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Original Research Article

New Insights for Promoting the Plant Growth and Germination and Applications in Agriculture

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Abstract

Drought is a generally prolonged period of dryness which creates significant damage to crops and prevents their effective growth. It can also refer to a prolonged period of extremely low precipitation, especially one that has a negative impact on growing or living conditions. Drought affects plants vary, depending on the various stages of the plant's growth and the duration, severity and frequency of the drought. During high concentration germination decreases with increasing level of drought. Water deficiency also reduces the dry biomass of seed and seedlings. Drought stress causes the decline in seedling of wheat. The field experiment was conducted by utilizing augmented block design. Augmented block design is used when a limited quantity of resources available for experiment. From upper position of the spike excluding awns to the soil surface in centimeter were noted before harvesting. Spikes from each plot were selected randomly and number of spikelets was counted starting from base of spike towards the spike end. Under drought, plant height, spikes, peduncle length of selected plants was affected and had significant differences during normal irrigation and rainfed conditions. Grain yield per plant had highly significant positive correlation spike length under water irrigation.

Keywords: Drought, effective growth, prolonged period, growing, living conditions.

INTRODUCTION

Drought is a generally prolonged period of dryness which creates significant damage to crops and prevents their effective growth. It can also refer to a prolonged period of extremely low precipitation, especially one that has a negative impact on growing or living conditions. Severe drought had been recorded during last few decades in many regions of Asia which might be challenging in Pakistan such as Mediterranean [1, 2]. It is the key factor in environment that is reducing global wheat grain yield, majorly in tropical, subtropical, arid and semi-arid regions of the world. In Pakistan rainfed areas with very high frequency of drought and irrigated area with very high water stress are 146 thousand hectares [2, 3].

Regardless of water resources decline and progressively increase in drought, yield loss is threatening in different provinces of Pakistan like Baluchistan and some parts of Sindh and Punjab. Improper conditions and lack of precipitation have been shown by climate change and global warming, which is challenge for crop researchers and plant breeders. It is necessary to grow new varieties and hybrids to adapt the changing environmental conditions. Drought stress induces ten percent yield at maturity, while mild stress does not primarily affect crop production during early vegetative growth periods. Drought affects plants vary, depending on the various stages of the plant's growth and the duration, severity and frequency of the drought [4-6]. But the rate of evaporation and transpiration decreases at the ripening stage to conserve and distribute nutrients to grain for yield. During the initial growth stage, tillering stage and plant height, drought has the most extreme impact on the plant. Flowering stage is adversely affected due to the disturbance in fertilization and grain fixation. It affects the viable seeds in plants. Leaf efficacy for use and assimilate transport towards grain is also affected during grain filling. Germination of wheat seeds is badly affected by water shortage. Seeds can tolerate dehydration for 4 days and after that water is not available to be absorbed by the seeds so that seed survival is decreased. During high concentration germination decreases with increasing level of drought. Water deficiency also reduces the dry biomass of seed and seedlings. Drought stress causes the decline in seedling of wheat. Water shortage causes the loss in turgor of cells and cell shrinked. Loss of turgor increased with the increase levels of water deficiency. Plants are not in straight form and stunt. Growth level decreased, premature leaves are formed and lost by plants, chlorophyll content declined and efficiency of chlorophyll disturbed. It also caused the short tillers number and leaves number per plant. Plant may die due lack of water. This research gaining the find out the wheat lines that are best adapted under drought conditions [7-11].

The field experiment was conducted by utilizing augmented block design. The germplasms were comprised of different test varieties or test treatments and check varieties or control treatments.

MATERIALS AND METHODS

Design of experiment:

A set of 80 wheat varieties/genotypes were obtained with Augmented block design is used when a limited quantity of resources available for experiment and more number of entries are to be tested. The whole experiment was elevated into two sets. There was one set as normally irrigated and other had no irrigation. Each set was divided into five blocks and each block had 20 entries including 15 test entries and 5 checks. The length of each plot had 2.5 m. Plant height was recorded with the help of meter rod when plant was fully matured and no more growth was observed. From upper position of the spike excluding awns to the soil surface in centimeter were noted before harvesting.

Average plant height = Sum of selected plant height / Number of selected plant

Spike length of five spikes was measured when spike was fully matured and no further growth was observed. Spike length was recorded by using measuring scale in centimeters (cm), base of spike to head excluding awns [12].

Average spike length = Sum of selected plant spike length / Number of selected plant

Spikes from each plot were selected randomly and number of spikelets was counted starting from base of spike towards the spike end. Then average was computed for each plant. Peduncle length of selected plants from every plot was measured with measuring scale from the last node of the plant to base of spike [13]. Then mean values were calculated.

Average peduncle length = Sum of selected plant tillers / Number of selected plant

Spike of the selected plants was harvested and weight was calculated by using electronic weighing balance. Grain weight per spike had been recorded in grams, then mean for each row had been calculated for further evaluation. Thousand grains were counted on seed counter and grain weight was measured by using electronic weighing balance. Grain yield was estimated by threshing main spikes of five plants from every plot.

Analysis of variance (ANOVA)

The performance of genotype was compared graphically under normal and drought conditions. ANOVA was done for checks for their blocking effect.

RESULTS & DISCUSSIONS

Data from the table 1 resulted that spike length had non significant blocking effect during normal irrigation and rainfed conditions. Checks had significant differences during normal irrigation and rainfed conditions.

Table 1: Analysis of Variance for spike length under normal and drought conditions

Sources	Df	Conditions	SS	MS	F
Block	4	Normal	14.249	3.562	2.21^{NS}
		Drought	1.2268	0.3067	0.40^{NS}
Checks	4	Normal	14.919	3.730	2.32*
		Drought	9.9851	2.4963	3.27*
Error	16	Normal	25.757	1.610	
		Drought	12.2047	0.7628	
Total	24	Normal	54.924		
		Drought	23.4166		

*=Significant at P≤ 0.05; NS= Non-significant

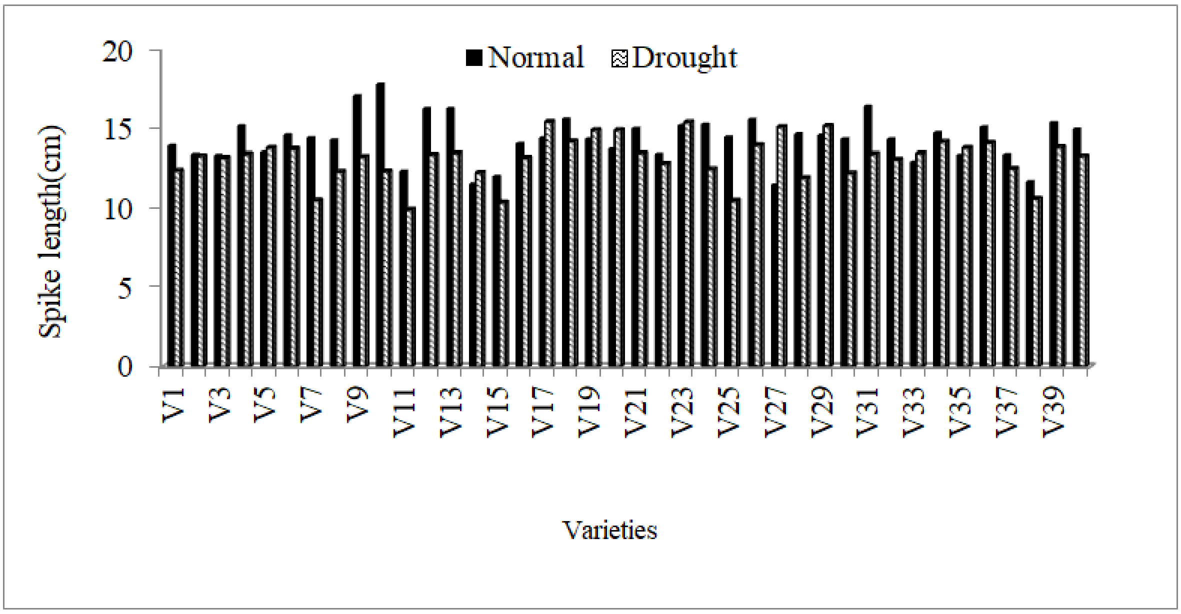

Fig 1: Mean values for spike length of 40 (1-40) wheat germplasm under normal and drought conditions

Data from the table 2 conducted that number of spikelets per spike had non significant blocking effect under normal and drought conditions. Checks had non significant differences during normal irrigation and rainfed conditions.

Table 2: Analysis of variance for number of spikelets/spike under normal and drought conditions

Sources	Df	Conditions	SS	MS	F
Block	4	Normal	8.960	2.240	1.42NS
		Drought	3.2711	0.8178	0.86NS
Checks	4	Normal	14.827	3.707	2.36NS
		Drought	8.7822	2.1956	2.31NS
Error	16	Normal	25.173	1.573	
		Drought	15.2178	0.9511	
Total	24	Normal	48.960		
		Drought	27.2711		

*=Significant at P≤ 0.05; NS= Non-significant

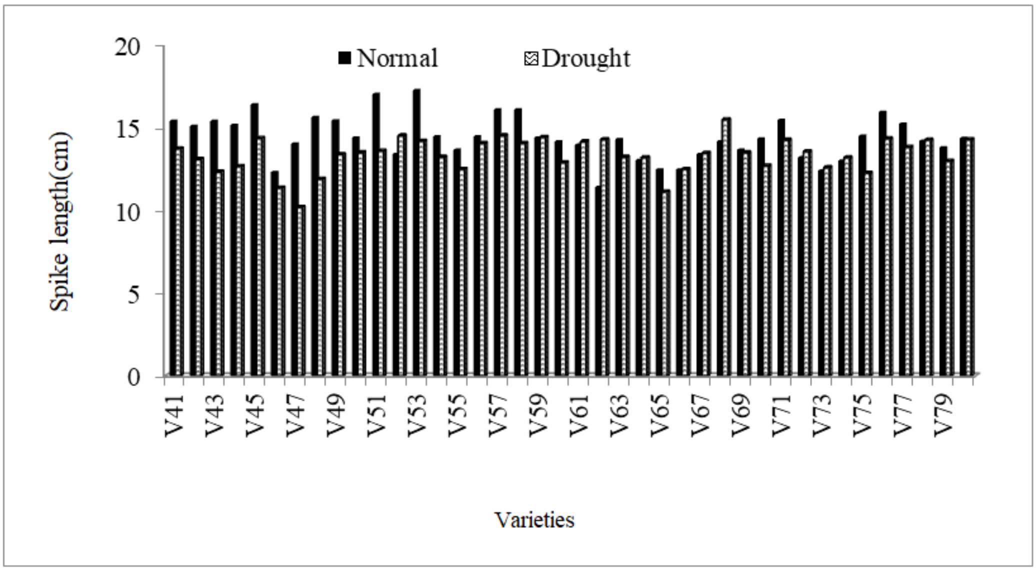

Fig 2: Mean values for spike length of 40 (41-80) wheat germplasm under normal and drought conditions

Peduncle length (cm)

Data from the table 3 revealed that peduncle length had non significant blocking effect during water availability and water unavailability. Checks had significant variation during normal irrigation and non significant variation during water deficit conditions.

Table 3: Analysis of Variance for peduncle length under normal condition

Sources	Df	Conditions	SS	MS	F
Block	4	Normal	118.07	29.52	2.46 NS
		Drought	8.39	2.10	0.15 NS
Checks	4	Normal	204.08	51.02	4024*
		Drought	80.19	20.05	1.39 NS
Error	16	Normal	192.36	12.02	
		Drought	230.68	14.42	
Total	24	Normal	514.51		
		Drought	319.26		

*=Significant at P≤ 0.05; NS= Non-significant

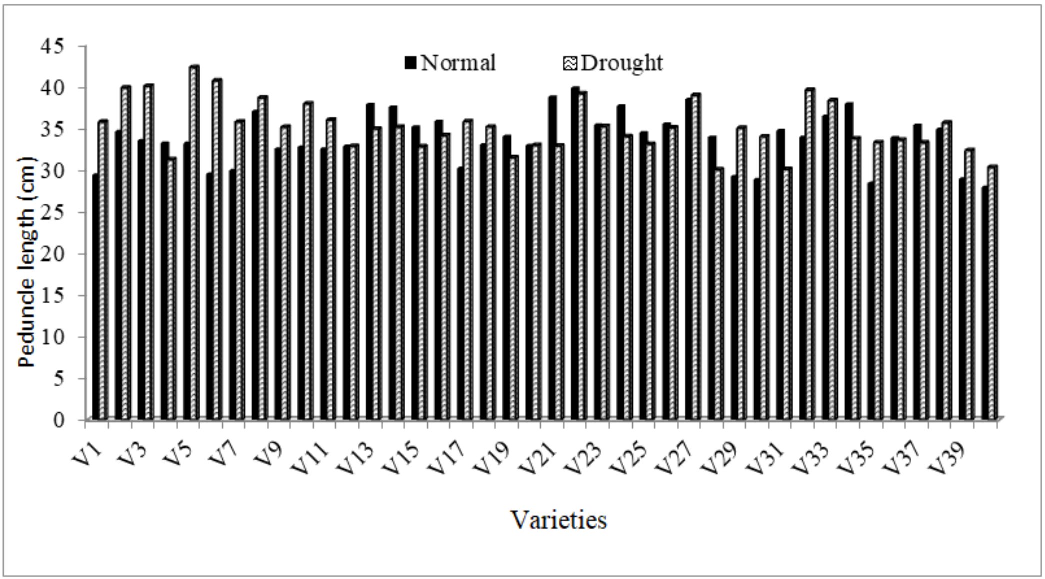

Fig 3: Mean values for peduncle length of 40 (1-40) wheat germplasm under normal and drought conditions

Grain weight per spike (g)

Data from the table 4 revealed that grain weight per spike had non significant blocking effect under normal and drought conditions. Checks had highly significant difference during normal irrigation and rainfed conditions.

Table 4: Analysis of variance for seed weight/spike under normal and drought conditions

Sources	DF	Conditions	SS	MS	F
Block	4	Normal	1.05758	0.266440	2.83NS
		Drought	0.23386	0.05846	0.90NS
Checks	4	Normal	2.92466	0.73117	7.82**
		Drought	1.46746	0.36686	5.65**
Error	16	Normal	1.49666	0.09354	
		Drought	1.03802	0.06488	
Total	24	Normal	5.47890		
		Drought	2.73934		

*=Significant at P≤ 0.05; NS= Non-significant

Grain weight per spike had higher value under normal condition as compared with drought condition.

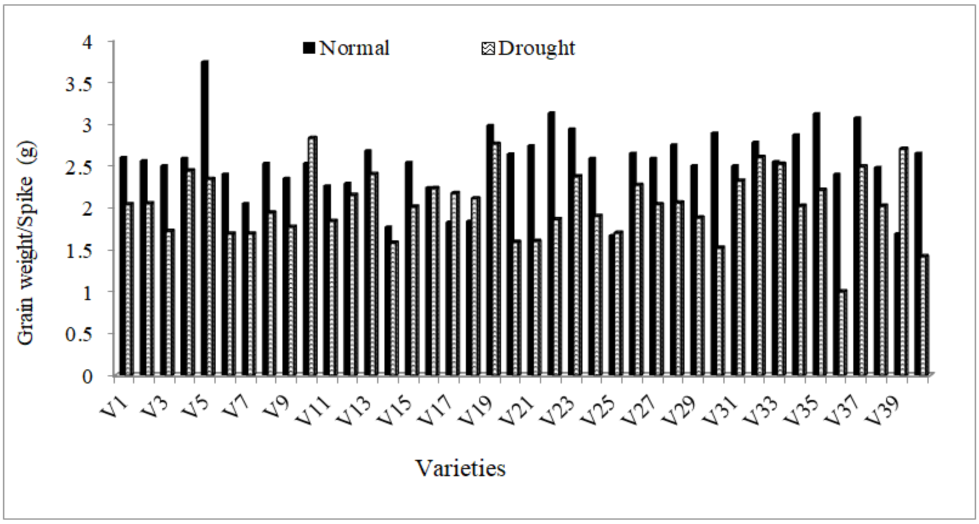

Fig 4: Mean values for grain weight per spike of 40 (1-40) wheat germplasm under normal and drought conditions

Thousand kernel weight (g)

Data from the table 5 conducted that thousand kernel weight had non significant blocking effect during water availability. During water deficiency thousand kernel weight had significant blocking effect and mean values were adjusted for further graphical representation. Checks had non significant variation during water availability and significant variation in water deficiency.

Table 5: Analysis of Variance for thousand kernel weight under normal and drought conditions

Sources	Df	Conditions	SS	MS	F
Block	4	Normal	165.61	41.40	1.12 NS
		Drought	103.136	25.784	3.35*
Checks	4	Normal	271.92	67.98	1.83 NS
		Drought	207.652	51.913	6.75*
Error	16	Normal	592.99	37.06	
		Drought	123.092	7.693	
Total	24	Normal	1030.52		
		Drought	433.880		

*=Significant at P≤ 0.05; NS= Non-significant

Thousand kernel weight had higher under normal condition as compared with drought condition.

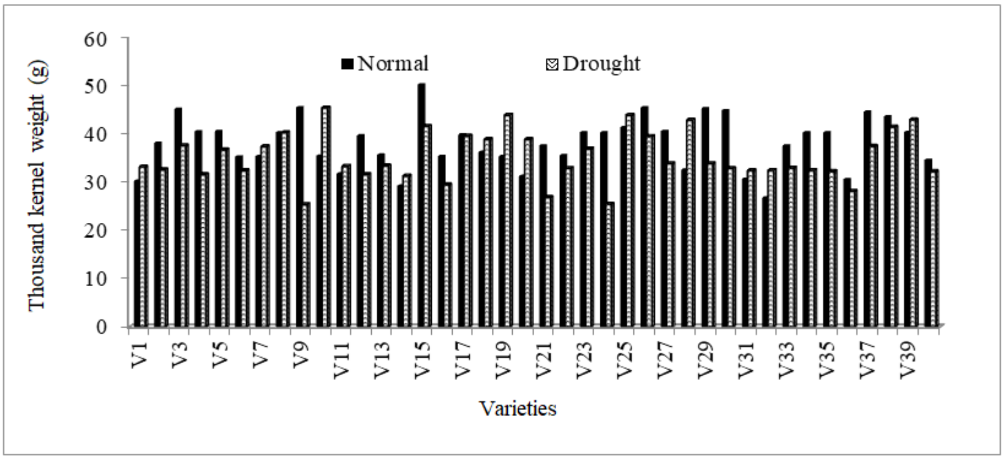

Fig 5: Mean values for thousand kernel weight of 40 (1-40) wheat germplasm under normal and drought conditions

Grain yield per plant (g)

Data from the table 6 resulted that grain yield per plant had non significant blocking effect under normal and drought condition. Checks had non significant variation during normal irrigation and rainfed conditions.

Table 6: Analysis of variance for yield per plant under normal and drought conditions

Sources	DF	Conditions	SS	MS	F
Block	4	Normal	1054.4	263.6	1.18NS
		Drought	273.44	68.36	0.81NS
Checks	4	Normal	824.2	206.1	0.92NS
		Drought	289.56	72.39	0.86NS
Error	16	Normal	3579.3	223.7	
		Drought	1345.69	84.11	
Total	24	Normal	5457.9		
		Drought	1908.69		

*=Significant at P≤ 0.05; NS= Non-significant

Normal and drought conditions respectively. Normally, grain yield remained higher under normal condition as compared with drought condition.

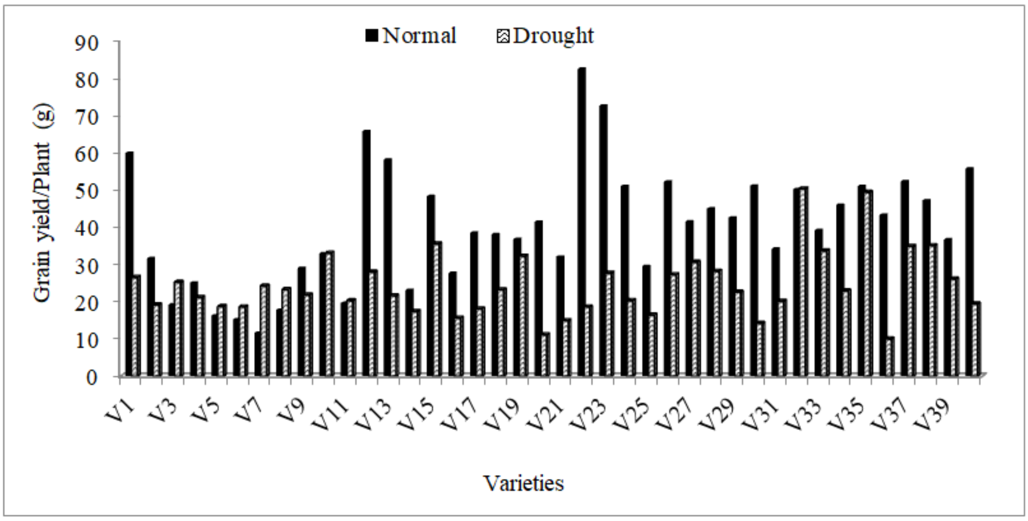

Fig 6: Mean values for grain yield per plant of 40 (1-40) wheat germplasm under normal and drought conditions

Maximum value for flag leaf area was calculated in V23, V-16144 (101.55 cm^2) and V21, V-18106 (92.2 cm^2) under normal and V5, Fakhar-E-Bakhar (81.68 cm^2) and V32, V-19553 (78.41 cm^2) genotypes under drought conditions. Fakhar-E-Bakhar (V76) had highest least significant increase (LSI) and observed mean combine value for flag leaf area among checks and no test entry had more flag leaf area than V76 (Fakhar-E-Bakhar) under normal condition. Test genotype V10 (V-Gold-16) had more flag leaf area than V77, Ghazi-19 (115.66 cm^2) and no other test entry had higher flag leaf area. Under drought condition all the check genotypes had more LSI value for flag leaf area than test entries. Results conducted that no test entry had more adaptive to drought stress according to the flag leaf area. It had positive highly significant correlation with yield per plant. Phenotypic traits which had effective performance promising for yield potential [15-17].

Maximum spike length was computed in V10, Gold-16 (17.8 cm) and V53, 15FJ05 (17.26 cm) genotypes under normal and V17, V-17259 (15.43 cm) and V29, V-19507 (15.16 cm) genotypes under drought conditions. V76, Fakhar-E-Bakhar (14.35 cm) and V80, Barani-17 (14.29 cm) had maximum spike length under drought conditions. Barani (V80) had highest least significant increase (LSI) and observed mean combine value for number of spikelets per spike among checks and no test entry had more spikelets than V80 (Barani-17) under normal condition. Test genotype V39 (HYT-55-40) had more spikelets than check V79, Ehsan-16 (23.6 spikelets) and V5 (Fakhar-E-Bakhar), V12 (Dharabi-11), V13 (Aas-11), V41 (AZRI-TW-1432), V42 (AZRI-TW-1578) and V43 (AZRI-TW-1579) test genotype had more spikelets than check V78, Akbar-19 (22.6 spikelets) under normal condition. Under drought condition only V12 (Dharabi-11) test genotype had more spikelets than check V78, Akbar-19 (20.73) and all other test genotype had less number of spikelets. It is spikelets variation differ the grain yield. More number of spikelets means more seeds in a spike and more adaptive to drought stress [18-21].

CONCLUSION

Grain yield per plant had highly significant positive correlation spike length under water irrigation. The field experiment was conducted by utilizing augmented block design. Under water stress, yield/plant had positive and highly significant correlation with tillers/plant, kernel weight/spike. During high concentration germination decreases with increasing level of drought. Water deficiency also reduces the dry biomass of seed and seedlings. Drought stress causes the decline in seedling of wheat.

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