INTRODUCTION

Maize is one of the most important cereal crops grown in Egypt. It is one of the most important crops used in human consumption and animal feeding.

The total average cultivated area of this crop was 1,898,103 faddan [+] in 1980 and the total production was 2,935,100 ton[++]. Maize production is not sufficient for local consumption due to low productivity per unit area. Shortage in the production of cereals, as in Egypt, is generally considered as an economic and social problem.

Recently, efforts are made to increase food and agricultural production, mainly through efficient use of fertilizers.

Increasing the use of macro-nutrients and consequent increased crop production, increased the uptake of micro-elements by crops. In certain soils micro-elements may become a limiting factor for increasing productivity.

The aim of the present investigation is to study the effect of some macro- and micro-elements on the growth and yield of maize.

(+) One faddan = 4200 m^2 or 0.42 ha.

(++) Annual Statistical Data, Ministry of Agriculture Cairo, 1980 (In Arabic).

REVIEW OF LITERATURE

1. Effect of Nitrogen Fertilizer:

Nitrogen has been found to be deficient in most of the Egyptian soils than other elements, and hence application of manures and fertilizers is necessary. Generally, the response of maize varieties to fertilization is high, especially to nitrogen application.

Jenny (1941), Krantz and Chandler (1954), Black (1957) and Hamdi *et al*. (1959) have related maize yield to the N content of the soil and have found that it is the first limiting factor in maize production.

The yield response of maize to extra nitrogen was clearly demonstrated by Vittum (1948), when 0, 50 and 100 pounds of nitrogen per acre were applied.

Jordan *et al*. (1950), in Mississippe, used nitrogen rates of 30, 60 and 120 pounds per acre for the hybrid maize Dixie 11 and found that number of ears per plant and ear weight increased as the nitrogen level increased.

Bennet *et al*. (1953) stated that leaf analysis provided a clearer indication of the nutrient status of plants than did grain analysis for all the three major nutrients N, P, K).

Hunter and Yungen (1955) pointed out that total N content of corn tissue significantly increased at all N levels, up to a two-fold increase occurring at 300 kg/ha rate.

Thomas (1956), in Alabama, reported that nitrogen fertilizer significantly increased corn yield. However, little or no increase was obtained above 40 pounds N per acre.

Hussein (1958), in Egypt, found that the yield of grain of American Early variety and Hybrid 110 increased with the application of nitrogen fertilizer up to 500 kg and 375 kg of calcium nitrate (15.5% N) per faddan, respectively. Plant height and ear position increased as the nitrogen level increased. Number of ears per plant, number of rows per ear, number of kernels per row, number of kernels per ear, ear length, ear weight, weight of kernels per ear and 1000-kernel were increased as the nitrogen fertilizer level increased.

Reichman et al. (1958) stated that corn yield as well as nitrogen percentage in maize leaves increased by applying nitrogen rates up to 80 pounds per acre. The same authors added that corn yield was highly correlated with nitrogen percentage in maize leaves.

Lal and Subbarso (1960) and Carleson et al. (1961) found that increasing rate of N-fertilizer resulted in enhancing plan height. The magnitude of increase over the unfertilized treatment depends on N rates of the soil.

El-Rouby (1961) concluded that high yield of corn grain was obtained by the application of at least 30 to 40 kg/fad. Maximum grain yield was usually attained at the levels of 75 to 90 kg, but differences between 30 and 45 kg and between 75 and 90 kg were not significant. He added that the grain analysis showed that not only the yield of grain and weight of stalks were affected by nitrogen fertilization, but also the grain quality in terms of protein content.

Rai (1961), working in Sudan, reported that the yield of grain and straw, plant population, number of ears, 1000-kernel weight and number of grains per ear increased with increasing nitrogen from 0 to 80 lb nitrogen per faddan. He added that the application of nitrogen accelerated early vegetative growth.

Hanway (1962) reviewed that maize yield potentiality was determined early in the season by leaf area, which was in turn affected by N fertilization.

Mahendra Pal (1962) found that a dose of 45 kg N/ha, of which a half was applied through soil and half through

maize foliage, increased stem diameter, dry matter content, number of ears per plant, weight of grains per ear and thereby grain yield.

Nielsen et al. (1963) found that total N content of maize plant was reported to be doubled when tho level of N was increased from 50 to 200 lb/acre, which reflected similarly in the grain yield.

Dimova (1965) reported that nitrogen application increased the vegetative growth of maize plants which contributed the best yield.

Eik and Hanway (1965), in Iowa, pointed out that increasing the availability of nutrients, particularly of nitrogen early in the season increased the number of leaves/plant but the size of leaves was more consistently increased. The same authors added that yield of maize tended to be linearly to the L.A.I. up to a value of 3.3 at silking.

Puntamaker et al. (1965) showed that protein content of maize grain increased with increasing level of nitrogen application.

Gonske and Keeny (1969) got a marked increase in dry matter yield of maize due to the first increment of N (100 kg/ha), but the further N increment did not yield

an appreciable increase. Also they added that nitrogen fertilization significantly increased the content of corn grain protein, where this effect was curvilinear with a maximum occuring at 160 kg N/ha.

Hamissa et al. (1969) indicated that the yield of maize increased gradually and consistently as the rate of nitrogen increased up to 60 kg N/fad. When the rate of nitrogen was raised up to 80 kg N/fad., the increase in yield declined.

As for leaf N content, Robinson (1969) found that there was a significant relationship between maize leaf N and maize yield. Leaf N percentage $<$ 1.75 or $>$ 2.60 were associated with low and high yields, respectively.

Sharma et al. (1969) did not get any significant increase in height of three maize hybrids with increasing the level of N up to 180 kg/ha. He added that nitrogen application had no significant effect on the diameter of maize plants.

Welch and Bonne (1969), in Illinois, presented data showing that grain yields of corn increased with increase in applied nitrogen, while grain moisture content at harvest decreased.

Abdulgalil (1970), in India, found that both ear length and yield per ear significantly increased as the level of N increased up to 180 kg N/ha. He added that there was an indication that maize plants receiving N through foliage had high N percentage in their tissue and grain. Moreover foliar application of ½ or ¼ of N doses at silking increased the protein yield significantly over soil application.

Brajendra and Singh (1970) showed that application of N up to 150 kg/ha increased 100-grain weight and the number of ears per maize plant.

Moursi et al. (1970-a) pointed out that there was an increase in the yield of ears and grains of maize with the addition of nitrogen fertilizer up to a level of 46.5 kg N/fad. They added that there was no relationship between the shelling percentage and the amounts of nitrogen fertilizer applied.

Moursi et al. (1970-b) reported that the diameter, fresh, as well as, the dry weight of the lowest five internodes of maize plant increased with adding N up to a level of 140 kg N/fad. In addition, they noticed that application of calcium nitrate increased the concentration of total nitrogen in the lowest five internodes of maize plant.

Saxena and Guatem (1971) showed that nitrogen content of the leaf was a dominated indicator of maize yield. The critical concentration of nitrogen in all green leaves, at 55 to 65 days after sowing, varied from 2.15 to 2.79 percent. In the ear leaf at the pollination stage, it varied from 2.0 to 2.66 percent, depending upon the growing season.

Assey (1972) showed that nitrogen had no significant effect on the diameter of maize plants. On the other hand, application of nitrogen fertilizer up to 30 kg N/fad. increased ear weight, weight of ear without husk, husk weight, weight of grains per ear, 100-grain weight and number of plants carrying more than one ear.

Moreover, Carleto (1972) found that dry matter of maize plant increased as N application increased up to 200 kg N/ha, while further increment up to 800 kg N/ha decreased it.

Hera et al. (1972), in Romania, found that the yields of maize generally increased with application of N and the highest yields of the most economic use of fertilizer were given by 100-200 kg N/ha.

Libois et al. (1972) reported that nitrogen content of grain increased from 1.27 - 1.61%, without applied

nitrogen, to 2.02% with the split dressing of 160 kg N/ha.

Mandloi et al. (1972) showed that plant height and the grain yield were successively increased with the increase in the rate of nitrogen from 0 to 80 or from 80 to 160 kg N/ha. Further amount of nitrogen fertilization up to 240 kg N/ha resulted in significant increase in plant height and the grain yield of maize.

Pathak and Tiwari (1972) showed that applied nitrogen markedly increased uptake of nitrogen in both grain and straw of maize.

Prohaszka and Gurabi (1972) claimed that application of 80-240 kg N/ha to maize plants affected nutrient concentration in the leaf more than in the grain of maize and positive correlations were found between yield and foliar N ($r = 0.55$).

Tanaka et al. (1972) indicated that the main factors affecting dry matter production after silking were L. A.I. and rate of dry matter production per unit leaf area. They added that nitrogen application increased L.A.I. to about a value of six.

Verma et al. (1972) reported that increasing the rates of applied nitrogen from zero to 150 kg N/ha, produced linear increase in nitrogen content in different maize plant parts and in grain.

Geisler (1973) showed that maximum vegetative growth and green matter yields were produced by the application of 100-200 kg/ha NO_3-N preferably 50 days after sowing. High yields of grain and high concentration of protein required dressing of >200 kg N/ha. 300 kg N applied to a knee high crop being the optimum for protein yields. Correlations between grain and protein yields were positive except for the low rate and early date of N fertilizing.

Hera et al. (1973), in Romania, noticed that an increase in maize yields, total N, globulin, albumin and NO_3 contents resulted from the increase in the rate of nitrogen from 0 to 70 or from 70 to 140 kg N/ha.

Jesmanowicz (1973), in Poland, reported that application of N up to 180 kg N/ha increased grain yields, ear length, 1000-grain weight and grain moisture and protein content.

Malik (1973) found that application of 120 kg N/ha significantly increased the grain yield, total uptake and the percent of protein in the grain as compared to the 60 kg N/ha.

Terman and Noggle (1973), in Alabama, found that application of 112 kg N/ha at sowing time or 28 and 84 kg N/ha at sowing time and at tasseling stage markedly increased the grain yields as well as N content. Split application

produced the same increase as a single basal dressing.

Gagro (1974), in Yugoslavia, showed that an increase in applied nitrogen levels up to 200 kg N/ha to maize plants increased stalk length as well as grain protein content.

Hamissa et al. (1974), in Egypt, reported that with increasing amounts of N fertilizer increase in N% and total N uptake in respect of grains, ears and straw were obtained.

Hussein et al. (1974), in Egypt, found that nitrogen fertilization had a significant effect on plant height, stem diameter, number of leaves and leaf area of maize. They also added that N application at 31 and 62 kg/fad. significantly increased the yield by 54% and 80% over the control.

Nair and Singh (1974), in India, found that average maize grain yields were increased from 3.38 t/ha in plots given no N to 4.86 and 5.72 t/ha by 75 and 150 kg N/ha respectively. Average yields were increased by application of N in split dressings from 4.41 t/ha when all the N was applied at sowing up to 5.94 t with 3 equal split dressings at sowing, 30 days after sowing and at tasseling.

Shanmugasundaram et al. (1974) noticed that the increase in the rate of applied N from nil to 72 kg/ha

increased grain yields from 3.41 to 5.19 t/ha and grain protein contents from 7.87 to 10.5%. 90 kg N/ha decreased them.

Terman and Allen (1974), in Alabama, reported that the dry matter in maize yields and uptake of N in the tops at 28, 36 and 47 days after sowing increased with increasing rates of applied N and with age. Concentration of N in both leaves and arial parts increased at 28 and 36 days after sowing with increasing rate of applied N.

Chalk et al. (1975) showed that nitrogen addition significantly increased grain yield and N uptake by corn.

Perry and Olson (1975) found that N applied at the rate of 90 or 180 kg/ha increased grain yields in maize, grain N content and grain/stover ratios.

Ryabchuk and Lyashinskii (1975), in Ukranie, reported that application of 45-60 kg N/ha markedly increased grain yield, fresh fodder yields, grain protein contents, contents of crude protein and dry matter in the fresh fodder.

Awad (1976), in Egyptian calcareous soil, suggested that plant height and diameter of maize stem significantly increased by applying different nitrogen levels up to 90 kg N/fad. but no significant difference was observed among 45 and 90 kg N/fad. levels.

Hussein et al. (1977), in Egypt, reported that ear length, ear diameter, ear weight, number of rows per ear, number of kernels per row, number of kernels/ear and weight of kernels per ear increased as the nitrogen level increased.

Abdel Meesih (1978), in Egypt, found that plant height increased by adding 45 kg N/fad., but no further significant increase was obtained due to the increase in N level up to 90 kg N/fad. Similar trend was observed regarding ear length, number of grain/ear, hundred grain weight, grain yield/ear and shelling percentage. This was also valid in straw yield and grain: straw ratio, On the other hand, increase in N level up to 90 kg N/fad. increased the dry weight and N content of each of the first ear leaf, leaf blades and residual and total plant dry weight.

Ghaly et al. (1980), in Egyptian calcareous soil, concluded that application of N rates to corn plant markedly and significantly increased grain production up to 14.39 and 19.23 ardabs/fad. for the 45 and 90 kg N/fad. treatment, compared with 2.5 ardabs for the check with no added N. They also added that N concentration in corn leaves markedly increased with increasing amount of added N.

Recently, Shafshak et al. (1981), in Egypt, reported that N fertilization significantly increased plant height,

ear position, leaf area of topmost ear, number of ears/plant, number of kernels/ear, ear length, ear weight, weight of kernels/ear, grain yield and protein yield. On the other hand, N reduced significantly the percentage of barren stalks. They added that N had no significant effect on stem diameter of maize plants, number of rows/ear and ear diameter. N concentration in ear leaves and in maize grains increased markedly with increasing levels of added N.

2. Effect of Zinc Application:

Macro as well as micro-nutrients are essential and are required for plant growth. Therefore, particular consideration should be given to the diagnosis and treatments of their complicated problems especially under arid conditions.

Woltz et al. (1953) reported that zinc was high in meristematic tissues and may be expected to be concentrated in the germ.

Brown at al. (1962) concluded that zinc concentration and total uptake of maize plants increased with increasing rates of applied zinc up to 25 lb/acre.

Bezdicek and Mc-Gregor (1964) reported that visual deficiency symptoms began to appear when the leaf zinc concentration is below 15 to 17 ppm.

Krantz and Melsted (1964) showed that, in severely deficient areas, zinc deficiency symptoms on corn are characterized by a yellow broad band beginning at the base of the leaf. The symptoms occur mainly on the lower leaf and may be seen when the young leaf is coming out of the whorl. The midrib and leaf margin remain green. Mild zinc deficiency may show an interval striping which occurs mainly on the lower half of the leaf.

Terman et al. (1966) studied the response of 2 successive crops of forage corn (Zea mays L.) to fine zinc sulphate mixed with 2 soils in greenhouse pot experiments. Zinc sulphate was incorporated alone or with ammonium nitrate and ammonium sulphate fertilizers. Forage yields and uptake of zinc were in the following order descending: Zn mixed alone with the soil, Zn in ammonium nitrate or ammonium sulphate granules, no applied Zn.

Gupta and Ram (1967) reported that zinc sulphate application at 21.5 kg/ha with a basal dressing of 120 kg N + 60 kg each of P_2O_5 and K_2O significantly increased the grain yield of maize over NPK treated plots.

Massy and Loffel (1967) reported that an uptake of 3 mg Zn/plant between tasseling and maturity occured in corn. However, Zn accumulation in the ear was greater

than 3 mg, indicating Zn transfer from other plant parts. Only two-thirds of Zn increase in the ear was accounted for by uptake. The stalk contributed most of the remainder, with portions above and below the ear each losing about one-fourth of their Zn. Most attention has been given to redistribution of elements such as N, P and K but there is evidence for micronutrient distribution in senescence.

Dibrova (1968) found that application of 3 to 8 kg Zn/ha as zinc sulphate over a basal dressing of 10 kg P_2O_5/ha increased grain yield by 8.8 - 27%. Higher rates were more effective than lower ones.

Panaiotov (1968), in Bulgaria, noticed that foliar application of 300 g $ZnSO_4$/ha as 0.05% solution increased grain yield of maize by 24.6%. Lower and higher rates of Zn had little or no effect.

Chundawat and Shekrawat (1970) reported that soil application of 25 kg Zn/ha as $ZnSO_4$ under low fertility have given significantly higher yield. Increase being 19.7% over the control.

Dives (1970), in E. Rhodesia, found that the broadcast application of 15-20 lb $ZnSO_4$/acre or 40-50 lb $ZnSO_4$/acre before sowing maize increased grain yields by up to 10 bags/ac (1 bag = 200 lb).

Meelu and Randhawa (1970), in a pot trail with a Zn deficient soil, noticed that 10 ppm Zn from 4 sources over a basal dressing of 10 ppm NPK increased dry matter yield of maize plant and plant content and uptake of Zn.

Armenu and Stefan (1971), in Romania, found that soil application of 2.5, 5 or 10 kg Zn/ha as $ZnSO_4$ or sprayed plants with solution of Zn corrected deficiency symptoms and increased Zn content. The highest yields were 9.89 t/ha grain given by 128 kg N + 64 kg P_2O_5 + 20 t f.y.m. with 10 kg Zn as $ZnSO_4$/ha and 9.78 t/ha given by the same fertilizers and spraying $ZnSO_4$ solution.

Beyers and Cotzer (1971) reported that zinc deficiency decreased the number of ears/plant, total ears, yield and plant dry matter at 60 days after sowing, but did not effect stover yield. They added that application of 10 lb Zn/morgen (one morgen = 0.86 ha) was effective to correct this deficiency.

Brown and Cormick (1971), in Missouri, found that maize grain yields were not affected by application of 10 or 20 lb Zn/acre, but applied Zn increased leaf Zn from 24 ppm in controls given no Zn to 87 ppm. Increasing soil fertility increased the Zn content of leaves at tasseling stage.

Rajagopal and Mehta (1971) reported that application of zinc at 5 ppm increased concentration and uptake of zinc significantly. They also added that zinc application had no appreciable effect on uptake of all the major nutrients studied (N, P, K, Ca and Mg).

Moreover, Safaya et al. (1971), in India, with maize grown in sierozem soils containing 0.06 - 0.38 ppm extractable Zn, showed that soil application of 10 ppm $ZnSO_4$ before sowing or foliar sprays of 0.3% $ZnSO_4$ + 0.15% $Ca(OH)_2$ applied 3 times at 5-day intervals beginning 25 days after sowing increased plant height. The foliar application of Zn markedly increased contents and uptake of Zn in the plants compared with the soil application. The response in dry matter yield to Zn application was inversely related to plant Zn content. Only the soil application of Zn increased significantly the dry matter yield.

Serry et al. (1971), in Egyptian calcareous soil, reported that application of zinc sulphate increased significantly the yield of maize grain over that produced by the control. Percentage yield increase for the 20 and 40 kg $ZnSO_4$/fed, were found to be 25 and 19.5, respectively.

Dornescu et al. (1972), in Romania, reported that application of 11 kg/ha Zn as zinc sulphate increased yields

with all fertilizer rates and increased plant height. In one site from three sites, yields were in many cases higher with zinc applied as a foliar spray at sixth to seventh leaf stage than that applied to soil as dust or solution and at another site yields were increased by spraying 3 times with a solution of 0.4% Zn.

Kuzentsov et al. (1972) demonstrated that application of zinc as zinc sulphate, oxide, dust or rayplex promoted growth and increased the grain yield significantly.

Schnoppinger et al. (1972) concluded that maize yield was increased through the addition of 7 and 14 kg Zn/ha as zinc sulphate or 4.4 kg Zn/ha as Zn-EDTA. A lower level of 2.2 kg Zn/ha was inadequate to increase yield.

Hawkings et al. (1973) reported that the application of 6.72 and 26.88 kg Zn/ha as zinc sulphate, increased leaf Zn contents to 23 and 40.9 ppm, respectively, as compared to 13.1 ppm with Zn application.

Martens et al. (1973), working on maize plants grown in a Zn deficient soil, received 0.34, 0.67 or 1.34 kg Zn/ha as Zn-EDTA or 1.34 kg Zn/ha as $ZnSO_4$ applied in a band in contact with the seed or 6.72 kg Zn/ha as $ZnSO_4$ in a band at 5.1 cm to one side of the seed, or 26.88 kg Zn/ha broadcast before sowing compared to the control

given no Zn, found that plant height at 52 days after sowing was increased by all Zn treatments, except by the band application at 5.1 cm to one side of the seed. Moreover, grain yields without applied Zn were 6.36 t/ha and were increased to 9.31 - 9.97 t/ha by Zn application with the seed, to 8.53 t/ha by banding to one side of the seed and 10.74 t/ha by broadcasting.

Osiname et al. (1973), in Nigeria, observed an increase in corn growth and development with Zn application. The same authors added that for highest grain yield, 12 ppm Zn in tissue appeared optimum.

Waters (1973), in Georgia, explained that Zn application increased forage yield and Zn content in corn plants. He also added that carbonic anhydrase activity was increased by applied Zn.

Antonov (1974), in Bulgaria, reported that application of zinc sulphate increased growth, accelerated tasseling and ear formation and increased grain maize yields. He also added that the residual Zn applied to a preceding crop also increased yields of maize.

Gregor et al.(1974), in Minnesota, found that ploughing in zinc sulphate at 22.4 - 44.8 kg Zn/ha produced higher leaf Zn contents in maize. Grain yields were increased by both ploughing in and band application of

zinc sulphate. Treating maize seed with Na_2 Zn-EDTA at 0.01 kg Zn/ha had no effect on leaf Zn or on annual grain yield but increased the 5-year yield under study.

Panaiotov and Stoyanov (1974), in Bulgaria, found that foliar application of a 0.025% solution of zinc sulphate increased grain maize yield from 8.13 t/ha for the control plants to 8.46 t/ha.

Rai et al. (1974) showed that soil and/or foliar application of zinc increased plant Zn content irrespective of initial soil Zn level.

Shukla and Prassad (1974) in greenhouse experiment, concluded that zinc application enhanced germination and plant growth of maize.

Tanner and Grant (1974), in Rodesia, found that application of 4.4 kg Zn/ha broadcasted with lime or 2.2 kg Zn/ha spot-placed in zincated NPK fertilizer increased the growth and maize yield responses.

El-Sokkary (1975), in Egypt, reported that in Egyptian alluvial and calcareous soils, the critical zinc levels were found to be 0.2, 0.4 and 0.7 ppm Zn as extracted by 0.1 NHCL, dithizone and EDTA-$(NH_4)_2CO_3$.

Hulagur et al. (1975), in India, found that Zn application increased dry matter production of maize.

Mawardi et al. (1975), in Egypt, found on calcareous soil that soil application of $ZnSO_4$ increased significantly the dry weight of maize plants by 56% over (NPK) treatment.

Palaveev et al. (1975) concluded that dry matter accumulation was affected by the application of Zn. There was a correlation ($r = 0.92$) between dry matter accumulation and amount of Zn extracted from the maize plants.

Awad (1976), in Egyptian calcareous soil, demonstrated that application of zinc sulphate at the rate of 20 kg/fad. to maize increased significantly the leaf dry matter over the check or treatment receiving zinc at higher rate of 40 kg $ZnSO_4$/fad. Moreover, with increasing zinc sulphate rates Zn concentration in grain was markedly increased.

Ohki et al. (1976) observed that plant dry weight at early silking stage was not affected by zinc rates due to sufficient zinc which was available in control plots.

Tesu et al. (1976), in Romania, reported that application of Zn increased stem growth and increased leaf dry matter content of maize.

Singh (1977), in India, found that applied $ZnSO_4$ increased Zn contents in tissues of maize.

Sinha and Singh (1977), in India, found that application of 25 kg $ZnSO_4$/ha increased the grain yield as well as

Zn content of maize over the untreated control.

Recently, Abdel Messih (1978), in Egypt, reported that addition of Zn or methods of fertilizer application affected significantly growth attributes at silking. Significant differences were found between the fertilized and unfertilized plants regarding ear length, ear diameter, number of row/ear, number of grains/ear, hundred grain weight, grain yield/ear and shelling percentage. This was, also valid in straw yield and grain: straw ratio, as well as, in the grain yield, in the first season. Also, both the grain Zn yield and Zn transference efficiency were decreased due to the application of ¾ of fertilizers through soil and the rest through foliage as compared to soil application.

Blaal and Mayr (1978), in Upper Austria, found that Zn application increased the dry matter yield of ears up to 143% and that of the rest of the plant by 65% compared with the untreated control. Combination of soil and foliar or split foliar application of Zn gave highest yields.

Dibrova (1978) reported that application of 20 kg/ha before ploughing or 5 kg Zn/ha at sowing increased plant height and weight, leaf area, number of ears by 6.6-16.1% and grain yields by 10.4 - 21.7%.

Shukla et al. (1978), in India, in pot trails with maize grown in Zn deficient soil found that application of 2.5 - 20 ppm Zn increased dry matter production from 5.3 to 22.5 - 25 g/pot, the difference between Zn levels was not significant. The uptake of Zn by plants increased with increasing Zn levels.

Ghaly et al. (1980), in Egypt, found on highly calcareous soils that soil application of 20 kg $ZnSO_4$ increased yield production by 0.97, 2.80 and 2.44 ardabs/fad. over those treatments received 0, 45 and 90 kg N/faddan, respectively.