B. 2010/2011 Technical Report of the Agronomic Project in Egypt

Research Team: (National Research Center)

1. Dr. Mustafa El-Fouly
2. Dr. El-Zanaty Abu El Nour
3. Dr. Adel Andel Chalet
4. Dr. Fuad Al-Said Abdullah

Location I: Oraby Village – Nobaria Sector – El-Behira Governorate

Winter season of 2010/2011 on wheat cv. Sakha 93

The experimental design was randomized complete block with three replicates.

Soil preparation and cultivation:
Soil was ploughed using a chisel plough, leveled by wooden leveler and divided into experimental units. Plot area was 10.5 m^2 (3.5m long and 3 m wide). Wheat grains were sown on November 30th in 2010/2011 season, at the rate of 70 kg / feddan .

Treatments:

1-Control	without any fertilizers addition (T1)
2- N:P_2O_5:K_2O	Farmer's Fertilizer 100 :31:0 kg / fed(T2).
3- N:P_2O_5	MoA 100 : 45 kg / fed. (T3).
4- N:K_2O	MoA 100 : 24 kg / fed. (T4).
5- N:P_2O_5:K_2O	MoA 100 : 45 : 24 kg /fed. (T5).
6- N:P_2O_5:K_2O	Based on soil testing 120 :45:48 kg / fed.(T6).
7- N:P_2O_5:K_2O	Based on soil testing + micronutrients 120:45:48 kg /fed.(T7).

Nitrogen doses were added in the form of ammonium nitrate (33.5% N) in all treatments except farmer treatment was urea (46% N) .The nitrogen fertilizer quantity for each plot was divided into three equal amounts, the first was added at the sowing time, the second was before the first irrigation and the third was before heading stage.
Phosphorus does was added in the form super phosphate (15.5% P_2O_5) added in one dose Prior to sowing. Potassium fertilizer was added as potassium sulfate (48% K_2O) and was broadcasted in two installments. The first was added at the sowing time and the second was before the first irrigation.
Micronutrient treatments were 1.5 gm/ liter in the form of multi chelated micronutrients compound (3 % Fe, 3 % Zn and 3% Mn) and were twicely sprayed. The first spray was carried out with 300 liter / fed. at 40 days after sowing (at tillering stage) and the second with 400 liter /fed. 60 days after sowing (before heading stage).
*All the recommended agronomic practices for growing wheat under irrigation in Nubaria area were followed except for the treatments under investigation.

Data recorded:
Yield and its components
At harvest, biological yield and grain yield were determined by cutting plants from 1$m^2$of each plot, and bundled, then weighted in kilograms /plot, and recorded in terms of ton/ha

while Harvest Index (HI) was calculated as follows : HI = grain yield / biological yield at maturity X 100. Also, plant height and number of spikes/m^2.At the same time, ten random spikes from each plot were sampled and the following traits were measured; One-Hundred Kernel Weight (g), Number of Spikelets per Spike and spike length (cm).

Chemical analysis:

Soil testing:-

A representative soil sample was taken after soil preparation and before fertilization and after harvest from the experimental sites (0-50 cm depth) , the soil samples were air dried, ground in a wooden mortar and passed through a 2 mm pores sieve to be analyzed for physical and chemical characteristics. Data are shown in Table (1).

Plant analysis:

Ten flag leaf and plants of random samples from each plot in three replication cutting at 75 days from planting and at harvest respectively were analyzed for macro and micronutrients. Flag leaves, straw and grains were washed in sequence with tap water, 0.01 N HCl – acidified bidistilled water and bidistilled water, respectively, and then dried in a ventilated oven at $70C^0$ till constant weight was obtained. The plant samples were ground in stainless steel mill with 0.5 mm sieve and kept in plastic containers for chemical analysis.

Protein: Calculated in grains as (N %) x 6.25.

Statistical Analysis:

The data collected were subjected to statistical analysis using the analysis of variance procedure as outlined by SAS program (SAS Institute, 1985).Means for the different factors were compared according to the least significant differences (L.S.D) at 0.05 level of probability.

Table (1): Soil physico-chemical characteristics of wheat experiment during 2010/2011season

Variable	Before sowing		After harvest					
		*T1	T2	T3	T4	T5	T6	T7
Sand %	31	31	31	31	31	31	31	31
Silt %	40	38	40	37	42	41	40	37
Clay %	29	31	29	32	27	28	29	32
Texture	CL	CL	CL	CL	CL	CL	CL	CL
PH	8.9	8.4	8.4	8.6	8.4	8.7	8.2	8.5
EC ds/m	2.2	2.6	2.3	2.4	2.2	2.4	3.3	3.7
CaCO3 %	25.0	22.8	21.2	28.0	26.0	22.8	23.0	27.8
Organic Matter %	0.5	1.0	2.1	2.7	2.2	2.0	2.5	2.9
(mg/100g soil)								
N	18	35	74	95	77	70	88	102
P	1.0	1.4	1.9	1.6	1.8	1.9	2.5	2.7
K	20	18	22	16	39	47	55	58
Ca	684	617	570	678	591	587	665	614
Na	50	69	50	65	59	61	80	85
Fe, ppm	6.72	7.01	6.50	7.55	6.44	8.00	8.90	8.88
Mn, ppm	1.36	1.20	1.28	0.96	1.16	1.06	1.72	1.68
Zn , ppm	1.20	1.25	1.08	1.28	1.00	1.18	1.45	1.54
Cu, ppm	0.95	1.02	1.00	1.22	1.10	1.12	0.88	1.01

Table (2): Yield and its components of wheat as affected by different levels of NPK and balanced fertilization during 2010/2011 season.

Treatment	Grain yield (ton/ha)	Biological yield (ton/ha)	Harvest Index (%)	Spike number / m^2	Spikelets No. / Spike	Spike length (cm)	100 - Kernel weight (g)	Plant height (cm)
Control	2.430	8.144	29.858	187.00	12.25	7. 25	4.088	73.25
Farmer Fertilizer	4.248	12.099	35.075	269.75	14.98	7.93	4.330	80.75
NP, MoA	5.038	13.921	36.185	278.75	15.75	8.48	4.480	87.25
NK, MoA.	5.343	14.416	37.045	280.25	16.20	9.13	4.580	90.00
NPK, MoA	5.937	15.458	38.452	287.50	16.60	9.80	4.660	98.50
NPK soil testing	6.746	16.932	39.700	306.00	17.10	10.05	4.870	105.25
NPK soil testing + micronutrients	7.781	18.759	41.475	318.75	17.90	10.50	5.110	107.25
LSD (0.05)	0.397	1.057	2.056	19.747	0.214	0.251	0.078	8.09

RESULTS AND DISCUSSION

Soil characterization:

Data in table (1), characterized soil as clay loam. pH value in soil was more than 8. Meanwhile, value of electric conductivity was 2.2 dS/m. In the same table, calcium carbonate content in soil was 25% the soil of the experimental site could be considered as highly calcareous. Organic matter percentage was 0.5%, such a low content of organic matter would be attributed to the climatic conditions of the area which favors rapid decomposition of organic matter.

Soil nutritional status:

Data of macro and micronutrient contents is soil of Nubaria are shown in Table (1), Values of total N, was low, probably due to low content of organic matter which different after harvest, available P and K content in soil were moderate may be attributed to silt and clay content of soil. Available Na content was high, values of DTPA extractable, Fe, Mn, Zn, and Cu contents, show that their contents were very low as compared to critical values of those available micronutrients content reported by Lindsay and Norvell (1969). Such low content may be attributed also to lime induced condition, which reduces the availability of these micronutrients in the soil. The above-mentioned soil characteristics reveal low power of supplying nutrients, especially micronutrients and K which may lead to imbalanced nutrition of plants grown on such soil.

Yield and its components:

There was significant response to NPK and foliar application with micronutrients with grain yield and its components asserting the decisive need for NPK with foliar micronutrients to wheat production in this soil (Table 2).

Regarding the yield components, increases in spike length due to adding NPK, foliar application with micronutrients ranged from 9% to 45%. The range of increase in plant height was 10% to 46%. Comparable range of increase for spike number / m2 was 44% to 70% and for 100 - kernel weight it was 6% to 25%, meanwhile spikelet No. / spike was 22 % to 46 %. Increases in grain yield were 75% to 220%, while the range of increase in biological yield was 49% to 130%. Also, harvest index(%) was 18% to 40% compared with control .The N,P,K soil test (120N: 45 P2O5 : 48 K2O kg / fed. based on soil test + micronutrients) with foliar micronutrients were the most effective N,P,K treatments in increasing the yield and yield components, while control treatment (0N,0P2O5 and 0 K2O Kg/fed.) was the lowest one.

Macro and Micronutrients concentration in flag leaf, grains and wheat straw:

The data in Tables (3, 4) and (5) cleared that of macro and micronutrients concentration in flag leaf , grains and straw wheat were high significant with application (120N: 45 P2O5 : 48 K2O kg / fed. based on soil testing + micronutrients) compared with another treatments.

Protein content in grains:

The data in Table (4) showed that protein contents in grains were high significant with application (120N: 45 P2O5 : 48 K2O kg / fed. based on soil testing + micronutrients). The increases in protein content due to adding NPK, foliar application with micronutrients were 146% compared with control treatment. Also any potassium treatment due to increases in protein contents .such increases may be attributed to the role of potassium in improving and uses efficient of nitrogen.

These results might be attributed to characterized soil as clay loam, pH value in soil more than 8, calcium carbonate content in soil was very high (25%), low organic matter percentage (0.5%) and low content from macro and micronutrients, Also lime induced condition, which reduces the availability of these micronutrients nutrients especially micronutrients and potassium which may lead to imbalanced nutrition of plants grown on such soil. So the best treatment was (120N: 45 P2O5: 48 K2O kg / fed. based on soil testing + micronutrients) depend on soil test with foliar micronutrients.

Finally: in general results may lead to the conclusion of the need for maintenance proper balance of nutrients when nutritive program is used especially for susceptible plants grown on problematic soil such as calcareous ones.

Summer Season

A summer field experiment was carried out in Oraby Village at Nubaria sector, El-Behira governorate, during summer season of 2011 to study the effect of NPK on the yield and its components of Maize (Zea mays, L.cv. single cross Hi Tek 2010 (white variety).

Summer season 2011:-

Maize grains were sown on June 23th 2011. The same recommended procedures were carried out.

Treatments were as follows:-

Control (without any fertilizers addition).

2- Recommended N : P2O5 (132 : 31 Kg/ fed.)

3- Recommended N : K2O (132 : 24 Kg/ fed.)

4- Recommended N : P2O5: K2O (132 : 31 : 24 Kg/ fed.)

5- Farmer's fertilization N : P2O5 : K2O (120 : 31 : 0 Kg/fed.) Control

6- Based on soil testing N : P2O5: K2O (132 : 31 : 48 Kg/ fed.)

7- Based on soil testing N:P2O5:K2O (132:31:48 Kg/fed)+ micron.foliar spray

Results and discussion

Yield and its components

There was significant response to NPK plus micronutrients foliar application on grain yield and its components asserting the decisive need for NPK with foliar micronutrients to maize production in this soil (Table 2).
Regarding the yield components increases in ear length due to adding NPK plus micronutrients foliar application ranged from 21% to 59%. The range of increase in ear diameter was 8% to 43%. Comparable range of increase for number of rows / ear was 17% to 44% and for the ear weight it was 45% to 135%. While the range of increase in 100-kernel weight was 21% to 67%. Also, shelling percentage was 25% to 39% on the other hand, Grain yield /fed. was increased by applying NPK plus foliar micronutrients. The increases in grain yield ranged between 81% to 227% compared with (control) treatment .The NPK based on soil testing (132 N,31 P2O5 and 48 K2O Kg/fed.) blus foliar micronutrients was the most effective NPK treatments in increasing the yield and yield components, while control treatment was the lowest one.

Macro and micro-nutrients concentration in ear leaves and grains:
The data presented in Tables (3, 4) cleared that, macro- and micro-nutrients concentrations in leaves and grains were significantly, affected by different levels of NPK and balanced fertilization. Where, the higher concentrations in ear leaves and grains were obtained with application of (132 N, 31 P_2O_5 and 48 K_2O Kg/fed.) compared with other treatments.
These results might be attributed to characterized Soil as clay loam, pH value in soil more than 8, calcium carbonate content in soil was very high (25.8%), low organic matter percentage (0.9%) and low content from macro and micronutrients, Also lime induced condition, which reduces the availability of these nutrients especially micronutrients and potassium which may lead to imbalanced nutrition of plants grown on such soil. So the best treatment was NPK (132 N: 31 P_2O_5: 48 K_2O kg/fed.) based on soil testing plus foliar micronutrients.
Finally: in general, results may lead to the conclusion of the need for maintenance proper balance of nutrients when nutritive program is used especially for susceptible plants grown on problematic soil such as calcareous ones.

Table (2): Yield and its components of maize as affected by different levels of NPK and balanced fertilization in 2011 season .

Treatment	Ear length (cm)	Ear diameter (cm)	Number of rows /ear	Ear weight (g)	Grain yield/ear (g)	100 - Kernel weight (g)	Shelling (%)	Grain yield (ardab/fad.)
Control	11.0	3.34	10.3	85.1	52.37	15.33	61.53	8.38
Farmer's Fertilizer	13.3	3.61	12.0	123.1	94.83	18.56	77.10	15.17
NP, MoA	14.3	3.92	12.0	155.3	124.70	19.09	80.30	19.95
NK, MoA	15.7	4.18	12.3	172.8	141.07	19.99	81.63	22.57
NPK, MoA	16.0	4.40	13.0	176.6	146.20	21.88	82.77	23.39
NPK soil testing	16.5	4.61	13.3	182.5	153.00	22.94	83.83	24.48
NPK soil testing + micronutrients	17.5	4.77	14.8	200.3	171.37	25.61	85.57	27.42
LSD (0.05)	**0.57**	**0.16**	**0.51**	**5.30**	**3.87**	**1.07**	**1.68**	**0.62**

Ardab = 140 Kg

Table (3): Nutrient contents in ear leaves of maize as affected by different levels of NPK and balanced fertilization in 2011 season .

Treatment	%			ppm		
	N	P	K	Fe	Mn	Zn
Control	1.68	0.170	2.83	84.00	30.67	20.67
Farmer's Fertilizer	2.05	0.227	2.87	89.67	33.67	23.33
NP, MoA	2.23	0.250	3.00	95.33	34.70	26.00
NK, MoA	2.28	0.177	3.03	101.00	34.75	27.00
NPK, MoA	2.32	0.280	3.03	104.03	36.33	28.00
NPK soil testing	2.43	0.277	3.07	112.00	39.67	30.00
NPK soil testing + micronutrients	2.47	0.293	3.17	139.67	44.67	32.67
LSD (0.05)	**0.12**	**0.019**	**0.26**	**4.79**	**1.53**	**1.62**

Table (4): Nutrient contents of maize grains as affected by different levels of NPK and balanced fertilization in 2011 season .

Treatment	%	ppm

	N	protein	P	K	Fe	Mn	Zn
Control	1.663	10.40	0.370	0.40	23.01	10.31	39.00
Farmer's Fertilizer	1.710	10.69	0.493	0.44	28.70	11.67	45.29
NP, MoA	1.773	11.09	0.553	0.47	32.03	13.30	48.00
NK, MoA	1.800	11.25	0.376	0.53	36.05	14.32	50.30
NPK, MoA	1.817	11.35	0.607	0.54	39.02	15.67	52.67
NPK soil testing	1.907	11.92	0.677	0.58	47.74	16.33	57.51
NPK soil testing + micronutrients	1.967	12.29	0.733	0.63	50.30	18.40	64.70
LSD (0.05)	**0.072**	**0.453**	**0.050**	**0.03**	**4.24**	**1.67**	**3.08**

Location II Kafer –El- Kadera village - El-Monofia Governorate

Winter season :Wheat

Treatments:

Control (without fertilizers addition).
Farmer's fertilization N 40 P 30.
N 60 P 50 K 48 according to MoA
N 60 P 50 according to MoA
N 60 K 48 according to MoA
N 80 P 60 K 55 based on soil testing
N 80 P 60 K 55 based on soil testing + Micronutrients Foliar Spray

Nitrogen, phosphorus and potassium fertilizers were applied to the soil after 30 days from sowing. Nitrogen was applied in the form of ammonium nitrate, phosphorus as single super phosphate and potassium as potassium sulphate. Micronutrients foliar spray was applied at 45 days after sowing, using chelated compound 3% Fe +3% Mn +3% Zn at rate of 1.5 g/l. The volume used was 250 l/fed.

At Harvest, one meter square was taken to determine:

Spike number/m2, number of grains/ spike, grains weight/ spike, 1000-grain weight, yield ardab/fed. , straw yield ton/ fed., and harvest index.

Statistical analysis:

The obtained data were subjected to the analysis of variance of randomized complete blocks design with four replicates according to (Snedecor and Cochran,1980) where the means of different treatments were compared using the least significant difference (L.S.D) test at 5% level of significant.

Chemical analysis:

Soil testing: soil samples were analyzed for texture with a hydrometer (Bouyoucos, 1954), for pH and electric conductivity (EC) using water extract (1:2.5) method, (Jackson, 1973), for total calcium carbonate (CaCO3%): calcimeter method was used as described by (Alison and Moodle, 1965). And for organic matter (O.M%) content was determined according to Walkley and Black, 1934) using potassium dichromate (Chapman and Pratt, 1978). Phosphorus was extracted using sodium bicarbonate (Olsen et al., 1954). Potassium (K) was extracted using ammonium acetate.

Plant analysis: The plant material was digested using acid mixture consisting of nitric, perchloric and sulfuric acids in the ratio of 8:1:1 (v/v), respectively (Chapman and Pratt, 1978). Nitrogen (N) was determined in the dry plant material using the boric acid modification described by (Ma and Zuazage, 1942), and distillation was carried out using a Buechi 320-N2-distillation unit.

Table 1: Soil analyses before sowing (0-30cm depth)

Character	Nutrient content	
Sand % **30.80**	**(mg /100g)**	
Silt % **28.00**	**Available – P**	**2.62**
Clay % **41.20**	**Available - K**	**26.3**
Soil Texture **S.C.L**	**Available - Mg**	**205**
pH **8.68**	**Available - Ca**	**713**
E.C dS/m **0.35**	**Available - Na**	**43.5**
$CaCO_3$ % **1.47**	**(mg/Kg)**	
O.M % **2.20**	**Available - Fe**	**30**
	Available - Mn	**28**
	Available - Zn	**2.6**
	Available - Cu	**5.1**

L = Low, M = Moderate, H = High

Phosphorus was photometrically determined using the molybdate vanadate method according to (Jackson, 1973). Potassium was determined using flame photometer Eppendorf. The soil data were evaluated using the criteria published by (Ankerman and Large, 1974) and (Lindsay and Norvell, 1978), whereas data of leaf analysis were evaluated according to the criteria reported by Jones et al. 1991 in Plant Analysis Handbook.

Wheat grains were sowing in 20th October, 2010. All agronomic practices were done as recommended.

Yield and yield components:

Data presented in Table (2) indicated that number of spike/m2, number of grains/spike, weight of grain/spike (1000-grains weight, grains yield ardeb/feddan, straw yield ton /feddan and harvest index were significantly affected by the treatments.

Treated wheat with (N80 P60 K55) +Fe, Mn, Zn, Cu and B gave significant higher of number of spike/m2, number of grains/spike, weight of grain/spike, 1000-grains weight, grains yield ardeb/feddan, straw yield ton /feddan and harvest index, followed by the treatments of (N80 P60 K55. On the other hand, control was the lowest one.

Table (2) Yield and yield components of wheat as affected by some NPK treatments

Treatment	**Spike number (m^2)**	**Grain number / spike**	**Weight of grain spike (g)**	**1000-grain Weight (g)**	**Grain yield Ardab/fed**	Straw yield/fed (ton)	Harvest index (%)
Second season **2010/2011**							
Control	277.7	44.5	0.61	18.2	9.29	4.51	28.3

Farmer fertilizer	301.0	48.3	1.52	19.0	12.89	4.65	34.2
NPK MoA	393.3	51.6	2.35	21.2	16.33	5.83	39.6
NP MoA.	374.3	49.8	1.90	22.3	15.45	4.75	36.2
NK MoA	386.7	51.2	2.20	21.6	16.21	5.93	39.1
NPK soil testing	393.0	56.7	2.39	23.1	22.85	5.67	41.0
NPK soil testing +micronutrients	423.3	59. 8	2.40	25.6	23.70	7.02	43.2
LSD. 5%	25.45	3.24	0.37	2.17	1.87	0.743	1.80

Leaf nutrient contents:

Results in Table (3) showed that all N concentrations in wheat leaves were in adequate level due to studied treatments except the control was low; concentrations of P and Na were low and of K were high; Ca, Mg, Fe, Mn, Zn and Cu concentrations were in the optimum ranges. Although the K and Mg concentration were with all treatments better than control. On the other hand, no significance differences were found among treatments for P, Ca, Na, Fe and Cu. Plant treated of NPK based on soil testing plus foliar application of micronutrients resulted in improvement concentrations of N, Fe, Mn and Zn nutrients in wheat leaves.

It is worth mentioning that the aforementioned treatment gave the highest significant increment in yield and its components.

Table (3) Nutrient contents and evaluation of wheat leaves as affected by different levels of NPK and balanced fertilization

Trt	%						ppm			
	N	P	K	Ca	Mg	Na	Fe	Mn	Zn	Cu
Second season **2010/2011**										
Control	2.49 L	0.15L	3.06H	0.87M	0.58M	0.02L	293M	51M	46M	13 M
Farmer fertilizer	3.47M	0.16L	3.41H	0.72M	0.61M	0.02L	282M	59 M	53M	14 M
NPK MoA	3.64 M	0.17L	3.54H	0.60M	0.68M	0.02L	274M	63M	54M	14 M
NP MoA.	3.29M	0.16L	3.26H	0.67M	0.61M	0.02L	294M	70 M	59M	17 M
NK MoA	3.27M	0.15L	3.47H	0.89M	0.68M	0.03L	272M	70M	64M	18 M
NPK soil testing	3.56M	0.15 L	3.43H	0.96M	0.83M	0.04L	294M	70M	57M	15M
NPK soil test+micr	3.77M	0.16L	3.53H	0.76M	0.80M	0.04L	300M	72M	68M	16 M
LSD. 5%	0.09	N.S	0.13	N.S	0.133	N.S	N.S	6	6	N.S

L = Low, M = Moderate, H = High

Grain nutrient contents:

Results in Table (4) showed that no significant differences among treatments concerning K,Fe, Zn and Cu. On the other hand, marked differences were obtained for N, P, Ca,Mg and Mn concentrations. The highest N and P concentrations was observed from control treatment, however, the highest calcium concentration was obtained as a result of applying NK recommended by Ministry of Agriculture.Morover, the highest Mn was obtained as a result of applying NPK based on soil testing.

Table (4) Nutrient contents in grains of wheat as affected by different levels of NPK and balanced fertilization

Treatment	%						ppm			
	N	P	K	Ca	Mg	Na	Fe	Mn	Zn	Cu
Second season 2010/2011										
Control	2.40	0.30	0.54	0.24	0.36	0.035	256	22	48	9.7
Farmer fertilizer	1.61	0.30	0.54	0.41	0.44	0.044	275	23	48	8.7
NPK MoA	1.98	0.29	0.48	0.39	0.42	0.035	270	27	46	7.3
NP MoA.	2.06	0.31	0.52	0.44	0.44	0.044	248	29	50	8.0
NK MoA	2.00	0.28	0.50	0.58	0.44	0.036	249	24	48	10.0
NPK soil testing	1.90	0.29	0.55	0.50	0.43	0.042	263	30	52	8.3
NPK soil testing +micronutrients	1.76	0.29	0.57	0.53	0.45	0.033	262	33	41	9.3
LSD. 5%	0.28	0.02	N.S	0.14	0.06	N.S	N.S	4	N.S	N.S

Grain nutrient uptake:

Results in Table (5) showed that there is different significant between all treatments on grain nutrient uptake. The treatment with NPK according to soil testing and foliar application of micronutrients was the higher in increasing the grain nutrient uptake from the soil following by the treatment with NPK according to soil testing, than the other treatments.

Table (5) Nutrient uptake in grains of wheat as affected by different levels of NPK and balanced fertilization

Treatment	Kg/ha						g/ha			
	N	P	K	Ca	Mg	Na	Fe	Mn	Zn	Cu
Second season 2010/2011										
Control	79.5	10.0	17.7	7.8	12.1	1.16	850	73	160	32
Farmer fertilizer	74.0	13.9	25.0	18.9	20.1	2.03	1265	106	221	40
NPK MoA	115.4	17.1	28.2	22.9	24.5	2.06	1572	157	268	43
NP MoA.	113.5	17.2	28.9	24.4	24.3	2.21	1368	162	274	44
NK MoA	116.1	16.0	29.1	33.4	25.3	2.06	1442	141	278	58
NPK soil testing	154.7	23.8	45.1	40.8	35.1	3.43	2143	245	427	68
NPK soil testing +micronutrients	149.2	24.2	48.5	44.8	38.4	2.82	2220	276	347	79
LSD. 5%	18.5	1.1	5.4	8.8	3.1	1.03	250	24	64	17

Table (1 -1): Soil physico-chemical characteristics of maize experiment during

Variable	Before sowing						
	*T1	T2	T3	T4	T5	T6	T 7
Sand %	31	31	31	31	31	31	31
Silt %	38	40	37	42	41	40	37
Clay %	31	29	32	27	28	29	32
Texture	Clay	Clay	Clay	Clay	Clay	Clay	Clay
PH	Loam	Loam	Loam	Loam	Loam	Loam	Loam
EC ds/m	8.4	8.4	8.6	8.4	8.7	8.2	8.5
Calcium Carbonate	2.6	2.3	2.4	2.2	2.4	3.3	3.7
%	22.8	21.2	28.0	26.0	22.8	23.0	27.8
Organic Matter %	1.0	2.1	2.7	2.2	2.0	2.5	2.9
N	35	74	95	77	70	88	102
P	1.4	1.9	1.6	1.8	1.9	2.5	2.7
K	18	22	16	39	47	55	58
(mg/100g soil)	617	570	678	591	587	665	614
Ca	69	50	65	59	61	80	85
Na							
Fe	7.01	6.50	7.55	6.44	8.00	8.90	8.88
Mn (ppm)	1.20	1.28	0.96	1.16	1.06	1.72	1.68
Zn	1.25	1.08	1.28	1.00	1.18	1.45	1.54
Cu	1.02	1.00	1.22	1.10	1.12	0.88	1.01

summer season of 2011

* T1= (Control) , T2= Farmer Fertilizer; T3= NP, Ministry Agric.; T4= NK, Ministry Agric;T5= NPK, Ministry Agric T6= NPK soil test; T7=NPK soil test +micronutrient

Variable	After harvest						
	*T1	T2	T3	T4	T5	T6	T 7
Sand %	31	31	31	31	31	31	31
Silt %	40	42	39	41	43	40	38
Clay %	29	27	30	28	26	29	31
Texture	Clay	Clay	Clay	Clay	Clay	Clay	Clay
PH	Loam	Loam	Loam	Loam	Loam	Loam	Loam
EC ds/m	8.3	8.5	8.6	8.4	8.7	8.4	8.5
Calcium Carbonate	2.1	2.0	2.5	1.9	2.1	2.6	2.8
%	29.8	26.2	28.7	26.9	25.8	29.0	29.8
Organic Matter %	0.9	1.7	2.0	1.9	1.8	2.1	2.5

N	31	76	83	79	80	110	112
P	1.1	1.4	1.6	1.3	1.8	2.7	2.8
K	19	19	13	29	30	45	50
(mg/100g soil)	610	550	688	591	597	685	623
Ca	73	43	65	59	72	89	95
Na							
Fe	4.01	4.50	6.55	5.44	5.00	6.90	7.88
Mn (ppm)	0.90	1.00	0.76	0.85	0.88	1.12	1.28
Zn	0.71	0.91	1.00	0.96	0.84	0.79	1.04
Cu	0.95	0.86	0.93	0.70	0.64	0.78	0.99

Table (1 -2): Soil physico-chemical characteristics of maize experiment during summer season of 2011

* T1= (Control) , T2= Farmer Fertilizer; T3= NP, Ministry Agric.; T4= NK, Ministry Agric;T5= NPK, Ministry Agric T6= NPK soil test; T7=NPK soil test +micronutrient

Summer season (Maize)

Materials and methods:

Maize grains were sowing in 6 June 2011. All agronomic practices were done as usual. Before sowing a representative soil sample was taken (Table 1).A complete randomized block design was used with four replicates.

Treatments were as follow:

T0 = control (without any fertilizers addition)

T1= N 80 + P 50 i.e. farmers' fertilizer addition

T2= N120 as ammonium nitrate 33.5% P 60 as single super phosphate 15.5%. K 48 as potassium sulphate 48-50% according to MoA

T3= N 120 P 60 according to MoA.

T4= N120 K 48 according MoA.

T5= N125 P65K 80 according soil testing

T6= N 125 P 65 K 80 according to soil testing + micronutrients as foliar application NPK were applied to the soil at (30 DAS) (N as ammonium nitrate 33.5% , P as single superphosphate 15.5%., and K as potassium sulphate 48%). Microelements used as a foliar application at (45 DAS).

Data Recorded

At harvest, ten individual plants were harvested to determine: Plant height, number of leaves /plant, ear length, number of row /ear, number of grains /ear, chilling %, grain yield /plant, 100-grain weight and grain yield (ton/ hectare).

At silking flag leaves were collect from all treatments to determine macro- and micro-nutrients.

Chemical analysis:

Soil testing: soil samples were analyzed for texture with a hydrometer (Bouyoucos, 1954), for pH and electric conductivity (EC) using water extract (1:2.5) method, (Jackson, 1973), total calcium carbonate (CaCO3%): calcimeter method was used as described by (Alison and Moodle, 1965). Organic matter (O.M%) content was determined according to Walkley and Black, 1934) using potassium dichromate (Chapman and Pratt, 1978). Phosphorus was extracted using sodium bicarbonate (Olsen et al., 1954). Potassium was extracted using ammonium acetate.

Plant analysis: The plant material was digested using an acid mixture consisting of nitric, perchloric and sulfuric acids in the ratio of 8:1:1 (v/v), respectively (Chapman

and Pratt, 1978). Nitrogen (N) was determined in the dry plant material using the boric acid modification described by (Ma and Zuazage, 1942), and distillation was done using a Buechi 320-N2-distillation unit. Phosphorus was photometrically determined using the molybdate vanadate method according to (Jackson, 1973). Potassium was determined using flame photometer Eppendorf. The soil data were evaluated using the criteria published by (Ankerman and Large, 1974) and (Lindsay and Norvell, 1978), whereas the leaf analysis data were evaluated according to the criteria reported by (Jones et al. 1991) in Plant Analysis Handbook.

Statistical analysis:

The obtained data were subjected to the analysis of variance of Randomized complete block design according to (Snedecor and Cochran,1980) where the means of different treatments were compared using the least significant difference (L.S.D) test at 5% level of significant.

Results and Discussion

Soil testing: the results in Table 1 summarized the physical and chemical characteristics of the soil where experiments were done, the value of pH showed alkalinity and O.M and EC was medium. The total CaCO3 content of the soil tended to be low. Data also showed that the soil had moderate available of P, K, Ca and Zn nutrients.

Table 1: Soil analyses before sowing (0-30cm depth) in third season

Character		Nutrient content	
Sand %	**30.80**	**(mg /100g)**	
Silt %	**28.00**	**Available – P**	**2.62M**
Clay %	**41.20**	**Available - K**	**26.3 M**
Soil Texture	**S.C.L**	**Available - Mg**	**205 H**
pH	**8.68 H**	**Available - Ca**	**713 M**
E.C dS/m	**0.35 M**	**Available - Na**	**43.5 H**
CaCO3 %	**1.90 L**	**(mg/Kg)**	
O.M %	**2.20 M**	**Available - Fe**	**30 H**
		Available - Mn	**28 H**
		Available - Zn	**2.6 M**
		Available - Cu	**5 H**

L = Low, M = Moderate, H = High

Yield and its components

Data presented in Table (2) indicated that numbers of leaves /plant, ear length, number of row /ear, grains number/row, 100-grains weight, grains yield /plant and yield ton/ ha were significantly affected by the different treatments. Treated maize with N 125, P 65 K 80 based on soil testing plus micronutrients foliar spray gave significant increments in number of Leaves/plant, ear length (cm), number of row/ear, grains number/row, chilling (%),100 grains weight (g), yield/ton hectare, grain yield/plant (g) followed by the NPK treatment which based on soil testing (N 125, P 65 K 80). On the other hand, control and farmer fertilizer was the lowest one. Maize treated with recommended N 120, P 60, K 48, according to Ministry of Agric. surpassed the treatments of N 120, P 60 and N120, K 48. The yield in third season was more than the first and second season. This may be due to accumulation of nutrients by the treatments with N, P, K and micronutrients.

Table (2) Yield and its components of maize as affected by different levels of NPK and balanced fertilization

Treatment	Number of leaves/plant	Ear length (cm)	Number of row/ear	Grains number per/row	Chilling (%)	100 grains weight (g)	Grain yield/plant (g)	Yield/ton/ha
Third season 2011								
Control	11.75	19.75	9.5	35.25	65.03	24.98	126.4	15.01
Farmer Fertilizer	13.13	22.43	10.5	41.75	71.95	29.18	178.9	21.30
NPK, MoA	16.25	25.70	12.5	51.50	79.05	34.95	226.8	27.07
NP, MoA	15.25	24.88	11.0	50.00	74.13	32.62	217.4	25.88
NK, MoA	14.50	24.15	11.5	46.50	75.75	34.47	220.5	26.24
NPK soil test	16.25	26.43	12.5	54.00	80.38	35.65	229.6	27.37
NPK soil test + micronutrients	16.73	27.75	13.5	56.50	82.90	37.68	256.6	30.58
LSD (5%)	1.24	1.33	1.82	4.67	1.72	1.25	8.89	1.06

Results in Table (3) showed that the two treatments of NPK soil test and NPK soil test + micronutrients gave high significant increases for most of nutrients as compared with the control. From the above mentioned results it is concluded that treated plants with NPK according to soil testing plus foliar application of micronutrients resulted in improving nutrient concentrations in maize leaves.

Table (3) Nutrient contents in ear leaves of maize as affected by different levels of NPK and Balanced fertilization

Treatment	%						ppm			
	N	P	K	Ca	Mg	Na	Fe	Mn	Zn	Cu
Third season 2011										
Control	2.48 L	0.33 M	4.83 H	0.45 M	0.71 H	0.31	422 H	40 M	45 M	19 M
Farmer Fertilizer	2.35 L	0.33 M	3.41 H	0.43 M	0.87 H	0.31	561 H	36 M	58 M	16 M
NPK, MoA	2.67 L	0.33 M	3.53 H	0.46 M	0.81 H	0.27	576 H	45 M	50 M	15 M
NP, MoA	2.30 L	0.31 M	2.49 H	0.48 M	0.90 H	0.29	433 H	48 M	41 M	16 M
NK, MoA	2.47 L	0.30 M	3.23 H	0.38 M	0.69 H	0.28	302 H	41 M	44 M	16 M
NPK soil test	2.86 M	0.29 M	2.88 H	0.44 M	0.99 H	0.38	526 H	56 M	52 M	15 M
NPK soil test + micronutrients	2.62 L	0.30 M	2.11 M	0.54 M	0.88 H	0.28	497 H	40 M	34 M	16 M
LSD 5%	0.29	N.S	1.39	N.S	N.S	0.04	70	N.S	11	2.37

VL = very low, L = Low, M = Moderate,
H = High

Seed nutrient contents:
Results in Table (4) showed that there is not different significant among treatments on seed nutrient contents, these may be returned to the dilution effect of seed nutrients because of high yield.

Table (4) Nutrient contents in seeds of maize as affected by different levels of NPK and balanced fertilization.

Treatment	%						ppm			
	N	P	K	Ca	Mg	Na	Fe	Mn	Zn	Cu
Third season 2011										
Control	1.29	0.27	0.50	0.64	0.21	0.08	76	39.3	20.3	11.3
Farmer Fertilizer	1.19	0.31	0.47	0.63	0.27	0.08	74	36.7	25.3	10.7
NPK, MoA	1.24	0.22	0.49	0.65	0.22	0.08	75	32.7	16.0	9.0
NP, MoA	0.91	0.23	0.53	0.63	0.23	0.08	72	32.7	17.3	9.3
NK, MoA	0.75	0.15	0.58	0.60	0.23	0.09	75	31.0	13.0	9.3
NPK soil test	0.71	0.18	0.62	0.59	0.32	0.09	72	28.7	17.0	8.7
NPK soil test + micronutrients	1.33	0.23	0.65	0.58	0.31	0.09	73	33.0	15.7	9.3
LSD 5%	0.08	0.03	N.S	N.S	0.05	N.S	2.07	3.13	4.34	1.23

Seed nutrient uptake:
Results in Table (5) showed that there is different significant effect among most of all the treatments and the treatment of NPK based on soil testing plus micronutrient foliar spray.

Table (5) Nutrient uptake in seeds of maize as affected by different levels of NPK and balanced fertilization

Treatment	Kg/ha						g/ha			
	N	P	K	Ca	Mg	Na	Fe	Mn	Zn	Cu
Third season 2011										
Control	193.6	40.5	75.1	96.1	31.5	12.0	1141	590	305	170
Farmer Fertilizer	253.5	66.0	100.1	134.2	57.5	17.0	1576	782	539	228
NPK, MoA	335.7	59.6	132.6	176.0	59.6	21.7	2030	885	433	244
NP, MoA	235.5	59.5	137.2	163.0	59.5	20.7	1863	846	448	241
NK, MoA	196.8	39.4	152.2	157.4	60.4	23.6	1968	813	341	244
NPK soil test	194.3	49.3	169.7	161.5	87.6	24.6	1971	786	465	238
NPK soil test + micronutrients	406.7	71.4	198.8	177.4	94.8	27.5	2232	1009	480	284
LSD 5%	16.02	8.03	33.30	12.0	13.42	3.56	57.30	76.00	100.11	25.12

Location III : Ismailia Training Center, Ismailia governorate,

A field experiment was carried out in Ismailia Agricultural Training Center, Ismailia governorate, during winter season of 2010/2011 to study the influence of N P K on wheat (cv. Sakha 94) yield and its components.

1. Experimental design:

The experimental design was randomize complete block with four replicates. Seven treatments, control (no addition T0), NP recommended (T1), NK recommended (T2), NPK recommended (T3), NPK farmer's use (T4), NPK based on soil testing (T5) and NPK based on soil testing + micronutrients (T6).

2. Soil preparation and cultivation:

Soil was ploughed using a hoeing. Plot area was 52 m^2 (8 m long and 6.5 m wide). Every plot contained 32 rows each of 20 cm width. Wheat grains were sown on Nov. 26rd in 2010, at the rate of 60 kg /feddan (Feddan = 4200 m^2) by hand drilling in rows.

3. Treatments:

1- Control (no addition) T0
2- N: P_2O_5 recommended 120: 22 kg/fed. (T1)
3- N: K_2O recommended 120: 24 kg/fed. (T2)
4- N: P_2O_5: K_2O recommended 120: 22: 24 kg/fed. (T3)
5- N: P_2O_5: K_2O farmer uses 70: 15: 24 kg/fed. (T4)
6- N: P_2O_5: K_2O based on soil testing 122: 45: 65 kg/fed. (T5)
7- N: P_2O_5: K_2O based on soil testing + micronutrients 122: 45: 65 kg/fed. (T6)

Nitrogen doses were added in the form of ammonium nitrate (33 % N) in three equal splits (at planting, 30 and 60 days after sowing). Phosphorus doses were added in the form of super phosphate (15.5% P_2O_5), at sowing. Potassium doses were added in the form of potassium sulfate (50 % K_2O), in two equal splits at sowing and 30 days from sowing. Micronutrient treatment was 1.5 gm/liter in the form of multi chelated micronutrients compound (3% Fe, 3% Zn and 3% Mn), where, two foliar sprays were applied. The first was carried out at 45 days from sowing using 350 l/fed. and the second was after two weeks from the first one using 400l/fed.

4. Irrigation:
Plants were irrigated at 7 days interval.

5. Weed control:
Pesticides (Granstar) were added, at rate of 8 g /fed. at 35 days after sowing.

Table (1): Physical and chemical characteristics of soil (0 – 50 cm depth) before sowing for 2010/2011 winter season.

Characteristics	Before Planting						
	T0	T1	T2	T3	T4	T5	T6
Sand (%)	84	83	85	83	86	85	85
Silt (%)	2	4	3	4	2	6	5
Clay (%)	14	13	12	13	12	9	10
Texture	LS	LS	LS	LS	LS	LS	LS
E.C dS/m	0.10	0.11	0.09	0.12	0.11	0.13	0.12
pH	8.92	8.88	8.56	8.69	8.94	8.49	8.39
$CaCO_3$ %	3.11	4.19	4.15	4.18	3.20	3.23	3.14
Organic Matter %	1.71	1.55	1.77	1.60	1.52	1.94	1.89
Macronutrients (mg/100 g soil)							
P	0.41	1.01	0.63	0.74	0.67	0.81	0.94
K	4.1	4.0	5.2	6.1	5.3	4.5	4.6
Na	4.1	3.5	3.6	4.2	5.1	3.6	3.8
Ca	80	85	82	91	75	74	72
Mg	3.2	3.1	3.8	3.4	3.5	3.2	3.1
Micronutrients (ppm)							
Fe	1.1	1.2	1.3	1.4	0.9	0.8	1.1
Mn	1.3	1.5	1.5	1.4	1.6	2.0	1.4
Zn	0.8	0.3	0.4	0.9	0.7	0.6	1.1
Cu	0.7	0.8	1.0	1.1	0.9	0.4	0.6

*** LS = Loamy Sand**

Table (2): Physical and chemical characteristics of soil (0 – 50 cm depth) after harvesting for 2010/2011 winter season.

Characteristics	After harvesting						
	T0	T1	T2	T3	T4	T5	T6
Sand (%)	81.6	81.6	85.6	81.6	85.6	81.6	85.6
Silt (%)	6	6	2	6	2	6	2
Clay (%)	12.4	12.4	12.4	12.4	12.4	12.4	12.4
Texture	LS	LS	LS	LS	LS	LS	LS
E.C dS/m	0.10	0.11	0.09	0.12	0.11	0.13	0.12
pH	8.57	8.49	8.60	8.63	8.56	8.53	8.69
$CaCO_3$ %	3.24	4.05	4.17	4.05	4.21	4.05	4.13
Organic Matter %	1.43	1.44	1.32	1.43	1.30	1.42	1.29
Macronutrients (mg/100 g soil)							
P	0.7	2.8	0.8	3.8	3.6	3.9	3.8
K	10.6	10.0	10.2	10.4	10.6	12.0	9.8
Na	4.8	2.6	2.2	2.6	2.6	2.4	2.0
Ca	480	450	530	530	520	520	490
Mg	28.3	23.5	20.5	21.5	24.2	25.1	17.5
Micronutrients (ppm)							
Fe	4.7	8.4	4.7	6.7	3.9	6.1	5.0
Mn	4.6	5.4	4.4	5.3	4.8	4.8	3.6
Zn	1.9	0.4	0.7	0.8	0.8	1.8	0.8
Cu	0.7	0.3	0.5	0.6	0.4	0.6	0.6

* LS = Loamy Sand

6. Data recorded:

1- Growth characteristics:-

A sample of 10 plants/plot was randomly taken at 90 days after sowing to determine the following characteristics:

- Dry weight g/ plant
- Wheat shoots were analyzed for macro- and micro-nutrients.

2- Yield and yield components: -

At maturity, i.e. 150 days (April 26th in 2011 season) after sowing the plants were harvested. Ten samples were taken to determine the following characteristics:

- Number of spikes / m^2
- Number of grains /spike
- Spike length (cm.)
- Weight of grains / spike (g)
- 1000 grains weight (g)
- Grain yield (ton/ ha).
- Straw yield (ton/ ha)

Grain and straw yields were determined by harvesting three rows of 3.9 m^2 (6.5 m long and 0.60 m wide).

Chemical analysis:

Soil testing:

A representative soil sample was taken before sowing and after harvesting from the experimental sites (0-50 cm depth) to be analyzed for physical and chemical characteristics. Data are shown in Tables (1 and 2).

Results

1. Growth parameters:

1. 1 Dry weight of shoots at 90 DAS (g/plant):

Data recorded in Table (3) showed clearly that accumulation of dry weight / plant of wheat was significantly affected by the applied NPK treatments. The best value was attainable when NPK fertilizers added based on soil testing + micronutrients (T6) as compared with the other treatments and control.

1. 2 Macronutrients content of wheat shoots at 90 DAS (mg/plant):

Uptake of macronutrients in wheat shoots as affected by different treatments of NPK are shown in Table 3. It is obvious that N, P, and K content were significantly increased as a result of appling of different NPK treatments. From the above mentioned results, it could be concluded that NPK treatment plus micronutrient foliar spray could increase shoot uptake of N, P and K at 90 days after sowing .

1. 3 Micronutrients content of wheat shoots at 90 DAS (µg/plant):

Results in Table (3) showed that, the highest values for Fe, Zn and Mn contents in wheat shoots were determined by the NPK application based on soil testing + micronutrients (N122 : P45 : K65 kg/fed. plus micronutrients spray).

2. Yield and yield components:

The effect of NPK on wheat yield and its components, (i.e plant height (cm), spike number/m^2, spike length (cm), grains number/spike, grains weight /spike (g), 1000-grain weight (g), grains yield/ha.(ton) and straw yield/ha.(ton) are presented in Tables (4).

Applied NPK fertilizer treatments had a significant effect on plant height (cm), spike number/m^2, spike length (cm), grains number/spike, grains weight /spike (g), 1000-grain weight (g), grains yield ton/ha. and straw yield ton/ha. (Table 4). Fertilizing wheat plants with 122 kg N/fed. + 45 kg P_2O_5/fed. + 65 kg K/fed. plus micronutrients (T6) produced the greatest increase for plant height, grains number/spike, spike length, grains weight /spike and grain yield/ha as compared with control and other treatments. While, the highest values for 1000-grain weight was obtained by the NPK application of N120 : P22 : K24 kg/fed.(T3). The highest values for Grains number/spike and straw yield/ha were determined by the NPK application of **122 N: 45** P_2O_5 **: 65** K_2O **kg/fed**. (T5). However, the lowest values of grain and straw yields were resulted from the untreated plants (control).

4. Dry weight of shoots and grains at harvesting (g/plant):

The effect of NPK on dry weight shoot, root and grains of wheat at harvest in 2010/2011 season are presented in Tables (5and 6). It is obvious that shoots dry weight at harvest was significantly increased as a result of applied different NPK treatments.. The most increment in DW of grains was obtained by the T6 treatment.

5. Chemical compositions at harvest:

5. 1 Shoot chemical compositions at harvest:

From the results presented in Table 5, shoot N uptake significantly increased as a result of applied NP (T1), NPK (T3), NPK (N5) and NPK (T6) as compared to the other treatments and control. It is also important to note that there are no significant differences among the aforementioned treatments. However, shoot P uptake showed marked increments due to either (T3) or (T6). While, the highest shoot K uptake was achieved by applying (t6) i.e. NPK based on soil testing plus micronutrients foliar spray. On the other hand, results in Table (5) show that, the highest values for Fe and Zn contents in wheat shoots at harvest were determined by the NPK fertilizers recommended by Ministry of Agriculture (MoA) (T3). While, the highest value for Mn content in wheat shoots at harvest was obtained by the NPK based on soil testing (T5) treatment.

5. 2 Grain chemical compositions at harvest:

Chemical composition of grains i.e., N, P, K, Fe, Mn, Zn and protein contents showed significant response to NPK application treatments (Table 6). Fertilizer application with NPK based on soil testing + plus micronutrients (T6), gave the highest value of N, P, K, Fe, Mn, Zn and protein contents measured in wheat grain compared with other treatments and control.

Table (3): Effect of NPK on dry weight (g/plant) and macro-micronutrients content of wheat shoot at 90 days after sowing season 2010/2011

Characteristics / Treatment	Shoot DW g/plant	N mg/plant	P mg/plant	K mg/plant		Fe µg /plant	Mn µg /plant	Zn µg /plant
T_0 (N P K) (0: 0: 0)	0.37	4.17	0.79	11.26		11.15	9.88	8.92
T_1 (N : P : K) (120: 22 : 0)	0.86	14.95	1.47	23.31		63.62	12.58	26.88
T_2 (N : P : K) (120: 0 : 24)	0.99	21.36	0.60	23.67		27.66	14.09	39.25
T_3 (N : P : K) (120: 22 : 24)	1.39	22.43	2.45	33.62		52.11	23.12	61.11
T_4 (N : P : K) (70 : 15 : 24)	1.07	19.05	1.57	27.33		41.91	18.58	52.57
T_5 (N : P : K) (122: 45 : 65)	1.43	23.49	1.93	36.48		53.29	20.58	43.38
T_6 (N : P : K) (122: 45 : 65) + MN*	1.67	29.76	2.95	53.46		64.76	28.9	77.38
LSD at 0.05	0.27	9.62	0.53	14.59		19.97	8.86	20.57

* MN = Micronutrients

Table (4): Effect of NPK on yield and yield component of wheat plants at 2010/2011 season

Characteristics / Treatment	Plant height (cm)	No. of spike / m^2	No. of grains /spike	Spike length (cm)	Grains weight /spike (g)	1000-grains weight (g)	Grains yield (ton/ha)	Straw yield (ton/ha)
T_0 (N P K) (0: 0: 0)	38.8	434.3	6.9	3.1	0.20	28.99	1.03	1.05
T_1 (N : P : K) (120: 22 : 0)	80.2	419.2	18.8	7.5	0.71	37.77	3.71	3.61
T_2 (N : P : K) (120: 0 : 24)	75.8	394.2	20.8	6.5	0.85	40.87	4.03	4.20
T_3 (N : P : K) (120: 22 : 24)	77.1	298.3	29.6	7.8	1.26	42.57	4.56	5.14
T_4 (N : P : K) (70 : 15 : 24)	74.6	397.5	28.7	7.9	0.87	30.31	4.14	5.02
T_5 (N : P : K) (122: 45 : 65)	77.5	444.2	26.7	9.1	1.03	38.58	5.53	5.63
T_6 (N : P : K) (122: 45 : 65) + MN*	82.3	420.7	37.3	9.2	1.29	34.58	6.25	4.83
LSD at 0.05	**6.7**	**61.8**	**6.4**	**2.15**	**0.09**	**2.78**	**2.03**	**1.13**

* **MN** = Micronutrients

Table (5): Effect of NPK on shoot dry weight (g/plant) and macro-micro nutrients content of wheat at harvest season 2010/2011

Characteristics / Treatment	Shoot DW g/plant	N mg/plant	P mg/plant	K mg/plant	Fe µg /plant	Mn µg /plant	Zn µg /plant
T_0 (N P K) (0: 0: 0)	0.78	1.03	1.24	13.88	73.29	3.52	63.79
T_1 (N : P : K) (120: 22 : 0)	1.05	9.95	0.43	23.14	92.33	2.01	114.17
T_2 (N : P : K) (120: 0 : 24)	2.03	6.67	1.02	44.23	144.17	6.00	180.83
T_3 (N : P : K) (120: 22 : 24)	2.39	8.83	1.32	53.16	240.05	7.20	217.70
T_4 (N : P : K) (70 : 15 : 24)	2.13	5.92	1.12	45.95	180.00	7.22	120.82
T_5 (N : P : K) (122: 45 : 65)	2.36	9.97	1.48	54.34	164.17	8.40	157.09
T_6 (N : P : K) (122: 45 : 65) + MN*	2.96	10.57	1.09	68.58	212.40	8.36	213.50
LSD at 0.05	**0.37**	**3.58**	**0.46**	**9.68**	**59.54**	**1.50**	**31.20**

* **MN** = Micronutrients

Table (6): Effect of NPK on grains dry weight (g/plant), macro-micro nutrients and protein content of wheat at harvest season 2010/2011

Characteristics / Treatment	Grains DW g/plant	N mg/plant	P mg/plant	K mg/plant	Fe µg /plant	Mn µg /plant	Zn µg /plant	Protein (%)
T_0 (N P K) (0: 0: 0)	0.21	6.05	0.59	2.41	19.20	3.06	9.36	9.59
T_1 (N : P : K) (120: 22 : 0)	1.22	39.6	5.33	13.20	25.21	16.81	42.61	11.67
T_2 (N : P : K) (120: 0 : 24)	1.18	37.2	5.40	11.40	30.05	15.66	51.00	10.77
T_3 (N : P : K) (120: 22 : 24)	1.53	60.12	6.62	15.62	32.41	22.23	54.65	12.09
T_4 (N : P : K) (70 : 15 : 24)	1.12	38.41	4.85	10.18	27.63	15.92	38.44	11.53
T_5 (N : P : K) (122: 45 : 65)	1.68	52.75	7.32	12.63	36.65	25.83	56.87	12.68
T_6 (N : P : K) (122: 45 : 65) + MN*	1.69	61.60	7.58	16.22	45.09	28.56	66.09	13.93
LSD at 0.05	**0.40**	**13.18**	**2.48**	**3.78**	**10.81**	**6.36**	**14.43**	**2.28**

* **MN** = Micronutrients

(Summer season 2011)

A summer field experiment was carried out in Ismailia Training Center, Ismailia governorate, during the growing seasons 2011 to study the influence of N P K on forage yield and yield components of fodder Sorghum (Sordan, hybrid between Nigro sweet x Sudan grass).

1. Experimental design:

The experimental design was randomize complete block with four replicates. Seven treatments NP recommended (T_1), NK recommended (T_2), NPK recommended (T_3), NPK farmer uses (T_4), NPK based on soil testing (T_5) and NPK based on soil testing + micronutrients (T_6) and control i.e. without any fertilizers addition (T_0).

2. Soil preparation and cultivation:

Soil was ploughed using a hoeing. Plot area was 52 m^2 (8 m long and 6.5 m wide). Sorghum grains were sown on May, 31th in 2011 season at the rate of 25 kg /feddan by hand sowing.

3. Treatments:

1- N : P_2O_5 : K_2O, 0 : 0 : 0 (control) (T_0)
2- N : P_2O_5 recommended, 140 : 30 kg/fed. (T_1)
3- N : K_2O recommended, 140 : 24 kg/fed. (T_2)
4- N : P_2O_5 : K_2O recommended, 140 : 30 : 24 kg/fed. (T_3)
5- N : P_2O_5 : K_2O farmer's rates 100 : 15 : 0 kg/fed. (T_4)
6- N : P_2O_5 : K_2O based on soil testing 175 : 20 : 59 kg/fed. (T_5)
7- N : P_2O_5 : K_2O based on soil testing + micronutrients 175 : 20 : 59 kg/fed. (T_6)

Nitrogen doses were added in the form of ammonium nitrate (33 % N) applied in three equal doses (15 days after emergence, after the first cut, and after the second cut). Potassium and phosphorus doses were added in the form of potassium sulfate (50% K_2O) and super phosphate (15.5% P_2O_5), respectively, during land preparation. Micronutrient treatments were sprayed at the rate of 1.5 gm/liter three times in the form of multi chelated micronutrients compound (3% Fe, 3% Zn and 3% Mn) were three sprayed. The first spray was carried out at 35 days after sowing, the second was after the first cut and the third was after the second cut.

The spraying solution was 250 l/fed.

4. Irrigation:

Plants were irrigated at 7 days interval.

Data recorded:-

1- Yield and plant height:

The forage yield was determined over three successive cuts at 50, 100 and 135 days from sowing .At each cut, plant height was measured.

Chemical analysis:

1. Soil testing:

A representative soil sample was taken after soil preparation and before fertilization and after harvest from the experimental sites at 0-50 cm depth . The soil samples were air dried, ground in a wooden mortar and passed through a 2 mm pores sieve to be analyzed for physical and chemical characteristics. Data are shown in Tables (1&2).

2. Plant analysis:

Sorghum shoots at cutting were analyzed for macro and micronutrients.

- shoots were washed in sequence with tap water, 0.01 N HCl- acidified bidistilled water and bidistilled water, respectively, and then dried in a ventilated oven at 60 C° till constant weight was obtained.
- The plant samples were ground in stainless steel mill with 0.5 mm sieve and kept in plastic containers for chemical analysis.

Table (1): Physical and chemical characteristics of soil (0 – 50 cm depth) before sowing.

Characteristics	Treatment						
	T_0	T_1	T_2	T_3	T_4	T_5	T_6

Sand (%)	81.6	81.6	85.6	81.6	85.6	81.6	85.6
Silt (%)	6	6	2	6	2	6	2
Clay (%)	12.4	12.4	12.4	12.4	12.4	12.4	12.4
Texture	**LS**	**LS**	**LS**	**LS**	**LS**	**LS**	**LS**
E.C dS/m	0.10	0.11	0.09	0.12	0.11	0.13	0.12
pH	8.57	8.49	8.60	8.63	8.56	8.53	8.69
$CaCO_3$ %	3.24	4.05	4.17	4.05	4.21	4.05	4.13
Organic Matter %	1.43	1.44	1.32	1.43	1.30	1.42	1.29
Macronutrients (mg/100 gm soil							
P	0.7	2.8	0.8	3.8	3.6	3.9	3.8
K	10.6	10.0	10.2	10.4	10.6	12.0	9.8
Na	4.8	2.6	2.2	2.6	2.6	2.4	2.0
Ca	480	450	530	530	520	520	490
Mg	28.3	23.5	20.5	21.5	24.2	25.1	17.5
Micronutrients (ppm)							
Fe	4.7	8.4	4.7	6.7	3.9	6.1	5.0
Mn	4.6	5.4	4.4	5.3	4.8	4.8	3.6
Zn	1.9	0.4	0.7	0.8	0.8	1.8	0.8
Cu	0.7	0.3	0.5	0.6	0.4	0.6	0.6

*** LS = Loamy Sand**

Table (2): Physical and chemical characteristics of soil (0 – 50 cm depth) after harvesting.

Characteristics	**Treatment**						
	T_0	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**
Sand (%)	81.6	81.6	85.6	81.6	85.6	81.6	85.6
Silt (%)	6	6	2	6	2	6	2
Clay (%)	12.4	12.4	12.4	12.4	12.4	12.4	12.4
Texture	**LS = Loamy Sand**						
E.C dS/m	0.12	0.16	0.19	0.12	0.21	0.10	0.23
pH	8.62	8.78	8.66	8.59	8.74	8.59	8.69
$CaCO_3$ %	3.34	4.25	3.87	4.50	3.68	3.92	3.59
Organic Matter %	1.63	1.74	1.52	1.40	1.51	1.71	1.83
Macronutrients mg/100 gm soil							
P	0.5	1.25	0.6	2.62	3.22	3.18	3.4
K	8.2	9.4	12.2	10.6	11.4	14.1	13.2
Na	4.9	4.5	4.6	3.8	4.2	4.6	4.8
Ca	450	440	510	516	522	540	510
Mg	27.2	21.3	22.2	25.5	19.4	17.2	19.4
Micronutrients part per million (ppm)							
Fe	2.2	3.4	5.1	4.6	2.6	5.4	4.1
Mn	3.4	5.1	5.0	4.0	5.2	6.1	4.6
Zn	1.1	0.6	0.4	0.7	0.5	0.9	0.4
Cu	0.2	0.4	0.4	0.4	0.5	0.7	0.6

Egypt: Iskandaria, April 2011

Egypt: Kafr Al Khadra, Jul 2011

Egypt: Ismailia, Dec 2011