Journal

J. Biol. Chem. Environ. Sci., 2010, Vol. 5(1): 95-107
www.acepsag.org

COMPOARATIVE CEREAL PRODUCTIVITY STATUS OF SOME DIFFERENT ROTATIONS WITHOR WITHOUT LEGUME CROP INCLUSION GROWN ON A SANDY SOILS IN TAHREER, EGYPT.

R.S. Abdel-Aal*, R.N. Kamh, H.M. Salem*, and H.F.El-Mansoury****

**Soils Department, Faculty of Agriculture, Moshtohor, Benha University.*
***Fertility and microbiological of soils Department, Desert Research Center, Egypt*

ABSTRACT

The objective of the present work was to assess the effect of crop rotation (cropping sequence) productivity of the soil in terms of yield of the adopted crops in each. A series of experiment was carried out at South Tahrir in West Delta in a factorial randomized complete block design with three replications. N was applied at 3 rates (low - medium - high) in addition to no-N for each crop (for wheat: 0, 70, 90 and 110kgN/fed, for maize: 0, 80, 100 and 120 kgN/fed, for peanut: 0, 30, 40 and 60 kgN/fed and for berseem: 0, 20, 30 and 40 kgN/fed). Based on the findings of this present work, the obtained results can be summarized as follows: a- Application of the high fertilizer nitrogen rate encouraged the growth and yield performance of all adopted crops. b- Cereal crops were inferior to leguminous ones especially in proliferating plant nutrients in the soil system. Productivity of soil as affected by rotation was assessed in terms of yield response of the grain crops (wheat and maize) as related to the position of the crop in the rotation. In all cases grain yield was greater when the crop followed a legume than when it followed a grain crop.

INTRODUCTION

Crop rotation is a planned order of specific crops planted on the same field. Crop rotation implies that succeeding crops are different

regarding genus, species, subspecies, or variety than the previous crop. Cropping systems vary in nitrogen content of the plant residues, and the accumulation of soil organic matter is in part related to this content.

Nitrogen nutrient management should furnish a balance between nutrient inputs and outputs for the sake of plant benefits over the long term **(**Bacon et al., 1990).

López-Bellido *et al*. (1996) found that legumes increase cereals grain yields. Cropping rotations of sequences exhaustive to the soil that decrease yields of crops. Karlen *et al* (1997) stated that it is always recommended to bring back to the soil system the depleted nutrients, and that the sustainability of cropping systems is largely determined by their impacts on the soil quality. According to Corbeels *et al*. (1998), the carryover residual effect of N fertilizer from a growing season to the next in soils can be substantial.

Introduction of legumes in the crop rotation is recommended to enhance the production of cereals. Use of legumes in a cropping system improves soil fertility through the changes taking place in the content of organic matter, soil microbial activity and deep root growth, which facilitates root penetration by cereal crops which succeed the legumes in the rotation (Herridge, 1982). Legumes fix atmospheric nitrogen in the soil adding amounts of N which varies widely according to species, location, management and other factors (Heichel, 1987**)**

Hirel et al. (2007**)** reviewed the increased knowledge of the regulatory mechanisms controlling plant nitrogen economy and to what extent it is vital for improving nitrogen use efficiency and reducing excessive input of fertilizers, while maintaining an acceptable yield

Current knowledge and prospects for future agronomic development and application for breeding crops adapted to lower fertilizer input are explored, taking into account the world economic and environmental constraints in the next century.

MATERIALS AND METHODS

A series of experiments was carried out on a sandy soil at South Tahrir in West Delta (30^0 36^- $54^=$ N, 29^0 53^- $23^=$ E). These studies were started in the winter of 2004/2005, summer 2005, winter 2005/2006, and summer 2006. Four crop rotations were designated and conducted.

Crops used were wheat"w" (Triticum aestivum C.V. Sakha93), maize"m"(Zea maize C.V. Bashaer13), peanut"p"(Arachis hypogae c.v.Giza5), and berseem"B" (Trifolium alexandarinum c.v.Serw1). The experimental area was shaped into (10m x 12m) plots. These plots hosted the experimental treatments in a randomized complete blocks design with three replications. The four crop rotations were as follows;

Rotation (Rt) designation		**Crops sequence (Cr)**
First rotation	Rt1	Wheat - maize - Wheat – maize (w-m-w-m)
Second rotation	Rt2	Wheat - Peanut - Wheat – maize (w-p-w-m)
Third rotation	Rt3	berseem - Peanut - Wheat – maize (b-p-w-m)
Fourth rotation	Rt4	berseem- maize -Berseem – maize (b-m-b-m)

Rotation designation"Rt_1: (w-m-w-m) Rt2: (w-p-w-m) Rt_3 :(b-p-w-m) and Rt_4 :(b-m-b-m).Sequence of crop is relevant rotation Cr_1:1^{st} Cr_2: 2^{nd} Cr_3: 3^{rd} Cr_4: 4^{th}.

Samples were collected at five depths 0-20, 20-40, 40-60, 60-80 and 80-100cm prior to and after cultivation to verify soil fertility status. These samples were air-dried, ground, passed through a 2-mm sieve and preserved in plastic containers for the required physical and chemical analyses as outlined by Black (1965).

Table 1 shows that the experimental field was mainly loamy sand in the top 40 cm and sand in the beneath soil layers down to 100 cm. Soils were also characterized by very low organic matter content and low salinity. The analysis of nutrient content reveals that the soil is poor in most nutrients but somewhat high in available N most probably owing to the residual effect of the previous legume crop (peanut) grown in the soil.

Table (1): Chemical and physical properties of soil before cultivation.

Depth cm	pH	E.C ds/m	OM	$CaCO_3$	Sand	Silt	Clay	Texture	C.E.C molc/kg soil
	Past extraction		g/kg		%				
0-20	7.49	0.86	5.5	41	83.7	10.1	6.2	L.S	6.42
20-40	7.56	0.91	3.2	42	83.6	10.3	6.1	L.S	6.81
40-60	7.75	0.72	1.8	36	87.6	8.2	4.2	S	4.72
60-80	7.87	0.68	1.1	27	89.7	5.9	4.4	S	3.95
80-100	8.01	0.59	0.8	25	91.4	5.4	3.2	S	3.48

Depth	Available nutrients in soil (mg/kg)						
	N	P	K	Fe	Mn	Zn	Cu
0-20	30	3.9	19.8	2.32	1.62	0.49	0.22
20-40	15	2.8	22.8	2.54	1.82	0.54	0.24
40-60	21	1.7	10.6	2.17	1.53	0.37	0.16
60-80	11	1.4	6.5	1.98	1.35	0.31	0.12
80-100	8	1.1	4.2	1.76	1.12	0.26	0.08

Depth	Total nutrients in soil (mg/kg)						
	N	P	K	Fe	Mn	Zn	Cu
0-20	550	187	1700	2100	200	45.6	12.2
20-40	520	174	1540	2050	200	45.5	11.8
40-60	340	121	1050	1780	175	42.0	11.7
60-80	320	61	560	1610	130	40.0	11.0
80-100	300	53	400	1500	118	40.0	10.5

S: Sand, L. S.: Loamy sand.

Fertilization used for crops of the experiment:

In all studied seasons, N, P, and K were applied to crops, Table 2. N was given at different rates. As can be seen from Table 2 the N-rates varied according to the crop. P as well as K was add at a constant rate to all plots.

Table 2 : Applied NPK rates to crops in the studied seasons.

Seasons	Winter	Summer	Winter	Summer
	2004/2005	2005	2005/2006	2006
Treatments (T)	Wheat	Maize	Peanut	Berseem
	Kg / fed			
N0	0	0	0	0
N_1	70	80	30	20
N_2	90	100	40	30
N_3	110	120	60	40
P	15	15	15	15
K	60	60	60	60

RESULTS AND DISCUSSION

Comparative rotation productivity of crops in all rotations which contained them:

Rotation Productivity assessed with regard to wheat crop:

Wheat was included in three rotations (Rt1,Rt2 and Rt3).It occupied five different positions (sequences), considered as five different treatments (Cr1Rt1, Cr3Rt1,Cr1Rt2, Cr3Rt2, and Cr3Rt3) for the purpose of productivity assessment. Table 3 and fig. 1 show that, the highest yield was obtained by Cr3Rt3. This indicates that growing wheat following two seasons of legume crops (Barseem followed by peanut) is the most productive rotation for wheat. The treatment which gave the second highest straw was Cr3Rt2, i.e. rotation Rt2 where wheat was cultivated following a grain crop then a legume crop (wheat, peanut). The lowest was Cr3Rt1 (i.e. being a third crop following two successive grain crops of wheat then maize. This is a clear indication of the benefit of growing wheat following legume crops, as opposed to its cultivation following grain crops. This occurred in presence of added N. Such a pattern of superi of Cr3Rt3 followed by Cr3Rt2, then Cr1 Rt2 over the Cr1Rt1 and lower than Cr3Rt1, occurred with grain yield under all condition of N addition. However regarding straw yield it was only Cr3Rt3 which surpassed the other rotations under all conditions of N. With no N addition other rotations were similar. Therefor in absence of added N, the only treatment which gave superiority was that of wheat following two

legume crop (Cr3Rt3).Under conditions of no added N, the Cr1Rt1, Cr3Rt1, Cr1Rt2, Cr3Rt2) were practically similar regarding straw yield indicating little benefit from the legume crop previous to the wheat crop. The wheat grain crop which succeeded two legume crops (Cr3Rt3) was superior in yield over those of Cr1Rt1; Cr3Rt1, and Cr4Rt2. Regarding the Cr1Rt1 and Cr1Rt2, Cr3Rt1, results show that there is no difference between them under conditions of no N. The two rotations Rt1 and Rt2 had wheat as the starting crop. Therefore wheat straw yields in these rotations were rather similar.

Table 3: Grains and straw yields of wheat crop as affected by the Sequence of the crop (Cr) in its relevant affected rotation (Rt) and N-fertilization levels (wheat was grown in Rt1, Rt2 andRt3)

Crop sequences and relevant rotation (Rt)						
Grain yield of wheat (Mg/f)						
Treatment (T)	Cr_1Rt_1	Cr_3Rt_1	Cr_1Rt_2	Cr_3Rt_2	Cr_3Rt3	Mean
N0	0.67	0.52	0.73	0.82	0.94	0.74
N1	1.74	1.54	1.79	2.04	2.14	1.85
N2	2.14	2.05	2.25	2.50	2.55	2.30
N3	3.05	2.89	3.10	3.25	3.33	3.12
Mean	1.90	1.75	1.97	2.15	2.24	2.00
LSD 5%	(T)Treatment 0.04		(Rt) Rotation 0.04		(T.Rt) Interaction n.s.	
Straw yield of wheat (Mg/f))						
N0	1.18	1.04	1.13	1.24	1.36	1.19
N1	4.60	4.12	4.54	4.62	4.71	4.52
N2	5.40	5.06	5.23	5.85	5.95	5.50
N3	6.16	5.93	6.34	6.63	6.72	6.36
mean	4.34	4.04	4.31	4.59	4.69	4.39
LSD 5%	(T)Treatment 0.09		(Rt) Rotation 0.10		(T.Rt) Interaction 0.20	

Nots

(1): Crops involved in rotation(Rt)as wheat"w", maize"m", peanut"p",and Berseem"b".

(2):Rotation designation "Rt_1 : (w-m-w-m) Rt_2 : (w-p-w-m) Rt_3:(b-p-w-m) Rt_4:(b-m-b-m)

(3): Sequence ofcrop is relevant rotation Cr_1 :1^{st} Cr_2: 2^{nd} Cr_3: 3^{rd} Cr_4: 4^{th}

(4): Treatments (T)

(5):N0,N1,N2,N3 rates of 0,70,90,100 kg/f for w,

(6):N0,N1,N2,N3 rates of 0,80,100,120 kg/f for m

,(7):N0,N1,N2,N3 rates of 0,20,40,60 kg/f for p

, (8):N0,N1,N2,N3 rates of 0,20,30,40 kg/f for b.

(9): (Mg/f)-(Megagram 10^{6g}/feddan).

The Cr3Rt1 had wheat following two grain crops (wheat, maize).This particular treatment showed significantly lower yield as compared with Cr1Rt1 and Cr1Rt2 treatments especially where N was applied. This shows that growing wheat following two successive grain yields is of a very negative effect. Therefore, growing wheat after two successive legume crops rendered soil productivity for wheat grain and straw considerably whether N was applied or not applied. This indicates that this particular rotation is the most productive of all rotations for wheat cro

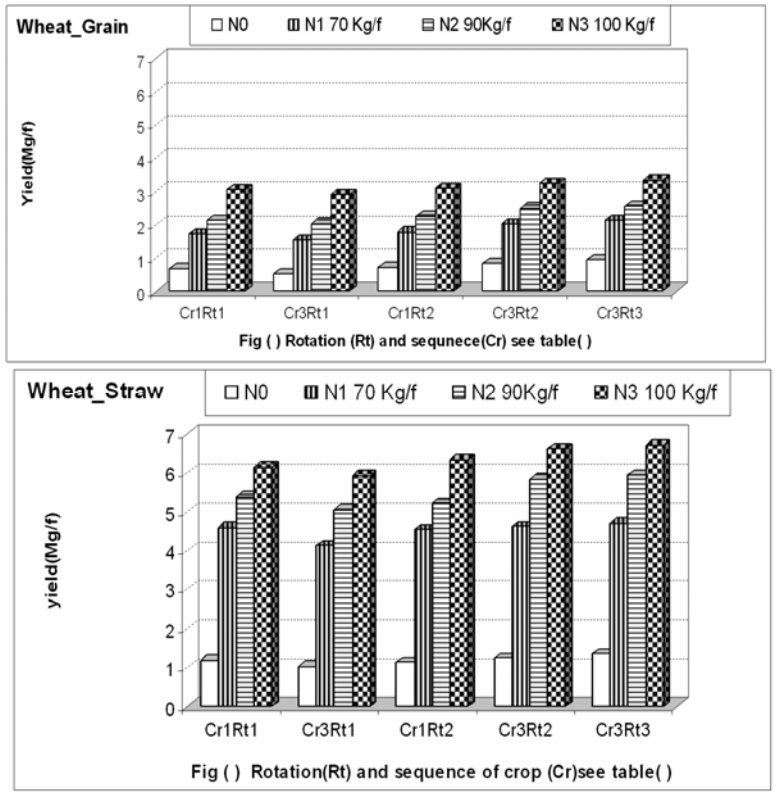

Fig 1: Grains and straw yields of wheat crop as affected by the sequence of the crop (Cr) in its relevant affected rotation (Rt) and N-fertilization levels (wheat was grown in Rt1 ,Rt2 andRt3)

In conclusion, productivity of the rotation (Rt1, Rt2 and Rt3) which included wheat crop show that (Rt3) was the most productive whirs Rt2was the least productive (regarding yield of wheat.) The wheat treatments within these rotations could be arranged in the following descending order:

(a) for yield of grains: Cr3Rt3 > Cr3Rt2 >Cr1Rt2 >Cr1Rt1 >Cr3Rt1
(b) for yield of Straw: Cr3Rt3 > Cr3Rt2 = Cr1Rt1 = Cr1Rt1= Cr3Rt1

In all condition of high Productivity wheat followed a legume crop

Rotation productivity assessed with regard to maize crop:

Maize was included in four rotations, Rt1, Rt2, Rt3and Rt4, and occupied six different position, i.e. different treatments (Cr2Rt1, Cr4Rt1, Cr4Rt2, Cr4Rt3, Cr2Rt4, Cr4Rt4).Table 4 and fig. 2 shows that the highest yield was obtend by Cr4Rt4 followed by Cr2Rt4 both being in rotation (Rt4). This indicates that growing maize following seasons of a legume crop (barseem) gave a high productivity. Thus, this particular rotation (Rt4) proved to be the most productive of all rotations for maize since maize in it was preceded by barseem in both of its sequences i.e. Cr2Rt4, Cr4Rt4. The lowest was Cr4Rt1 (with maize being the fourth crop following three grain crops (i.e. no legume rotation). Thus the main effect show the following order Cr4Rt4 >Cr2Rt4 > Cr4Rt3 >Cr4Rt2 >Cr2Rt1> Cr4Rt1.

Table 4: Grains and stover yield of maize crop as affected by the sequence of the crop (Cr) in its relevant affected rotation (Rt) and N-fertilization levels. (Maize was grown in Rt1 in Rt4).

Crop sequences and relevant rotation (Rt)							
Grain yieldof maize(Mg/f)							
T	Cr2Rt1	Cr4Rt1	Cr4Rt2	Cr4Rt3	Cr2Rt4	Cr4Rt4	Mean
N0	0.75	0.69	0.72	1.18	1.21	1.26	0.97
N1	3.03	2.69	3.42	3.23	3.29	3.32	3.16
N2	3.32	3.19	3.53	3.59	3.67	3.74	3.51
N3	3.45	3.34	3.17	3.65	3.85	3.96	3.57
Mean	2.64	2.48	2.71	2.91	3.01	3.07	2.80
LSD 5%	T 0.03		Rt 0.04		T.Rt 0.08		
Stover yield of maize (Mg/f)							
N0	1.29	1.21	1.32	1.52	1.65	1.73	1.43
N1	5.14	4.91	5.93	5.31	5.74	5.85	5.48
N2	5.89	5.55	6.54	6.15	6.43	6.58	6.19
N3	6.40	6.04	5.23	6.87	6.97	7.15	6.44
Mean	4.68	4.43	4.72	4.96	5.20	5.33	4.89
LSD 5%	T 0.06		Rt 0.07		T.Rt 0.15		

This pattern was particularly evident in presence of applied N at the high rates. However under conditions of no N, the pattern was Cr4Rt4 = Cr2Rt4= Cr4Rt3> Cr2Rt1= Cr4rt1=Cr4Rt2. This reflects the benefit of growing maize following a legume crops, (particularly berseem) as opposed to its cultivation following a grain crop. Therefore, superiority of growing maize

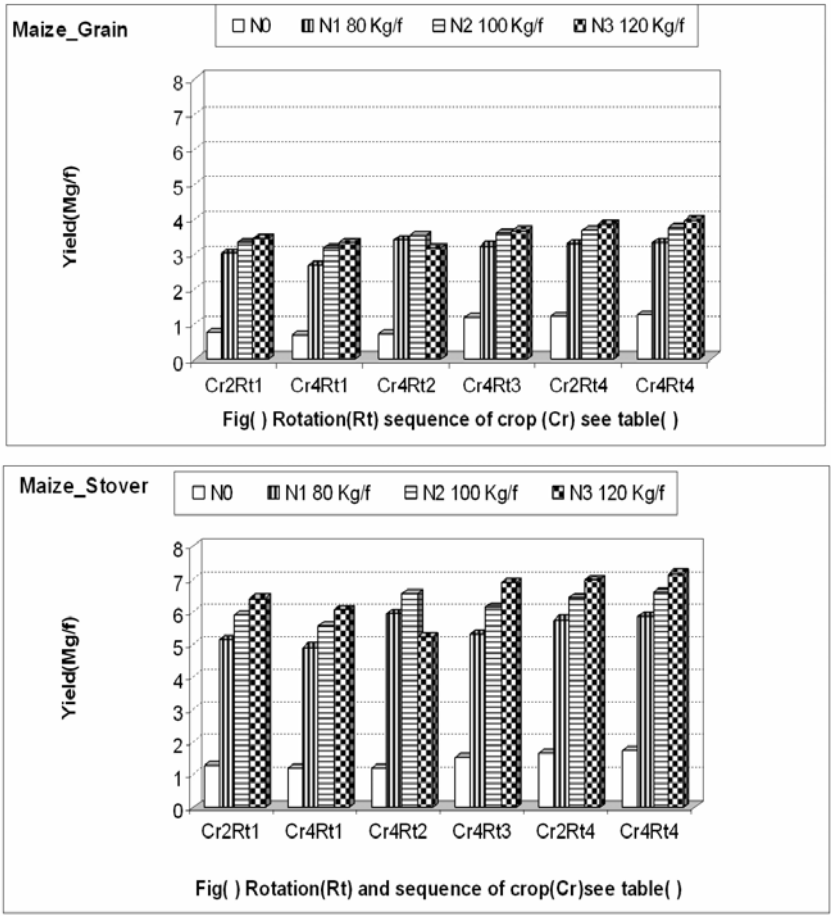

Fig 2: Grains and stover yield of maize crop as affected by the sequence of the crop (Cr) in its relevant affected rotation (Rt) and N-fertilization levels. (Maize was grown in Rt1 in Rt4

Following legumes over its growing following grain crops was particularly evident in presence of N. In absence of added N, the three treatments of Cr4Rt4, Cr2Rt4, and Cr4Rt3 were similar; also the other three treatment Cr4Rt2, Cr2Rt1, and Cr4Rt1were similar. This indicates that superiority of one-legume rotations (Rt2) over the no – legume rotation (Rt1) occurred only where N was applied. Under conditions of no N, the Rt2 did not surpass Rt1 in productivity. Both of the two rotations Rt1 and Rt2 contain grain crops. However one of them (Rt1) contains no legume; the other (Rt2) contains one legume crop (Peanut). Therefore, maize yields in Rt1and Rt2 rotations were lower than in the two other rotations (Rt3 and Rt4).

Available nutrients at end of each rotation:

Tables (5, 6 &7) show the available nutrients (N, P and K) at end of each rotation. It can be concluded that the 1st rotation Rt1 (which included only grain crops) is the lowest with regarding to the available nutrients but the 4th one Rt4 (which included two legume crops Cr1 and Cr3) is the highest in the content of available nutrients i.e. N, P and K. It is clear that the residual effect of legumes is more effective and consequently increasing soil fertility than grain crops.

Table 5: Available N at end of the last crop of each rotation (expressed as kg/f) through 0-100cm depth).

N(kg/f)	Rotation (Rt1)				Rotation (Rt2)			
	N0	N1	N2	N3	N0	N1	N2	N3
Inetial	85	85	85	85	85	85	85	85
N applid	0	300	380	460	0	240	320	400
Residual	43	103	89	43	41	135	132	86
	Rotation (Rt3)				**Rotation (Rt4)**			
Inetial	85	85	85	85	85	85	85	85
N applid	0	190	260	330	0	200	260	320
Residual	31	114	123	123	19	30	29	57

Table 6: Available P at end of the last crop of each rotation (expressed as kg/f) through 0-100cm depth).

P(kg/f)	Rotation (Rt1)				Rotation (Rt2)			
	N0	N1	N2	N3	N0	N1	N2	N3
Inetial	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9
P applid	60	60	60	60	60	60	60	60
Residual	57.6	44.1	38.9	33.2	56.8	45.0	40.2	34.9
	Rotation (Rt3)				**Rotation (Rt4)**			
Inetial	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9
P applid	60	60	60	60	60	60	60	60
Residual	31.0	55.9	43.2	37.1	56.3	38.4	32.8	28.4

Table 7: Available K at end of the last crop of each rotation (expressed as kg/f) through 0-100cm depth).

K(kg/f)	Rotation (Rt1)				Rotation (Rt2)			
	N0	N1	N2	N3	N0	N1	N2	N3
Inetial	140	140	140	140	140	140	140	140
K applid	240	240	240	240	240	240	240	240
Residual	324	126	75	31	319	161	102	57
	Rotation (Rt3)				**Rotation (Rt4)**			
inetial	140	140	140	140	140	140	140	140
K applid	240	240	240	240	240	240	240	240
Residual	321	186	127	101	319	155	113	87

REFERENCES

Bacon, S.C., L.E. Lanyon, and R.M. Schlander, Jr. (1990). Plant nutrient flow in the managed pathways of an intensive dairy farm. Agron J. 82:755–761.

López-Bellido L., Fuentes M., Castillo J.E., López Garrido F.J., Fernández E.J. (1996). Long-term tillage, crop rotation, and nitrogen effects on wheat yield under rainfed Mediterranean conditions, Agron. J. 88: 783–791.

Karlen, D.L., M.J. Mausbach, J.W. Doran, R.G. Cline, R.F. Harris, And G.E. Shuman (1997). Soil quality: A concept, definition, and framework for evaluation. Soil Sci. Soc. Am. J. 61:4–10.

Corbeels M., Hofman G., Van Cleemput O. (1998). Residual effect of nitrogen fertilization in a wheat–sunflower cropping sequence on a Vertisol under semi-arid Mediterranean conditions. Eur. Agron. J. 9:109-116.

Black, C. A. (ed.) (1965). Method of soil analysis, Part 2, Chemical and Microbiological. Properties, American Society of Agronomy, Inc, Madison,USA..

Heichel G.H. (1987). Legumes as a source of nitrogen in conservation tillage systems, in: Power J.F. (ed.), the role of legumes in conservation tillage systems, Soil Conserv. Soc. Am. Iowa, pp. 29–34.

Hirel, B.; J. Le Gouis; B. Ney; and A. Gallais (2007). The challenge of improving nitrogen use efficiency in crop plants: towards a more central role for genetic variability and quantitative genetics within integrated approaches. J. of Experimental Botany 58 (9): 2369-2387.

مقارنة انتاجية الحبوب لبعض ا لدورات المختلفة في وجودمحصول بقولي او عدمه مزروعة في تربة رملية في منطقةجنوب التحرير-مصر

[*] رأفت سرور السيد عبد العال.[**] رجب نبيه قمح. [*] هيثم محمد شحاته سالم [*]*حسين فتحى شاكر المنصورى

* قسم الاراضي كلية الزراعة- مشتهر جامعة بنها
**قسم خصوبة وميكروبيولوجيا الاراضي مركز بحوث الصحراء- القاهرة

نفذت سلسلة تجارب لمقارنةو لتقييم انتاجية محاصيل الحبوب في4 دورات زراعية بجنوب التحرير (غرب الدلتا) فى مواسم شتاء 2005/2004 ، صيف 2005 ، شتاء 2006/2005 ، صيف 2006. وكانت الدورات كما يلى:

- الدورة الأولى Rt1 وتشمل (قمح - ذرة - قمح - ذرة).
- الدوة الثانية Rt2 وتشمل (قمح - فول سودانى - قمح - ذرة).
- الدورة الثالثة Rt3 وتشمل (برسيم - فول سودانى - قمح - ذرة).
- الدورة الرابعة Rt4 وتشمل (برسيم - ذرة - برسيم - ذرة).

أجريت الدراسة فى تجارب عاملية بتصميم قطاعات كاملة العشوائية فى ثلاث مكررات ، حيث قسمت المساحة إلى 48 قطعة تجريبية بمساحة 10×12م للقطعة الواحدة. وكان الفول السودانى هو المحصول المنزرع فى منطقة التجربة قبل تنفيذ الدراسة.

وقد أضيف النيتروجين بثلاث معدلات (منخفض - متوسط - مرتفع) بالإضافة إلى معاملة المقارنة (صفر نيتروجين)، وكانت هذه المعدلات مختلفة لكل محصول على حده وذلك كما يلى:

- للقمح (صفر - 70 - 90 - 110 كجم ن /فدان).
- للذرة (صفر - 80 - 100 - 120 كجم ن /فدان).
- للفول السودانى (صفر - 30 - 40 - 60 كجم ن /فدان).
- للبرسيم (صفر - 20 - 30 - 40 كجم ن /فدان).

ويمكن ايجاز أهم النتائج المتحصل عليها من هذه الدراسة فيما يلى:

A) أدت إضافة المعدل المرتفع من النيتروجين إلى تحسين النمو والإنتاجية لكل المحاصيل.

B) انت المحاصيل النجيلية أكثر استنزافاً للمغذيات الموجودة بالتربة مقارنة بغيرها من المحاصيل البقولية.

قد تم تقييم إنتاجية التربة تبعاً لتاثرها بالدورة ، وذلك بدلالة الاستجابات المحصولية لمحاصيل الحبوب (القمح - الذرة) وفقاً لارتباطها بموقع المحصول فى الدورة. كانت إنتاجية الحبوب فى كل الحالات أكبر عندما كان محصول الحبوب يلى محصول بقولى مما لو كان يلى محصول حبوب.