IMPACT OF MOISTURE DEPLETION PERCENTAGES ON SOME GROWTH CHARACTERS AND YIELD 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 moisture depletion effect for some traits of selected genotypes during 2014-2015, which depended to the long term of breeding program (2008-2014). The 9th selected genotypes 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 results revealed significant differences among depletion %, genotypes and their interaction in all studied characters. Moisture depletion 20% of available water indicated the superiority of number days to 50% flowering (110.3 days), plant height (98..29 cm), flag leaf area (34.8 cm^2), flag leaf angle (67.70^0), number days to 100% physiological maturity (146.53 days), spike length (11.53 cm), number of spikelets spike^{-1} (18.07), grain yield (5.06 t ha^{-1}) and highest water use efficiency (1.63 kg m^{-3}). The lowest value of the characters were found by depletion 80% of available water. The genotype 179 to took highest number of days to 50% flowering (114 days), IPA99 had highest flag leaf area (33.21 cm^2) and highest period of 100% physiological maturity (145.75 days), genotype 27 had highest plant height (102.11 cm) and 186 produced highest spike length (11.75 cm), highest number of spikelests spike^{-1} (19.58), highest yield (5.64 t ha^{-1}). Significant differences were found in interactions between genotypes and water stress in most characters studied, this shows of genotypes tolerance differences to water stress. So we can select one or more genotype , which tolerance to 20% moisture depletion.

Key words: water stress, days for flowering, physiological maturity, spike length, hard wheat water use efficiency.

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مجلة العلوم الزراعية العراقية -2018: 49(2):160-170 ضاحي و بكتاش

تاثير نسب الاستنزاف الرطوبي على صفات النمو والحاصل 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 صفات النمو والحاصل وكفاءة استعمال الماء للتراكيب الوراثية المنتخبة من حنطة الخبز في الموسم 2014 – 2015 والتي تمت انتخابها من برناج تربية طويلة الامد (2008 – 2014). طبقت تجربة حقلية في الموسم 2015–2016 لتقييم تسعة تراكيب وراثية منتخبة بالاضافة الى صنف المقارنة اباء 99، بترتيب الالواح المنشقة وفق تصميم RCBD بثلاث مكررات تضمنت الالواح الرئيسة اربع نسب لا ستنزاف الرطوبي (20% و40% و60% و80%) من الماء الجاهز واحتوت الالواح الثانوية التراكيب المنتخبة التسعة وصنف المقارنة. اظهرت النتائج وجود فروقات معنوية بين نسب الاستنزاف الرطوبي والتراكيب الوراثية والتداخل بينهما، وذلك بتفوق نسبة استنزاف 20% لاغلب صفات النمو، حيث حققت اعلى القيم لعدد الايام من الزراعة حتى 50% تزهير (110.3 يوم) ولارتفاع النبات (98.29 سم) ولمساحة ورقة العلم (34.80 سم^2) ولزاوية ورقة العلم (67.70^0) ولعدد ايام 100% نضج فسلجي (146.53 يوم) ولطول السنبلة (11.53 سم) ولعدد السنيبلات سنبلة$^{-1}$ (18.07 سنيبلة سنبلة$^{-1}$) واقل القيم لمتوسطات للصفات سجلته نسبة استنزاف 80% من الماء الجاهز، حقق التركيب الوراثي 179 اعلى عدد ايام 50% تزهير (114 يوم) واعلى زاوية ورقة العلم (71.2^0) وسجل اباء99 اعلى مساحة لورقة العلم (33.2 سم^2) وعدد ايام 100% نضج فسلجي (53 ،146 يوم) واعطى التركيب الوراثي 27 اعلى ارتفاع للنبات (102.1 سم) وحقق التركيب الوراثي 186 اعلى متوسط لطول السنبلة 11.75 سم وعدد السنيبلات سنبلة$^{-1}$ 19.58 سنيبلة سنبلة$^{-1}$) واعلى حاصل حبوب (5.64 طن هـ$^{-1}$). وجد اختلاف معنوي لمعاملات التداخل بين نسب الاستنزاف والتراكيب الوراثية لاغلب الصفات مما يدل ان التراكيب الوراثية سلكت سلوكا مختلفة تجاه مستويات نسب الاستنزاف ولكن ليس بنفس الكمية وهذا يعني امكانية انتخاب تركيب واحد او اكثر يكون متحملا للاجهاد.

كلمات مفتاحية: الاجهاد الرطوبي، عدد ايام التزهير والنضج الفسلجي، طول السنبلة، الحنطة الصلبة، كفاءة استعمال المياه.

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INTRODAUCTION

Bread wheat (*Triticum aestivum* L), one of the most important cereal crops in the world and Iraq. More than 33% of the world population are use wheat as main food. It is also, the first cereal crop in the Iraq. Wheat crop cultivated at all the world countries during years, but the differences in time of seeding and type of the genotype. Water deficiency could be one of the limiting factor of wheat production in Iraq . Environmental variances in the World and 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 the irrigation amount and water depletion around the active roots, and using genotypes with low water consumption, through 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 highest genetic diversity. Hybridization is the best way to get genetic variation in second generation as new gene recombination, breeder can select promising genotypes from segregated generation to develop new pure lines and varieties in the future, which superior in the grain yield, yield components and some other desirable characters. The selection after crossing in wheat could be carried out according to the aim of 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. There are different procedures of selection, mass selection, pure line selection, inbred line selection and spike per row selection, (26). 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 (22). Baktash (9) defined the selection is the picking out plants with desired traits from the heterogametic population. 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 (5, 6. 7. 8, 23). Selection could be increases the frequency of favorable genes for the studied traits, which causes the improvement of those traits (13, 19, 20. 21). Selection program for local genotypes undesirable because those genotypes were highly homozygous pure lines, and to improve local genotypes must be induce genetic variations. The objective of this research, hybridization among local and exotic genotypes and application of pure line selection for the superior lines , which adapted to water stress (32).

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 9^{th} 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):

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	

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

p= soil weighted moisture content
M_{sw} = moist soil mass
M_s = dray soil mass
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

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

θ = 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.

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

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.

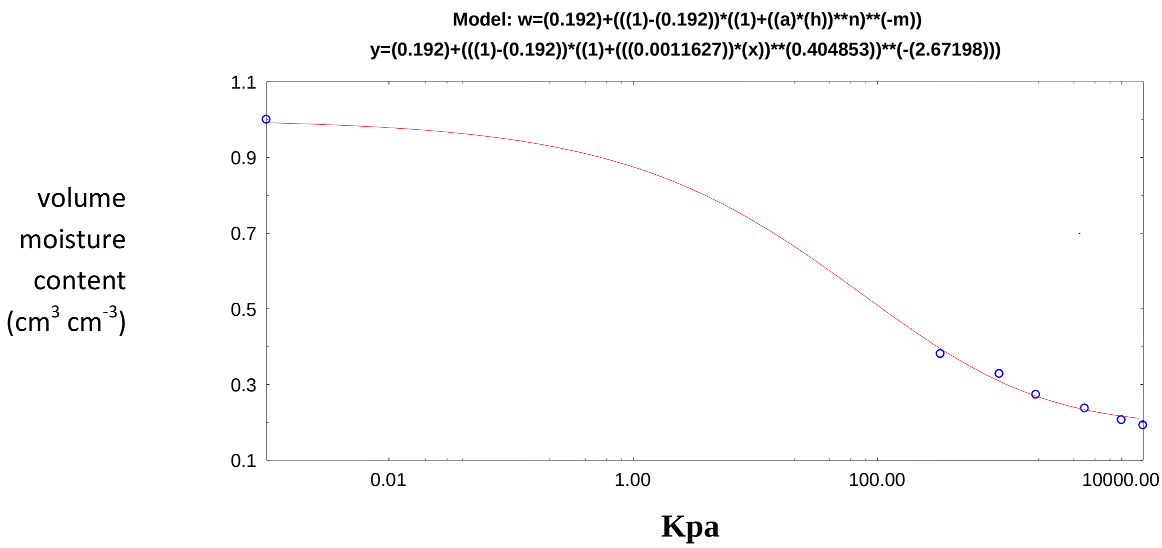

Figure 1. Soil moisture discretion curve for the experimental field

RESULTS AND DISCUSSION

Number of days from seeding to 50% flowering : Results in Table 2 shows significant differences among moisture depletion %, wheat genotypes and their interaction on their effect on number of days to 50% flowering. Moisture depletion 20%, had the highest number of days (110.3 days), while the lowest number of days (107.0 days) under 80% moisture depletion. This reveal that with increasing the depletion % , decreased the number of days from seeding to 50% flowering, this is due to increasing of biological activity, may be within the plants to protect from the water stress, and this can be explain an adaptation behavior (10, 11, 33). The wheat genotypes were also, differed significantly in number of days from seeding to 50% flowering of wheat plants , (Table 2). The highest number of days (113.6 days), in genotype 179. While, the shortest time 105.3 days , for the genotype 129. This variation among genotypes may be due to due to the genetic variation among genotypes, (4, 10, 11. 20). The interaction among moisture depletion % and genotypes was significant, this reveal that the response of wheat genotypes to moisture depletion % were differed due to genotypes. The number of days to 50% flowering decreased for all the genotypes with increasing moisture depletion from 20% to 40 %, 60% and the lowest for the genotypes under 80% moisture depletion.

Table 2. Means number of days from seeding to 50% flowering 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	112.0	109.3	109.3	108.0	110.3
44	H6P1-4	111.0	108.7	108.7	107.0	109.3
186	H2-2	111.0	109.7	109.7	109.0	110.3
117	H11P3-4	110.7	107.0	107.0	106.0	108.1
27	H4P4-2	108.3	105.0	105.0	105.0	106.5
17	H4P2-2	107.3	106.7	106.7	106.7	107.1
129	H12P1-3	107.7	104.3	104.3	103.3	105.3
179	H15P3-2	114.0	113.3	113.3	113.0	113.6
147	H12P6-1	110.3	107.7	107.7	106.0	108.1
45	H6P1-5	109.7	108.3	108.3	106.3	108.3
LSD 5 %		1.44				0.75
Depletion means		110.3	109.4	108.0	107.0	LSD 5% 0.34

Flag leaf area (cm^2)

Results in Table 3 shows significant differences among moisture depletion %, wheat genotypes and their interaction in flag leaf area. Genotypes flag leaf area decreased with increasing moisture depletion %. The highest flag leaf area (34.80 cm^2) produced from the plants under treatment 20% moisture depletion. While, the lowest flag leaf area (21.27 cm^2) for the genotypes using 80% moisture depletion . the reason of the flag leaf area reduction from increasing moisture depletion % was due to reduction in the cell size, it's length, mitosis and reduction in maturation period. This results agreed with those obtained by, Al-Badeery (2). Hashim (18) and Mohammed (28). The results, also revealed significant differences among genotypes in flag leaf area. The control variety IPA99 superior (33.21cm^2) compered other genotypes in this trait, but, didn't differed significantly from the genotype 186 , which had 33.12 cm^2. While, the genotype 147 produced the lowest (23.05 cm^2) flag leaf area . The reason of the genotypes differences in flag leaf area due to differences in genetic material among these genotypes, (20, 22, 28).The significant differences in interaction between moisture depletion % and genotypes, shows the genotype response differences among to moisture depletion % in flag leaf area character. All the wheat genotypes had lowest flag leaves area with increasing moisture depletion %.

Table 3. Means of flag leaf area 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	39.71	38.34	28.36	26.42	33.21
44	H6P1-4	37.00	32.96	27.76	25.31	30.76
186	H2-2	37.14	34.11	33.27	27.95	33.12
117	H11P3-4	34.11	31.88	29.98	22.71	29.67
27	H4P4-2	36.10	34.25	25.22	20.46	29.03
17	H4P2-2	32.35	25.30	21.38	18.81	24.46
129	H12P1-3	34.53	24.66	20.38	16.80	24.09
179	H15P3-2	32.08	25.48	21.67	19.29	24.63
147	H12P6-1	31.22	24.33	19.65	17.01	23.05
45	H6P1-5	33.72	32.81	23.07	20.95	27.64
LSD 5 %		4.15				1.95
Depletion Means		34.80	30.41	25.07	21.57	LSD 5 % 2.29

Flag leaf angle

Results in Table 4 shows significant differences among moisture depletion %, wheat genotypes and their interaction in flag leaf angle. Moisture depletion 20% and 40% had the largest flag leaf angle (67.70 , 65.07 degrees), respectively. Narrow flag leaf angle (61.40 degrees), had within plants growth under 80 % moisture depletion, which didn't differs from 60% depletion. Such as to other characters, wheat genotypes differed significantly in flag leaf angle (Table4). The genotype 179 had the largest flag leaf angle (71.17 degrees), but didn't significantly differed from the control variety IPA 99. Narrow flag leaf angle (58.58 degrees) had for the plants of genotype 45, which didn't significantly differed from the genotype 147. The results of this study agreed with the results of Baktash and Naes (11), Kang *et al* (22) and Simon (30). From scientific view with increasing flag leaf angle increase exposer of flag leaf area to the sources of energy (sun shine) and causes to increase photosynthesis and dray mater accumulation (12 , 15). The Significant interaction among moisture depletion % and genotypes in flag leaf angle, indicate that the response of wheat genotypes to moisture deletion % were differed due to differences of depletion % and genetic constitution of the genotype and this variation inverse to the productivity of the genotype .

Plant height (cm)

Results in Table 5 shows significant differences among moisture depletion % , wheat genotypes and their interaction in plant height. The highest plant 98.29 cm had plants under 20% moisture depletion. With increasing moisture depletion % decreased plant height, the means of shortest plants height 84.55 cm produced under 80% moisture depletion .The reason for the reduction in plant height with increasing moisture depletion % was, the highest depletion caused decreasing in mitosis, cell elongation, length and number of days to flowering (Table2), flag leaves area (Table 3) and flag leaf angle (Tabl4), which caused reduction in dray mater accumulation. These results agree with the results of Abd El-kareem and Elsaidy (1) and Mohammed (28) . Significant differences were found among wheat genotypes in plant height , the genotype 27 had tallest plants (102.11cm) and didn't differed from the genotype 17. While, the genotype 186 had shortest plants (66.52 cm). The response of genotypes in this experiment to moisture depletion were differed according to percent of depletion. Plant height of the control variety IPA99 reduced 9% , 11% , 23% for moisture deletions 40% , 60 , 80% , respectively , when compare with 20% depletion .

Table 4. Means of flag leaves angle for selected genotypes under the moisture depletion% effect for the season 2015- 2016

Genotypes No.	Genotypes	Depletion %				Genotypes Means
		20 %	40 %	60 %	80 %	
1	IPA99	71.67	70.33	67.33	67.67	69.25
44	H6P1-4	70.00	65.67	65.67	70.00	67.83
186	H2-2	65.00	65.00	70.33	54.67	63.75
117	H11P3-4	73.33	60.33	73.00	61.67	67.08
27	H4P4-2	69.33	57.67	57.33	59.00	60.83
17	H4P2-2	61.67	66.33	58.00	56.67	60.67
129	H12P1-3	65.00	61.33	55.00	60.67	60.50
179	H15P3-2	72.67	69.00	71.00	72.00	71.17
147	H12P6-1	64.00	65.33	58.33	60.00	61.92
45	H6P1-5	64.33	69.67	48.67	51.67	58.58
LSD 5 %		7.76				3.88
Depletion means		67.70	65.07	62.47	61.40	LSD 5% 3.06

Table 5 Means of plant height 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	104.50	95.03	93.30	80.77	93.40
44	H6P1-4	106.20	98.87	91.13	84.10	95.07
186	H2-2	70.53	69.53	64.27	61.73	66.52
117	H11P3-4	105.50	102.77	96.23	87.00	97.87
27	H4P4-2	106.87	105.93	98.57	97.07	102.11
17	H4P2-2	103.33	105.13	99.00	94.10	100.39
129	H12P1-3	97.17	94.57	89.80	86.60	92.03
179	H15P3-2	97.10	97.87	89.50	86.27	92.68
147	H12P6-1	94.10	89.20	88.60	81.03	88.23
45	H6P1-5	97.57	94.27	91.80	86.87	92.62
LSD 5 %				4.871		2.304
Depletion means		98.29	95.32	90.22	84.55	LSD 5% 2.615

Number of days from seeding to physiological maturity:

Results in Table 6 shows significant differences among moisture depletion %, genotypes and their interaction in the number of days from seeding to physiological maturity of wheat plants. The plants at the 20% depletion takes longest period (146 days) from seeding to physiological maturity, while the shortest period (142 days) of the plants growth at the 80% depletion . The results of this experiment agreed with the results obtained by, Al-Temimi (4) and Baktash and Naes (11), they found significant differences in number of days from seeding to physiological maturity. The results of this experiment shows variations among wheat genotypes in number of days from seeding to physiological maturity (29), (Table 6). The wheat variety IPA 99, takes highest number of days from seeding to physiological maturity (147 days), while, the genotype 129 had the shortest number of days (141 days). Several researchers, AL-Eseel (3), AL-Timimi (4), Hashim (20) , they found significant difference among wheat genotypes in number of days from number of days to physiological maturity. 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%, with ratio 1.35%, 2,48 % and 2, 25 %, respectively. This shows that the response of genotypes to moisture depletion in plant height differed according to the moisture depletion % .

Table 6. Means number of days from seeding to physiological maturity for wheat selected genotypes under the moisture depletion % effect for the season 2015- 2016

Genotypes No.	Genotypes	Depletion %				Genotypes
		20 %	40 %	60 %	80 %	Means
1	IPA99	149.00	147.33	146.00	145.67	147.00
44	H6P1-4	145.67	146.00	146.33	142.00	145.00
186	H2-2	146.00	143.33	141.67	141.00	143.00
117	H11P3-4	148.67	146.00	146.33	142.67	145.50
27	H4P4-2	147.33	145.33	140.33	142.67	145.42
17	H4P2-2	146.00	144.33	140.33	139.00	142.42
129	H12P1-3	144.33	141.66	140.67	140.33	141.75
179	H15P3-2	148.00	146.00	144.33	144.67	145.75
147	H12P6-1	145.67	145.67	143.33	142.67	144.33
45	H6P1-5	144.77	143.00	143.33	140.00	142.75
LSD 5 %		1.34				0.63
Depletion		146.53	144.87	143.70	142.07	LSD 5%
means						0.75

Spike length (cm)

Results in Table 7 shows significant differences among moisture depletion %, wheat genotypes and their interaction in spike length. Plants under moisture depletion 20%, produced tallest spike length (11.53 cm), while the shortest (10.51 cm) produced from plants under 80% moisture depletion. This reveal that with increasing the depletion % decreased the spike length, this is due to decreases in initiation and development of spikelets, which reduced the spike length. The reduction in spike length with increasing moisture depletion due to reduction in sources of dray mater in flag leaf (Table 3), flag leaf angle (Table 4) and reduction in number of days from seeding to physiological maturity (Table 6).The results of this experiment agreed with the results of Hashim (19) and Mer and Ama (26), and didn't agreed with results of Al-Badeery (2). The wheat genotypes were also, differed significantly in spike length, (Table 7) . The tallest spike length (11.75 cm) produced wheat genotype 117 . While , the shortest spike length (9.11cm) produced from the plants of genotype 117 . This variation among genotypes may be due to due to the genetic variation among those genotypes, which used in this experiments, (13, 16, 31). The interaction among moisture depletion % and genotypes was significant, this reveal that the response of genotypes to moisture depletion % in spike length was differed due to genotypes, that impact of moisture depletion to some genotypes more or less than others . In general with increasing moisture depletion from 20% to 40%, 60% and 80% decreased the spike length of the genotypes , (Table 7)

Number of spikelets spike^{-1}

Results in Table 8 shows significant differences among moisture depletion % , wheat genotypes and their interaction in number of spikelets spike^{-1} . The moisture depletion % impact to the number of spikelets spike^{-1} , moisture depletion 20% produced the highest number of spikelets spike $^{-1}$ (18.07 cm) ,while 80% moisture depletion produced the lowest (17.07) number of spikelets spike^{-1} . The wheat genotypes differed significantly in number of spikelets spike^{-1} , the genotype 186 produced highest number of spikelent spike^{-1} (19.58), but didn't significantly differed from the genotypes IPA99 and 179 . The genotype 17 produced the lowest (15.83), this variation due to the variances in spike length (Table 7) . The results of this experiment agreed with results obtained by , Hamadan *et al* (16) , Hassan (20) and Maqbool *et al* (25) . Response of wheat genotypes to moisture depletion in this experiment was significant , this shows that impact of depletion % to the wheat genotypes differed due to genetic materials variation among genotypes.

Table 7. Means spike length (cm) 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	12.40	11.97	11.63	10.80	11.70
44	H6P1-4	11.76	10.53	9.73	10.87	10.70
186	H2-2	12.50	12.03	10.27	12.20	11.75
117	H11P3-4	10.03	9.57	8.00	8.03	9.11
27	H4P4-2	12.30	11.50	11.00	12.03	11.71
17	H4P2-2	10.17	9.70	10.73	9.33	9.98
129	H12P1-3	11.33	11.10	11.23	10.33	11.00
179	H15P3-2	10.97	11.73	11.42	11.67	11.45
147	H12P6-1	12.60	11.23	10.83	11.87	11.63
45	H6P1-5	11.30	10.07	10.23	8.97	10.14
LSD 5 %				1.29		0.62
Depletion Means		11.53	10.94	10.51	10.96	LSD 5% 0.67

Table 8. Means number of spikelets spike^{-1} for wheat selected genotypes nder the moisture depletion % effect for the season 2015- 2016

Genotypes No.	Genotypes	Depletion %				Genotypes Means
		20 %	40 %	60 %	80 %	
1	IPA99	20.00	20.33	19.33	18.00	19.42
44	H6P1-4	18.00	16.67	16.33	18.67	17.42
186	H2-2	20.33	18.00	19.67	20.33	19.58
117	H11P3-4	16.00	16.33	15.33	17.33	16.25
27	H4P4-2	17.67	18.00	17.33	18.33	17.83
17	H4P2-2	15.33	15.67	15.00	17.33	15.83
129	H12P1-3	17.00	17.00	16.67	15.67	16.58
179	H15P3-2	19.33	19.67	17.67	19.67	19.08
147	H12P6-1	19.00	17.67	17.00	19.33	18.25
45	H6P1-5	18.00	18.00	16.67	16.00	17,17
LSD 5 %		1.56				0.77
Depletion Means		18.07	17.73	17.10	18.07	LSD 5% 0.64

Grain yield (t ha^{-1})

Results in Table 9 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 plants under moisture depletion 20% . 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 comparison with the grain yield of the treatment depletion 20% . The reason for reduction due to decrease in flag leaves area (Table 3), which reduced net photosynthesis , then dray matter accumulation, spike length (Table 7) and number of spikelets plant^{-1} (Table 8) . The results of this study agreed with the results of Mer and and Ama (20) and Ngwako and Mashiqa (31), they mentioned that with increasing the moisture depletion % decreased one or more wheat yield components and this cause reduction in grain yield. Wheat genotypes significantly differed in grain yield, the genotype 186 produced highest grain yield (5.642 t ha^{-1}), with ratio 43.42% in comparison to the check variety IPA99. 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 several characters like , flag leaves area , spike length and number of spikelets spike^{-1} (Tables 3 , 7 , 8), the same results were found by Baktash and Naes (10) , Hamadan *et al* (16), and Hassan (20). The response of wheat genotypes to moisture depletion % differed due to genotypes and water depletion, according to these results with increasing moisture depletion % decreased the genotypes grain yield.

Table 9. Means of grain yield mt 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

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

Results in the Table 10 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% and 80% caused reduction in water use efficiency . The treatment 20% moisture depletion had the 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% when compare to moisture depletion 20%, 40% 60%. respectively. The reason of increasing water use efficiency from using 20% moisture depletion %, due to increasing plant leaf area (Table 3), grain yield (Table 9) and decreasing evaporation from soil surfaces , which caused to increase in water use efficiency. These results agreed with results foun by , Baloch *et al* (13), Mahamed *et al* (24) Mohammed (28) and Ngwako and Mashia (31). The wheat genotypes differed significantly in water use efficiency for grain yield Table 10) .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 superiority of 186 in number of spikes length (Table 7), number of spikelts spike $^{-1}$ (Table 8)and grain yield (Tables 9). 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* (24) and Mohamme (28). Response of wheat genotypes to moisture depletion in this experiment was significant, this shows that impact of moisture depletion % to the wheat genotypes water use efficiency differed due to genetic materials vaiation among genotypes .

Table 10. 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
LSD 5 %		0.25				0.13
Depletion Means		1.63	1.63	1.48	1.38	
					LSD 5%	0.09

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