Performance of Two Barley Cultivars as Influenced By N-Fertilization and Crop Rotations under Rainfed Conditions in the Northwest Coast of Egypt

Naem M. Moselhy[1] and Ragb. M. Aly[2]
[1] Sustainable Development Center for Matrouh Resources, Desert Research Center, Egypt.
[2] Agronomy Department., Fuclty of Agricultur, Zagazig Univ., Egypt.

Received on: 17 10/2010 ***Accepted: 13 /12/2010***

ABSTRACT

Four field experiments were carried out at Ras El-Hekma (56 km east of Marsa Matrouh city) under rainfed conditions during the period from 2003 to 2007 in order to obtain reliable information about the performance of two barley cvs. (Giza 125 and Giza 126) as influenced by three N-fertilization levels (zero, 40 and 80 Kg N/ ha) and three crop rotations; i.e., barley after barley (B/B), barley after fallow (B/ F) and barley after vetch (B/ V).

The obtained results showed that Giza 126 was superior to Giza 125 in different grain yield attributes, grain and straw yields, as well as water use efficiency (WUE) in all years of the study. However, the reverse was always true in respect with field stubble yield. With few exceptions, results, generally, showed that B/ V rotation recorded the highest values of grain yield and its attributes, as well as WUE in all years. On the other hand, B/ B rotation recorded the lowest values of all the above mentioned traits in most cases. It was observed that, in the relatively drier first three years, grain yield and its attributes, as well as WUE for grain production, showed a positive consistent and significant response to N-increments up to the higher level (80 Kg N/ ha). This was, also, the same for field stubble yield in the fourth year. With the relatively high rainfall precipitation, that occurred in the fourth year, grain yield attributes, grain and straw yields, as well as WUE, also, showed a positive response to N application, but only up to 40 Kg/ ha.

Ultimately, results of the present work concluded that WUE could be enhanced and, hence, an economic grain yield of barley could be obtained with the choice of the adaptable Giza 126 cv. along with the application of the optimal N level for each followed crop rotation; i.e., 80 Kg N/ ha in B/ B and B/ F rotations and 40 Kg N/ ha in B/ V rotation.

Key words: crop rotation, yield attributes, straw and grain yields, vetch, N-fertilization, water use efficiency.

INTRODUCTION

The long-term average rainfall precipitation in the Northwest coast (NWC) zone of Egypt is about 140 mm/ year. Rainfall precipitation in this area is confined to the winter growing season. Barley is the most adapted and wide spread cereal and forage crop under rainfed conditions in that area, where livestock keeping is the main source of farm income in the arid (Moselhy, 2001) and semi-arid regions (Watts and El-Mourid, 1988).

In wet years, rainfed growing of barley covers about 83000 ha in the NWC plateau of Egypt. But, in dry years, this area is reduced by about 40-50 % (MRMP, 2002). However, the expansion in rainfed mono-cropping planting led to deterioration of native plant resources and exposed soil surface to wind erosion (Jones and Singh, 1995). The main problems confronting rainfed growing in eroded soils of arid and semi-arid sandy soil areas are the low water and nutrient elements conservation, due to the removal of soil organic matter. Under such conditions, many studies demonstrated the benefits of certain crop rotations, especially when these rotations included different crop species (Karaca *et al.*, 1991). For instance, it was found that leguminous crops provide the subsequent cereals with part of their nitrogen needs (Reeves, 1991; Papastylianou and Panayiotou, 1993; Cook, 2006). The advantages of barley –leguminous rotations over continuous planting of barley were, also, recorded by Pala (1994), in Syria and Moselhy (1999) in Egypt.

It is clearly evident, under low rainfall precipitation (120-150 mm/year), that nitrogen fertilizer application, at sowing, has a somewhat favorable effect on grain yield of barley. However, under high rainfall precipitation, split application of N-fertilizer over the vegetative growth stages, also, increased grain yield and grain protein content of barley (Mason, 1975). However, recovery of applied N by wheat in the dryland is commonly less than 50 percent (White *et al.*, 1994). The optimal response of wheat and barley, in Syria, increased from 50 Kg N/ ha, under rainfed conditions, to 100 Kg N/ ha under supplemental irrigation (Oweis *et al.*, 1998).

The present study was aimed to obtain dependable information about the performance of two barley cultivars when grown in different crop rotations and their response to N-fertilizer application under rainfed conditions of the NWC of Egypt.

MATERIALS AND METHODS

The present experiments were carried out under rainfed conditions in El-Hebla plateau (11 km south of Ras El-Hekma), 56 Km east of Marsa Matrouh, Northwest coast of Egypt, during four seasons (2003/04, 2004/05, 2005/06 and 2006/07). This study was aimed to study the effect of different crop rotations and nitrogen fertilizer levels on productivity of two barley cultivars.

The treatments were two barley cultivars (Giza 125 and Giza 126), three crop rotations; i.e., barley after barley (B/B), barley after fallow (B/F) and barley after green grazed vetch (B/V), as well as three nitrogen levels; i. e., zero (N_0), 40 Kg N/ ha (N_1) and 80 Kg N/ ha (N_2). The field experiments were established in the 2002/ 2003 season, where the plots of vetch and barley were sown as preceding crops and plots as fallow were left without planting.

Seeds of barley (*Hordeum vulgare*, L.), at a rate of 72 Kg/ha for both cultivars, were broadcasted after rainfall. Treated seeds (soaked in water for 12 hr.) of vetch (*Vicia monantha*, L.), at a rate of 50 Kg/ ha, were used each growing season. The sowing date of barley and vetch differed from season to season, according to the onset of effective rainfall. The sowing dates after effective rainfall were 15^{th}, 5^{th}, 10^{th}, 20^{th} of Nov. for the first, second, third and fourth seasons, respectively.

The experiments were laid out in a strip-split plot design, with four replicates. The two barley cultivars were allocated in the main plots, while, the sub-plots were devoted to crop rotations and nitrogen levels were distributed in the sub-sub-plots. Each sub-sub plot area was 100 m^2 (5 m wide x 20 m long). Each sub-plot of crop rotation treatments was divided into two sections for sowing the alternate crops in a two-course rotation every winter season.

The nitrogen fertilizer was added in the form of ammonium nitrate (33.5 % N) in one dose as soil application on sowing time. Other cultural practices were applied as usual in barley fields under rainfed conditions.

The soil of the experimental site was sandy-loam in texture. Soil chemical analysis indicated the presence of 0.022-0.025 % available nitrogen, 22-27 ppm phosphorus and high $CaCo_3$ content (23-26 %). The EC of the soil ranged between 0.23 to 0.25 mmhos/cm (Lab. of Desert Research Center at Matrouh).

The amount and distribution of rainfall during the experimentation periods are shown in Table (1). Rainfall distribution was uniform with a suitable amount only in the last season, compared to the previous three winter seasons. The total amount of rainfall was 91.0, 122.0, 113.2 and 140.1 mm for 2003/04, 2004/05, 2005/06 and 2006/07 winter seasons, respectively.

Table 1: Monthly rainfall (mm) during the four growing seasons of the study.

Season	Month							Total
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	
2003/2004	0.0	0.0	14.5	36.5	33.5	6.5	0.0	91.0
2004/2005	0.0	17.4	25.4	42.7	36.5	0.0	0.0	122.0
2005/2006	0.0	7.6	32.9	34.2	33.5	5.0	0.0	113.2
2006/2007	0.0	0.0	33.5	22.6	31.0	33.0	20.0	140.1

Source: Meterological Station of Matrouh Resource Management Project (MRMP).

At harvest time, 50 m^2 from each experimental unit was used to determine grain yield and its components for barley, as well as field stubble, which was estimated as Scandinavian feed units (SFUs), where, one Kg of barley grain equals one SFU, while, one Kg of dry matter equals 0.45 SFU (Le Houerou, 1986). Vetch plots were fenced and grazed by Barqi sheep at 50% of flowering stage each growing season. Water use efficiency (WUE), for grain production per mm of rain water, was calculated.

The collected data were statistically analyzed, according to Snedecor and Cochran (1967). Duncan's multiple range test was used for comparison among means (Duncan, 1955).

RESULTS AND DISCUSSION

A. Cultivars differences:

Data, presented in Table 2, showed a significant difference between the two cultivars of barley in plant height, spike length, number of tillers/m^2, number of spikes/ m^2 and number of grains/ spike overall the four years of study, as well as 1000-grain weight only in the later two years. Giza 126 cv. was superior to Giza125 in such characters. The obtained results indicated that Giza 126 overestimated Giza 125 with 10.0, 9.5, 9.2 and 9.3 % in number of spikes/ m^2 and with 16.9, 17.2, 17.4 and 15.7 % in number of grains/ spike over the four years, in a respective order. Moreover, grains of Giza 126 were heavier than those of Giza 125 with about 12.2 and 13.4 % in the third and fourth years, respectively. These results indicated that Giza 126 cv. had a genetic makeup that enabled it to use the limited environmental resources of such areas more efficiently.

Consequently, Giza 126 significantly outyielded Giza 125 in grain, straw and field stubble yields, except in the year of high rainfall; i.e., the fourth one, where, the differences between the two cultivars, in grain and straw yields, did not reach the level of significance (Table 3). Nevertheless, the percentage of increase in grain yield of Giza 126, over Giza 125, reached 33.8, 38.7, 36.9 and 24.4 % in the four years, in a respective order. Meanwhile, as shown in Table 3, it is clear that Giza 126 used rainfall water more efficiently than Giza 125. Even though, the increase in WUE by grain yield of Giza 126 over Giza 125 reached 34.4, 38.8, 36.9 and 24.4 % in the four years, in a respective order. The higher values of Giza 126 over Giza 125, in grain yield and WUE, reflected that Giza 126 enjoyed an efficient root system, which had a certain penetration and/ or ramification ability that enabled the plants to absorb more water. These results are in harmony with those obtained by Megahed and Mohamed (2001); Abdel-Hamid and Mohamed (2002) and Abdel-Hameed *et al.*, (2005).

B. Effect of crop rotations:

As shown in Table 2, results of the first three years revealed that barley/ vetch (B/V) rotation gave the tallest barley plants, followed by barley/ fallow (B/F), then, barley/ barley (B/B) rotations. However, the differences amc ıg the three rotations, in plant height, were not significant in the fourth year of high rainfall. Also, results of the first three years showed that B/V rotation recorded the highest values of tillers number/ m^2 and number of spikes/ m^2, followed by B/F, then, B/B rotations. But, in the fourth year of a high rainfall, B/V and B/ F rotations had a similar higher number of tillers/ m^2 and number of spikes/ m^2, as compared with B/B rotation. Moreover, results of the four years indicated that B/V rotation attained the longest spikes and the highest number of grains/ spike, while, B/ B rotation recorded the lowest values of both traits. As observed from data of 1000-grain weight, though the differences among the three rotations were not significant in the first two years, but, with the advance to the third and fourth years, the B/V rotation produced the heaviest grains, followed by B/F, then, B/B rotations. These results, generally, reflected the favorable effect for B/V rotation in water conservation, as compared with B/B under conditions of such areas.

Table 2: Effect of cultivars, crop rotations and nitrogen fertilizer levels on grain yield attributes of barley in the four growing seasons.

Main effects	Plant height (cm)				Spike length (cm)			
and interactions	2003/04	2004/05	2005/06	2006/07	2003/04	2004/05	2005/06	2006/07
Cultivars (C):								
Giza 125	58.1 b	58.6 b	56.8 b	60.3 b	5.18 b	5.25 b	5.10 b	5.24 b
Giza 126	63.5 a	64.4 a	62.6 a	64.2 a	5.98 a	6.06 a	5.94 a	5.97 a
F. test	*	*	*	*	*	*	*	*
Rotations (R):								
Barley after Barley	55.8 c	55.4 c	53.9 c	59.8	4.82 c	4.84 c	4.97 c	4.97 c
Barley after Fallow	60.2 b	61.0 b	59.4 b	61.3	5.66 b	5.78 b	5.99 b	5.61 b
Barley after Vetch	66.4 a	68.0 a	65.8 a	65.6	6.26 a	6.63 a	6.17 a	6.23 a
F. test	*	*	*	N.S	*	*	*	*
N. levels (N):								
0 Kg N/fed.	56.1 c	56.6 c	54.8 c	58.4 b	5.13 c	5.19 c	5.07 c	5.18 b
40 Kg N/fed.	61.9 b	61.9 b	60.4 b	63.2 a	5.71 b	5.77 b	5.64 b	5.80 a
60 Kg N/fed.	64.5 a	65.9 a	62.9 a	65.1 a	5.90 a	6.01 a	5.85 a	5.83 a
F. test	*	*	*	*	*	*	*	*
Interactions:								
C x R	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
C x N	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
R x N	*	*	*	*	*	*	*	*
C x R x N	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
Main effects	**Number of tillers/ m^2**				**Number of spikes/ m^2**			
and interactions	2003/04	2004/05	2005/06	2006/07	2003/04	2004/05	2005/06	2006/07
Cultivars (C):								
Giza 125	237.1 b	239.7 b	235.8 b	236.5 b	162.3 b	168.6 b	154.6 b	163.1 b
Giza 126	252.1 a	254.2 a	250.6 a	252.8 a	178.6 a	184.6 a	168.9 a	178.2 a
F. test	*	*	*	*	*	*	*	*
Rotations (R):								
Barley after Barley	231.2 c	233.1 c	228.7 c	233.7 b	160.7 c	165.5 c	151.3 c	162.1 b
Barley after Fallow	247.9 b	250.3 b	246.4 b	248.2 a	172.0 b	178.5 b	163.4 b	172.9 a
Barley after Vetch	254.6 a	257.6 a	254.4 a	252.0 a	178.6 a	185.6 a	170.5 a	176.9 a
F. test	*	*	*	*	*	*	*	*
N. levels (N):								

0 Kg N/fed.	234.0 c	237.2 c	233.1 c	234.9 b	161.5 c	168.2 c	152.9 c	161.8 b
40 Kg N/fed.	247.4 b	249.4 b	245.8 b	248.5 a	172.9 b	178.6 b	164.0 b	173.8 a
60 Kg N/fed.	251.9 a	254.3 a	250.7 a	250.6 a	176.9 a	182.9 a	168.2 a	176.3 a
F. test	*	*	*	*	*	*	*	*
Interactions:								
C x R	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
C x N	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
R x N	*	*	*	*	*	*	*	*
C x R x N	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

Main effects and interactions	Number of grains/ spike				1000-grain weight (g)			
	2003/04	2004/05	2005/06	2006/07	2003/04	2004/05	2005/06	2006/7
Cultivars (C):								
Giza 125	25.89 b	26.30 b	25.07 b	26.41 b	29.8	30.29	27.22 b	27.29 b
Giza 126	30.27 a	30.82 a	29.44 a	30.56 a	30.86	31.02	30.53 a	30.96 a
F. test	*	*	*	*	N.S	N.S	*	*
Rotations (R):								
Barley after Barley	24.01 c	24.17 c	23.39 c	24.94 c	31.21	31.13	27.42 c	27.79 c
Barley after Fallow	28.74 b	29.33 b	27.72 b	29.06 b	29.12	29.63	28.71 b	29.11 b
Barley after Vetch	31.49 a	32.17 a	30.67 a	31.44 a	30.65	31.18	30.50 a	30.47 a
F. test	*	*	*	*	N.S	N.S	*	*
N. levels (N):								
0 Kg N/fed.	25.22 c	25.67 c	24.72 c	25.44 b	26.27 b	26.55 b	26.07 c	26.57 b
40 Kg N/fed.	28.69 b	28.87 b	27.61 b	29.89 a	33.58 a	32.43 a	29.72 b	30.40 a
60 Kg N/fed.	30.32 a	31.11 a	29.44 a	30.11 a	31.14 a	32.96 a	30.84 a	30.40 a
F. test	*	*	*	*	*	*	*	*
Interactions:								
C x R	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
C x N	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
R x N	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
C x R x N	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

*: Significant at 0.05 level of probability, N.S: Not significant.
Values followed by similar letters are not significantly different at P < 0.05 by Duncan's multiple range test.

As evident from results in Table 3, B/V rotation produced the highest straw and field stubble yields, followed by B/F, then, B/B rotations. A similar trend was found for grain yield in the two years of low rainfall; i.e., the first and third years, while, in the other two years of relatively high rainfall, B/V and B/F rotations were similar in producing higher grain yield than B/B rotation. The superiority of B/V and B/F rotations over B/B one, in grain yield, was in coincidence with high WUE by the former two rotations over the latter rotation (Table 3). The superiority of B/V rotation over B/ F, in grain yield of the drier years, could be explained through the role of preceding legume crop in improving the supply of nitrogen to the subsequent barley. These results are in harmony with those obtained, under rainfed conditions in Syria, by Pala (1994) and Christiansen *et al.*, (1994), and in the NWC of Egypt by Abdel Aleem and Sabry (1994) and Moselhy (1999).

C. Effect of nitrogen fertilization:

Results in Table 2 clarified that barley plant height, spike length, number of tillers and spikes/ m^2, as well as number of grains/ spike showed a positive and significant response to N application, in the relatively drier first three years, up to the higher level tested; i.e., 80 Kg/ ha. But, in the fourth year of relatively high rainfall, the positive response for such traits to N application, only, was up to 40 Kg/ ha. Also, in the two drier years; i.e., the first and the third one, 1000-grain weight of barley positively responded to addition of N up to 80 Kg N/ ha, whereas, the positive response of this trait to N-fertilizer, in the relatively higher rainfall year, only, was up to 40 Kg N/ ha. These results denoted the adverse effect of water stress on N use efficiency by barley.

Similarly, results in Table 3 exhibited a significant response of grain and straw yields, in the first three years, as well as field stubble yield in the four years, to addition of N fertilizer up to 80 Kg N/ ha. However, in the fourth year of relatively high rainfall, the response of grain and straw yields, only, was significant up to 40 Kg N/ ha. These results reflected the favorable role of the relatively higher rainfall during the fourth year in increasing the N use efficiency for production of high grain and straw yields of barley.

Meanwhile, as shown in Table 3, data of the first drier three years indicated positive and consistent significant response in WUE for grain production to added nitrogen up to the higher N level (80 Kg N/ha). But, in the fourth year of high rainfall, the positive response in WUE for grain production to N application was insignificant after addition of 40 Kg N/ha. It is observed, here, that the levels of N-fertilizer, which could enhance WUE for grain yield of barley, varied from one year to another, depending on the amount of rainfall. In other words, the presented results implied that, under certain limits of water availability, high levels of N-fertilizer, applied at sowing, might enhance grain production in barley, when crop plants were exposed to severe water stress. These results are in harmony with those found by Milad (2006). However, under the conditions of relatively high rainfall (more than 150 mm), Mason (1975) demonstrated the favorable effects of split application of N-fertilizer, over the vegetative growth stages, on grain yield and grain protein content of barley.

Table 3: Effect of cultivars, crop rotations and nitrogen fertilizer levels on grain and straw yields, field stubble and water use efficiency in the four growing seasons.

Main effects	Grain yield (t/ ha)				Straw yield (t/ ha)			
and interactions	2003/04	2004/05	2005/06	2006/07	2003/04	2004/05	2005/06	2006/07
Cultivars (C):								
Giza 125	0.713 b	0.692 b	0.672 b	0.798	1.067 b	1.038 b	1.007 b	1.188
Giza 126	0.954 a	0.960 a	0.920 a	0.993	1.423 a	1.434 a	1.378 a	1.477
F. test	*	*	*	N.S	*	*	*	N.S
Rotations (R):								
Barley after Barley	0.702 c	0.679 b	0.645 c	0.814 b	1.048 c	1.014 c	0.968 c	1.206 c
Barley after Fallow	0.850 b	0.853 a	0.818 b	0.900 a	1.230 b	1.278 b	1.225 b	1.341 b
Barley after Vetch	0.947 a	0.946 a	0.923 a	0.927 a	1.418 a	1.416 a	1.384 a	1.449 a
F. test	*	*	*	*	*	*	*	*
N. levels (N):								
0 Kg N/fad.	0.736 c	0.727 c	0.704 c	0.812 b	1.101 c	1.087 c	1.056 c	1.208 b
40 Kg N/fad.	0.853 b	0.846 b	0.810 b	0.917 a	1.275 b	1.266 b	1.214 b	1.364 a
60 Kg N/fad.	0.910 a	0.906 a	0.873 a	0.957 a	1.360 a	1.355 a	1.308 a	1.425 a
F. test	*	*	*	*	*	*	*	*
Interactions:								
C x R	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
C x N	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
R x N	*	*	*	*	*	*	*	*
C x R x N	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
Main effects	**Field stubble (kg/ ha)**				**Water use efficiency (Kg grains/mm)**			
and interactions	2003/04	2004/05	2005/06	2006/07	2003/04	2004/05	2005/06	2006/07
Cultivars (C):								
Giza 125	143.4 a	145.7 a	141.0 a	137.6 a	6.22 b	5.67 b	5.93 b	5.69 b
Giza 126	130.9 b	132.3 b	130.3 b	126.5 b	8.36 a	7.87 a	8.12 a	7.08 a
F. test	*	*	*	*	*	*	*	*
Rotations (R):								
Barley after Barley	150.0 a	153.1 a	148.3 a	142.9 a	6.11 b	5.56 b	5.70 b	5.81 b
Barley after Fallow	133.6 b	134.4 b	132.4 b	130.6 b	7.44 a	6.99 a	7.23 a	6.42 a
Barley after Vetch	127.8 c	129.5 c	126.2 c	122.7 c	8.31 a	7.76 a	8.15 a	6.93 a
F. test	*	*	*	*	*	*	*	*
N. levels (N):								
0 Kg N/fad.	148.0 a	148.2 a	144.4 a	147.4 a	6.22 c	5.96 c	6.22 c	5.80 b
40 Kg N/fad.	136.9 b	138.7 b	134.9 b	133.2 b	7.79 b	6.93 b	7.16 b	6.55 a
60 Kg N/fad.	126.5 c	130.1 c	127.6 c	115.6 c	7.97 a	7.42 a	7.71 a	6.83 a
F. test	*	*	*	*	*	*	*	*
Interactions:								
C x R	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
C x N	N.S	N.S	N.S	N.S	*	*	*	*
R x N	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
C x R x N	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

*: Significant at 0.05 level of probability, N.S: Not significant.
Values followed by similar letters are not significantly different at $P < 0.05$ by Duncan's multiple range test.

D. Effect of interactions:

Data in Tables 2 and 3 showed that crop rotation significantly interacted with N-fertilizer on each of plant height, spike length, number of tillers and spikes/ m^2 and grain and straw yields/ ha, as well as WUE for grain production during the four seasons. Since data, relating to the effects of this interaction on these attributes, did not add valuable information to those of the main effects, representation could be confined to data pertaining the effects of this interaction on grain and straw yields, as well as WUE, where yields are functions of different yield attributes, as shown in Table 4.

The recorded data (Table 4) showed that grain and straw yields of barley in B/ B and B/ F rotations showed a positive and consistent significant response to N-fertilization up to 80 Kg N/ ha, except for grain yield in B/ F rotation in the fourth year, where, the maximum grain yield was recorded when the crop received 40 Kg N/ ha. Meanwhile, the significantly highest grain and straw yields of barley in B/ V rotation were obtained, in different years, when the plants received 40 Kg N/ ha. Moreover, with the application of N level, which maximized barley production, B/ V rotation recorded the highest values of grain and straw yields, compared to the B/ B rotation, except in comparison between grain yield for B/ B and B/ F rotations in the fourth year of a relatively high rainfall precipitation, where, the difference did not reach the level of significance.

Barley cultivars significantly interacted with N level in regard to WUE for grain production of barley, as presented in Table 5. It is obvious, under different levels of N-fertilizer, that the grain yield of Giza 126 used water more efficiently than that of Giza 125. Meanwhile, WUE for grain yield of the two barley cultivars was significantly increased with each N-fertilizer increment up to 80 Kg N/ ha, except for grain yield of Giza 126 in the fourth year with increasing N level from 40 to 80 Kg N/ ha. Under the drier conditions, like that in the first year, the present results concluded that choice of the adapted barley cultivar; i.e., Giza 126, with N fertilization of 80 Kg N/ ha should be demonstrated to enhance WUE for grain production. These results are in harmony with those obtained, under rainfed conditions in Syria, by Oweis *et al.*, (1998).

Table 4: Grain and straw yields (t/ha) as affected by the interaction between crop rotations and N levels throughout the four seasons.

Crop rotations	Nitrogen levels	Grain yield (t/ ha)				Straw yield (t/ ha)			
		2003/ 04	2004/ 05	2005/ 06	2006/ 07	2003/ 04	2004/ 05	2005/ 06	2006/ 07
Barley after barley	Zero	0.492 f	0.535 g	0.511 h	0.646 e	0.742 f	0.803 g	0.767 g	0.963 e
	40 Kg N/ha.	0.690 c	0.690 f	0.651 g	0.841 d	1.035 e	1.034 f	0.975 f	1.242 d
	80 Kg N/ha.	0.823 d	0.811 d	0.775 e	0.955 b	1.233 d	1.205 d	1.162 d	1.413 b
Barley after fallow	Zero	0.703 e	0.745 e	0.723 f	0.838 d	1.050 e	1.116 e	1.083 e	1.242 d
	40 Kg N/ha.	0.867 c	0.883 c	0.841 d	0.926 c	1.285 c	1.322 c	1.258 c	1.382 c
	80 Kg N/ha.	0.922 b	0.931 b	0.891 b	0.936 bc	1.363 b	1.397 b	1.335 b	1.400 bc
Barley after vetch	Zero	0.912 b	0.901 c	0.878 c	0.952 b	1.370 b	1.343 c	1.317 b	1.419 b
	40 Kg N/ha.	0.963 a	0.964 a	0.939 a	0.985 a	1.446 a	1.441 a	1.410 a	1.468 a
	80 Kg N/ha.	0.968 a	0.975 a	0.952 a	0.979 a	1.457 a	1.463 a	1.426 a	1.461 a

Values followed by similar letters are not significantly different at $P < 0.05$ by Duncan's multiple range test.

Table 5: Water use efficiency (Kg grains/mm) as affected by the interaction between cultivars and nitrogen levels in the four seasons.

Cultivars	N levels	2003/04	2004/05	2005/06	2006/07
Giza 125	Zero	6.42 f	5.02 f	5.28 f	5.01 e
	40 Kg N/ha.	7.75 e	5.78 e	5.96 e	5.72 d
	80 Kg N/ha.	8.54 d	6.21 d	6.55 d	6.34 c
Giza 126	Zero	9.02 c	6.89 c	7.15 c	6.57 b
	40 Kg N/ha.	10.71 b	8.08 b	8.35 b	7.37 a
	80 Kg N/ha.	11.34 a	8.63 a	8.86 a	7.31 a

Values followed by similar letters are not significantly different at $P < 0.05$ by Duncan's multiple range test.

Results of the present study indicated that Giza 126 surpassed Giza 125 in grain yield and its attributes overall years. This might be ascribed to the adaptation of the first cultivar to the adverse environmental conditions. compared to the latter cultivar. Also, B/V rotation produced the highest grain yield and its attributes of barley, compared to continuous barley growing. On the other hand, superiority of B/V to B/F, or continuous barley, might be attributed to better adaptability to drought stress of the native vetch and its high ability for nodulation, according to the fact that specialized bacteria are more adapted to stress conditions than those of other food legumes. Results, also, revealed that WUE could be enhanced and, hence, an economic grain yield of barley could be obtained, with the choice of adaptable Giza 126 cv. along with the application of ·he optimal N level for each followed crop rotation: i.e., 80 Kg N/ ha, in B/B and B/ F rotations, and 40 Kg N/ ha in B/ V rotation

REFERENCES

Abdel Aleem, M. M. and S. R. S. Sabry. **1994.** Effect of crop rotation and chemical and biological nitrogen fertilizers on sustainability of wheat production in the northwest coast of Egypt. Proc. 6^{th} Conf. Agon., Al Azhar Univ., Cairo, (1): 351-363.

Abdel-Hameed, I. M. and Salwa, M. A. I. Ash-Shormillesy. **2005.** Effect of nitrogen and micronutrients fertilizations on yield of some barley cultivars grown under sandy soil conditions. Zagazig J. Agric. Res. **32** (5):1381-1401.

Abdel-Hamid, M. and G. A. Mohamed. **2002.** Response of some barley varieties to bio-fertilizers in middle Egypt. Egypt J. Agric. Res. **80** (3): 1189-1200.

Christiansen, S.,F. Bahhady, E. Thomson, M. Singh and A. Ferdawi. **1994.** On-farm trials comparing forage legume/ barley rotation to fallow/ barley rotation and continuous barley in northwest Syria. Pasture, Forage and Livestock Program Annual Report, ICARDA, Aleppo, Syria, PP: 53-67.

Cook, R. J. **2006.** Toward cropping systems that enhance productivity and sustainability. National Academy of the USA, **103** (49): 18389-18394.

Duncan, D.B. **1955.** Multiple range and multiple F-test. Biometrics 11, PP. 1-24.

Jones, M. J. and M. Singh. **1995.** Yields of crop dry matter and nitrogen in long-term barley rotation trials at two sites in northern Syria. J. of Agric. Sci. Cambridge **124** (11): 389-402.

Karaca, M., M. Guler, N. Durutan, K. Meyveci, M. Avci, H. Eyuboglu and A. Avcin. **1991.** Effect of rotation system on wheat yield and water use efficiency in dryland areas of centeral Anatolia. Soil and Crop Management for Improved Water-Use Efficiency in Rainfed Areas. Proc. International Workshop, Ankara, Turkey, May 15-19, 1989, PP: 43-51.

Le Houerou, H. N. **1986.** Salt-tolerant plants of economic value in the Mediterranean basin. Reclamation and Re-vegetation Research **5:** 319-341.

Mason, M. G. **1975.** Nitrogen fertilizers for cereal production. J. Agric. West. Austr. **16**: 3-10.

Megahed, M. A. M. and Samia G. A. Mohamed. **2001.** Evaluation of barley yield under some bio-fertilizers and nitrogen treatments, using some statistical parameters. Zagazig J. Agric. Res. **28** (6): 991-1008.

Milad, R. A. **2006.** Effects of water stress and nitrogen fertilization on growth yield and grain production of barley. Alex. J. Agric. Res. **27** (3): 292-300.

Moselhy, N. M. M. **2001.** Agronomic practices that enhance the productivity of interplanted barley and saltbush (*Atriplex nummularia* L.) shrubs under rainfed conditions on the Northwest coast of Egypt. Desert Inst. Bull. **51**(1): 197-215, Egypt.

Moselhy, M. M. **1999.** Crop rotations for sustainability of rainfed barley production in Egypt's northwest coast. Desert and Dryland Development: Challenges and Potential in the New Millennium. Proc. of the 6^{th} Inter. Conf. on the Development of Dry Lands. 22-27 Aug. 1999, Cairo, Egypt, ICARDA, Aleppo, Syria, PP: 106-111.

MRMP. **2002.** Matrouh Resource Management Project (MRMP) Documents 870, -IDA Credit 2504-EGT. PP: 65-73.

Oweis, T., M. Pala and J. Ryan. **1998.** Stabilizing rainfed wheat yields with supplemental irrigation in a Mediterranean – type climate. Agron. J. **90**: 672-681.

Pala, M. **1994.** Effect of type and harvest time of forage legumes on yields in barley-forage legume rotations. FRMP Annual Report, ICARDA, Aleppo, Syria, PP: 31-44.

Papastylianou, I. and G. S. Panayiotou. **1993.** Productivity and economic and financial profitability of three rainfed rotation systems in Cyprus. Agric. Res. Inst., Mini.Agric. and Natural Resources, Nicosia, Cyprus, Tech. Bull. No. 148.

Reeves, T. G. **1991.** The introduction, development, management and impact of legumes in cereal rotation in Southern Australia. Soil and Crop Management for Improved Water-Use Efficiency in Rainfed Areas. Proc. International Workshop, Ankara, Turkey, May 15-19, 1989, PP: 52-59.

Snedecor, G. W. and Cochran, W. G. **1967.** Statistical Methods. 5^{th} ed. Iowa State Univ. Press, Iowa, USA. PP: 258-380.

Watts, D. and M. El-Mourid. **1988.** Rainfall pattern and probabilities in the semi-arid cereal production region of Morocco. Institute National de la Researche Agronomique, Settat, Morocco, PP: 124-131.

White, P.F., N.K. Nersoyan and S. Christiansen. **1994.** Nitrogen cycling in dry Mediterranean zones: Changes in soil N and organic matter under several crop/ livestock production systems. Aust. J. Agric. Res. **45**: 1293-1307.

الملخص العربى

تأثر أداء صنفين من الشعير بالتسميد النيتروجينى والدورات الزراعية تحت ظروف الزراعة المطرية بالساحل الشمالى الغربى لمصر

نعيم مصلحى محمد[1] ، رجب محمد على[2]

[1]شعبة البيئة وزراعات المناطق الجافة – مركز بحوث

[2] قسم المحاصيل – كلية الزراعة– جامعة الزقازيق.

أجريت هذه الدراسة تحت ظرو ف الزراعة المطرية بمنطقة رأس الحكمة (٥٦ كم شرق مدينة مرسى مطروح) خلال الفترة الممتدة من عام ٢٠٠٣ حتى عام ٢٠٠٧ ، وذلك بهدف دراسة تأثر أداء صنفين من الشعير (جيزة ١٢٥ وجيزة ١٢٦) بالتسميد النتروجينى عند الزراعة (بدون تسميد و ٤٠ و ٨٠ كجم ن/ هكتار) والدورات الزراعية (شعير/ شعير وشعير/ بور وشعير/ بقيا) ، وأثر ذلك على محصول الحبوب ومكوناته فى الشعير. وقد أظهرت النتائج ما يلي:

- تفوق الصنف "جيزة ١٢٦" على الصنف "جيزة ١٢٥" فى محصول الحبوب للشعير ومكوناته وكذلك كفاءة استخدام مياه الأمطار فى انتاج الحبوب خلال كل سنوات الدراسة، وكان العكس جليا فى حاصل مخلفات الحقل بعد الحصاد.
- أظهرت النتائج أن الدورة الزراعية (شعير / بقيا) سجلت أعلى القيم فى صفات محصول الحبوب للشعير ومكوناته ، وكذلك كفاءة استخدام مياه الأمطار فى انتاج للحبوب خلال كل سنوات الدراسة. فى حين سجلت الدورة الزراعية (شعير/ شعير) أقل القيم فى صفات محصول الحبوب للشعير ومكوناته خلال السنوات الأربعة.
- أظهرت كل صفات محصول الحبوب للشعير ومكوناته وكذلك كفاءة استخدام المياه استجابة معنوية لزيادة مستوى السماد النيتروجينى حتى ٨٠ كجم ن/ هكتار خلال الثلاث سنوات الأولى والجافة نسبيا. بينما– فى السنة الرابعة عالية الهطول المطرى نسبيا– فقد أظهرت هذه الصفات استجابة معنوية ولكن فقط حتى مستوى ٤٠ كجم ن/ هكتار.
- يستنتج من هذه الدراسة أن كفاءة استخدام مياه الأمطار يمكنها زيادة الانتاج الاقتصادى للشعير، والذى يمكن الحصول عليه بإختيار الصنف الأكثر تأقلماً (جيزة ١٢٦) وإضافة السماد النيتروجينى بالمستوى الأمثل لكل دورة زراعية (إضافة ٨٠ كجم ن/ هكتار فى الدورتين الزراعيتين: شعير/ شعير وشعير/ بور ، وإضافة ٤٠ كجم ن/ هكتار فى الدورة الزراعية: شعير/ بقيا).