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# Effect of Time and Rate of Fertilizer Application on Nutrient Uptake by Wheat from Kufra Desert Soil

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## ABSTRACT

A field trial was conducted in the Kufra desert to determine the response of the dwarf wheat to fertilizer treatment before and after planting. Leaf contents of potassium (K), nitrogen (N), phosphorus (P), Zinc (Zn), protein and chlorophyll were estimated.

Although no K was added to the Kufra virgin soil, plant leaves contained relatively high K (1.1 to 1.9%). In absence of phosphorus fertilizer, wheat plants were stunted and tended to accumulate higher levels of nutrients. Chlorophyll content increased in phosphorus-deficient plants that received ammonium sulfate-N. Uptake of ammonium sulfate-N was more efficient than Urea-N. Losses from Urea-N under Kufra conditions were apparently high.

Zinc and phosphorus have to be added because of their low level in Kufra Soil.


## INTRODUCTION

Most reports have shown that nutrients absorption by wheat was increased by increasing level of application (3,6,7,8). Urea was found to be inferior to many other sources of nitrogen when applied to sandy soils and under semi-arid conditions (2,4,5). Mason *et al.* (8) observed that losses of nitrogen applied to wheat on sandy soil were greatest with early application. Addition of zinc to zinc-deficient soils was found to increase zinc content in wheat plants (9).

The present study was initiated to obtain information on nutrients uptake by wheat plants grown in sandy soil and under the arid climate of the Kufra desert in the south eastern region of the Libyan Arab Republic.

## MATERIALS AND METHODS

A field experiment was conducted at the Kufra Agricultural Project, Kufra Oasis. It consisted of 6 preplanting treatments of fertilizer, 2 nitrogen sources as top dressing at 4 levels. The experimental plots were laid in a split-split-plot design in 4 replications. Three

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levels of 0, 220, and 440 kg/ha of 18–50–0, with and without 44 kg/ha zinc sulfate (36% zn) were added before planting. Four levels of ammonium sulfate (21% N) namely 0, 15, 28 and 50 kgN/ha were topdressed in 3 applications at 3 week intervals starting at the time of crown root emergence (24 days after sowing).

The dwarf wheat variety 'FAO 8156', *Triticum aestivum* L. was sown in November 23, 1970, at the rate of 80 kg/ha in rows 30 cm wide. The experimental plots were irrigated daily by sprinklers until full emergence. After stand was established, water was applied every other day until maturity.

Leaf samples were collected for chemical analysis in February 22, 1971. After samples were dried, they were air mailed to Nelson Laboratories, Stockton, California, U.S.A. for tissue analysis. Leaf contents of K, N, P, Zn, protein and chlorophyll were determined on a dry-weight basis.

## RESULTS AND DISCUSSION

*Potassium* (K). Percentage K in leaf tissue as affected by preplanting treatments as well as postemergence nitrogen levels is indicated in Fig. 1. Leaf K content ranged from 1.1 to 1.9% of leaf dry weight. The higher level of K was found in plants which received no preplanting phosphorus. This apparent accumulation of K by phosphorus-deficient plants could be attributed to their poor growth (5). No effect on leaf-K content was observed with zinc application.

Since K was not added to the newly cultivated soil, the relatively high K content of leaves suggests that the virgin Kufra soil contains enough available K. This conclusion is supported by the recent findings by Abdulgawad *et al.*. (1). These workers found that uncultivated Kufra soil contains the plagoclase and muscovite minerals which release K. These minerals may account for the high K level in plant tissue in absence of K fertilizer.

*Nitrogen* (N). Figure 2 shows the percentage total N as a function of preplanting and postemergence fertilizer treatment. Leaf N content varied from 0.7 to 2.8% depending on the growth conditions of the plants. The lower level was always found in healthy and normally growing plants. On the other hand the higher N content was found in stunted and poorly growing plants. This may indicate the usual tendency for accumulating N by poor plants. Such phenomenon is associated with low phosphorus. Plants received preplanting phosphorus showed normal growth and lower nitrogen percentage in their leaves. From the present data, although limited, it seems that enough phosphorus is required for assimilation of N by plants. Leaf N content was not affected by zinc application.

Percentage total N in leaves of plants treated with ammonium sulfate N equal to 50% of Urea-N as postemergence application, was more or less as in plants treated with Urea N. Based on dry matter accumulation and nitrogen percentage in leaves, it was reported that uptake of N by wheat leaves was 42 and 127 g/kgN from Urea and ammonium sulfate N, respectively (5). Therefore, it appears that Urea-N, as broadcast, is less available to wheat plants than ammonium sulfate N. Also, G. Worker (unpublished data, 1970) observed that Urea-N was not available to wheat plants when applied before planting. Because of the dry climate and the alkaline sandy soil of Kufra, the inferiority of urea-N could be attributed to high losses by leaching and volatilization (2).

*Phosphorus* (P). Absorption of phosphorus by wheat plants as affected by rates of fertilizer application is represented by Fig. 3. Percentage total phosphorus (P) in wheat leaves ranged from 0.05 to 0.3% depending on the rate of phosphorus fertilizer. When

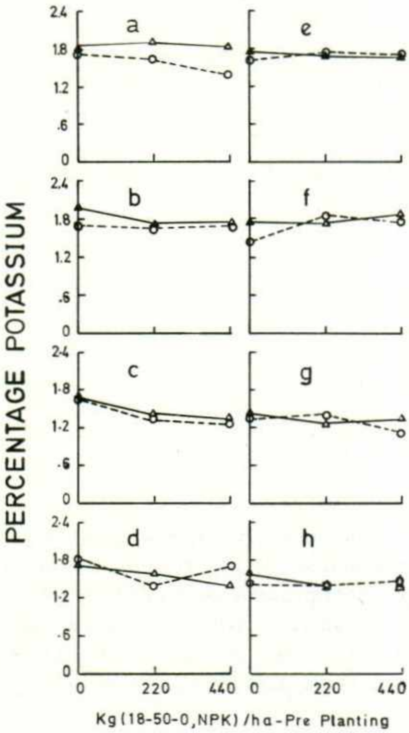


Fig. 1. Percentage potassium in leaves as functions of preplanting and postemergence fertilizer treatment. (Preplanting Kg/ha zinc sulfate); –0–, 0; –Δ–.44, (postemergence KgN/ha of ammonium sulfate): (a), 0; (b), 15; (c), 28; and (d) 50. (postemergence KgN/ha of Urea): (e), 0; (f), 34; (g), 63; and (h), 100.

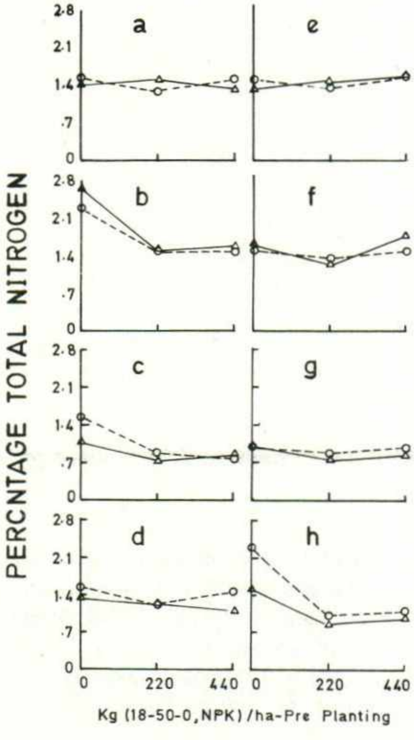


Fig. 2. Percentage total nitrogen in leaves as functions of preplanting and postemergence fertilizer treatment. (Preplanting Kg/ha zinc sulfate): –0–, 0; –Δ–, 44. (postemergence KgN/ha of ammonium sulfate): (a), 0; (b), 15; (c), 28; and (d), 50. (postemergence Kg N/ha of urea): (e), 0; (f), 34; (g), 63; and (h), 100.

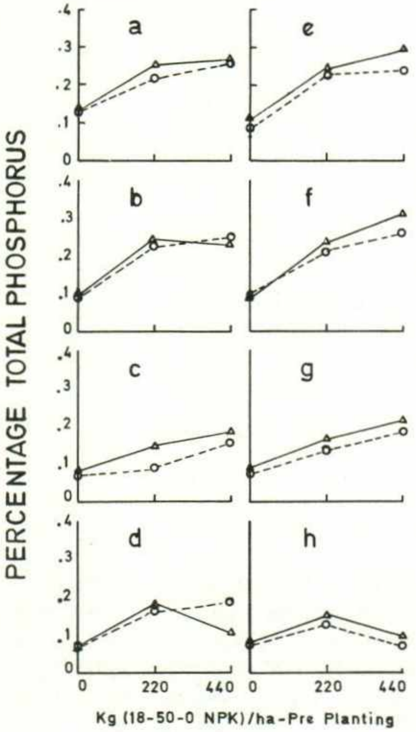


Fig. 3. Percentage total phosphorus in leaves as functions of preplanting and postemergence fertilizer treatment. (Preplanting kg/ha zinc sulfate): –0–, 0; –Δ–, 44. (Postemergence KgN/ha of ammonium sulfate): (a), 0; (b), 15; (c), 28; and (d), 50. (Postemergence kgN/ha of urea): (e), 0; (f), 34; (g), 63; and (h), 100.

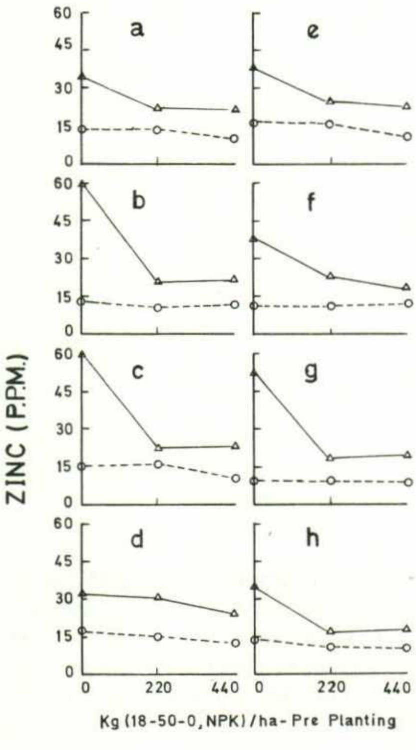


Fig. 4. Zinc content in leaves as functions of preplanting and postemergence fertilizer treatment. (Preplanting kg/ha zinc sulfate): –0–, 0; –Δ–, 44. (Postemergence KgN/ha of ammonium sulfate): (a), 0; (b), 15; (c), 28; and (d), 50. (Postemergence kgN/ha of urea): (e), 0; (f), 34; (g), 63; and (h), 100.

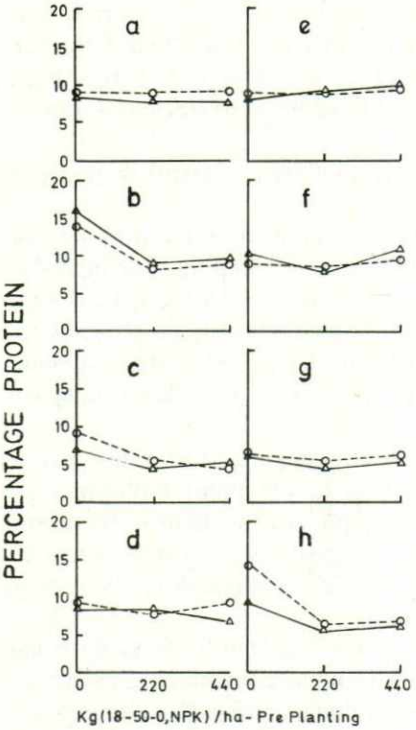


Fig. 5. Percentage protein in leaves as functions of preplanting and postemergence fertilizer treatment. (Preplanting kg/ha zinc sulfate): --0--, 0; -Δ-, 44. (Postemergence kgN/ha of ammonium sulfate): (a), 0; (b), 15; (c), 28; and (d), 50. (Postemergence kgN/ha of urea); (e), 0; (f), 34; (g), 63; and (h), 100.

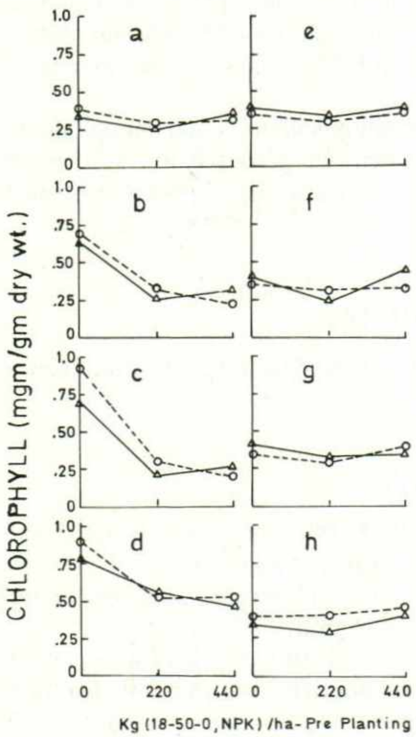


Fig. 6. Chlorophyll content in leaves as functions of preplanting and postemergence fertilizer treatment. (Preplanting Kg/ha zinc sulfate): --0--, 0; -Δ-. 44. (Postemergence kgN/ha of ammonium sulfate): (a), 0; (b), 15; (c), 28; and (d), 50. (Postemergence kgN/ha of urea): (e), 0; (f), 34; (g), 63; and (h), 100.

the soil received no phosphorus, the leaf P content was as low as 0.05%. There was an apparent increase in P uptake with increased applied P from 0 to 220 kg P/ha. However, percentage phosphorus in leaves decreased with increasing postemergence N (Compare Fig. 3a with Fig. 3b and c; Fig. 3e with Fig. 3f, g and h). Addition of zinc did not interfere with P uptake.

From this study, it appears that phosphorus is required for successful cropping in Kufra soil.

*Zinc* (zn). Fig. 4 represents leaf zinc content. Zinc was applied at 0 and 44 kg zinc sulfate/ha before planting. Absorption of zinc ranged from 9 to 60 ppm. The high zinc content was found in stunted plants that received no phosphorus. Dry weight of these plants was only 8% of those supplied with enough phosphorus (5). Therefore, zinc content appears to be high in these plants because of their low dry matter content. As indicated by Fig. 4, b, c and g, application of postemergence N to phosphorus-deficient plants resulted in more accumulation of zinc.

*Protein*. Leaf protein content as affected by fertilizer treatment is shown in Fig. 5. A range of 4.4 to 15% protein was observed. The upper range was found in phosphorus-deficient plants; whereas low protein was found in phosphorus-rich plants. This trend coincided with N level in leaves (see Fig. 2). Also, it appears that Urea-N is less efficient in protein formation that ammonium sulfate N. Zinc application showed no effect on leaf protein content.

*Chlorophyll*. Figure 6 represents chlorophyll content as affected by fertilizer treatments. A range of 0.25 to 0.95% was observed in leaf chlorophyll content. In phosphorus-deficient plants, chlorophyll was greatly affected by level and source of postemergence nitrogen. In absence of phosphorus fertilizer, postemergence ammonium sulfate-N at 0, 15, 28 and 50 kg/ha resulted in 0.36, 0.70, 0.80, and 0.80 mg chlorophyll/g dry leaf (Fig. 6a, b, c, and d). On the other hand urea-N did not affect chlorophyll content at any level of application (Fig. 6e, f, g and h). It appears that in phosphorus-deficient plants, postemergence ammonium sulfate-N enhanced chlorophyll formation; whereas urea-N had no effect on chlorophyll.

Chlorophyll content in plants supplied with ammonium sulfate-N and enough phosphorus was considerably lower than in phosphorus-deficient plants (0.4 versus 0.8 mg chlorophyll/g dry tissue). It seems that at low phosphorus, the larger part of absorbed nitrogen is diverted into chlorophyll synthesis.

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