RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

I. Growth characters

Data presented in Table (3) shows the effect of N-levels, P_2O_5 levels and some micronutrients on plant height, number of leaves/ plant, fresh and dry weight of plants/ m^2, flag leaf area, number of tillers and spikes/ m^2 in the combined analysis of the two seasons (1999/ 2000 and 2000/ 2001 seasons).

A- Effect of nitrogen levels

A. 1- Plant height

The results showed that the increase in N- level from zero to 120 kg N/ feddan did not significantly induce any apparent increase in plant height in the combined analysis.

Similar results were obtained by Hefni (1982) and Salem (1999) who found that plant height of wheat was not significantly affected by the rate of nitrogen.

A. 2- Number of leaves per plant

The results showed that no significant differences were observed between the four levels of nitrogen fertilizer in number of leaves per plant in the combined analysis of the two growing seasons (Table 3). The unfertitlized treatment gave the lowest values of leaves number/ plant.

A. 3- Fresh and dry weight of plants/ m^2

The average values of fresh and dry weight of plants (g)/ m^2 were significantly increased by increasing N level up to 120 kg N/ feddan in the combined analysis of 1999/ 2000 and 2000/

2001 seasons (Table 3). However, no significant differences were observed between 80 and 120 kg/ fed. The maximum fresh and dry weight of plants/ m^2 were 508.1 and 217.0 gm, respectively, produced by applying 120 kg N/ feddan. On the other hand, the minimum ones were 410.3 and 184.9 gm, obtained from unfertilized wheat plant. There was no significant difference between 80 and 120 kg N/ feddan on fresh and dry weight of plants/ m^2. Also, no significant difference was obtained between unfertilized wheat plant and added 40 kg N/ feddan. The increase in fresh and dry weight of plants/ m^2 due to the increase in N level is a result of the effect of nitrogen in increasing number of tillers/ m^2. Nitrogen increases the metabolic activity in plants which contributes to the increase in the accumulation of metabolic in plants tissues and this in turn increases the dry matter of plant. Similar conclusion was reported by Abd El- Latif and El- Tuhamy (1986), Zahran and Mosalem (1993), Darwiche (1994), Khaled (1994), Mohamed (1994), Dardiry (1999) and Zaghloul (1999).

A. 4- Flag leaf area

Results in Table (3) indicate that flag leaf area of wheat plants was not significantly affected by increasing N level up to 120 kg N/ feddan in combined analysis of the two growing seasons. This result may be due to the sufficient level of soil fertility at Moshtohor region (Table 1). The application of 40, 80 and 120 kg N/ feddan resulted in increasing the flag leaf area by 2.4, 2.7 and 4.1 % respectively, over the check treatment. The same trend was found by Ibrahim and Abdel- Aal (1991), Darwiche (1994), Mohamed (1994). Zaghloul (1999) and Abou

El- Ela, Sabah (2001) found that nitrogen application up to 90 kg N/ feddan significantly increased flag leaf area.

A. 5- Number of tillers/ m^2

The average values of tillers number per square meter were significantly affected by N levels in combined analysis of the two growing seasons (Table 3). It was obvious that N application significantly increased the number of tillers/ m^2. The increase in N level from zero to 40, 80 and 120 kg N/ feddan significantly increased the number of spikes/ m^2 by 2.1, 18.3 and 22.32 % , respectively over the control. The differences between 80 and 120 kg N/ feddan as well as between unfertilized treatment and 40 kg N/ feddan were not significant.

It could be concluded that increasing nitrogen application up to 80 kg N/ feddan consistently increased the number of tillers/ m^2. The increase in number of tillers/ m^2 may be due to the fact that nitrogen is an important major element to encourage the meristematic and metabolic activities in plants.

These results are in accordance with those obtained by Hefni (1982), Abd El- Latif and El- Tuhamy (1986), Abd El-Shaheed (1988), Khaled (1994), Zaher (1996) and Zaghloul (1999).

A. 6- Number of spikes / m^2

The effect of nitrogen levels on number of spikes / m^2 in the combined analysis is shown in Table (3). The results indicate that number of spikes/ / m^2 was significantly increased by increasing N level up to 120 kg N/ feddan. Application of nitrogen fertilizer at the rate of 120 kg N/ feddan produced the maximum number of spikes / m^2 (505.2). Whereas, no significant difference was observed between adding 80 and 120 kg N/ feddan and between zero nitrogen and 40 kg N/ feddan on number of spikes / m^2 . The application of 40, 80 and 120 kg N/ feddan increased number of spikes / m^2 over control by 5.8, 23.5 and 28.8 % , respectively. This increase clearly indicated that prominent role of N on vegetative growth, tillering and fertility in wheat. These results are in harmony with those obtained by Day *et al.* (1978), Hagras (1985b), Gab- Alla *et al.* (1986), Abd El- Shaheed (1988), Mahgoub- Hayam (1990), Rady and Abo- El- Zahab (1990), Ibrahim and Abdel- Aal (1991), Abo- Warda (1993), Darwiche (1994), El- Yamany (1994), Hegab (1994), Khaled (1994), Salwau (1994), Zaher (1996), El- Ghareib *et al.* (1998), Dardiry (1999), Hassan and Gaballah (2000), Nunir *et al.* (2000) and Abou El- Ala, Sabah (2001).

B- Effect of phosphorus levels

B. 1- Plant height

The effect of phosphorus application on plant height was significant in the combined analysis of the two growing seasons. Application of 24 kg P_2O_5/ feddan led to an increase the plant height over the check treatment by 1.7 %. Similar results were reported by Oliveira and Camargo (1984), Hassan (1995), Aly (1998), El- Bana (2000) and Salem and Mohamed (2000) who showed that plant height of wheat responded to P application.

B. 2- Number of leaves per plant

Data recorded in Table (3) clearly indicate insignificant differences between number of leaves per plant by adding 24 kg P_2O_5/ feddan when compared with the control treatment in the combined analysis. Similar trend was obtained by Fadl- Manal (1999) who showed that phosphorus fertilizer had no significant effect on dry weight of leaves.

B. 3- Fresh and dry weight of plants/ m^2

The effect of P level on fresh and dry weight of plants/ m^2 were significant in the combined analysis of the two growing seasons as shown in Table (3). The application of 24 kg P_2O_5/ feddan increased fresh and dry weight of plants/ m^2 by 13 and 9.3 %, respectively as compared with the unfertilized treatment. The effect of phosphorus may be due to the regulation of many enzymatic process and activation of some enzymes by phosphorus . These results are in harmony with those obtained by Hassan (1995).

B. 4- Flag leaf area

Results in Table (3) indicate that flag leaf area of wheat plants was significantly affected by adding phosphorus at 24 kg P_2O_5/ feddan in the combined analysis of the two growing seasons. The application of 24 kg P_2O_5/ feddan resulted in increasing the flag leaf area by 4.6 % over the check treatment. Abo- Warda (1993) indicated that phosphorus fertilizer had no significant influence on flag leaf area under newly reclaimed calcareous soil condition.

B. 5- Number of tillers / m^2

Data of the combined analysis of the two growing seasons (1999/ 2000 and 2000/ 2001 seasons) indicate that the levels of phosphorus fertilization had no significant effect on number of tillers/ m^2. All differences between the two P levels were far below the level of significance which indicates that P status in the soil was not so critical that a supply of P fertilizer for wheat was needed at this stage of growth. The same trend was obtained by Fadl- Manal (1999) who showed that phosphorus fertilizer had no significant effect on number of stems / m^2 . On the other hand, Ashraf *et al.* (1990), Hassan (1995), Malik *et al.* (1995) and El- Bana (2000) indicated that number of tillers/ m^2 responded to P application up to 45.0 kg P_2O_5/ feddan.

B. 6- Number of spikes / m^2

Results in Table (3) indicate that the number of spikes/ m^2 was not significantly affected by increasing phosphorus level up to 24 kg P_2O_5/ feddan. This results behave in the same trend of the pervious character (number of tillers/ m^2). The application of 24 kg P_2O_5/ feddan resulted in increasing the number of spikes/ m^2 by 1.5 % over the check treatment in the combined analysis. These results are similar to those of Abo- Warda (1993) and Fadl- Manal (1999) who showed that phosphorus fertilizer had no significant effect on the number of spikes/ m^2 . On the contrary, Hassan (1995), Malik *et al.* (1995), Aly (1998), El- Bana (2000) and Salem and Mohamed (2000) showed that increasing phosphorus level up to 46.5 kg P_2O_5/ feddan resulted in a significant increases in number of spikes/ m^2 .

C- Effect of microelements

C. 1- Plant height

The results in Table (3) clearly indicate that foliar application of microelements gave highly significant increases in plant height of wheat when compared with the check treatment in the combined analysis of the two growing seasons. Whereas, no significant difference was found between $ZnSO_4$ (0.3 %), $MnSO_4$ (0.3%) and $ZnSO_4$ (0.3 %) + $MnSO_4$ (0.3 %) on plant height. The tallest plant was 97.4 cm, obtained from adding zinc sulphate with manganese sulphate as foliar application, but the check treatment (unfertilized plants) gave the shortest wheat plant (94.7 cm).

Foliar application of microelements, i.e., $ZnSO_4$ and $MnSO_4$ and $ZnSO_4$ + $MnSO_4$ resulted in increasing the plant height by 1.6 %, 1.8 % and 2.9 % , respectively over the check treatment. The increasing of plant height by foliar application of microelements may be due to the role of micronutrients such as Zn and Mn which are essential for the activity of plants. The rate of cell elongation was higher with Zn and Mn and is involved in the biosynthesis of the plant auxin indole- 3- acetic acid (Burstrom, 1950). These results are in harmony with those obtained by Youssef and Salem (1976), Mahmoud and El-Mandoh (1982), Abd El- Shaheed (1988), Omar and Ebrahim (1990), Zahran and Mosalem (1993), Khaled (1994), Salwau (1994), Abd El-Fatah, Nagwa (1995), Abd El- Mottalb *et al.* (1997) and Gobarh, Mirvat (1998). On the other hand, Gab Alla *et al.* (1986), Shams El- Din (1993) reported that Zn. Mn and other microelements had no significant effect on plant height of wheat.

C. 2- Number of leaves/ plant

The average values of leaves number/ plant was not significantly affected by foliar application of microelements under study in the combined analysis. It could be concluded that the number of leaves/ plant failed to show any response to foliar application of microelements. These results may be due to the fact that number of leaves/ plant is genetical character which is not affected by environmental conditions. Similar results were obtained by Hassanien (1999) who found that number of leaves/ plant was not affected by foliar application of microelements.

C. 3- Fresh and dry weight of plants/ m^2

The effect of foliar application of some microelements on fresh and dry weight of plants/ m^2 are presented in Table (3).

Fresh weight of plants/ m^2 was significantly increased with foliar application of microelements when compared with the control treatment. The highest value of fresh weight of plants/ m^2 was 475.2 gm, obtained from foliar application of $ZnSo_4$ + $MnSo_4$ at 3%. Whereas, the lowest one was 449.1 gm, produced from untreated plants of microelements. The difference between zinc sulphate and manganese sulphate as foliar application on fresh weight of plants/ m^2 was not significant and this was similar on plant height, flag leaf area and number of tillers and spikes/ m^2 . On the other hand, spraying of microelements had no significant effect on dry weigh of plants / m^2 in combined analysis of the two growing seasons. Foliar application of zinc sulphate, manganese sulphate, and zinc sulphate + manganese sulphate increased dry weight of plants/ m^2 by 2.0%, 3.2 % and 7.0 % , respectively over the control treatment. These results are mainly due to the role of microelements as essential components of some dehyrogenases, proteinases and peptidases enzymes, also alcohol dehaydrogenases and hexokinase require such elements for their activity (Valley and Wacker, 1970). These results are in accordance with those obtained by Mourad *et al.* (1992), Khaled (1994) and Gowily, Alham *et al.* (1997).

C. 4- Flag leaf area

It is clear that flag leaf area significantly increased with foliar application of microelements in the combined analysis of 1999/ 2000 and 2000/ 2001 growing seasons as shown in Table (3). The highest value of flag leaf area was 43.4 cm^2, produced from foliar application of $ZnSO_4$ + $MnSO_4$ at 0.3 %. While, the lowest one was 41.3 cm^2, obtained from without application of microelements. No significant differences were obtained between adding manganese sulphate and zinc sulphate + manganese sulphate as foliar application on flag leaf area. Also, no significant difference was found between foliar application of zinc sulphate and manganese sulphate at 0.3 % on flag leaf area. The increase in flag leaf area with foliar application of microelements may be due to the fact that Zn participates in the production of IAA parts. These results agree with those obtained by Mourad *et al.* (1992) and Abd El- Fatah, Nagwa (1995).

C. 5- Number of tillers / m^2

Data in Table (3) show that number of tillers/ m^2 was not significantly increased by foliar application of microelements in the combined analysis. Foliar application of Zn, Mn and Zn + Mn nutrients increased number of tillers/ m^2 by 7.0 %, 5.2 % and 6.9 % , respectively, when compared with the control treatments. It is clear that increases in number of tillers/ m^2 were obtained as a result of microelements application were below the level of significance. These results are in accordance with that obtained by Gab- Alla *et al.* (1986) who showed that spraying Zn at 0.4 % or Mn at 0.2 % had no significant effect on number of tillers/ m^2 .

C. 6- Number of spikes / m^2

The results indicate that adding Zn and Mn elements significantly increased the number of spikes/ m^2 in the combined analysis of the two growing seasons as shown in Table (3). The highest value of spikes number/ m^2 was 462.2, obtained by application of $ZnSO_4$ at 0.3 %. Whereas, the lowest one was 428.4, produced from untreated plants with foliar application of microelements. Also, spikes number/ m^2 of wheat showed increases at all treatments of microelements application. Number of spikes/ m^2 increased over the control treatment by 7.9%, 5.3 and 6.3% when foliar application of Zn, Mn and Zn + Mn , respectively. These results are in harmony with those obtained by Mahmoud and El- Mandoh (1982), Abd El- Shaheed (1988), Mourad *et al.* (1992), Khaled (1994), Salwau (1994), Abd El- Fatah, Nagwa (1995) and Gobarh, Mirvat (1998).

D- Interaction effects

D. a - Interaction effect between nitrogen and phosphorus levels

The effect of the interaction between N- levels and P_2O_5 levels was significant on fresh weight of plants/ m^2, number of

Table (3) : The average values of plant height, number of leaves/ plant, fresh and dry weight of plants/m^2, flag leaf area, number of tillers/ m^2 and number of spikes/ m^2 after 105 days from sowing as affected by N levels, P levels and micronutrients (Combined analysis).

Characters / Treatment	Plant height (cm)	No. of leaves / plant	Fresh weight of plants g/ m^2	Dry weight of plants g/ m^2	Flag leaf area cm^2	No. of tillers/ m^2	No. of spikes/ m^2
N- level kg/ fed.							
1- 0	95.9 a	3.1 a	410.3 b	184.9 b	41.2 a	426.0 b	392.3 b
2- 40	95.9 a	3.2 a	414.0 b	186.4 b	42.2 a	434.8 b	414.9 b
3- 80	96.9 a	3.2 a	493.2 a	216.9 a	42.3 a	504.2 a	484.7 a
4- 120	96.1 a	3.2 a	508.1 a	217.0 a	42.9 a	521.1 a	505.2 a
F- test	N.S	N.S	*	**	N.S	**	**
P level kg/ fed.							
1- 0	95.4 b	3.2 a	428.5 b	192.4 b	41.2 b	471.7 a	446.0 a
2- 24	97.0 a	3.1 a	484.3 a	210.3 a	43.1 a	471.3 a	452.6 a
F- test	**	N.S	*	**	*	N.S	N.S
Microelements							
1- 0	94.7 b	3.2 a	449.1 b	195.3 a	41.3 b	449.9 a	428.4 b
2- Zn	96.2 ab	3.2 a	450.2 b	199.3 a	41.6 b	481.4 a	462.2 a
3- Mn	96.4 a	3.2 a	451.1 b	201.5 a	42.3 ab	473.5 a	451.2 ab
4-Zn+Mn	97.4 a	3.0 a	475.2 a	209.2 a	43.4 a	481.2 a	455.4 a
F- test	**	N.S	*	N.S	*	N.S	*

tillers and spikes / m^2 in the combined analysis of the two growing seasons as shown in Table (4). Whereas, the other characters of growth under study were not significantly affected by the interaction between nitrogen levels and phosphorus levels. This means that each of this factors act independently on their effect on those characters, consequently, the data were excluded.

D- a- 1. Fresh weight of plants/ m^2 :

There was a significant difference of the average values of fresh weight of plants / m^2 as affected by the interaction between N and P level in the combined analysis (Table 4). The highest values of fresh weight of plants/ m^2 was 540.8 gm, obtained from application of 120 kg N + 24 kg P_2O_5/ feddan. Whereas, application of 40 kg N + 0 phosphorus fertilizer gave the lowest values of fresh weight of plants/ m^2 (367.8 gm). While, no significant difference was obtained between the interaction of zero N + zero P and 40 kg N + zero P / feddan on fresh weight of plants/ feddan.

D-a- 2. Number of tillers and spikes/ m^2

The results in Table (4) indicated that the interaction between N levels and P levels was significant for the number of tillers and spikes/ m^2 in the combined analysis. Application of 120 kg N + 24 kg P_2O_5/ feddan gave the maximum mean values of tillers and spikes number/ m^2 equal to551.8 and 536.7 , respectively. No significant difference was recorded between the interaction between 80 kg N + zero P_2O_5 and 120 kg N + 24 kg P_2O_5/ feddan on the mean values of number of tillers and spikes/ m^2. On the other hand, the minimum ones were 412.3

Table (4): The average values of fresh weight of plants/ m^2, number of tillers and spikes/ m^2 as affected by the interaction between N levels and P levels in the combined analysis of the two seasons.

Character N x P interaction		Fresh weight of plants/ m2	No. of tillers/ m^2	No. of spikes/ m^2
N- levels	P- levels			
0	0	373.1	412.3	372.0
	24	447.5	439.7	412.7
40	0	367.8	436.0	417.0
	24	460.3	430.7	412.9
80	0	497.8	458.3	521.3
	24	488.6	460.2	448.2
120	0	475.5	490.3	473.8
	24	540.8	551.8	536.7
L.S.D at 5 %		27.86	30.88	22.81

and 372.0 , respectively, produced from without application of nitrogen and phosphorus fertilizers. It could be concluded that application of 120 kg N + 24 kg P_2O_5/ feddan to wheat plants gave the highest values of tillers and spikes number/ m^2. The same trend was observed by Hassan (1995).

D- b- Interaction effect between nitrogen levels and microelements:

The interaction effect between N- levels and foliar application of microelements on fresh weight of plants per m^2 , number of tillers and spikes/ m^2 were significant in the combined analysis of the two growing seasons as shown in Table (5). On the contrary, the mean values of plant height, number of leaves/ plant, dry weight of plants/ m^2 and flag leaf area were not significantly affected by the interaction between N- levels and microelements. These factors act independently on their effect on these characters, consequently, the data were excluded.

D- b- 1. Fresh weight of plants/ m^2

The results in Table (5) indicate a significant interaction effect for N levels and microelements on fresh weight of plants/ m^2 . It was clear that the maximum fresh weight of plants/ m^2 was 525.9 gm, obtained from application 120 kg N and foliar application of manganese sulphate at 0.3 % . Whereas, the minimum one was 383.3 gm, produced from zero N and foliar application of zinc sulphate at 0.3 %. On the other hand, no significant difference was obtained between the interaction of zero and 40 kg N/ feddan with foliar application of Zn or Mn nutrients on fresh weight of plants/ m^2 . These results are in accordance with that obtained by Khaled (1994).

D- b- 2. Number of tillers and spikes/ m^2

The results in Table (5) show that the interaction between N levels and foliar application of microelements had a significant effect on number of tillers and spikes / m^2 in the combined analysis. The highest number of tillers and spikes/ m^2 were 548 and 540.7, respectively, produced from adding 120 kg N + foliar application of zinc sulphate at 0.3 %. Whereas, the lowest ones were 396 and 357.3 , respectively, produced from the check treatment .

These results might be attributed to the effect of nitrogen and zinc or manganese fertilization on accelerating wheat vegetative growth, increasing number of tillers and spikes/ m^2 Similar results were observed by Abd El- Shaheed (1988) who found that the interaction between N level and microelements had a significant effect on number of tiller/ m^2 , however number of spikes/ m^2 was not significant .

D- c. Interaction effect between phosphorus levels and microelements

The results in Table (6) indicate the significant effect of the interaction between phosphorus levels and foliar application of microelements on plant height, fresh weight of plants/ m^2, number of tillers and spikes/ m^2 in the combined analysis of the two growing seasons. On the other hand, the other characters of growth under study were not significantly affected by the interaction between phosphorus levels and foliar application of microelements, consequently, the data were excluded.

Table (5): The average values of fresh weight of plant/ m^2, number of tillers and spikes/ m^2 as affected by the interaction between N levels and some microelements in the combined analysis of the two seasons.

Character N x Micro interaction		Fresh weight of plants(gm)/ m^2	No. of tillers/ m^2	No. of spikes/ m^2
N- levels	Microelements			
0	0	405.4	396.0	357.3
	Zn	383.3	433.3	401.3
	Mn	389.1	404.7	366.7
	Zn + Mn	463.6	470.0	444.0
40	0	383.7	404.7	388.0
	Zn	408.8	398.7	382.9
	Mn	394.0	474.0	448.8
	Zn + Mn	469.8	462.0	440.0
80	0	504.5	488.5	477.0
	Zn	514.9	545.8	524.0
	Mn	495.3	516.0	500.0
	Zn + Mn	458.0	534.0	503.3
120	0	507.4	510.7	491.3
	Zn	489.6	548.0	540.7
	Mn	525.9	499.3	489.3
	Zn + Mn	509.7	459.0	434.3
L.S.D at 5 %		42.04	52.09	49.61

D- c- 1. Plant height

The average values of plant height was significantly increased by increasing P_2O_5 level with foliar application of microelements. The tallest plant was 98.6 cm, produced from adding 24 kg P_2O_5/ feddan with foliar application of $ZnSO_4$ + $MnSO_4$ at 0.3 %. Whereas, the shortest wheat plant was 93.6 cm, produced from zero P, Zn and Mn fertilizer .

D- c- 2. Fresh weight of plants/ m^2

Table (6) obviously indicate that the average values of fresh weight of plants/ m^2 was significantly affected by the interaction between phosphorus levels and microelements in the combined analysis. The maximum fresh weight of plants/ m^2 was 505.4 g obtained from adding 24 kg P_2O_5/ feddan without foliar application of microelements. No significant difference was obtained between the interaction of 24 kg P_2O_5 with foliar application of Zn + Mn nutrients at 0.3 % on fresh weight of plants/ m^2 . Whereas, the minimum one was 395.1 gm, produced from zero phosphorus fertilizer and without foliar application of microelements. These results are logical since Zn and Mn elements increase the activity of several enzymes.

D- c- 3. Number of tillers and spikes/ m^2

There was a significant difference in number of tillers and spikes/ m^2 due to the interaction between phosphorus level and foliar application of microelements in the combined analysis of the two growing seasons as shown in Table (6). The highest values of number of tillers and spikes/ m^2 were 499 and 481 , respectively, obtained from foliar application of Zn nutrients

Table (6): The average values of plant height, fresh weight of plant/ m^2, number of tillers and spikes/ m^2 as affected by the interaction between P levels and some microelements in the combined analysis of the two seasons.

Character P x Micro. interaction		Plant height (cm)	Fresh weight of plants/ m^2	No. of tillers/ m^2	No. of spikes/ m^2
P- levels	Microelements				
0	0	93.6	395.1	425.3	399.8
	Zn	96.8	430.2	499.0	481.0
	Mn	94.9	431.3	478.3	451.7
	Zn + Mn	96.2	457.5	484.3	451.7
24	0	95.9	505.4	474.6	457.0
	Zn	95.7	468.0	463.9	443.5
	Mn	97.9	470.9	468.7	450.8
	Zn + Mn	98.6	493.0	478.2	459.2
L.S.D at 5 %		2.20	29.73	36.85	35.06

and zero phosphorus fertilizer. On the other hand, the lowest ones were 425.3 and 399.8 , respectively, produced from the control treatment of phosphorus and microelements. The difference between the other treatments were not significant .

The same trend of results was obtained by Salem and Mohamed (2000) who observed that combined application of phosphorus at 46.5 kg P_2O_5/ feddan and spraying Zn + Fe + Cu gave satisfactory increase in number of tillers and spikes/ m^2 of wheat grown under newly reclaimed sandy soil.

D- d. Interaction effect between the three factors (second order interaction)

Results in Table (7) show that the mean values of fresh weight of plants/ m^2, number of tillers and spikes/ m^2 were significantly affected by the interaction between nitrogen levels, phosphorus levels and foliar application of microelements in the combined analysis of the two growing seasons. Whereas, the other characters of growth ,i.e., plant height, number of leaves/ plant, flag leaf area and dry weight of plants/ m^2 were not significantly affected by the interaction between the three factors under study in the combined analysis, consequently, the data were excluded.

D-d- 1. Fresh weight of plants/ m^2

Table (7) revealed that the interaction effect between the three factors was highly significant on fresh weight of plants/ m^2 . It was clear that the interaction between 120 kg N/ feddan + 24 kg P_2O_5/ feddan with foliar application of manganese sulphate at 0.3 % gave the maximum mean values of fresh weight of plants/ m^2 (590.3 g). While, the minimum one was 317.2 g, obtained from adding 40 kg N/ fed + 0 P + 0 microelements.

It could be concluded that the best treatment was 120 kg N + 24 kg P_2O_5/ feddan with foliar application of manganese sulphate at 0.3 % for producing the highest values of fresh weight of plants/ m^2 .

D- d- 2. Number of tillers and spikes/ m^2

The second order interaction affected highly significantly number of tillers and spikes/ m^2 in the combined analysis as shown in Table (7). The highest number of tillers and spikes/ m^2 were 632 and 592 , respectively, produced from adding 80 kg N/ feddan without phosphorus fertilizer and application of zinc sulphate at 0.3 % as foliar application. Whereas, unfertilized plants of nitrogen and phosphorus and without application of microelements gave the lowest mean value of tillers number/ m^2 (340). On the other hand, no significant difference was obtained between the interaction zero N + zero P + zero microelements and 40 kg N + zero P + zero microelements on number of tillers/ m^2. Also, the lowest number of spikes/ m^2 was 293.3, produced from the interaction between 40 kg N/ feddan zero phosphorus fertilizer and zero Zn and Mn elements .

II- Yield and yield components

A- Effect of nitrogen levels

A. 1- Spike characters

Table (8) show the effect of N levels on spike length, spike weight, grain weight/ spike, number of grains/ spike and

Table (7): The average values of fresh weight of plants/ m^2, number of tillers and spikes/ m^2 as affected by the interaction between N, P levels and some microelements in the combined analysis of the two seasons.

Characters		Fresh weight of plants (g)/ m^2				No. of tillers/ m^2				No. of spikes/ m^2			
Microelements		0	Zn	Mn	Zn + Mn	0	Zn	Mn	Zn + Mn	0	Zn	Mn	Zn + Mn
N-levels	P-levels												
0	0	321.3	343.7	390.0	437.5	340.0	473.3	526.7	464.0	328.0	405.3	502.7	432.0
	24	489.5	422.8	388.2	489.7	469.3	384.0	421.3	460.0	448.0	360.5	395.0	448.0
40	0	317.2	378.0	366.3	409.7	344.0	426.7	406.7	472.0	293.3	402.7	360.0	432.0
	24	450.2	439.5	481.7	529.8	448.0	440.0	402.7	468.0	421.3	400.0	373.3	456.0
80	0	487.5	517.2	507.3	479.0	533.3	632.0	524.0	504.0	513.3	592.0	512.0	468.0
	24	521.5	512.7	483.3	437.0	488.0	464.0	474.7	444.0	469.3	456.0	466.7	400.7
120	0	454.5	482.0	461.5	504.0	484.0	524.0	456.0	497.3	464.7	524.0	432.0	474.7
	24	560.3	497.2	590.3	515.3	493.0	567.5	576.0	570.7	489.3	557.3	568.0	532.0
L.S.D at 5%		59.46				73.67				70.16			

1000- grain weight in the combined analysis of 1999/ 2000 and 2000/ 2001 seasons.

It is observed that the increase in N level from zero to 120 kg/ feddan did not significantly influence spike length, spike weight, grain weight per spike and 1000- grain weight. Similar results are also reported by Hefni (1982) in spike weight, Abd El- Shaheed (1988) in weight of grains/ spike, Zahran and Mosalem (1993) in spike length and 1000- grain weight, Abd El- Fatah, Nagwa (1995) in grain weight/ spike and 1000- grain weight, El- Sherbieny *et al.* (1999) in spike length and 1000- grain weight, El- Sawi (2001) in spike length, grain weight/ spike and 1000- grain weight.

Regarding to number of grains/ spike, the effect of N level on this trait was significant in the combined analysis (Table 8). The increase in level from zero to 40, 80 and 120 kg N/ feddan significantly increased the number of grains/ spike by 2.9, 4.9 and 5.0% , respectively. Whereas, no significant differences was obtained between adding 40, 80 and 120 kg N/ feddan on number of grains/ spike. The results reported by Day *et al.* (1978), Abdel- Gawad *et al.* (1979), Abd El- Latif and El- Tuhamy (1986), Gab- Alla *et al.* (1986), Abd El- Shaheed (1988), El- Ghareib and El- Monofi (1988), Rady and Abo El- Zahab (1990), Ibrahim and Abdel- Aal (1991), Abo- Warda (1993), Zahran and Mosalem (1993), Darwiche (1994), El- Yamany (1994), Khaled (1994), Salwau (1994), El- Gharieb *et al.* (1998), Kotb (1998), Dardiry (1999), Mehasen (1999), Salem (1999), Zaghloul (1999), Hassan and Gaballah (2000), Munir *et al.* (2000) and Abou El- Ela, Sabah (20001) who found that increasing N level resulted in increasing the number of grains/ spike.

A. 2- Grain yield (kg)/ feddan

The mean values of grain yield/ feddan were significantly increased by increasing N level from zero to 120 kg N/ feddan in the second season and in the combined analysis of the two growing seasons as shown in Table (9). The increase in N level from zero to 40, 80 and 120 kg N/ feddan significantly increased grain yield/ feddan by 13.8, 15.5 and 21.4 % , respectively, in the second season, corresponding to 6.72, 7.9 and 11.9 %, , respectively in the combined analysis. Whereas, no significant difference was obtained between adding 40, 80 and 120 kg N/ feddan on grain yield/ feddan. The present result is quite clear manifestation for the prominent role of N on wheat grain yield in the soil under study. The increase in grain yield due to the increase in N level is a result of the effect of N in increasing number of spikes/ m^2, number of grains/ spike and 1000- grain weight.

The present results are in agreement with those obtained by Abdel- Gawad *et al.* (1979), Hefni (1982), Hagras (1985), Abd El- Latif and El- Tuhamy (1986), Gab- Alla *et al.* (1986), Jaffari and Abd- Mishani (1987), Abd El- Shaheed (1988), El-Gharieb and El- Monofi (1988), Ashraf *et al.* (1990), Mahgoub-Hayam (1990), Rady and Abo El- Zahab (1990), Ibrahim and Abdel- Aal (1991), Mohamed *et al.* (1992), Abo- Warda (1993), Darwiche (1994), El- Yamany (1994), Hegab (1994), Khaled (1994), Zaher (1996), El- Ghareib *et al.* (1998), Kotb (1998), El-Sherbieny *et al.* (1999), Mehasen (1999), Zaghloul (1999), Hassan and Gaballah (2000), Munir *et al.* (2000) and Abou El-Ela, Sabah (2001).

A. 3- Biological yield kg/ feddan

The results presented in Table (9) indicate that the mean values of biological yield kg/ feddan was significantly affected by application of nitrogen fertilizer in the second season and combined analysis of the two growing seasons, whereas N levels did not show any significant effect on the biological yield per feddan in the first season.

The highest mean values of biological yield/ feddan were 10073.87, 8898.79 and 9486.33 kg/ fed., obtained from adding 120 kg N/ feddan in the first and second seasons as well as in the combined analysis of the two growing seasons , respectively. Whereas, the lowest ones were 9098.56, 7530.60 and 8317.58 kg/ feddan, respectively, produced from the control treatment.

In the combined analysis, application of nitrogen fertilizer at 40, 80 and 120 kg N/ feddan resulted in increasing biological yield/ feddan over the control treatment by 8.47, 12.21 and 14.05 % , respectively.

It could be concluded that nitrogen application caused a significant effect in increasing biological yield due to the significant increase in dry weight of plants/ m^2, number of tillers and spikes/ m^2 and grain yield/ feddan. Similar results were reported by Rady and Abo El- Zahab (1990), Darwiche (1994), Khaled (1994), Salwau (1994), Zaher (1996), El- Sherbieny *et al.* (1999), Mehasen (1999) and Zaghloul (1999).

B- Effect of phosphorus levels

B. 1- Spike characters

The results in combined analysis show that the mean values of spike length, spike weight, grain weight/ spike, number of grains/ spike and 1000- grain weight were not significantly affected by application of phosphorus fertilizer as shown in Table (8).

It was clear that, slight increases 1000- grain weight were observed due to applying phosphorus at 24 kg P_2O_5/ feddan when compared with the control. The increases were far below the level of significance .

The results are in full accordance with those obtained by Abo- Warda (1993), Aly (1998) and Salem and Mohamed (2000). Opposite results were reported by Oliveira and Camargo (1984), Malik *et al.* (1995), Kotb (1998), Fadl- Manal (1999), El- Bana (2000), Salem and Mohamed (2000) and Sadek *et al.* (2000) who found that spike characters and 1000- grain weight responded to P application.

B. 2- Grain yield (kg)/ feddan

From data recorded in Table (9) one can observe that phosphorus levels significantly increased grain yield/ feddan in the first and second seasons as well as in the combined analysis of the two growing season. Application of 24 kg P_2O_5/ feddan resulted in increasing grain yield over the control treatment by 18.96, 11.7 and 15.2 % in 1999/ 2000 and 2000/ 2001 seasons and combined analysis , respectively. Under the conditions of the present study it could be concluded that the application of 24 kg P_2O_5/ feddan in recommended for wheat grain in clay soil.

The effect of phosphorus on grain yield may be due to the regulation of many enzymatic process and activation of some enzymes by phosphorus. These results are in harmony with those obtained by Oliveria and Camargo (1984), Jaggi and Minhas (1990), Ashraf *et al.* (1990), Abo- Warda (1993), Aly (1998), Kotb (1998), El- Bana (2000), Salem and Mohamed (2000) and Sadek *et al.* (2000).

B. 3- Biological yield (kg)/ feddan

The effect of phosphorus fertilizer level on biological yield/ feddan was highly significant in the first and second season as well as highly significant in the combined analysis of both seasons (Table 9).

Application of 24 kg P_2O_5/ feddan significantly increased biological yield/ feddan over the control treatment by 10.14, 13.13 and 11.61 % in the first and second seasons and in the combined analysis , respectively. These results may be due to the effect of phosphorus level on plant height, fresh and dry weight of plants/ m^2, flag leaf area and grain yield/ feddan. These results agree with those obtained by Ashraf *et al.* (1990), Aly (1998) and Salem and Mohamed (2000).

C- Effect of microelements

C. 1- Spike characters

Data in Table (8) indicate that foliar application of microelements significantly increased spike length, grain weight/ spike and 1000- grain weight in the combined analysis of the two growing season, when compared with the control treatment, whereas microelements spraying on wheat plants did not show any significant effect on spike weight and number of grains/ spike.

It is obvious that foliar application of Zn, Mn and Zn + Mn nutrients increased spike length by 3.4 %, 4.1% and 6.1%, respectively, when compared with the control treatment. Also, 1000- grain weight gave the same trend in spike length as affected by application of microelements. Whereas, the differences between the three treatments of microelements were not significant on spike length, grain weight/ spike and 1000- grain weight.

It could be concluded that foliar application of zinc sulphate 0.3 % or manganese sulphate 0.3 % gave the highest values of spike length, grain weight/ spike and 1000- grain weight. This might be attributed to the positive effect of $ZnSO_4$ and $MnSO_4$ on spike characters. Also, 1000- grain weight increased by foliar application of microelements may be due to encrouage the plant growth, stimulation of N uptake, more enzymatic formation and activity (Devlin, 1966) and then more dry matter production which will be stored in the grains. These results are in harmony with those obtained by Youssef and Salem (1976), Ashoub *et al.* (1982), Mahmoud and El- Mandoh (1982), abd- El- Shaheed (1988), Mourad *et al.* (1992), Zahran and Mosalem (1993), Salwau (1994), Abd El- Fatah, Nagwa (1995), Abd El- Mottalb *et al.* (1997), Gowily, Ahlam *et al.* (1997), Gobarh, Mirvat (1998) and Salem and Mohamed (2000) who found that spike length, weight of grains/ spike and 1000 grain weight were significantly increased by foliar application of microelements. Also, Gab- Alla *et al.* (1986), Abd El- Shaheed (1988) and Salwau (1994) revealed that application of Zn and Mn elements to wheat plants did not give any significant increases on number of grains/ spike and spike weight.

C. 2- Grain yield (kg)/ feddan

The results in Table (9) show that the mean values of grain yield (kg)/ feddan was significantly increased by foliar application of microelements in the second season and combined analysis of the two growing seasons. Whereas, adding of microelements caused in significant increase in the grain yield of wheat in the first season. Application of $ZnSo_4$, $MnSo_4$ and $ZnSo_4$ + $MnSo_4$ as foliar application to wheat plant at a rate of 0.3 % increased grain yield/ feddan by 4.3, 4.9 and 8.7 %, respectively over the control treatment in the combined analysis. On the other hand, no significant difference was obtained between foliar application of Zn and Mn nutrients on grain yield/ feddan in the combined analysis. The increase in grain yield due to foliar application of microelements to wheat plants may be attributed to the increment of spike length, weight of grains/ spike, 1000- grain weight and number of spikes/ m^2. Many other investigators reported that microelements had significant effect on grain yield/ feddan (Youssef and Salem, 1976; Samai *et al.*, 1979; Hefni, 1980; Ashoub, *et al.*, 1982; Mahmoud and El- Mandoh, 1982; El- Kholany and Hefni, 1985; Gab- Alla *et al.* 1986; Takkar *et al.*, 1986; Abd El- Shaheed, 1988; Omar and Ebrahim, 1990; Hassan *et al.*, 1992; Mourad *et al.*, 1992; Shams El- Din, 1993; Zahran and Mosalem, 1993; Khaled, 1994;

Salwau, 1994; Abd El- Fatah, Nagwa, 1995; Gobarh, Mirvat, 1998 and Salem and Mohamed, 2000).

C. 3- Biological yield (kg)/ feddan

No significant difference were observed between Zn and Mn elements regarding biological yield/ feddan in both seasons and combined analysis of the two growing seasons (Table 9). Foliar application of $ZnSo_4$, $MnSo_4$ and $ZnSo_4$ + $MnSo_4$ nutrients equal to 0.3 %, 0.3 % and 0.3 + 0.3 % increased biological yield/ feddan over the control treatment by 1.5, 3.5 and 1.4 % , respectively. The increases were far below the level of significance.

Similar results were obtained by Samai *et al.* (1979) who revealed that the application of Zn- element to wheat plant did not give any significant increases on straw yield per unit area. Whereas, many other investigators reported that microelements had significant effect on biological yield (Hefni, 1980; Gab-Alla *et al.*, 1986; Abd El- Shaheed, 1988; Mourad *et al.*, 1992; Salwau, 1994 and Abd El- Fatah, Nagwa, 1995).

D- Interaction effect

D- a. Interaction effect between N levels and P levels

Table (10) clarified that the mean values of grains number/ spike in the combined analysis and grain yield/ feddan in the first season and combined analysis of the two growing seasons were significantly affected by the interaction between nitrogen levels and phosphorus levels. Whereas, the interaction between the two factors did not significantly affect spike length. Spike weight, weight of grains/ spike, 1000- grain weight and

Table (8) : The average values of spike length, spike weight, grain weight/ spike, number of grains/ spike and 1000 grain weight as affected by N , P, Zn and Mn elements (Combined analysis).

Character / Treatment	Spike length (cm)	Spike weight (gm)	Grain weight/ spike (gm)	No. of grains/ spike	1000-grain weight (gm)
N- level kg/ fed.					
1- 0	15.2 a	6.3 a	3.5 a	67.7 b	51.6 a
2- 40	15.3 a	6.1 a	3.3 a	69.7 ab	51.9 a
3- 80	15.3 a	6.1 a	3.4 a	71.0 a	52.2 a
4- 120	15.3 a	6.3 a	3.3 a	71.1 a	53.1 a
F- test	N.S	N.S	N.S	**	N.S
P level kg/ fed.					
1- 0	15.3 a	6.2 a	3.4 a	70.0 a	51.6 a
2- 24	15.2 a	6.2 a	3.4 a	69.8 a	52.8 a
F- test	N.S	N.S	N.S	N.S	N.S
Microelements					
1- 0	14.8 b	6.0 a	3.2 b	67.2 a	50.9 b
2- Zn	15.3 a	6.3 a	3.5 a	70.2 a	52.3 a
3- Mn	15.4 a	6.3 a	3.5 a	70.6 a	52.7 a
4-Zn+Mn	15.7 a	6.4 a	3.5 a	71.6 a	52.9 a
F- test	**	N.S	**	N.S	**

Table (9): The average values of grain yield and biological yield/ feddan as affected by N levels, P levels and some micronutrients in both seasons and their combined analysis.

Characters / Treatment	Grain yield kg/ fed.			Biological yield kg/ fed.		
	First season	Second season	Comb.	First season	Second season	Comb.
N- level kg/ fed.						
1- 0	2829.85 a	2569.84 b	2699.84 b	9098.56 a	7536.60 b	8317.58 b
2- 40	2837.86 a	2925.16 a	2881.51 a	9390.16 a	8653.40 a	9021.78 a
3- 80	2859.04 a	2967.25 a	2913.14 a	9839.56 a	8826.29 a	9332.92 a
4- 120	2923.08 a	3121.15 a	3022.12 a	10073.90a	8898.79 a	9486.33 a
F- test	N.S	**	**	N.S	**	**
P level kg/ fed.						
1- 0	2614.65 b	2736.34 b	2675.49 b	9137.47 b	7950.07 b	8543.77 b
2- 24	3110.28 a	3055.36 a	3082.82 a	10063.6 a	9007.46 a	9535.54 a
F- test	**	**	**	**	**	**
Microelements						
1- 0	2796.67 a	2714.26 b	2755.46 c	9340.10 a	8456.62 a	8898.4 a
2- Zn	2821.31 a	2929.22 ab	2875.26 b	9485.92 a	8560.61 a	9023.3 a
3- Mn	2903.48 a	2875.52 ab	2889.50 b	9867.00 a	8554.29 a	9210.6 a
4-Zn+Mn	2928.38 a	3064.40 a	2996.39 a	9709.15 a	8343.55 a	9026.3 a
F- test	N.S	**	*	N.S	N.S	N.S

biological yield/ feddan. This means that each of this factors act independently on their effect on its characters. Consequently, the data were excluded.

D- a- 1. Number of grains/ spike

No significant differences was obtained between the interaction of 120 kg N + 24 kg $P_2O_5$and 40 kg N + zero P_2O_5as well as between 80 kg N + zero $P_2O_5$and 80 kg N + 24 kg P_2O_5/ feddan on number of grains/ spike. On the other hand, the lowest one was 66, produced from without application of nitrogen and phosphorus fertilizers. Similar results were reported by Hassan (1995) who found that applying NP fertilization up to 90 kg N + 45 kg P_2O_5/ feddan caused a significant increase in yield components of wheat.

D- a- 2 Grain yield (kg)/ feddan

Results in Table (10) showed that the interaction between N level and P level significantly affected grain yield/ feddan in the first season and combined analysis of the two growing seasons. The maximum mean values of grain yield was 3207.7 kg/ feddan, obtained from adding 120 kg N + 24 kg P_2o_5 / feddan in the combined analysis. While, the interaction between 120 kg N + 24 kg P_2O_5/ feddan and 80 kg N + 24 kg P_2O_5/ feddan on grain yield/ feddan was not significant . The increase in grain yield due to the increase in NP levels is a result of the effect of NP increasing number of spikes. m^2 and 1000- grain weight.

The same trend was obtained by Abo- Warda (1993), Hassan (1995) and Sadek- Iman *et al.* (2000). Whereas, Fadl, Manal (1999) pointed out that the interaction between nitrogen

Table (10): The average values of grain number/ spike in the combined analysis and grain yield/ feddan in both seasons and their combined as affected by the interaction between N levels and P levels.

Characters		No. of grains/ spike	Grain yield (kg)/ fed.		
Season		Comb.	First	Second	Combined
N- levels	P-levels				
0	0	66.5	2450.1	2393.9	2422.0
	24	68.8	3209.6	2745.8	2977.7
40	0	72.4	2814.6	2823.2	2818.8
	24	67.1	2861.1	3027.1	2944.1
80	0	71.8	2468.6	2780.4	2624.6
	24	70.4	3249.4	3154.1	3201.8
120	0	69.3	2725.2	2947.8	2836.5
	24	72.7	3120.9	3294.5	3207.7
L.S.D at 5 %		4.73	303.66	N.S	312.23

and phosphorus fertilizer had no significant effect on grain yield/ feddan.

D- b. Interaction effect between N levels and microelements

The effect of the interaction between N levels and foliar application of microelements was significant on spike weight, number of grains/ spike and 1000- grain weight in the combined analysis (Table 11) as well as grain yield and biological yield/ feddan in the second season and combined analysis of the two growing seasons (Table 12). Whereas, the interaction between the two factors did not significantly affect spike length and grain weight/ spike in the combined analysis, consequently, the data were excluded .

D. b- 1. Spike weight

The difference between the average values of spike weight was significantly affected by the interaction between N levels and foliar application of microelements in the combined analysis (Table 11). Application of 120 kg N/ feddan with foliar application of manganese sulphate at 0.3 % gave the maximum weight of spike (6.9 gm). While, the minimum one was 5.6 gm, produced from application of 40 kg N/ feddan without foliar application of microelements. It could be concluded that foliar application of microelements was more efficient than increasing N level on spike weight. The previous results are similar with those obtained by Gab- Alla *et al.* (1986) and Khaled (1994).

D- b- 2. Number of grains/ spike

Data presented in Table (11) show the effect of N level and foliar application of microelements which was significant on number of grains/ spike in the combined analysis. The highest number of grains/ spike was 76.80, obtained from adding 80 kg N/ feddan with foliar application of manganese sulphate at 0.3 %. On the other hand, the lowest one was 64.41, produced from adding 40 kg N/ feddan without foliar application of microelements.

The same trend was obtained by Zahran and Mosalem (1993), Khaled (1994) and Abd El- Fatah, Nagwa (1995) who indicated that the interaction of N and microelements fertilization on number of grains/ spike was significant .

D- b- 3. 1000- grain weight

The mean values of 1000- grain weight were significantly increased by increasing N level up to 120 kg N/ feddan with foliar application of microelements in the combined analysis of the two growing seasons. Application of nitrogen fertilizer at 120 kg N / feddan with foliar application of zinc sulphate at 0.3 % gave the greatest values of 1000- grain weight (55.04 g). Whereas, no significant difference was obtained by the interaction between 80 and 120 kg N/ feddan with foliar application of microelement on 1000- grain weight. On the other hand, the minimum weight of 1000- grain was 49.93 gm, produced from adding 40 kg N/ feddan with foliar application of $ZnSO_4$ at 0.3 %.

These results agree with that obtained by Zahran and Mosalem (1993).

D- b- 4. Grain yield (kg)/ feddan

There was a significant difference of the mean values of grain yield/ feddan due to the interaction between N level and foliar application of microelements in the first season and combined analysis as shown in Table (12). The maximum grain yield/ feddan was 3180.7 kg, produced from application of 120 kg N with Zn + Mn at 0.3 %. Whereas, the minimum one was 2485.4 kg/ feddan, obtained from without application of nitrogen and foliar application of zinc. On the other hand, there was a little difference between 80 and 120 kg N/ feddan with foliar application of Zn, Mn and Zn + Mn nutrients on grain yield/ feddan.

These results are in accordance with those obtained by Gab- Alla *et al.* (1986), Saad *et al.* (1987), Abd El- Shaheed (1988), Zahran and Mosalem (1993), Kandeel and El- Maddah (1998) and Shams *et al.* (1999).

D- b- 5. Biological yield (kg)/ feddan

The results in Table (12) indicate the effect of interaction between N level and microelements that was highly significant on biological yield (kg)/ feddan in the first season and combined analysis of the two growing seasons. The highest mean values of biological yield/ feddan was 9829.9 kg, produced from adding 120 kg N/ feddan with foliar application of $ZnSO_4$ at 0.3 % , whereas the lowest one was 7447.4 kg/ feddan, obtained form zero nitrogen and microelements in the combined analysis.

These results are in harmony with those obtained by Gab- Alla *et al.* (1986), Abd El- Shaheed (1988), Khaled (1994), Kandeel and El- Maddah (1998) and Shams *et al.* (1999).

Table (11): The average values of spike weight, number of grains/ spike and 1000- grain weight as affected by the interaction between N levels and some microelements in the combined analysis of the two seasons.

Character / N x microelements interaction		Spike weight (gm)	No. of grains/ spike	1000- grain weight
N- levels	Microelements			
0	0	6.4	64.99	51.55
	Zn	6.2	67.71	51.16
	Mn	6.4	66.38	51.42
	Zn + Mn	6.2	71.66	52.47
40	0	5.6	64.41	51.08
	Zn	6.5	72.01	49.93
	Mn	6.1	71.31	53.73
	Zn + Mn	6.4	71.16	52.97
80	0	5.6	69.04	50.70
	Zn	6.3	66.55	53.22
	Mn	5.8	76.80	52.46
	Zn + Mn	6.6	72.04	52.34
120	0	6.3	70.35	50.33
	Zn	6.0	74.51	55.04
	Mn	6.9	67.83	53.06
	Zn + Mn	6.4	71.40	53.78
L.S.D at 5 %		0.63	4.73	3.42

Table (12): The average values of grain yield and biological yield/ feddan as affected by the interaction between N levels and some microelements in both seasons and their combined analysis .

Character		Grain yield (kg)/ fed.			Biological yield (kg)/ fed.		
Seasons		First	Second	Comb.	First	Second	Comb.
N-levels	Microelements						
0	0	3073.4	2285.4	2679.4	7834.9	7059.9	7447.4
	Zn	2290.8	2680.1	2485.4	9972.5	7447.7	9695.1
	Mn	3009.8	2518.3	2764.1	9675.3	7916.5	8795.9
	Zn + Mn	2946.1	2795.7	2870.7	8911.5	7752.2	8331.8
40	0	2861.4	2856.0	2858.7	10813.9	8722.2	9768.1
	Zn	2909.1	2892.1	2900.6	7926.9	8691.4	8309.1
	Mn	2715.2	3026.2	2870.7	9407.7	8298.3	8853.0
	Zn + Mn	2865.8	2926.2	2895.9	9412.1	8901.6	9156.8
80	0	2624.8	2662.2	2643.5	9747.8	9100.7	9424.2
	Zn	3009.4	2716.5	2862.9	9586.1	8515.5	9050.8
	Mn	2971.5	3244.9	3108.2	9924.2	9100.7	9512.4
	Zn + Mn	2830.5	3245.4	3037.9	10100	8581.7	9340.9
120	0	2627.2	3053.4	2840.3	8963.7	8491.3	8727.5
	Zn	3076.7	3213.5	3145.1	10458	9201.3	9829.9
	Mn	2917.3	2927.5	2922.4	10461	8895.1	9677.9
	Zn + Mn	3071.1	3290.2	3180.7	10413	9006.8	9709.8
L.S.D at 5 %		497.3	N.S	491.69	722.79	N.S	688.78

D- C. Interaction effect between phosphorus levels and foliar application of microelements

Results in Table (13) indicated that the interaction between phosphorus levels and foliar application of microelements significantly affected spike length in the combined analysis of the two growing seasons. Whereas, the other characters of spike, 1000- grain weight, grain yield and biological yield/ feddan were not significantly affected by the interaction between phosphorus level and foliar application of microelements. This means that each of these factors act independently on their effect on these characters, consequently the data were excluded.

Spike length

There was a significant difference in spike length due to the interaction between phosphorus levels and foliar application of microelements in the combined analysis as shown in Table (13). Without application of phosphorus with foliar application of Zinc sulphate + manganese sulphate at 0.3 % gave the tallest spike (15.68 cm), whereas without application of phosphorus and microelements produced the shortest spike (14.62 cm). Foliar application of Zn + Mn without phosphorus fertilizer gave the tallest spike length.

Results reported by Salem and Mohamed (2000) observed that application of phosphorus at 46.5 kg P_2O_5/ feddan and spraying Zn + Fe + Cu gave satisfactory increase in the yield components of wheat under newly reclaimed sandy soil.

Table (13): The average values of spike length as affected by the interaction between P levels and some microelements in the combined analysis of the two season.

Character	Spike length (cm)	
P_2O_5- level kg/fed.	0	24
Microelements		
0	14.62	14.94
Zn	15.29	15.33
Mn	15.68	15.09
Zn + Mn	15.79	15.53
L.S.D at 5 %	0.50	

D- d Interaction effect between the three factors

The effect of the interaction between N levels, P_2O_5 levels and foliar application of microelements was significant on spike length and number of grains/ spike in the combined analysis (Table 14) as well as biological yield /feddan in the first and second seasons and combined analysis of the two growing seasons (Table (15). Whereas, the interaction between the three factors under study had no significant effect on spike weight, weight of grains/ spike, 1000- grain weight and grain yield/ feddan in combined analysis, consequently the data were excluded.

D- d- 1 Spike length

The data presented in Table (14) indicate that spike length was significantly affected by the second order interaction. The tallest spike was 16.2 cm, produced from foliar application of Zn + Mn nutrients without application of nitrogen and phosphorus fertilizer. No significant difference was obtained between the interaction of 0 N + 0 P + Zn + Mn and 120 kg N + 24 kg N + Zn + Mn on the mean values of spike length. Whereas, the shortest spike was 13.6 cm, produced from without application of nitrogen, phosphorus and microelements. These results are logical since Zn and Mn fertilization increase the activity of several enzymes .

D- d- 2. Number of grains/ spike

The obtained data in Table (14) clearly show that the interaction between N, P and foliar application of microelements was statistically significant on number of grains/ spike in the combined analysis of the two growing seasons. The maximum mean values of grains number/ spike was 78.11, produced from applied 120 kg N + 24 kg P_2O_5 and foliar application of zinc sulphate at 0.3 %. On the other hand, the minimum one was 56.7, obtained from 40 kg N + 24 kg P_2O_5 without foliar application of microelements. The increase in number of grains/ spike may be due to increase in spike length as affected by increasing NP levels and foliar application of microelements.

D- d- 3. Biological yield (kg)/ feddan

Application of 80 kg N + 24 kg P_2O_5 with foliar application of Zn + Mn caused a significant increase in biological yield by 48.7 % over the control treatment (without application of N, P and microelements in the combined analysis as shown in Table (15).

These results might be attributed to the effect of nitrogen zinc and manganese fertilization in accelerating wheat vegetative growth, increasing dry matter production and increasing yield components of wheat and grain yield.

III Correlation coefficient

The association between grain yield and some characters of yield components of wheat in the combined analysis of the two growing season are shown in Table (16).

There was positive and significant correlation coefficient between spike length and each of spike weight (r = 0.409) and grain weight/ spike (r = 0.419).

Also, the results showed that spike weight was positively and highly significantly correlated with number of gains/ spike (r= 0.460**) and grain weight/ spike (r = 0.643**).

Table (14): The average values of spike length and number of grains/ spike as affected by the interaction between N, P levels and some microelements in the combined analysis of the two seasons.

Characters		Spike length (cm)				No. of grains/ spike			
Microelements		0	Zn	Mn	Zn + Mn	0	Zn	Mn	Zn + Mn
N- levels	P- levels								
0	0	15.0	14.5	15.4	16.2	62.0	63.9	68.4	71.7
	24	15.4	15.4	15.2	14.7	67. 9	71.5	64.4	71.6
40	0	13.6	15.1	16.1	15.6	72.1	73.0	74.9	69.4
	24	15.3	15.7	14.9	15.8	56.7	71.0	67.6	72.9
80	0	15.5	15.8	15.9	15.8	72.6	65.8	76.1	72.6
	24	14.2	14.8	15.1	15.5	65.5	67.3	77.9	71.5
120	0	14.3	15.8	15.3	15.6	70.9	70.9	63.5	71.8
	24	14.9	15.4	15.2	16.1	69.8	78.11	72.1	70.9
L.S.D at 5%		0.99				7.65			

Table (15): The average values of biological yield/ feddan as affected by the interaction between N, P levels and some microelements in both seasons and their combined analysis .

Characters		First season				Second season				Combined			
Microelements		0	Zn	Mn	Zn + Mn	0	Zn	Mn	Zn + Mn	0	Zn	Mn	Zn + Mn
N- levels	P- levels												
0	0	7214.5	8979.8	9461.3	8838.5	6507.5	6730.6	7285.1	7094.7	6861.0	7855.2	8373.2	7966.6
	24	8455.3	10965.2	9889.3	8984.5	7612.8	8104.8	8548.0	8409.8	8034.1	9535.0	9218.6	8697.1
40	0	9484.3	7371.2	9155.5	8456.6	8088.5	8126.1	8044.4	9036.3	8786.4	7748.6	8599.9	8746.4
	24	12143.6	8432.6	9659.9	10367.5	9356.0	9256.8	8552.2	8766.9	10749.8	8844.7	9106.1	9567.2
80	0	10068.9	9875.1	10264.8	8700.7	9663.0	8902.1	7281.	7060.5	9865.9	9388.6	8772.9	7880.6
	24	9426.7	9297.1	9583.7	11499.5	8538.4	8128.9	10933.3	10103.3	8982.5	8713.0	10258.5	10801.2
120	0	7873.7	10146.2	10436.9	9871.3	7915.3	8386.5	8336.3	8743.2	7894.5	9266.3	9386.6	9307.2
	24	10053.8	10770.1	10484.6	10954.5	9069.4	10017.2	9453.9	9270.5	9561.6	10393.6	9969.2	10112.5
L.S.D at 5%		1445.59				1309.58				1377.59			

Positive and highly significant correlation coefficient was found between number of grains/ spike and grain weight/ spike (r = 0.755**).

Also, there was positive and significant correlation was detected between number of tillers/ m^2 and number of spikes/ m^2 (r = 0.934**).

Highly significant positive correlation was obtained between grain yield/ feddan and biological yield (r= 0.882**).

The same results reported by Abd Fatah, Nagwa (1995) who found that significant positive correlation coefficient between grain weight/ spike and each of spike length and number of gains/ spike. Also, El- Sherbieny *et al.* (1999) showed that positive and significant correlation with straw yield and grain / straw ratio. Whereas, Hassan and Gaballa (2000) indicated that grain yield was positively and significantly correlated with number of spikes/ m^2, spike length, number of grains/ spike, 1000 grain weight and straw yield/ feddan.

V Grain quality

The effect of N levels, P levels and foliar application of microelements on the mean values of zinc and manganese concentration (ppm), N % and protein content in wheat grains in the combined analysis of the two growing seasons as well as protein yield (kg)/ feddan in both seasons and combined analysis are presented in Table (17).

A- Effect of nitrogen levels

A- 1. Zn content (ppm)

The results in Table (17) reveal that Zn content in wheat grain increased with increasing N level. These increases were

Table (16) Simple correlation coefficient between grain yield and yield components of wheat in the combined analysis of the two growing seasons.

Characters	Spike length (cm)	Spike weight (gm)	No. of grains/ spike	Grain weight/ spike	No. of tillers/m^2	No. of spikes/ m^2	1000 grain weight (gm)	Biological yield kg/ fed.	Grain yield Kg/ fed.
1- Spike length	1.000								
2- Spike weight	0.409*	1.000							
3- No. of grains/ spike	0.256	0.460**	1.000						
4- Grain weight/ spike	0.419*	0.643**	0.755**	1.000					
5- No. of tillers/m^2	0.133	0.074	0.048	-0.025	1.000				
6- No. of spikes/ m^2	-0.149	-0.006	0.095	0.051	0.934**	1.000			
7- 1000 grain weight	0.288	0.131	-0.075	0.260	-0.137	-0.132	1.000		
7- Biological yield/ fed.	0.028	0.097	0.016	-0.059	0.014	-0.049	-0.036	1.000	
8- Grain yield/ fed.	0.073	0.146	0.020	-0.026	0.133	0.074	-0.025	0.882**	1.000

below the level of significance in the combined analysis of the two growing seasons. The increase in N level from zero to 120 kg / feddan increased Zn content in wheat grain by 10.32 %.

These results clearly indicate that increasing nitrogen fertilization increased the concentration of Zn in wheat grains. Abd El- Shaheed (1988) pointed out that zinc content in grains was not significantly affected by N level. On the other hand, Gab- Alla *et al.* (1986) and Abd El- Fatah, Nagwa (1995) concluded that the relationship between nitrogen fertilization and Zn content in grains was positive.

A- 2. Mn content (ppm)

The effect of N levels on manganese content of wheat grains was not significant in combined analysis of 1999/ 2000 and 2000/ 2001 seasons as shown in Table (17). It was clear that the concentration of manganese was decreased by increasing N level up to 80 kg N/ feddan. The highest content of manganese was 16.49 ppm, produced from unfertilized treatment. Whereas, application of 80 kg N/ feddan gave the lowest one (12.68 ppm).

It could be concluded that the relationship between N fertilization and Mn content was negative . On the other hand, other investigators reported that Mn content in wheat grains was significantly increased by increasing nitrogen rate (Gab Alla *et al.*, 1986; Radwan *et al.*, 1993; Khaled, 1994 and Abd El- Fatah, Nagwa, 1996).

A- 3. Protein content (%)

Table (17) indicated that crude protein in wheat grain were highly significantly affected by N levels in the combined analysis of the two growing seasons. The differences between adding 40 and 80 kg N/ feddan on N and protein percentage were not significant .

The application of 120 kg N/ feddan gave the highest protein content in wheat grain which was equal to 14.30 %, whereas without application of nitrogen gave the lowest one (9.12 %).

This result is mainly due to the positive effect of nitrogen element as constituent of amino acids, amides, N basis and nucleoproteins. In addition, nitrogen is essential for some plant enzymes, chlorophyll formation, DNA and RNA synthesis. Increasing protein percentage in wheat grains by adding N levels was obtained by Gab- Alla *et al.* (1986). Abd El- Shaheed (1988), Bruckner and Morey (1988), Flower *et al.* (1989), Ashraf *et al.* (1990). Ibrahim and Abdel- Aal (1991), Abo Warda (1993), El- Faham, Sawsan and Hussein (1993), Radwan *et al.* (1993), Darwiche (1994), Hegab (1994), Khaled (1994), Salwau (1994), Zaher (1996), El- Ghareib *et al.* (1998), Dardiry (1999), El- Sherbieny *et al.* (1999), Shams *et al.* (1999), Zaghloul (1999) and Abou El- Ela, Sabah (2001).

A- 4. Protein yield (kg)/ feddan

The results in Table (17) show that there was a high significant differences between N levels on protein yield/ feddan in both seasons and combined analysis of the two growing seasons. The differences between zero, 40 and 80 kg N/ feddan were not significant in the first season and in the combined analysis. Also, the difference between zero and 40 kg N/ feddan as well as between 80 and 120 kg N/ feddan on protein yield were not significant in the second season. The application of 40, 80 and 120 kg N/ feddan increased protein yield by 3.24, 14.06 and 60.97 % , respectively over without fertilizer of nitrogen in the combined analysis of the two growing seasons. The increase in protein yield may be due to the increase in grain yield/ feddan and protein content in wheat grain.

These results are in agreement with those obtained by Mohamed *et al.* (1992) and Abd El- Fatah, Nagwa (1995).

B- Effect of phosphorus levels

1 - B. Zn content (ppm)

The results in Table (17) show that zinc concentration in wheat grain was highly significantly decreased by adding 24 kg P_2O_5/ feddan when compared without fertilization of phosphorus in the combined analysis of 1999/ 2000 and 2000/ 2001 seasons.

These results are not in agreement with those obtained by Fadl- Manal (1999) and Salem and Mohamed (2000) who found that content of Zn in grain was not significantly increased by increasing phosphorus levels up to 46.5 kg P_2O_5/ feddan may be due to the direct effect of P element in increasing photosynthesis activity and subsequently chemical content such as Zn content.

2- B. Mn content (ppm)

Data given in Table (17) indicate that content of Mn in grain was not significantly increased with adding 24 kg P_2O_5/ feddan when compared without phosphorus fertilizer in combined analysis of the two growing seasons. Application of 24 kg P_2O_5/ feddan increased manganese concentration over the control treatment by 12.8 %. The favourable effect of phosphorus fertilization on chemical composition of grains may be due to the direct effect of this essential element in increasing photosynthesis activity and subsequently chemical content such as manganese. These results are in harmony with that obtained by Fadl- Manal (1999).

3- B. Protein content (%)

The results of the combined analysis in Table (17) stated that the effect of phosphorus levels had no significant effect on protein content in wheat grain. These results indicate clearly that the soil of this experiments has no need to phosphorus fertilization may be due to the high content on phosphorus in the soil (Table 1). Also, the phosphorus requirement for optimal growth is in the range of 0.3 to 0.5 % of the plant dry weight during the vegetative stages of growth. Also, the fixation of the applied phosphorus and to possible transfer of the available phosphorus to its unavailable form. Results reported by Abo-Warda (1993) and Fadl- Manal (1999) showed that phosphorus application did not significantly affect N % and protein content in wheat grain.

4- B. Protein yield (kg)/ feddan

The results presented in Table (17) show that phosphorus fertilizer application significantly increased protein yield/ feddan in the first and second seasons as well as in the combined analysis of the two growing seasons.

Applying phosphorus at a rate of 24 kg P_2O_5/ feddan increased protein yield/ feddan over the check treatment by 22.8, 10.77 and 16.5 % in the first and second seasons and combined analysis, , respectively.

The increase in protein yield due to the application of phosphorus fertilizer is a result of the effect of phosphorus in increasing gain yield and protein content in wheat grains. Similar results were obtained by Ashraf *et al.* (1990) and Salem and Mohamed (2000) showed that protein yield tended to increase significantly with increasing phosphorus level up to 46.5 kg P_2O_5/ feddan.

C- Effect of microelements

C. 1- Zn content (ppm)

The difference between the four treatments of foliar application of microelements on zinc content in wheat grains in the combined analysis are shown in Table (17).

It was evident that foliar application of zinc nutrient caused significant increases of the mean values of zinc content when compared with the other treatments. The maximum mean values of zinc content in wheat grains was 55.43 ppm, obtained from foliar application of zinc sulphate at 0.3 %. Whereas, no significant difference was obtained between adding zinc nutrient and untreated plant of microelements on Zn content. On the other hand, the minimum one was 43.15 ppm, produced form foliar application of manganese sulphate at 0.3 %. In this respect, Peterson (1969) indicated that Zn has been shown to bind various cellular fractions. These results are in accordance with those obtained by Gab- Alla *et al.* (1986), Abd El- Shaheed

(1988), Abd El- Fatah, Nagwa (1995), Abd El- Mattalb *et al.* (1997) and Kandeel and El- Maddah (1998).

C. 2- Mn content (ppm)

Table (17) show Mn content in wheat grains as affected by foliar application of microelements in the combined analysis of the two growing seasons. It was clear that foliar application of Zn, Mn and Zn + Mn nutrients significantly resulted in increasing the mean values of Mn content in wheat grains by 23.94, 25.49 and 16.72 % , respectively over untreated plants. Application of zinc sulphate at 0.3 % gave the highest concentration of Mn content in wheat grains. Whereas, no significant difference was obtained between the three treatments of microelements on Mn content. The increase in the grain content of Mn due to the application of microelements surely reflected on increasing Mn uptake by plants. Similar result was obtained by Abd El- Fatah, Nagwa (1995).

C. 3- Protein content (%)

Protein in wheat grain were not significantly affected by application of microelements in the combined analysis (Table 17). The highest values of protein percentage in wheat grain was 11.14 %, obtained from foliar application of manganese sulphate at 0.3 % . Whereas, the lowest one was 10.81 %, produced from foliar application of $ZnSO_4$ + $MnSO_4$ at 0.3 %. The increment in protein percentage by Mn application might be attributed to the essential role of this element for activator of several enzymes, nucleotides synthesis and chromatin- bound RNA polymerse. Increasing protein content in wheat grains by application of some microelements was obtained by Hefni

(1980), El- Kholany and Hefni (1985), Gab- Alla *et al.* (1986), Abd El- Shaheed (1988), Omar and Ebrahim (1990), Mourad *et al.* (1992), Salwau (1994), Abd El- Fatah, Nagwa (1995), Gowily, Ahlam *et al.* (1997), Gobarh, Mirvat (1998) and Salem and Mohamed (2000).

C. 4- Protein yield kg/ feddan

Table (17) indicated that protein yield/ feddan significantly increased by foliar application of microelements in the combined analysis of the two growing seasons. Foliar application of $ZnSO_4$, $MnSO_4$ and $ZnSO_4$ + $MnSO_4$ at 0.3% resulted in increasing protein yield by 3.34, 9.63, and 3.83 % , respectively over untreated plants.

It was clear that foliar application of Mn nutrient gave the highest mean values of protein yield/ feddan in the first and second seasons and combined analysis.

The increase in protein yield may be due to the increase in grain yield and crude protein percentage as affected by foliar application of microelements. These results are in accordance with those obtained by Hassan *et al.* (1992) and El- Habbal *et al.* (1995).

D- Interaction effect

D- a. Interaction effect between N levels and P_2O_5 levels

The effect of the interaction between nitrogen levels and phosphorus level was significant on zinc content, protein content in wheat grains in the combined analysis as well as protein yield/ feddan in the first season and combined analysis (Table 18). Whereas, Mn content in wheat grains was not

Table (17) : The average values of Zn content, Mn content, and protein % in wheat grain in the combined analysis and protein yield/ fed. in both seasons as well as their combined analysis as affected by N levels, P levels and some micronutrients .

Characters / Treatment	Zn ppm	Mn ppm	Protein %	Protein yield (kg)/ fed.		
	Comb	Comb	Comb	First	Second	Comb
N- level kg/ fed.						
1- 0	48.14 a	16.49 a	9.12 c	240.03 b	286.79 b	263.41 c
2- 40	49.02 a	14.46 a	10.16 b	251.07 b	292.85 b	271.96bc
3- 80	47.66 a	12.68 a	10.17 b	252.07 b	348.82 a	300.45 b
4- 120	53.11 a	13.82 a	14.30 a	496.76 a	357.26 a	427.01 a
F- test	N.S	N.S	**	**	**	**
P level kg/ fed.						
1- 0	51.32 a	13.50 a	10.90 a	278.21 b	305.01 b	291.61 b
2- 24	47.64 b	15.23 a	10.97 a	341.75 a	337.85 a	339.80 a
F- test	**	N.S	N.S	**	**	**
Microelements						
1- 0	51.94 ab	12.32 b	10.98 a	294.99 a	310.97 a	302.98 b
2- Zn	55.43 a	15.27 a	10.83 a	308.24 a	317.95 a	313.10ab
3- Mn	43.15 c	15.46 a	11.14 a	329.11a	335.19 a	332.16 a
4-Zn+Mn	47.40bc	14.38 a	10.81 a	307.59 a	321.61 a	314.60ab
F- test	**	**	N.S	N.S	N.S	*

significantly affected by the interaction between nitrogen and phosphorus levels, consequently, the data were excluded .

D- a- 1. Zn content (ppm)

The results in Table (18) show that the interaction between N levels and P levels significantly affected Zn content in wheat grains in the combined analysis of the two growing seasons. The maximum mean values of zinc content was 65.94 ppm, obtained from application of 120 kg N/ feddan without application of phosphorus. Whereas, the minimum one was 39.30 ppm, produced from adding 80 kg N/ feddan with zero phosphorus fertilizer. No significant difference was obtained between the interaction of 80 kg N + zero P and 120 kg N + 24 kg P_2O_5/ feddan on zinc content.

D- a- 2. Protein content (%)

There were a significant differences in protein content in wheat grains due to the interaction between N levels and P levels in the combined analysis of the two growing seasons as shown in Table (18).

Application of 120 kg N/ feddan without application of phosphorus fertilizer gave the highest protein content in wheat grains which equal to 14.69 %. While, the lowest one was 8.94 %, produced from without application of nitrogen and phosphorus fertilizer.

It could be concluded that the increase in N application upto the highest level without phosphorus fertilizer produced the highest protein content in wheat grain. This could be due to the fixation of the applied P due to possible transfer of the available

P to its unavailable form. Agbary (1993) and Hassan (1995) found that applying 120 kg N + 80 kg P_2O_5/ ha and 90 kg N + 45 kg P_2O_5/ feddan , respectively caused a significant increase in protein content in wheat grains.

D- a- 3. Protein yield kg/ feddan

The effect of the interaction between nitrogen and phosphorus levels was highly significant in the first season and combined analysis (Table 18). The maximum mean values of protein yield/ feddan was 557.0 kg, obtained from adding 120 kg N + 24 kg P_2O_5/ feddan in the combined analysis . Whereas, without application of nitrogen and phosphorus fertilizer gave the minimum protein yield/ feddan which equal to 248.60 kg / feddan. However, no significant difference was obtained between the interaction zero N + zero P and 40 kg N + zero P on protein yield.

It could be concluded that the highest level of nitrogen and phosphorus fertilizer under study gave the greatest yield of wheat protein. The increase in protein yield may be due to the increase in grain yield and protein content as affected by increasing levels of nitrogen and phosphorus fertilizer.

D- b. Interaction effect of N levels and microelements

The average values of Zn and Mn content in wheat grains in the combined analysis as well as protein yield/ feddan in both seasons and in the combined analysis of the two growing seasons were significantly affected by the interaction between N levels and foliar application of microelements (Table 19). Whereas, the interaction between two factors did not affect significantly crude

Table (18): The average values of Zn content, and protein % in wheat grains in combined analysis as well as protein yield/ feddan in both seasons and their combined as affected by the interaction between N levels and P levels .

Characters		Zn ppm	Protein %	Protein yield (kg)/ fed.		
Seasons		Comb	Comb	First	Second	Comb
N-levels	P-levels					
0	0	52.80	8.94	215.97	281.03	248.60
	24	43.47	9.30	264.09	292.56	278.33
40	0	47.22	9.60	199.76	281.45	248.61
	24	50.81	10.73	302.38	304.24	303.31
80	0	39.30	10.39	260.63	317.25	288.94
	24	56.02	9.95	243.5	380.40	311.96
120	0	65.94	14.69	436.50	340.32	388.41
	24	40.27	13.91	557.00	374.20	465.60
L.S.D at 5 %		4.17	0.78	37.65	N.S	35.61

protein % in the combined analysis of the two growing seasons, consequently, the data were excluded .

D- b- 1. Zn content (ppm)

The results in Table (19) show that Zn content in wheat grain significantly increased by increasing N level up to 120 kg/ feddan with foliar application of microelements in the combined analysis. The highest values of Zn content in wheat grain was 74.68 ppm, produced from application of 120 kg N/ feddan with foliar application of zinc sulphate at 0.3 %. Whereas, the lowest one was 39.22 ppm, obtained from adding 40 kg N with foliar application of Zn + Mn nutrients. Also, no significant difference was obtained between the interaction between 40 kg N with Zn + Mn and 80 kg N + Mn on zinc content in wheat grains.

It could be concluded that application of 120 kg N with foliar application of zinc sulphate at 0.3 % gave the highest zinc content in wheat grains. Similar trend was obtained by El-Koumey *et al.* (1997).

D- b- 2. Mn content (ppm)

There was a significant difference on Mn content in wheat grains due to the interaction between N level and foliar application of microelements in the combined analysis of the two growing seasons as shown in Table (19). The highest values of Mn content was 20.54 ppm, produced from applied 120 kg N/ feddan with foliar application of zinc sulphate at 0.3 %. On the other hand, the lowest value of Mn content was 9.92 ppm, obtained from applying 80 kg N/ feddan and untreated plants of foliar spraying of microelements. The difference between the interaction between 80 kg N + zero microelements, 80 kg N + Zn and 120 kg N + Mn were not significant on Mn content in wheat grains.

D- b- 3. Protein yield (kg)/ feddan

The results in Table (19) show that protein yield per feddan was significantly affected by the interaction between N level and foliar application of microelements in both seasons and combined analysis of the two growing seasons.

In combined analysis, application of 120 kg N + $MnSO_4$ at 0.3 % gave the maximum protein yield per feddan which was equal to 459.54 kg/ feddan. Whereas, the minimum one was 244.58 kg, obtained from untreated plants of nitrogen and microelements.

In general, protein yield significantly increased by increasing N level up to 120 kg N/ feddan with foliar application of microelements.

Similar results were obtained by Gab Alla *et al.* (1986), Salwau (1994) and Abd El- Fatah, Nagwa (1995).

D- C- Interaction effect between phosphorus levels and microelements

The effect of the interaction between phosphorus levels and foliar application of microelements were significant on Mn content, protein content in wheat grains in the combined analysis as well as protein yield kg/ feddan in both seasons and combined analysis (Table 20).

Table (19): The average values of Zn and Mn content in wheat grains in combined analysis and protein yield/ feddan in both seasons and combined analysis as affected by the interaction between N levels and some microelements .

Characters		Zn (ppm)	Mn (ppm)	Protein yield kg/ fed.		
Seasons		Comb	Comb	First	Second	Comb
N-levels	Microelements					
0	0	57.02	14.47	214.1	275.1	244.6
	Zn	45.29	19.38	256.9	307.3	282.1
	Mn	39.45	16.69	258.2	286.2	272.2
	Zn + Mn	50.78	15.39	230.9	278.6	254.8
40	0	45.96	12.95	290.1	302.7	296.9
	Zn	59.11	11.25	196.7	297.9	247.3
	Mn	51.78	17.96	252.8	283.6	268.2
	Zn + Mn	39.22	15.67	264.7	287.2	275.9
80	0	44.04	9.92	244.6	282.3	263.5
	Zn	50.02	9.93	256.9	322.8	289.9
	Mn	39.25	17.17	270.8	386.6	328.7
	Zn + Mn	57.33	13.69	235.9	403.6	319.8
120	0	53.33	11.92	431.3	383.8	407.5
	Zn	74.68	20.54	522.4	343.9	433.1
	Mn	42.14	10.03	534.7	384.4	459.5
	Zn + Mn	42.27	12.77	498.7	317.0	407.9
L.S.D at 5 %		11.798	3.34	57.88	54.43	56.15

On the other hand, Zn content in wheat grain was not significantly affected by the interaction between P_2O_5 levels and microelements, consequently, the data were excluded.

D- C- 1. Mn content (ppm)

Table (20) illustrated that the interaction effect between phosphorus levels and foliar application of microelements was highly significant on Mn content in wheat grains in the combined analysis of the two growing seasons. The highest mean value of Mn content was 17.89 ppm, obtained from adding 24 kg P_2O_5/ feddan + foliar application of $ZnSO_4$ with $MnSo_4$ at 0.3 %. While, no significant difference was obtained by adding 24 kg P_2O_5/ feddan with foliar application of Zn + Mn or Mn nutrients. On the other hand, the lowest one was 10.37 ppm, produced from application of 24 kg P_2O_5/ feddan + zero microelements.

It could be concluded that adding phosphorus fertilizer at 24 kg P_2O_5/ feddan with foliar application of manganese sulphate or with zinc sulphate at 0.3 % gave the greatest content of Mn in wheat grains.

D-C- 2. Protein content (%)

Results in Table (20) indicate that protein content in wheat grains was significantly affected by the interaction between P level and microelements in the combined analysis of the two growing seasons.

It was clear that the interaction between foliar spraying of manganese sulphate at 0.3 % without application of phosphorus fertilizer gave the highest crude protein in wheat grain. Also, the interaction between 24 kg P_2O_5/ feddan without foliar of microelements gave the same trend on protein in wheat grains. Whereas, the lowest ones were 1.84 and 10.51%, produced from foliar spraying of zinc sulphate at 0.3 % alone or application of 24 kg P_2O_5/ feddan with foliar spraying of $ZnSO_4$ + $MnSO_4$ at 0.3 % .

D- C- 3. Protein yield (kg)/ feddan

The results in Table (20) show that the interaction between phosphorus level and foliar application of microelements significantly affected protein yield per feddan in both seasons and combined analysis of the two growing seasons. The greatest protein yield/ feddan was 342.3 kg, produced from adding 24 kg P_2O_5/ feddan with foliar spraying of zinc sulphate at 0.3 % in the combined analysis. Whereas, no significant difference was obtained from the interaction between adding 24 kg P_2O_5/ feddan with different microelements and without application of phosphorus fertilizer with foliar application of $MnSO_4$ at 0.3 % on protein yield/ feddan. On the other hand, without application of phosphorus and microelements gave the lowest value of protein yield/ feddan.

Similar results were also reported by Salem and Mohamed (2000) who observed that combined application of phosphorus at 46.5 kg P_2O_5/ feddan and spraying Zn + Fe + Cu gave satisfactory increase in the protein yield of wheat Sids 1 cultivar grown under newly reclaimed sandy soil.

D- d- Interaction effect between the three factors

D- d- 1 Zn content

There was a significant difference of the average values of Zn content in wheat grains due to the interaction between N

Table (20): The average values of Mn content, and protein % in the combined analysis and protein yield/ feddan in both seasons and combined analysis as affected by the interaction between P levels and some microelements .

Characters		Mn ppm	Protein %	Protein yield (kg)/ fed.		
Seasons		Comb	Comb	First	Second	Comb.
P-levels	Microelements					
0	0	14.27	10.53	249.07	274.38	261.7
	Zn	15.78	10.51	273.28	294.47	283.9
	Mn	13.07	11.48	329.11	325.56	327.3
	Zn + Mn	10.87	11.10	261.39	325.63	293.5
24	0	10.37	11.42	340.89	347.56	344.2
	Zn	14.78	11.16	343.20	341.43	342.3
	Mn	17.86	10.80	329.11	344.83	337.0
	Zn + Mn	17.89	10.51	353.79	317.59	335.7
L.S.D at 5 %		2.34	0.65	40.93	38.49	39.71

levels, P levels and foliar application of microelements in the combined analysis as shown in Table (21). Application of 120 kg N/ feddan with foliar application of zinc sulphate at 0.3 % without phosphorus fertilizer gave the maximum mean values of zinc content in wheat grains (81.56 ppm). Whereas, the minimum one was 25.4 ppm, produced from 120 kg N + 24 kg P_2O_5 + $MnSO_4$ at 0.3 % in the combined analysis of the two growing seasons.

It was clear that the response of wheat plants to Zn application under higher levels of nitrogen fertilizer to increasing Zn content in wheat grains.

D- d- 2. Mn content (ppm)

Mn content in wheat grains was significantly affected by the interaction between N levels, P levels and microelements in the combined analysis of the two growing seasons as shown in Table (21). The highest value of Mn content in wheat grains was 23.75 ppm produced from adding 80 kg N + 24 kg P_2O_5/ feddan with foliar application of manganese sulphate at 0.3 %. While, the lowest one was 5.67 ppm, produced from 80 kg N + 24 kg P_2O_5 + zinc sulphate at 0.3 % .

It could be concluded that manganese concentration (ppm) in wheat grains increased by increasing NP levels with foliar application of manganese sulphate at 0.3 % .

D- d- 3. Protein content (%)

The average values of nitrogen and protein percentage in wheat grains as affected by the interaction between the three factors in the combined analysis of the two growing seasons are illustrated in Table (22).

Application of 120 kg N/ feddan with foliar spraying of $ZnSO_4$ + $MnSo_4$ at 0.3 % without adding of phosphorus fertilizer significantly increased protein content in wheat grains by 96.50 and 95.48 % , respectively, over the control treatment (without N, P and microelements). Whereas, no significant difference was obtained between the interaction between 120 kg N + zero P + Mn and 120 kg N + zero P + (Zn + Mn) on content of nitrogen and protein.

D- d- 4. Protein yield (kg)/ feddan

The second order interaction affected significantly the protein yield/ feddan in the first and second seasons as well as their combined analysis as shown in Table (23).

The maximum mean values of protein yield/ feddan were 674.9 and 512.7 kg, produced from 120 kg N + 24 kg P_2O_5/ feddan with foliar application of zinc sulphate at 0.3 % in the first and combined analysis of the two growing seasons , respectively. Whereas, adding 80 kg N + 24 kg P_2O_5/ feddan with foliar application of manganese sulphate at 0.3 % gave the highest mean value of protein yield/ feddan (459.6 kg) in the second season. On the other hand, without application of nitrogen and phosphorus with foliar application of different microelements gave the lowest mean values of protein yield/ feddan.

It could be concluded that the greatest protein yield/ feddan was obtained from increasing levels of nitrogen up to 120 kg N/ feddan with 24 kg P_2O_5/ feddan and foliar spraying of zinc sulphate at 0.3 %.

Table (21): The average values of Zn and Mn content in wheat grains as affected by the interaction between N, P levels and some microelements in the combined analysis of the two seasons.

Characters		Zn ppm				Mn ppm			
Microelements		0	Zn	Mn	Zn + Mn	0	Zn	Mn	Zn + Mn
N- levels	P- levels								
0	0	52.64	56.77	44.13	57.67	13.15	18.39	16.70	13.70
	24	57.28	37.94	34.77	43.89	15.80	20.37	17.18	17.08
40	0	49.52	52.94	45.38	44.05	16.73	12.57	14.51	10.86
	24	42.40	65.27	58.17	37.38	9.17	9.921	21.42	20.49
80	0	30.72	49.26	37.38	39.85	13.10	14.21	10.59	7.52
	24	57.36	50.78	44.12	74.82	6.74	5.67	23.75	19.87
120	0	75.49	81.56	58.88	47.83	14.09	17.93	10.97	11.42
	24	67.80	31.18	25.40	36.72	9.76	23.16	9.09	14.12
L.S.D at 5%		16.66				4.76			

Table (22): The average values of protein percentage in wheat grain as affected by the interaction between N. P levels and some microelements in the combined analysis of the two seasons.

Characters		Protein %			
Microelements		0	Zn	Mn	Zn + Mn
N- levels	P- levels				
0	0	8.18	9.15	9.79	8.63
	24	10.42	9.55	8.82	8.44
40	0	8.541	8.88	10.43	10.55
	24	11.23	10.99	9.99	10.72
80	0	11.59	10.32	10.45	9.23
	24	9.58	9.20	11.23	9.79
120	0	13.81	13.68	15.28	15.99
	24	14.48	14.91	13.15	13.11
L.S.D at 5%		1.30			

Table (23): The average values of protein yield (kg)/ feddan as affected by the interaction between N, P levels and some microelements in both seasons and their combined analysis .

Characters		First season				Second season				Combined			
Microelements		0	Zn	Mn	Zn + Mn	0	Zn	Mn	Zn + Mn	0	Zn	Mn	Zn + Mn
N-levels	P-levels												
0	0	172.1	254.1	251.7	186.1	281.1	281.5	284.4	277.1	226.8	267.8	268.1	231.8
	24	256.1	259.7	264.7	275.9	269.1	233.1	287.9	280.2	262.6	273.8	276.3	278.1
40	0	208.3	157.0	249.6	184.2	233.0	289.9	310.5	292.4	249.1	233.7	279.5	238.3
	24	371.8	236.4	256.0	345.3	372.3	306.0	256.7	282.0	372.1	271.2	256.4	313.6
80	0	291.4	312.1	238.3	200.8	231.0	269.5	313.6	454.9	301.7	290.8	275.9	327.8
	24	197.7	201.9	303.2	271.2	333.7	376.0	459.6	352.3	286.8	288.9	381.4	311.7
120	0	324.5	370.0	575.9	476.6	352.4	337.1	393.7	278.1	338.4	353.5	484.8	377.4
	24	538.0	674.9	492.5	522.8	415.2	350.6	375.1	355.9	444.3	512.7	433.8	439.3
L.S.D at 5 %		81.85				77.02				79.43			