was 75% RD + Mix + FYM that gave the highest values of all an aforementioned traits. The highest values were 956.45, 105.17 & 881.17 (mg/plant) in the first season and 1446.48, 212.97 & 1578.78 (mg/plant) in the second season for nitrogen, phosphorus and potassium uptake, respectively. Further additions of NPK-fertilizers tell the rate of 100% RD had no significant effect on N, P & K uptakes during both seasons of 2008-2009 and 2009-2010.

Use efficiency of N, P and K fertilizers:

As shown in Figs from 1 to 6 it can be observed that cultivated of wheat plant in the presence of FYM stimulated the use efficiency of NPK than those cultivating in the absence of FYM.

Data in the same Figs revealed that; the use efficiency of N, P and K at the rates of NPK of this study reached the maximum with the application of 50% RD from N, P and K fertilizers, whereas it reached the minimum for the plants treated with N, P and K at the rate of 100% RD.

The same data also, showed that at any level of N, P and K fertilization co-inoculation of wheat seeds before sowing with the mixture of biofertilization was superior for increasing the values of N, P and K use efficiency following by cerealin, phosphoren, K-mg and finally the control treatment.

However, at any fertilization treatment the use efficiency of N, P and K appeared higher for the plants treated with N, P and K fertilizers at the rate of 50% RD in combination with inoculation wheat seeds with the mixture of biofertilizers in the presence of FYM at the rate of 20 m^3/fed.

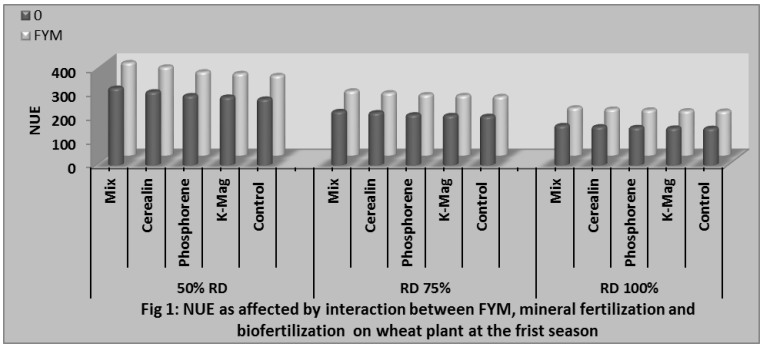

Fig 1: NUE as affected by interaction between FYM, mineral fertilization and biofertilization on wheat plant at the frist season

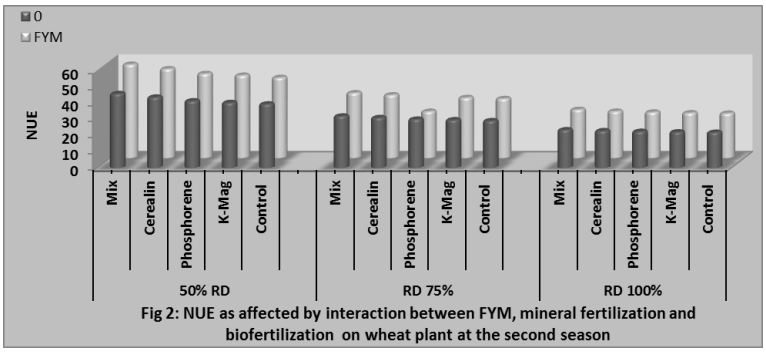

Fig 2: NUE as affected by interaction between FYM, mineral fertilization and biofertilization on wheat plant at the second season

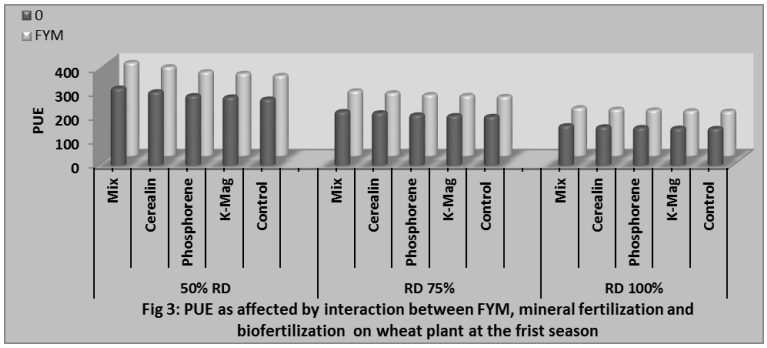

Fig 3: PUE as affected by interaction between FYM, mineral fertilization and biofertilization on wheat plant at the frist season

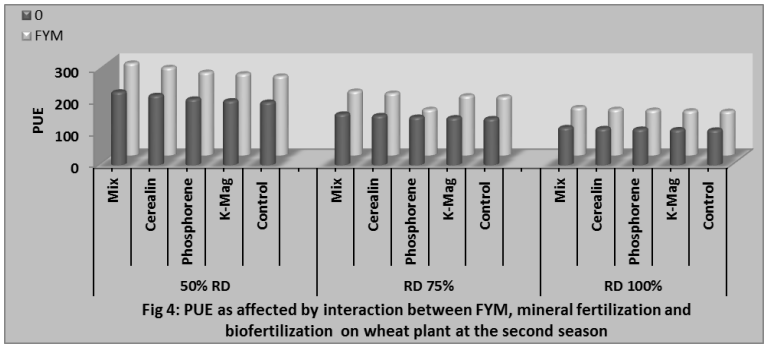

Fig 4: PUE as affected by interaction between FYM, mineral fertilization and biofertilization on wheat plant at the second season

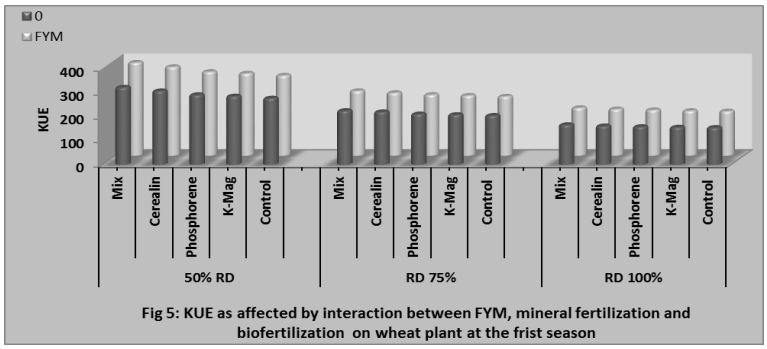

Fig 5: KUE as affected by interaction between FYM, mineral fertilization and biofertilization on wheat plant at the frist season

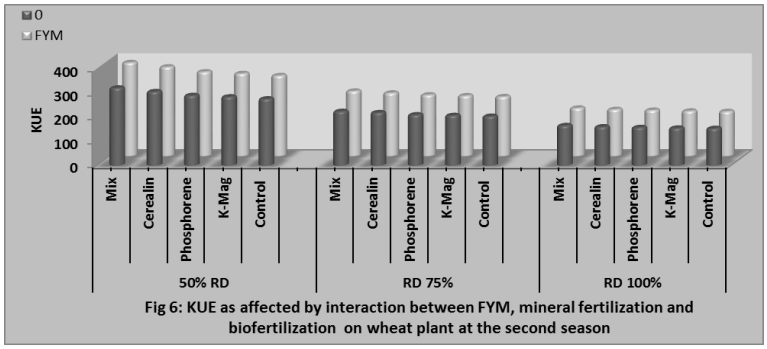

Fig 6: KUE as affected by interaction between FYM, mineral fertilization and biofertilization on wheat plant at the second season

DISCUSSION

Results mentioned previously can be discussed as follow:

The mixed bio fertilizer in combination with FYM and NPK-fertilization at the rate of 75 % RD had remarkable influence on N, P and K contents as well as the use efficiency of NPK fertilizers by wheat plant. These improving effects can be attributed to the role played by N-fixing (Cerealin), P and K solubilizing bacteria (Phosphoren and K-mg) in secreting chelater substances, as organic acids which are important for solubilization of springly soluble inorganic P. Moreover, the hormonal exudates of Azotobacter sp. can modify root growth, morphology and physiology, resulting in more absorption of N, P and K from the soil. These findings matched well with those obtained by ; Mohammed 2002, El-Sirafy 2003, El-Zeky 2005, Han and Lee 2006, Aziz *et al.,* 2007, Bond *et al.,* 2008 and Nasser and El-Gizawy 2009.

The results of these investigations also have proved that; a stimulation effect on the activities of biofertilizers under study was happened due to an addition of FYM. Additionally, using of NPK-fertilizers in higher doses inhibited the activity and growth of these bacteria. Thus , the most suitable treatment , which gave the highest yield was connected the plant treated with the mixture of biofertilizers and NPK-fertilizers at the rate of 75% from the recommended doses in the presence of FYM at the rate of $20m^3.fed^{-1}$. The present results were in agreement with the findings of Abdel-Naser and Hussien 2001, El-Naggar *et al.,* 2005, Hammad *et al.,* 2007, Zeidan 2007, Mukherjee 2008, Nasser and El-Gizawy 2009 and El-Sirafy *et al.,* 2010.

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تقليل استخدام جرعه الأسمده المعدنيه لنبات القمح بإستخدام الأسمده الحيويه: التركيب الكيماوى وكفاءه استخدام السماد .

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أجريت تجربه أصص وتجربه حقليه فى المزرعه التجريبيه لكليه الزراعه – جامعه المنصوره خلال موسمى النمو الشتويين 2008-2009 و 2009-2010 على الترتيب لدراسه امكانيه الاحلال الجزئى او الكلى للاسمده الحيويه والعضويه فى زراعه القمح بدلا من الاسمده المعدنيه. اشتملت التجربه على 40 معامله فى تصميم قطع منشقه مرتين وهى تمثل كل التفاعلات الممكنه بين معاملتى تسميد عضوى فى وجود او عدم وجود سماد المزرعه كقطع رئيسيه و 4 معاملات من التسميد المعدنى NPK بمعدلات صفر, 50 , 75 و 100% من الموصى به بمعرفه وزاره الزراعه واستصلاح الاراضى كقطع منشقه والتلقيح البكتيرى لبذور القمح فى 5 معاملات من التسميد الحيوى تشتمل على السريالين ، والفوسفورين ، K-mg ومخلوط منهم بنسبه 1:1:1 كقطع تحت منشقه.

وقد اظهرت النتائج أن:

- اضافه السماد البلدى فى الموسمين ادى لحدوث زياده معنويه فى كلا من محتوى النبات من النتيتروجين و الفوسفور والبوتاسيوم وكذلك معدل امتصاص الاوراق عن تلك التى لم يضاف اليها السماد البلدى.
- زياده معدل التسميد المعدنى NPK من 50 الى 75 ، 100% ادى لحدوث زياده معنويه فى كل الصفات السابقه وقد سجلت اعلى القيم عند اضافه 100% من السماد المعدنى .
- التلقيح البكتيرى لبذور القمح بالسيريالين و الفوسفورين و K-mg على صوره فرديه ادى لزياده معنويه لكل الصفات السابقه وسجلت معامله المخلوط زياده واضحه فى كل الصفات.
- التلقيح البكتيرى بالاسمده الحيويه سواء على صوره فرديه او كمخلوط فى وجود معدل التسميد المعدنى NPK 75% فى وجود السماد البلدى ادى لحدوث زياده معنويه فى محتوى النبات من النيتروجين والفوسفور سجلت اعلى القيم عند المعامله بـ 75%RD من FYM + NPK +Mix لم تظهر فروق معنويه بالنسبه لمحتوى البذور من البوتاسيوم .
- اظهرت معادله حساب كفاءه التسميد اعلى القيم عند مستوى 50% NPK فى وجود التلقيح البكتيرى بالمخلوط وكذلك السماد البلدى بمعدل 20 م^3/فدان.

الاستنتاج:

وبذلك يمكننا ان نوصى بالتلقيح البكتيرى لبذور القمح بمخلوط الاسمده الحيويه مع التسميد المعدنى بمعدل 57، 11، 14 كجم/فدان للنيتروجين والفوسفور والبوتاسيوم على الترتيب مع اضافه السماد البلدى بمعدل 20 م^3/فدان وذلك للحصول على اعلى محصول اقتصادى للقمح.

قام بتحكيم البحث

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