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Fertilization management of wheat crop and rate of response to nitrogen fertilization

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ABSTRACT

Soil fertility depletion and soil quality decline have been threatening the ecological and economic sustainability of crop production. The use of high yielding varieties results in the depletion of soil nutrient content which should be considered in setting the crop fertilization strategy. In this concern, field experiment was carried out for two successive winter seasons (2013 & 2014) in the clay soil of Bahtim Research Station, Agriculture Research Center, to study the effectiveness of fertilization management on wheat productivity on old land. The results indicate that, nutrient deficiency is one of the major constraints facing wheat production. Deficiency of phosphorus supply led to the earliness of physiological maturity stage and heading date, moreover, an increase in the number of spikes existed in spite of the decrease in the number and weight of wheat grains. Also the highest values of grain yield, plant height, 1000-grain weight, number of spikes m^{-2} existed as a result of increasing nitrogen up to $100kgfed^{-1}$. Results indicate also that nitrogen uptake and the use efficiency of N, P and K were improved if combined with P and K applications. The utilization efficiency of 100 kg $Nfed^{-1}$ was higher than 50 and 75 kg $Nfed^{-1}$ levels. On the other hand the highest P and K release from fertilizers were obtained with PK treatment with increasing nitrogen levels. Statistically, positive significant correlations were found between availability of soil NO_3, NH_4, total N, P $mgkg^{-1}$ and EC (dSm^{-1}) values with grain yield, N and P content in wheat grains. The relation between available K in soil and grain K content is positive and significant.

Keywords: Fertilization, Management, wheat, , Nitrogen.

INTRODUCTION

Wheat is the one of the most important cereal crop used in human and animal feed in Egypt. Recently a great attention of several investigations has been directed to increase the productivity of wheat to minimize the gap between the Egyptian production and consumption by increasing the cultivated area and wheat yield per unit area (Zaki *et al* 2012). It provides almost 20 % of the food calories for people of the world. In Egypt, the 3.39 million feddans production about 9.2 million tons (Agric, Statistic Bulletin 2014). Production of wheat could be increased by planting high yielding varieties and application of the appropriate agro techniques.

Concerning the problems facing wheat production, soil fertility decline is the pressing issue in Africa (Vanlauwe *et al*., 2010). Low soil fertility is one of the major production constraints of Egyptian farmers. For optimum plant growth, nutrients must be available for plant in sufficient and balanced quantities. Amsal *et al.*, (2000) also reported that nutrient deficiency is one of the major constraints to wheat production, whereas the application of nitrogen and phosphorus significantly increased all crop parameters studied. Marschner (1995) in contrast to shoot growth, root growth is much less inhibited under P deficiency, leading to reduction in shoot-root dry weight ratio.

Nitrogen is the principal material required for plant growth and yield increase. Application of proper amount of nitrogen is considered to obtain reasonable crop of wheat. It is quite normal that increasing levels of applied N increased grain yield of wheat (Behera, *et al*., 2000). Tayebeh et al., (2011), indicate that the different N rates (120, 240 and 360 kgha^{-1}) have a significant effect on grain yield increment (46, 72 and 78% respectively) compared to control. Also spikes number m^{-2}, seeds number spike^{-1} and 1000 grain weight were significantly enhanced by increasing nitrogen levels where it reached (46, 72 and 78% respectively), Thus, the yield of wheat is a function of many factors, among them is the efficient fertilizer management which must combine rate, time, placement and source of application in a manner that optimizes crop yield and quality, while minimizing nutrient losses to the environment (Grant, *et al*., 1984).

Although phosphorus is required in lower amounts than other major nutrients, it is critical in the early stages of growth. Typical phosphorus contents of plants range between 0.1 to 0.46 percent P on a dry weight basis, approximately ten times less than for nitrogen or potassium. Phosphorus apparently stimulates young root development and the uptake of some nutrients and their transport within the plant as well as the synthesis (Brady and Weil, 2002). High phosphorus dose contributed in achieving the highest 1000 grain weight. These findings indicate that application of the high dose of phosphorus in combination with nitrogen, i.e. in 1:1 ratio contributed maximum to translocate dry matter and physiological attributes towards the yield attributes in wheat variety Kaleem *et al.* (2009).

Potassium is a macronutrient element which is required in high concentration for plant growth. It is estimated that potassium occupied a critical position for wheat requirements (Saifullah *et al*., 2002). Presence of potassium plays essential roles in various enzyme activation, photosynthetic, protein synthesis, osmoregulation, energy transfer, stomatal movement, cation-anion balance and stress resistance (Wang *et al*., 2013). Similar findings are also depicted by Kausar *et al*., (2012) that potassium is an essential nutrient where growth of plants increased by applying potassium fertilizer and there is more absorption of nitrogen contents by the use of fertilizer as investigated by (Tzortzakis, 2010 and Ashraf *et al*., 2013) in roots and shoots. Potassium application as K_2SO_4 increased nitrogen concentration to some extent (Gupta and Huang, 2014). These facts indicate that SO_4 plays an important role in the formation of some proteins which ultimately has positive effect on plant growth.

Invariably, many agricultural soils of the world are deficient in one or more of the essential nutrients needed to support healthy plants. Acidity, alkalinity, salinity, anthropogenic processes, nature of farming, and erosion can lead to soil degradation. Additions of fertilizers and/or amendments are essential for a proper nutrient supply and maximum yields (Baligar *et al*., 2001).

The study mainly aims to study the effect of fertilization management for wheat (*Triticum aestivum* L., var. Giza171) and the rate of response to nitrogen levels.

MATERIALS AND METHODS

A field experiment was carried out in clay soil at Bahtim Research Station, Agriculture Research Center, Kalubia Governorate, Egypt (Latitude 30° 8′ 31.316″ N and Longitude 31° 16′ 53.714″ E) for two successive winter seasons of 2013\2014 and 2014\2015 to study the effect of fertilization management for wheat (*Triticum aestivum* L., var. Giza171) and the rate of response to nitrogen levels. The current experiment was designed as a split plot design, with three replicates and an area of 3.5 × 3 m for each plot. The main treatments were fertilizers treatment (0, P, K and PK). Sub-treatments were nitrogen levels (0, 50, 75 and 100 Kg Nfed^{-1}). Seeding rate was 60 Kgfed^{-1}.

The main characteristics of the experimental soil were analyzed according to the methods described by Ryan *et al*., (1996), and the data are presented in Table 1.

Table 1: Soil characteristics of the experiment location in the two winter seasons 2013/2014 and 2014/2015.

Soil characteristics					
Particle size distribution	**2013/2014**	**2014/2015**	**Cations and anions in saturated extract (meq/100 g soil)**		
				2013/2014	**2014/2015**
Sand %	20	16	Ca^{++}	7.3	7.7
Silt %	25	34	Mg^{++}	4.6	6.7
Clay %	55	50	Na^{+}	7.0	6.5
Textural class	Clay	Clay	K^{+}	1.4	1.5
OM %	1.5	1.7	CO_3^{--}	-	-
CEC,meq/100g soil	59	63.5	HCO_3^{-}	3.2	3.6
pH (1:2.5)	7.7	7.6	CL^{-}	4.2	6.1
			$SO4^{-}$	12.9	12.7
EC,dSm^{-1}(1-5)	2.1	2.3			
Available macronutrient (mgkg^{-1} soil)					
N		P		K	
2013/14	2014/15	2013/14	2014/15	2013/14	2014/15
35.4	37.4	5.4	7.4	290	340

Phosphorus and potassium fertilizers were applied at 15 kg P_2O_5 fed^{-1} and 24 Kg K_2O fed^{-1} in the forms of super phosphate (15% P_2O_5) and potassium sulfate (48% K_2O), respectively, which were added during land preparation. While, nitrogen was applied as ammonium nitrate (33.5% N) at 0, 50, 75 and 100 Kg N fed^{-1}, where 20 % of the total dose was applied at sowing, 40 % before the first irrigation and 40 % before the second one.

The following data recorded were days to heading, days to maturity, plant height (cm), number of spikes m^{-2}, 1000-grain weight (g) and grain yield kgfed^{-1}. Representative samples of wheat yield were collected from bulk plot, weighed, oven dried at 70 C^{o}, ground and prepared for digestion using H_2SO_4 and H_2O_2 as described by Page et al., (1982). Then the digests were subjected to measure macronutrients (P and K) using the procedure described by Ryan *et al*., (1996). Total nitrogen was determined by wet oxidation using Kjeldahl digestion and distillation procedures, Parkinson and Allen (1975).

Soil samples were taken from each sub- treatment after harvesting, air dried, crushed and passed through a 2-mm sieve for estimating soil pH Thomas (1996), electrical conductivity (EC) Rhoades (1996) and available macronutrients (N, P and K) Page et al., (1982).

Some growth parameters were examined as follows:

1- Agronomic efficiency (AE): is defined as the economic production obtained per unit of nutrient applied. It can be calculated as follows:

$$AE\ (g\text{-}g^{-1}) = \frac{Gf - Gu}{Na} \qquad \textbf{(Fageria, } \textbf{\textit{et al}}\textbf{., 1996).}$$

Where *Gf* is the yield of the fertilized crop (kgfed^{-1}), *Gu* is the yield of the unfertilized crop (kgfed^{-1}) and *Na* is the quantity of nutrient applied (kgfed^{-1}).

2- Apparent recovery efficiency (ARc): is defined as the quantity of nutrient absorbed per unit of nutrient applied. It can be calculated as follows:

$$ARc\ (g\text{-}g^{-1}) = \frac{Nf - Nu}{Na} \times 100 \qquad \textbf{(Fageria, } \textbf{\textit{et al}}\textbf{., 1996).}$$

Where: *Nf* is the nutrient uptake (kgfed^{-1}) of the fertilized crop, and *Nu* is the nutrient uptake (kgfed^{-1}) of the unfertilized crop.

3- Apparent net nutrient release (ARe): is defined as the percent of nutrient supplying power of N, P and K sources.

$$ARe\ (g\text{-}g^{-1}) = \frac{AT - AC}{Na} \times 100 \qquad \textbf{(Fageria, } \textbf{\textit{et al}}\textbf{., 1996).}$$

Where: *AT* available nutrient (mgkg^{-1}) of treated soil, and *AC* available nutrient (mgKg^{-1}) in control soil.

The obtained data were subjected to statistical analysis by (Snedecor and Cochran 1980).

RESULTS AND DISCUSSION

Effect of P and K application on grain wheat yield and yield components under different applied N levels:

Data in Table 2 indicate that productivity of wheat grain yield (kgfed^{-1}) and 1000-grain weight of wheat were significantly affected by the adopted P and K and PK fertilizers. The highest values of such parameters were obtained in case of applying combined P and K. Meanwhile, the days to heading, physiological maturity and number of spikes m^{-2} were affected by each P and K application alone. These results indicate that, nutrient deficiency is one of the major constraints to wheat production. Deficiency of phosphorus supply led to the early physiological maturity stage, increase of days to heading and increase in the number of spikes m^{-2}. These results agree with Brady and Weil (2002) Phosphorus deficiency causes purple discoloration, delay in maturity and stunted plant growth. Besides, reduction in leaf expansion and leaf surface area is the most striking effects in plants suffering from P deficiency. Nutrient depletion result by farming without replenishing nutrients over time, and chemical imbalance issues often major causes of continuous decrease of cereals, beside removal of crop residues, leaching, low levels of fertilizer usage and unbalanced application of nutrients Agegnehu *et al*., (2014).

Table 2: Effect of fertilization management on wheat yield and its components under different N levels, average of two -seson mean.

Treatments		Grain Yield ($kgfed^{-1}$)	Plant height (Cm)	Days to heading	Number of spikes (m^{-2})	1000- grain Weight (g)	physiologica maturity (days)
Main treatments mean							
0		2907	84.50	81.5	289.3	50.50	125
P- fertilizer		3063	86.00	81.7	301.8	51.12	126
K- fertilizer		3168	88.12	81.8	329.8	52.75	128
PK-fertilizers		3523	89.62	81.2	317.3	54.12	128
LSD 0.05		267	NS	NS	NS	1.21	NS
Sub treatments mean							
0 N		876	77.25	81.1	198.0	42.62	125
50 kg $Nfed^{-1}$		3271	87.25	82.3	287.3	49.25	126
75 kg $Nfed^{-1}$		4188	90.00	81.3	346.6	56.37	127
100 kg $Nfed^{-1}$		4325	93.75	81.5	406.5	60.25	129
LSD 0.05		110	3.72	0.90	30.43	2.26	2.16
Interaction							
0	0 N	800	72.50	81.0	173.0	41.00	124
	50 N	2897	87.50	82.5	238.5	49.00	125
	75 N	3855	85.00	81.0	345.5	54.50	127
	100 N	4077	93.00	81.5	400.0	57.50	127
P	0 N	850	75.00	81.5	189.0	42.50	125
	50 N	3002	87.50	82.0	274.0	48.00	126
	75 N	4142	90.00	82.0	338.0	55.50	126
	100 N	4257	91.50	81.5	406.5	58.50	130
K	0 N	907	80.50	81.0	224.5	43.00	126
	50 N	2967	86.00	83.0	331.0	49.50	127
	75 N	4352	92.50	81.5	355.0	56.50	128
	100 N	4445	93.50	82.0	409.0	62.00	130
PK	0 N	950	81.00	81.0	205.5	44.00	125
	50 N	4217	88.00	82.0	306.0	50.50	127
	75 N	4405	82.50	81.0	348.0	59.00	129
	100 N	4522	97.00	81.0	410.0	63.00	130
LSD 0.05		132	4.36	NS	NS	NS	NS

N=nitrogen fertilizers P=phosphate fertilizers K=phosphate fertilizers A=treatment B= nitrogen level AB=interaction

According to Table 2 data indicate that, application of the assessed different nitrogen levels affected significantly all the parameters under investigation. Gradual increases were noticed due to increasing N rate and the highest figures were recorded with the highest N rate e, g, 100 kgfed^{-1}. The response of plant height to nitrogen application was positive; such increase in plant height may be due to the stimulation of cell division and internodes elongation by increasing N applications. Also the increase in yield could be mainly due to similar increases in number of spikes m^{-2} and 1000-grain weight. These results are in close agreement with those obtained by Khaled and El-Rawy (2012), Khaled and Hammad (2014) who concluded that the lateness of maturity date could be explained as a result of increasing the vegetative growth by increasing nitrogen applications.

Concerning the interactions between fertilizer treatment and N levels on such parameters, results reveal that the applying 100 kg Nfed^{-1} combined with PK fertilizer gave the highest wheat grain yield and plant height. Meanwhile, the lowest ones were obtained in case of the absence of N, P and K applications. However, an insignificant increase in either 1000-grain weight or number of spikes m^{-2} exists. These results could be enhanced with those obtained by Khaled and Hammad (2014).

Grain macronutrient content:

Data in Table 3 show that the highest significant values of N, P and K% and uptakes of wheat grain were obtained when P and K levels were applied. This may be due to application NH_4 ion release from soil as a result of K application and helped the crop for better uptake of nitrogen (Sharma and Ramna 1993). Moreover, potassium application also significantly helped uptake of N and P in straw as well as wheat grain Ghulamm *et al*., 2010). On the other hand, data indicate that the P % and uptake of grain wheat were increased significantly with P application. Jiang *et al*., (2006) indicate that, N and P uptake could be enhanced by increased P applications.

Concerning nitrogen levels, data in Table 3 show that the highest increase of N, P and K % and uptake of wheat grain was noticed by increasing nitrogen levels applications. This result indicates that the increase of nitrogen efficiency in wheat is improved with optimum fertilizer rate of application. In this study, the main reason behind poor grain yield can also be attributed to lowest N, P and K uptake by plants, which ultimately recorded minimum values of all nutrients uptake with P and K. The integrated application of NP fertilizer with manure resulted in a significant increase in nutrient concentration and uptake, of wheat grain and straw yields (Agegnehu *et al*., 2014).

With regard to the studied factors interaction effects on N, P and K % and uptake of wheat grain, data show that the highest significant increase of such parameters were recorded in case of applying P and K fertilizer together and the highest N levels, meanwhile, the lowest ones were in case of absence of N, P and K fertilizers. These results indicate that, integrated soil fertility management plays a critical role in short-term nutrient availability and longer-term maintenance of soil organic matter and sustainability of crop productivity in most smallholder farming systems Agegnehu *et al*., (2014). The lack of integration of fertilization is the main reason for productivity decrease wheat, and also the lack of awareness of many farmers in Egypt.

Table 3: Effect of fertilization management on N, P and K % and content (kgfed^{-1}) in grain yield of wheat plants under different levels of N (average of two season mean 2013&2014).

Treatments		Nutrients content in wheat grains (%)			Nutrients uptake in wheat grain (Kgfed^{-1})		
		N	P	K	N	P	K
0		2.82	0.32	1.74	88.53	9.36	49.62
P		2.73	0.46	1.77	85.50	14.35	55.75
K		2.33	0.30	1.99	77.18	10.05	63.12
PK		3.93	0.39	2.80	142.4	13.58	102.5
LSD 0.05 A		0.74	0.1	0.005	22.97	2.84	2.38
0 N		2.43	0.37	1.94	21.63	3.27	17.00
50 N		3.09	0.35	2.13	103.6	11.38	72.12
75 N		3.13	0.34	2.06	131.3	14.32	87.50
100 N		3.16	0.42	2.17	137.0	18.36	94.37
LSD 0.05 B		0.29	0.07	0.123	12.74	2.01	4.01
0	0 N	1.87	0.35	1.84	15.00	2.80	14.50
	50 N	3.18	0.31	1.87	92.15	9.00	54.50
	75 N	3.12	0.30	1.45	120.00	11.75	56.00
	100 N	3.12	0.34	1.81	127.00	13.90	73.50
P	0 N	2.53	0.47	1.61	21.65	4.00	13.50
	50 N	2.72	0.48	1.78	81.85	14.45	53.50
	75 N	2.84	0.39	1.80	117.5	16.15	74.50
	100 N	2.84	0.53	1.92	121.0	22.80	81.50
K	0 N	1.87	0.25	1.96	17.20	2.35	18.00
	50 N	2.52	0.29	2.08	74.55	8.60	61.50
	75 N	2.38	0.31	1.96	103.5	13.50	85.50
	100 N	2.55	0.35	1.97	113.5	15.75	87.50
PK	0 N	3.46	0.41	2.36	32.70	3.95	22.00
	50 N	3.94	0.32	2.82	166.0	13.50	119.0
	75 N	4.20	0.36	3.04	184.5	15.90	134.0
	100 N	4.13	0.46	2.98	186.5	21.00	135.0
LSD 0.05 AB		0.41	NS	0.17	18.1	2.86	5.70

N=nitrogen fertilizers P=phosphate fertilizers K=Potassium fertilizers A=treatment B=nitrogen level AB=interaction

Agronomic efficiency and apparent net N, P and K recovery of the wheat grain:

The response of wheat plant planted in clay soil to different P and K alone or together and N levels can be calculated from dry matter increase over control. Data in Table 4 show that the relation of agronomic efficiency (yield increase per unit of N or P or K applied) for grain yield of wheat, reveal that, using P and K fertilizer combined with nitrogen levels increased the use efficiency of N, P and K of wheat grain yield. Also, the utilization efficiency of 100 kgfed^{-1} N level was higher than either 50 or 75 kgfed^{-1} N levels.

Table 4: Effect of fertilization management on N, P and K agronomic efficiency (g-g^{-1}) and recovery % for grain yield of wheat under different N levels (two sesons 2013:2014).

Treatments	Agronomic efficiency	Recovery in

		(g-g^{-1})			grain yield %		
		N	**P**	**K**	**N**	**P**	**K**
0		28.12	140.5	87.87	98.25	43.75	145.5
P		29.37	147.5	92.37	85.50	64.25	176.0
K		30.12	150.7	94.25	80.37	52.37	188.7
PK		34.25	171.5	107.2	146.2	68.87	334.0
LSD 0.05 (A)		3.59	15.71	10.03	26.99	4.92	7.81
0 N		-	-	-	-	-	-
50 N		31.87	159.6	99.87	109.5	54.00	228.8
75 N		44.12	220.8	138.1	146.7	73.62	293.0
100 N		45.87	229.7	143.7	154.1	101.6	322.3
LSD 0.05 (B)		2.16	8.12	5.19	16.06	13.54	15.69
0	0 N	-	-	-	-	-	-
	50 N	28.0	140.0	87.50	103.0	41.00	164.5
	75 N	41.0	203.5	127.5	140.5	60.00	171.5
	100 N	43.5	218.5	136.5	149.5	74.00	246.0
P	0 N	-	-	-	-	-	-
	50 N	28.5	143.5	90.00	80.00	69.50	166.0
	75 N	43.5	219.5	137.5	128.5	81.00	254.0
	100 N	45.5	227.0	142.0	133.0	125.0	284.0
K	0 N	-	-	-	-	-	-
	50 N	27.5	137.5	86.00	77.00	42.00	183.0
	75 N	46.0	230.0	143.5	115.5	74.00	281.5
	100 N	47.0	235.5	147.5	129.0	93.50	290.5
PK	0 N	-	-	-	-	-	-
	50 N	43.5	217.5	136.0	177.5	63.50	402.0
	75 N	46.0	230.5	144.0	202.5	79.50	465.0
	100 N	47.5	238.0	149.0	205.0	114.0	469.0
LSD 0.05 (AB)		3.0	11.55	7.38	23.59	19.25	22.30

N=nitrogen fertilizers P=phosphate fertilizers K=Potassium fertilizers A=treatment B=nitrogen level AB=interaction

This confirms that the use of P and K fertilizers with N is economically better for the farmer. Increasing levels of N and P application and their interaction significantly and positively affected grain yield of wheat and concentration of N and P in the plant (Yasin, 2015).

The efficiency of using different P and K alone or together and N levels for wheat crop was calculated as percentage of quantities utilized from the added treatment (subtracting that utilized from the native soil N, P and K in the control). Data in Table 4 show apparent N, P and K recovery of the wheat crop as affected by using P and K fertilizers with 100 kgfed^{-1} N levels resulted in higher efficiency than the application of either P or K treatments. Similar results pointed out that the estimates of overall efficiency of applied fertilizer is about or lower than 50% for N, less than 10 % for P, and about 40 % for K. Plants that are efficient in absorption and utilization of nutrients greatly enhance the efficiency of applied fertilizers, reducing cost of inputs, and preventing losses of nutrients to ecosystem Baligar *et al*., (2001).

Apparent net N, P and K release in clay soil as affected by applying P and K alone or together and nitrogen levels:

Available N and P in soil after wheat harvesting were calculated and presented in Table 5. Data clearly show that, the highest significant values of available inorganic N (No_3, NH_4, and total N) and available P in soil after wheat harvesting were obtained at PK fertilized treatments under different N levels. Also the highest significant values of available inorganic N (No_3, NH_4 and total N) and available P in soil were obtained at 100 Kg Nfed^{-1}. This result indicates that highest positive relation exists between N and P fertilization on available or residual effect from N and P nutrients in soil after wheat harvesting. Similar results obtained by Brady and Weil (2002) reported that plant roots take up N from the soil solution principally as nitrate (NO_3^-) and ammonium (NH_4^+) and the effects of these two ions on the pH of the root rhizosphere is known to influence the uptake of other companion ions, such as phosphate.

Concerning available K in soil solution after wheat harvesting, data in Table 5 indicate that increases of available K mg kg^{-1} in soil at K treatment is higher than PK treatment. Also the concentration of available K (mgkg^{-1}) in soil increased with increases in N levels. These results may be attributed to rapidly depleting by plants and slow compensation of K in the soil. This result is consistent with the explanation (El Zanaty., 2015) where he explained that, the continuous K-consumption is governed by the K-concentration in the soil solution and the transfer of K from exchangeable and fixed forms to soil solution. The transfer rate from soil potassium (capacity) to (K-intensity) affected the kinetic factor of potassium renewal Barber (1984). During K-uptake, plants reduce its concentration in the immediate vicinity of roots which releases K-ions from the minerals. However, K- releases in many cases is too slow to meet the plant requirements, Cox *et al.*, (1999).

Data in Table 5 show that, the increase of P and K release as affected by P and K alone or together and nitrogen levels. The highest P and K release from fertilizers were obtained in case of using P and K fertilizers. Data also indicate that, P and K release from fertilizer increase by increasing nitrogen levels. These results were in agreement with the findings of Jun Fan, *et al.,* (2010) which clearly show that a balanced fertilizer N, P and K ratio is an effective method for increasing crop yields, enhancing N uptake and reducing NO_3^- N leaching losses.

Table 5: Dynamic change of available N, P and K mg kg^{-1} or apparent N, P and K release % as affected by different P and K and PK under different N levels.

Treatment		Available mg kg^{-1}					Release %					Ec	pH
		NO_3	NH_4	Total N	P	K	NO_3	NH_4	Total N	P	K		
0		190	95.87	284.5	4.88	270	47.25	14.50	59.25	15.31	77.87	2.2	7.49
P		200	106.7	306.7	15.87	300	28.00	21.12	49.00	83.00	45.00	2.0	7.43
K		231	108.5	339.5	13.87	353	46.62	14.75	61.25	70.25	86.50	1.9	7.46
PK		223	123.7	347.0	16.35	349	27.50	25.75	53.50	83.00	9.000	1.9	7.34
LSD 0.05 A		0.28	0.28	2.81	0.015	27.85	2.9	2.5	2.81	0.14	0.2	0.1	0.015
0 N		180	94.62	274.5	3.00	295	-	-	-	-	-	0.17	7.41
50 N		194	108.0	302.0	12.62	319	29.00	27.00	54.75	62.06	45.75	1.7	7.41
75 N		210	112.2	322.5	14.75	325	40.50	23.50	64.00	76.00	73.25	2.0	7.44
100 N		260	120.0	378.7	20.65	332	79.87	25.62	104.2	113.0	99.37	2.0	7.47
LSD 0.05 B		0.28	0.28	2.81	0.05	27.0	2.8	2.1	2.81	0.14	0.28	0.1	0.015
0	0 N	153	84.50	237.0	2.50	214	-	-	-	-	-	1.8	7.44
	50 N	175	91.00	266.0	3.00	277	49.00	14.00	58.00	3.25	54.00	1.8	7.54
	75 N	194	96.00	290.0	4.00	286	55.00	16.00	71.00	10.00	92.00	2.1	7.51
	100 N	238	112.0	345.0	10.0	304	85.00	28.00	108.0	48.00	165.0	2.4	7.50
P	0 N	175	91.00	266.0	3.00	289	-	-	-	-	-	2.5	7.38
	50 N	181	105.0	286.0	17.0	293	12.00	28.00	40.00	90.00	15.00	1.9	7.44
	75 N	192	112.0	304.0	18.0	307	23.00	28.00	51.00	97.00	75.00	2.0	7.48
	100 N	252	119.0	371.0	25.5	311	77.00	28.00	105.00	145.0	90.00	1.9	7.44
K	0 N	189	98.00	287.0	3.00	333	-	-	-	-	-	2.2	7.41
	50 N	196	110.0	306.0	13.0	359	14.00	24.00	38.00	65.00	108.0	1.7	7.42
	75 N	224	112.0	336.0	18.50	360	47.00	19.00	65.00	100.0	113.0	2.2	7.41
	100 N	315	114.0	429.0	21.00	363	125.5	16.00	142.0	116.0	125.0	1.9	7.62
PK	0 N	203	105.0	308.0	3.500	347	-	-	-	-	-	2.0	7.41
	50 N	224	126.0	350.0	17.50	348	41.00	42.00	83.00	90.00	6.00	1.7	7.27
	75 N	231	129.0	360.0	18.50	350	37.00	31.00	69.00	97.00	13.00	1.9	7.37
	100 N	235	135.0	370.0	26.05	351	37.00	30.00	62.00	145.0	17.00	1.9	7.34
LSD 0.05 AB		0.39	0.3	3.9	0.07	NS	4.0	3.0	2.99	0.20	0.3	0.2	0.022

N=nitrogen fertilizers level P=phosphate fertilizers K= Potassium fertilizers
A=treatment B= nitrogen level AB=interaction

The correlation between the concentration of nutrients changes relative to one another in soil and plant:

Data presented in Table 6 &7 shows the correlation between some soil properties, grain yield, N, P and K content in wheat grain after harvesting.

Data indicate that, the correlation between availability of NO_3, NH_4, total N, P (mgkg^{-1}) and Ec values were of positive and high significant effect on grain yield and NP content in grain wheat. Moreover, relations between pH values and available K in soil were non-significant. Moreover, the relation between available K in soil and K content in grain wheat is positive and significant. These results show the importance of available NO_3, NH_4, total N, P and K (mgkg^{-1}) in soil for wheat grains. This result was in agreement with the findings of Schulthess *et al.,* (1997) who pointed out that increasing levels of N and P application and their interaction significantly and positively affected grain yield of wheat and concentration of N and P in the plants.

According to the concentration of nutrients changes relative to one another in soil data in Table 7 show that the correlations between available NO_3, NH_4, total N, P and K mgkg^{-1} were of positive and high significant effects with one another. Moreover, relations between Ec dSm^{-1}, pH values and available nutrient in soil were non-significant. Similar results were obtained by Brady and Weil (2002).

Table 6: The correlation between concentration of macronutrients in soil and wheat grain yield and N, P and K content in wheat grain after harvesting.

Soil properties	Nutrients content in grain wheat			
	Grain yield	**Nitrogen**	**Phosphors**	**Potassium**
Available NO3	r = 0.65 **	r = 0.56 *	r = 0.63 **	r = 0.61 *
Available NH4	r = 0.74 ***	r = 0.83 ***	r = 0.77 ***	r = 0.90 ***
(NO3 and NH4)	r = 0.73 **	r = 0.68 **	r = 0.72 **	r = 0.74 ***
Available P	r = 0.79 ***	r = 0.73 **	r = 0.90 ***	r = 0.81 ***
Available K	r = 0.43 NS	r = 0. 42 NS	r = 0.33 NS	r = 0.55 *
EC dS m^{-1}values	r = 0.55 *	r = 0.52 *	r = 0.54 *	r = 0.38 NS
pH values	r = 0.10 NS	r = - 0.15 NS	r = 0.03 NS	r = - 0.25 NS

Table 7: The correlation between concentration of nutrients changes relative to one another in soil.

Soil properties	Available nutrient in soil mg kg^{-1}				
	NO_3	**NH_4**	**(NO_3 & NH_4)**	**P**	**K**
Available NO3	-	-	-	-	r = 0.64 **
Available NH4	r = 0.66 **	-	-	-	r = 0.71 **
(NO3 and NH4)	r = 0.97 ***	r = 0.81 ***	-	-	r = 0.71 **
Available P	r = 0.67 **	r = 0.85 ***	r = 0.78 ***	-	r = 0.53 *
Available K	r = 0.64 **	r = 0.71 **	r = 0.71 **	r = 0.85 ***	-
EC dS m^{-1}values	r = 0.27 NS	r = 0.26NS	r = 0.27 NS	r = 0.27 NS	r = - 0.01NS
pH values	r = 0.24 NS	r = -0.39NS	r = 0.07 NS	r = -0.15 NS	r = -0.23 NS

N = Nitrogen P = Phosphate K = Potassium EC= electrical conductivity

CONCLUSION

The study points out the economic importance of the integrated soil fertility management and the increase use efficiency of nitrogen fertilization by applying phosphorus and potassium fertilizers. Moreover, the lack of integration of fertilization is considered the main reason in decreasing the productivity of wheat. The fertilization plays a critical role in short-term nutrient availability and longer-term soil maintenance and sustainability of crop productivity. It was therefore important to upgrade the awareness of many farmers in Egypt toward the importance of the integration of fertilization which gives a higher yield through providing fertilizer as a way to self-sufficiency of wheat yield production. The state's policy should consider phosphate and potassium fertilization and not Just nitrogen fertilization.

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إدارة التسميد لمحصول القمح ومعدل الاستجابة للتسميد النيتروجيني

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استنزاف خصوبة التربة قد يهدد الإستدامة البيئية والاقتصادية لإنتاج المحاصيل. ومن أجل تحسين خصوبة التربة وإدارة المغذيات. أجريت تجربة حقلية لمدة موسمين شتويين متعاقبين (٢٠١٣ ، ٢٠١٤) في تربة طينية بمحطة البحوث الزراعية بهتيم - مركز البحوث الزراعية لدراسة تأثير إدارة التسميد المعدني على إنتاجية القمح (*Triticum aestivum* L., Var. Giza 171) ومعدل الاستجابة للتسميد النيتروجيني. وتؤكد النتائج أن نقص المغذيات هي واحدة من أهم المعوقات الرئيسية لإنتاج القمح. حيث وجد أن نقص إمدادات التربة بالفوسفور أدى إلى التبكير في مرحلة النضج الفسيولوجي مع إطالة فترة النضج كما أدي إلى زيادة عدد السنابل على الرغم من انخفاض عدد ووزن حبوب القمح. وقد تم الحصول علي أعلى محصول وكذلك أعلي قيم في أطوال النبات ووزن ١٠٠٠ حبة عند التسميد بالفوسفور والبوتاسيوم مع النتروجين. مع زيادة عدد السنابل بزيادة التسميد النيتروجيني إلى ١٠٠ كج فدان$^{-1}$. وتشير النتائج الي تحسن إمتصاص النيتروجين بإضافة التسميد الفوسفاتي والبوتاسي. كما أدي إستخدام التسميد الفوسفاتي والبوتاسي مع مستويات مختلفة من التسميد النتروجيني إلي زيادة كفاءة استخدام النتروجين والفوسفور والبوتاسيوم لإنتاج القمح حيث زادت كفاءة استخدام ١٠٠ وحده للفدان من النتروجين المضاف مقارنة بإضافة

٥٠ ، ٧٥ وحدة للفدان. من ناحية أخرى تم الحصول على أعلى قيمة لإنطلاق الفوسفور والبوتاسيوم من الأسمدة مع إضافة السماد الفوسفاتي والبوتاسي ومع زيادة مستويات السماد النيتروجيني المضاف. وجدت إرتباطات ذات دلالة إحصائية عند مستوى إحتمال كبير بين تركيز النتروجين المعدني وكل من الفوسفور والبوتاسيوم وقيم التوصيل الكهربي بالتربة والنبات. وأكدت الدراسة على الأهمية الاقتصادية للإدارة المتكاملة لخصوبة التربة وزيادة كفاءة استخدام النيتروجين.