Improved Wheat Production During some Agricultural Practices and Reducing Environmental Pollution

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Abstract

Two field experiments were conducted at extension farm, in El-Mansoura Center, Dakahlia district, Egypt, during 1996/97 and 1997/98 seasons to study the effect of different fertilization treatments; times of foliar spraying of super Grow of some wheat cultivars on the chemical composition of grains and straw for reducing pollution. The trails were arranged in a strip split plot design with four replications. The main findings could be summarized as follows:

The recommended NPK fertilization recorded highest concentrations of cadmium, lead, zinc, iron, nitrate, nitrite in grains and concentrations of nitrate and nitrite in straw compared with other fertilization treatment in both seasons. However, the lowest concentrations produced from biofertilization (syrialin + phosphorin + organic fertilizers) compared with other treatment over both seasons.

Foliar application of super Grow at tillering + elongation and or at tillering + heading stages significantly increased the concentration of cadmium, lead, zinc, iron, nitrate, nitrite in grains as well as concentrations of nitrate and nitrite in straw compared with other time of applications over both seasons. However, the lowest concentration of cadmium, lead, iron, zinc, nitrate, nitrite in grains as well as concentrations of nitrate and nitrite in straw produced from foliar application at tillering stage (40 days from sowing) over both seasons.

The three wheat cultivars did not differ in cadmium, lead, nitrate, nitrite concentration in grains and nitrate, nitrite in straw over both seasons. However, the maximum cadmium and lead concentration in grains were produced from the Gemmiza 3 cultivar (0.120 and 0.114 ppm) followed by Sakha 69 cultivar (0.116 and 0.106 ppm) and Sids 8 cultivar (0.117 and 0.109 ppm) over the two seasons. Highest zinc and lead concentrations in grains was obtained from Sakha 69 cultivar followed by Gemmiza 3 and Sids 8 cultivars.

Maximum concentration of cadmium in grains was obtained from adding the recommended NPK fertilization with spraying Super Grow at tillering + heading stages (40 + 80 days from sowing) over both seasons. The highest concentration in grain from adding the recommended NPK fertilization with spraying at tillering + elongation stages (40 and 60 days from sowing) and/or at tillering + heading stages (40 + 80 days from sowing) over both seasons. The minimum concentration of zinc and iron in grain was produced from spraying Super Grow at tillering + elongation stages (40 and 60 days from sowing) and sown Sakha 69 and/or Gemmiza 3 cultivars over both seasons.

Generally, it can be concluded that adding biofertilization of syrialin + phosphorin + organic fertilizer, spraying Super Grow at tillering + elongation stages (40 and 60 days from sowing) and sown sids 8 or Gemmiza 3 cultivars was the most effective treatment for raising wheat productivity and reducing mineral fertilization as well as reducing pollution under environmental conditions of Dakahlia Governorate.

Introduction

Wheat (*Triticum aestivum*, L.) is considered one of the main cereal crops in the world as well as in Egypt and Libya. The importance of wheat as a major food source for man in many countries has increased consistently in the last decade. Increasing wheat productivity is a national target in Egypt and Libya to fill the gap between wheat consumption and production.

The total cultivated wheat area with wheat in Egypt was about million hectars (2.5 million faddans) producing was about 6.3 million tons (42 million ardabs) in 1999 season with an average of 6.76 ton/hectares (18.94 ardab/faddan), (Gomaa, 1999). Meanwhile, the total cultivated area with wheat in Libya was about 30 thousand hectares (12.6 thousand faddans) in 1999 season with a national average of about 5.41 ton/hectares (15.15 ardab /faddan)*.

Environmental pollution, especially by increasing chemical fertilization is one of the most effective factors in the destruction of the biosphere components. Among all chemical contaminants nitrate, nitrite and heavy metal particularly in soil and subsequently plants are considered potential hazardous contaminants in the biosphere to human health. The utilization of chemical fertilization on agricultural land introduces harmful substances into soil. When absorbed by wheat plants these contaminants enter the food chain affecting both animal and human.

The nitrates being in water and food have serious effects, as they cause diseases for children and ruminant animals called “Methemoglobinemia” that caused a high ratio of mortality for children and animals, while the adult can endure nitrates being in water. These diseases are caused when the child or animal drink water full of high ratio of nitrates or take food full of a high ratio more than 10 parts of million and, in this case the nitrates are to be reduced in the bowels to nitrates that are to be absorbed in the blood current, then combined with hemoglobin transforming it to methemoglobin, and blood comes to be in capable of carrying oxygen during respiration. Of the bad effects that are possible for nitrification process is composing of nitrosamines compounds and these consist by combining of nitrite (whether consisted by ammonia oxidation or nitrates reduction) with some products of insecticides decay. It has become evident that these compounds cause cancer and cells mutation (W.H.O., 1984). According to Bergstrom and Brink (1986), it is reasonable to expect that the loss of nitrate by leaching occurs more readily than ammonium especially in coarse-texture soils. Ammonium may be retained in soils as an exchangeable ion on clay surface or it may from relatively stable complexes with some organic substances. Ibrahim (1990) found that the concentration of NH_4-N and NO_3-N in the drainage water from silty clay soils is much higher than from clay soil. Tahoun *et al.* (1993) did a quantitative estimate of nitrogen losses from Egyptian soils. Fields with tile drain facilities were monitored for nitrogen inputs and outputs. They found that leaching losses of nitrogen from soils under corn ranged between 7 and 49 kg/fad. Also, Sveda *et al.* (1992) found that ammonium fertilizers and urea may undergo loss by volatization soon after application but, denitrification and leaching loss may occur later when the NH_4-N has been oxidized to NO_3-N.

Plant absorb nitrogen from soil in the nitrate form or ammonium or both depending on the availability of each. As early as El-Baisary *et al.* (1982) studied the effect of N applied as calcium ammonium nitrate or urea to wheat plant. They stated that the amount of nitrogen accumulated in grains was less with calcium ammonium nitrate than with urea. In addition, the amount of nitrogen in straw greatly affected by nitrogen application without significant differences among nitrogen forms. In another study, Mabler *et al.* (1994) found that grain yield of wheat and nitrogen use efficiency were insignificant affected when NH_4NO_3 or urea were used.

Toxic metals derived from soil parent materials usually constitute by far the major group in soils. Hassan (1997) cited from literature that cadmium pollution of the environment has been rapidly increasing in recent decades as a result of rising consumption of cd by industry. Unlike pb and cu which have been utilized for centuries, cd had only been widely used this century. More than half of the cd ever used in industry was produced in the last 25 years. Hutton (1982), also mentioned that sources of soil contamination by cd are the mining and smelting of pb and zn, atmospheric and soil pollution. He has also added that phosphate fertilizers are an important example of cd impurity and their continual use has led to significant increases in the cd, zn, fe, content of many agricultural soils.

The objectives of this investigation was to study the utilization of some agricultural practices to improve wheat productivity for the three evaluated wheat cultivars, Sakha 69, Sids 8 and Gemmiza 3 through different fertilization treatments, time of foliar nutrients application and their interaction. Minimizing the environmental pollution with the mineral fertilizers, in particular nitrogenous ones is considered among the study targets.

Materials and Methods

Two field experiments were conducted in Mansoura Center, Dakahlia Governorate, during 1996/97 and 1997/98 seasons. This investigation was aimed to study the effect of different fertilization treatments

1- without
2- recommended NPK (70 kg N, 23 kg P_2O_5 and 25 kg K_2O/fad)
3- 40 m^3 farmyard (FYM) manure/fed
4- inoculation grains of syrialin (400) + phosphorin (600) + 40 m^3 organic fertilizer/fed. 5- inoculation grains of syrialin (600) + phosphorin (600) + 40 m^3 organic fertilizer/fed and
5- syrialin 800 gm /fad + phosphorin 800 gm /fad + organic fertilizer at rate 40 m^3 /fad.

Times of foliar nutrition of Super Grow nutrient at tillering (40 days from sowing), at elongation (60 days from sowing), at heading (80 days from sowing), at tillering + elongation stages, at tillering + heading stages on growth, yield and yield components of the three wheat cultivars i.e. Sakha 69, Sids 8 and Gemmiza 3.

A strip split plot design with four replications was used. The horizontal plots were devoted as above mentioned six fertilization treatments. The vertical plots were allocated with the five times of foliar application of Super Grow nutrients as above mentioned. The sub plots were occupied by the chosen three wheat cultivars, namely Sakha 69, Sids 8 and Gemmiza 3. The sub plots area was 3.0 x 3.5 m (10.5 m^2) i.e. 1/400 fad. The recommended of nitrogen fertilization in the form of urea (46.5 % N) was used at a rate of 70 kg N /fad and applied in two equal portions with the first watering and before the second watering. Calcium super phosphate at a rate of 150 kg/fad (15.5 % P_2O_5) and potassium sulphate at a rate of 50 kg K_2O/fad (50 % K_2O)

were added during land preparation. Bacterial inoculation of wheat grains was done immediately before sowing irrigation. Bio-fertilizer included Azotobacter, Azosprillum and Bacillus bacteria and obtained from A.R.C. Ministry of Agriculture. Organic fertilizer as farmyard manure was taken from dairy farm, Agric. Experiments Station Fac. of Agric. Mansoura Univ. and it contents showed in Table 1. Foliar application of Super Grow 20-20-20 at a rate of 50 gm/300 liter water was used in this study. Super Grow contains of 20 % of total nitrogen, 20 % available phosphoric acid (P_2O_5), 20 % soluble potash (K_2O), 0.15 % Fe, 0.05 % Mn, 0.05 % Cu, 0.005 % Mo, 0.2 % S, 0.15 % Zn, 0.05 % Mg, 0.05 % Ca and 0.02 % B. Grains of wheat cultivars were obtained from Wheat Breeding Section, A.R.C. The experimental soil was loamy clay texture, the mechanical and chemical analysis of experimental soil are presented in Table 2. Water samples were collected from the different drains passing through the area and used in irrigating the soils at different periods. Also, water samples were taken from normal canal (Dommitta branch) to represent Nile water, the chemical composition of Nile water from normal canal (Dommitte branch) are presented in Table 3.

Table 1: Chemical analysis of the Farmyard manure in the two seasons.

PH	Organic carbon %	Total nitrogen %	C/N ratio %	Total phosphorus %	Total potassium %
7.21	19.35	1.46	13.1	0.26	1.41

Table 2: Mechanical and chemical analysis of experimental soil in both seasons.

	Mechanical analysis						
seasons	**Coarse sand %**	**Fine sand %**	**Silt %**	**Clay %**	**Organic matter %**	**pH**	**Total nitrogen %**
1996/97	5.49	19.80	36.29	38.42	1.88	7.80	0.122
1997/98	6.59	18.80	40.41	34.20	1.81	7.75	0.117

In both seasons, wheat was preceded by maize. Grains of wheat cultivars were sown on mid November at a rate of 70 kg/fad in both seasons. At harvest, ten guarded plants of one square meter of each sub plots were taken at random to estimate the following characters:

1- Heavy metals (cadmium, lead, zinc and iron) was estimated in a digestive solution ($HClO_4$ - H_2SO_4 - HNO_3) by an atomic absorption spectrophotometer method according A.O.A.C. (1980).

2- Nitrates in the plant: As described by Singh (1988), 0.1 gm of finely ground sample with 50 ml of 2 % acetic acid in a conical flask was rotary shaken for 20 minutes and filtered. Nitrate was determined in the filtrate according to Bremner (1965).

Table 3: Chemical composition of Nile water from normal canal (Dommitte branch) in 1996/97 and 1997/98 seasons.

Variables	Seasons	
	1996/97	**1997/98**
pH	7.55	7.53
Ec ds/m	0.48	0.47
Soluble anions and cations (mg/L):		
CO_3 (ppm)	---	---
HCO^-_3 (ppm)	3.10	3.09
Cl^- (ppm)	1.42	1.39
SO^{--}_4 (ppm)	0.28	0.22
Ca^{++} (ppm)	1.79	1.77
Mg^{++} (ppm)	1.22	1.21
Na^+ (ppm)	1.55	1.50
K^+ (ppm)	0.24	0.22
Fe (ppm)	0.400	0.300
Mn (ppm)	0.080	0.070
Zn (ppm)	0.070	0.090
Cu (ppm)	0.010	0.020
Co (ppm)	0.050	0.040
Ni (ppm)	0.010	0.010
Cd (ppm)	0.001	0.002
Pb (ppm)	0.050	0.051

Data of the two seasons were subjected to the proper statistical analysis of the technique of analysis of variance of strip split plot design as mentioned by Gomez and Gomez (1984). Treatment means were compared using New Least Significant Differences (N.L.S.D.) test at 5 % and 1 % level of probability.

Results and Discussion

A- Fertilization treatments effects:

Data presented in Tables 4 and 5 show that fertilization treatments significantly affected the concentrations of cadmium, lead, zinc, iron, nitrate, nitrite in grains and nitrate, nitrite in straw over both seasons. Adding the treatments of recommended NPK fertilization as mineral fertilization produced highest concentration of cadmium, lead, zinc, iron, nitrate, nitrite in grains and nitrate, nitrite in straw compared with other treatments over both seasons, which were 0.204, 0.177, 40.50, 38.35, 4.140, 0.198 ppm in the grains and 3.168, 0.136 ppm in the straw, respectively. In addition, the lowest concentrations produce from without fertilization treatment followed by bio-fertilization treatments

B- Time of foliar nutrition effects:

Super Grow foliar application at different stages significantly affected concentrations of cadmium, lead, zinc, iron, nitrate, nitrite in grains and nitrate, nitrite in straw as presented in Tables 4 and 5. Foliar application of Super Grow at tillering + elongation and/or at tillering + heading stages maximized concentrations of cadmium, lead, iron, nitrite in grains and nitrate, nitrite in straw compared with other times of spraying in both seasons. Meanwhile, foliar spraying of Super Grow at tillering + elongation stages significantly maximize concentrations of zinc and nitrate in grains compared with other time of spraying in both seasons. In addition, the lowest concentration produce from foliar spraying at tillering stage.

C- Cultivar performance:

Data presented in Tables 4 and 5 show that tested cultivars significantly differed in concentrations of zinc and iron in both seasons. Maximum concentration of iron in grains were obtained from sown Gemmiza 3 cultivar followed by Sakha 69 and Sids 8 cultivar came in the last rank, which were 29.39, 29.08 and 28.80 ppm over both seasons. Meanwhile, the highest concentration of zinc in grains were obtained from sown Sakha 69 cultivar followed by Gemmiza 3 and Sids 8 cultivars came in the last rank, which were 28.25, 28.11 and 27.64 ppm over both seasons. Over both seasons, concentrations of cadmium, lead, nitrate, nitrite in grains and nitrate, nitrite in straw of wheat cultivars was not significantly affected in wheat cultivars, but Gemmiza 3 cultivar tended to be the highest as shown in Tables 4 and 5.

D- Significant interaction effects:

The interaction between fertilization treatments and times of foliar nutrient application significantly affected concentrations of Cadmium and lead in both seasons as shown in Table 6. Maximum concentration of cadmium was obtained from adding recommended NPK fertilization and foliar application at tillering + heading stages over both seasons compared with other treatments. Meanwhile, the highest concentration of lead was obtained from adding recommended NPK fertilization and foliar application at tillering + elongation and/or at tillering + heading stages, which were 0.205 and 0.207 ppm with insignificant differences over both seasons. The lowest concentrations of cadmium and lead in grains were produced from the interaction between without fertilization treatment and foliar application at all stages with insignificant differences over both seasons.

The interaction between times of foliar application and some wheat cultivars significantly affected concentration of zinc and iron in both seasons as presented in Table 7. Maximum concentration of zinc and iron were produced from foliar application os super grow at tillering + elongation and/or at tillering + heading stages and sown Sakha 69 or Gemmiza 3 cultivars in both seasons, which were 29.73, 30.17 and 31.32, 31.37 ppm and/or 29.35, 29.38 and 31.35, 31.76 ppm respectively. All interactions had insignificant effects on concentration of nitrate, nitrite in grains and nitrate, nitrite in straw over both seasons indicating that each both the three tested factors acted separately.

Table 4: Means of cadmium, lead, zinc and iron concentrations in grains (ppm) as affected by fertilization treatments, time of foliar nutrition of some wheat cultivars over both seasons.

Characters Treatments	Concentrations in grains (ppm)			
	Cadmium	**Lead**	**Zinc**	**Iron**
A: Fertilization treatments				
Without fertilization	0.060	0.051	18.80	19.46
NPK fertilizer (Recom.)	0.204	0.177	40.50	38.35
Organic fertilizer	0.115	0.111	29.79	28.63
S 400+P 400+O40	0.108	0.105	27.79	28.96
S 600+P 600+O40	0.107	0.106	25.53	29.58
S 800+P 800+O40	0.111	0.107	25.59	29.56
F-Test	*	*	**	*
N-LSD at 5 %	0.003	0.002	0.43	0.37
N-LSD at 1 %	---	---	0.58	---
B: Time foliar nutrition				
At tillering stage	0.098	0.091	24.56	25.58
At elongation stage	0.118	0.109	28.13	27.06
At heading stage	0.121	0.112	28.55	30.07
At tillering + elongation	0.125	0.119	29.61	31.33
At tillering + heading	0.126	0.119	29.16	31.40
F-Test	*	*	**	*
N-LSD at 5 %	0.001	0.004	0.25	0.25
N-LSD at 1 %	---	---	0.34	---
C: Cultivars				
Sakha 69	0.116	0.106	28.25	29.08
Sida 8	0.117	0.109	27.64	28.80
Gemmiza 3	0.120	0.114	28.11	29.39
F-Test	N.S	N.S	**	**
N-LSD at 5 %	---	---	0.21	0.20
N-LSD at 1 %	---	---	0.27	0.26

S= Syrialin , P= Phosphorin and O= Organic fertilizer

Table 5: Means of nitrate, nitrite concentration in grains and straw (ppm) as affected by fertilization treatments, time of foliar nutrition of some wheat cultivars over both seasons.

Characters / Treatments	Concentrations in grains		Concentrations in straw	
	Nitrate (ppm)	Nitrite (ppm)	Nitrate (ppm)	Nitrite (ppm)
A: Fertilization treatments				
Without fertilization	2.122	0.102	1.021	0.044
NPK fertilizer (Recom.)	4.140	0.198	3.168	0.136
Organic fertilizer	3.242	0.129	2.424	0.109
S 400+P 400+O40	3.046	0.135	2.342	0.102
S 600+P 600+O40	2.837	0.128	2.329	0.098
S 800+P 800+O40	2.955	0.127	2.331	0.106
F-Test	*	*	**	*
N-LSD at 5 %	0.008	0.003	0.014	0.003
N-LSD at 1 %	---	---	0.019	---
B: Time foliar nutrition				
At tillering stage	2.551	0.125	2.087	0.083
At elongation stage	2.908	0.136	2.267	0.096
At heading stage	3.246	0.139	2.309	0.104
At tillering + elongation	3.306	0.141	2.342	0.106
At tillering + heading	3.274	0.142	2.340	0.106
F-Test	**	*	*	*
N-LSD at 5 %	0.008	0.002	0.007	0.003
N-LSD at 1 %	0.010	---	---	---
C: Cultivars				
Sakha 69	3.058	0.143	2.277	0.100
Sida 8	3.043	0.134	2.255	0.099
Gemmiza 3	3.069	0.133	2.275	0.098
F-Test	N.S	N.S	N.S	N.S
N-LSD at 5 %	---	---	---	---
N-LSD at 1 %	---	---	---	---

S= Syrialin , P= Phosphorin and O= Orgaic fertilizer

Table 6: Means of cadmium and lead concentrations in grains (ppm) as affected by the interaction between fertilization treatments and time of foliar nutrients over both seasons.

Characters / Treatments		Concentrations in grains (PPm) Cadmuim	Lead
Without fertilization	At tillering stage	0.058	0.050
	At elongation stage	0.058	0.049
	At heading stage	0.060	0.051
	At tillering +elongation	0.062	0.055
	At tillering + heading	0.062	0.051
NPK fertilizer (Recom.)	At tillering stage	0.158	0.133
	At elongation stage	0.200	0.175
	At heading stage	0.212	0.167
	At tillering +elongation	0.225	0.205
	At tillering + heading	0.226	0.207
Organic fertilizer	At tillering stage	0.109	0.103
	At elongation stage	0.117	0.110
	At heading stage	0.118	0.117
	At tillering +elongation	0.117	0.112
	At tillering + heading	0.114	0.115
Syrialin 400 + phosphorin 400 + organic 40	At tillering stage	0.082	0.083
	At elongation stage	0.113	0.105
	At heading stage	0.111	0.107
	At tillering+elongation	0.117	0.115
	At tillering + heading	0.116	0.115
Syrialin 600 + phosphorin 600 + organic 40	At tillering stage	0.082	0.085
	At elongation stage	0.111	0.107
	At heading stage	0.111	0.112
	At tillering +elongation	0.112	0.113
	At tillering + heading	0.119	0.113
Syrialin 800 + phosphorin 800 + organic 40	At tillering stage	0.099	0.090
	At elongation stage	0.110	0.106
	At heading stage	0.112	0.115
	At tillering+elongation	0.119	0.111
	At tillering + heading	0.117	0.111
F-Test		**	**
N-LSD at 5 %		0.007	0.006
N-LSD at 1 %		0.009	0.008

Table 7: Means of zinc and iron concentrations in grains (ppm) as affected by the interaction between time of foliar nutrients and wheat cultivars over both seasons.

Characters		Concentrations in grains (PPm)	
Treatments		Cadmuim	Lead
At tillering stage	Sakha 69	25.13	25.98
	Sids 8	24.31	25.45
	Gemmiza 3	24.23	25.32
At elongation stage	Sakha 69	28.70	26.67
	Sids 8	27.64	26.48
	Gemmiza 3	28.05	28.02
At heading stage	Sakha 69	28.36	30.07
	Sids 8	28.54	29.66
	Gemmiza 3	28.74	30.48
At tillering+elongation	Sakha 69	29.73	31.32
	Sids 8	28.94	31.29
	Gemmiza 3	30.17	31.37
At tillering + heading	Sakha 69	29.35	31.35
	Sids 8	28.76	31.10
	Gemmiza 3	29.38	31.76
F-Test		**	**
N-LSD at 5 %		0.51	0.49
N-LSD at 1 %		0.67	0.65

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