

Wheat cultivars evaluation by agronomic traits, application of three nitrogen levels and nitrogen efficiency parameters

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Abstract

Ten wheat cultivars (cv.) and three nitrogen levels were used in this field experiment which was conducted at the University of Kufa, Faculty of Agriculture, during the winter season of 2013.. The aim of this experiment was to compare ten wheat cv. toward agronomic traits, nitrogen levels application and nitrogen efficiency parameters. The fertilizer levels were Zero (control) , 200 kg . h□¹ and 400 kg . h□¹ . The wheat cv. were selected to represent the experimental materials and they are listed in Table 1. All agronomic traits values (plant height PLH, spike length (SL), tillers number (TN), life tillers number (LTN), stem dry weight (SDW), leaf dry weight (LDW), grain dry weight (GDW) and total weight (TW) were increased as the nitrogen application levels increased. Root dry weight RDW behaved differently in which RDW increased with decreasing nitrogen availability in soil.

Results revealed that total dry matter produced per unit nitrogen absorbed NE₁ averaged over the ten wheat cv. increased where ever the availability of nitrogen in soil reduced. The NE₁ values was 60.91, 50.03 and 45.39 under nitrogen levels of Zero, 200 kg . h□¹ and 400 kg . h□¹ , respectively. Similar trends were observed toward total grain yield per unit nitrogen absorbed NE₂ and NE₃, which was the product of the ratio of grain nitrogen to stover nitrogen, times NE₂. The ratio of grain nitrogen to stover nitrogen TEFF was represented transfer efficiency. TEFF value behavior was different, in which its value increased as nitrogen level increased in soil.

Results also showed significant differences among wheat cv. toward NE₁, NE₂, NE₃ and TEFF. . Sham 9 cv. had the highest NE₁ value (61.518) while Tamous 2 gave the lowest (47.173). Sham 9 and Tamous 2 behaved in the same manner toward NE₂ and NE₃ . The ranking of wheat cv. toward TEFF was different and sham 9 which was one of the highest in NE₁, NE₂, and NE₃ came the last in TEFF. It could be concluded that cv. with low values of NE₁, NE₂ and NE₃ are not necessarily have low grain yield.

Keywords : Field crops , wheat cultivars evaluation, agronomic traits, nitrogen levels, nitrogen efficiency parameters.

Introduction

Wheat *Triticum aestivum* is the most important cultivated crop in the world and account for majority of end-products for human diets (9) . Wheat and rice represent about 40% of world food production. Wheat can be planted in cool and temperate climates. Further more, between the time being and the year 2025, the globe population is expected to increase from 6 billion to 10 billion as published by Dyson (3). It is challenge to the scientific community to increase food production world-wide, and the challenge is also extended to the Iraqi agriculture scholars to work hard for wheat self-support Iraq. That will ensure Iraqi food security and sustainable food production for more than 30 million of Iraqi people. It will be also contribute to the federal Iraqi budget and decrease dependability on oil export which represents now almost 94% of total federal budget.

Nitrogen is the most important plant nutrient for crops, in general, and, in particular, for wheat production. Efficient use of nitrogen is critical for economic sustainability of cropping system. Agriculture food

production was doubled worldwide over the last 40 years, and that was coupled with a 7-fold increase in nitrogen fertilizer use (1). This increase in nitrogen fertilizer use led to a serious concerns. Nitrate nitrogen might leach out of the wheat rooting zone and sometimes contaminate even the ground water. However, nitrate in soil might be existed naturally or come from different sources such as fertilizer application, manure addition, and organic matter decomposition. Nitrate nitrogen can go to atmosphere as gases (N_2 or N_2O) or move down to the ground water. Because of the high nitrogen fertilizer cost and pollution, the selection and breeding of efficient nitrogen wheat cv. and genotypes become extremely important. Genotypes can be named as N-efficient, if they are able to recover much of nitrogen from soil and produced above average yield at low nitrogen level application as suggested by Graham (4). However, Sattelmasher *et al.* (13) mentioned that plants which were able to convert high percent of nitrogen ,comparatively better , into grain

production, than other genotypes and varieties, were considered efficient. This experiment was designed to determine the nitrogen efficient wheat cv. by using different parameters under three levels of nitrogen applications. Successful selection of efficient nitrogen wheat cv. will decrease the cost of wheat production and lower environmental pollution.

Materials and Methods

Field experiment was conducted at the University of Kufa, Faculty of Agriculture at city of Kufa during the winter season of 2013. The objective of this experiment was to compare ten wheat cultivars (cv.) toward agronomic traits, nitrogen levels application and nitrogen efficiency parameters. The ten wheat cv. were selected to represent the experimental materials and they are listed in Table 1. They were obtained from the Iraqi Agriculture Ministry, Office of Seed Evaluation and Distribution. The agronomic traits are:

- 1-Plant Height (PLH) cm.
- 2-Spike Length (SL) cm.
- 3-Tiller Number (TN).
- 4-Live Tiller Number (LTN).

5-Root Dry Weight (RDW) g.

6-Stem Dry Weight (STW) g.

7-Leaf Dry Weight (LDW) g.

8-Grain Dry Weight GDW g.

9-Total Weight (TW) g.

The three levels of nitrogen fertilizer were 1-Zero (control). 2- 200 kg . h⁻¹ and 3- 400 kg . h⁻¹. The fertilizer was urea with the content of 46% nitrogen. The nitrogen efficiency parameters which were used by Maranville *et al.* (8) and Zweifel (16) are:

- 1-Total dry matter produced per unit nitrogen absorbed (NE₁).
- 2-Total grain yield per unit nitrogen absorbed (NE₂).
- 3-Transfer efficiency, which is the ratio of grain nitrogen to Stover nitrogen TEFF.
- 4- The product of (NE₂) times (TEFF) which named (NE₃).

Split plot design with factorial arrangement and three replications was used. Nitrogen level was put in the main plot while wheat cv. was sub plot. Nitrogen levels were assigned randomly to the main plots and wheat cv. were randomly assigned to the sub plots within each replication. The soil was sandy loam and slightly alkaline

(pH=7.6) , while the EC was 3.1 ds. The soil was prepared by using mold board and a drag harrow before sowing to provide ideal seed bed. The dimensions of each plot were 3 x 4 meters. Wheat seeds were sown by hand at an average of 100 kg .h⁻¹ and covered by manual harrows. Irrigation was preformed directly after sowing and repeated every each couple weeks. Hands weeds control practices were carried out throughout the growing season as needed. Two plants were randomly selected from inside of each plot at physiological maturity stage. The combined two plants samples were separated into Roots, Stems, Leaves and Grains. The roots were completely washed with tap water and all soil was

removed. The separated plant parts were dried at 60 C° in an electric oven for three days. After that, they were weighed to determine dry matter weight. Roots, leaves, stems and grains were ground in an electric mill to pass through a 20 mesh (1 mm) screen. A 50 mg homogenous sub sample for each plant part was taken for N concentration analysis by the kjeldahl method. . The data was analyzed for treatments differences and Least Significant Differences LSD Test was used to determine significant differences among wheat cv. within each nitrogen fertilization treatment for the above mentioned parameters designated significant by the analysis of variance ANOVA (14).

Table 1. Ten wheat cv. used in this experiment.

<u>Code Number</u>	<u>Wheat Cv. Name</u>
1	Tamous 2
2	Amm AL-Rabee
3	IPA 90
4	Local 90
5	IPA 99
6	Certified Tamous 2
7	AL-Rasheed
8	Certified IPA 99
9	Abu-Greeb
10	Sham 9

Results and Discussion

Results in Table 2 showed that agronomic traits values increased as the nitrogen application levels increased, and significant differences were detected except for LDW, in which no significant differences were found. The increase in the above mentioned traits gave a comprehensive picture about the importance of nitrogen and prove that nitrogen is the most essential element in determining yield potential of wheat. Significant differences among nitrogen treatments for GDW and TW were found, and the values were higher at the high level of nitrogen supply. The same trend was observed in rice and found by Tabuchi *et al.* (15). The trend for RDW was completely different in which that as the availability of nitrogen reduced, the RDW production increased, and the differences were significant. Roots are extremely important to acquisition of water and nitrogen, especially under nitrogen stress situation. So this increase in RDW can be explained as a tool for plants to survive under stress nitrogen conditions, and so roots grew better

and produce more dry weight. Lemaire *et al.* (6) reported that under nitrogen limitation supply, nitrogen uptake in sorghum was high and that could be due to a more developed root system.

Results in Table 2 showed that the values of NE_1 averaged over the ten wheat cv. to represent the effect of nitrogen treatments, increased where ever the availability of nitrogen decreased. The highest values of NE_1 were obtained under unfertilized control and declined as the nitrogen fertilizer increased with significant differences were detected. The NE_1 values were 60.91, 50.03 and 45.39 under nitrogen levels of Zero, 200 kg.h $\square^{-1}$ and 400 kg. h $\square^{-1}$, respectively (Table 2). Reports by Maranville *et al.*, (8) and Zweifel, (16) mentioned similar results in sorghum. This showed that plants absorbed high amount of nitrogen under high nitrogen availability situation, but unfortunately use it in inefficient manner to produce biomass. The same trend was detected for the terms NE_2 and NE_3 and that in complete agreement with results published by Maranville *et al.*, (8) and Zweifel, (16). It is

interesting to observe that TEFF values behavior was different from NE_1 , NE_2 and NE_3 in which that the values of TEFF elevated as the nitrogen availability in soil increased. The differences among the three TEFF values were significant for the three levels of nitrogen, and they were 0.641, 0.615 and 0.557 for the nitrogen levels 400 $kg.h^{-1}$, 200 $kg.h^{-1}$ and the unfertilized control, respectively, as shown in Table 2. Similar results were reported by Moll *et al.*, (11), Mi *et al.*, (10) Liu *et al.*, (7) , Rathke *et al.*, (12) and Dawson *et al.*, (3). who found that nitrogen efficiency was higher under low nitrogen conditions, and transferring nitrogen from stover to grain increased with increasing nitrogen in soil.

The idea is that wheat grain yield must be enhanced in soil which presently cultivated with wheat in Iraq and that can be done by selecting or breeding high grain wheat cv. This could give a chance for future and large step that could give real benefits and food security down the roads. Results in Table 3 showed significant differences

among the ten wheat cv. toward NE_1 , NE_2 , NE_3 and TEFF parameters . Sham 9 cv. had the highest NE_1 value (61.518) while Tamous 2 cv. gave the lowest value (47.173). Amm AL-Rabee , IPA 99 and Certified Tamous 2 came the second, third and fourth, respectively. For NE_2 , Certified Tamous 2 , Sham 9 , IPA 90 and Amm AL-Rabee had the highest values as they were for NE_1 . Tamous 2 gave the lowest NE_2 value as it acted with NE_1 evaluation term. Certified tamous 2, IPA 90 and Sham 9 were from the best highest cv. in NE_3 and they similarly acted toward NE_1 and NE_2 . The ranking of wheat varieties toward TEFF term is different and Sham 9 which was one of the highest in NE_1 , NE_2 and NE_3 came the last in TEFF values. That means Sham 9 had low ability to transfer nitrogen from stover to grain and so needs heavier application of nitrogen fertilizer. Habash *et al.*, (5) mentioned that 60-95 % of grain nitrogen came from the remobilization of nitrogen stored in shoots in hexaploid wheat and non-efficient nitrogen remobilization genotypes need more nitrogen

Table 2: Effect of Nitrogen Levels on Studied Parameters.

Nitrogen g GDW g TW g Level	NE1	NE2	NE3	TEFF	PLH cm	SL cm	TN	LTN	RDW g	SDW g	LDW
1- Zero (control)	60.911	40.493	22.784	0.557	60.700	9.333	7.433	5.600	11.539	16.892	
15.35 12.63	56.190										
2- 200 kg. h□ ⁻¹	50.035	35.568	21.907	0.615	60.868	9.800	8.333	6.600	11.146	21.568	
16.029 13.28	60.169										
3- 400kg.h□ ⁻¹	45.386	33.337	22.004	0.541	65.033	9.933	9.700	8.033	11.007	24.720	
16.573 14.68	67.295										
LDS*	0.411	0.325	0.042	0.056	2.215	0.588	0.480	0.461	0.480	0.827	0.799
0.583 1.631											

*LSD at P=0.05 for differences among means in columns for a particular variable.

Table 3: Effect of Cultivars on Studied Parameters.

Cultivar	NE1	NE2	NE3	TEFF	PLH cm	SL cm	TN	LTN	RDW g	SDW g	LDW g	GDW g
TW g												
1 - Tamous2	47.173	32.091	18.446	1.831	49.778	9.111	8.222	6.444	12.564	26.373	19.754	
17.123	77.916											
2- Amm	58.450	38.133	20.705	1.466	70.667	8.770	8.888	7.111	11.132	22.333	15.508	
13.132	60.066											
AL-Rabee												
3- IPA 90	52.656	38.633	24.595	1.706	64.444	9.11	8.888	7.222	10.67	20.677	14.150	
13.118	58.484											
4 - Local 90	49.217	38.130	26.780	1.825	70.888	10.444	7.888	6.444	10.891	15.646	14.388	
13.932	51.951											
5- IPA 99	53.211	32.558	15.595	1.507	62.333	10.444	9.222	7.444	10.887	21.852	16.868	
13.463	62.366											
6- Certified	53.002	40.172	28.317	1.580	56.333	9.111	8.444	6.777	12,336	22.937	17.475	
13.714	67.119											
Tamous2												
7-AL-Rasheed	49.535	36.622	23.968	1.850	69.667	12.22	9.222	7.444	10.654	22.767	16.885	
13.433	60.878											

8-Certified	48.801	34.240	20.851	1.839	54.889	9.33	7.444	6.555	10.571	20.027	14.395
11.968	53.591										
IPA 99											
9- Abu-	47.548	34.065	21.131	1.868	55.556	8.886	7.555	6.666	10.391	16.706	14.140
11.898	52.358										
Greeb											
10- Sham	61.518	39.977	21.926	1.413	67.444	9.776	9.111	7.333	12.203	21.583	16.307
13.557	67.487										
LSD *	0.750	0.593	0.774	0.103	4.045	1.074	0.876	0.843	0.877	1.509	1.459
2.979											1.069

LSD at P= 0.05 for differences among means in columns for a particular variable.

fertilizer. Over all conclusion can be obtained from nitrogen efficiency results in which cv. with low NE_1 , NE_2 and NE_3 values are not necessarily have low grain yield and total plant weight. Tamous 2 cv. had the lowest NE_1 and NE_2 values and in the same time had the highest grain yield and total plant weight (Table 3). This can be explained that Tamous 2 cv. produced high grain yield and total dry weight, but in the same time absorbed much more nitrogen, which led to low NE_1 and NE_2 values.

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تقيم أصناف الحنطة بواسطة الصفات النباتية ، مستويات النتروجين ، ومقاييس الكفاءة النيتروجينية .

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المستخلص:

عشرة اصناف من الحنطة و ثلاثة مستويات من النيتروجين تم استعمالها في التجربة الحقلية التي تم تنفيذها في كلية الزراعة جامعة الكوفة في 2013/10/15 بهدف المقارنة بين أصناف الحنطة العشرة على اساس الصفات النباتية ومقاييس الكفاءة النيتروجينية لتحديد افضل الاصناف في استعمال النتروجين وزيادة الانتاج و تحت ثلاثة مستويات من سماد اليوريا . النتائج اوضحت ان الصفات النباتية مثل طول النبات (سم)، طول السنبلة(سم) ، مجموع الفروع، الفروع الحية، الوزن الجاف للسيقان، الاوراق، الحبوب و اخيرا مجموع الوزن الجاف(غم) ازدادت مع زيادة النيتروجين المضاف للنباتات. ولكن حال لجذور كان مختلفا اذ كلما قل مستوى النيتروجين في التربة زاد الوزن الجاف للجذور . النتائج اوضحت ايضا بان الكفاءة النيتروجينية الأولية NE1 التي هي مجموع المادة الجافة المنتجة لمجموع النتروجين الممتص والكفاءة النيتروجينية الثانية NE2 التي هي وزن الحبوب المنتجة لمجموع النتروجين الممتص والكفاءة النيتروجينية الثالثة NE3 التي هي النسبة بين النتروجين في الحبوب على النتروجين في الأجزاء الخضرية مضروبا في الكفاءة النيتروجينية الثانية ازدادت كلما قلت كمية النيتروجين المضاف للتربة . سلوك كفاءة نقل النيتروجين من الاجزاء الخضرية الى الحبوب TEFF كان مختلف حيث ان نسبة ازدادت مع ازدياد توفر النيتروجين في التربة .

النتائج اظهرت كذلك الاختلافات المعنوية بين اصناف الحنطة بالنسبة للمقاييس NE1, NE2, NE3, TEFF.

الصنف شام 9 حصل على اكبر قيمة بالنسبة الى NE1 (61.518) بينما الصنف تموز 2 اعطى اقل قيمة (47.173). هذين الصنفين اعطيا نفس السلوك بالنسبة NE2, NE3, ترتيب الاصناف اعتمادا على TEFF كان مختلفا حيث ان شام 9 الذي حصل على مرتبة مرتفعة بالنسبة للمقاييس NE1, NE2, NE3 كان الاخير بالنسبة للمقياس TEFF . الاستنتاج الاخير هو ان الاصناف التي لها مقدار قليل لمقاييس الكفاءة النيتروجينية هي ليست بالضرورة اعطت انتاج حبوب قليل.

كلمات مفتاحية :- محاصيل حقلية . تقم اصناف الحنطة . تجارب حقلية . مستويات النتروجين . مؤشرات كفاءة النتروجين