INTRODUCTION

Wheat is one of the main cereal crops all over the world and one of the most important winter cereal crops in Egypt.

In Egypt, wheat under irrigation, covers about 2.0 million feddans* in winter growing season and the productivity increased to about 15-16 ardab**/feddan in old land (Nile Valley). In the new lands either under regular irrigation or rainfed condition the area exceeded 0.5 million feddans with the average grain yield of 6.4 ardab/feddan. This resulted to a total production to about 5 million ton of wheat grain which meets about 50% of local needs.

The total annual national production of wheat can be increased by increasing the wheat area and by introducing high yielding varieties showing great response to the increase in N fertilization and micronutrients application. Also, the newly cultivated sandy soil needs to verifying the proper doses of nitrogen and micronutrients to give the maximum yield as possible.

The shortage of macro- and micro-elements in clay or sandy soil decreased the yield of crops.

The target of this research is to investigate and revealed the response of some new wheat cultivars to different levels of nitrogen and application of foliar at the two region i.e. Bahtim and Nobaria on growth characters, yield and yield components, chemical content and technological properties of wheat grains.

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* One feddan = 4200 m^2
** One ardab = 150 kg

REVIEW OF LITERATURE

The review of literature in the present study will discuss the effect of nitrogen levels, foliar application of micronutrients and wheat cultivars on growth, yield and yield components as well as chemical contents and technological properties of wheat grains.

I. Effect of N levels

Gandhi and Nathawat (1968) in sandy loam soil, found that higher doses of nitrogen (201.7 kg N/ha) increased the protein and gluten content in wheat grains and decreased the hardness of the kernel, interrelationship of quality factors as evidenced by simple correlation coefficient reveal that Gluten and kernel hardness are positively correlated with the grain yield, kernel hardness is inversely related to gluten and seed weight.

Fuehring (1969), on calcareous soil showed that grain yield of Mexican semi-dwarf wheat (*Triticum aestivum* L. pitic 62) was increased economically by N application up to 300 kg/ha.

Eweida *et al.* (1971), mentioned that application of 40 kg N/fed., on poor soil, produced more than double grain and straw yields as compared with the control treatment (without nitrogen). Raising the nitrogen level up to 60 kg N/fed., increased significantly straw yield than 40 kg N/fed. Whereas application of 40 or 60 kg N/fed, in fertile soil did not significantly affected grain as well as straw yield.

Gupta and Singh (1971) indicated that nitrogen application up to 200 kg N/ha increased the number of grains per ear, ear length and grain yield of wheat, but reduced the 1000-grain weight.

Sharma *et al.* (1972) on silt loam soil of Pantnagar, studied six level of nitrogen (0, 40, 80, 120, 160 and 200 kg N/ha) and six varieties (Kalyan Sona, Sonalika, UP 301, EA 222-1, HD 1944 and HD 1949) in the first season and 4

varieties (Kalyan Sona, UP 301, Hira and UP 301) in the second season. They found that the economic optimum dose varied from a minimum of 103 kg N/ha in EA 222-1 to maximum of 161 kg N in "HD 1949" in the first season, whereas the economic dose varied from a minimum of 101 kg N/ha in Kalyan Sona to a maximum of 220 kg N/ha in UP 301 in the second season.

Hussain *et al.* (1976) at Lyallpur, found that grain yield increased from 3200 lb/ac for the unfertilized (control) to 3392 lb/ac with 125 lb N/ac in the first season and from 2064 to 2704 lb/ac in the second season. But the difference in grain yield between the 75, 100 and 125 lb N/ac rates were not significant.

Nass *et al.* (1976) mentioned that the grain yields of Selkink, Streng and Kolibri cultivars increased with increasing rates of N from 45 kg N/ha to 90 kg N/ha, while the yield of high yielding cultivars Ankra and Opal were not significantly higher at 90 kg N than at 67.5 kg N/ha. Also, they found that number of spikes/m^2 increased but number of kernels/spike and kernel weight did not increased with increasing N rates. Photosynthetic area as measured by spike extrusion, spike area and flag leaf area and kernel N yield increased significantly at 90 kg N/ha.

Khalil *et al.* (1977) reported that wheat grain yield, number and weight of grains/spike and spike length increased by increasing nitrogen rate from 40 to 80 kg N/fed., while 1000 grain weight tended to decrease by increasing the nitrogen level to 80 kg N/fed.

Day *et al.* (1978) on silty clay loam soil (sand, silt and clay = 6, 62 and 32%, respectively) showed that the higher rate of N fertilizer (136 kg N/ha) resulted in more heads per unit area, more seeds per head and higher grain yield, than did the lower N level (34 kg N/ha).

Abdel-Gawad *et al.* (1979) in Egypt, recorded that there was a progressive increase in plant height, spike length, number of grains/spike, grain and straw yield of wheat by increasing the level of nitrogen up to 40 kg N/fed. The maximum grain yield of Mexipak cultivar was obtained by 60 kg N/fed.

Gheith (1983) in Egypt, indicated that nitrogen fertilization increased significantly plant height, number of grains/spike, grain yield/unit area, straw yield and grain protein content of wheat, while weight of 1000-grain weight were not significantly affected by increasing nitrogen up to 60 kg N/fed.

Ghosh and Mukhopadhay (1984) on low fertility acidic lateritic soils of West Bengal found that low N rates up to 40 kg N/ha increased plant height, number of eras/m^2, number of grains/ear and 1000-grain weight and resulted to a higher yield.

Chandrasek Haraiah *et al.* (1985) in Dharwad, showed that nitrogen at 150 kg/ha recorded significantly higher plant height, ear length and grain yield as compared to 50 kg N/ha in deep black soil.

Eweida *et al.* (1985) showed that increasing nitrogen rates significantly increased grain and straw yield per feddan, number of spikes/m^2, 1000-grain weight, hectoliter weight, protein percentage, dry gluten and sedimentation value, while increasing nitrogen rates decreased ash percentage.

Abd El-Rouf *et al.* (1986) found that adding nitrogen up to 75 kg/fed significantly increased number of spikes/m^2, number of spikelets per spike, number of grains/spike and 1000 grain weight as well as grain and straw yield per feddan. Also they found that applying nitrogen at rates of 25, 50, 75 and 100 kg N/fed, increased grain yield by 59.9, 72.1, 96.5 and 112.2% over the control treatment in the first season and by 87.2, 110.7, 120.1 and 134.8% in the second season, respectively.

Abd El-Hamed *et al.* (1986) revealed that dry and wet gluten increased as nitrogen fertilizer increased from 30 kg to 120 kg N/fed.

Abdel-Latif and El-Tuhamy (1986) reported that number of productive tillers/plant, dry matter per plant, spike length, grains number/spike, 1000-grain weight, grain and straw yield of wheat significantly increased by increasing N level up to 120 kg N/fed.

Shalaby (1986) concluded that plant height, number of spike/m^2, number of spikelets per spike, number of kernels per spike and grain yield/ha increased significantly by the application of higher nitrogen levels (180 kg N/ha). However 100 kernel weight was decreased or not affected by increasing nitrogen levels.

Al-Aghbare (1988) found that plant height, number of tillers and spikes/m^2, spike length, number of grains per spike, 1000 grain weight, grain and straw yield per feddan and protein content were significantly increased by increasing nitrogen fertilization up to 70 kg N/fed as compared with the control treatment (zero N/fed). However there was significant differences between the average of 70 and 105 kg N/feddan. On the other hand, spike weight was not affected by nitrogen fertilization.

Bruckner and Morey (1988) on a Greenville sandy clay loam soil, mentioned that grain protein, tiller density and kernels per head were increased, while harvest index and kernel weight decreased as N rate increased. Nitrogen rates up to 67 kg N/ha caused luxurious N consumption and contributed to undesirable grain protein increases in both years and reduced soft red-winter wheat milling and baking quality by increasing flour protein and endosperm hardness.

El-Sayed and Esmail (1988) indicated that plant height, number of tillers and spikes per plant, number of spikelets and grains/spike, weight of 1000-grain, grain

and straw yield/fed and protein percentage in grains significantly increased as nitrogen fertilizer levels increased from 30 up to 60 kg N/fed in both seasons.

Ibrahim (1988) reported that plant height, number of spikes/m^2, number of tillers/m^2, spike length, number of spikelets/spike, number of grains/spike, grain and straw yield per feddan and protein content were significantly increased by increasing N level up to 100 kg N/fed. On the other hand, 1000-grain weight was significantly decreased by increasing N-level up to 100 kg N/fed, whereas Zn, Cu and Fe content in grains was not affected by nitrogen levels.

Abo Warda (1989) found that flag leaf area, plant height, spike length, number of spikelets per spike, spike yield, number of spikes/m^2 and straw yield/fed were not significantly affected by the applied nitrogen levels in both season. On the contrary, wheat grain yield was affected with the applied nitrogen in the two seasons. The application of 25, 50 and 75 kg N/fed, increased the grain yield by 41, 28 and 39% over the control in the first season respectively. The corresponding increase in grain yield in the second season were 14, 20 and 28%, respectively.

Eissa *et al.* (1990) showed that the recommended nitrogen level to obtain maximum grain yield, differed from location to another. It was 90 kg N/fed for El-Gemmiza in both seasons, being 60 and 120 kg/fed for Sids and Shandawell, respectively in 1987/1988 season only. At Sakha, no significant differences was obtained for nitrogen application.

Joshi *et al.* (1990) illustrated that applying 0, 50, 75, 100 and 125 kg N/ha to wheat (cv. HD 2) gave grain protein content of 11.01 - 14.26%, gluten contents of 8.8 - 10.53%. The N rates had no effect on 1000-grain wheat.

Mhgoub (1990) showed that addition of 60 kg N/fed resulted in tallest plants and spikes over other levels in the first season, and produced greatest grain yield in

both seasons. This was attributed to the greatest number of spikes/m^2, number and weight of grains/spike.

Abd El-Maaboud (1991) on calcareous soil, indicated that there was a positive effect of nitrogen fertilizer in increasing flag leaf area, plant height, number of both tillers and spikes/m^2, the characteristics of the spike length, grain weight per main spike, yield of grain, straw and protein/fed and protein percentage by increasing N level from 50 to 75 kg/fed. Also he found that there was insignificant differences in seed index due to the increase in nitrogen fertilizer from 50 to 75 kg/fed.

El-Salhy (1991) pointed out that number of tillers and spikes/m^2 and spike length increased by increasing nitrogen fertilizer from 45 to 75 kg N/fed. Spike weight, number of grains/spike, weight of 1000-grains and protein percentage were not affected by nitrogen application except the latter three characters in one season only. Also, he found that grain yield of wheat was significantly increased by increasing N level up to 60 kg/fed, further increase of nitrogen application caused a reduction in grain yield.

El-Ganbeehy and Shalaby (1992) found that number of spikes/m^2, number of spikelets/spike and spike length increased significantly as nitrogen level increased up to 150 kg N/ha in both seasons, whereas 100-kernel weight and plant height were not affected by nitrogen application. They added also that 150 kg N/ha produced the highest grain yield in both seasons.

Fayed (1992) revealed that plant height, spike length, spikelets number/spike, 1000-grain weight, grain weight/spike, spikes number/m^2, grain and straw yield/fed significantly increased by increasing nitrogen level up to 160 kg/fed. The response of grain yield to added nitrogen level emphasized that the expected maximum N level in newly cultivated sandy soil of this study was 232.4 kg N/fed (average of two seasons).

Miceli *et al.* (1992) found that number of spikes/m^2, grain yield/ha, crude protein, protein yield and gluten percentage were increased by increasing N level up to 210 kg N/ha. The grain yield did not exceed 5 t/ha obtained with the highest N level in the first season and with 140 kg N/ha in the second season.

Mohamed *et al.* (1992) showed that grain and protein yield were increased proportionally with N application up to 75 kg N/fed at Sids and Mallawi and up to 90 kg N/fed at Shandawell and Mattana. However straw yield positively responded to N application up to 90 kg N/fed at the different locations.

Abo-Warda (1993) in Egypt under calcareous soil condition, found that the increase in nitrogen application level up to 120 kg/fed, significantly increased flag leaf area, plant height, spike length, number of spikelets/spike, number of grains/spike, number of spikes/m^2, 1000-grain weight, grain and straw yields per feddan and protein percentage. Applying N at a rate of 30, 60, 90 and 120 kg/fed increased grain yield over the control by 125, 297, 432 and 505%, respectively in the first season and it was 135, 254, 399 and 426% in the second season.

Morsy (1993) in Egypt, pointed out that plant height, flag leaf area, number of tillers/m^2, number of spikes/m^2, spike length, number of spikelets/spike, spike weight, number of grains/spike, grain and straw yield per feddan and grain crude protein percentage were significantly increased by increasing N level up to 90 kg/fed. Although the difference between 60 and 90 kg N/fed was not significant in both seasons. While the effect of nitrogen levels on grains weight/spike and 1000-grain weight were significant in one season out of two.

Shalaby *et al.* (1993) showed that plant height and grain yield/plot were significantly increased by increasing N level up to 210 kg/ha, but insignificant increase was observed due to the application of 140 and 210 kg N/ha. Number of spikelets per spike and spike length increased with increasing N level in one

season. Nitrogen fertilization had no obvious effect on 1000-grain weight of wheat over the two seasons of study.

Mohamed (1994) reported that plant height, flag leaf area, number of tillers and spike/m², spike length, spike weight, grain weight/spike, 1000-grain weight, biological yield, grain yield and protein yield per feddan and protein percentage in wheat grains were increased by increasing N level up to 90 kg/fed in both seasons. While number of grains/spike, number of spikelets/spike and number of grains/spiklets were significantly increased by increasing N level in one season out of two.

Salwau (1994) found that soil application of nitrogen level up to 75 kg/fed increased significantly plant height, number of spikes/m², spike characters, biological and grain yield per feddan and protein content in wheat grains. The soil application of 30, 45, 60 and 75 kg N/feddan resulted in increasing the grain yield by 77.76%, 106.22%, 132.22% and 122.78% respectively over the control in combined analysis.

II. Varietal Differences

Shishikina (1970) found that the protein content in the grain of S. Kazakhstan wheats ranged from 13.0 to 20.5%. Grain of CV. Kirigizkaya 23, Stepnyachka 30, and Semirechenskoya 11 contained more protein (16.2-17.2%) than that of the standard c.v. Bezostaya (15.7%). He added that gluten content ranged from 27 to 41.2% overall cultivars.

Gupta and Singh (1971) indicated that the maximum number of grains per ear was found in Kalyan Sona c.v., whereas the 1000-grain weight and ear length were more in Sonalika Sona c.v. and 331 c.v. were superior than Sonalika in yield.

Singh and Dastane (1971) showed that Kalyan Sona c.v. gave the maximum yield (49.9 q/ha), followed by Safed Lerma (45.9 q/ha) and Sonalika (42.5 q/ha) when sown on equal grain weight basis. Sonalika had boldest grain yield was best on per plant basis.

Gomaa *et al.* (1977) stated that the superiority of the variety Chenab 70 over Giza 155 is obvious and evidenced by the significant increase in grain yield and number of kernels per spike. Significant difference in spike length in favour of Chenab 70 was obtained only in the first season. However, Giza 155 showed a significant increase in weight of 1000 kernels. No significant varietal differences were obtained regarding the number of spikelets per spike, weight of kernels per spike and number of spikes per square meter.

Abd El-Gawad *et al.* (1979) concluded that spike length, number of grains per spike and spike yield of Mexipak C.V. surpassed those of Giza 155 by 18%, 19% and 4% respectively. On the contrary, plant height, straw yield of Giza 155 exceeded those of Mexipak by 9% and 18% respectively.

Mohiuddin and Croy (1980) revealed that difference among five hard red winter wheat cultivar (Tam W101, Palo Dura, Danne, Centurk and Caprock) were significant for all traits studied. Tam W101 and Caprock were higher yielding than the other cultivars in both years. Tam W 101 had fewer kernels per spike than the other cultivars. Tam W 101 had much greater kernel weight than other cultivars. Caprock had the highest number of kernels per spike. Flag leaf area duration and peduncle area duration were greater for Tam W 101 and Carpock cultivars in the first season, but were greater only for Tam W 101 cultivar in the second season.

Hussein *et al.* (1981) found that Giza 157 and Sakha 8 cultivars did not differ significantly in plant height, number of spikelets/spike, spike length and number of grains per spike, Giza 157 was earlier in heading and had longer grain filling period than that of Sakha 8.

Mohamed and Ebaid (1983) reported that productivity of Sakha 61 surpassed the other wheat cultivars i.e. Sakha 8 and Giza 157. The spike length tended to increase in case of variety Sakha 61. Sakha 8 variety gave the least number of spikelets per spike, while the highest number was produced by Giza 157 variety. The whole yield of plant (grain + straw) of Sakha 61 variety surpassed the yield of the other cultivars with significant differences.

Ghandorah (1985) in Saudi Arabia, showed that Super X (*Triticum aesitivum* L. em Thell) had significantly higher grain yield, tillers number/m² and kernels number/spike than the Jori 69 (*Triticum durum*) in both seasons, whereas Jori variety had higher kernel weight and N% in kernel than the Super X variety.

Eweida *et al.* (1985) mentioned that Sakha 61 in 1979/1980 season and Line 61-1677 in 1980/1981 season outyielded the other genotypes in grain yield. The highest straw yield was obtained from Line 61-1677 in the two seasons. Sakha 61 in 1970/1980 season and Sakha 8 in 1980/1981 season gave the highest values of productivity score. The highest protein percentage was obtained from Line 61-1677 in the two seasons.

Abd El-Raouf *et al.* (1986) showed that significant differences among varieties (Giza 157 and Sakha 69 (*T. aestivum* L.), Stork S and Bittern S (*T. durum*) in each of plant height, time of heading, number of spikes/m², spike length, number of spikelets/spike, number of grains/spike, 1000-grain weight, grain and straw yield per feddan.

El-Banna *et al.* (1986) indicated that Mexican cultivars i.e. Mexipak 69 and Super X exceeded the Egyptian cultivars i.e. Giza 155 and Giza 157 for grain number/spike, grains weight/spike and grain yield/fed, while the Egyptian cultivars surpassed the Mexican cultivars for plant height and 1000-grain weight. The differences among the local cultivars or the Mexican wheat cultivars for spike grain number, 1000-grain weight and grain yield/feddan were not significant.

Gomaa *et al.* (1988) concluded that Giza 163 was superior at North Delta and Middle Egypt. They also found that Giza 164 was superior at South Delta and Upper Egypt.

Abo-Warda (1989) studied the response of some old varieties i.e. Mabrouk, Tosson, Giza 155 and Giza 156 and some new wheat varieties i.e., Giza 157, Sakha 8, Sakha 61 and Sakha 69 to different levels of nitrogen fertilization. He found that the new tested wheat varieties were superior to the old ones in flag leaf area, spike length, number of spikelets/spike. The four old varieties were significantly taller than the four new varieties. The new varieties produced lower numbers of spikes/m^2 and could be arranged in a descending order as follows: Sakha 61, Sakha 69, Sakha 8 and Giza 157. The new varieties outyielded the old ones with one exceptional case for Giza 155 which was one of the best varieties in the second season. Meanwhile, Sakha 69 and Sakha 61 ranked on first position in the first and second season, respectively. Also, Tosson was the least productive variety in both seasons.

Sharshar (1989) found that Sakha 69 cultivar produced higher grain and straw yield, spike length, 1000-grain weight and crude protein content as compared to Sakha 8.

Abd El-Gawad *et al.* (1990) mentioned that wheat cultivars Giza 157 and Sakha 8 differed significantly in number of spikes/m^2, 1000-grain weight and grain yield/fed. Whereas differences between other yield attributes were not significant. Grain yield/fed, number of spikes/m^2 and 1000-grain weight of Sakha 8 surpassed those of Giza 157 cultivar.

Eissa *et al.* (1990) concluded that the highest yield was obtained from Giza 163 and from Giza 162 at Sakha in the first and second seasons, respectively, while Giza 163 and Giza 164 produced the highest grain yield in the other three locations in both seasons.

Ellen (1990) found that the wheat grain yield of Arminda was higher than that of Okapi due to the larger number of kernels per ear, although the higher 1000-grain weight of Okapi partly compensated for the smaller number of kernels per ear. Total N yield was greater in Arminda than in Okapi. Carbohydrate formed before anthesis accounted for 23% of Arminda yield and for 10% of Okapi grain yield.

Gehl *et al.* (1990) showed that the three Canadian cultivars, Glenlea, Katepwa and HY 320 produced comparatively higher grain yield than the three American cultivars, Len, Marshall and Solar. The ranking and relative yields (%) of the six cultivars averaged across all experiments and treatments were as follows: HY 320 (100) > Marshall (94) = Solar (94) > Glenlea (80) > (76) = Katepwa (76).

Dorgham (1991) on calcareous soil, indicated that 1000-grain weight of Sakha 8 cultivar surpassed that of Giza 157 cultivar, whereas other yield attributed and chemical composition of the two wheat cultivars did not differ significantly.

El Kalla *et al.* (1994) showed that Sakha 92 surpassed Sakha 8 and Sakha 69 in plant height, number of tillers and spikes/m^2, spike characters and 1000-grain weight. Sakha 92 recorded the highest grain and straw yield per feddan.

El-Kalla *et al.* (1992) found that Gemmiza 1 c.v. surpassed Sakha 69 and Giza 163 cultivars in grain yield with 0.56 and 0.29 ardab/fed. Sakha 69 had the tallest plants, meanwhile Giza 163 came in the second rank in this trait. The highest number of tillers and spikes/m^2, number and weight of grains/spike, 1000-grain weight and sequently the higher grain yield were observed with Gemmiza cultivar, Giza 163 recorded the longest spikes and grain protein content.

III. Effect of foliar application of micronutrients

Ivanov and Bossert (1970) found that foliar spray of Mn or Cu applied to wheat increased the grain yield of wheat.

Lamanov (1970) on gray forest soil, showed that spraying Zn, Mn and Cu on wheat plants increased the uptake of Zn in plant during the growth period, Zn and Mn were more effective than Cu.

Yossef and Abdel Rahman (1976) showed that addition of 0, 1.25, 2.5 or 7.5 kg Zn/ha had no significant effect on grain weight/ear, 1000-grain weight, grain yield and protein quantity and quality.

Ismail *et al.* (1977) indicated that there was no significant response to rate and time of micro-elements application on plant height, spike length, 1000-grain weight and grain yield of wheat.

Saleh (1979) mentioned that leaf area, number of spikes/plant, main spike length, weight of grains per main spike, protein content and total carbohydrate content in wheat grains increased significantly with spraying the wheat plant with Zn, B or with mixture of micro-elements if compared with the control plants. On the other hand, Mn treatment recorded lower values in this respect.

Samui *et al.* (1979) observed that foliar spraying with micro-elements to wheat at late tillering stage differed significantly in respect of grain and straw yield. However, straw yield was higher in comparison to grain yield.

Barsoum (1980) found that number of spikes per plant, plant height, spike length, weight of kernels per spike, 1000-grain weight and straw yield/fed, crude protein content, Mn, Cu content in wheat grains were significantly increased by application of Zn, Mn and Cu up to 0.4% of each.

Hefni (1980) showed that, addition of Zn and Mn as foliar spray increased significantly yield components as well as grain and straw yield.

Mahmoud and El-Mandoh (1982) studied the effect of foliar application of some micro-nutrients (B, Zn, Mn, Cu and Fe) sprayed either alone or in

combination with 2% urea solution. They found that micro-nutrients significantly affected growth, yield and grain quality of wheat.

Ibrahim (1984) showed that plant height, number of spikes/plant, spike length, number of spikelets/spike, grains number/spike, weight of grains/spike. weight of 1000-grain, grain and straw yield, protein content increased significantly with foliar application of micro-elements (Zn, Fe, Zn + Fe and Zn + Mn) .

Saad *et al.* (1984) indicated that the highest grain yield was obtained by spraying wheat with urea + Zn or with urea + Cu + Zn, but the highest straw yield and protein content in grains were obtained by spraying Irral (containing as a percentage N, K, Mg, Fe, Zn, Mn, B and Cu were 15, 4, 3, 0.4, 8.0, 1.0 and 1.0, respectively).

El-Kholany and Hefni (1985) observed that Zn, Mn or Mn+Zn application significantly increased grain yield and straw yield and uptake of N, P and K elements in wheat grains, while Fe+Mn application reduced grain yield and N, P and K uptake. Straw weight and N, Mn or Zn taken up by straw were reduced with Fe.

Khattab *et al.* (1985) stated that number of ears/m^2 and number of grains per ear were not affected significantly by fertilization on calcareous soil. Also, they concluded that critical levels of EDTA extractable zinc in leaves were 7 ppm, 36 ppm, respectively for wheat on the basis of these two levels of fertility.

Gab Alla *et al.* (1986) showed that spraying Zn at 0.4% or Mn at 0.2% had no significant effect on plant height, spike length, number of spikes/m^2, spike weight, number and weight of grains/spike. On the contrary, 1000 grains weight, grain and straw yield, protein percentage, Zn and Mn contents were significantly affected by applying Zn at 0.2%.

Sherif (1986) indicated that foliar application of micro-elements with urea had no significant effect on plant height and number of tillers/m², whereas number of spikes/m², weight of 1000-grain, grain and straw yield were significantly increased by foliar application of Zn, Fe at tillering.

El-Hawary *et al.* (1987) demonstrated that spraying Fulaz D (containing 9.2% Mn, 2.8% Fe, 2.8% Zn, in chelated form and Fulaz A (containing 7% Mn, 2.0 Zn, 2.3% Cu in chelated form) increased significantly number of spikes/m², length of spike and number of spikelets/spike.

Badawi *et al.* (1988) indicated that foliar nutrients (complesal and stimulal) significantly increased plant height, number of tillers and spikes/plant, number of grains and 1000-grain weight as well as grain and straw yield. Stimulal (80 N, 80 P_2O_5, 80 K_2O, 0.20 Mg, 0.10 Fe, 0.10 Mn, 0.50 Zn and 0.10 Cu gm/kg) followed by Complesal (250 N, 160 P_2O_5, 120 K_2O, 1.70 Fe, 0.85 Mn, 0.07 Zn and 0.85 Cu gm/kg) recorded the highest grain and straw yield/fed.

El-Sayed and Esmail (1988) revealed that spraying wheat plants with folifertile (consisted of 22% N, 21% P_2O_5, 17% K_2O, 0.167% S, 0.0790% Mg, 0.0370% Fe, 0.0395% Mn, 0.0068% Zn, 0.0076% Cu, 0.0050% Mo, 0.0033% B and 0.0020 Co) significantly increased plant height, yield components of wheat, grain and straw yield/fed and protein percentage in grain.

Ibrahim (1988) recorded that micro-elements fertilization showed a significant effect on plant height, number of spikes/m², number of tillers/m², spike length, number of spikelets/spike, number of grains/spike, 1000-grain weight, grain and straw yield per feddan, and protein content in wheat grain, but grain weight/spike, Zn, Cu and Fe contents in grains did not affected by micro-elements treatments.

Sachdev *et al.* (1988) found that Zn uptake by wheat increased with increasing Zn levels (0.5 and 10 kg/ha), but the percentage utilization was much lower with 10 kg Zn/ha than with 5 kg Zn/ha. Application of various Mn rates did not affect the percentage of Zn.

Amin *et al.* (1989) studied the effect of Zn at rate of 0, 1, 2 or 4 kg and 0, 1.25 or 2.5 kg Cu/ha on wheat cv Pak-81 who grown on mingora silt loam soil. They found that the highest grain (2.5 t/ha) and straw (4.43 t/ha) yield were obtained with 4 kg Zn + 2.5 kg Cu and 2 kg Zn + 1.25 kg Cu, respectively. Zn content in grains and straw, increased with the increase in Zn application at the various Cu level, whereas Cu content in grains and straw decreased by increasing level of Zn application.

Gheith *et al.* (1989) indicated that foliar application of micro-elements had a significant effect on all previous traits except grain weight/spike, contents of Cu, Zn and Fe in wheat grains were not significantly affected by micro-elements treatments. Foliar application of cupper sulphate (0.67) gave the tallest plants and highest number of spikes/m^2, number of tillers/m^2, 1000-grain weight, yield straw, yield/fed, protein content was insignificantly increased by increasing applied zinc sulphate at a rate of 0.6%. On the other hand, the lowest grain and straw yield as well as protein content were obtained by adding ferrous sulphate at 0.3%.

Abd El-Hadi *et al.* (1990) observed that wheat responded to the foliar fertilization of Fe, Mn and Zn, the increase in grain yield ranged between 1.2 to 2.6 ardab/fed.

Hegrazy *et al.* (1990) reported that grain/straw ratio was significantly increased by boron addition which led to an increments of 35% over check treatment 22% over Fe-treatment and 28% over Zn treatment. The higher insignificant, they added that, in grain and straw yield obtained by B and Zn fertilization relative to Fe control treatments.

Hassan *et al.* (1992) obtained that grain yield reached to about 13% by spraying micronutrients mixture and to 16.27% by spraying Zn-chelate over the unsprayed treatment, straw yield was only increased by about 10% due to application of Zn-chelated and the mixture of micronutrients and by about 20% by application multinutrient F.F. Protein yield/fed was found to increase by Zn chelate (18.7%) and Fe-chelate (11%) and was not affected by other treatments.

Sharma *et al.* (1992) found that grain and straw yield were significantly affected by the different micro-nutrients (Zn, Cu, Mn and Fe). $CuSO_4$ (20 kg/ha) resulted to the highest grain yield (47.1 kg/ha) and straw yield (56.1 g/ha) followed by $ZnSO_4$ (15 kg/ha) (42.5 and 55.8 g/ha grain and straw respectively). Both the two levels of Fe application (10 and 20 kg $FeSO_4$/ha) did not significantly influence the grain yield of wheat over the control.

Morsy (1993) showed that foliar application of micronutrient chemicals involved in the study had significant effect on plant height, flag leaf area, number of spikes/m^2, spike weight, grain and straw yield, and grain crude protein percentage. On the other hand, number of tillers/m^2, spike length, number of spikelets/spike, number of grains/spike, grain weight/spike and 1000-grain weight did not significantly affected by foliar application of micronutrients.

Salwau (1994) indicated that plant height, number of spikes/m^2, spike length, number of spikelets/spike, 1000-grain weight, grain and straw yield/fed as well as protein percentage and protein yield/fed were significantly increased by spraying urea with different micronutrients as compared to the control treatment. On the other hand, foliar application treatments had no significant effect on number of grains/spike, spike weight and grains weight/spike.