Egypt. J. Agron . **Vol. 33,** No.2, pp.141- 154(2011)

Response of Barley (*Hordeum vulgare* L.) Cultivars to Nitrogen Fertilizer with Sprinkler Irrigation under Sandy Soil Conditions

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TWO FIELD experiments were carried out in the Experimental Farm, El-Khattara Region, Faculty of Agriculture, Zagazig University, Sharkia Governorate, Egypt during two winter successive seasons (2009/2010 – 2010/2011). The experiments aimed to study the response of hull-less barley cultivars (Giza 129, Giza 130 and Giza 131) to nitrogen fertilizer levels (40, 60 and 80 kg N/fed) under sprinkler irrigation in sandy soil conditions.

The obtained results could be summarized as follows: Significant differences between the three barley cultivars in all characters during both seasons and their combined were found. Where barley cultivar Giza 131 followed by barley cultivar Giza 130 recorded the highest values regarding plant height (77.7 and 77.6cm), spike length (6.9 and 6.5cm), number of spikelets per spike(54.6 and 53.9), number of grains per spike(42.25 and 37.82), grain weight per spike(1.80 and 1.66 g) and grain(1.533 and 1.455 ton) and straw yields (2.712 and 2.582 ton/fed), respectively. While Giza 129 gave the lowest values of plant height 75.4 cm, spike length 6.3 cm, no.of spikelets per spike 49.4, no.of grains per spike 37.3, grain weight per spike 1.58g, grain yield 1.445 and straw yield 2.512 ton per fed. The increase of N level from 40 to 60 and 80 kg N/fed was followed by a significant increase in mentioned characters in both seasons and their combined analysis. The significant interaction between the studied factors indicated that planting Giza 131 which receiving the higher dose of N (80 kg N/fed) exceeded those of cultivars Giza 129 and Giza 130. This is expected when Giza 131 gave the highest values of 1000-grain weight (39.36 gm) as well as grain yield (1.600 ton/fed) than those receiving 40 or 60 kg N/fed, whereas, the lower values (37.73 g and 1.542 ton/fed for previous traits, respectively) were achieved by planting Giza 129 and fertilized with the 1st dose of 40 kg N/fed, respectively. The yield could have been maximized to 1.607, 1.654 and 1.602 tons/fed due to predicted N addition of 111.11, 110.86 and 77.14 kg N/fed to cultivars of Giza 129, Giza 130 and Giza 131. Based on response equation, the highest optimum yields was 1.570 ton/fed by using of 99.56 kg N/fed were added to cultivar of Giza 130.

Keywords: Naked Barley (nomenclature), Cultivars, Nitrogen, Sprinkler irrigation, Sandy soil, Feddan= 4200 m^2 = 0.42 from hectare.

Barley (*Hordeum vulgare* L.) is considered to be one of the most important cereal crops in the world as well as in Egypt (FAO, 2007). In Egypt, the national production of cereals is relatively lower than the consumption demands. It was suggested to use barley as a complementary cereal crop to minimize this gab because of barley's ability, compared with other cereal crops, to grow well under the drought conditions common to Egypt and it is mainly used for animal feeding (including both grain and straw) and bread making by Bedowin people living in the desert and dry areas. Many producer showed that barley cultivars differ in growth characters, yield and yield components. Concerning cultivars, Noaman *et al*. (1996) detected a significant difference between three barley cultivars (Giza124 surpassed Giza123 and C.C.89) were grown in sandy reclaimed soil. El-Bawab (1998) indicates that barley cultivar Giza 124 showed the highest grain yield at most localities (high frequency). Cultivar Giza 123 is stable and has high yielding productivity in Upper Egypt, while, L6R93/1 was more adopted for Suez Canal area. El-Hadi *et al*. (1998) revealed that cultivar of Giza 124 surpassed the Giza 121, Giza 123 and composite cross 89 for plant height, flag leaf area, number of spikes m^2, number of grains spike, weight of grains spike, 1000-grain weight and grain yield/fed . El-Kholy & El-Bawab (1998) reported that barley cultivar Giza 124 and barley cultivar Giza 125 gave the highest above mentioned characters except number of spikes m^2 followed by barley cultivar Giza 126 and barley cultivar Giza 128 under newly reclaimed soils. Abd Alla (2004) indicated that the interaction between barley cultivars (Giza 129, Giza 130 and Giza 131) and nitrogen levels (zero, 40 and 80 kg/fed) was significant and showed that grain yield of Giza 131 exhibit in the highest response grain yield to the increase of N level in clay soil. Abd El-Hameed & Ash-Shormillesy (2005) found that both of husked barley cvs. Giza124 and Giza 2000 recorded the highest plant height (90.8 and 91.7cm) and spike length (8.5 and 8.6 cm). Whereas, both of Giza125 and Giza 126 recoded the highest of number of spikelets spike (54.9 and 48.2), number of grains spike (42.1 and 41.3), grain weight spike (2.1 and 1.9 g) and grain (1.698 and 1.684), straw (2.916 and 2.956) and biological yields(4.614 and 4.624 tons/fed, respectively.

Nitrogen plays an important role in plant life and is considered an indispensable element for several vital functions. Barley yield and yield attributes were increased with increasing nitrogen levels in newly reclaimed or sandy soils. El-Sayed *et al*. (1996) found that N fertilizer levels as the most important macro-element for the barley at the poor sandy soils. About 31.3, 32.1 and 31.6% increases in straw, grain and biological yields/fed were achieved with increasing N level from71 to 214 kg N/ha., respectively. Abdel- Hamid & Mohamed (2000) reported that, N fertilizer significantly affected yield and yield attributes of barley. Salem *et al.* (2000) showed that spike length, number of grain per spike, grain weight per spike, 1000-grain weight and grain yield/fed were significantly increased with increasing nitrogen fertilizer levels from 15 to 45 kg N/fed. El-Bawab *et al*. (2003) showed that barley yield responded to N level up to 75 kg/ fed through increasing the most of yield and yield attributes studied. Abd El-Hameed & Ash-Shormillesy (2005) reported that increase of N level from 35 to 70 kg N/fed was followed by a significant increase in plant

height (90.50 cm), spike length (8.48 cm), number of spikelets per spike (52.66), number of grains per spike(42.64), grain weight per spike(2.015 g) grain (1.690 ton), straw (2.806 ton) and biological yields(4.490 ton/fed). Potarzycki & Grzebisz (2007) reported that the highest total grain yield was harvested on plots fertilized with 60 kg N/ha. Ahmed (2009), reported that N increment up to 100 kg/fed had favorable significant effects on plant height, grain weight spike number of grains spike , 1000-grain weight and grain yield. Therefore, this study was aimed to study the response of three cultivars (Giza 129, Giza 130 and Giza 131) to three nitrogen fertilizer levels (40, 60 and 80 kg N/fed) in sandy soil conditions under sprinkler irrigation system during two winter successive seasons (2009/2010 – 2010/2011).

Material and Methods

Two field experiments were carried out in the Experimental Farm El-Khattara Region, Faculty of Agriculture, Zagazig University, Sharkia Governorate Egypt during two winter successive seasons (2009/2010 – 2010/2011). The experiment aimed to study the response of three six rows barley (*Hordeum vulgare* L.) cultivars (Giza 129, Giza 130 and Giza 131) to nitrogen fertilizer levels (40, 60 and 80 kg N/fed) under sandy soil conditions with sprinkler irrigation system. Soil analysis results according to average over of the two seasons for the upper 30 cm of soil depth, field soil was found as sandy texture, had an average pH value of 7.7 ;0.51organic matter and had 12.5, 3.4 and 132 ppm available N, P and K, respectively. Each experiment included 9 treatments which were the combination of three cultivars (*Hordeum vulgare* L.) used were Giza 129, Giza 130 and Giza 131 and three levels of nitrogen fertilizer (40, 60 and 80 kg N / feddan) .

A split plot design with three replicates was used; cultivars were assigned to the main plots, and fertilizer doses were allocated the sub plots. Each plot was 5.0 m^2 (2.5 m. in length and 2.0 m. in width) included 10 rows, 20 cm apart. Seeds (400 grains/m^2) were hand drilled on December 10^{th} and 14^{th} in the first and second seasons, respectively in both seasons. Phosphorus fertilizer was applied during soil preparation in the form of calcium super phosphate (15.5% P_2O_5) with 31.0 kg P_2O_5/feddan. Nitrogen fertilizer levels were 40, 60 and 80 kg N/feddan. Nitrogen in form of ammonium sulphate (20.5% N) was supplied in seven equal doses at 10, 20, 30, 40, 50, 60 and 70 days after sowing. Barley was sown after a fallow in the two seasons. A fixed rate of 50 kg K_20/feddan of Potassium sulphate (48% K_2O) was given partly at sowing and heading. Sprinkler irrigation was scheduled at an almost one week interval during winter and this period was shortened to four or five days from the beginning of spring up to fifteen days before harvest. Normal cultural practices were applied as recommended to region's barley growers.

Response to nitrogen fertilization doses

The present study seeks to find out the differential response of the three newly released barley cultivars to N fertilization levels. Significance of three

cultivars response to N increments and the significant N. C interactions calculated according to Snedecor & Cochran (1981), using the orthogonal polynomial Tables. The significance of the linear and quadratic components of each of the equations was tested and hence the response could be described as linear (first order) or quadratic (second order). The predicted maximum (Y_{max}) and optimums ($Y_{opt.}$) of grain yields, as well as, the predicted maximum ($X_{max.}$) and optimum (X_{opt}) N levels were calculated according to Sukhatme (1941) as explained by Abdul Galil *et al.* (2003) using the following equations:

$Y^{\wedge}$= a+bx-cx2, $Y^{\wedge}_{opt.}$= Y_0 + (b-r)2/4c, (X_{max}) = X_0 + b/2c (u)
$X_{opt.}$ = X_0+ b-r/2c (u) Y_{max} =Y_0 +b2/4c

where: Y_0 =Grain yield at the lowest N level (X_0), *i.e.* 40 kg N /fed (ardab / feddan). Feddan = 4200 m^2 = 0.42 from hectare.
Xopt. = optimum N levels (kg/fed.), Xmax. = maximum N levels (kg/fed), Yopt. = optimum grain yield (ton/fed.) and Y max = maximum grain yield (ton/fed).
b = Measures the linear components of the response equation.
c= Measures the quadratic components of the response equation.
r =q/p, q = Cost of N unit (u) *i.e.* 40 kg N /fed. = 120.0 L.E.
p= price of a unit yield (ardab) = 400 L.E., Ardab=150 kg=0.15 from ton, u= the interval between levels of N.

For all characters under study the predicted maximum averages which could have been obtained if the N level was increased to a certain maximum, *i.e.* $X_{max.}$ were also calculated in order to define the yield limiting components.

Harvest was made during the last week of April in the first and second seasons. Sample of ten guarded plants were taken from each plot to measure: (1) Height of barley plant (from soil surface up to spike tip); ten spikes were randomly selected from each treatment to measure, (2) Spike length (cm), (3) Number of spikelets per spike, (4) Number of grains per spike, (5) Grain weight per spike (g), (6) 1000- grain weight (g), the inner seven rows of each sub- plot by a long of 1.5 m (2.10 m^2) were harvested to determine, (7) Grain yield (ton/ fed) and (8) Straw yield (ton/ fed).

Statistical analysis of each experiment was performed as the methods of Steel & Torrie (1980). Significant differences among the various means for different characters were compared with of Duncan's multiple range test (1955).

Results and Discussion

Plant height (cm), spike length (cm) and number of spikelets /spike

Cultivar differences effect

Results presented in Table 1 show that, plant height, spike length and number of spikelets per spike of the three barley cultivars in both seasons and their combined were affected by N fertilizer levels. It was evident (from the combined

analysis) that barley cultivar Giza131 surpassed in plant height (77.7cm), spike length (6.9 cm) and number of spikelets /spike (54.6) the other two cultivars (Giza 129 and Giza 130). Meanwhile, Giza 129 produced the lowest values (75.4 cm for plant height, 6.3 cm for spike length and 49.4 for spikelet per spike). The differences in plant height, spike length did not reach the level of significance. The differences in number of spikelets per spike among the evaluated three barley cultivars might be attributed to the genetically variations. Several investigators noticed the varietals differences regarding aforementioned traits from them Noaman *et al*. (1996), El-Bawab (1998), El-Hadi *et al*. (1998). Abd Alla (2004) in clay soil and Abd El Hameed & Ash-Shormillesy (2005) in sandy soil conditions with surface irrigation system.

Nitrogen level effect

Regarding the influence of nitrogen fertilization (Table 1), the results revealed significant differences through the two seasons and their mean. Raising nitrogen fertilizer level from 40 to 60 and up to 80 kg N/fed, led to gradual increase in plant height, spike length and number of spikelets per spike of barley plants. Therefore, the highest values of these traits were achieved by addition the high dose of N (80 kg N/fed), while the low rate of 40 kg N /fed gave the lowest one. The average increase for the mean of both seasons for 1^{st} and 2^{nd} N-increment reached about 3.6 and 9.2% for plant height, 11.86 and 22.03% for spike length and 4.4 and 10.77% for no. of spikelets per spike, respectively. Such increment in plant height, spike length and number of spikelets per spike accompanied with increasing N level might be attributed to the stimulation of internodes elongation and enhancing growth. The positive role of nitrogen in plant height, spike length and number of spikelets per spike of barley is extensively reported in the literature where many authors got significant increase in that traits due to addition of nitrogen up to 60 kg N/fed. These results are similar with those obtained by Glelah *et al*. (1992), El-Hadi *et al*. (1998), El-Kholy & El-Bawab (1998) and Ghulan & Al-Joloud (1998), Abdel- Hamid & Mohamed (2000), El-Bawab *et al*. (2003), Abd El Hameed & Ash-Shormillesy (2005) and Ahmed *et al*. (2009) in sandy soil conditions with surface irrigation system.

Interaction effect

As shown in the combined analysis, The interaction effect between barley cultivars and nitrogen fertilizer levels on number of spikelets per spike in Tables 1 and 1-a were significant . It was quite clear from these Tables that addition of N has increased the response of number of spikelets per spike to N increments, this response was linear when N was added up to 80 kg N/fed for three cultivars indicating that need for more N than the highest level tried in this study in order to maximize number of spikelets per spike for all cultivars. Also, receiving Giza 131 the highest amount of nitrogen dose (80 kg N/fed) barley plants gave the highest values of that trait (58.03 spikelet per spike) while, the lowest values (48.23 spikelet per spike) were obtained by Giza 129 when plants receiving the lowest dose of nitrogen (40 kg N/fed).

TABLE 1. Plant height (cm), spike length (cm) and number of spikelets per spike of barley as affected by cultivars, nitrogen fertilizer levels during two successive seasons (2009/2010 - 2010/2011) and their combined.

Main effects and interaction	Plant height(cm)			Spike length(cm)			Number of spikelets per spike		
	2009/ 2010	2010/ 2011	Comb.	2009/ 2010	2010/ 2011	Comb.	2009/ 2010	2010/ 2011	Comb.
Cultivars (C)									
Giza129	75.6	75.3	75.4	6.2	6.5	6.3	48.3	50.6	49.4
Giza130	78.7	76.5	77.6	6.5	6.6	6.5	53.9	53.2	53.9
Giza131	78.4	77	77.7	7.0	6.9	6.9	56.0	53.5	54.6
F-test	NS	NS	NS	NS	NS	NS	**	**	**
$L.S.D_{05}$	---	---	---	---	---	---	4.9	1.3	1.15
Nitrogen fertilization (N)									
40 kg N/fed	74.4	73.2	73.8	6.0	6.0	5.9	49.2	51.0	50.1
60 kg N/fed	76.9	75.9	76.5	6.5	6.8	6.6	52.3	52.3	52.3
80 kg N/fed	81.4	79.7	80.6	7.1	7.3	7.2	56.7	54.0	55.5
F-test	**	**	**	**	**	**	**	**	**
$L.S.D_{05}$	3.4	1.48	1. 97	0.38	0.35	0.30	2.28	1.3	0.93
Interaction									
CXN	NS	NS	NS	NS	NS	NS	*	NS	*

NS, * and **: indicate Not significant, significant and highly significant at 0.05 and 0.01 level, respectively. Comb.= combined, C= cultivars and N= nitrogen fertilization. Feddan= 4200 m^2 = 0.42 from hectare.

TABLE(1-a). Number of spikelet spike of barley as affected by the interaction between cultivars and nitrogen fertilizer levels, as well as, response equations and predicted maximum number of spikelet per spike (Y max) and N level (X max) in the combined data.

Nitrogen fertilizer levels and cultivars	40kgN/ fed	60kgN/ fed	80kgN/ fed	Ave- rage	Y^=a+bx-cx2	X max (NL)	Y max
Giza 129	BC 48.23 b	BA 49.3 b	A 50.8 b	49.44	48.23 + 1.715 x	--------	-------
Giza 130	C 50.4 a	B 53.3 a	A 57.7 a	53.8	50.4+ 5.15 x	--------	-------
Giza 131	C 51.8 a	B 54.4 a	A 58.03 a	54.74	51.8+ 4.145 x	--------	------
Average	50.14	52.33	55.51				

Analysis according to Sukhatme (1941) as explained by Abdul Galil *et al.* (2003).
$Y^{\wedge}$= a+bx-cx2, $Y^{\wedge}_{opt.}$= Y_0 + (b-r)2/4c, (X_{max}) = X_0 + b/2c (u) $X_{opt.}$ = X_0+ b-r/2c (u) Y_{max} =Y_0 +b2/4c where: Y_0 =Grain yield at the lowest N level (X_0), *i.e.* 40 kg N /fed (ardab /feddan).Xopt. = Optimum N levels (kg/fed), X max. = Maximum N levels (kg/fed), Yopt. = Optimum grain yield (ton/fed) and Y max = Maximum grain yield (ton/fed).b = Measures the linear components of the response equation. c = Measures the quadratic components of the response equation. r =q/p, q = Cost of N unit (u), *i.e.* 40 kg N /fed= 120.0 L.E. p = price of a unit yield (ardab) = 400 L.E., Ardab=150 kg=0.15 from ton. u= the interval between levels of N, feddan= 0.42 from hectare.

Number of grains and its weight/spike (gm)

Cultivar differences effect

Results presented in Table 2 show that, number of grains per spike and grain weight per spike of three barley cultivars in both seasons and their combined significantly differed .It was evident that the highest means of the previous characters (42.25 grain per spike and 1.80 gram for grain per spike) were obtained by using Giza 131 when compared with the other cultivars Giza 129 and Giza 130. Meanwhile, Giza 129 produced the lowest values (37.3 grain per spike and 1.58 gram for grains per spike). The differences in number of grains per spike and grain weight per spike (gm) among the evaluated barley cultivars might be attributed to the genetically variations. Several investigators noticed the varietals differences regarding aforementioned traits from them Noaman et al. (1996), El-Bawab (1998), El-Hadi et al. (1998). Abd Alla (2004) in clay soil and Abd El Hameed & Ash-Shormillesy (2005) in sandy soil conditions with surface irrigation system.

TABLE 2. Number of grains per spike and grain weight per spike (g) of barley as affected by cultivars, nitrogen fertilizer levels during two successive seasons (2009/2010 and 2010/2011) and their combined .

Main effects and interaction	Number of grains per spike			Grain weight per spike (g)		
	2009/2010	2010/2011	Comb.	2009/2010	2010/2011	Comb.
Cultivars (C)						
Giza 129	37.2	38.4	37.3	1.54	1.63	1.58
Giza 130	36.3	38.2	37.82	1.61	1.73	1.66
Giza 131	42.2	42.3	42.25	1.74	1.85	180
F-test	*	*	*	*	*	*
$L.S.D_{05}$	4.6	1.5	2.5	0.09	0.04	0.05
Nitrogen fertilization (N)						
40 kg N/fed	36.1	38.2	37.2	1.45	1.57	1.51
60 kg N/fed	38.8	39.6	39.2	1.58	1.74	1.65
80 kg N/fed	40.9	41.1	40.97	1.83	1.90	1.88
F-test	*	*	*	*	*	*
$L.S.D_{0.05}$	1.6	1.5	1.09	0.06	0.03	0.05
Interaction						
C X N	NS	NS	*	*	*	*

NS, * and **: indicate Not significant, significant and highly significant at 0.05 and 0.01 level, respectively. Comb. = combined, C= cultivars and N= nitrogen fertilization. Feddan= 4200 m^2 =0.42 from hectare.

Nitrogen level effect

Regarding the influence of nitrogen fertilization (Table 2) the results revealed significant differences through the two seasons and the combined. Raising nitrogen fertilizer level from 40 to 60 and up to 80 kg N/fed, led to gradual increase in number of grains per spike and grain weight per spike (gm). Therefore, the highest values of number of grains per spike (40.97) and grain weight per spike (1.88 g) were achieved by addition the highest dose of N (80 kg N/fed), while the lowest dose of 40 kg N/fed gave the lowest one (37.2 grain per spike and 1.51 g for grains per spike). The average increase for the mean of both seasons for 1^{st} and 2^{nd} N-increment reached about 5.4 and 10.13% for number of grains per spike and 9.2 and 24.5% for grain weight per spike, respectively. Such increments might be attributed

to the positive role of nitrogen in increasing photosynthesis activity which cause more flower fertility and setting per spike, and stimulation the plant capacity in building more metabolites which translocate to develop grains to increase grain weight. Several investigators, came to the same conclusion; included Glelah *et al.* (1992), El-Hadi *et al.* (1998), El-Kholy & El-Bawab (1998) and Ghulan & Al-Joloud (1998), Abdel- Hamid & Mohamed (2000), El-Bawab *et al.* (2003), Abd El Hameed & Ash-Shormillesy (2005) and Ahmed *et al.* (2009) in sandy soil conditions with surface irrigation system.

Interaction effect

Data of the mean of both seasons, show significant interaction effect between barley cultivars and nitrogen fertilizer levels on number of grains per spike and it's weight in (Tables 2, 2-a and 2-b, respectively). It was quite clear from these tables that addition of N has increased the response of number of grains and it's weight per spike to N increments, this response was linear when N was added up to 80 kg N/fed indicating that need for more N than the highest level tried in this study in order to maximize number of grains per spike and grain weight per spike for all cultivars. But, this response was quadratic in number of grains/spike when using 130 cv. There was a significant decrement of -0.745 grain/spike, indicating a significant bending in the response curve. The data indicate that receiving Giza 131 the highest amount of nitrogen dose (80 kg N/fed) gave the highest values of that traits (45.1 grain per spike and 2.00 g of grains per spike) while, the lowest values (39.2 grain per spike and 1.766 g of grains per spike) were recorded by using Giza 129 which, receiving the low amount of nitrogen dose (40 kg N/fed).

TABLE (2-a). Number of grains spike of barley as affected by the interaction between cultivars and nitrogen fertilizer levels, as well as, response equations and predicted maximum Number of grains/spike /spike (Y max) and N level (X max) in the combined data.

Nitrogen fertilizer levels and cultivars	40kgN/ fed	60kgN/ fed	80kgN/ fed	Average	$Y^{\wedge}$= a+bx-cx2	X max	Y max
Giza 129	CB 35.66 b	B 37.4 b	A 39.2 b	37.42	35.66 +1.83x	-------	-------
Giza 130	B 36.2 b	A 38.26 b	A 38.83 b	37.76	36.2 +2.805x- 0. 745 x2	78.05	38.84
Giza 131	CB 39.73 a	B 41.93 a	A 45.1 a	42.25	39.73 +3.655x	-------	-------
Average	37.19	39.02	41.04				

Analysis according to Sukhatme (1941) as explained by Abdul Galil *et al.* (2003).
$Y^{\wedge}$= a+bx-cx2, $Y^{\wedge}_{opt.}$= Y_0 + (b-r)2/4c, (X_{max}) = X_0 + b/2c (u) $X_{opt.}$ = X_0+ b-r/2c (u) Y_{max} =Y_0 +b2/4c
where: Y_0 =Grain yield at the lowest N level (X_0), *i.e.* 40 kg N /fed (ardab /feddan).Xopt. = Optimum N levels (kg/fed), X max. = Maximum N levels (kg/fed), Yopt. = Optimum grain yield (ton/fed) and Y max = Maximum grain yield (ton/fed).b = Measures the linear components of the response equation. c = Measures the quadratic components of the response equation. r =q/p, q = Cost of N unit (u), *i.e.* 40 kg N /fed= 120.0 L.E. p = price of a unit yield (ardab) = 400 L.E., Ardab=150 kg=0.15 from ton.u= the interval between levels of N, feddan= 0.42 from hectare.

TABLE(2-b). Grain weight (g)/spike of barley cultivars as affected by the interaction between and nitrogen fertilizer levels, as well as , response equations and predicted maximum grain weight (gm)/spike (Ymax) and N level (Xmax) in the combined data.

Nitrogen fertilizer levels and cultivars	40kgN/ fed	60kgN/ fed	80kgN/ fed	Average	Y^= a+bx-cx2	X max (NL)	Y max (gm)
Giza 129	B 1.433 b	B 1.533 bc	A 1.766 b	1.577	1.433 + 0.299 x		
Giza 130	C 1.466 b	B 1.666 b	A 1.900 a	1.677	1.466 +0.251x		
Giza 131	C 1.633 a	B 1.766 a	A 2.000 a	1.799	1.633 + 0.286x		
Average	1.510	1.655	1.888				

Analysis according to Sukhatme (1941) as explained by Abdul Galil *et al.* (2003).
$Y^{\wedge}$= a+bx-cx2, $Y^{\wedge}_{opt.}$= Y_0 + (b-r)2/4c, (X_{max}) = X_0 + b/2c (u) $X_{opt.}$ = X_0+ b-r/2c (u) Y_{max} =Y_0 +b2/4c where: Y_0 =Grain yield at the lowest N level (X_0), *i.e.* 40 kg N /fed (ardab /feddan).Xopt. = Optimum N levels (kg/fed), X max. = Maximum N levels (kg/fed), Yopt. = Optimum grain yield (ton/fed) and Y max = Maximum grain yield (ton/fed).b = Measures the linear components of the response equation. c = Measures the quadratic components of the response equation. r =q/p, q = Cost of N unit (u), *i.e.* 40 kg N /fed= 120.0 L.E. p = price of a unit yield (ardab) = 400 L.E., Ardab=150 kg=0.15 from ton.u= the interval between levels of N, feddan= 0.42 from hectare.

1000-grain weight (gm), grain and straw yields (ton/fed)

Cultivar differences effect

Data given in Table 3 clearly indicate that, Giza 131 produced, the heaviest grains expressed as 1000-grain weight (38.0 g) and gave the highest grain yield (1.533 ton/fed) and straw yield (2.712 ton/fed) followed by Giza 130 (36.5 g,1.455 and 2.582 tons/fed, for previous traits, respectively). While, Giza 129 recorded the lowest means (34.7 g, 1.450 and 2.512 tons/fed for previous traits, respectively) The differences in 1000-grain weight (g), grain yield (ton/fed) and straw yield (ton/fed) among the evaluated cultivars might be attributed to the genetically variations. Several investigators noticed the varietals differences regarding aforementioned traits from them Noaman *et al.* (1996), El-Bawab (1998), El-Hadi *et al.* (1998). Abd Alla, (2004) in clay soil and Abd El- Hameed & Ash-Shormillesy (2005) in sandy soil conditions with surface irrigation system.

Nitrogen level effect

Regarding the influence of nitrogen fertilization, the results revealed highly significant differences through the two seasons and the combined analysis. Meanwhile, raising nitrogen fertilizer level from 40 to 60 and up to 80 kg N/fed, increased 1000-grain weight (g), grain yield (ton/fed) and straw yield (ton/fed). Here, it can be noticed that the increase in grain yield (ton/fed) caused by N-increments up to 80 kg N/fed is in accompaniment with the increase in spike length and number of spikelets per spike (Table 1), consequently, number of grains per spike and grain weight per spike (Table 2) and 1000- grain weight (Table 3) increased with application of N up to the higher level tested (80 kg N/fed). The average increase for the mean of both seasons for 1^{st} and 2^{nd} N-increment reached about 4.62 and 11.56% for 1000-grain weight and 10.53 and 16.6% for grain yield, respectively. These results are in harmony with those

obtained by Glelah *et al*. (1992), El-Hadi *et al*. (1998), El-Kholy & El-Bawab (1998) and Ghulan & Al-Joloud (1998), Abdel- Hamid & Mohamed (2000), El-Bawab *et al*. (2003), Abd El-Hameed & Ash-Shormillesy (2005) and Ahmed (2009) in sandy soil conditions with surface irrigation system.

Interaction effect

Data of the mean of both seasons, show significant interaction effect between cultivars and N fertilizer level on 1000-grain weight (Table 3-a) and grain yield (Table 3-b), again, It was quite clear from these tables that addition of N has increased the response of 1000-grain weight to N increments, this response was linear when N was added up to 80 kg N/fed for three cultivars indicating that need for more N than the highest level tried in this study in order to maximize that trait. Also, each N increment produced a linear increase of 0.192, 0.182 and 0.163 tons/fed. for cultivars Giza 129, Giza 131 and Giza 130, respectively and a significant decrement were -0.027, -0.049 and-0.023 tons / fed in respective order. Hence, high grain yield maximum of 1.607,1.602 and 1.654 tons/fed could be obtained if high N levels of 111.11 , 77.14 and 110.86 kg N/fed in respective order. The results , further indicated that, optimum yields were 1.374, 1.504 and 1.570 tons/fed. could be obtained when 75, 99.56 and 64.58 kg N/fed. were added to the all cvs. in respective order. It can be seen that planting Giza131 which receiving the higher dose of N (80 kg N/fed) gave the higher values of 1000-grain weight (39.36 g) as well as grain yield (1.600 ton/fed) than those receiving 40 or 60 kg N/fed, whereas, the lower values (37.73 g and 1.542 ton/fed for previous traits, respectively) were achieved by using Giza 129 when it was fertilized with the 1st dose of 40 kg N/fed (Tables 3, 3-a and 3-b), respectively.

TABLE 3. 1000-grain weight(g), grain yield (ton/fed) and straw yield (ton/fed) of barley as affected by cultivars, nitrogen fertilizer levels during two successive seasons (2009/2010 and 2010/2011) and their combined.

Main effects and interaction	1000-grain weight(g)			Grain yield (ton/fed)			Straw yield (ton/fed)		
	2009/ 2010	2010/ 2011	Comb.	2009/ 2010	2010/ 2011	Comb.	2009/ 2010	2010/ 2011	Comb.
Cultivars (C)									
Giza 129	35.17	34.3	34.7	1.431	1.450	1.445	2.562	2.443	2.512
Giza 130	36.48	36.4	36.5	1.447	1.452	1.455	2.667	2.575	2.582
Giza 131	48.44	37.5	38.0	1.513	1.548	1.533	2.704	2.723	2.712
F-test	**	**	**	**	**	**	**	**	**
L.S.D$_{0.05}$	1.35	1.24	0.69	0.05	0.07	0.06	0.08	0.14	0.03
Nitrogen fertilization (N)									
40 kg N/fed	34.6	34.8	34.6	1.333	1.378	1.355	2.480	2.485	2.441
60 kg N/fed	36.3	36.0	36.2	1.462	1.495	1.498	2.626	2.575	2.591
80 kg N/fed	39.2	37.4	38.3	1.590	1.577	1.580	2.826	2.682	2.756
F-test	**	**	**	**	**	**	**	**	**
L.S.D$_{0.05}$	0.69	0.75	0.39	0.05	0.06	0.04	0.08	0.04	0.07
Interaction C X N	*	NS	*	*	*	*	*	NS	NS

NS, * and **: indicate Not significant, significant and highly significant at 0.05 and 0.01 level, respectively. Comb.= combined, C= cultivars and N= nitrogen fertilization, Fed.=0.42 from hectare, LSD= least significant difference.

TABLE(3-a). 1000- grain weight (g)/spike of barley as affected by the interaction between cultivars and nitrogen fertilizer levels, as well as, response equations and predicted maximum 1000- grain weight (gm)/spike (Ymax) and N level (Xmax) in the combined data.

Nitrogen fertilizer levels and cultivars	40kgN/ fed	60kgN/ fed	80kgN/ fed	Average	Y^= a+bx-cx2	X max (NL)	Y max (gm)
Giza 129	C 31.56 c	B 34.63 c	A 37.73 b	34.64	31.56 +3. 115 x	------	------
Giza 130	BC 35.6 ab	B 36.10 a b	A 37.86 b	36.52	35.6 + 2.39 x	------	------
Giza 131	CB 36.73 a	B 37.86 a	A 39.36 a	37.98	36.73 +1.635 x	------	------
Average	34.63	36.19	38.32				

Analysis according to Sukhatme (1941) as explained by Abdul Galil *et al.* (2003).
$Y^{\wedge}$= a+bx-cx2, $Y^{\wedge}_{opt.}$= Y_0 + (b-r)2/4c, (X_{max}) = X_0 + b/2c (u) $X_{opt.}$ = X_0+ b-r/2c (u) Y_{max} =Y_0 +b2/4c
where: Y_0 =Grain yield at the lowest N level (X_0), *i.e.* 40 kg N /fed (ardab /feddan).Xopt. = Optimum N levels (kg/fed), X max. = Maximum N levels (kg/fed), Yopt. = Optimum grain yield (ton/fed) and Y max = Maximum grain yield (ton/fed).b = Measures the linear components of the response equation. c = Measures the quadratic components of the response equation. r =q/p, q = Cost of N unit (u), *i.e.* 40 kg N /fed= 120.0 L.E. p = price of a unit yield (ardab) = 400 L.E., Ardab=150 kg=0.15 from ton. u= the interval between levels of N, feddan= 0.42 from hectare.

TABLE(3-b). Grain yield (ton/fed) of barley as affected by the interaction between cultivars and nitrogen fertilizer levels as well as, response equations and predicted maximum and optimum number of spikelets/spike (Y max and optimum) and N level (X max and optimum) in the combined data.

Nitrogen fertilizer levels and cultivars	40kgN/ fed	60kgN/ fed	80kg N/fed	Average	Y^= a+bx-cx2	X max (NL)	Y max (ton)	X Opt. (NL)	Y Opt. (ton)
Giza 129	C 1.266 cb	B 1.431 bc	A 1.542 b	1.413	1.266 +0.192 x - 0.027x2	111.11	1.607	75.0	1.374
Giza 130	BC 1.366 ab	B 1.506 ab	A 1.600 a	1.490	1.366 +0.163 x- 0.023x2	110.86	1.654	99.56	1.57
Giza 131	CB 1.433 a	B 1.566a	A 1.600 a	1.533	1.433 +0.182x- 0.049x2	77.14	1.602	64.58	1.504
Average	1.355	1.501	1.580						

Analysis according to Sukhatme (1941) as explained by Abdul Galil *et al.* (2003).
$Y^{\wedge}$= a+bx-cx2, $Y^{\wedge}_{opt.}$= Y_0 + (b-r)2/4c, (X_{max}) = X_0 + b/2c (u) $X_{opt.}$ = X_0+ b-r/2c (u) Y_{max} =Y_0 +b2/4c
where: Y_0 =Grain yield at the lowest N level (X_0), *i.e.* 40 kg N /fed (ardab /feddan).Xopt. = Optimum N levels (kg/fed), X max. = Maximum N levels (kg/fed), Yopt. = Optimum grain yield (ton/fed) and Y max = Maximum grain yield (ton/fed).b = Measures the linear components of the response equation. c = Measures the quadratic components of the response equation. r =q/p, q = Cost of N unit (u), *i.e.* 40 kg N /fed= 120.0 L.E. p = price of a unit yield (ardab) = 400 L.E., Ardab=150 kg=0.15 from ton. u= the interval between levels of N, feddan= 0.42 from hectare.

Conclusion

It can be seen that planting Giza 131 which receiving the highest dose of N (80 kg N/fed) exceeded those of Giza 129 and Giza 130 . This is expected when Giza 131 gave the highest values of plant height (77.7 cm), spike length (6.9 cm), number of spikelets per spike (54.6), number of grains per spike (42.25), grain weight per spike (1.80 g), 1000-grain weight (39.36 g) as well as grain yield (1.600 ton/fed) than those receiving 40 or 60 kg N/fed, whereas, the lowest values (75.4 cm, 6.3 cm, 49.4, 37.3, 1.58g, 37.73g and 1.542 ton/fed for previous traits, respectively) were achieved by planting Giza 129 and fertilized with the 1st dose of 40 kg N/fed, respectively. The yield could have been maximized to 1.607, 1.654 and 1.602 tons/fed due to predicted N addition of 111.11, 110.86 and 77.14 kg N /fed to cultivars Giza 129, Giza 130 and Giza 131. The results , further indicated that, optimum yields were 1.374, 1.504 and 1.570 tons/fed could be obtained when 75, 99.56 and 64.58 kg N/fed were added to the all cvs. in respective order.

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(*Received* 10/11/2011;
accepted 17/1/2012)

استجابة أصناف الشعير العاري للسماد النيتروجينى تحت نظام الري بالرش بالأراضي الرملية

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اقيمت تجربتان حقليتان خلال موسمى ٢٠٠٩/٢٠١٠و٢٠١٠/٢٠١١ بالمزرعة التجريبية بكلية الزراعة- جامعة الزقازيق بمنطقة الخطارة - بمحافظة الشرقية لدراسة استجابة بعض أصناف من الشعير العاري سداسي الصفوف(جيزة ١٢٩ – جيزة ١٣٠ و جيزة ١٣١) لمعدلات السماد النيتروجينى (٤٠ -٦٠ و٨٠ كجم ن/فدان) .

ويمكن تلخيص أهم النتائج التى تم التحصل عليهاعلى النحو التالى:

١- اختلفت اصناف الشعير العاري معنويا في جميع الصفات تحت الدراسة حيث تفوق الصنف جيزة ١٣١ وتلاه الصنف جيزة ١٣٠ في ارتفاع النبات ، طول السنبلة، عدد السنيبلات بالسنبلة، عدد حبوب السنبلة، وزن حبوب السنبلة، محصول الحبوب و القش (طن للفدان) بينما أعطى الصنف جيزة ١٢٩ اقل القيم لجميع الصفات تحت الدراسة خلال موسمي الدراسة و التحليل المشترك.

٢- أدت اضافة السماد النيتروجينى حتى٨٠ كجم للفدان إلى زيادة معنوية لجميع الصفات السابق ذكرها خلال موسمى الدراسة و التحليل المشترك.

٣- أوضحت نتائج التحليل التجميعى للموسمين التأثير المعنوى لتداخل الفعل بين الأصناف ومستويات السماد النيتروجينى على عدد سنيبلات /السنبلة، عدد حبوب السنبلة، وزن الألف حبة ومحصول الحبوب وتبين أن استخدام الصنف جيزة ١٣١ أو جيزة ١٣٠ وبإضافة ٨٠ كجم نيتروجين للفدان هى أفضل معاملة تم التوصل اليها (التحليل المشترك).أقصى محصول حبوب١,٦٠٧ و ١,٦٠٢و ١,٦٥٤ طن للفدان بإضافة أقصى معدل من السماد النيتروجينى ١١١,١١ و ٧٧,١٤ و ٨٦, ١١٠كجم ن للفدان , وأن مثل محصول ١,٣٧٤ و ١,٥٠٤ و ١,٥٧ طن للفدان بإضافة ٧٥ ، ٩٩,٥٦ و ٦٤,٥٨ كجم ن للفدان للأصناف جيزة ١٢٩ وجيزة ١٣١وجيزة ١٣٠على الترتيب.