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RESPONSE OF WHEAT VARIETIES TO NITROGEN UNDER RAINFED AND IRRIGATION

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ABSTRACT

Two field experiments were conducted at two locations; Turkey and Egypt. Eight recommended spring wheat varieties were planted in 2000/2001 season under two levels of nitrogen fertilizer (70 and 140 kg N/ha) under rain-fed conditions at the experimental farm of the Faculty of Agriculture, Ege University, Izmir, Turkey. In 2000/2001 season, the same varieties in addition to Giza 164 and Sohag 1 were sown under irrigation at the farm of Agriculture Faculty, Minofiya University, Egypt.

Nitrogen significantly affected all studied traits except kernels per spike. Genotypes also differed significantly for the studied traits under both nitrogen levels and over N levels and locations. The varieties x nitrogen interaction was significant for all studied traits except plant height and grain yield.

A negative grain yield response index (GYRI) for nitrogen under rain-fed (water stress) was obtained.

The Turkish Basriby variety gave the highest grain yield under both N levels and either under rain-fed conditions in Turkey or under irrigation in Egypt. Thus, high yielding varieties under irrigation can possibly be adapted to conditions of moisture stress.

Key words: ***Wheat, Nitrogen Fertilizer, Rainfed, Yield.***

INTRODUCTION

Growing wheat under rain-fed or minimum irrigation conditions become an objective in north coast and reclaimed desert areas of Egypt. Nitrogen fertilizer is an important factor in wheat production package. Soils of the north coast and reclaimed areas are poor in organic matter and nitrogen. Therefore, wheat production in those areas is low and improved management practices are needed to increase production efficiency. Several studies indicated that wheat grain yield shows high response to nitrogen application (Awad *et al* 2000 and Sadek 2000) and moisture supply (Sharma *et al* 1992).

Genotypic differences in initial water content (IWC) and rate of water loss (RWL) were reported in wheat (Haley *et al* 1993). Significant genotype x environment (G X E) effects for (IWC) and (RWL) suggested selection for high IWC or low RWL in irrigated environments.

Significant correlations were observed between IWC and stomatal frequency (r = -0.57 and -0.78), RWL and leaf area (r = 0.74 and 0.71), RWL and heading date (r = 0.63 and 0.57), Correlations between RWL (subirrigated) and test weight (dry land) suggested selection for RWL in irrigated environments. Al-Hakimi *et al* (1995) found positive correlation between grain yield and RWC. Mackown *et al* (1996) reported that, there are differentiation in nitrate uptake and assimilation. The increase in soluble sugar by decreasing water supply may be due to the increase of chlorophyll and photosynthesis rate. It was also found that increasing N application rate and decreasing of irrigation level are potential factors for increasing the water use efficiency (Nielsen and Halovrson 1991, Singh *et al* 1996 and Abo-Warda 2002).

MATERIALS AND METHODS

This study was carried out during 2000/2001 and 2001/2002 seasons. In 2000/2001 season, the recommended sowing date was 30th November under rain-fed condition in Farm of Agriculture Faculty, Ege University, Izmir, Turkey. The treatments of this study comprised eight spring wheat varieties as shown in Table (1, No. 1-8) and two levels of nitrogen (70 and/or 140 kg N/ha). The normal fertilization level is (120 kg N/ha) in this location under rain-fed. The total rain-fall during the growing season was recorded in Table (2). Chemical analysis of soil at the Farm of Agriculture Faculty, Ege University, Izmir, Turkey is given in Table (2).

Table 1. The names and pedigree of the varieties.

No.		Entry name/cross	Pedigree
1	Basribey 95 (*T. aestivum*)	Jupateco/Bluejay//Ures	CM67458-4Y-1M-3Y-1M-2Y-OB
2	Kasifbey 95(*T. aestivum*)	Hork/Yambill//Kalyan/Bluebired	
3	Menemen 88(*T. aestivum*)	Not available	
4	Cumhuriyet 75 (*T. aestivum*)	SN64//TZPP/Y54/3/SN64/AN64/4/FR* 211Y/KT	IL21406-602-300Y-os
5	Ege 88 (*T. durum*)	Jori/Anhinga//Flamingo	CM97-126M-1M-4Y-OM
6	Salihli 92 (*T. durum*)	SHWA//21563/anhinga/3/Ege88	
7	Yavors (*T. durum*)	Not available	
8	Alter (*T. durum*)	Not available	
9	Giza 164 (*T. aestivum*)	Kv z/Buha"s"//kal/Bb cm 330 27-F-15N-2Y-1.4-2Y-OB	
10	Sohag I (*T. durum*)	Gdo v2 469/Jo"s"//61.130/Lds	

In 2001/2002 season, the recommended sowing date was 20th November. The previous varieties (Table 1, No. 1-8) as well as two Egyptian cultivars, viz. Giza 164 and /Sohag 1 were grown under normal irrigation in Farm of Agriculture Faculty, Menofiya University, Egypt.

Each experiment was laid in a Randomized Complete Blocks Design with three replications. Each plot consisted of six rows 2.5 m long with 20 cm between rows. Number of kernels per plot was 1050 kernels (350 kernels per m^2). Grains were machinery sown in Turkey and via hand in Egypt. Nitrogen as ammonium nitrate (33.5% N) was applied at two levels (70 and/or 140 kg N/ha=29.4 and/or 50.4 kg N/fed) in two doses, 1/3 during sowing and 2/3 at tillering stage. In Turkey, the data were recorded on all varieties for drought measurements i.e. leaf area (LA cm^2), flag leaf area (FLA cm^2), osmotic pressure (OP MPa), stomatal frequency mm^2 (SF) and relative water content (RWC%). Also, the following traits were recorded: heading data (HD days), plant height (PH cm^2), number of spikes per m^2 (NOS/m^2), number of kernels per spike (NOK/S), grain yield/m^2 (GY), 1000-kernels weight (g), and protein content(%). In Egypt, the data were record in each plot on HD, PH, and yield and yield components. Grain yield response index (GYRI) was calculated as outlined by Fageria and Barbosa (1981):

$$GYRI = \frac{\text{Yield under high N - Yield under low N}}{High\ N - Low\ N}$$

Table 2. Total rain-fall during 2000/2001 season in Bornova - Izmir, Turkey and chemicals analysis of Farm of Faculty of Agriculture, Ege University.

Month		Rainfall[1] (ml)
December	2000	33.0
January	2001	74.9
February	2001	90.3
March	2001	15.5
April	2001	69.20
May	2001	28.70
Total per growing season		311.6

Soil characteristics	Values
pH	7.6
T. salinity (%)	0.09
Organic matter (%)	1.2
N %	0.06
P ppm	2.7
K ppm	306
Ca ppm	3100
Na ppm	85
Mg ppm	90
Fe ppm	10.0
Cu ppm	2.0
Zn ppm	1.1
Mn ppm	27.0
NO^-_3	22.3
NO^-_2	0.45
NH^+_4	15.3

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The data were subjected to proper statistical analysis of variance, and the combined analysis was conducted over the two nitrogen treatments in Turkey according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

This study involves two parts. The first part was carried out in Turkey, aiming to (1) evaluation of eight wheat varieties under two levels of nitrogen under rain-fed only and (2) Investigating the nitrogen fertilization effect on drought tolerance.

The second part was done in Egypt to evaluate ten wheat varieties (eight of them were common to both countries), in Egypt under normal irrigation condition.

(Part 1) Genotypes performance

The analysis of variance for drought measurements, growth, yield and yield components is presented in Table (3). Significant genotypes mean squares were detected for all the studied traits in both levels as well as the combined analysis indicating wide variation among the genotypes used in present study. Besides, mean squares due to (varieties x nitrogen) were significant for all the studied traits except plant height and grain yield, indicating that the genotypes response differed negatively or positively to nitrogen fertilizer under stress Ehdaie *et al* (1999) and Abo-Warda (2002) reached similar conclusion.

Nitrogen effect

Results indicated that nitrogen mean squares were significant for all the studied traits except number of kernels per spike. Also, the mean values for (LA), (FLA), (OP), (SF), HD, PH and protein content were higher for 140 kg N/ha than those of 70 kg N/ha. The mean values of the previous traits under 140 kg N/ha were 32.53, 35.75, 10.11, 5302, 114.78, 84.7 and 11.00, respectively. However, the mean values at 70 kg N/ha for relative water content, number of spikes/m^2, number of kernels/spike, 1000-kernel weight, and grain yield/m^2 were higher than those of 140 kg N/ha. The recorded decreasing averages in percentages are -3.96%; 8.3%, -0.611%, -12.88% and -7.19% indicating that increasing the nitrogen fertilizer under the shortage of water leads to decreasing these traits. These findings agree with the results of Mishra *et al* (1998), Ehdaie *et al* (1999) and Sadek (2002). Also, Bansal and Sinha (1991) suggested that, under water stress, grain development competes with the roots and stem for nitrogen mobilized from

Table 3. The observed mean squares from analysis of variances for traits studied in Turkey.

Source of variance	D.F		Leaf area (cm^2)			Flag leaf area (cm^2)			Osmotic pressure (Mpa)			No. of stomatal m^2		
	N	C	N_1	N_2	C	N_1	N_2	C	N_1	N_2	C	N_1	N_2	C
Nitrogen	-	1	-	-	200.6**	-	-	316**	-	-	20.3**			20662**
Replication with nitrogen	2	4	3.47	0.333	1.89	2.68	1.178	2.23	0.062	0.030	0.046	1448	1825	1636
Genotype	7	7	28.5**	24.1**	36.7**	37.9**	154.2**	167.3**	1.99**	3.95**	4.37**	62080**	37100**	7929**
G x N	-	7		15.8**				24.86**	-		1.49**			91251**
Error	14	28	2.12	2.35	2.24	6.63	1.66	4.14	0.107	0.282	0.194	1865	3432	2648

Table 3. Continue.

Source of variance	Relative water content (RWC) (%)			Heading date (days)			Plant height (cm)			No. of spikes/m^2		
	N_1	N_2	C	N_1	N_2	C	N_1	N_2	C	N_1	N_2	C
Nitrogen	-	-	235**	-	-	2.38**	-	-	295**	-	-	9380**
Replication with nitrogen	0.808	0.917	0.811	0.875	5.290**	3.06**	3.875	15.3*	9.59*	15.56	4.65	10.1
Genotype	115.5**	208.6**	303**	24.56**	20.19**	39.19**	160.8**	183.6**	341.1**	4169**	3593**	645.1**
G x N			33.05**			5.33**			3.3			9178**
Error	6.224	1.255	3.74	0.923	0.245	0.584	2.11	2.53	2.32	107.9	45.9	76.9

Table 3. Continue.

Source of variance	No. of kernels/spike			1000 kernels weight (g)			Grain yield (g/m^2)			Protein content (%)		
	N_1	N_2	C	N_1	N_2	C	N_1	N_2	C	N_1	N_2	C
Nitrogen			0.334			294.0**			48198**			12.67**
Replication with nitrogen	2.61	8.11	12.81	0.754	2.34	1.547	369.4	28.31	198.8	0.008	0.088	0.848
Genotype	137.3**	93.92**	221.7**	105.2**	114.2**	195.8**	4327**	1615.9**	3971**	0.594**	0.618**	1.044**
G x N			66.3**			164.9**			1991**			0.168**
Error	5.40	4.85	5.13	7.4	1.99	4.69	211	378	295	0.013	0.049	0.031

	Leaf area			Flag leaf area			Osmotic pressure			No. of stomatal m^2		
	N_1	N_2	C	N_1	N_2	C	N_1	N_2	C	N_1	N_2	C
1	24.1 d	31.4 cd	27.8 c	26.9 c	27.5 e	27.2 d	9.96 b	10.7 ab	10.3 a	4753 e	5013 c	4883 d
2	31.1 a	32.7 bc	31.9 b	32.1 b	38.9 b	35.5 b	8.73 c	9.43 c	9.08 b	4469 g	4918 c	4693 e
3	32.4 a	34.5 b	33.4 a	30.8 bc	31.0 d	30.9 c	8.66 c	8.83 c	8.74 b	5427 b	5753 a	5520 a
4	30.4 ab	37.6 a	34.0 a	38.5 a	51.2 a	44.9 a	7.56 d	9.70 bc	8.63 b	4611 f	5131 b	4871 d
5	30.3 ab	32.6 bc	31.5 ab	30.1 bc	34.6 c	32.4 bc	7.6 d	10.5 ab	9.07 b	5640 a	5695 a	566 a
6	28.1 bc	28.8 d	28.5 c	28.2 bc	35.4 c	331.8 c	9.60 b	11.10 a	10.4 a	5053 d	5175 b	5114 c
7	25.8 cd	29.2 d	27.5 c	28.7 bc	31.0 d	29.8 cd	7.8 d	9.76 bc	8.78 d	5295 c	5652 a	5423 b
8	25.1 d	33.4 bc	29.2 bc	30.0 bc	36.4 c	33.2 bc	10.6 a	10.8 ab	10.70 a	4469 g	5699 a	5084 c

Table 4. Continue.

	Relative water content (RWC)			Heading date			Plant height			No. of spikes/m2		
	N1	N2	C	N1	N2	C	N1	N2	C	N1	N2	C
1	70.4 b	62.6 e	66.5 d	109 d	113 d	111 d	75.7 d	80.8 d	77.9 d	392 a	373 a	382 a
2	70.0 b	76.4 c	73.2 bc	115 a	118 a	117 a	81.7 b	88.7 b	85.2 b	373 b	343 b	358 b
3	72.0 cd	72.7 d	72.3 c	112 b	115 c	114 bc	80.0 b	88.3 b	84.2 bc	367 b	285 d	326 c
4	73.5 cd	64.5 e	69.0 d	105 e	111 e	108 e	96.0 a	101.3 a	98.7 a	342 c	280 d	311 c
5	84.3 ab	83.5 b	83.9 a	113 b	1116 b	115 b	77.7 cd	79.7 de	78.7 d	298 d	284 d	291 d
6	87.1 a	86.4 a	86.8 a	1123 b	115 c	114 bc	71.7 e	77.0 e	74.4 e	326 cd	310 c	318 c
7	75.6 c	71.2 d	73.4 bc	111 c	115 c	113 cd	75.2 d	80.7 d	78.2 d	315 de	322 c	318 c
8	80.5 b	71.8 d	76.2 b	110 cd	116 b	113 cd	79.2 bc	84.0 c	81.9 c	288 ef	276 d	282 d

Table 4. Continue.

	No. of kernels/spike			1000 kernels weight			Grain yield (g/m^2)			Protein content		
	N1	N2	C	N1	N2	C	N1	N2	C	N1	N2	C
1	52.5 ab	51.5 a	52.0 ab	33.23 d	33.3 c	33.3 d	490 a	404 ab	447 a	8.93 f	10.2 d	9.56 d
2	53.8 ab	51.4 a	52.6 ab	39.89 c	29.5 d	34.6 cd	457 b	364 c	410.5 bc	9.71 e	11.00 bc	10.4 c
3	50.2 bc	48.5 ab	49.85 bc	3633 dc	32.5 c	34.4 cd	503 a	374 bc	538.5 ad	10.2 bc	11.7 a	10.9 a
4	36.3 d	39.6 c	37.9 d	43.8 b	39.0 b	41.4 cd	413 cd	383 abc	398 c	10.1 cd	11.7 c	10.4 c
5	45.5 c	48.6 ab	47.1 bc	53.2 a	46.3 a	49.8 a	399 d	365 c	382 c	10.4 a	11.2 b	10.3 ab
6	45.1 c	44.6 bc	44.8 c	43.5 b	44.6 a	44.1 b	413 cd	347 c	380 c	10.1 cd	10.7 c	10.4 c
7	55.7 a	54.2 a	54.9 a	40.4 c	33.1 c	36.8 cd	455 b	418 a	436.5 ab	9.7 e	10.6 c	10.2 c
8	54.8 ab	53.6 a	54.2 a	41.2 b	33.7 c	37.4 c	425 e	394 ab	409.5 bc	9.9 de	11.2 b	10.5 bc

the leaves. Joubert (1987) suggested that leaf water potential during the flag leaf stage, under moisture stress conditions, may be indicator of differences in drought tolerance.

Mean performances of varieties at both nitrogen treatments as well as the combined date are presented in Table (4). The varieties Basribey gave the highest value for grain yield (404 g and 447 g/m^2) in level 140 Kg N/ha and the combined analysis. Also, its gave the lowest mean values for LA, FLA, PH in both levels as well as the combined analysis. In addition, it gave the highest mean values for number of spikes per m^2 in both levels as well as the combined analysis. The varieties Mcnemen 88 gave the highest grain yield (503 g/m^2) in level 1 (70 kg N/ha). Also, it gave the highest protein content in level 2 and the combined analysis.

The results indicated that wheat varieties under study representing a wide range of diversity for agronomic characters and drought resistance. Grain yield of all cultivars was reduced by drought stress and cultivars differed in yield stability. Singh *et al* (1996) and Darwish (1998) showed that significant differences of genotypes for all drought measurements.

Grain yield response index (GYRI)

Table (5) shows values of GYRI. The results indicated that total values of (GYRI) under rain-fed (water shortage) were negative, indicating decrements in grain yield by increasing N-levels under stress. These results may be due to increasing some traits viz. LA, FLA, no. of stomatal, heading date, plant height and decreased RWC at high N levels which in turn decreased the resistance to drought and consequently decreased the grain yield and its components as a result of low water content in plants. Similar results were also obtained by Singh and Srivastava (1996), Sadek (2002) and Abo-Warda (2002).

Table 5. Grain yield response index (GYRI)

Variety	GYRI (%)
1	-6.0
2	-6.6
3	-9.14
4	-2.29
5	-2.57
6	-4.71
7	-2.57
8	-2.14
Mean	-4.50

(Part 2)

In Egypt

The analysis of variance for studied traits in Egypt is presented in Table (6).

Table 6. The observed mean squares from analysis of variances for traits studied in Egypt.

Source of variance	df	HD (days)	PH (cm^2)	No. of spikes per m^2	No. of kernels per spike	1000 kernels weight (g)	Grain yield/m^2 (g)
Replication	2	2.1	10.04	222.4	0.15	12.45	44.9
Genotype	9	156.6**	50.8**	3176.4**	74.1**	132.7**	8522**
Error	18	1.32	0.996	256.5	6.68	5.15	172

Mean squares due to genotypes were significant for all the studied traits indicating wide variations among the genotypes used under normal irrigation in Egypt. Mean performances of the ten varieties are presented in Table (7).

Table 7. Mean performance of the ten varieties for all studied traits in Egypt.

Genotype	HD (days)	PH (cm^2)	No. of spikes per m^2	No. of kernels per spike	1000 kernels weight (g)	Grain yield per m^2 (g)	Increase of grain yield on	
							G. 164	Sohag 1
1	119.3 ab	94.7 e	492.0 a	53.0 ab	38.3 ef	589.6 a	27.06	39.8
2	118.3 b	96.0 c	407.0 e	56.0 a	35.7 f	526.6 b	13.49	24.9
3	110.3 c	97.3 b	442.0 bc	52.6 ab	41.0 ce	523.0 b	12.71	24.1
4	109.3 c	105.0 a	460.6 ab	40.3 d	51.7 ab	454.3 c	-2.08	7.76
5	121.3 a	95.0 cd	405.6 f	48.9 bc	54.7 a	537.0 b	15.7	27.4
6	120.3 ab	96.7 bc	431.6 cd	47.5c	53.3 a	570.0 a	22.8	35.2
7	120.0 ab	97.0 b	413.2 cd	56.0 a	49.0 b	523.3 b	12.7	24.12
8	120.0 ab	96.0 bc	410.3	56.3 a	43.3 c	475.0 c	2.37	12.67
9	105.0 d	105.0 a	428.7 cd	51.6 bc	40.7 ce	464.0 c	0.00	10.1
10	102.0 e	93.0 e	376.0 g	47.3 c	48.0 b	421.6 d	-9.13	00.00
$\bar{X}$	115.3	97.6	426.8	50.96	45.6	508.6	13.09	24.49

It was shown that the Turkish variety Basriby (*T. aestivum*) gave the best grain yield (589 g/m^2). It surpassed G 164 by about 27.1%. Moreover, the variety Salihli (*T. durum*) was the best durum variety for grain yield (570 g/m^2). It surpassed Sohag 1 by 35.2% under normal irrigation. The results indicated that high yielding varieties under normal condition possibly can give high yield under stress. Also, the varieties exhibited high yielding at Turkish conditions (stress and normal conditions) gave the same trend at Egyptian conditions (surface irrigation).

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استجابة بعض أصناف القمح الربيعى للتسميد الأزوتى تحت الرى المطرى فى تركيا والرى الطبيعى فى مصر

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أجريت هذه الدراسة فى دولتين (تركيا ، مصر) فى الموسم الأول ٢٠٠٠/٢٠٠١م ، تم تقييم ثمانية أصناف من القمح الربيعى باستخدام مستويين من التسميد الآزوتى (٧٠ ، ١٤٠ كجم نيتروجين للهكتار) تحت الرى المطرى فقط فى مزرعة كلية الزراعة جامعة ايجه بازمير – تركيا. وفى الموسم ٢٠٠١/٢٠٠٢م ، تم تقييم هذه الأصناف مع صنفين مصريين هما جيزه ١٦٤ ، سوهاج ١ ، تحت الرى الطبيعى فى مزرعة كلية الزراعة بجامعة المنوفية.

وكانت أهم النتائج المتحصل عليها ما يلى:

١- كان التباين الراجع لمعاملات التسميد معنويا لكل الصفات المدروسة عدا عدد الحبوب فى السنبلة.
٢- كان التباين الراجع للأصناف معنويا لكل الصفات المدروسة لكلا المستويين من التسميد الآزوتى والتحليل المشترك فى تركيا ، وكذلك تحت ظروف الرى الطبيعى فى مصر.
٣- كان التباين الراجع للتفاعل بين النتروجين والأصناف معنويا لكل الصفات المدروسة عدا طول النبات ومحصول الحبوب بالمتر المربع.
٤- دليل استجابة المحصول للتسميد الآزوتى كانت سالبة تحت ظروف الرى المطرى (نقص الماء) مما يشير إلى أهمية التسميد الآزوتى المقنن تحت نقص الماء.

٥- أعطــى الصــنف الــتركى Basribey أحسن قيم للمحصول لكلا المستويين من التسميد الآزوتى والتحلــيل المشــترك تحــت ظــروف الرى المطرى فى تركيا ، كما أعطى أحسن قيمة للمحصول والحــبوب تحــت ظــروف الــرى الطبــيعى فى مصر ، مما يشير إلى أن التراكيب الوراثية ذات المحصول العالى تحت ظروف الرى الطبيعى من الممكن أن تكون جيدة تحت ظروف نقص الماء.