13TH INT'L ANNUAL FERTILIZERS FORUM

6-8 Feb. 2007

SHARM EL-SHEIKH, EGYPT

Fertilizers Feed the world

13th AFA Int'l Annual Fertilizers Forum &Exhibition

6-8 February 2007

Intercontinental Hotel- Sharm El-Sheikh

Balanced Fertilization under Intensive Cropping System In Egyptian Agriculture

Mr. Abd El Hadi, A.H & Mr.Abo soliman

Soils, Water & Environment Research Institute ARC

Egypt

Balanced Fertilization under intensive cropping system in Egyptian agriculture

Abd El Hadi, A.H and Abo soliman, M.S. soils, Water and Environment Research Institute ARC . Giza. Egypt.

1. Introduction

The responsibility of Egyptian Agriculture today is manifold. It has to meet the need of food for the rising population and to provide the raw materials required for industry and export. To achieve growth in food and agricultural production under the intensive system of cropping that prevails in Egypt, all measures to contribute the increase of soil productivity and fertility have to be mobilized and more effectively applied to reach this goal. The prospective view on world agriculture in the FOA study indicates the pressing need to intensify agricultural production on the already cultivated land and this will require much more intensive agriculture practices including the use of chemical fertilizers.

The Egyptian agriculture is one of the oldest agricultural civilizations in the world. The River Nile allowed a sedentary agricultural society to develop thousands of years. The agricultural sector now accounts for about 20% of both the Gross Domestic product (GDP), total exports 34 and about 32% of the total labor force, which means that the Egyptian economy still relies heavily on the agricultural sector.

The Nile Delta and a narrow strip of arable land alongside the Nile provide much of Egypt's food. The demand of food is increasing yearly due to the increase in population, which is projected to reach 98 million by 2025.

As a result of the situation, governmental policy and research programs are directed towards increasing total production. This requires increasing crop intensification and extensive use of inputs, particularly inorganic fertilizer, which results in increasing the pressure on the limited natural-resource base, mainly soil and water.

The Agricultural sector in Egyptian economy provides:

- 20 % of Gross Domestic Product
- 34% of the total exports
- 32% of the total labor force
- Much of the Egyptian food supply

2. Limited land resources

Egypt occupies a total area of about 100 million hectares. Out of this area, the agricultural land base is about 3.2 million hectares, covering three different production zones:

1-The old irrigated lands, with an area of 2.3 million hectares, lying in the Nile Valley and Delta. They represent the most fertile soils in Egypt.

2-The "newly" reclaimed lands, with a potential area of 0.8 million hectares. These include the newly reclaimed desert lands of sandy and calcareous origin, where soil is poor in organic matter and in macro and micronutrients.

3-The rainfed areas, with about 0.1 million hectares of sandy soil, located in the Northwest Coast and North Sinai.

On a per capita basis, the area of cultivated land in Egypt is among the lowest in the world, and is estimated at 0.05ha.

3. Scarcity of water

Agriculture in Egypt is almost entirely dependent on irrigation from the Nile. Of the 55.5 billion cubic meters (BCM) of Nile water allocated to Egypt, 84% is used for agriculture. Egypt's share of Nile water constitutes about 97% of its renewable water supply. The rest is from scattered rainfall along a narrow strip in the Western desert and Sinai.

The annual per capita share of freshwater resources is now 930 m^3. This amount is expected to drop to 350 m^3 by the year 2025. Therefore, the need to use non-conventional resources, such as agricultural drainage water and treated wastewater, becomes essential. Currently, about 4 billions m^3 of agricultural drainage water is officially reused for irrigation every year, with an average salinity of 1045 ppm.

4. Intensive cropping systems and excessive use of fertilizer

Agricultural land in Egypt is favourable to intensive agriculture. As a result of the optimum climatic conditions and a perennial intensity of irrigation water, crop yields are high. Due to intensive cropping the total cropped area is estimated at about 5.7 million hectares giving a cropping intensity of around 180% for the country as a whole.

At present, it is estimated that wheat, clover (berseem), cotton, rice, and maize account for 80% of the cropped area. Wheat and berseem are the principal winter crops. In summer, cotton and rice are important cash crops, while maize and sorghum are major subsistence crops.

Characterization of the Egyptian Soils

The Egyptian soils varied with respect to their texture from sandy to heavy clay soils as shown in the table. Average value of total soluble nitrogen is very low and organic matter is also low, the soil reaction was slightly alkaline. The available phosphorous values determined by Oslen's method are moderate. However, the available potassium ranged between low and high extracted by 1 N ammonium acetate solution. The DTPA extractable micronutrients (Zn, Mn and Fe) show lower values of Zn in sandy and sandy calcareous soils, and adequate amounts of Mn and Fe in all tested soils.

Table (1): Analysis of Egyptian Soils

Location	North Delta	South Delta	East Delta	West Delta	Middle Egypt	Upper Egypt
Texture	Clay	Clay loam	Sandy	Sand calcar.	Loamy clay	Loamy
pH (soil;water1:2.5)	7.9-8.3	7.8-8.2	7.6-7.9	7.7-8.1	7.5-8.1	7.7-8.2
T.T.S%	0.2-0.5	0.2-0.4	0.1-0.6	0.2-0.6	0.1-0.5	0.1-0.4
CaCO3	2.6-4.4	2.0-3.1	1.0-5.1	11.0-30.0	2.3-4.9	2.5-5.1
O.M%	1.9-2.6	1.8-2.4	0.4-0.9	0.7-1.5	1.5-2.0	1.2-1.9
Soluble N ppm	25.0-50.0	30-60	10.0-20.0	10.0-30.0	20.0-30.0	20.0-25.0
Available P ppm	5.4-10.0	3.5-16.5	2.0-20.0	1.5-10.5	2.5-20.0	3.0-18.o
Available K ppm	250-500	300-250	105-358	100-300	250-380	280-400
Available Zn ppm	0.5-4.0	0.6-6.0	0.5-1.2	0.4-1.5	0.8-3.9	0.5-4.0
Available Mn ppm	13.1-45.6	11.2-37.2	3.0-11.7	10.0-20.0	8.6-51.9	10.0-47.0
Available Fe ppm	20.8-63.4	19.0-27.4	6.7-16.4	12.0-18.0	13.0-37.0	12.4-40.8

Fertilizer Requirements

Great efforts have been focused on tackling the factors that lead to a significant increase in crop production. Among theses factors that may achieve such a target is the proper fertilization of different crops. This well obviously increases the demand for minerals fertilizers. Egypt utilizes fertilizers at an accelerating rate, especially nitrogen fertilizers followed by phosphatic fertilizers then potassium fertilizers. This is due to the horizontal expansion (adding new cultivated reclaimed areas) and the vertical expansion (using high yielding varieties as well as optimum recommended agricultural practices).

Fertilizer consumption

- Consequently Egypt is considered to be a heavy user of mineral fertilizers, especially nitrogen fertilizers followed by phosphate fertilizers then potassium fertilizers which are the least consumed types of chemical fertilizers in Egypt as shown in the next Table (2).

Table (2): Amounts of N, P and K fertilizers consumed during the period 1965/66-2005

Year	N-fertilize (15.5%N) (in1000 t)	P-fertilize (15%P_2O_5) (in1000 t)	K-fertilizer (48%K_2O) t	Total nutrient amount(kg/ha)
1965/66	1823	346	1458	136
1970/71	2122	329	3750	148
1975/76	2580	307	3958	179
1980/81	3665	693	19583	273
1981/82	4032	893	23711	303
1982/83	4252	953	20090	328
1983/84	4812	1066	36500	369
1984/85	4922	1093	50400	380
1985/86	4990	1219	50800	392
1986/87	5013	1233	60200	397
1988/89	5174	1200	63204	405
1989/90	5226	1100	60000	402
2000	5682	955	60000	421
2005	6750	955	60000	488

Source: Principal Bank for Development &Agricultural credit-Fertilizer administration

From the data reported in this table, the ratio of $N:P_2O_5:K_2O$ was 60.4:11.4: 4.1 in 1980/81 and declined to 36.3:5.5:1 in 2005 since the consumed amount of K-sulphate increased from 19,583 tons in1980/81 to 60,000 tons in 2005 and this had a positive effect on the balance among the three nutrients.

- Zinc sulphate fertilizer has been introduced to the Egyptian farmers particularly for bady nurseries. About 1500 tons of Zn-sulphate are usually consumed. Also about 18,656 tons of compound and foliar fertilizers of Zn, Fe, Mn and Cu are consumed for field and horticultural crops especially those grown in the newly reclaimed soils**.**

Climate and general features of Egyptian Agriculture

It has been reported that the climate of the Mediterranean coastal areas including The Nile Delta is of the Mediterranean type characterized by the mild rainy winter and hot dry summer. The climate of the rest of Egypt south Cairo is of the desert type. The climate in Egypt is generally favourable all the year round and suitable for growing a wide variety of crops. Field crops cover roughly 90% of the total cropped area and 10% for vegetables and fruits in the old land.

Under the prevailing cropping patterns, in the 2 or 3 year regular crop rotations; there are almost two crops a year in the same field giving a cropping index of 200 per cent whereas a cropping index of 300 per cent is for vegetable crop areas. The perennial sugarcane and permanent orchard areas have a cropping index of 100 per cent (Table 3).

Table (3): Total Cropped area in 2004 (about 5.83 million hectar)

Crop	Area (hectar)	Crop	Area (hectar)
Cereals	2.651.000	Vegetables	0.546.000
Legumes	0.187.000	Fruits	0.692.000
Oil crops	0.157.000	Date palm	0.029.000
Sugar crops	0.189.432	Cotton	0.208.000
Potato	0.079.068	Forage crops	1.098.000

Source: Agricultural Economic Institute, ARC.

Results from long term experiments

Series of simple long-term trials were carried out during the period 1981-1990 at 5 Governorates namely El Monofia (10 trials), El-Gharbia (16) El-Sharkia (15) Beni Seweef (15 trials) and El-Menia (8 trial) to study the effect of K-addition on the farmer fields and under his prevailing crop rotation.

K-treatments (with and without potassium): recommended rates of nitrogen and phosphorus for every cultivated crop were added in the proper time and method.
The table below summarized the obtained yield for every crop under with and without K-application in MT/ha, and the increase over without K, as well as, the total number of field trials and number of experiments with significant effect of K-application (table 4).

Table (4): Effect of K-fertilizer on production of some crops under the Egyptian condition between 1981-1990

Crops	No. of experiments		Yield	MT/ha	Yield increase over 0-K	
	Total	With sign. eff.	+K	0-K	Ton/ha	%
Cotton	121	42	3.58	3.38	0.20	6
Soybean	29	9	4.08	3.66	0.42	11
Rice grain	48	23	7.75	7.18	0.57	8
Maize grain	347	77	5.59	5.36	0.23	4
Wheat grain	198	92	5.14	4.75	0.39	8
Berseem t/ha.cut	163	80	29.24	27.52	1.72	6
F.Bean grain	137	47	4.26	3.91	0.35	9
Orange seedless	3	3	31.40	25.30	5.10	20
Grape (Rosine)	3	3	12.33	15.50	3.17	25
Total	1049	376				

Each kg K2O of sop increased the crop yield as follows.

		VCR
Wheat grain yield	3.33 kg	2.3
Rice grain yield	4.75 kg	2.0
Maize grain yield	2.08 kg	--
Faba bean grain yield	2.79 kg	6.6
Soybean grain yield	3.50 kg	2.7
Seed cotton yield	1.67 kg	4.0
Berseem fresh weight	57 kg	9.1
Orange Fruits after 3 years	30 kg	7.5
Grape Fruits after 3 years	27 kg	8.5

Table (5): Effect of P and K fertilization on soybean grain yield (means of 14 trials)

N	P2O5	K2O	Grain yield		Protein yield	
Kg/ ha			Ton/ha	Rel. yield	Kg/ha	Rel. yield
37	0	0	3.53	100	1.35	100
37	0	60	3.84	109	1.52	113
37	60	0	3.97	113	1.65	122
37	60	60	4.38	124	1.76	130

Soyabean grain yield.

A considerable response to potassium and phosphorus application for soyabean has been obtained in 14 field experiments carried out in two years on farmer, fields. It has been mentioned that the response to potassium at the rate of 60 Kg K_2O/ ha increased by (+ 9%), while phosphorus effect was much higher than K-alone. Application of P+ K together at the rate of 60 Kg / ha increased the grain yield by (+ 24%). It might be due to the interaction effect between both of them (table 5).

Table (6): Effect 0f NPK fertilization on grain yield and crude protein of wheat grain - average of 38 trials

N	P_2O_5	K_2O	Grain yield		Crude protein yield	
Kg/ha			Ton/ha	% increase	Kg/ha	% increase
105	36	0	4.55	Control	535.4	Control
140	36	0	5.15	+13%	597.2	+12%
175	36	0	5.26	+16%	618.9	+16%
175	72	0	5.11	+12%	608.9	+14%
175	72	120	5.51	+21%	646.4	+21%

Wheat grain yield.

The whole of 38 wheat trials responded positively to application of 120Kg K_2O / ha versus 0 K_2O. The average increase in grain yield was 0.5 ton / ha (+ 9%) and increased the crude protein by 9% (table 6)

Table (7): Effect of K fertilization on grain and crude protein of faba bean (means of 13 trials)

N	P2O5	K2O	Grain yield		Crude protein	
Kg/ha			Ton/ha	%	Kg/ha	%
37	72	0	4.59	100	13o5	100
37	72	120	5.00	109	1505	115

Vicia faba grain yield.

Vicia faba is one of the most important grain yield in Egypt. As shown in (table, 7) that grain yield of vicia faba was positively affected by K- fertilization in the cultivated area. The response to K- application vary greatly depending on the location and the year. Not only the grain yield increased with about (+ 9 %), but also the crude protein yield of grain had been also increased by about (+ 15%) (table, 7).

Table (8): Effect of K and P fertilization on grape yields. (Variety: Red Rome, grown on sandy calcareous soil)

Treatment			1982	1983	1984	Aver.	% over Control.
N	P2O5	K2O	yield				
Kg/ha			Ton/ha				
330	-	-	25.70	14.08	17.81	19.20	
330	100	-	26.80	21.11	18.25	22.25	16
330	-	100	27.00	21.11	21.29	23.13	20
330	100	100	30.20	22.22	23.06	24.08	25

- **N.B: Plot area was 400 m2 (90 trees, 4 years old), replicated 3 times.**
- **P and K fertilization were splitted into two equal doses, one at the first irrigation (end Feb.), the other one, one month later.**

Table (9): Effect of K-addition on Sugar cane in Egypt

Middle Egypt area						
N.P	K2O	**ratoon1**	**ratoon2**	**ratoon3**	**ratoon4**	Average
Kg/ha		Ton/ha				
N.P	0	186.6	164.5	143.1	190.2	161.1
N.P	120	194.0	177.0	162.1	172.8	176.5
Difference %		4	8	13	15	10
Upper Egypt area						
N.P	0	113.4	74.8	83.1	-	90.4
N.P	120	116.5	85.0	99.8	-	100.4
Difference %		3	14	20	-	11
Sucrose was also increased by 1%						

Grape yield.

On a sandy calcareous soil, a long term field experiment was conducted for 3 years with grapes (variety, Red Roma). Phosphorus and potassium fertilizer were applied at the rate of 100 Kg/ K_2O / ha. On the average, adding phosphorus alone gave an increase of about 3 tons/ ha. While potassioum alone increased the grape yield by 4 tons/ ha. When both of phosphorus and potassium were applied together at the rate of 100 Kg K2O/ ha, they produced the the highest increase by 5 tons/ ha, as shown in (table, 9).

Addition of potassium to sugar – crane plants mixed with recommended N and P fertilizer in sugar area in Middle and upper Egypt increase the sugar cane production and sucrose % as well. These increases over 0 K2O were higher at the 4^{th} ratoon (15%) comparing to the 1^{st} one (4%) at middle Egypt, while these increases reached to 20% at the 3^{rd} comparing first one at upper Egypt region (table 9)

The effect of Potassium on Drought Resistance in crop production Under the Egyptian Conditions

Series of long-term experiments were carried out during the period of 1992 to 1995 at eastern part of Nile Delta (sandy and sand loamy soils) to study the efficiency of potassium at 4 levels (K0, K120, K240 and K360 kg K2O/ha) on crop production under saline and water stresses.

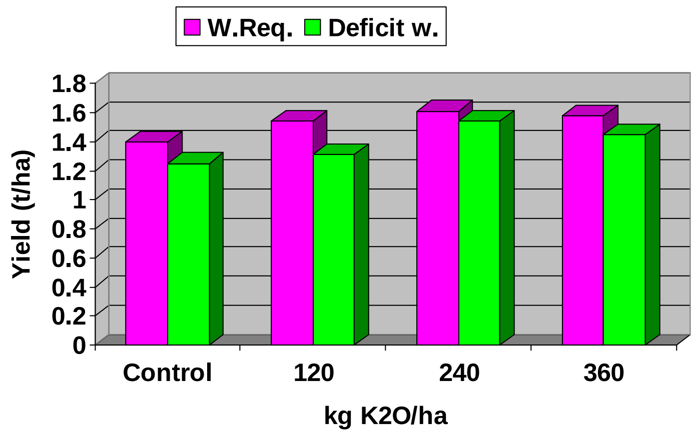
Three methods of irrigation (sprinkler, drip and surface irrigation) with required and deficit irrigation water amounts were used.

The table below summarized the obtained results.

The obtained results

Crops	Effect of		KxIrr.interaction	Best K*Tr.,	Max.yield increase % of	
	K	No.,Irrig			Req. irr.	Def.irr.
Sprinkler Irrigation						
Alfalfa	**s**	**hs**	**ns**	**120**	**9.30**	**5.60**
Drip irrigation						
Garlic	**ns**	**hs**	**hs**	**240**	**75.00**	**36.00**
V.faba	**ns**	**hs**	**ns**	**12o**	**42.50**	**25.00**
Garlic	**ns**	**hs**	**ns**	**120**	**16.50**	**43.00**
Surface irrigation						
Wheat	**ns**	**hs**	**ns**	**-**	**18.00**	**56.00**
Sesame	**ns**	**s**	**ns**	**240**	**24.00**	**31.00**
V.faba	**ns**	**hs**	**ns**	**240**	**11.00**	**23.00**
Gr.nut	**ns**	**hs**	**ns**	**240**	**8.90**	**23.00**
Sesame	**s**	**hs**	**ns**	**240**	**12.50**	**6.60**

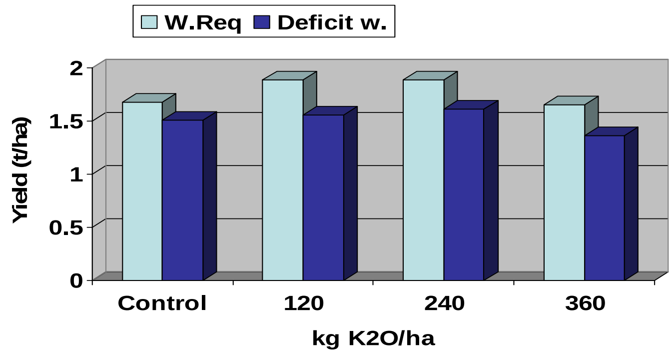
Effect of different levels Potassium and irrigation on Groundnut yield (t/ha) at Kasseen



LSD(5%):
K-Fertlization=0.07 t/ha   Irrigation=0.05
K*irrigation=ns   C.V=5.1%

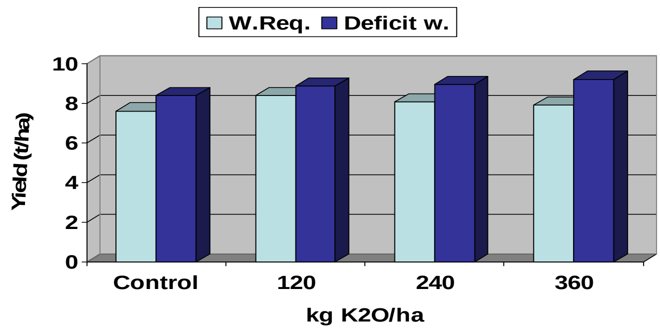
The FiG. show that Req. W gave higher yields under all the tested treatments. Application of K with different rates gave higher yields under Req. and deficit water. The rate of 240 Kg K_2O was the best treatment

Effect of different levels of Potassium and irrigation on Sesame yield (t/ha) at Kasseen

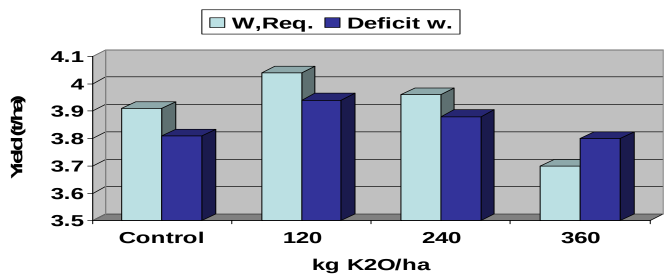


LSD(5%):
K-Fertlization=0.17 t/ha   Irrigation=0.12
K*irrigation=ns   C.V=10.2%

Effect of different levels of Potassium and irrigation on Rice yield (t/ha) at ElSerw



Effect of different levels of Potassium and irrigation on Cotton yield(lint+seed) t/ha at ElSerw



- For sesame 120 and 240 Kg K_2O gave similar and some what higher yield while 360 Kg K_2O gave less than the control.
- For rice, deficit of water gave higher yields and the rates (120, 240 and 360 Kg/ Ha) gave similar values.
- For cotton, Req. water gave higher yields when (120 and 240 were used with the superioty of 120 Kg. The rate of 360 Kg K_2O gave the least values and oppiste values for Req. and deficit water treat ments.

Table (10): Effect of K-Fertilization on orange production average of 3 seasons

Treatment			Loamy soil		Clay soil	
N	P2O5	K2O	1985-1987		1985-1986	
Kg/ha			Ton/ha	Relative yield	Ton/ha	Relative yield
428	107	0	25.1	100	18.9	100
428	107	120	31.2	124	24.0	127
428	107	180	31.3	125	-	-
422	107	240	30.5	121	26.0	138
Variety			Navel orange		Sweet orange	

The results in (table 10) indicated that addition of sop to citrus threes in combination with recommended NP increased the Orange fruits by 25% in loamy soil and by 38% in clay soil comparing to $0K_2O$ after 3 seasons

Conclusions from experiments:

Under balanced fertilization, the obtained yield increases by K- application over Np level were as **follows:**

- Soya been grain yield increased by 24% and the crude protein by 30%.
- Faba been grain yield increased by 9% and crude protein by 15%.
- Wheat grain yield increased by 9% and crude protein by 7%.
- Melable sugar – cane increased by 11-15% and Sucrose % by 1%.
- Grape fruit, increased by 25% and orange fruits by 21- 38% through 3 seasons.

Each addition of one Kg K2o as sop increased the different crop yield as follows:

- Wheat grain yield 3.33 Kg faba been grain yield 2.79 Kg seed cotton yield 1.67 Kg.
- Rice grain yield 4.75 Kg soya been grain yield 3.50 Kg Orange fraits after 3 seasons 30 Kg.
- Maize grain yield 2.08 Kg Berseen fresh yield 57 Kg Grape fruits after 3 seasons 27 Kg.
- K response is more important in sandy soils, calcareous soils and saline conditions.
- Water management is a key factor in fertilizer efficiency.
- Potassium form plays a key role in soil sustainability.
- Farmer’s training is necessary to promote a better balanced fertilization.