EFFECT OF DEPLETION PERCENTAGE ON YIELD , YIELD COMPONENTS AND WATER USE EFICIENCY FOR SELECTED GENOTYPES OF BREAD WHEAT

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ABSTRACT

A field experiments were carried out at the Abu- Graib Research Station - Office of Agricultural Research Ministry of Agriculture , to investigate effect of moisture deletion for some traits of selected wheat genotypes , during 2014-2015, which depend to the long term of breeding program (2008-2014) . The 9th selected genotypes and the control variety IPA 99 were evaluated using split plot arrangement within RCBD and three replications. The main plots included four moisture depletion (20%, 40%, 60% and 80%) of available water while, genotypes occupied sub plots .The results revealed significant differences among depletion, genotypes and their interaction of all studied traits. Moisture depletion 20% , showed the superiority of number of spikes m^{-2} (385.7), number of grains spike^{-1} (57.23 grain), weight of 1000 grains (40.85 gm), higher grain yield (5.06 t ha^{-1}), higher biological yield (16.51 t ha^{-1}), and highest water use efficiency for grain yield (1.63 kg m^{-3}). Significant differences were found among genotypes and interactions between genotypes and water stress in most studied characters , this shows of genotypes performance differences to water stress. So we can select one or more genotype which tolerance to water stress.

Key words: water stress, grain yield, number of spikes, number of grains spike^{-1}, grain weight,
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تاثير نسب الاستنزاف الرطوبي على الحاصل ومكوناته وكفاءة استعمال الماء للتراكيب الوراثية المنتخبة من حنطة الخبز

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المستخلص

نفذت تجربة حقلية في حقول محطة ابحاث ابي غريب التابعة لدائرة البحوث الزراعية– وزارة الزراعة خلال الموسم الشتوي 2015– 2016 بهدف معرفة تاثير نسب الاستنزاف الرطوبي والتراكيب الوراثية والتداخل بينهما على الحاصل ومكوناته وكفاءة استعمال الماء للتراكيب الوراثية المنتخبة من حنطة الخبز في الموسم 2014 – 2015 والتي تمت انتخابها من برناج تربية طويلة الامد (2008 – 2014). طبقت التجربة بترتيب الالواح المنشقة وفق تصميم RCBD بثلاث مكررات تضمنت الالواح الرئيسة اربع نسب استنزاف 20% و40% و60% و80% من الماء الجاهز واحتوت الالواح الثانوية التراكيب الوراثية المنتخبة التسعة وصنف المقارنة.. اظهرت النتائج وجود فروقات معنوية بين نسب الاستنزاف والتراكيب والتداخل بينهما،وذلك بتفوق نسبة استنزاف 20% باعطائها اعلى عدد سنابل م$^{-2}$ (385.7) واعلى عدد حبوب بالسنبلة (57.23 حبة) واعلى وزن 1000 حبة (40.85 غم) واعلى حاصل حبوب (5.06 طن هـ$^{-1}$) واعلى حاصل بيولوجي (16.51 طن هـ) وكفاءة استعمال ماء عالية (1.63 كغم م$^{-3}$). وجدت فروقات معنوية بين التراكيب الوراثية المنتخبة و التداخل بين نسب الاستنزاف لاغلب الصفات المدروسة مما يدل على ان التراكيب الوراثية سلكت سلوكا مختلفا تجاه مستويات نسب الاستنزاف ولكن ليس بنفس الكمية وهذا يعني امكانية انتخاب تركيب واحد او اكثر يكون متحملا للاجهاد.

كلمات مفتاحية: تحمل الجفاف، حاصل الحبوب، عدد السنابل، عدد الحبوب بالسنبلة، وزن حبة، طول السنبلة،

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INTRODAUCTION

Wheat (*Triticum aestivum* L.) important crop cultivate at all the world countries during year , but the differences in time of seeding and type of the genotype. Water deficiency could be one of the limiting factor for wheat production in Iraq. Environmental variances in the Iraq, especially warmth climatic and decrease in precipitations and water resources in Iraq, lack of water management. The important way for water management in Iraq is to control irrigation amount and water depletion around the active roots, beside that using genotypes with lowest water consumption, this need to breeding programs. Any population genetically improvement depend on the genetic variation within the same population or using mutation induction, introduction from other regions hybridization between different pure lines of the same species and more useful when they have widest genetic diversity. Hybridization is the best way to get genetic variation in second generations as new gene recombination, breeder can select promising genotypes from segregated generations to develop new pure lines and varieties in the future. The selection after crossing in wheat could be carried out according to the aim of the crossing, in the most cases improving one or more yield components to develop grain yield. The success of selection generally depend to the genetic variation of the segregated generation, which increase the chance of improvement and development promising genotypes. The Biological Scientist Johannnson, during 1903 - 1926, developed pure line selection, using self pollinated crops and found that the selection was useless in pure lines (13). In general, selection and it's success depend on additive gene action, selection could be done to increase favorable genes for desired characters and applied until reducing the genetic gain (9 , 12). Selection could be increases the frequency of favorable genes for the studied traits, which causes the improvement of those traits (10, 11). Selection program for local genotypes undesirable because those genotypes were highly homozygous pure lines, and to improve of local genotypes must be induce genetic variations. The objective of this research, to investigate the effect of water depletion % on yield, yield components and water use efficiency for selected genotypes of bread wheat.

MATERIALS AND METHODS

A field experiments were carried out at the Abu- Graib Research Station - Office of Agricultural Research Ministry of Agriculture, to investigate depletion effect for some traits of selected genotypes during 2014-2015, which depend on the long term of breeding program (2008-2014). The 9th selected genotypes (Table 1) and the control variety IPA 99 were evaluated during season 2015-2016, using split plot arrangement within RCBD and three replications. The main plots included four levels of water stress (20%, 40%, 60% and 80% depletion of available water) , while, genotypes occupied sub plots . The experiment was conducted on the loam clay soil . Soil samples were took from 30 cm depth and analyzed for chemical and physical characteristics of the soil. The experimental field was fertilized with 100 kgP_2O_5.ha^{-1} as TSP, added before seed seeding . Nitrogen fertilizer as urea (46% N)was added with quantity 200 kg.ha^{-1}, two times: before seeding and at booting stage,. Soil moisture tested using, Zein (35) method and estimated using the formula suggested by Kovda, Berg and Hangun (23):

$$P_w = \left(\frac{M_{sw} - M_s}{M_s} \right) \text{x } 100$$

p= soil weighted moisture content

M_{sw} = moist soil mass

M_s = dray soil mass

Table 1. Selected genotypes , used in varietal trail , season 2015-b 2016

No.	Genotype	Cross MxF	Grain weight mg	No. of grains $spike^{-1}$
17	H4P2-2	Indian 9 x IPA95	49.5	
27	H4P4-2	Indian 9x IPA95	46.3	
44	H6P1-4	Indian 9x Mexibak	44.0	
45	H6P1-5	Indian 9x Mexibak	47.7	
117	H11P3-4	Shaam 6 x India 9	45.8	
129	H12P1-3	Abu-Graib3x IPA95		75
147	H12P6-1	Abu-Graib3x IPA95		79
179	H15P3-2	Fateh x Abu-Ghraib3		81
186	H2P1	IPA95 x IPA99		82

Calculated water was added to experimental unite to soil depth of 0 - 20 cm and 0 - 40 cm, and homogeneity distributed, (27), volume moisture content was calculated and water depth (d) was estimated according to depletion treatments.

$$\theta = (PW)(\ell_b)$$

volume moisture (%)content , ($m^3\ m^{-1}$)

ℓ_b = moist soil mass (1.3 mega gm m^{-3})

Water used for experimental unit was calculated for each water depletion 20% , 40% , 60 , 80% from available water.

$$W = a.As\left(\frac{\%Pw^{Fc} - \%Pw^{w}}{100}\right) \times \frac{D}{100}$$

W= water volume could be add for irrigation (m^3)

a= Area would be irrigate (m^2)

As= phenotypic density {meka gm $(m^3)^{-1}$}

Pw^{FC}= soil moisture percent according to the weight at field capacity

Pw^{W}= soil moisture content before irrigation

D = soil depth

Water use efficiency calculated according to grain yield calculated (6):

WUE_f = GY / WA

WUE_f = Water use efficiency of the field (kg m^3)

GY = Total grain yield (kg ha^{-1})

WA = Irrigation water added to the field

The quantity of water calculated to the depth of 20 cm until tillering (ZGs^{21}) and then to 40 cm 2nd nod discover (ZGS_{32}) to the calculation of water depletion, 20%, 40%, 60% and 80%, from available water. The irrigation was continued from, ZGs21 to ZGS^{81}, (34). Available water (F.C. – P.W.P) was estimated from soil moisture characteristic curve (Fig. 1). Different growth characters were recorded; Number of days from planting to 50 % flowering, flag leaf area cm^{-2}, flag leaf angle, plant height (cm), number of days from planting to physiological maturity, spike length cm^{-1} , number of spikelets. $spike^{-1}$ .grain yield t ha^{-1} and water use efficiency. The results were analyzed statistically, using analysis of variance. The means were compared using LSD 5 %, by statistical program, Genestate.

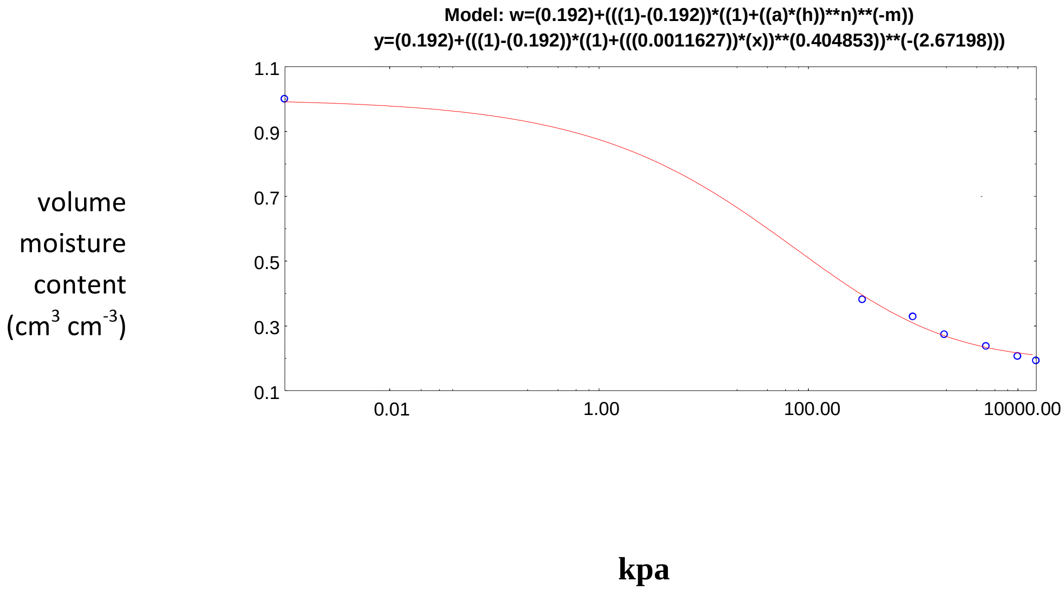

Figure 1. Soil moisture discretion curve for the experimental field

RESULTS AND DISCUSSION

Number of Spikes m^{-2} : Results in Table 2 shows significant differences among moisture depletion %, wheat genotypes and their interaction in number of spikes m^{-2}. Plants under 20 % moisture depletion produced highest number of spikes m^{-2} (385.70 spikes), while the lowest number of spikes m^{-2} (281.2 spikes) produced from plants under 80% moisture depletion. The reason may be due to decrease in number of fertile tillers, which happened from reduction of supplemented of nutrition materials and it's available under higher moisture depletion %, this results agreed with opinion of other researchers, Al-Obaidy (1) and Amer *et al* (2). Wheat genotypes differed significantly in number of spikes m^{-2}, (31, 32), the genotype 129 produced highest number of spikes m $^{-2}$ (364.3 spikes) and didn't significantly differed from the genotype 27, which produced 293.8 spikes, and didn't differed from genotypes 27, IPA99, 147. The variances among genotypes due to genetic variation among wheat genotypes. The results also reveal that the response of wheat genotypes were differed due to moisture depletion percentages. This shows that each genotype had specific moisture depletion response.

Table 2. Means number of spikes m^{-2} for wheat selected genotypes under the moisture depletion % effect for the season 2015- 2016

Genotypes No.	Genotypes	Depletion % 20 %	40 %	60 %	80 %	Genotypes Means
1	IPA99	338.0	385.7	283.3	212.7	304.9
44	H6P1-4	378.0	369.3	337.7	320.0	351.2
186	H2-2	383.7	357.0	335.3	322.7	349.7
117	H11P3-4	448.0	306.0	296.7	267.7	329.6
27	H4P4-2	307.7	389.7	254.7	223.0	293.8
17	H4P2-2	317.3	365.7	342.7	315.7	335.3
129	H12P1-3	427.3	399.7	338.7	291.7	364.3
179	H15P3-2	437.3	324.3	332.7	315.0	352.3
147	H12P6-1	424.7	327.3	286.3	235.7	318.5
45	H6P1-5	395.3	334.7	374.0	308.3	353.1
LSD 5 %		72.7				35.5
Depletion Means		385.7	355.9	318.2	281.2	
LSD 5%		33.5				

Number of grains $spike^{-1}$

Results in Table 3 shows significant differences among moisture depletion %, wheat genotypes and their interaction in number of grains $spike^{-1}$. This character decreased with increasing moisture depletion %. The highest number of grains $spike^{-1}$(57.23 grains) produced from plants under treatment 20% moisture depletion and didn't significantly differed from the treatment 40 % depletion, which spikes produced 54.90 grains. While, the lowest (45.33 grains) produced from the plants under 80% moisture depletion. The reason of reduction in number of grains $spike^{-1}$ from increasing moisture depletion % was due to reduction in the cell size, it's length, mitosis, which causes reduction in the flag leaf area, spike length. Results of this research agreed with the results obtained by, Ameer *et al* (2), Baloch *et al* (13) and Dhahi and Baktash (14). The results, also revealed significant differences among genotypes in number of grains $spike^{-1}$, the genotype 186 superior (64.58 grains) and follow that the genotypes 147, 44, IPA 99, which didn't differed significantly. The significant differences in interaction between moisture depletion % and genotypes, shows the genotype response differences among moisture depletion % in number of grains $spike^{-1}$.

Weight of 1000 grains gm^{-1}

Results in Table 4 shows significant differences among moisture depletion % , wheat genotypes and their interaction in weight of 1000 grains gm^{-1} .The plants under 20 % moisture depletion had highest 1000 grain weight (40.85 gm) and didn't significantly differed from 40 % of moisture depletion, which produced weight of 1000 grains 39.73 gm. The lowest weight of 1000 grains (37.91 gm) produced from plants under 80% moisture depletion, but this moisture depletion didn't significantly differed from 60% moisture depletion, which produced weight of 1000 grains 38.77 gm. The results of this experiment agreed with results of AL-Timimi (4) and Baktash and Hassan (5), mentioned that the highest moisture depletion % caused reduction in 1000 grains weight.

Also the results of this experiment agreed with results of , Al-Obiady (1). Significant differences were found among genotypes in weight of 1000 grains gm^{-1}, the wheat genotype 17 produced heavy 1000 grains (48.60 gm), while the genotype 129 lowest grain weight (33.11 gm). The reason of the variances among genotypes due to the variation in genetic materials. The results of this experiment agreed with results of Baktash and Naes (10, 11), Hamdan *et al* (16) and Hassan (20). Significant interaction was found among moisture depletion % and genotypes in 1000 grains weight, this indicated that the response of wheat genotypes to moisture deletion % were differed due to differences of depletion % and genetic constitution of the genotype, that each genotype had it's own response to moisture depletion % .

Table 3. Means number grains $spike^{-1}$ for wheat selected genotypes under the moisture depletion % effect for the season 2015- 2016

Genotypes No.	Genotypes	Depletion %				Genotypes Means
		20 %	40 %	60 %	80 %	
1	IPA99	58.00	56.67	56.00	54.00	56.17
44	H6P1-4	60.00	58.00	55.00	50.00	56.00
186	H2-2	70.33	64.00	64.33	59.67	64.58
117	H11P3-4	49.00	57.00	43.67	44.00	48.42
27	H4P4-2	62.67	51.33	49.67	48.33	53.00
17	H4P2-2	43.67	39.67	37.00	34.00	38.58
129	H12P1-3	52.00	50.00	37.67	36.00	43.92
179	H15P3-2	54.67	59.00	47.00	42.00	50.67
147	H12P6-1	68.00	56.67	57.33	53.00	58.75
45	H6P1-5	54.00	56.00	50.00	32.00	48.00
LSD 5 %		6.96				3.41
Depletion Means		57.23	54.90	49.00	45.33	51.81
LSD 5%		3.15				

Table 4. Means weight of 1000 grains gm^{-1} for wheat selected genotypes under the moisture depletion % effect for the season 2015- 2016

Genotypes No.	Genotypes	Depletion %				Genotypes Means
		20 %	40 %	60 %	80 %	
1	IPA99	37.35	31.93	37.25	38.15	36.17
44	H6P1-4	48.33	37.91	40.14	33.48	39.97
186	H2-2	36.51	39.67	39.45	35.93	37.91
117	H11P3-4	43.32	49.59	48.00	44.26	46.29
27	H4P4-2	40.28	25.17	35.16	34.84	33.86
17	H4P2-2	51.25	52.65	44.34	46.17	48.60
129	H12P1-3	34.62	33.35	35.05	29.43	33.11
179	H15P3-2	33.13	41.27	35.29	38.45	37.04
147	H12P6-1	35.61	37.31	35.44	39.28	36.91
45	H6P1-5	47.98	48.47	37.58	39.15	43.29
LSD 5 %		5.11				2.57
Depletion Means		40.9	39.73	38.77	37.91	
LSD 5%		1.91				

Grain yield (t ha^{-1})

Results in Table 5 shows significant differences among moisture depletion %, wheat genotypes and their interaction in grain yield. The highest grain yield (5.055 t ha^{-1}) produced from the plants under 20 % moisture depletion. Wheat grain yield decreased with increasing depletion from 20 % to 80%, the lowest grain yield (3.236 t ha^{-1}) produced from the plants under 80% depletion, this reduction about 35.98% in compare with the grain yield of the treatment 20% moisture depletion, (28, 29, 30). The reason of the reduction due to reduction in flag leaves area, which reduced net photosynthesis , then dray matter accumulation, spike length, number of spikes m^{-2} (Table 2) number of grains $spike^{-1}$ (Table3) and weight of 1000 grains (Table4). The results of this study agreed with the results of other researchers (18, 19), they mentioned that with increasing the moisture depletion % decreased one or more of wheat yield components. Wheat genotypes significantly differed in grain yield, the genotype 186 produced highest grain yield (5.642 t ha^{-1}), with the ratio 43.42% in compare to check variety IPA99 (15, 17, 21). The genotype 27 produced the lowest grain yield (3.128 t ha^{-1}). The superiority of the genotype 186 in grain yield, due to it had constant capacity system and it's superiority in number of spikes $plant^{-1}$, (Tables 3), the same results were found by many researchers (3, 6 .7 ,8). The response of wheat genotypes differed due to moisture depletion % , according to these results with increasing moisture depletion % decreased the genotypes grain yield and each genotype had it's response to moisture depletion.

Table 5. Means of grain yield ha^{-1} for wheat selected genotypes under the moisture depletion % effect for the season 2015- 2016

Genotypes No.	Genotypes	Depletion %				Genotypes Means
		20 %	40 %	60 %	80 %	
1	IPA99	4.44	4.56	3.55	2.80	3.93
44	H6P1-4	4.89	5.56	4.04	3.82	4.58
186	H2-2	6.36	6.67	5.54	4.00	5.64
117	H11P3-4	4.78	3.52	2.78	2.55	3.41
27	H4P4-2	3.98	3.51	2.62	2.41	3.13
17	H4P2-2	3.93	3.98	3.55	2.87	3.58
129	H12P1-3	5.03	4.93	4.11	3.35	4.35
179	H15P3-2	5.40	5.09	4.33	3.84	4.67
147	H12P6-1	6.01	4.69	4.37	2.85	4.48
45	H6P1-5	5.34	5.45	4.27	3.87	4.73
LSD 5 %		0.70				0.35
Depletion Means		5.06	4.80	3.92	3.24	LSD 5% 0.27

Biological yield (t ha^{-1})

Results in Table 6 shows significant differences among moisture depletion %, genotypes and their interaction of the biological yield. With increasing moisture depletion % decreased biological yield. Wheat plants at the 20% depletion produced highest biological yield (16.51 t ha^{-1}), while the lowest (12.13 t ha^{-1}) produced from the plants under 80% moisture depletion with reduction ratio value 26.53% in compare to the biological yield of the treatment 20% moisture depletion%. Reduction in biological yield from using 80% moisture depletion due to reduction in grain yield and yield components (Tables 2, 3, 4, 5). Results of this experiment agreed with the results obtained by some researchers (1, 16, 24, 25, 26). The results of this experiment shows variations among wheat genotypes in biological yield, (Table 6). Wheat genotype 179 produced highest biological yield (15.85 t ha^{-1}) and didn't significantly differed from the genotype 186, while, the genotype 27 produced the lowest biological yield (12.11 t ha^{-1}). Reason. of the differences among wheat genotypes in biological yield was due to differences in some yield components. The results of this experiment agreed with the results found by Hamadan *et al* (16). The interaction among moisture depletion % and wheat genotypes was significant. All the wheat genotypes decreased in this characters with increasing moisture depletion to 40%, 60 % and 80%, This shows that the response of genotypes to moisture depletion% in biological yield differed according to the moisture depletion %.

Table 6. Means biological yield (t ha^{-1}) for wheat selected genotypes under the moisture depletion % effect for the season 2015- 2016

Genotypes No.	Genotypes	Depletion %				Genotypes means
		20 %	40 %	60 %	80 %	
1	IPA99	15.94	16.25	14.04	11.33	14.39
44	H6P1-4	14.38	17.19	12.82	13.17	14.39
186	H2-2	15.94	15.21	15.16	13.33	14.91
117	H11P3-4	19.38	13.75	12.82	12.12	14.52
27	H4P4-2	15.01	13.44	10.00	10.00	12.11
17	H4P2-2	15.32	12.50	11.70	10.92	12.61
129	H12P1-3	15.94	16.45	13.45	13.44	14.82
179	H15P3-2	18.54	16.25	14.92	13.68	15.85
147	H12P6-1	18.13	13.75	12.86	9.91	13.66
45	H6P1-5	16.58	14.69	14.38	13.39	14.76
LSD5 %		2.05				0.98
Depletion Means		16.51	14.95	13.21	12.13	/
LSD5%		1.07				

Water use efficiency for grain yield (kg^{-3})

Results in Table 7 shows significant differences among moisture depletion % , wheat genotypes and their interaction in water use efficiency. The moisture depletion % impact significantly to the water use efficiency, with increasing moisture depletion from 20% to 80% caused reduction in water use efficiency. The treatments 20% and 40% water depletion had highest water use efficiency (1.63 kg m^{-3}). While the 80 % moisture depletion, had the lowest water use efficiency (1.38 kg m^{-3}). The reduction ratio in water use efficiency from using 80% moisture depletion % (15.34%, 15.34%, 6.76%) from moisture depletion percent 20% , 40% 60% . respectively. The reason of increasing water use efficiency from using 20% moisture depletion %, due to increasing plant leaf area , grain yield and decreasing evaporation from soil surfaces, which caused to decrease in water use efficiency. These results agreed with results found by, Ameer *et al* (2), Farhood and Ali (8), Mahamed *et al* (14) and Mahmood and Ahmed (15). The wheat genotypes differed significantly in water use efficiency for grain yield .The genotype 186 had highest (2.03 kg m^{-3}), which superior to the control (IPA 99) with ratio 43.97%. The genotypes 45, 147, 179, 129, 44 didn't significantly differed and had lowest than the genotype 186, in water use efficiency, the reason for that due to superiority of 186 in number of spikes m^{-2}, number of grains spike $^{-1}$ and grain yield (Tables 2, 3, 5). The genotypes 27, 117, 17, had lowest water use efficiency (1.12, 1.22 and 1.30), respectively. The results of this experiment agreed with those found by Mahamed *et al* (14) and Mahmood and Ahmed (15) and Siddique (23). Response of wheat genotypes to moisture depletion in this experiment was significant, this shows that impact of moisture depletion % to the wheat genotypes differed due to genetic materials variation among genotyps.

Table 7. Means of water use efficiency for wheat selected genotypes under the moisture depletion % effect for the season 2015- 2016

Genotypes No.	Genotypes	Depletion %				Genotypes means
		20 %	40 %	60 %	80 %	
1	IPA99	1.56	1.55	1.34	1.20	1.41
44	H6P1-4	1.58	1.89	1.52	1.63	1.66
186	H2-2	2.05	2.26	2.09	1.71	2.03
117	H11P3-4	1.54	1.20	1.05	1.09	1.22
27	H4P4-2	1.28	1.19	0.99	1.03	1.12
17	H4P2-2	1.27	1.35	1.34	1.23	1.30
129	H12P1-3	1.62	1.64	1.55	1.43	1.57
179	H15P3-2	1.74	1.73	1.63	1.64	1.69
147	H12P6-1	1.94	1.59	1.65	1.22	1.60
45	H6P1-5	1.72	1.85	1.61	1.66	1.71
LSD5 %		0.25				0.13
Depletion Means		1.63	1.63	1.48	1.38	
LSD5%	0.09					

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