EFFECT OF DIFFERENT NITROGEN AND POTASSIUM LEVELS AND FOLIAR APPLICATION OF BORON ON WHEAT YIELD

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ABSTRACT

From the present study, it could be concluded that the highest concentration of nitrogen in wheat grains was obtained at 90 kg N fed^{-1} in the presence of potassium and spraying with boron. Increasing nitrogen levels increased the amount of nitrogen uptake by grains of wheat. Also the crude protein (%) in grains increased gradually with increasing nitrogen level in the presence of potassium and spraying with boron. The highest concentration of K in grains of wheat was obtained at the high levels of nitrogen in the presence of potassium and spraying with boron. Also the highest amounts of K uptake by the grains of wheat were recorded by the high levels of nitrogen in the presence of potassium and spraying of boron.

Key words: *Nitrogen, potassium, boron, wheat, and foliar applications*

Abbreviations and units:
Fed = Feddan = 4200 m^2 = *0.42 ha*
Ardab of wheat = 150 kg
L.E. = Egyptian pound = 0.16 $ (American dollar)

I. INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important agricultural food and feed crops worldwide. Wheat supplies about 20% of the energy and about 25% of the protein requirements of the world population (***Evans, 1998***). An additional contribution to the human diet is via the nutrition of animals that provide milk and meat. Wheat is such a widely grown crop because it can be used for a wide variety of food products (e.g. bread, cakes, cereals, beer etc.) and secondary products (e.g. starch, gluten etc.) (***Hoegy and Fangmeier, 2008)***. According to the statistical data from FAO in 2009, the wheat harvested area in Egypt was 1321750 ha and the production was 8523000 ton (***FAOSTAT, 2011***).

Wheat crop occupies an outstanding position among the world major crops; it is the most important cereal crop flour for making bread in Egypt.

The consumption of wheat in Egypt is greater than production. The amount of imported wheat is about 50% of the consumption. The increase of wheat production is very important goal and must be achieved.

The solution may be by increasing the yield per unit area, through selection of new high yielding varieties and application of the most favouvrable culture treatments. Supply of wheat with its need of fertilizers, either macro or micro nutrients, is considerd one of the most important factor affecting yield of grains.

It is well known that nitrogen fertilizer exerts significant effect on the growth and yield of wheat plants. Most of the results obtained concering the effect of different levels of nitrogen on wheat showed that grain yield increased with increasing the level of

application up to certain level.

Wheat is more prone to B deficiency than rice and maize, and some dicots including soybean and mungbean. Although it has been reported to adversely affect many processes of wheat growth and development, B deficiency depresses commercial wheat yield primarily through grain set failure, which is in turn caused by male sterility. The function of wheat anthers has been found to be impaired when their B concentration per unit dry weight was 10 times that found limiting for vegetative growth.

The aim of this work is to investigate the effect of nitrogen and potassium levels in the presence and in the absence of boron on wheat yield and its components.

II. MATERIALS AND METHODS

The present investigation was conducted at Kafr El-Sheikh, in the Northern Region of the Nile Delta, Egypt, during 2002. EC = 1.60 dS m^{-1}, pH = 7.9 (1:2.5), O.M. = 1.63 % and available N, K and B were 20, 390 and 0.64 mg kg^{-1}, respectively.

Available N in the soil is extracted by K_2SO_4 and measured by Devarda alloy method according to **Page et al. (1984)**. Available potassium was measured by flame photometer in ammonium acetate extract according to **Jackson (1958)**. Available boron was measured using atomic absorption spectrometry using DTPA extraction according to **Lindsay and Norvell (1978)**.

The experiment was conducted using five nitrogen levels in the form of urea 46.5% (0, 30, 60, 90 and 120 kg N fed^{-1}). The levels of nitrogen were added in the presence and absence of potassium fertilization and also with and without boron spraying. The levels of potassium were (0 and 50 kg K_2O fed^{-1}. in the form of potassium sulphate. After 80 days from sowing, the boron solution at a concentration of 0.1 % was sprayed in the form of boric acid. The experiment was carried out in a split–split plot design with four replicates.

Nitrogen fertilizer was added in four doses. The first dose, 15 kg N fed^{-1}, was broadcasted together with 15 kg P_2O_5 fed^{-1} as calcium superphosphate (15.5% P_2O_5) and 50 kg K_2O fed^{-1} as potassium sulphate (50 % K_2O) at planting. The second dose (50% of the remaining dose of urea fertilizer) was applied at tillering stage (before the second irrigation). The third dose (25% of the remaining dose) was applied at elongation stage (before the third irrigation). The last dose (the rest of dose) was applied at the flowering stage (before the fourth irrigation).

III. RESULTS AND DISCUSSION

Effects of N, K and B on the grain yield:

The effect of N, K and B on the grain yield of wheat is presented in Fig. 1. The results indicated that, with increasing N application level, the grain yield per fed increased (73.64%). The results showed that, when the nitrogen increased over 90 kg N fed^{-1} a decrease in the grain yield was observed.

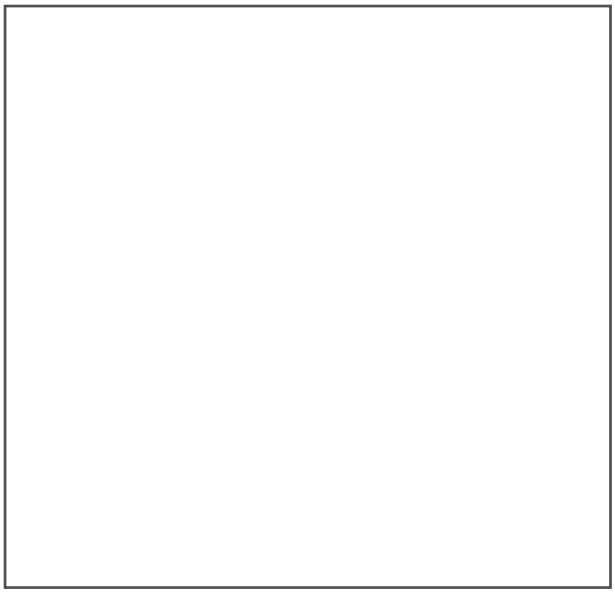

Fig. 1: Effect of graded N applications on grain yield of wheat in the presence and absence of K and B

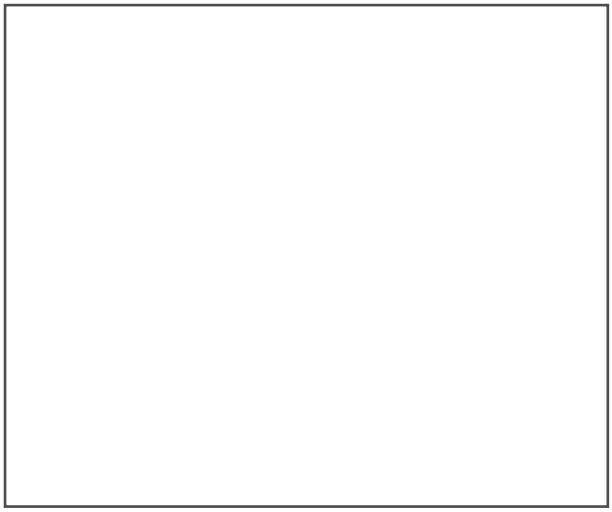

Fig. 2: Effect of graded N applications on N uptake by wheat in the presence and absence of K and B

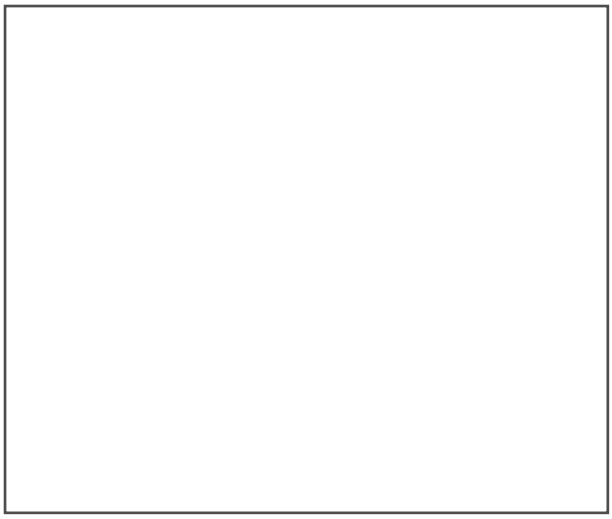

Fig. 3: Effect of graded N applications on K uptake by wheat in the presence and absence of K and B

The results also in Fig. 2 showed that the nitrogen content in grains of wheat increased significantly with increasing N levels. The highest nitrogen content (49.08 kg N fed^{-1}) was obtained at level of N 90 kg N fed^{-1}.

The uptake of potassium by grains of wheat increased significantly with increasing N levels up to 90 kg N fed^{-1} as shown in Fig. 3. The highest content of potassium in grain (16.99 kg K fed^{-1}) was obtained with application 90 kg N/fed. Similar results were obtained by **Faizy *et al*. (1986)**.

***Quantitative approach*:**

The polynomial quadratic equations that were established to express the response of wheat grains yield to nitrogen application in the presence and absence of boron and of potassium. These polynomial equations have been used to express the fertilizer–plant relationships (***Hammad and El-Shebiny, 1999***)

Table 1 showed that the B_0 values (the yield when the N fertilizer units equal zero) increased from 9.85 to 10.01 (for B only), 10.19 (for K only), and 10.30 (for B and K only) ardab fed^{-1}. The B_0 value is the calculated grain yield when no N fertilizer added. These values depended on soil N only.

The return per feddan from the applied optimum rates of N under N levels treatments presented in Table 2. The return per feddan by using nitrogen with boron and potassium treatment (2059 L.E) is greater than that by using nitrogen with potassium (1838 L.E) or other treatments.

A key to understanding B deficiency in wheat appears to be the relative sensitivity of its reproductive process. Published accounts of responses to low B in field grown wheat invariably reported on the effect of B deficiency on male fertility, grain set and grain yield (Table 3). Evidence of adverse effects of low B on vegetative parameters such as straw yield, tiller number, and secondary reproductive organs such as number of spikelets per ear is rare. In contrast to the effect on male fertility and grain set, B deficiency tended to increase the weight of individual grains (***Rerkasem and Jamjod, 2004***).

It could be concluded that increasing nitrogen level up to 90 kg N fed^{-1} increased the grain and straw (results not included) yield of wheat and its components; this increase was more pronounced in the presence of potassium and spraying with boron.

It is clear that great beneficial of splitting nitrogen fertilizer into four doses, potassium fertilization and foliar spraying with boron increased yield and protein content of wheat. The highest grain yield was obtained with 90 kg N, 50 kg K_2O, 15 kg P_2O_5 fed^{-1} and foliar spraying with boron after 80 days from sowing at concentration 0.1%. It could be recommended that using balanced fertilization increase the yield of wheat.

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Table 1: Calculated wheat grain yield (ardab fed^{-1}) as affected by different rates of nitrogen in the presence and absence of potassium and boron

	Calculated grain yield (ardab fed-1)				
Treatments					
			N0	N1	
			0 kg N fed-1	30 kg N fed-1	
Seed yield	Grains per spikelet	mg per seed			
51–61	25–73	106–121b	Straw yield, ears per m2, spikelets per ear	Rerkasem et al. (1989)	
25–65	21–57	123–141b	Straw yield, ears per m2, spikelets per ear	Rerkasem and Loneragan (1994)	
3–75	------	121–164b	---------	Subedi et al. (1997)	
62–88	------	120–130b	Above ground biomass, Plant height, Spikelets per ear	Pant et al. (1998)	

[a] Relative to performance in B sufficiency.

[b] Increased in low B.

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