Impact of soil and foliar fertilization on yield and net income of maize plants alluvial clay soil.

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ABSTRACT

The study was aimed to investigate the effect of methods and levels of nitrogen, phosphorus and potassium application on maize growth, yield components, yields, nutrient uptake as well as net income. Two field experiments were carried out in the at Agricultural Farm of Sids Agricultural Research Station, ARC, Beni – Swif Governorate, Egypt during the two successive seasons of 2013 and 2014.

The nitrogen treatments were 120 kg N/fed as soil application (N_1), 90 kg N/fed as soil application + two time foliar spraying of 2% urea solution (N_2) and 60 kg N/fed as soil application + two time foliar spraying of 2% urea solution (N_3). The phosphorus treatments were 13.6 kg P/fed as soil application (P_1) , 6.8 kg P/fed as soil application + two time foliar spraying of 0.33% (P_2), and two time foliar spraying of 0.33% P (P_3). The potassium treatments were 39.8 kg K/ fed as soil application (K_1) , 19.9 kg K/fed as soil application + two time foliar spraying of 2% potassium sulphate solution (K_2) , and two time foliar spraying of 2% potassium sulphate solution (K_3). A factorial experiment design included 27 treatments with four replications was performed. The results reveal that maize plant height, dry weight/plant, number of rows / ear , number of grains/ row , 100 – grain weight , grain , stover and biological yields as well as nutrient uptake and net income were significantly responded to methods and levels of N,P and K application. On the other hand combined soil application with foliar spraying (90 kg N/ fed with foliar spraying of 2% urea solution, 6.8 kg P/fed with foliar spraying of o.33% P or 19.9 kg K/fed with foliar spraying of 2% potassium sulphate solution) gave higher values , of growth parameter except plant height with 120 kg N/fed which recorded the tallest maize plant . In general, the recommended treatment for quality and quantity as well as the net income of maize was 90 kg N/ fed as soil application in combination with foliar spraying of 2% urea solution + 6.8 kg P/fed as soil application in combination with foliar spraying of 0.33% P + 19.9 kg K/fed as soil application in combination with foliar spraying of 2% potassium sulphate solution.

Key words: NPK fertilization, soil application, foliar spraying, growth parameters, yield and its components, nutrient uptake and net income.

Introduction

Maize (**Zea mays L.**) is the most important cereal crops grown in the world after wheat and rice with respect to the area and principally. It is an important source of carbohydrate, protein, iron, vitamin B and minerals. It is the most important cereal fodder and grain crop under both irrigated and rainfed agricultural systems in the semi – arid and arid tropics. Maize has numerous uses and ranks second only to wheat among the worlds cereal crops in terms of total production. Also, because of its worldwide distribution and lower price, relative to other cereals, maize has a wide range of uses than any other cereals. It is the stable food crop and the base of most rural diets, as well as a cash crop. In poor communities, it is the main source of calories and protein, as well as the primary weaning food for babies. In developed countries, maize is consumed mainly as second.

The new high yielding hybrids will be adapted to different cultural practices such. Also, in Egypt, intensive cropping has become more common and N, P and K fertilizers the primary function of soil productivity and fertility restoration has become less effective. On the other hand, most of soil in Egypt are known to be poor in fertility status, hence it is need to supplement the amount of nutrients for optimal crop performance. The poor fertility status is even more related to chemical than physical properties (***Fernandez and Sanche, 1990***). Though the nutrients such as N, P and K supplied by mineral fertilizers are usually specific and released rather fast.

Nitrogen is a vital plant nutrient and major determining factor required for maize production. It is very essential for plant growth and makes up 1-4 % of the dry matter of plants. Nitrogen is a component of protein and nucleic acids and also an integral component of many other compounds essential for plant growth processes including chbrophyll and many enzymes. ***Gebrail et al (2005)*** , ***Siam et al (2008)***, ***Ali et al (2012)*** and ***Thirupathi, et al (2016)*** reported that added nitrogen as soil application improved growth and yield and its components on maize plant .***Ismail et al (2006)***, ***Sarhan (2006)***, ***Sadik et al (2009)*** and ***Abd El-Hafeez et al (2013)*** found that N,P and K uptake in maize grains and stover were significantly responded to soil nitrogen application .

Phosphorus is another essential nutrient required to increase maize productivity. Phosphorus plays an important role in many physiological processes, involved in enzymatic reactions in plant, essential factor for cell divition because it is constituent element of nucleoproteins which are involved in the cell reproduction processes, a component of a chemical essential to the reactions of carbohydrate synthesis and degradation, important for seed and

fruit formation and crop maturation as well as affects quality of the grains and it may increase the plant resistance to diseaces. ***Hussain et al (2007)***, ***Yosefi et al (2011)*** and ***Amahakiam and Osemwota (2012)*** stated that supplied maize plant with phosphorus as soil application resulted in a positive effect on growth and yield and yield components. ***Kruczek (2005)*** and ***Crozier et al (2009)*** indicated that phosphorus added to soil enhanced phosphorus concentration and uptake in maize.

Potassium is, one of the essential nutrient in plant. It plays essential roles in enzyme activation, protein synthesis, photosynthesis, osmoregulation, stomatal movement, energy transfer, cation – anion balance and stress resistance. Maize productivity were increased due to potassium soil application (***Sedrak, 2007*** and ***Maqsood et al 2013)***. Also, nutrients status of maize were increased due to potassium soil application (***Kubar et al .2013*** and ***Zorkany, 2014***).

Foliar feeding has been used as a mean of supplying supplemental doses of macro and micro nutrients, plant hormones stimulants and beneficial substances. Observed effects of foliar fertilization have included yield increases, resistance to plant diseaces and insect, improved drought tolerance and enhanced crops quality. In term of nutrient absorption, foliar fertilization can absorbed from 8 to 20 times as efficient as ground application (***Anonymous 1985***). ***Parasuraman et al (2008)***, ***Hu et al (2008)***, ***Khan et al (20016)*** reported that maize productivity improved due to foliar spraying of N P K fertilizers.

This study was conducted to determine the yield and growth of maize plant as affected by N, P and K fertilization as soil application as well as supplement part of them as foliar spraying.

Materials and Methods

The current study was conducted at the Agricultural Farm of Sids Agricultural Research Station, ARC, Beni-Swif Governorate, Egypt during the two summer seasons of 2013 and 2014 to evaluate the effect of applied NPK fertilizers as soil or foliar application on plant growth parameters, yield and yield compents, NPK uptake and the net income of maize plant .The experimental design was a randomized com plate block factorial involving three factors as follows : a , b , c, Each treatment was replicated four times .

The factors were.

Factor A Nitrogen fertilizer. 120 kg N/fed as soil application (N_1), 90 kg N/fed as soil application + foliar spraying of 2% urea solution twice (N_2) and 60 kg N/fed as soil application + foliar spraying of 2% urea solution twice (N_3) .

Factor B Phosphorus fertilizer. 13.6 kg P/fed as soil application (P_1) in form of superphosphate (15.5 P_2O_5) , 6.8 kg P/fed as soil application + foliar spraying of 0.33% P as the supernatant of 10 and 20 kg/fed superphosphate soaking for the first and second spraying, respectively twice (P_2) and foliar spraying of 0.33% P as the supernatant of 10 and 20 kg/fed superphosphate soaking for the first and second spraying, respectively twice (P_3).

Factor C Potassium fertilizer. 39.8 kg K/fed as soil application (K_1) in form of potassium sulphate 48% K_2O, 19.9 kg K/fed as soil application + foliar spraying of 2% potassium sulphate solution twice (K_2) and foliar spraying of 2% potassium sulphate solution twice (K_3).

The preceding crop was wheat in the two studied seasons. The plot area was 3x3.5 m = 1/400 fed. Each experimental plot consisted of five rows, three meters along and 0.70 m apart. Grains of maize (***Zea mays L.***), Single Cross 10 were sowing in hills, 0.30 m apart in 11 and 17 May in the two seasons , respectively. Thinning was done before the first irrigation to one plant/hill which gave about 20000 plant/fed. Other cultural practices for maize production were done as in district.

The total number treatment war 3x3x3x4= 108 plot.

The soil application of nitrogen fertilizer was added at two equal doses, as ammonium nitrate , 33.5% N, the first before the first irrigation and the second before the second irrigation while nitrogen foliar spraying was done as urea 46.5% N . On the other hand, soil application of phosphorus fertilizer was done before planting during the land preparation, anal potassium soil application was done at two equal doses, the first before planting during the land preparation and the other after one month from maize sowing. However , the foliar spraying of N, P or K war done performed tow time , the first after the first irrigation and the second one after one month later at a rate of 200 and 400 L/fed in the two foliar application , respectively.

Data recorded:

Five plants were randomly taken from each plot during tasseling – silking stage (about 60 days age) from the two inner rows to measure some growth characters such as:

1- Plant height (cm)
2- Dry weight / plant (g)
3- Number of leaves /plant
4- Leaf area (cm^2)

At harvesting, five plants were randomly taken from each plot from the two inner rows to measure some yield components such as:

1-The number of rows/ ear
2-The number of grains / row
3-100 – grain weight

Also, grain and stover yields were measured for each plot and calculated as Mg/ h^{-1}

Nitrogen, phosphorus and potassium percent in both grains and stover were determined according to the method described by ***Chapman and Pratt (1961)*** and nutrient uptake was calculated.

Net income was calculated as:

Net income = price of weight of maize grains – price of added fertilizer

The average price of maize grains /t was about 3000 L.E in the two season

The average price of one kg N from urea and ammonium nitrate were 6.37 and 8.84 L.E, respectively (2960 L.E/t for each)

The average price of one kg P was 19.8 L.E (1340 L.E/t) from superphosphate fertilizer (0.33 % P)

The average price of one kg K was 19.33 L.E (7700 L.E/t) from potassium sulphate fertilizer (48% K_2O)

The cost of fertilizer application workers was neglected because the cost of soil application is somewhat equal to those for foliar spraying.

Soil analysis:

Representive soil sample (0-30) was taken before planting from the experiment sites in the two seasons to determine some physical (according to ***Piper, 1950***) and chemical (according to the standard methods cited by ***Jacson, 1967)*** Soil properties and listed in Table (1) as follows:

Table 1. Physical and chemical properties of the experimental soil.

Property	First season	Second season
Particle size distribution		
Sand %	17.22	15.71
Silt %	29.13	31.08
Clay %	53.65	53.21
Texture class	clay	clay
pH (in soil paste extract)	8.0	8.1
EC dSm -1 (in soil paste extract)	1.31	1. 35
Organic matter g kg $^{-1}$	13.5	12.0
Soulble cations m mole L^{-1}		
Ca^{2+}	4.71	4.85
Mg^{2+}	4.38	4.49
Na^{+}	2.11	2.29
K^{+}	1.80	1.85
Soulble anions m mole L^{-1}		
$CO3_2^{-}$	--	--
HCO_3^{-}	1.61	1.75
CI-	4.92	4.96
$SO4_2^{-}$	6.47	6.77
Available N mg kg $^{-1}$	25.3	27.1
Available P mg kg $^{-1}$	10.7	9.5
Available K mg kg $^{-1}$	170	182

Results and Discussion

Growth parameters.

Data presented in Tables 2, 3, 4 and 5 show the effect of applied nitrogen , phosphorus and potassium fertilization on maize growth at 60 days from planting namely, plant height , dry weight/plant, number of leaves / plant and leaf area. The results show that nitrogen treatments (N_1, N_2 and N_3) had significant effects on maize growth, except the number of leaves / plant. The highest values of the studied parameters were obtained under 120 kg N/ fed as soil application (N_1), whereas added 60 kg N/fed as soil application plus foliar spraying of 2% urea solution twice (N_3) exhibited the lowest ones. Furthermore, (N_1) statistically gave dry weight / plant equal to that obtained under 90 kg N/fed as soil application + tow time foliar spraying of 2% urea solution (N_2). The increase in maize growth due to increasing the N level up to 120 kg/ fed is mainly due to the vital role of nitrogen in plant growth , as it is necessary for protoplasm formation and photosynthesis in all plant, it is also necessary for cell devition and merestimatic activity in organs . These results are similar to those obtained by ***Sarhan (2006)*** and ***Sadik et al (2009)*** who stated that maize plants was increased as nitrogen fertilization increased.

As for phosphorus or potassium treatments the obtained results reveal that plant height, dry weight/plant and leaf area were positively responded to the added P_1 (13.6 kg P /fed as soil application) or P_2 (6.8 kg P/fed as soil application + tow time foliar spraying of 0.33% P) as well as K_1 (39.9 kg K/fed as soil application) or (19.9 kg K/fed as soil application + tow time foliar spraying of 2% potassium sulphate solution). Whereas the, number of leaves / plant did not respond to phosphorus or potassium treatments. The beneficial of mixing soil application with foliar spraying is mainly due to the fact that foliar spraying method provide rapid nutrient utilization and enables quick correction of nutrient difficiencies, However, the response fo foliar fertilization is often temporary

due to minute amount of applied nutrient (***Halvin et al, 2005***). The obtained results are in agreement with those obtained by . While, the positive effect of increasing potassium levels (K_1) is mainly due to potassium is an essential macronutrient, it plays essential roles in enzyme activation , protein photosynthesis, osmo regulation, stomata movement , energy transfer , phloem transport , cation – anion balance , and stress resistance (***Mingle and kiry,1987***) . These results agree with those obtained by ***Sidrak (2007)*** who stated that growth parameter of maize was significantly affected by increasing potassium rates.

On the other hand, N_3 (60 kg/ fed as soil application + foliar spraying of 2% urea solution twice), P_3 (foliar spraying of 0.33% P twice) or K_3 (tow time foliar spraying of 2% potassium solution) treatment yield gave the lowest values of plant height, dry weight / plant and leaf area of maize plant as compared with N_1,N_2 + sp , P_1,P_2+^{S}P and K_1,K_2 +^{S}P , respectively

The interaction between treatments indicate that the treatment of N_1+P_1 o + K_1 gave the highest plant height, leaf area and dry weight of maize plant the other hand, the treatment of N_3 + P_3 + K_3 gave the lowest values of the abovementioned growth parameters.

Table 2 . Effect of soil and foliar application of different N,P and K levels on plant height of 60 days from planting (cm)

Nitrogen	Phosphorus	Potassium							
		First season				second season			
		K_1	K_2	K_3	Mean	K_1	K_2	K_3	Mean
N_1	P_1	185.22	184.04	176.30	181.85	183.19	181.35	178.50	181.01
	P_2	183.40	183.10	175.80	180.77	180.94	180.09	177.30	179.44
	P_3	177.50	176.80	173.20	175.83	177.90	177.30	173.50	176.23
Mean		182.04	181.31	175.10	179.15	180.68	179.58	176.43	178.89
N_2	P_1	180.11	179.33	175.60	178.35	179.00	178.60	175.5	177.7
	P_2	179.22	178.60	175.30	177.71	178.30	177.90	175.00	177.07
	P_3	175.20	174.80	171.40	173.80	174.82	175.30	172.91	174.34
Mean		178.18	177.58	174.10	176.62	177.37	177.27	174.47	176.37
N_3	P_1	174.11	173.90	167.30	171.77	173.55	172.10	168.46	171.37
	P_2	173.80	173.30	166.50	171.20	171.41	171.09	167.79	170.10
	P_3	168.30	167.5	163.22	166.34	168.46	167.79	165.11	167.12
Mean		172.07	171.57	165.67	169.77	171.14	170.33	167.12	169.53
Mean of P	P_1	179.81	179.09	173.07	177.32	178.58	177.35	174.15	176.69
	P_2	178.81	178.33	172.53	176.56	176.88	176.36	173.36	175.53
	P_3	173.67	173.03	169.27	171.99	173.73	173.96	170.51	172.56
Mean of K		177.43	176.82	171.62	175.29	176.40	175.72	172.63	174.93
L.S.D. at 0,05		A=1.72 B= 1.73 C =1.13 AB=N.S. AC= N.S. BC=N.S. ABC= N.S.				A=1.55 B =1.64 C = 1.17 AB= N.S. AC= N.S. BC= N.S. ABC= N.S.			

N_1 = 120 kg N/ fed as soil application
N_2 = 90 kg N/ fed as soil application + two time foliar spraying of 2% urea
N_3 = 60 kg N/ fed as soil application + two time foliar spraying of 2% urea
P_1 = 13.6 kg P/fed as soil application
P_2 = 6.8 kg P/fed as soil application + two time foliar spraying of 0.33% P
P_3 = tow time foliar spraying of 0.33% P
K_1= 39.9 kg K /fed as soil application
K_2=19.9 kg K /fed as soil application+ two time foliar spraying of 2% potassium sulphate
K_3 = two time foliar spraying of 2% potassium sulphate

Table 3. Effect of soil and foliar application of different N,P and K levels on dry weight of 60 days from planting (g/ plant)

Nitrogen	Phosphorus	Potassium							
		First season				second season			
		K_1	K_2	K_3	Mean	K_1	K_2	K_3	Mean
N_1	P_1	92.10	91.50	88.05	90.55	91.25	90.80	87.40	89.82
	P_2	91.50	90.60	87.80	89.96	89.75	89.50	86.10	88.45
	P_3	86.70	86.50	83.30	85.50	87.00	85.30	83.50	85.27
Mean		90.10	89.53	86.38	88.67	89.33	88.53	85.67	87.85
N_2	P_1	90.10	89.40	82.90	87.47	89.56	86.15	83.76	86.49
	P_2	89.80	89.50	82.00	87.10	88.44	85.76	82.35	85.52
	P_3	83.10	83.00	76.77	81.62	82.65	81.12	77.37	80.38
Mean		87.67	87.30	80.56	85.40	86.88	84.34	81.16	84.13
N_3	P_1	75.90	75.50	70.33	73.91	78.27	77.00	75.10	76.79
	P_2	75.15	75.10	70.10	73.45	77.25	75.25	73.50	75.33
	P_3	71.22	71.00	69.20	70.47	73.10	73.05	70.30	72.15
Mean		74.09	73.87	69.88	72.61	76.21	75.10	72.97	74.76
Mean of P	P_1	86.03	85.47	80.43	83.98	86.36	84.65	82.09	84.37
	P_2	85.48	85.07	79.97	83.51	85.15	83.50	80.65	83.10
	P_3	80.34	80.17	76.42	78.98	80.92	79.82	77.06	79.27
Mean of K		83.95	83.57	78.94	82.15	84.14	82.66	79.93	82.24
L.S.D. at 0,05		A=3.95 B =2.01 C =1.03 AB= NS AC = NS BC= NS ABC= NS				A=3.83 B =1.73 C =1.79 AB= NS AC = NS BC= NS ABC= NS			

N_1 = 120 kg N/ fed as soil application
N_2 = 90 kg N/ fed as soil application + two time foliar spraying of 2% urea
N_3 = 60 kg N/ fed as soil application + two time foliar spraying of 2% urea
P_1 = 13.6 kg P/fed as soil application
P_2 = 6.8 kg P/fed as soil application + two time foliar spraying of 0.33% P
P_3 = tow time foliar spraying of 0.33% P
K_1= 39.9 kg K /fed as soil application
K_2=19.9 kg K /fed as soil application+ two time foliar spraying of 2% potassium sulphate
K_3 = two time foliar spraying of 2% potassium sulphate

Table 4. Effect of soil and foliar application of different N,P and K levels on number of leaves/ plant at of 60 days from plantin

Nitrogen	Phosphorus	Potassium							
		First season				second season			
		K_1	K_2	K_3	Mean	K_1	K_2	K_3	Mean
N_1	P_1	13.13	13.09	12.90	13.04	13.09	13.02	12.20	12.77
	P_2	13.10	13.05	12.80	12.98	13.04	13.01	12.10	12.72
	P_3	12.80	12.65	12.20	12.55	12.71	12.68	12.00	12.46
Mean		13.01	12.93	12.63	12.86	12.95	12.90	12.10	12.65
N_2	P_1	13.10	13.08	12.72	12.97	13.01	12.97	12.15	12.69
	P_2	13.03	13.00	12.70	12.91	12.97	12.95	12.09	12.67
	P_3	12.64	12.60	12.40	12.55	12.72	12.70	12.00	12.47
Mean		12.92	12.89	12.61	12.81	12.90	12.87	12.08	12.61
N_3	P_1	12.60	12.60	12.34	12.51	12.70	12.69	12.10	12.50
	P_2	12.54	12.50	12.30	12.45	12.66	12.56	12.00	12.41
	P_3	12.10	12.10	11.80	12.00	12.52	12.53	11.70	12.25
Mean		12.41	12.40	12.15	12.32	12.63	12.59	11.93	12.39
Mean of P	P_1	12.94	12.92	12.65	12.84	12.93	12.89	12.15	12.66
	P_2	12.89	12.85	12.60	12.78	12.89	12.84	12.06	12.60
	P_3	12.51	12.45	12.13	12.36	12.65	12.64	11.90	12.40
Mean of K		12.78	12.74	12.46	12.66	12.82	12.79	12.04	12.55
L.S.D. at 0,05		A=NS B =NS C=NS AB=NS AC=NS BC=NS ABC= NS				A=NS B =NS C=NS AB=NS AC=NS BC=NS ABC= NS			

N_1 = 120 kg N/ fed as soil application

N_2 = 90 kg N/ fed as soil application + two time foliar spraying of 2% urea
N_3 = 60 kg N/ fed as soil application + two time foliar spraying of 2% urea
P_1 = 13.6 kg P/fed as soil application
P_2 = 6.8 kg P/fed as soil application + two time foliar spraying of 0.33% P
P_3 = tow time foliar spraying of 0.33% P
K_1= 39.9 kg K /fed as soil application
K_2=19.9 kg K /fed as soil application+ two time foliar spraying of 2% potassium sulphate
K_3 = two time foliar spraying of 2% potassium sulphate

Table 5. Effect of soil and foliar application of different N,P and K levels on leaf area of 60 days from planting (cm^2)

Nitrogen	Phosphorus	Potassium							
		First season				second season			
		K_1	K_2	K_3	Mean	K_1	K_2	K_3	Mean
N_1	P_1	680.11	680.00	633.60	664.57	697.85	688.85	648.90	678.53
	P_2	670.20	671.11	630.50	657.27	680.34	680.00	647.07	667.47
	P_3	640.30	636.12	600.22	625.55	658.65	632.02	607.89	632.85
Mean		663.47	662.41	621.44	649.13	669.96	666.96	632.95	659.62
N_2	P_1	651.22	650.30	600.11	633.88	634.40	630.20	604.67	623.09
	P_2	648.00	645.70	595.20	629.63	620.70	613.13	601.25	611.69
	P_3	601.50	599.08	560.50	587.03	595.55	576.62	576.62	582.93
Mean		633.57	631,69	585.27	616.85	616.88	606.65	594.18	605.90
N_3	P_1	540.11	536.02	500.30	525.48	538.90	534.10	511.40	526.47
	P_2	531.40	530.90	500.00	520.77	526.74	525.65	500.20	517.53
	P_3	453.11	450.20	430.20	444.50	480.11	470.20	425.40	458.57
Mean		508.21	505.71	476.83	496.92	513.58	510.32	479.00	500.86
Mean of P	P_1	623.81	622.11	578.00	607.98	622.05	617.72	588.32	609.36
	P_2	616.53	615.90	575.23	602.56	609.26	606.59	581.17	599.01
	P_3	564.97	561.80	530.31	552.36	578.10	559.61	536.64	558.12
Mean of K		601.77	599.94	561.18	587.63	603.14	594.64	568.71	588.83
L.S.D. at 0,05		A=11.53 B =9.16 C =8.6 AB=NS AC=NS BC=NS ABC=NS				A=12.07 B =12.03 C =10.76 AB=NS AC=NS BC=NS ABC=NS			

N_1 = 120 kg N/ fed as soil application
N_2 = 90 kg N/ fed as soil application + two time foliar spraying of 2% urea
N_3 = 60 kg N/ fed as soil application + two time foliar spraying of 2% urea
P_1 = 13.6 kg P/fed as soil application
P_2 = 6.8 kg P/fed as soil application + two time foliar spraying of 0.33% P
P_3 = tow time foliar spraying of 0.33% P
K_1= 39.9 kg K /fed as soil application
K_2=19.9 kg K /fed as soil application+ two time foliar spraying of 2% potassium sulphate
K_3 = two time foliar spraying of 2% potassium sulphate

Yield components

The present results in Tables 6, 7 and 8 indicate that the studied yield components of maize , namely , number of rows/ ear , number of grains / ear and 100 – grain yield were affected by nitrogen phosphorus and potassium treatments. Statistically, N_1, P_1 and K_1treatments gave highest number of rows/ear (12.87, 12.84 and 12.85), number of grains/ear (46.11, 45.45 and 45.44) and 100- grain weight (29.67, 29.48 and 29.41), equal to those obtained under N_1 (12.81, 45.44 and 29.36), P_2 (12.81, 45.17 and 29.22) and K_2 (12.82, 45.25 and 29.14) respectively in the first season . The same trend was obtained in the second season. Such improvement in yield components is mainly due to the effects of the applied the nutrient on maize growth as Soil application and foliar spray to gather. These results are in line with those obtained by ***Salwau and Shams El- Din (1992)*** and ***Gebraiel et al (2005)*** for nitrogen; ***El- Azab (2015)*** and ***Gul et al (2015)*** for phosphorus and ***Mqsood et al (2013)*** for potassium treatments.

Concerning the effect of the interaction between treatment on maize yield components , in general the data reveal that the highest number of rows/ ear , number of grains/ ear and 100 – grain weight were obtained dromr maize plants treated with N_1 or N_2 + P_1 or P_2 + K_1 or K_2 treatment . On the other hand the plants supplied with N_3 + P_3 + K_3 treatment yielded the lowest maize yield components. As compared with other two previous treatments.

Table 6. Effect of soil and foliar application of different N,P and K levels on number of rows / ear

Nitrogen	Phosphorus	Potassium							
		First season				second season			
		K_1	K_2	K_3	Mean	K_1	K_2	K_3	Mean
N_1	P_1	13.00	12.95	12.81	12.92	13.05	13.00	12.88	12.98
	P_2	12.91	12.90	12.81	12.87	12.90	12.90	12.85	12.88
	P_3	12.87	12.83	12.79	12.83	12.80	12.85	12.80	12.82
Mean		12.92	12.89	12.80	12.87	12.92	12.92	12.84	12.89
N_2	P_1	12.92	12.90	12.76	12.86	12.95	12.90	12.80	12.88
	P_2	12.92	12.85	12.75	12.84	12.91	12.86	12.80	12.86
	P_3	12.76	12.72	12.70	12.73	12.83	12.80	12.75	12.79
Mean		12.87	12.82	12.74	12.81	12.90	12.85	12.78	12.84
N_3	P_1	12.81	12.78	12.66	12.75	12.80	12.80	12.70	12.77
	P_2	12.76	12.73	12.66	12.72	12.80	12.75	12.66	12.73
	P_3	12.71	12.68	12.51	12.63	12.70	12.63	12.50	12.61
Mean		12.76	12.73	12.61	12.70	12.76	12.73	12.62	12.70
Mean of P	P_1	12.91	12.88	12.74	12.84	12.93	12.90	12.79	12.88
	P_2	12.86	12.83	12.74	12.81	12.86	12.84	12.77	12.82
	P_3	12.78	12.74	12.67	12.73	12.78	12.76	12.68	12.74
Mean of K		12.85	12.82	12.72	12.79	12.86	12.83	12.75	12.81
L.S.D. at 0,05		A=0.08 B =0.09 C =0.07 AB=NS AC=NS BC=NS ABC=NS				A=0.07 B = 0.09 C =0.06 AB=NS AC=NS BC=NS ABC=NS			

N_1 = 120 kg N/ fed as soil application
N_2 = 90 kg N/ fed as soil application + two time foliar spraying of 2% urea
N_3 = 60 kg N/ fed as soil application + two time foliar spraying of 2% urea
P_1 = 13.6 kg P/fed as soil application
P_2 = 6.8 kg P/fed as soil application + two time foliar spraying of 0.33% P
P_3 = tow time foliar spraying of 0.33% P
K_1= 39.9 kg K /fed as soil application
K_2=19.9 kg K /fed as soil application+ two time foliar spraying of 2% potassium sulphate
K_3 = two time foliar spraying of 2% potassium sulphate

Table 7. Effect of soil and foliar application of different N,P and K levels on number of grains / row

Nitrogen	Phosphorus	Potassium							
		First season				second season			
		K_1	K_2	K_3	Mean	K_1	K_2	K_3	Mean
N_1	P_1	46.80	46.65	45.75	46.40	46.91	46.80	45.80	46.51
	P_2	46.70	46.53	45.60	46.28	46.85	46.73	45.69	46.42
	P_3	45.80	45.60	45.55	45.65	46.39	46.30	45.50	46.06
Mean		46.43	46.26	45.63	46.11	45.72	46.61	45.67	46.33
N_2	P_1	46.11	45.90	45.20	45.74	46.09	45.87	45.30	45.75
	P_2	45.80	45.71	45.10	45.54	45.79	45.73	45.20	45.57
	P_3	45.30	45.11	44.70	45.04	45.69	45.32	44.55	45.19
Mean		45.75	45.57	45.00	45.44	45.86	45.64	45.02	45.51
N_3	P_1	44.55	44.30	43.80	44.22	44.66	43.69	42.51	43.62
	P_2	44.10	43.90	43.05	43.68	43.52	43.35	41.64	42.84
	P_3	43.80	43.50	42.80	43.37	43.05	42.92	41.45	42.47
Mean		44.15	43.90	43.22	43.76	43.75	43.32	41.87	42.98
Mean of P	P_1	45.82	45.62	44.92	45.45	45.89	45.45	44.54	45.29
	P_2	44.53	45.38	44.58	45.17	45.39	45.27	44.18	44.94
	P_3	44.97	44.74	44.35	44.69	45.04	44.85	43.83	44.57
Mean of K		45.44	45.25	44.62	45.10	45.44	45.19	44.18	44.92
L.S.D. at 0,05		A=0.93 B= 0.63 C=o.43 AB=NS AC=NS BC=NS ABC=NS				A=0.97 B= 0.61 C=o.56 AB=NS AC =NS BC=NS ABC=NS			

N_1 = 120 kg N/ fed as soil application
N_2 = 90 kg N/ fed as soil application + two time foliar spraying of 2% urea
N_3 = 60 kg N/ fed as soil application + two time foliar spraying of 2% urea

P_1 = 13.6 kg P/fed as soil application
P_2 = 6.8 kg P/fed as soil application + two time foliar spraying of 0.33% P
P_3 = tow time foliar spraying of 0.33% P
K_1= 39.9 kg K /fed as soil application
K_2=19.9 kg K /fed as soil application+ two time foliar spraying of 2% potassium sulphate
K_3 = two time foliar spraying of 2% potassium sulphate

Table 8. Effect of soil and foliar application of different N,P and K levels on 100 – grain weight (g)

Nitrogen	Phosphorus	Potassium							
		First season				second season			
		K_1	K_2	K_3	Mean	K_1	K_2	K_3	Mean
N_1	P_1	30.40	30.10	29.80	30.10	30.90	30.76	30.60	30.75
	P_2	30.10	29.80	29.50	29.80	30.77	30.69	30.30	30.59
	P_3	29.40	29.10	28.80	29.10	30.56	30.37	30.05	30.33
Mean		29.97	29.67	29.37	29.67	30.74	30.61	30.32	30.56
N_2	P_1	30.15	30.00	29.30	29.82	30.37	29.75	29.11	29.74
	P_2	29.90	29.70	29.10	29.57	29.90	29.60	28.80	29.43
	P_3	29.10	28.80	28.20	28.70	29.10	28.90	28.60	28.87
Mean		29.72	29.50	28.87	29.36	29.79	29.42	28.84	29.35
N_3	P_1	28.90	28.60	28.05	28.52	29.05	28.85	28.69	28.86
	P_2	28.70	28.50	27.70	28.30	28.77	28.50	27.90	28.39
	P_3	28.00	27.70	27.05	27.58	28.10	27.80	26.61	27.50
Mean		28.53	28.27	27.60	28.13	28.64	28.38	27.73	28.25
Mean of P	P_1	29.82	29.57	29.05	29.48	30.11	29.79	29.47	29.79
	P_2	29.57	29.33	28.77	29.22	29.81	29.60	29.00	29.47
	P_3	28.85	28.53	28.02	28.46	29.25	29.02	28.85	29.04
Mean of K		29.41	29.14	28.61	29.05	29.72	29.49	29.11	29.43
L.S.D. at 0,05		A= 0.31 B= 0.30 C=0.29 AB= NS AC = NS BC= NS ABC= NS				A=0.39 B=0.33 C=0.28 AB= NS AC = NS BC= NS ABC= NS			

N_1 = 120 kg N/ fed as soil application
N_2 = 90 kg N/ fed as soil application + two time foliar spraying of 2% urea
N_3 = 60 kg N/ fed as soil application + two time foliar spraying of 2% urea
P_1 = 13.6 kg P/fed as soil application
P_2 = 6.8 kg P/fed as soil application + two time foliar spraying of 0.33% P
P_3 = tow time foliar spraying of 0.33% P
K_1= 39.9 kg K /fed as soil application
K_2=19.9 kg K /fed as soil application+ two time foliar spraying of 2% potassium sulphate
K_3 = two time foliar spraying of 2% potassium sulphate

Yield

The data listed in Table 9, 10 and 11 represent the response of maize yields , i.e., grains, stover and biological yields to the NPK fertilization . It is evident from the data that maize yields were significantly responded to nitrogen, phosphorus and potassium fertilization in both seasons. The highest maize yields was recorded for the plants fertilized with N_1 + P_1 + K_1. On the other hand N_3 + P_3 + K_3 treatments produced the lowest maize yield. The relative increasing in grain yield due to N_1 and N_2, P_1 or P_2 and K_1 or K_2 was 40.3 or 40.2; 30.0 or 29.9; and 23.4 or 23.3 % over N_3 treatment in the first season, respectively. The corresponding increase in the second season was 35.4 or 33.7; 26.3 or 24.6 % and 19.6 or 18.9 % in the abovementioned order. Similer trends were obtained for stover and biological yields. These results could be explained by effects of these treatments on growth and yield components of maize as mentioned before. These results are similar to those obtained by ***Allam et al (2001)*** and ***Ismail et al (2006)***.

Regarding the interaction between treatments or among them, the results clearly reveal that grains, stover and biological yields were not significantly affected by these interaction. This means that the highest values of grains and stover yields were exhibited under N_1 + P_1 + K_1 in both seasons except for grain yield in the first season, where the treatment of N1+P2+K1 gave the highest value . On the other hand, N_3 + P_3 + K_3 treatment recorded the lowest values of grains, stover and biological yields.

Net income

Data in Table 12 represent the response of maize grain net income to NPK fertilization. The data indicate that N_2, P_1 or P_2 as well as K_1 or K_2 gave the highest net income of maize grains, while N_3, P_3 or K_3 recorded the lowest net income in the first seasons and second seasons. The value of net income resulted from N_2, P_1 or P_2 and K_1 or K_2 exceeded that obtained from N_3, P_3 or K_3 by about 2154.86, 1356.33 or 1433.9 and 878.57 or 1195.66 L.E in the first season, respectively. The corresponding values for the second

season was 1729.86, 1408.09 or 1398.23 and 723.89 or 835.03 in abovementioned order.

Concerning the effect of the interaction between treatments, the results show that the maize plants fertilized $N_2 + P_2 + K_2$ treatment recorded the highest net income of maize grains, whereas the lowest net income were produced for plants fertilized with $N_3 + P_3 + K_1$ in the first season and $N_2+P_3+K_3$ in second seasons

Table 9. Effect of soil and foliar application of different N,P and K levels on grain yield (Mg/h $^{-1}$)

Nitrogen	Phosphorus	Potassium							
		First season				second season			
		K_1	K_2	K_3	Mean	K_1	K_2	K_3	Mean
N_1	P_1	7.217	7.190	5.719	6.709	7.340	7.267	6.100	6.902
	P_2	7.233	7.231	5.686	6.717	7.300	7.200	5.933	6.811
	P_3	5.381	5.407	4.640	5.143	5.683	5.664	5.017	5.455
Mean		6.610	6.610	5.348	6.189	6.774	6.710	5.683	6.389
N_2	P_1	7.183	7.202	5.736	6.707	7.133	7.110	6.000	6.748
	P_2	7.219	7.198	5.686	6.701	7.167	7.083	5.833	6.694
	P_3	5.374	5.350	4.707	5.144	5.740	5.733	4.867	5.447
Mean		6.593	6.583	5.376	6.184	6.667	6.643	5.567	6.292
N_3	P_1	5.236	5.231	3.840	4.769	5.433	5.407	4.567	5.136
	P_2	5.219	5.200	3.857	4.759	5.417	5.400	4.267	5.028
	P_3	3.702	3.705	3.702	3.703	4.133	4.110	3.683	3.975
Mean		4.719	4.712	3.800	4.410	4.995	4.971	4.171	4.713
Mean of P	P_1	6.545	6.540	5.098	6.061	6.636	6.595	5.555	6.262
	P_2	6.557	6.543	5.076	6.059	6.629	6.562	5.345	6.179
	P_3	4.819	4.821	4.350	4.663	5.186	5.169	4.521	4.959
Mean of K		5.974	5.969	4.840	5.594	6.150	6.110	5.140	5.800
L.S.D. at 0,05		A= 0.16 B = 0.12 C =0.09 AB= NS AC = NS BC= NS ABC= NS				A= 0.19 B = 0.13 C =0.07 AB= NS AC = NS BC= NS ABC= NS			

N_1 = 120 kg N/ fed as soil application
N_2 = 90 kg N/ fed as soil application + two time foliar spraying of 2% urea
N_3 = 60 kg N/ fed as soil application + two time foliar spraying of 2% urea
P_1 = 13.6 kg P/fed as soil application
P_2 = 6.8 kg P/fed as soil application + two time foliar spraying of 0.33% P
P_3 = tow time foliar spraying of 0.33% P
K_1= 39.9 kg K /fed as soil application
K_2=19.9 kg K /fed as soil application+ two time foliar spraying of 2% potassium sulphate
K_3 = two time foliar spraying of 2% potassium sulphate

Table 10. Effect of soil and foliar application of different N,P and K levels on Stover yield (Mg/h $^{-1}$)

Nitrogen	Phosphorus	Potassium							
		First season				second season			
		K_1	K_2	K_3	Mean	K_1	K_2	K_3	Mean
	P_1	8.833	8.548	7.905	8.429	9.190	8.929	8.333	8.817
N_1	P_2	8.571	8.429	7.833	8.278	9.048	8.810	8.095	8.651
	P_3	8.333	8.119	7.476	7.976	8.762	8.286	7.405	8.151
Mean		8.571	8.357	7.738	8.222	9.000	8.667	7.952	8.540
	P_1	8.548	8.452	7.833	8.278	8.929	8.690	8.095	8.571
N_2	P_2	8.405	8.357	7.619	8.127	8.810	8.571	8.000	8.460
	P_3	7.952	7.857	7.262	7.690	8.333	8.286	7.786	8.135
Mean		8.286	8.214	7.571	8.024	8.690	8.524	7.952	8.389
	P_1	7.381	7.262	6.905	7.183	7.619	7.452	6.905	7.325
N_3	P_2	7.143	7.000	6.690	6.944	7.381	7.262	6.190	6.944
	P_3	6.714	6.429	6.024	6.389	6.762	6.333	5.524	6.206
Mean		7.071	6.905	6.548	6.841	7.262	7.024	6.238	6.841
	P_1	8.262	8.095	7.548	7.968	8.571	8.357	7.786	8.238
Mean of P	P_2	8.048	7.929	7.381	7.786	8.405	8.214	7.429	8.016
	P_3	7.667	7.476	6.905	7.349	7.952	7.643	6.905	7.500
Mean of K		8.000	7.833	7.286	7.706	8.310	8.071	7.381	7.921
L.S.D. at 0,05		A=0.18 B =0.15 C = 0.16 AB= NS AC= NS BC=NS ABC=NS				A=0.37 B =0.18 C = 0.22 AB= NS AC= NS BC=NS ABC=NS			

N_1 = 120 kg N/ fed as soil application
N_2 = 90 kg N/ fed as soil application + two time foliar spraying of 2% urea
N_3 = 60 kg N/ fed as soil application + two time foliar spraying of 2% urea
P_1 = 13.6 kg P/fed as soil application
P_2 = 6.8 kg P/fed as soil application + two time foliar spraying of 0.33% P
P_3 = tow time foliar spraying of 0.33% P
K_1= 39.9 kg K /fed as soil application
K_2=19.9 kg K /fed as soil application+ two time foliar spraying of 2% potassium sulphate
K_3 = two time foliar spraying of 2% potassium sulphate

Table 11. Effect of soil and foliar application of different N,P and K levels on biological yield (Mg/h $^{-1}$)

Nitrogen	Phosphorus	Potassium							
		First season				second season			
		K_1	K_2	K_3	Mean	K_1	K_2	K_3	Mean
	P_1	16.050	15.738	13.624	15.137	16.531	16.195	14.433	15.720
N_1	P_2	15.805	15.660	13.519	14.994	16.348	16.010	14.029	15.462
	P_3	13.714	13.526	12.117	13.119	14.445	13.950	12.421	13.606
Mean		15.190	14.974	13.086	14.417	15.774	15.386	13.629	14.929
	P_1	15.731	15.655	13.569	14.985	16.062	15.800	14.095	15.319
N_2	P_2	15.624	15.555	13.305	14.828	15.976	15.655	13.833	15.155
	P_3	13.326	13.207	11.969	12.834	14.074	14.019	12.652	13.582
Mean		14.893	14.805	12.948	14.215	15.371	15.157	13.526	14.685
	P_1	12.617	12.493	10.745	11.952	13.052	12.860	11.471	12.461
N_3	P_2	12.362	12.200	10.333	11.632	12.798	12.662	10.290	11.917
	P_3	10.417	10.133	9.726	10.092	10.895	10.443	9.207	10.182
Mean		11.798	11.610	10.340	11.249	12.248	11.988	10.379	11.538
	P_1	14.800	14.629	12.645	14.025	15.214	14.952	13.333	14.500
Mean of P	P_2	14.598	14.471	12.457	13.842	15.040	14.776	12.774	14.197
	P_3	12.486	12.288	11.271	12.015	13.138	12.805	11.426	12.456
Mean of K		13.962	13.795	12.124	13.294	14.464	14.179	12.512	13.718
L.S.D. at 0,05		A= 0.19 B= 0.24 C=0.21 AB= NS AC= NS BC= NS ABC= NS				A= 0.25 B= 0.30 C=0.24 AB= NS AC= NS BC= NS ABC= NS			

N_1 = 120 kg N/ fed as soil application
N_2 = 90 kg N/ fed as soil application + two time foliar spraying of 2% urea
N_3 = 60 kg N/ fed as soil application + two time foliar spraying of 2% urea

P_1 = 13.6 kg P/fed as soil application
P_2 = 6.8 kg P/fed as soil application + two time foliar spraying of 0.33% P
P_3 = tow time foliar spraying of 0.33% P
K_1= 39.9 kg K /fed as soil application
K_2=19.9 kg K /fed as soil application+ two time foliar spraying of 2% potassium sulphate
K_3 = two time foliar spraying of 2% potassium sulphate

Table 12. Effect of soil and foliar application of different N,P and K levels on net income (L.E/ h^{-1})

Nitrogen	Phosphorus	Potassium							
		First season				second season			
		K_1	K_2	K_3	Mean	K_1	K_2	K_3	Mean
N_1	P_1	16952	17262	13765	15993	17325	17493	14907	16575
	P_2	17233	17615	13894	16247	17431	17520	14630	16527
	P_3	12000	12469	11085	11851	12908	13240	12215	12787
Mean		15395	15782	12915	14697	15888	16084	13917	15296
N_2	P_1	17400	17848	14359	16536	17245	17567	15153	16655
	P_2	17736	18062	14443	16747	17580	17719	14882	16727
	P_3	12529	16545	11833	13636	13628	13995	12310	13311
Mean		15888	17485	13545	15639	16151	16427	14115	15564
N_3	P_1	12190	12563	9309	11354	12781	13090	11485	12452
	P_2	12366	12442	9586	11465	12961	13299	10815	12358
	P_3	8140	8539	9445	8708	9437	9754	9388	9526
Mean		10899	11180	9447	10509	11726	12048	10563	11446
Mean of P	P_1	15514	15891	12478	14627	15784	16050	13848	15227
	P_2	15779	16039	12641	14820	15990	16179	13442	15204
	P_3	10890	12517	10788	11398	11991	12330	11304	11875
Mean of K		14061	14816	11969	13615	14588	14853	12865	14102
L.S.D. at 0,05		A=65.02 B= 104.25 C =49.75 AB=NS AC=NS BC= NS ABC= NS				A= 75.19 B=60.19 C=55.96 AB=NS AC=NS BC= NS ABC= NS			

N_1 = 120 kg N/ fed as soil application
N_2 = 90 kg N/ fed as soil application + two time foliar spraying of 2% urea
N_3 = 60 kg N/ fed as soil application + two time foliar spraying of 2% urea
P_1 = 13.6 kg P/fed as soil application
P_2 = 6.8 kg P/fed as soil application + two time foliar spraying of 0.33% P
P_3 = tow time foliar spraying of 0.33% P
K_1= 39.9 kg K /fed as soil application
K_2=19.9 kg K /fed as soil application+ two time foliar spraying of 2% potassium sulphate
K_3 = two time foliar spraying of 2% potassium sulphate

Nutrient uptake

The effect of methods and levels of NPK fertilization on total N, P and K uptake (in both grain and stover) were listed in Tables 13,14 and 15. The data reveal that total nitrogen uptake were significantly affected by nitrogen , phosphorus and potassium treatments , where N_2 , P_1 or P_2 as well as K_1 or K_2 treatments exhibited the highest nitrogen uptake in both season . On the other hand N_3, P_3 or K_3 treatments recorded the lowest nitrogen uptake. The combinations between treatments show that the highest total nitrogen uptake was durned under N_2 + P_1 or P_2 + K_1 or K_2 treatment. On the other hand, N_3 + P_3 + K_3 treatment recorded the lowest total nitrogen uptake in both seasons.

As for total phosphorus uptake, the results indicate that N_1 or N_2, P_2 as well as K_1 or K_2 treatments gave the highest phosphorus uptake, whereas, N_3, P_3 or k_3 treatments exhibited the lowest total phosphorus uptake in both season. The interaction between treatments reveal that N_1 or N_2 +P_2 + K_1 or K_2 treatment resulted in the highest total phosphorus uptake, whereas, the lowest total phosphorus uptake was recoded under the treatment of N_3 + P_3 + K_3 in both seasons.

Concerning potassium uptake, the data show that total potassium uptake was significantly responded to N, P and K treatments, where the highest total potassium uptake were recorded under N_1 or N_2 , P_1 or P_2 , K_1 or K_2 treatments , while N_3 , P_3 or K_3 yielded the lowest total potassium uptake in both seasons. The interaction between the treatments revael that the highest potassium uptake was obtained due to N1 or N_2 + P_1 or P_2 + K_1 or K_2 treatment , while the treatment of N_3 + P_3 + K_3 treatment gave the lowest potassium uptake . The superiority of N_2, P_1 or P_2 and K_1 or K_2 treatment on total nitrogen, phosphorus and potassium uptake over the other treatments is mainly due to its effect on both grains and stover yields as discussed before (Tables 7 and 8). In this concern, **Halvin et al (2005)** mentioned that foliar fertilizer is a form of liquid fertilizer through the foliage plants. This

method tends to provide for rapid nutrient utilization. However, the response to foliar fertilizer only is often temporary due to minute amount applied nutrient, therefore combined foliar spraying with soil application gave the highest nutrient uptake.

Table 13. Effect of soil and foliar application of different N,P and K levels on total nitrogen uptake (kg/ h^{-1})

Nitrogen	Phosphorus	Potassium							
		First season				second season			
		K_1	K_2	K_3	Mean	K_1	K_2	K_3	Mean
N_1	P_1	196.90	191.81	166.31	185.01	202.76	200.45	177.12	193.44
	P_2	193.38	193.48	164.86	183.90	200.62	196.60	171.95	189.72
	P_3	166.76	162.86	161.64	163.75	176.00	168.36	150.43	164.93
Mean		185.69	182.71	164.26	177.56	193.12	188.48	166.50	182.70
N_2	P_1	229.83	229.69	198.83	219.45	238.24	234.48	208.88	227.20
	P_2	230.17	229.07	193.81	217.68	237.02	230.88	203.45	223.79
	P_3	194.43	192.24	173.79	186.82	206.38	206.19	184.64	199.07
Mean		218.14	217.00	188.81	207.98	227.21	223.86	199.00	216.69
N_3	P_1	165.45	163.74	138.86	156.02	170.10	168.26	148.86	162.40
	P_2	162.29	159.76	136.79	152.94	166.76	165.29	136.55	156.20
	P_3	135.60	131.14	126.81	131.18	141.19	135.40	119.50	132.03
Mean		154.45	151.55	134.14	146.71	159.36	156.31	134.98	150.21
Mean of P	P_1	197.40	195.07	168.00	186.83	203.69	201.07	178.29	194.35
	P_2	195.29	194.10	165.14	184.84	201.48	197.60	170.64	189.90
	P_3	165.60	162.07	154.07	160.58	174.52	169.98	151.52	165.34
Mean of K		186.10	183.74	162.40	177.41	193.24	189.55	166.81	183.20
L.S.D. at 0,05		A=5.47 B=4.63 C=4.72 AB=NS AC = NS BC= NS ABC= NS				A= 5.68 B = 4.72 C =5.92 AB=NS AC = NS BC= NS ABC= NS			

N_1 = 120 kg N/ fed as soil application
N_2 = 90 kg N/ fed as soil application + two time foliar spraying of 2% urea
N_3 = 60 kg N/ fed as soil application + two time foliar spraying of 2% urea
P_1 = 13.6 kg P/fed as soil application
P_2 = 6.8 kg P/fed as soil application + two time foliar spraying of 0.33% P
P_3 = tow time foliar spraying of 0.33% P
K_1= 39.9 kg K /fed as soil application
K_2=19.9 kg K /fed as soil application+ two time foliar spraying of 2% potassium sulphate
K_3 = two time foliar spraying of 2% potassium sulphate

Table 14. Effect of soil and foliar application of different N,P and K levels on total phosphorus uptake (kg/ h^{-1})

Nitrogen	Phosphorus	Potassium							
		First season				second season			
		K_1	K_2	K_3	Mean	K_1	K_2	K_3	Mean
N_1	P_1	55.29	53.74	45.29	51.44	56.55	55.31	49.50	53.79
	P_2	68.33	69.26	60.81	66.13	72.55	72.02	61.79	68.79
	P_3	53.86	53.02	47.14	51.34	57.88	56.21	48.05	54.05
Mean		59.17	58.67	51.07	56.30	62.33	61.21	53.12	58.89
N_2	P_1	55.86	55.83	47.31	53.00	55.86	55.14	49.86	53.62
	P_2	69.24	68.12	58.50	65.29	70.98	71.24	62.07	68.10
	P_3	53.12	51.79	47.98	50.96	54.55	55.76	50.50	53.60
Mean		59.40	58.67	51.26	56.44	60.45	60.71	54.14	58.44
N_3	P_1	42.55	41.50	34.55	39.53	42.95	43.71	38.50	41.72
	P_2	53.90	53.62	44.64	50.72	56.17	56.38	45.76	52.77
	P_3	40.31	39.10	37.81	39.07	42.71	40.19	37.02	39.98
Mean		45.60	44.74	39.00	43.11	47.29	46.76	40.43	44.83
Mean of P	P_1	51.24	50.36	42.38	47.99	51.79	51.43	45.95	49.72
	P_2	70.98	63.67	64.31	66.32	66.57	66.55	56.55	63.22
	P_3	49.10	47.98	44.31	47.13	51.71	50.71	45.19	49.21
Mean of K		57.10	54.00	49.98	53.69	56.69	56.24	49.24	54.06
L.S.D. at 0,05		A=3.34 B = 3.79 C =1.71 AB=NS AC = NS BC= NS ABC= NS				A=3.96 B = 3.24 C =1.75 AB=NS AC = NS BC= NS ABC= NS			

N_1 = 120 kg N/ fed as soil application
N_2 = 90 kg N/ fed as soil application + two time foliar spraying of 2% urea
N_3 = 60 kg N/ fed as soil application + two time foliar spraying of 2% urea
P_1 = 13.6 kg P/fed as soil application
P_2 = 6.8 kg P/fed as soil application + two time foliar spraying of 0.33% P
P_3 = tow time foliar spraying of 0.33% P
K_1= 39.9 kg K /fed as soil application
K_2=19.9 kg K /fed as soil application+ two time foliar spraying of 2% potassium sulphate
K_3 = two time foliar spraying of 2% potassium sulphate

Table 15. Effect of soil and foliar application of different N,P and K levels on total potassium uptake (kg/ h^{-1})

Nitrogen	Phosphorus	Potassium							
		First season				second season			
		K_1	K_2	K_3	Mean	K_1	K_2	K_3	Mean
N_1	P_1	196.00	214.64	183.50	198.05	211.45	230.05	193.76	211.75
	P_2	193.33	214.02	180.83	196.06	207.26	226.64	189.71	207.87
	P_3	171.60	185.60	161.98	173.06	187.12	199.14	168.48	184.91
Mean		186.98	204.74	175.43	189.05	201.95	218.62	183.98	201.52
N_2	P_1	190.19	211.79	180.02	194.00	202.40	222.98	188.45	204.61
	P_2	188.52	211.12	176.83	192.16	201.67	221.60	185.19	202.82
	P_3	164.24	180.45	159.52	168.07	179.86	199.38	170.90	183.38
Mean		180.98	201.12	172.12	184.74	194.64	214.64	181.52	196.94
N_3	P_1	154.86	171.90	144.74	157.17	167.52	183.05	154.74	168.44
	P_2	153.10	166.88	141.45	153.81	163.81	180.45	141.21	161.83
	P_3	131.31	140.14	129.29	133.58	141.93	149.60	125.60	139.04
Mean		150.93	159.64	138.50	149.69	157.76	171.02	140.52	156.44
Mean of P	P_1	180.36	199.45	169.43	183.08	193.79	212.02	178.98	194.93
	P_2	178.31	197.33	166.38	180.67	190.90	209.57	172.05	190.84
	P_3	155.71	168.74	150.26	158.24	169.64	182.71	155.00	169.12
Mean of K		171.45	188.50	162.02	173.99	184.79	201.43	168.67	184.96
L.S.D. at 0,05		A=2.25 B =2.03 C =2.19 AB=NS AC = NS BC= NS ABC= NS				A=2.96 B =2.16 C =2.50 AB=NS AC = NS BC= NS ABC= NS			

N_1 = 120 kg N/ fed as soil application
N_2 = 90 kg N/ fed as soil application + two time foliar spraying of 2% urea
N_3 = 60 kg N/ fed as soil application + two time foliar spraying of 2% urea
P_1 = 13.6 kg P/fed as soil application
P_2 = 6.8 kg P/fed as soil application + two time foliar spraying of 0.33% P
P_3 = tow time foliar spraying of 0.33% P
K_1= 39.9 kg K /fed as soil application
K_2=19.9 kg K /fed as soil application+ two time foliar spraying of 2% potassium sulphate
K_3 = two time foliar spraying of 2% potassium sulphate

Conclusion

It could be concluded that mixed of N_2+P_2+K_2 90 kg N/fed as soil application with foliar spraying of 2% urea solution two time mixed 6.8 kg P /fed as soil application with foliar spraying of 0.33% two time + combined 19.9 kg K/ fed as soil application with foliar spraying of 2% potassium sulphate solution two time gave the highest net income of maize plant under the studied soil.

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تداعيات التسميد الارضى والورقي لعناصر النيتروجين والفوسفور والبوتاسيوم على محصول وصافى الدخل لنبات الذرة النامية على الاراضى الطينية الرسوبية

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*كلية الزراعة جامعة بنها ** مركز البحوث الزراعية

اجريت تجربتان حقليتان على محصول الذرة الشامية فى موسمي النمو ٢٠١٣ – ٢٠١٤ فى محطة البحوث الزراعية بسدس بمحافظة بنى سويف (مركز البحوث الزراعية) لدراسة تاثير اضافة مستويات مختلفة من عناصر النيتروجين والفوسفور والبوتاسيوم اما اضافة ارضية او رشا وتداخلاتهم ، على خصائص النمو (طول النبات ، وزن النبات الجاف ، عدد اوراق النبات ، مساحة الورقة) ومكونات المحصول (عدد الصفوف فى الكوز ، عدد الحبوب فى الصف ، وزن المائة حبة) والمحصول (محصول الحبوب ومحصول القش والمحصول البيولوجى) وعلى صافى دخل محصول الحبوب والامتصاص الكلى (فى الحبوب والقش) لعناصر النيتروجين والفوسفور والبوتاسيوم .

وكانت معاملات التجربة كما يلى :-

معاملات النيتروجين :

١٢٠.١كجم نيتروجين / فدان اضافة ارضية (ن١)

٩٠.٢ كجم نيتروجين/فدان اضافة ارضية + رش ٢% يوريا مرتين (ن٢)

٦٠.٣ كجم نيتروجين/فدان اضافة ارضية + رش ٢% يوريا مرتين (ن٣)

معاملات الفوسفور :

١ . ١٣.٦كجم فوسفور / فدان اضافة ارضية (فو١)

رش ٣٣. % فوسفور مرتين (فو٢) + ٢ . ٦.٨ كجم فوسفور / فدان اضافة ارضية

٣ . رش ٣٣. % فوسفور مرتين (فو٣)

معاملات البوتاسيوم :

١. ٣٩.٩ كجم بوتاسيوم / فدان اضافة ارضية (بو١)

٢. ١٩.٩ كجم بوتاسيوم / فدان اضافة ارضية + رش ٢% كبريتات بوتاسيوم مرتين (بو٢)

٣. رش ٢% كبريتات بوتاسيوم مرتين (بو٣)

ويمكن تلخيص اهم النائج كما يلى :-

ادت المعاملة (ن١) الى اعلى قيم لطول النبات ومساحة الورقة والوزن الجاف للنبات وعدد الصفوف فى الكوز ووزن المائة حبة ومن ناحية اخرى فان معاملتى ن١ و ن٢ ادات الى اعلى قيم الوزن الجاف للنبات وعدد الحبوب بالصف ومحصول الحبوب ومحصول القش والمحصول البيولوجى والامتصاص الكلى للفوسفور والبوتاسيوم ، بينما اعلى امتصاص للنيتروجين الكلى وصافى الدخل كان للمعاملة (ن٢) ، ولم يتاثر عدد اوراق النبات بمعاملات النيتروجين

– ادت معاملات فو١ او فو٢ او بو١ او بو٢ الى اعلى قيم طول النبات والوزن الجاف للنبات ومساحة الورقة وعدد الصفوف فى الكوز وعدد الحبوب فى الصف ووزن المائة حبة ومحصول الحبوب والقش والمحصول البيولوجى وصافى دخل الحبوب والامتصاص الكلى للنيتروجين . ومن ناحية اخرى فقد ادت معاملات فو٢ ، بو٢ الى اعلى قيم الامتصاص للفوسفور والبوتاسيوم على الترتيب بينما لم يتاثر عدد اوراق النبات بمعاملات الفوسفور والبوتاسيوم .

– ادت معاملات ن٣ ، فو٣،بو٣ الى اقل القيم من خصائص النمو والمحصول ومكوناتة وصافى الدخل وامتصاص العناصر .

– عموما فان معاملة ن١ او ن٢ + فو١ او فو٢ + بو١ او بو٢ ادت الى الحصول على اعلى قيم للصفات المدروسة .

وبناء على النتائج المتحصل عليها تحت ظروف مثل هذه الاراضى يمكن ان توصى الدراسة بتسميد نبات الذرة الشامية بمعدل ٩٠ كجم نيتروجين + رش ٢% محلول اليوريا مرتين + ٦.٨ كجم فوسفور/فدان اضافة ارضية + رش ٠.٣٣% فوسفور مرتين + ١٩.٩ كجم بوتاسيوم/ فدان + رش ٢% محلول كبريتات بوتاسيوم مرتين للحصول على اعلى محصول حبوب واعلى عائد اقتصادى .