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Effects of Water Stress and Nitrogen Fertilization on Growth Yield and Grain Production of Barley

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Abstract

Reclamation of new lands was and still going in rather slow rate not parallel to the increase in population. Therefore increasing the efficiency of production of the existing land will contribute to the solution of this problem. Barley is one of the most important winter cereal crops grown mainly in areas where limited water supply is a feature and crops depend upon rainfall.

The present study was conducted to investigate the effect of water stress and N fertilization on growth yield and grain production of barley and N uptake by plants and N behavior in the soil under investigation. The experiment was carried out under greenhouse conditions in a "Randomized complete Block (RCB) design with three replicates the soil has sandy clay loam and salinity was 7.15 dS/m but sodicity was 11.0. However, total carbonate and organic matter content were 2.05% and 0.71% respectively. The fresh weight of barley increased by increasing period of growth up to elongation and then slightly decreased at the heading stage. Also, the highest fresh and dry matter weight of Barley in general, was obtained by application of N as ammonium sulphate under soil moisture at 100% F.C. Application of N fertilized increased grains yield compared with the unfertilized plants. In addition, application N as ammonium sulphate showed an increase over when urea was used with about 13.7%. Applying N as two equal doses was more effective than when applied as one dose. The relative increase due to splitting the amount of applied N was 147.5% and 132.6% when urea and ammonium sulphate were used respectively. The highest grains yield was obtained by applying N as two doses of ammonium sulphate when soil moisture was maintained around 75% of the soil field capacity.

Keywords: *Barley, Urea, Ammonium, sulphate, Field capacity, water stress.*

1. Introduction

Food habits of people are changing towards increasing consumption of animal protein. Reclamation of new lands was and still going in rather slow rate not parallel to the increase in population. Therefore increasing the efficiency of production of the existing land will contribute to the solution

of this problem. Wheat as well as, Barley are the most important cereal crops in the world. Barley is one of the most important winter cereal crops grown mainly in areas where limited water supply is a feature and crops depend mainly upon rainfall. Barley like any other crops is affected by the agronomic practices, such as irrigation and nitrogen fertilization.

Barley is nutritious and its protein content can be higher and it has a large amount of dietary fiber important for intestinal function and lowering blood cholesterol (Newman, 1984). It is salt tolerant, Barley has the advantage over other cereal crops has less water requirement to grow and produce satisfactorily (FAO, 1987).

Ligon and Benoit (1966), found that the increased soil moisture tension resulted in decreases in total leaf area development, quality and stalk weigh. Hussien and Khadr (1979) and Hussien et. al. (1978) found that the vegetative growth decreased with 80% depletion of soil moisture but was unaffected by 60,40, or 20% depletion. Misra (1976), Misra et al (1980) and Shaaban et al (1983) and Chaturvedi and Sinha (1981) reported that straw and grain yield of barley increased by increasing number of irrigation up to (3, 4 and 5) irrigations, respectively.

El-Monayeri et. al. (1983) found that plant height, fresh and dry weights plants as well as moisture %, decreased with increasing moisture stress. Khattari and Till (1993) found that the 80% of F.C. level. Hooda and Kalra (1977) stated that irrigation increased the grain yield of barley.

Also, Farahat (1978) demonstrated that depletion of available soil moisture decreased in spike length, grain index and yields of grain and straw. Sinsinwar and Singh (1980) reported that maximum grain yield of Barley was obtained with one supplementary irrigation at tillering.

Cannel et al. (1958) showed that nitrogen concentration in plants increased by decreasing soil moisture levels. Radner and Vasiler (1973) showed that N content of barley grains decreased by increasing the number of irrigations. Shevelukha et. al. (1978) found that the highest yields obtained with soil moisture content (60 – 70%) of yield capacity.

Abd-Alla (2004) and El-Kallal (2005) indicated that the increase in nitrogen fertilization level from the level 50 to the levels 100 and 150 Kg N/ha gave significant increase in grain and straw yield of barley and wheat crops.

Osman et. al. (1992) emphasized that the plant and total dry matter production plant were significantly greater by the application of 45 – 60 Kg N/fad and spraying barley plants at tillering stage with 6%. Abo El-Khair (1995) found that application of 400 mg N/Kg soil in three forms of urea, ammonium nitrate and ammonium sulphate to the soil increased the N content of all forms of N.

Orphanos and Krentos (1980) found that fertilizer N correlated positively with N content of the levels of the leaves, straw and grains of barley. Richards et al (1996) studied the effects of applied N on soil nitrate N content after harvest of barley. They found that applying N up to the economic optimum rate was associated with small increases in soil nitrate after harvest (4 Kg N/ha).

The present study was conducted to investigate the effect of water stress and N fertilization on growth yield and yield production of barley (*Hordeum Vulgare* L) and N-uptake by plants and N

behaviour in the soil under investigation.

2. Materials and Methods

A pot experimental was carried out under greenhouse conditions, soil used in this investigation was collected from the surface layer (0 – 30 cm), it has a sandy clay loam. PE pots were filled with 10 Kg soil/pot. All pots received P (superphosphate 6.5% P) and K as potassium sulphate (42 % K) at rates 6 and 20 mg/Kg soil, respectively during seed–bed preparation. Twenty five seeds/pots were planted , and when the seedling were 10 day old, only 20 plants were left in each pot. The experiment was carried out in Randomize Complete Black (RCB) design including two factors as follows:

1- Moisture stress, 3 moisture regimes (WFC%):

$M_1 = 100\%$, $M_2 = 75\%$, $M_3 = 50\ \%$.

2- N – treatment including 2 forms of N being as follows:

a- Urea fertilizer in (1 and 2) dose.

b- Ammonium sulphate fertilizer in (1 and 2) dose.

c- Control without N

Treatments were carried out in 3 replaces. Some main chemical and physical analysis were carried out according to methods outlined in Page et. al. (1982) and Klute (1986).

3. Results and Discussion

Soil Characteristics:

To achieve the aims and objectives of this study, soil used in this investigation was collected from the surface layer (0 – 30 cm); the soil was sandy clay loam. Some physical and chemical properties of the soil are presented in Table (1).

The soil salinity and sodicity were 7.15 dS_m^{-1} and 11.0 respectively. However, total carbonate and the organic matter content were low (2.05 and 0.71%) respectively. These low levels of, O.M content confirm the rapid decomposition of O.M under arid conditions

A pot experiment was conducted in the greenhouse to study the effect of soil moisture stress and N fertilization on barley (Hordeum Vulgare) yield and its chemical composition for N at different stages of growth i.e, tillering, elongation, heading and harvesting.

Table 1. Some physical and chemical properties of soil under study:

Criteria	I. Values	Criteria	II. Values
III. Particle-size distribution:		IV. Soluble cations, meq/100	
V. Sand %	54.4	VI. Ca^{++}	19.3
Silt %	18.1	Mg^{++}	10.4
Clay %	VII. 27.5	Na^{+}	40.9
Texture class	VIII. sandy clay loam	K^{+}	0.8
IX. Saturation percentage, %	51.0	X. Soluble Anions, meq/100g	
Field capacity, %	20.50	$CO^{-2}_3 + HCO^{-}_3$	4.0
Wilting point	10.50	Cl^{-}	41.0
EC (1:1 water extract), dS/m	7.15	SO_4^{-2}	26.5
pH (1:1 water suspension)	7.50	XI. Available nutrients, mg/kg	
Organic matter, %	0.71	N	23.0
Total N, %	0.23	P	0.5
$CaCO_3$ %	2.05	K	40.00

The dry matter yield for the different samples were recorded . At the end of experiment soil samples were taken for chemical analysis. The obtained result will be discussed under the following subheading:

1- Vegetative Growth Stages:

1-1- Fresh Weight:

The data in Table (2) and Figure (1) represent the fresh weight of barley increased by increasing period of growth up to elongation and then slightly decreased at the heading stage. This trend was highly recognized under irrigation to maintain soil moisture level about 100% of the soil field capacity. The height relative increased was noticed during the elongation stage, followed by tillering stage while at heading stage the differences were narrowed. The relative values over the 50% FC treatment were 120.9 and 167.1% for 75% and 100% FC for during the tillering stage. For the

elongation and heading stages the corresponding relative values were 241.2% & 352.8 and 174.9 & 147.7% respectively.

Regarding the effect of N addition, the data revealed that N application increased fresh weight of barley during growth stage compared with control.

Concerning the differences between N sources, the data showed slight changes between Urea and ammonium sulphate (AS). The highest fresh weight of barley in general was obtained by application of N as (AS) under soil moisture at 100% FC.

1-2- Dry Weight:

The data in Table (2) and Figure (2) indicate that the dry weight increased progressively up to the heading stage, it can be seen that increasing soil moisture content from 50 to 100% FC which increased the dry matter accumulation. With regard to the effect of N application as different sources, the data presented high increases and (AS) was superior.

Table 2. effect of soil moisture regime and nitrogen fertilizion on fresh and dry matter yield of barley at different stages of growth

Growth stages	Weight	Moisture regime as % of F C (M)	Nitrogen fertilizer and splitting {N} 60 Kg N/Faddan					
			Ua	Ub	AS a	AS b	Control	Mean
Tillering	Fresh	100%	10.38	13.99	11.75	16.54	4.60	11.47
		75%	7.51	11.71	5.77	11.31	4.31	8.12
		50%	6.21	7.33	5.36	6.36	3.03	5.66
		Mean	8.03	11.01	7.62	11.40	4.01	
		$LSD_{0.05}$	M=1.303 N=1.682 MxN= 2.914					
	Dry	100%	1.14	1.74	1.45	2.15	0.59	1.41
		75%	1.00	1.65	0.85	1.75	0.54	1.15
		50%	0.93	1.16	0.83	1.01	0.40	0.86
		Mean	1.02	1.51	1.04	1.63	0.51	
		$LSD_{0.05}$	M=0.384 N=0.496 MxN= n.s.					
Econsat	Fresh	100%	26.22	37.33	34.74	36.42	8.81	28.70
		75%	17.87	24.95	18.56	21.86	8.02	81.25
		50%	7.41	11.36	8.46	9.68	4.11	8.20
		Mean	17.16	24.54	20.58	22.65	6.98	

		$LSD_{0.05}$	M=2.864	N=n.s.	MxN=6.404			
	Dry	100%	3.14	5.17	5.02	5.22	1.55	4.02
		75%	2.34	3.59	2.63	3.43	1.48	2.69
		50%	1.37	1.91	1.57	1.68	0.81	1.46
		Mean	2.28	3.55	3.07	3.44	1.28	
		$LSD_{0.05}$	M=0.515	N=0.665	MxN= 1.500			
Heading	Fresh	100%	17.53	24.46	19.50	24.61	6.61	18.54
		75%	20.76	21.82	21.61	22.97	6.57	18.74
		50%	11.87	13.74	12.82	17.35	5.94	12.34
		Mean	16.72	20.00	17.97	21.64	6.37	
		$LSD_{0.05}$	M=1.931	N=2.494	MxN=n.s.			
	Dry	100%	5.17	5.60	6.23	6.60	2.10	5.14
		75%	5.38	5.82	5.52	6.00	2.00	4.94
		50%	2.99	3.73	3.74	4.20	1.76	3.28
		Mean	4.51	5.05	5.16	5.60	1.95	
		$LSD_{0.05}$	M=0.677	N=0.874	MxN= n.s			

Control= Without N fertilization, U= urea, AS= ammonium sulphate, a= one dose, b= two doses.

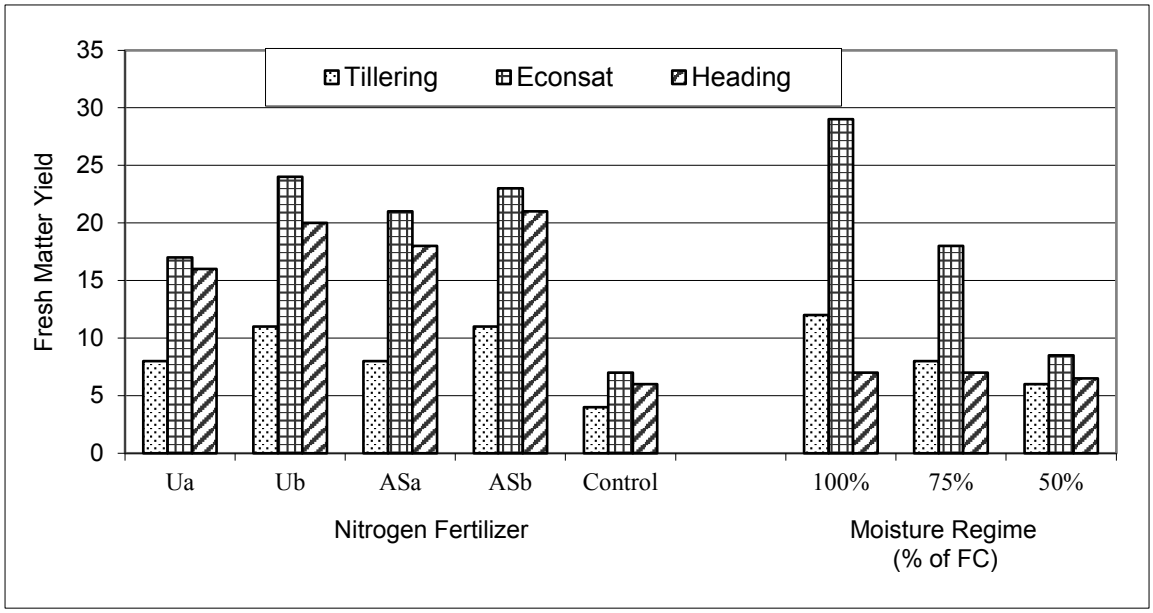

Figure 1. Effect of soil moisture regime and nitrogen fertilization on fresh matter yield at different growth stages.

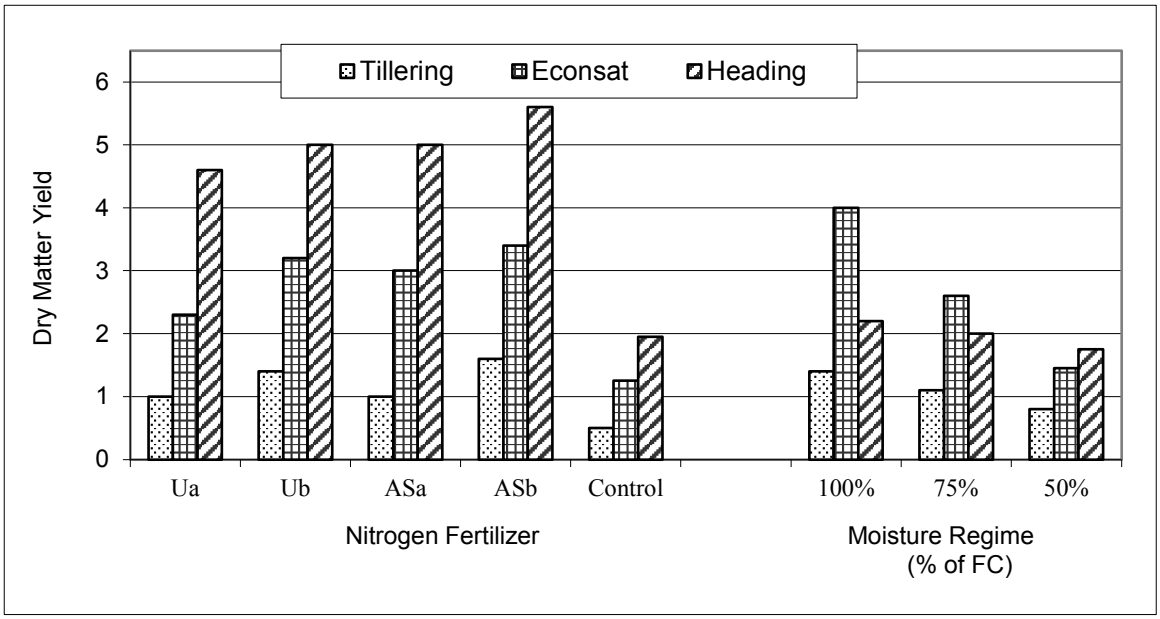

Figure 2. Effect of soil moisture regime and nitrogen fertilization on dry matter yield at different growth stages.

In addition, applying (N) fertilizer as 2 doses was favorable than as one dose were: 148.0 and 156.7% for U and AS respectively at the tillering stage. The Corresponding relative values were 155.7% and 112.1% at the elongation and heading stages respectively.

Concerning the interaction between N application and soil moisture regime; the data showed that the highest dry matter yield was obtained by applying (AS) as 2 doses when soil moisture was maintained around 100% of the F.C. This was true for the different stages of growth.

1-3- Chemical Composition:-

1-3-1- Nitrogen Content:

The data in Figure (3) indicate that increasing soil moisture from 50% to 100% of the F.C. showed slight increase in N%. This was true for the elongation and heading stages of growth while at tillering

stage it showed a slight decrease. This means that soil moisture increased the absorption of (N). N% gradually decreased through the tillering stage to heading stage. Regarding the effect (N) application, it can be relatively noticed that there were high increases due to N treatments. The differences between N source were slight.

1-3-2- Nitrogen Uptake:

The data in Figure (4) show that N uptake increased considerably at the elongation stage compared with the tillering stage while the amount of N uptake at the heading stage showed slight differences Soil moisture increased the N uptake by barley plants. The relative values of 75% and 100% F.C. over the 50% F.C. treatment are 128.8% & 156.7%; 189.9% & 309.1% and heading stages respectively. The N uptake markedly increased by N application. As showed slight increases compared with urea. In addition, splitting the added N as 2 doses was superior that adding N as one dose

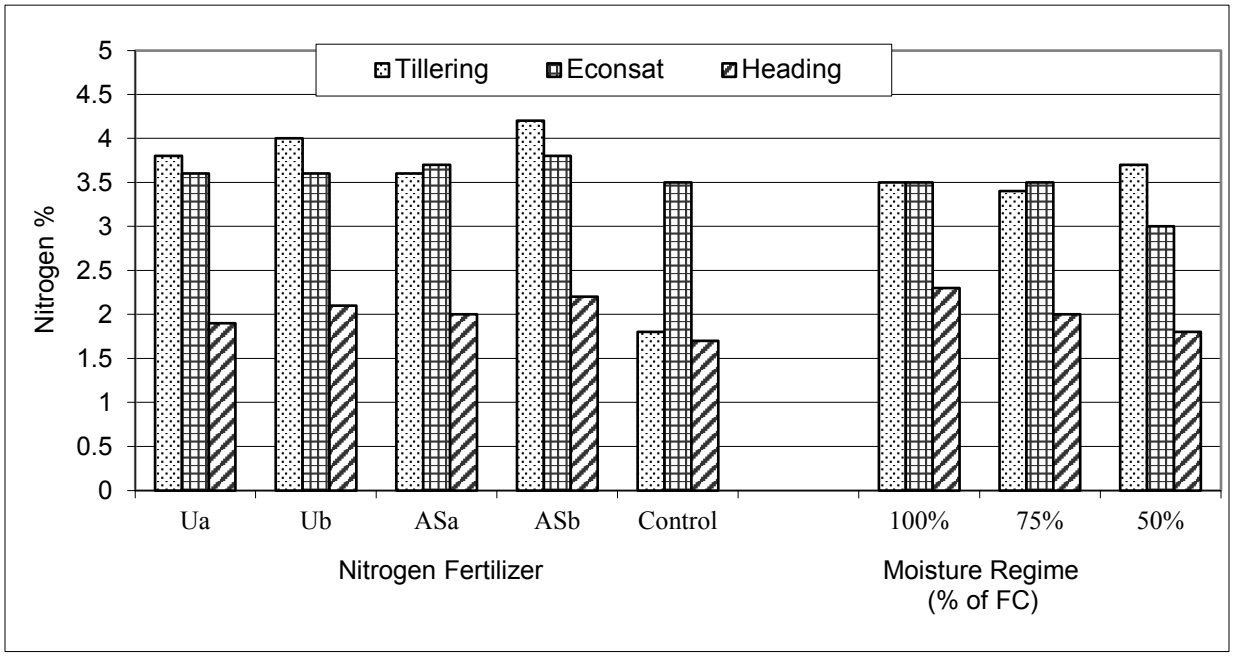

Figure 3. Effect of soil moisture regime and nitrogen fertilization on nitrogen percentage at different growth stages.

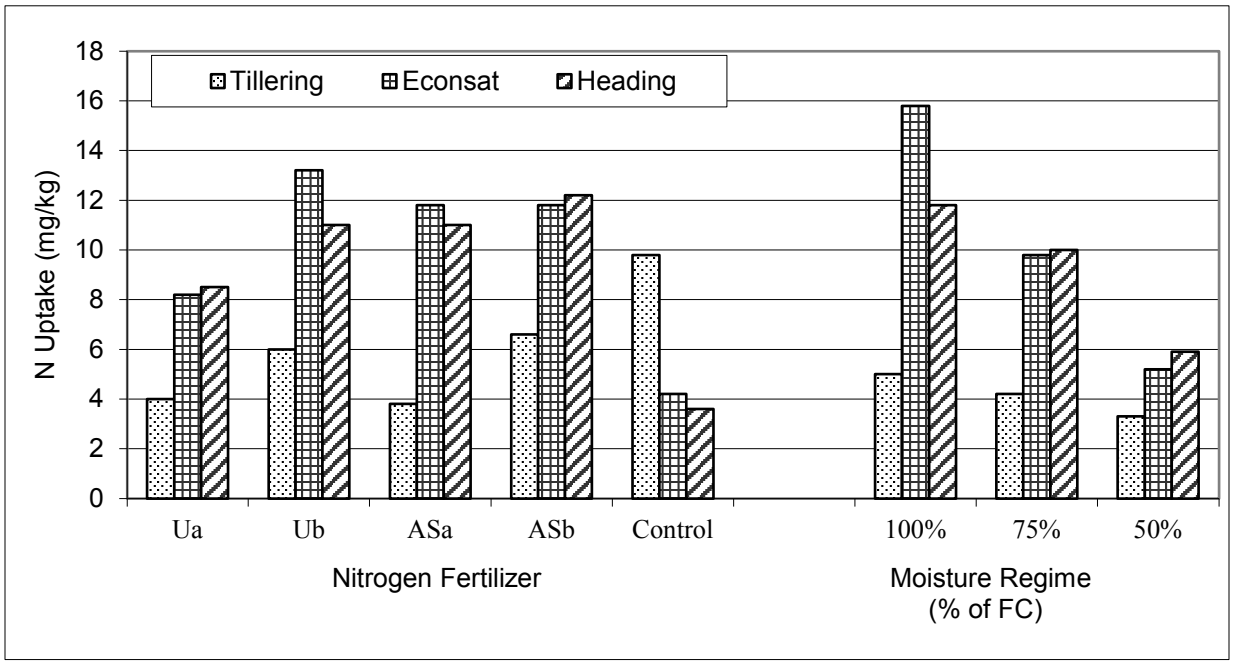

Figure 4. Effect of soil moisture regime and nitrogen fertilization on nitrogen uptake at different growth stages.

2- Harvesting Stage:

2-1- Grain Yield:

The data in Table (3) and Figure (5) show that raising soil moisture level from 50% to 75% of the soil field capacity increased grain yield with nearly two folds. On the other hand maintaining soil moisture around the field capacity showed a decrease in grains yield compared by 75% FC but it is 'still higher than the 50% F.C. Relative value of 100% and 75% FC over the 50% FC treatment were 159.9% and 206.3% respectively.

Application of N fertilizer increased grains yield compared with the unfertilized plants. In addition, application N as ammonium sulphate showed an increase over when urea was used with about 13.7%. Applying N as two equal doses was more effective than when applied as one dose. The relative increase due to splitting the amount of applied N was 147.5% and 132.6% when urea and ammonium sulphate.

were used respectively. The highest grains yield was obtained by applying nitrogen as two doses of ammonium sulphate when soil moisture was maintained around 75% of the soil field capacity.

2.2 Straw Yield:

Straw yield increased progressively by increasing soil moisture level from 50% FC up to 100% FC. The relative values of straw yield over the 50% FC were 141.8% and 195.5% for the 75% and 100% field capacity treatments respectively. N application generally increased '. straw yield when compared with the control. This trend was more pronounced when nitrogen was added as, ammonium sulphate. Splitting the amount of added nitrogen as two equal doses was superior than when added as one dose. The relative values over the control were 122.4 and 115.9% when urea was added as two doses or one dose respectively. For ammonium sulphate, the corresponding relatively values were 136.5% and 115.6%. The highest yield of straw was obtained by applying ammonium sulphate or urea as two doses and maintaining soil moisture around the field capacity.

Table 3. Effect of soil moisture regime and nitrogen fertilizion on yield of grains and straw.

Yield	Moisture regime as % of F C (M)	Nitrogen fertilizer and splitting {N} 60 Kg N/Faddan					
		Ua	Ub	AS a	AS b	Control	Mean
Grains yield	100%	4.08	5.75	4.08	6.44	3.95	4.86
	75%	4.74	7.18	7.30	8.17	3.97	6.27
	50%	2.75	4.11	2.61	3.93	1.82	3.04
	Mean	3.85	5.68	4.66	6.18	3.24	
	$LSD_{0.05}$	M=.947 N=n.s. MxN= 2.118					
Straw yild	100%	25.73	27.33	22.77	27.23	23.99	25.41
	75%	16.81	17.60	19.41	24.35	14.06	18.44
	50%	13.27	14.00	13.49	14.15	10.10	13.00
	Mean	18.60	19.60	18.55	21.91	16.50	
	$LSD_{0.05}$	M=2.427 N=n.s. MxN=n..s.					
Grains /straw	100%	0.15	0.21	0.12	0.23	0.16	0.18
	75%	0.28	0.40	0.37	0.33	0.28	0.33
	50%	0.20	0.29	0.19	0.27	0.18	0.22
	Mean	0.21	0.24	0.24	0.27	0.20	
	$LSD_{0.05}$						

Control = Without N fertilization, U= urea, AS= ammonium sulphate, a= one dose, b= two doses

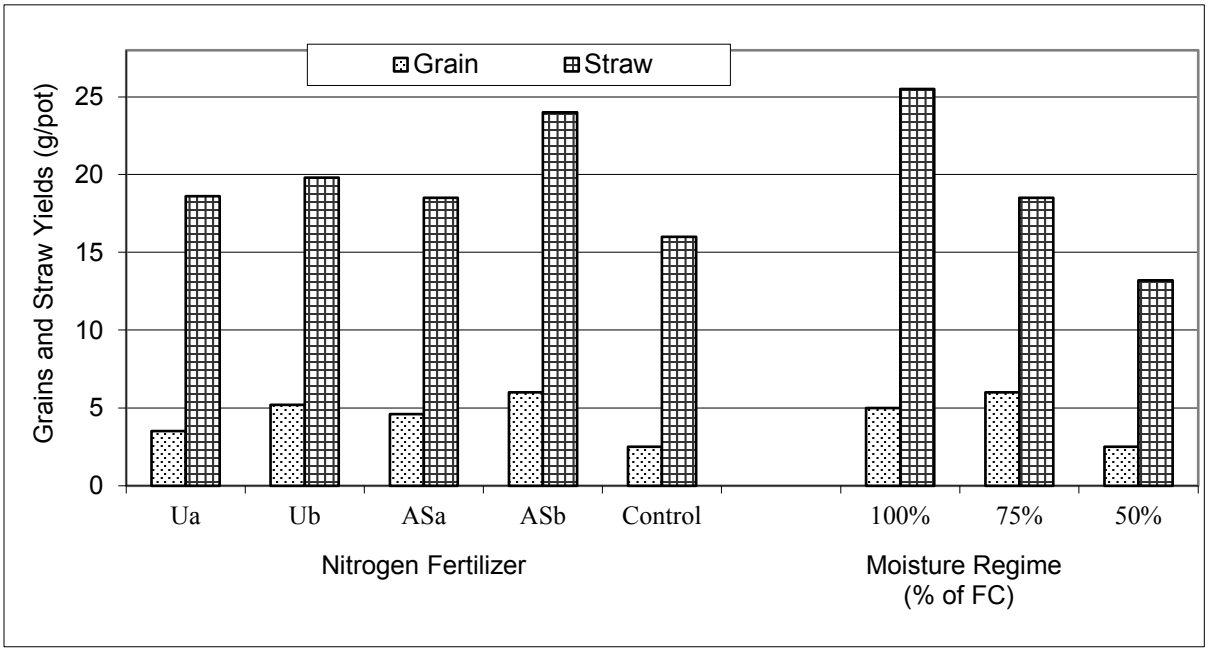

Figure 5. Effect of soil moisture regime and nitrogen fertilization on grain and straw yields of barley.

References

[1] Abd Alla, M.M. (2004): Influence of nitrogen level and its application time on yield and quality of some new Hull – Less barley. J . Agric . Sci . Mansoura Univ., 29 (5): 2201 – 2216.

[2] Abo El – Khair, R . A. (1995): Nitrogen transformation in soil under different moisture conditions. Al – Azhar J . Agric . Res., Vol. 21.21.pp.281 – 293.

[3] Cannel, G . H.; K.B. Tyler and C.W. Asbell (1958): The effects of irrigation and fertilizer on yield Blackheart and nutrient uptake of celery. Proc., Amr. Soc. Hort . Sci: 74, 539 – 545.

[4] Chaturvedi, G . S. and P . K . Sinha (1981): Effect of irrigation on tillering wheat, triticale and barley in water – limited environment. Irrg . Soc, (2): 225 – 235.

[5] El–Kallal, E.S, (2005): Effect of different levels of nitrogen fertilizer and plant regulator culter on growth, and yield components of wheat crop in Libya, M. Sc. Thesis, Faculty of Agriculture El – Tahadi University, Sirt.

[6] El–Monayeri; M.O.; A.M.Hegazi; N.H. Ezzat H. M.. Salem and S. M. Tahoun (1983): Growth and yield of some wheat and barley varieties grown under different moisture stress levels. Annals of Agric. Sci., Moshothor., 20: 231 – 243.

[7] Farahat, R. M. V. (1978): Water regime of plants during different stages of growth. M. Sc. Thesis, Fac. of Agric., Ain – Shams Univ., Egypt. FAO (1987). Production. Vol. 41.

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[8] Hooda, R. S and G. S. Kalra (1977): Response of barley varieties to levels of nitrogen under irrigated and unirrigated conditions. Indian of Agron. 22 (3): 153 – 156.
[9] Hussein, M.M.; and A.A. Khadr (1979): Effect of irrigation and nitrogen application on growth and yield of plants, Egypt J. Agron. 4, No.2, pp. 205 – 219.
[10] Hussien, M.M.; A, Firgany and A.A. Hand Khadr (1978): Soil moisture and phosphrus fertilizer influence on growth, yield and grain chemical composition of barley. Research Bulletin, Faculty of Agric. Ain Shams University, 925 – 22pp.
[11] Khattari, S.K. and A.M. Till (1993): Critical level of $NaHCO_3$ extractable P to wheat and barley under different soil water levels in three soil types Dirasat Series B, Pure and Applied Science, 20 (3): 7 – 20.
[12] Klute, A. (1986): Methods of Soil Analysis. Part 1. Physical and Mineralogical properties. Agron. Monograph No 9, ASA, Madison, Wisc. U.S.A.
[13] Ligon, J.T. and E.R. Benoit (1966): Morphological effects of moisture stress barley and tobacco, Agron. J. 58: 35 – 38.
[14] Misra, B.N. (1976): Effect of levels of nitrogen on yield and yield attributing characters of different varieties of barley: Indian J. Haron. 21 (1): 73 – 74.
[15] Misra, B.N.; K.N. Singh and L.V.S Shastry (1980): Nutrient and irrigation requirements of 2 – row and 6 – row barley, Indian J. Agron. 25 (3): 410 – 414.
[16] Newman, R.K. (1984): New ways with barley. Dept Homs Econ, Mantan State Univ. Bozeman, Mt. 59717.
[17] Orphanos, P.I. and V.D. Krentos (1980): concentration of N, P and K in leaves, straw and grain of wheat and barley as influenced by N and P fertilizers under semi arid conditions. Agric. Res. Inst., Nicosia, Cyprus. J. Agric. Sci. 94; 551 – 556.
[18] Osman, A.O.; A. Abou Bakr; I.M. Abdel–Aziz and H.H. El–Mashhady (1992): Response of barley to nitrogen and magnesium fertilization, Egypt. J. Appl. Sci., 2(4): 376 – 385.
[19] Page, A.L., R.H. Miller and R. Keeny (1982): Methods of Soil Analysis. Part 2 Chemical and Microbiological Properties, Agron. Monograph No. 9, ASA, Madison, Wisc. U.S.A.
[20] Rander, R., and V.T. Vasiter (1973): Effect of of irrigation on yield and malting quality of barley. Rastenieu Alni nauki, 10 (4), 63 Plovdi, Bulgaria.
[21] Richards, I.R.; P.A. Wallace and G.a. Pauls on (1996): Effects of applied nitrogen on soil nitrate – nitrogen content after harvest of winter barley. Fert. Res.. 45 (7): 61 – 67.
[22] Shaaban, S.; M.E. El Harron and A.Y.M. El–Taweet (1983): Growth and yield response of two barley Cultivars to irrigation frequency and nitrogen fertilizer. Anuals Agric. Sci. 28, (3). Indian J. Agron. Vol. V; pp 438 – 440.
[23] Shevelukha, V.S.; I.I. Berestor and Sip. Kalik (1978): Effect of moisture supply and mineral nutrition on plant nutrient uptake and yield of barley, In Ustoichivost, Zemovykh Kul'tur Kfaktoram Sredy. Minsk, Belorussian SSR. 21 – 30. Soil and fert., 43 (1): 490, 1980).
[24] Sinsinwar, B.S. and R.S. Singh (1980: Response of barley to levels of nitrogen, Phosphorus and supplementary irrigation. Indian J. Agron. 25 (4): 627 – 630.