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Studying the grain yield and yield components in advanced rain fed wheat genotypes

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ABSTRACT

The present research was conducted to analyze the grain yield and yield components of advanced rain fed wheat genotypes during the farming year 2010-2011 in the Agricultural Researches and Natural Resources Station of Ardebil (one of the coldest areas in Iran). Results indicated that except for total number of tillers and number of fertile tillers, there is a significant difference between the understudy wheat genotypes at 1% or confidence interval of 99% in terms of all evaluated traits. This this could indicate the high genetic diversity among the genotypes for selection of the respective traits. There was a significant difference between the respective genotypes in terms of total plant weight (biomass) at 1%. Mean using Duncan's method at 5% suggested that the genotype No. 13 had the highest total biomass and was ranked in class A, along with genotypes No. 1, No. 8, and No. 16. Furthermore, grain yields of genotypes varied in the range 3.19 to 5.79 kg per plot. The highest grain yields were reported for genotypes No. 17, No. 13, and No. 3 with 5.79, 5.77, and 5.76 kg/plot, respectively. These genotypes were categorized in class A. The higher yields of these genotypes might result from genetic features of genotype and their capability in transferring larger amount of matters to the plant sink.

Keywords: Rain fed wheat, yield, genetic diversity.

INTRODUCTION

The population growth phenomenon in developing countries, diversity of foods, and their high consumption in the advanced countries have led to an increase in the global demand for food to an unprecedented level in the history. Wheat – under scientific name of Triticum aestivum - is the first cereal and the most important agricultural product of the world [1]. High compatibility of this crop and also its various usages in human's nutrition system have marked it as the most significant cereal of the world especially in developing countries. Wheat approximately accounts for 20% of nutritional resources of the people around the world [2]. Wheat not only is a crucial commercial commodity but also a powerful weapon in the modern world with increasing strategic significance as time goes on. Wheat bread is specifically important in Iran as the dominant food [3]. Furthermore, the necessity for availability of this crop as a political-economical leverage is absolutely tangible. According to estimations of International Administration of Policy-making for Food, the global demand for wheat will increase up to 40% of the current level by 2020. Whereas, the accessible resource's for wheat production are facing serious limitations. Therefore, it is predicted that around 100 million tons of shortage will occur for wheat supply in the global markets in the aforementioned year [4]. Water deficiency impacts on plants and their reactions to cope with the drought stress are various. Even the growth stage's in plants which undergo the drought stress and water shortage is significant regarding the drought tolerance since plants exhibit different tolerances to environmental stresses at different stages of their growth. Accordingly, for sustainable production of wheat crop, it is highly important to identify the wheat cultivars and lines which have high yields in stress-free conditions as well as acceptable yields in drought stress states. Water deficiency is among the main environmental which decreases wheat production in arid and semi-arid regions [5, 6, 7]. The wheat-cultivated land area of Iran is estimated to be about 6.61 million hectares, 38.57

percent's of which are irrigated fields and the rest 61.43 percent's are produced in rain fed (dry) farming conditions. Iran's wheat production is estimated to be 12.5 million tons [8], 70% of which are produced in semi-arid and cold regions of Iran. Limited irrigation water and moisture deficiency in different growth stages of crop are regarded as the most significant constraints against the wheat growth in these areas [9]. Enhancement of wheat grain yield in these areas have not been successful through eugenic treatments and generation of drought compatible and resistant cultivars, because many plant traits and environmental factors are involved in the occurrence of dry-resistant phenomena and crop enhancement. In addition, these traits and factors exhibit interactions, as well. Consequently, identification of drought-tolerant genotypes are particularly vital. To do so, the current project was carried out aimed at selecting the genotypes with high yield and tolerant to drought stress under water deficiency conditions through assessment of some traits and factors affecting the grain yield which could be used in eugenic programs.

MATERIALS AND METHODS

This research was conducted during the farming year 2010-2011 in Ardebil's Agricultural Research Station. 20 wheat cultivars and lines were tested in randomized complete blocks design with three replications. The tested tree lines are included in Table 1. 6 lines with a length of 6 meters and 20 cm apart from each other were plant in each plot. Area of each plot was 7.2 m^2 and the harvested area was equal to 6 m^2 after omission of two half meters from both ends of every plot for excluding the margin effect. The seeds were planted in October 2010 and plots were irrigated in accordance with common local schedule and procedures: twice in autumn and three times in spring. The following traits were measured and assessed: plant height, total number of tillers, number of fertile tillers, peduncle length, ear length, total biomass, straw weight, and grain yield. Following the measurement of the aforementioned traits and recording the results in special papers and after averaging, simple variance analysis was performed for all the traits measured in randomized complete blocks designs with three replications. Prior to statistical analyses, the respective data were verified in terms of normality using Kolmogorov-Smirnov test. Then, having attested the normal distribution, the variance analysis of data were performed and their means were compared by means of SAS software. The means were subsequently compared using multi-domain Duncan's test at 5%.

Table 1 - pedigree and characteristics of 20 wheat genotypes evaluated

NO	Genotype / Line
1	Oroum
2	Zareh
3	Mihan
4	Owl//Ombul/Alamo
5	Bow"s"/Crow"s"//Kie"s"/Vee"s"/3/MV17
6	Fdo 2062
7	Zarrin*2/Gaspard
8	Babaga
9	Pyn*2/Co725052/3/Kauz*2/Yaco//Kauz
10	Alvand*2/Gaspard
11	Shi#4414/Crows"s"//Gk Sagvari/Ca8055
12	308.02.2/Weaver//F362K2.121
13	Zander/3/Kauz*2/Yaco//Kauz
14	Gascogne/Col. no.3625//Zarrin
15	Fdo 4085
16	Fdo 1104-2
17	Fdo 5121
18	Fdo 6087
19	Bez/Nad//Kzm(Es85-24)/3/Ptzniska/Ut1556-170
20	Kleiber/2*Fl80//Donsk.Poluk./3/Ks82W409/…

RESULTS AND DISCUSSION

ANOVA results for the respective traits are shown in table 2. The results indicate that there is significant difference between understudy wheat genotypes under study in terms of all the evaluated traits except for total number of tillers and number of fertile tillers at 1% (or confidence interval of 99%). This is suggestive of a high genetic diversity among the genotypes for selection of the respective traits. Among the understudy traits, the minimum and maximum variation coefficients were observed in straw weight and plant height with 27.48 and 6.27 percent's, respectively. Nematollahi in 2012 reported the lowest and highest variations respectively for straw weight and plant height in a study on 20 barley genotypes [10].

Jafarzadeh (2009) reported significant contrast among 25 genotypes in his study in at 1% based on the ANOVA test results and through measuring and assessing different traits such as number of days before heading, plant height, maturation time, number of grains per ear, number of fertile tillers, harvest index, 1000-grains weight, and grain yield [11].

Amini (2003) also reported a significant contrast among the evaluated genotypes at 1% through assessment of ANOVA results for the following traits: number of days until heading, plant height, maturation time, number of grains per ear, 1000-grains weight, and grain yield [12]. Averages of the genotypes under the present study were compared using multi-range Duncan's test at 5% and the results are presented in table 2. Among the understudy genotypes, there were no significant difference in terms of total number of tillers and number of fertile tillers (Table 2). Sarmadnia (1981) stated that the first genetically controlled yield component is number of fertile tillers. Nevertheless, the number of fertile tillers is tightly linked to moisture regime of the soil, and number of fertile tillers increases by reduction in soil density [13]. Ears in genotypes 13 and 14 were 13.33 cm longer than others and ranked in the superior class together with genotypes 1, 2, 3, 7, 8, 10, 12, 19, and 20. Ear length is regarded among the major components of yield in fine-grained cereals, and for improving the grain yield per unit surface area, it is advisable to select the genotypes having maximum value of this trait. Fischer and Maurer (1987) hold the opinion that an important component of grain yield i.e. number of grain per ear (sink ability) is determined in the growth stage of the young ear [14]. Thus, this growth stage is a critical period for determining the potential of grain yield. Calderini et al (1999) believed that enhancement of grain yield during the recent years is mainly resulted from the increase in the number of grains per ear and this component of the yield plays a more remarkable role, comparing to the grain weight. Although both sink and source agents restrict the grain yield, evidences demonstrate that sink is more restricting, even for the newly planted wheat lines [15]. As a conclusion of reviewing numerous papers, Slafer stated that the difference observed in the grain yield is mainly attributed to the variations occurring in the number of grains per square meter [16]. Eugenie aimed at potential enhancement is to a large extent resulted from the increase in sink capacity, and in most cases, it is achieved through increase in number of grains [17]. Therefore, enhancement of sink capacity through increasing the number of grains in the major and minor ears could lead to improvement of the economical yield [17].

Table 2 - Results of variance analysis Evaluation of wheat genotypes

Source of Variations	df	Mean Square							
		Total claw	Number of Claws Fertile	Hyacinth Length	Plant Height	Straw Weight	Total plant weight	Peduncle length	Yield
Rep	2	0.842	0.053	17.65	81.23	15.60	55.36	5.15	0.020
Genotype	19	0.224^{ns}	0.255^{ns}	8.83^{**}	255.28^{**}	39.50^{**}	151.57^{**}	40.51^{**}	1.450^{**}
Error	38	0.488	0.298	1.182	37.97	39.44	147.97	3.35	0. 393
CV (%)	-	20.92	9.94	9.94	6.27	27.47	23.44	11.66	13.30

** and ** Significantly at $p < 0.05$ and < 0.01, respectively*

Table 3 - Comparison of characteristics of wheat genotypes were evaluated by Duncan's test at 5% probability level

Genotypes	Characters															
	Total claw		Number of Claws Fertile		Hyacinth Length		Plant Height		Straw Weight		Total plant weight		Peduncle length		Yield	
1	3.53	a	3.33	ab	11.27	a-d	100.5	a-e	24.26	ab	64.91	ab	19.00	a-d	4.06	cd
2	3.46	a	3.00	ab	11.67	a-c	103.7	a-e	27.32	ab	45.36	f-h	20.87	a	4.71	a-c
3	3.26	a	2.46	b	12.87	ab	96.87	c-f	19.56	ab	53.85	c-f	16.53	b-e	5.76	a
4	3.13	a	2.66	ab	10.87	b-d	95.53	d-g	22.99	ab	50.85	d-g	11.60	fg	4.90	a-c
5	3.73	a	3.13	ab	10.47	c-f	97.00	c-f	18.82	ab	47.46	e-h	16.07	c-e	4.23	b-d
6	3.06	a	2.60	ab	8.60	e-g	84.67	g-i	18.91	ab	45.51	f-h	11.73	fg	4.85	a-c
7	3.20	a	2.86	ab	11.33	a-d	107.2	a-d	23.40	ab	53.18	c-g	15.60	de	5.41	ab
8	3.33	a	3.13	ab	12.80	ab	108.1	a-c	25.90	ab	59.48	a-d	18.40	a-d	3.92	cd
9	3.26	a	3.06	ab	10.60	cd	102.3	a-e	20.85	ab	44.10	gh	18.73	a-d	3.19	d
10	3.60	a	3.33	ab	12.33	a-c	107.4	a-d	23.29	ab	53.32	c-g	20.00	ab	5.03	a-c
11	3.20	a	2.93	ab	10.53	c-e	109.5	ab	27.70	ab	56.53	b-e	17.93	a-d	5.03	a-c
12	3.73	a	2.80	ab	11.47	a-d	110.3	a	24.16	ab	55.91	c-e	19.40	a-c	4.43	bc
13	3.06	a	3.00	ab	13.33	a	101.6	a-e	25.65	ab	65.83	a	13.80	ef	5.77	a
14	3.00	a	2.73	ab	13.33	a	100.5	a-e	20.76	ab	49.23	e-h	19.33	a-c	4.17	cd
15	3.06	a	2.86	ab	7.80	g	77.73	i	15.52	ab	40.24	h	11.20	f-h	5.41	ab
16	3. 86	a	3.60	a	8.53	fg	93.53	e-h	25.65	ab	61.63	a-c	13.53	ef	4.29	b-d
17	3.40	a	2.60	ab	7.93	g	82.60	hi	20.76	ab	47.28	e-h	10.00	gh	5.79	a
18	3.26	a	2.60	ab	9.46	d-g	87.53	f-i	15.52	b	44.28	gh	8.13	h	4.68	a-c
19	3.66	a	3.13	ab	11.80	a-c	98.07	b-f	25.88	ab	49.02	e-h	16.13	c-e	4.14	cd
20	2.93	a	2.80	ab	11.80	a-c	102.5	a-e	19.04	ab	49.99	e-g	16.20	c-e	4.40	bc

Differences between averages of each column which have common characters are not significant at probability level of 5%

Genotypes 11 and 12 with a plant height of 110 cm are significantly different from others and ranked in the superior class together with genotypes 1, 2, 7, 8, 9, 13, 14, and 20. No significant contrast was observed among the genotypes under study in terms of the straw weight. The difference among the evaluated genotypes was significant in terms of total biomass in at 1% as mea comparison through Duncan method at 5% indicated the fact that the genotype 13 had the largest biomass and the genotypes 1, 8, and 16 were also categorized in class A (Table 3). Peduncle lengths of the evaluated genotypes varied in the range 8.13 cm (genotype 18) to 20.87 cm (genotype 2). Peduncle lengths of genotypes 1, 2, 8, 9, 10, 11, 12, and 14 were placed in class A (Table 3). The grain yields of the understudy genotypes varied in the range 3.19 (genotype 9) to 5.79 kg per plot (genotype 17), (Table 3).

The largest grain yields belonged to genotypes 17, 13, and 3 with 5.79, 5.77, and 5.67 kg/plot, respectively; these genotypes were categrozied in class A together with genotypes 2, 4, 6, 7, 10, 13, 11, 15, and 18. This improvement in grain yield seems to result from the gentic characteristics of genotypes and their capability of transferring larger amount of matters to the sinks. Genotype 9 had the lowest grain yield among the genotypes and ranked in class D (Table 3).

CONCLUSION

ANOVA results of the data acquired from measurement of the traits under current study showed that the genotypes were significantly different from each other with respect to most of the traits except for total number of tillers and number of fertile tillers. Also, the largest grain yields were observed for genotypes 17, 13, and 3 with 5.79, 5.77, and 5.76 kilograms per plot, respectively.

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