Egypt. J. Soil. Vol. 42, No. 3, pp. 463-477 (2002)

Soil Fertility Status as Affected by Different Fertilzer Levels and 5 Crop Rotations under Rainfed Conditions at North Sinai

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UNDER RAINFED conditions in North Sinai, 2 locations namely El-Barth (sandy loam to loamy soil) and Rafah (sandy soil) were selected for a long term trial with 4 fertilizer treatments: control, NP, organic manure, and (NP+organic manure) and 5 crop rotations : (Barley/ fallow) (I) Wheat/Wheat (II) Barley/Barley (III), Barley/Peas (IV) and Barley/Lentil (V). The experiment was carried out at both locations. Soil samples were collected before planting as well as after 2 years of crop rotation to determine the concentration of N, P, K, and organic matter content, as well as Zn, Fe, Mn, and Cu in the soil and to evaluate the effect of the fertilizer treatments under the above mentioned crop rotations. Results obtained show the following:

At El-Barth location (Low rainfall) : The building up of the nitrogen, phosphorus and manganese content was improved under the different crop rotations, while the content of potassium and iron were not affected. Zinc and copper soil contents were decreased, especially under monocropping barley rotation. Regarding yield data of the two growing seasons 1996/97 and 1997/98, it was found that barley grain yield was increased by improving soil fertility status.The increases in the yield in 1997/98, were high compared with the yield in 1996/97 due to the high amount of rainfall (220 mm) in the growing season 1997/98, compared with the irregular rainfall amount (80mm) in the season 1996/97.

At Rafah location (Medium rainfall): The building up of the nitrogen, phosphorus, iron, zinc and manganese content was improved in comparison with the concentration of these nutrients at the beginning of the field trial. However, the potassium and copper concentration decreased with about 50% versus their concentration at the begining of the experiment. The grain yield of the season 1996/97 was higher than the one of 1997/98. This could be attributed to the lower soil K-content due to the high raifall amount (390 mm), which lead to the movement of soluble K from the root zone of the sandy soil in this region.

Key words : Soil fertility, Rainfed conditions, North Sinai.

The rainfed area of North of Sinai, which is about 100000 feddan, suffers from low and erratic rainfall, rapid deterioration of ground water, wind erosion, lack of land use policy, absence of crop rotation, with the prevailing monocropping barley, and deficiency in plant nutrients, organic matter and lack of fertilizer supply.

Worldwide, research on fertilization under rainfed condition is very limited, and even more limited in Egypt. The application of phosphate fertilizers showed to increase the yields of wheat, barley and most food and forage legumes. Matter (1977), Hajji Matter (1984) and Somell (1984) studied the relationship between soil fertility, environment and effect of multisite in the dry areas. They demonstrated the importance of nitrogen and phosphorus in yield improvement of cereals in general and especially in barley in Syria. Cooper *et al.* (1987) reported that nitrogen responses are closely related to amounts of rainfall and tend to decrease with decreasing available soil moisture. However, El Sayed *et al.* (1998) reported that addition of nitrogen and phosphorus at the rate of 35kg N + 35 kg P_2O_5/ha in North Sinai increased the grain and straw yield of barley and also the N and P-content of grain and straw.

Experimental Work

A long-term trial (LTT) was carried out in the 1996/97 growing winter season and in 1997/98 as well (2 years crop rotation), at Rafah location (5km from the sea) and at El Barth location (25 km from the sea) to evaluate the following factors:

A- Five crop rotations:

1- Barley/ Fallow 2- Wheat/ Wheat 3- Barley/Barley

4- Barley/ Peas 5- Barley/ Lentil.

B- Four fertilizer treatments:

1- Control

2- NP

3- Manure

4- Manure + NP

Organic manure(5m^3/fed.), nitrogen (20 kg N/fed.) and phosphorus (20 kg P_2O_5/ fed.) were applied prior to planting and incorporated into the soil. The experimental design was a complete randomized block design in 3 replicates with a plot size of 500 m^2.

Soil analysis

Soil surface samples (0- 30cm) were collected from each plot individually prior to planting (0 - time) and afier a 2 -years crop rotation and subjected to chemical analysis for the available macronutrients (N, P and K), according to Jackson (1973), micronutrients (Fe, Zn, Mn and Cu), according to Lindsay and Norvell (1978) and soil organic matter content, according to Walkely and Black (1934). At harvest, grain and straw were collected and the yield statistically analysed.

Content of chicken manure

N %	K%	P%	Fe ppm	Zn ppm	Cu ppm	Mn ppm
1.56	0.35	0.4	456	90	15	90

Mechanical soil analysis :

Location	Depth cm	Sand %	Silt %	Clay %	$CaCO_3$ %	O.M. %	Texture
ElBarth	0-30	65.5	19.9	14.6	17.85	0.28	Sandy Loam
	30-60	70.2	18.8	11.0	28.05	0.25	
Rafah	0-30	92.8	4.4	3.4	2.8	0.07	Sandy
	30-60	92.4	3.4	2.8	2.6	0.06	

Results and Discussion

Under rainfed conditions in North Sinai, two locations (El Barth and Rafah) were selected and a long term trial with 4 fertilizer treatments (control, NP, organic manure and NP + organic manure) and five crop rotations (barley/ fallow (I); wheat/wheat (II); barley/barley (III); barley/ peas (IV) and barley/lentil (V) was carried out at both locations. Soil samples were collected at zero time (prior to planting), as well as after the two years crop rotations to determine the concentration of N, P, K and organic matter as well as Zn, Fe, Mn and Cu in the soil and to evaluate the effect of the different fertilizer treatments and the above mentioned crop rotations on the sustainability of the soil fertility and its productivity in both locations. Soil analysis and yield obtained in two experiments are described.

El Barth location

Organic matter

In comparison with the zero time sample at the start of the experiment, it was found that soil organic matter content was significantly increased by about 58-47 % under fallow rotation, monocropping wheat rotation and barley/lentil rotation, with no apparent difference among fertilizer treatments. However, it was still low since its content in the soil was only 0.27-0.28 % . On the other hand, soil organic matter content was not affected by different treatments under the rotations of monocropping barley/ barley (Table 1).

Macronutrients (N, P and K)

Soil nutrient build-up of nitrogen and phosphorus was improved by different treatments under the investigated crop rotations especially phosphorus (Table 1). Nitrogen content was nearly doubled, but it was still very low (19-20 ppm), maybe due to its high leachability, where as phosphorus build-up was strongly improved since it increased from 1-3 ppm for zero time sample to 10-12 ppm after two-years crop rotation. Noteworthy, the medium level soil Olsen-P content required by most crops is 10-15 ppm, according to Mengel and Kirkby (1978). In the meanwhile, soil K-content was not enhanced by different fertilizer treatments and remained at low level (171-174 ppm) or different investigated crop rotations, maybe because K-fertilizer application was not involved in fertilizer treatments. This shows that K-fertilizer application is necessary to improve soil K build-up and to have a good nutrient balance in the soil for plant growth. It was also noticed that there were slight differences among the treatments or crop rotations in the available N, P and K soil contents.

Micronutrients

The data of micronutrients (Fe, Zn, Mn and Cu) showed that available Fe in the soil was slightly affected by fertilizer treatments compared with zero-time sampling. Samples taken after the fallow rotation and barley/ peas rotation showed slight increase (3.0-4.2 ppm), while the other rotations showed no effects. It was observed that the soil Fe content fell in the medium range (2-4 ppm).

In the meanwhile, soil contents of both Zn and Cu decreased under different treatments and crop rotations, compared with zero time samples. The available zinc content decreased from 0.8-1.6 ppm for zero time samples to 0.7 ppm under the investigated rotations. The decrease was pronounced (from 1.6 ppm to 0.7 ppm) under monocropping barley rotation, while monocropping wheat rotation recorded the least (from 0.8 to 0.7 ppm). Soil analysis showed a marked decrease in the available Cu- content compared to zero time samples. It decreased from 1.5-3.5 ppm for the zero time sample to 0.8-0.9 ppm after two-years crop rotation. Again, the monocropping barley rotation recorded the highest decrease (from 3.5 ppm to 0.8 ppm) the monocropping wheat rotation showed the least decrease (from 1.5 ppm to 0.9 ppm). Noteworthy, the available Cu- content fell in the sufficient range for plant growth, according to Mortvedt *et al*. (1992) while zinc fell in the medium range. This indicates that the studied crops especially barley, need more zinc and copper and both micronutrients should be included in the fertilizer recommendation to achieve building-up of soil fertility. On the other hand, the available Mn was strongly increased by different treatments under different crop rotations. The fallow rotation showed the highest increase from 1.4 ppm for zero time sample to 3.9 ppm, while the barley/lentil recorded the least increase from 3.1 ppm for zero time sample to 3.6 ppm after 2-years crop rotation. It is noteworthy to mention that there were no apparent differences among the fertilizer treatments or rotations, but the availability of Mn soil content reached the sufficient range for growing most crops (Table 2).

Finally, it could be concluded that nutrient build-up of nitrogen, phosphorus and manganese were improved under different crop rotations, while soil contents of K and Fe, which were in the medium range, were not affected. Zn- and Cu- contents were declined, especially under monocropping barley rotation, and they were still in the medium range for growing different crops.

TABLE 1. Soil fertility status as affected by crop rotations and fertilizer levels after 2-years crop rotation under rainfed conditions in North Sinai, Loc. El Barth, 1998 (LTT).

Crop Rot.:	Barley/ Fallow				Wheat/ Wheat				Barley/ Barley				Barley/ Pea				Barley/ Lentil			
Fert.levels	O.M.%	N	P	K	O.M.%	N	P	K	O.M.%	N	P	K	O.M.%	N	P	K	O.M.%	N	P	K
	ppm																			
0 time 1996	0.17	14	3	163	0.17	10	1	149	0.29	10	2	182	0.19	11	3	146	0.25	10	3	196
Control	0.26	20	10	168	0.27	21	12	175	0.26	19	10	168	0.25	18	12	165	0.25	18	11	168
NP	0.27	20	10	181	0.28	19	13	172	0.25	19	11	173	0.30	20	11	177	0.27	21	12	169
Manure	0.28	21	11	175	0.26	20	12	168	0.26	19	10	176	0.28	19	13	175	0.27	19	11	174
Manure+NP	0.27	20	10	177	0.28	20	10	165	0.28	19	10	177	0.24	19	13	178	0.26	20	11	172
Mean	0.27	20	10	175	0.27	20	12	170	0.26	19	10	174	0.28	19	12	174	0.26	20	11	171

TABLE 2. Soil fertility status as affected by crop rotations and fertilizer levels after 2-years crop rotation under rainfed conditions in North Sinai, Loc. El Barth, 1998 (LTT).

Crop Rot.:	Barley/ Fallow				Wheat/ Wheat				Barley/ Barley				Barley/ Pea				Barley/ Lentil			
Fert.levels	Fe	Zn	Mn	Cu	Fe	Zn	Mn	Cu	Fe	Zn	Mn	Cu	Fe	Zn	Mn	Cu	Fe	Zn	Mn	Cu
	ppm																			
0 time 1996	3.1	1.0	1.4	2.2	4.7	0.8	1.8	1.5	4.0	1.6	2.2	3.5	3.0	0.9	1.9	2.7	3.6	1.1	3.1	2.9
Control	3.7	0.7	3.4	0.8	3.7	0.7	3.8	0.9	4.2	0.7	3.8	0.9	3.7	0.7	4.2	0.8	3.1	0.7	3.7	0.8
NP	3.7	0.7	4.1	0.7	3.6	0.6	4.1	0.8	3.8	0.7	3.7	0.8	4.2	0.6	3.8	0.8	3.7	0.7	3.6	0.9
Manure	4.1	0.8	4.2	0.7	4.1	0.7	3.6	0.8	4.0	0.7	3.6	0.7	3.5	0.7	3.7	0.8	3.6	0.6	3.5	0.8
Manure+NP	3	0.7	3.8	0.8	4.0	0.6	3.9	0.9	3.6	0.8	3.6	0.8	3.8	0.7	4.0	0.9	3.5	0.7	3.4	0.8
Mean	3.8	0.7	3.9	0.8	3.9	0.7	3.9	0.9	3.9	0.7	3.7	0.8	3.8	0.7	3.9	0.8	3.5	0.7	3.6	0.8

Regarding yield data during the two growing seasons 1996/97 and 1997/98 (Table 3), it was noticed that barley grain yield was improved by improving soil fertility status. It was increased from 0.541 to 1.82 t/ha under fallow rotation; from 0.607 to 1.01 t/ha under monocropping barley rotation; from 0.534 to 1.65 t/ha under barley/peas rotation and finally from 0.616 to 1.74 t/ha under barley /lentil rotation. The fallow rotation recorded the highest increase compared with the other ones including barley rotations. On the other hand, wheat grain yield as well as pea and lentil seed yield, were slightly affected (Table 3) One of the most important factors compared for increasing production at El-Barth in 1997/98 was the higher amount of rainfall in the season 1997/98 (220 mm), compared with the season 1996/97 (80 mm).

2.Rafah location

Five prevailing rotations were also set up in the 1996/97 and 1997/98 growing seasons. Barley was involved in four rotations, *i.e.* monocropping barley rotation, barley-pea, barley-lentil and fallow rotation, while wheat was included in monocropping wheat rotation. Soil samples were taken after two-year crop rotation and subjected to chemical analysis for organic matter, and available macro- and micro- nutrients. The results were compared to those of zero time samples to evaluate soil fertility status.

Organic matter

It was noticed that organic matter soil content markedly increased in this location with different fertilizer treatments and rotations (Table 4). The barley/peas rotation showed the highest increase (from 0.13 to 0.26 %), while the wheat monocropping showed the least increase (from 0.18 to 0.25 %). It was also observed that the organic manure treatment and barley/peas rotation gave the highest value (0.3 %). However the soil was still very poor in organic matter content since the organic matter content ranged from 0.22 to 0.26 % after the 2-years crop rotation.

Macronutrients (N, P and K)

The available N level was nearly doubled under the fallow rotation and tripled under the other rotations, after 2-years crop rotations. It increased from 10 ppm for zero time sampling to 21 ppm under fallow rotation and from 6 - 8 ppm to 19 - 22 ppm under the other rotations. However, it remained in the low range (<40 ppm). Regarding the available soil P-status, it was markedly improved by different treatments under different rotations. The available P-level increased from 4 ppm for zero time sample to 10 - 12 ppm after 2-years crop rotation reaching to the medium range required by different crops.

TABLE 3. Mean values of soil fertility parameters as affected by fertilizer treatments and different 5 crop rotations at El-Barth Location

Crop Rot.:	Barley/ Fallow				Wheat/ Wheat				Barley/ Barley				Barley/ Pea				Barley/ Lentil			
Macronutrients(ppm) and Organic matter (%)																				
	N	P	K	OM	N	P	K	OM	N	P	K	OM	N	P	K	OM	N	P	K	OM
0-time	14	3	163	0.17	10	1	149	0.17	10	2	182	0.29	11	3	146	0.19	10	3	196	0.25
After 2-yr. Rot.	20	10	175	0.27	20	12	170	0.27	19	10	174	0.26	19	12	174	0.28	20	11	171	0.26
Micronutrients (ppm)																				
	Fe	Zn	Mn	Cu	Fe	Zn	Mn	Cu	Fe	Zn	Mn	Cu	Fe	Zn	Mn	Cu	Fe	Zn	Mn	Cu
0-time	3.1	1.0	1.4	2.2	4.7	0.8	1.8	1.5	4.0	1.6	2.2	3.5	3.0	0.9	1.9	2.7	3.6	1.1	3.1	2.9
After 2-yr. Rot.	3.8	0.7	3.9	0.8	3.9	0.7	3.9	0.9	3.9	0.7	3.7	0.8	3.8	0.7	3.9	0.8	3.5	0.7	3.6	0.8
Grain yield t/ha	1996 / 97		0.541		1.01				0.61				0.534 + 2.485 pea				0.616 + 0.321 Lentil			
	1997 / 98		1.82		1.00				1.01				1.65 + 2.03 pea				1.74 + 0.511 Lentil			

TABLE 4. Soil fertility status as affected by crop rotations and fertilizer levels after 2-years crop rotation under rainfed conditions in North Sinai, Loc. El Barth, 1998 (LTT).

Crop Rot.:	Barley/ Fallow				Wheat/ Wheat				Barley/ Barley				Barley/ Pea				Barley/ Lentil			
Fert.levels	O.M.%	N	P	K	O.M.%	N	P	K	O.M.%	N	P	K	O.M.%	N	P	K	O.M.%	N	P	K
ppm																				
0 time 1996	0.16	10	4	142	0.18	6	4	148	0.11	7	4	163	0.13	8	4	172	0.15	8	4	156
Control	0.23	20	10	82	0.28	22	10	74	0.23	18	10	75	0.22	19	10	71	0.24	21	10	77
NP	0.27	20	11	73	0.25	19	10	67	0.22	20	10	74	0.25	22	11	73	0.26	22	11	70
Manure	0.27	20	9	71	0.25	21	10	70	0.20	19	9	72	0.30	22	9	70	0.24	19	11	75
Manure+NP	0.25	23	12	75	0.23	19	11	72	0.23	20	10	74	0.28	21	10	76	0.27	22	12	77
Mean	0.26	21	11	75	0.25	20	10	71	0.22	19	10	74	0.26	21	10	73	0.25	21	11	75

On the contrary, the available K-content showed pronounced decreases under the studied rotations. The available K-content decreased from 142 - 172 ppm for zero time samples to 71 - 75 ppm after 2-years crop rotation which represents 50.44 % of K-level at zero time (at the start of the experiment). These results show clearly that plants depleted more K and a fertilizer package of recommendations should comprise K- fertilizer application. It is worth mentioning that there were no or only slight differences among the investigated treatments.

Micronutrients (Fe, Zn, Mn and Cu)

In comparison with the zero time samples, the available Fe, Zn and Mn levels were strongly improved by different treatments. The Fe-level increased from 4.2 for zero time samples to 6.0 ppm after 2-years crop rotation under the fallow rotation and from 2.2 - 2.9 ppm for zero time samples to 5.2-5.8 ppm after 2-years crop rotation, exceeding the medium range (2 - 4 ppm) required by most crops. The monocropping wheat rotation showed the highest enhancement in Fe-level, while fallow rotation recorded the least Fe-level. In the meanwhile, the available Zn- level was markedly enhanced by the different studied treatments under different crop rotations. It was increased from 0.7 to 2.3 ppm under fallow rotation, from 0.5 to 2.2 ppm with monocropping wheat rotation, from 1.1 to 2.2 ppm under monocropping barley rotation and from 0.8 to 2.1 ppm under barley/ legume rotation, reaching the sufficient level required by crops under all crop rotations. The Mn-content also increased from 1.3-1.5 ppm for zero time samples to 2.0 - 2.4 ppm after 2-years crop rotation, reaching the medium range required by different crops.

On the contrary, the available Cu-level under different treatments was declined after 2-years crop rotations. The monoculture wheat rotation recorded the highest decrease (from 2.2 ppm for zero time samples to 1.1 ppm after 2-years rotation) and the monoculture barley rotation showed the lowest decrease (from 1.4 to 1.1 ppm) and barley/peas rotation showed no marked changes in the available Cu after 2-years crop rotation. However, the available Cu level is still in the range needed by different crops (Table 5).

Finally, it could be concluded that building-up of soil fertility status for N and P, as well as Fe, Zn and Mn was well improved by different fertilizer treatments without pronounced differences among them. However, the available

K- and Cu-levels were decreased, showing that inclusion of K-fertilizer in fertilizer recommendation is necessary.

Although there was an improvement in most nutrient building-up, yield data showed decreases to a different extent under different rotations. Barley grain yield decreased from 2.5 t/ha in 1996/97 to 2.2 tha in 1997/98 under fallow rotation, from 2.4 to 0.9 t/ha under monocropping barley rotation, from 2.5 to 2.2 t/ha under barley rotation and from 2.6 to 2.1 t/ha under barley/lentil rotation. It was noticed that the monocropping barley rotation showed the highest decrease in barley grain yield. Wheat grain yield also showed a pronounced decrease from 2.4 to 0.6 t/ha, peas seed yield from 2.5 to 1.4 t/ha and lentil yield from 1.1 to 0.5 t/ha. The decreases in yield could be attributed to unfavorable climatic conditions, especially the rate of rainfall during the 1997/98 growing season at Rafah.

Discussion and Conclusion

Under rainfed conditions in North Sinai, the soil suffers from low and erratic rainfall, absence of crop rotation with the prevailing monocropping barley, soil deficiency in plant nutrients, low organic matter content and lack of fertilizers supply. The soil analysis before the start of both experiments at El Barth and Rafah locations (0-time), showed a low concentration of macro- and micronutrients and organic matter as well (tables 1, 2, 4 and 5). After a 2-years crop rotation, using chemical and organic fertilizers (NP; organic manure and NP+ organic manure) under five different crop rotations, the soil analysis indicated an improvements of most levels of plant nutrients, which were positively reflected by the increase of the production of barley, wheat, peas and lentil, compared with the control treatment, (tables 3 and 6). These results are in agreement with those of Matter (1977 and 1984); Hajji (1984); Somell (1984) and El Sayed *et al.* (1998), who reported that yield of barley, wheat and most food forage legumes increased by application of nitrogen and phosphorus fertilizers under rainfed conditions.

In loamy soil, like in El-Barth location, the obtained grain yields of barley, wheat, peas and lentil were higher in the growing season 1997/98 than those obtained in 1996/97. This could be attributed to the increase of the regular

TABLE 5. Soil fertility status as affected by crop rotations and fertilizer levels after 2-year crop rotation under rainfed conditions in North Sinai, Loc. Rafah, 1998 (LTT).

Crop Rot.:	Barley/ Fallow				Wheat/ Wheat				Barley/ Barley				Barley/ Pea				Barley/ Lentil			
Fert.levels	Fe	Zn	Mn	Cu	Fe	Zn	Mn	Cu	Fe	Zn	Mn	Cu	Fe	Zn	Mn	Cu	Fe	Zn	Mn	Cu
ppm																				
0 time 1996	4.2	0.7	1.5	2.3	2.4	0.5	1.4	2.2	2.2	1.1	1.3	1.4	2.6	0.8	1.3	1.0	2.9	0.8	1.4	1.7
Control	6.4	2.5	2.3	1.3	6.2	2.2	1.9	1.2	5.2	2.1	1.8	0.9	5.2	2.1	1.9	0.9	4.9	1.9	1.9	1.1
NP	6.1	2.3	2.7	1.3	6.6	2.4	2.3	1.1	5.5	2.1	2.2	1.0	5.4	2.2	1.7	1.3	5.4	7.2	2.0	1.3
Manure	5.8	2.0	2.5	1.2	5.2	1.8	1.8	1.1	5.1	2.4	2.0	1.1	6.1	1.7	2.1	1.2	4.8	2.0	1.9	1.1
Manure+NP	5.7	2.5	2.2	1.2	5.3	2.3	2.4	1.1	5.7	2.3	2.4	1.2	5.3	2.4	2.2	1.1	5.2	2.4	2.3	1.2
Mean	6.0	2.3	2.4	1.3	5.8	2.2	2.1	1.1	5.4	2.2	2.2	1.1	5.5	2.1	2.0	1.1	5.2	2.1	2.0	1.2

TABLE 6. Mean values of soil fertility parameters as affected by fertilizer treatments and different 5 crop rotations as Rafah Location, 1998 (LTT).

Crop Rot.:	Barley/ Fallow				Wheat/ Wheat				Barley/ Barley				Barley/ Pea				Barley/ Lentil			
Macronutrients(ppm) and Organic matter (%)																				
	N	P	K	OM	N	P	K	OM	N	P	K	OM	N	P	K	OM	N	P	K	OM
0-time	10	4	142	0.16	6	4	148	0.18	7	4	163	0.11	8	4	172	0.13	8	4	156	0.15
After 2-yr. Rot.	21	11	75	0.26	20	10	71	0.25	19	10	74	0.22	21	10	73	0.26	21	11	75	0.25
Micronutrients (ppm)																				
	Fe	Zn	Mn	Cu	Fe	Zn	Mn	Cu	Fe	Zn	Mn	Cu	Fe	Zn	Mn	Cu	Fe	Zn	Mn	Cu
0-time	4.2	0.7	1.5	2.3	2.4	0.5	1.4	2.2	2.2	1.1	1.3	1.4	2.6	0.8	1.3	1.0	2.9	0.8	1.8	1.7
After 2-yr. Rot.	6.0	2.3	2.4	1.3	5.8	2.2	2.1	1.1	5.4	2.2	2.2	1.1	5.5	2.1	2.0	1.1	5.2	2.1	2.0	1.2
Grain yield t/ha	1996 / 97		2.509		2.407				2.436				2.504 + 2.513 pea				2.586 + 1.08 Lentil			
	1997 / 98		2.210		0.560				0.900				2.17 + 1.370 pea				2.060 + 0.540 Lentil			

rainfall amount (220 mm) in season 97/98 compared with the irregular rainfall amount (8Omm) in the season 1996/97. Furthermore, the high moisture content of the soil under these conditions enhanced and it increased the activity and the availability of the plant nutrients in the rhizosphere, which covered the requirements for plant growth. A certain amount of these nutrients was stiu found after harvesting time. In this connection, Schilling *et al.* (1998) reported that in the rhizosphere, a mixture of rhizodeposition and' its conversion products exists, which affects the binding of phosphorus in the soil and the P-transport to the roots. Cooper *et al.* (1987) mentioned that nitrogen responses are closely related to the amount of rainfall and tended to decrease with decreasing available soil moisture. However, in sandy soil like at Rafah location, the soil fertility status was improved, except for the level of potassium, which decreased to about 50% from the level at the start of the experiment. This may be due to the low level of field capacity in a sandy soil, as well as to the high rainfall amount in that season (390mm), which removed potassium from the root zone to the deeper and that may lead to the unbalanced ratio of the nutrients in the soil solution. In this case, potassium could be a limiting factor for plant growth (concentration of K ranged between 71-75 ppm) .

Acknowledgment: We would like to thank ICARDA for their technical and financial support .

References

Cooper, M., Gregory, D. Tully and Harris, H.C. (1987) Improving water use efficiency of annual crops in the rainfed farming system of West Asia and North Africa. *Expt. Agric.* **23,** 113.

El Sayed , A., Kadry , W., Noaman, M. and Mosehy, M. (1998) Response of barley to nitrogen and phosphorus fertilization under rainfed agriculture conditions in Egypt. *Conference of Rainfed Agriculture in Arabic Countries, Cairo, 7-9 March* (1998).

Hajji, K.L. (1984) The relationship between soil content of phosphorus and the response of wheat to phosphate in rainfed agriculture . In : *Proceedings of Soil Directorate / ICARDA, Workshop of Fertilizer Use in the Dry Areas ;* pp. 138-150.

Jackson, M.L. (1973) " Soil Chemical Analysis". Prentice Hall of India Private limited. New Delhi.

Lindsay, W.L. and Norvell, W.A. (1978) Development of DTPA soil test for zinc, iron, manganese and copper. *Soil Sci. Soc. Amer.* **3. 42,** 421.

Matter, A. (1977) Yields and response of cereal crops to phosphate fertilization under changing rainfall conditions. *Agron.* **3. 69,** 879-881.

Matter, A. (1984) Barley productivity of rainfed soils as related to soil precipitation and fertilization in a pilot area of Syria. In: *Proceedings of Soil Directorate/ ICARDA, Workshop of Fertilizer Use in the Dry Areas;* pp. 121-137.

Mengel, K. and Kirkloy, E.A. (1978) Principles of Plant Nutrition Der Bund, AG. Been/Switzerland.

Mortvedt, J.J., Giordane, P.M. and Lindsay, W.L. (1992) *Micronutrients in Agriculture".* Soil Science Society of America, Inc. Madison, Wisconsin, USA.

Schilling, G., Gransee, A., Deubel, A., LeVzovic, O. and Ruppel, S. (1998) Phosphorus availability , root exudates and microbial activity in the rhizosphere, *Z.Pflanzenernabr. Bodenk.,* **161,** 465.

Somell, K. (1984) Environmental variability and multiple site, multiple-season trials. Discussion paper No. 12, Farming System Program (FSP)/ ICARDA. In : *Proceedings of Soil Directorate/ ICARDA, Workshop of Fertilizer Use in the Dry Areas.*

Walkley, A. and Black, I.A. (1934) An examination of the degl-arff method for determining soil organic matter of the chromic acid titration method. *Soil Sci.* **37,** 29.

(*Received* 10/2000)

تأثير خصوبة التربة بمعاملات التسميد المختلفة تحت خمس دورات محصولية فى ظروف الأراضى المطرية بشمال سيناء

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تم اختيار موقعين هما البرث (رملية طميية-طميية) ورفح (تربة رملية) تحت ظروف المطر بشمال سيناء لاقامة تجربة مستديمة تشتمل على اربع معاملات سمادية (المقارنة -ن فو-سماد عضوى-ن فو + سماد عضوى) وخمسة دورات محصولية (شعير/بور) - (قمح / قمح)-(شعير/شعير) - (شعير/بسلة) - (شعير/عدس) وقد أجريت هذه التجربة فى كلا الموقعين . وقد تم أخذ عينات تربة قبل الزراعة وبعد عامين من الدورات المحصولية وذلك لتقدير تركيز كل من النيتروجين والفوسفور والبوتاسيوم والمادة العضوية علاوة على الزنك والحديد والمنجنيز والنحاس فى التربة لتقييم أثر المعاملات السمادية تحت الدورات المحصولية سابقة الذكر وقد أوضحت النتائج المتحصل عليها مايلى :

موقع البرث : (امطار منخفضة) تحسن مستوى النيتروجين والفوسفور والمنجنيز تحت ظروف الدورات المحصولية المختلفة بينما محتوى التربة من البوتاسيوم والحديد لم يتأثر . محتوى التربة من الزنك والنحاس قد انخفضت خاصة تحت ظروف دورة المحصول الواحد (شعير / شعير)وفيما يتعلق ببيانات المحصول للموسمين ١٩٩٩٦ / ١٩٩٧ ، ١٩٩٧/ ١٩٩٨ وجد أن محصول الشعير يزداد بتحسن حالة خصوبة التربة .الزيادة فى الموسم ١٩٩٧/١٩٩٨ كانت اكثر منها بالموسم ١٩٩٦ /١٩٩٧ وذلك راجع لزيادة كمية مياه المطر المنتظمة (٢٢٠مم) فى الموسم ١٩٩٧/١٩٩٨ مقارنة بكمية مياه المطر المنخفضة وغير المنتظمة فى الموسم ١٩٩٦/١٩٩٧ (٨٠ مم) .

موقع رفح : (معدلات أمطار معتدلة) لوحظ تحسن خصوبة

التربة بالنسبة لتركيز النيتروجين والفوسفور والحديد والزنك والمنجنيز مقارنه بتركيز هذه العناصر عند بداية التجربة . مع ذلك فان تركيز كل من البوتاسيوم والنحاس انخفض بمعدل ٥٠ ٪ عنه فى بداية التجربة .

محصول الحبوب فى الموسم ١٩٩٦/١٩٩٧ كان أعلا من المتحصل عليه فى الموسم التالى ١٩٩٧ / ١٩٩٨ . وقد يرجع ذلك لانخفاض محتوى التربة من البوتاسيوم لارتفاع معدل المطر (٣٩٠ مم) الذى ادى الى تحرك البوتاسيوم الذائب خارج نطاق المجموع الجذرى تحت ظروف الأراضى الرملية بهذا الموقع .