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EFFECT OF UREA FERTILIZATION AND SULFUR APPLICATION AS SOIL AMENDMENT ON GROWTH, QUALITY AND CHEMICAL COMPOSITION OF WHEAT

BY

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CHAPTER 1

INTRODUCTION

Economic development of modern society depends on field crops as materials necessary directly or indirectly, for human consumption.

Wheat (*Triticum aestivum*, L.) is the most important cereal crop in the world in terms of area and production and it is a stable food for more than one third of the world population. Wheat contributes more calories and protein in the world diet than any other food crop.

In Egypt, wheat is the main winter cereal crop. It is used as a stable food grain for urban and rural societies and as a major source of straw for animal feeding. The wheat area over the last 8 years (1998-2006) has been expanded in the old cultivated land (2.500 million feddan[*]) and about 0.6 million feddan in new land on valley, wheat covers a total area of about three million feddan, which produce about 8 million tons annually.

However, total wheat consumption has increased drastically due to overall population growth of about 2.5% per year. Therefore, Egypt imports about 45 percent of wheat requirements. This reflects the size of the problem and the needed efforts to increase wheat production. Thus, increasing production per unit area of wheat appears to be one of the important factors for the application of nitrogen fertilization and sulfur application.

Nitrogen plays essential role in plant biochemistry and physiology. Nitrogen fertilizer of wheat crop cause increases tiller density and tiller fertility with the overall effect determined by the rate and timing of application. Consequently, with few exceptions; increased nitrogen application gives increased ear population density at harvest.

The sharp rise in the requirement of wheat for nitrogen just before stem extension, most of research work indicated that, the considerable variation in the response of ear population density to N among seasons and sites might be the consequence of variation in the timing of N application and availability in relation to crop demand. The influence of nitrogen fertilization on the number of grains per ear is also normally positive, but the effects tend to be smaller than for ear population density for wheat. Detailed studies of ear development have revealed that, increased availability of nitrogen is associated with, improved spikelets fertility and more grains per fertile spikelets, but it has relatively little upon the duration of spikelets initiation and ear size, **(Morsy *et al*., 1999 and Attallah *et al*., 2004)**.

Individual grain weight at harvest is determined by the supply of assimilate from current photosynthesis or from storage, during the period of grain – filling from just after anthesis to maturity. Since nitrogen fertilizer causes increases in dry matter production and

[*] Agricultural statistics, Economic Affairs sector, Ministry of Agricultural and land Reclamation, MOALR, Egypt.

leaf area duration, it might be expected that, cereal grains would tend to be heavier with increasing application of nitrogen. However, by the time of anthesis, the level of fertilization has already determined the number of grains per unit area, by the degree of stimulation of tiller fertility, spikelets initiation and flore fertility. **(Shalaby, E.E., 1986).**

Sulfur is one of the most important nutrients, it used as soil amendments, which promotes the soil physical and chemical properties. Sulfur decreases the PH value at the root Zone, increase the availability of most nutrients in soil. **(Duke and Reisenauer, 1986)**.It plays an important role in protein and lipid metabolism, which account to major component of wheat grain. This is fact due to that sulfur is essential for the synthesis of certain amino acids and vitamins. Sulfur is also presented in some coenzymes including biotin, thiamin and coenzyme A, which are essential for metabolism. **(Mohammed and Kandeel, 1998)**.

The objective of the present study were confined to investigate the effect of urea fertilization and sulfur application as soil amendment and their interaction on growth, grain yield ,yield components , straw yield quality and chemical composition of wheat.

CONTENTS

LIST OF TABLES

CHAPTER 3

MATERIALS AND METHODS

The presented investigation was carried out during the two successive seasons of 2006/2007 and 2007/2008 at the experimental farm of the Faculty of Agriculture, Saba Basha, Alexandria University at Abees, Alexandria, Egypt, to study the effect of urea fertilization and sulfur application as soil amendment on growth, quality and chemical composition of wheat (variety Sakha 93).

Soil samples were taken from the experimental sites from the top 30 cm. The mechanical and chemical properties of the experimental sites are given in **Table (1)**.

The sowing was done by using hand broadcasting methods on November 23th in 2006 and 27th in 2007 respectively. The preceding crop was cotton in the first and second season.

3.1. Experimental design

Split plot design with four replications was used in both seasons of experimentation .Each experiment included 15 treatments. The three sulfur (S) application (0-200 and 400 kg/fed) were distributed at random in the main plots, whereas the five urea fertilization levels (zero, 25, 50, 75 and 100 kg N/fed.) were allocated randomly in the sub-plots. The area of sub-plots was 10.5m^2 ($^1/_{400}$ fed) (3.5m long x 3m width).

3.1.1. Main plots (sulfur application).

- Zero S.
- 200 kg S/fed.
- 400 kg S/fed., during seed bed preparation.

3.1.2. Sub-plots (Nitrogen fertilizations)

The nitrogen fertilizer was applied at five rates. The first rate was added to the control treatment. The four rates (25, 50, 75 and 100 kg N/fed.) were added to the others treatments. The added nitrogen fertilizer was in the form of urea (46,5%N), the amount of nitrogen was divided into three portions; 20% at sowing, 40% was applied immediately before the first irrigation and 40% was applied before the second irrigation.

Phosphorus fertilizer was applied at the rate of 15.5 kg P_2O_5/fed., (100 kg calcium super phosphate) during seed bed preparation other cultural practices were applied as recommended during the two growing seasons.

3.2. Characters studied

3.2.1. Growth analysis

Representative samples plants in ¼ m^2 were taken from each plot at age 75, 95 and 115 days after sowing (DAS) to estimate the following traits:

- Plant height:

Measured as the distance from soil surface to the tip of the spike in cm.

Table (1): Some physical and chemical properties of the soil of experimental soil during 2006/2007 and 2007/2008 seasons

Soil properties	2006/2007	2007/2008
A) Mechanical analysis		
Clay %	41.50	43.30
Sand %	36.00	36.80
Silt %	18.30	18.40
Soil texture	**Clay loam soil**	
B) Chemical properties:		
PH (1 : 1)	7.80	8.20
E.C. (dS/m)	1.85	2.30
1) Soluble cations (1:2) (ml/kg soil) :		
Ca^{++}	4.35	4.50
Mg^{++}	3.40	3.65
Na^{++}	8.80	8.55
K^{+}	0.83	0.87
Available K^{++}	0.91	0.95
2) Soluble anions (1:2) (ml/kg soil):		
$Co^{-}_{3} + HCO^{-}_{3}$	2.50	2.37
Cl^{-}	13.74	14.33
SO^{--}_{4}	0.46	0.52
Calcium carbonate (%)	7.44	8.30
Organic matter (%)	0.84	0.90
Total nitrogen %	0.44	0.40
Available phosphate (mg / kg)	0.37	0.45

- Dry matter accumulation :

The plants were fractioned into stems and leaves then dried to a constant weight in forced draft air oven at 70^{o}C, then the total dry weight in grams per m^2 was computed (g/m^2).

- Number of leaves:

Number of leaves per plant was calculated as an average of the sample plants.

- Leaf area index (LAI):

LAI expresses the ratio of leaf area to the ground area occupied by the crop. The total leaf area was determined by using leaf area meter model CI-203.

- Crop growth rate (CGR):

The increase of plant material per unit of ground area per unit of time

CGR = $(W_2-W_1) / (T_2-T_1)$ g/m2/week **Radford (1967)**

Where W_1 and W_2 respectively refer to dry weight at time (T_1 and T_2)

- Relative growth rate (RGR):

The increase of plant material per unit of material percent per unit of time.

RGR = $(Log_eW_2-Log_eW_1)/(T_2-T_1)$ g/g/week **Radford (1967)**.

- Total chlorophyll content:

It was determined by spectrophotometer apparatus using ten leaves from each plot at 95 and 115days from the planting according to the method that described by **Moran (1982)**.

3.2.2. <u>Yield and yield components</u>

At harvest time, one square meter was taken from each plot to determine the following traits:

- Plant height at harvest :

The length of ten random plants were measured in cm from each plot in cm from soil surface to the tip of the main spike excluding awns.

- Spike length :

Length of ten randomly selected main spikes was measured in cm and their averages were calculated to express mean spike length in cm.

- Number of spikelets/spike:

It was determined asan average number of spikelets of ten main spikes from each plot at harvest time.

- Number of grains/spike:

Average number of grains in ten randomly chosen main spikes, was estimated.

- Number of spikes/m^2

It was estimated by counting all spikes per square meter.

- Number of tillers/ m2

    Was estimated at the number of fertile and sterile tillers/m^2 at harvest.

- 1000 – grain weight :

    Thousand of grains were counted from each plot after harvesting and weighted in grams to nearest (0.019) and the average of the treatments was recorded.

- Straw yield :

    Straw yield was calculated using the following equation

Biological yield (kg/fed)-grain yield kg/fed then it was converted to t/fed.

- Grain yield :

    Recorded from the harvested area after threshing and then converted to t / fed.

- Biological yield :

    Wheat plants were harvested. Guarded square meter from the center of each plot was manually harvested then gathered in bundles.

    The air – dried bundles were weighted and then converted to ton/fed.

- Harvest index :

Harvest index was calculated using the following equation

Harvest index = Grain yield/biological yield X 100.

3.2.3. Chemical composition

Powder of grains was Wet-digested with H_2SO_4 –H_2O_2 digest **(Lowther, 1980)** and the following determination were carried out on the digested solution:

1. Total potassium was determined using the flam spectrophotometer (Koch **and Moowad, 1977)**.
2. Total P was determined using vandate and only phosphoric method **(Jackson, 1967)**.
3. Total N-determined calorimetrically by the Nessler method **(Chapman and Pratt, 1978)**.
4. Protein contents (grain crude protein (%)): Crude protein was determined according to percentage of nitrogen content (5.75) to obtain the percentage of grain protein according to A. O.A.C. (1990).
5. Total S was determined using the atomic adsorption spectro photometer **(Jakson 1967).**
6. Total micronutrient (Fe, Zn, and Ca) were determined using the atomic adsorption spectrophotometer **(Jackson 1967).**
7. Total soluble sugars were determined colorimetrically according to the method of **Malik *and Singh*. (1980)**.Non-reducing sugar were calculated by difference according to the following equation:

    % Non reducing sugar = % total sugar - % reducing sugar

3.3. Statistical analysis

Collected data were statistically analyzed as split plot design experiment, using analysis of variance (ANOVA) according Gomez and **Gomez (1984).** The treatment means were compared using Fishers test at ($P = 0.05$) the least significant difference (L.S.D.) was performed to estimate the significant differences among treatments.