Assiut J. Agric. Sci., 52 (5) 2021 (45-63) *ISSN: 1110-0486*
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Performance of Pearl Millet (*Pennisetum glaucum*) Genotypes for Forage Yield and its Components under Normal and Water Stress Irrigation

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Accepted for publication on: 11/1/2022

Abstract

Twenty pearl millet genotypes were grown in two experiments i.e. normal and water stress irrigation during two seasons (2019 and 2020) at Agronomy Dept., Faculty of Agriculture, Assiut University. The variance due to interaction between genotypes x irrigation was significant for all studied traits, except chlorophyll content in 2019 season. Moreover, mean squares due to treatments of irrigation and genotypes were significant for all traits i.e. plant height, number of tillers/plant, leaves/ stems ratio, fresh and dry protein forage yields and chlorophyll content in both seasons, except total protein forage yield in 2019 season, suggesting that all traits were markedly affected by water stress and possessed a wide range of differences among the studied genotypes. Mainly, the water stress caused a decrease in plant height, number of tillers/ plant, leaves/stems ratio, total fresh, dry and protein forage yields and chlorophyll content by 28.1, 47.2, 21.9, 34.0, 20.3, 12.6 and 14.7%, respectively, as average of the two seasons. The used pearl millet genotypes were classified according to drought susceptible index (DSI) into two groups i.e. less than unity, tolerant to drought, and the other large then unity, susceptibility to drought. Some of those genotypes were differed from season to season for reduction and DSI and from trail to another. The superior genotype using DSI were genotypes Nos. 1 and 2 and there were tolerant to drought stress for forage yield. The obtained results could propose the DSI as a good tool to select the most adapted genotypes under water stress condition.

Keywords: *Pearl millet, forage yield, irrigation, water stress.*

Introduction

Pearl millet (Bulrush millet) [*Pennisetum glaucum* (L.) R.Br.] (2n=2x=14) is an important C4 small-grained cereal crop that belongs to family *Poaceae* and subfamily *Panicoideae* with a large genome size (~2352 Mbp).

Pearl millet is considered in many regions of the world a multi-purpose crop. It provides nutritious food for human poultry feed and fodder for ruminants compared to other cereal crops. Pearl millet is the sixth most important cereal in the world after wheat, rice, maize, barley and sorghum Singh, D. and R. Perez-Maldonado (2003). It is a major crop in the semi-arid dry land regions in Southeast Asia and Africa (Henry and Kettlewell 1996 and Baltensperger 2002). Mostly, Pearl millet cultivated by the resource poor farmers in the semi-arid regions of sub-Saharan Africa and the Indian subcontinent for food and beverages (Haussmann *et al*., 2012 and Abubakar *et al*., 2019).

In USA and Australia, it is considered a high-quality forage crop (Andrews *et al*. 1993). Likewise, in Africa and Asia it provides food security to almost 90 million poor peo-

ple inhabiting across their high temperate regions. Pearl millet quality as a fodder may exceed other fodder grasses, where Stobbs (1975) found that feeding forage millet to milking cows resulted in higher milk yield as compared with feeding forage sorghum.

In Egypt, Egyptian clover is used well to feed livestock during winter, however, during summer, pearl millet can complete with summer cereals, e.g. corn and sorghum, which are being used to feed livestock. Yet, identifying adapted genotypes from exotic genotypes will help pearl millet to compete with each cereal crops efficiently.

Drought is a paly genic stress and considered as one of the most important factors limiting crop yields around the world. As climate change leads to increasingly hotter and drier summers, the importance of drought constraints on yield and yield components has increased were high temperature and water stress often reduce plant growth and crop yields.

In addition, pearl millet is adapted to water limited conditions and can stand well against such adverse conditions producing biomass and grains more than other cereals crops (Bidinger and Hash 2004). Egypt suffer from water scarcity, therefore, identifying drought – tolerant genotypes, which may be used to develop drought – tolerant varieties, is vital issue under such circumstance. Thus, identifying drought – tolerant genotypes of pearl millet will be paramount to save water and fill in the shortage of summer forage crops.

The objectives of this study were evaluate twenty exotic germplasm of pearl millet for fodder traits under normal irrigated and water stressed environments. Besides estimate drought susceptibility index for studied genotypes under those environments.

Materials and Methods

A- Plant materials and growing conditions

A set of twenty pearl millet (eighteen accessions beside two Egyptians varieties *i.e.* Shandaweel - 1 and New valley) were used for the current study.

The previous accessions obtained from plant Genetic resources unit, United States USDA ARS in (Table 1).

Table 1. The name and origin of the studied genotypes

Item	Accessions	Plant Name	Country
1	PI 661274	Grif 16613	India
2	PI 661269	Grif 16608	India
3	PI 661268	Grif 16607	India
4	PI 613105	NM-2A4	United states, Nebraska
5	PI 613102	NM-1A4	United states, Nebraska
6	PI 613101	NM-1A1	United states, Nebraska
7	PI 596510	ICMA 92666	India Andhra Pradesh
8	PI 587024	15012	Saudi Arabia
9	PI 587023	12010	Yemen
10	PI 587022	1272	Yemen
11	PI 587014	1128	Yemen
12	PI 587010	1100	Yemen
13	PI 587004	1084	Yemen
14	PI 586993	1019	Yemen
15	PI 586992	1017	Yemen
16	PI 564585	TIFT 8677	United states, Georgia
17	PI 537070	C042	Niger
18	PI 535955	Dogona	Cameroon
19	New valley		Egypt
20	Shandaweel -1		Egypt

The aforementioned genotypes were grown during two growing summer seasons (2019 and 2020) at Agricultural Research Station, Faculty of Agriculture, Assuit University, Egypt (27.19 N, 31.16 E; Clay Soil) (Table 2).

Table 2. Some physical and chemical properties of the experiment at site.

Soil properties	2019 and 2020
1- Physical properties	
Sand %	25.9
Silt %	24.70
Clay %	49.40
Text grade	Clay
Water saturation %	71.2
Field capacity %	44.2
2- Chemical properties	
pH (1:2.5) suspension	7.80
Organic matter %	1.62
Total nitrogen %	0.09
Total caco3 %	1.20

These twenty genotypes were sown in a strip plot design with three replications. Plot size was one row of two m in length and 60 cm apart. The distance among hills was 10 cm. Af-

ter full emergence seedling were thinned leaving one plants/hill.

The sowing dates were 10th and 15th June in first and second season, respectively. Irrigation system was arranged in vertical strips and the genotypes in horizontal strips.

Treatments involved two irrigation system, optimal and drought condition, genotypes were irrigated regularly 3 times for each cut and took one m^3 for optimum irrigation, however, under the drought condition each irrigation was taken 0.5 m^3 for 12 m^2 area.

Fertilization i.e. nitrogen, phosphorus and all cultural practices were maintained at optimum level for maximum pearl millet productivity.

Three cuts were taken in each season for each irrigation system.

B- Data recorded

A. Forage yield and its components

Data of the following traits were recorded at the time of each cut for each season on a sample of 10 plants randomly collected from the center of each plot.

1- **Mean stem height, (PH) cm:** The mean of stem height in centimeter was determined at harvest for each cut as in average of 10 plants measurement from soil surface to the tip of the tallest tiller. Then the average of the three cuts was taken for each season.

2- **Number of tillers/plant (TP):** The number of tillers/plant was taken in each genotype at the harvest for each cut. Then the average of three cuts was taken for each season.

3- **Mean leaves stems ratio (LSR):** A sample of fresh forage in each genotype (one kg) was hand separated to leaves and stems. Each component was weighed immediately to estimate the fresh leaves/stems ratio. Then the average of three cuts was taken.

4- **Total fresh forage yield/plant, kg (FFY):** It was determined by hand clipping of each genotype and the total of the three cuts were taken for each season.

5- **Mean dry matter percentage (DMP):** It was determined from random samples of 200 g from each row at each cut, after drying in oven at 70°C until weight constancy. Then the mean of three cuts were taken for each season.

6- **Total dry forage yield/plant, g (DFY):** estimated by using, green forage yield/plant of each row x mean dry matter percentage. Then the total of three cuts were taken for each season.

7- **Mean protein percentage (PP):** It was determined in second and third cuts for second season in Lab. Qual. Procedure, Faculty of Agriculture, Assiut University by the micro-Kjeldahl method as outlined by A.O.A.C (1995) to estimate the total nitrogen. Nitrogen percentage was multiplied by 6.25 to obtained crude protein.

8- **Protein yield/plant (row) (PFY):** Estimated by using dry forage yield/ plant x average protein percentage. Then the total of three cuts was taken for each season.

9- **Total chlorophyll (mg/m^2) (CC)**: Total chlorophyll (Chl. a + b) was determined in blades of pearl millet leaves at heading stage by chlorophyll Meter SPAD-502Plus reported by (Dash *et al*. 2007) as**:**

SPAD calibration equations:

$Y= 0.118x^2 + 0.919x + 7.925$

Where, y represents chlorophyll concentration in mg/m^2

x represents SPAD value.

C. Statistical analysis

The separate analysis of variance was done on mean basis according to Gomez and Gomez (1984) (Table 2). Means were compared using R L.S.D. test at 5% level of probability.

Variances of all studied traits between two seasons was detected according to Bartlett`s test (1939) and revealed to be not homogeneity, consequently the combine analysis have not performed.

Analysis of variance for all studied traits were analyzed using PROC GLM in SAS v.9.0 (The SAS Institute Inc., Cary, NC, USA 2002).

Table 3. Analysis of variance for irrigation in each experiment

Source of variance	d.f	
Replications (r)	r-1	=2
Irrigation (T)	t-1	= 1
Error (a)	(t-1)(r-1)	= 2
Genotypes (G)	g-1	=19
Error(b)	(g-1)(r-1)	=38
G X T	(g-1)(t-1)	=19
Error (c)	(g-1)(t-1)(r-1)	= 38

Drought susceptibility index (DSI):

Drought susceptibility index was calculated according to the method of Fischer and Maurer (1978). Yield of individual genotypes was determining under stress (Yd) and favorable well-watered (Yw) conditions. Average yield of all genotypes under drought (xd) and well-watered conditions (xw) were used to calculate drought intensity (D) as: D= (1-xd/xw). The mean drought susceptibility index (DSI) of individual genotype was calculated as: S = (1-Yd/Yw)/D. Genotypes with average susceptibility or tolerance to drought have S value of 1.0 indicate less susceptibility and great tolerance to drought. Meanwhile, a value of S = 0.0 indicates maximum possible drought resistance (no effect of drought on yield).

Results and Discussion

The results obtained from the current investigation are presented as follows:

I-Performance of pearl millet genotypes under normal and water stress

Separate analysis of variance for all agronomical traits of both seasons revealed highly significant differences among the evaluated pear millet genotypes (Table 4). Moreover, the differences between treatments of irrigation (normal and water stress) were significant of highly significant for all studied traits, except total protein forage yield in first season. Similarly, the genotypes x irrigation treatments interaction showed highly significant for all studied traits, except for chlorophyll content in 2019 season. The obtained results proposed the different genetic make-up of those pear millet genotypes under the

study. These results are in line with those obtained by Yadv and Bhatnagar (2001), Yadav (2008 a & b) Kholova *et al*. (2010), Saifullah *et al*. (2011), Yadav and Kumar (2013), Yadav *et al*. (2014). They found that there was a good amount of variation among pear millet genotypes as well as significant difference recorded between normal and water stress for all studied traits.

Table 4. Mean squares for agronomical traits for all genotypes during the two growing seasons under normal and water stress.

Source	DF	Mean squares							
		Plant Height Cm		Number of tiller/plant		Leaves stem ratio %		Total fresh forage yield/plant, kg	
		2019	2020	2019	2020	2019	2020	2019	2020
Rep.	2	5.0324	0.0608	0.62892	0.00000258	0.0040328**	0.0000216	0.0038575	0.00004433
Water stress (A)	1	136846.17**	35069.025**	300.45**	326.7**	0.7984**	0.43814**	7.4451008**	5.2459008**
Error (a)	2	1.5236	1.5840	0.07045	0.03639	0.00000307	0.0000101	0.00009500	0.00002233
Genotypes (B)	19	687.82853**	1877.2764**	0.96396**	6.2824**	0.01912**	0.00649**	0.4858391**	0.52025**
Error (b)	38	8.917	1.621	0.16112	0.02633	0.002467	0.00000201	0.0050233	0.00004424
Gen. x Treat.	19	146.3876**	186.03955**	0.53478**	0.50459**	0.005543**	0.00845**	0.023157**	0.0284991**
Error (c)	38	9.1257	1.2063	0.1446	0.0526	0.0000837	0.00000283	0.0042201	0.0000797

Table 4. Continued.

Source	DF	Mean squares					
		Total dry weight/plant, g		Total protein yield, g.		Chl content mg/m^2	
		2019	2020	2019	2020	2019	2020
Rep.	2	505.99	13.12	22.107	0.314	302.25	59.25
Water stress (A)	1	31503.82**	79355.46**	69.130	947.869**	83005.96*	48106.86**
Error (a)	2	200.50	23.63	10.656	0.988	934.11	45.88
Genotypes (B)	19	14564.5**	16569.32**	785.528**	882.346**	3014.72**	33459.02**
Error (b)	38	265.92	20.67	11.358	1.014	1082.91	77.68
Gen. x Treat.	19	587.46**	1180.72**	40.068**	53.834**	490.77	1141.002**
Error (c)	38	176.32	33.81	8.019	1.524	353.83	54.42

*, ** Significant at 0.05 and 0.01 level of probability, respectively.

I.1- Plant height (cm)

Plant height is an essential factor in determining the forage yield for forage crops. Tuckak *et al*. (2008) reported that plant height is an important yield component and it is often used as a criterion when choosing superior genotypes in an early stage of selection. Means of plant height in 2019 and 2020 seasons for twenty genotypes under normal and water stress were given in Table 5.

In 2019 season, the average of plant height under normal irrigation ranged from 149.44 for genotype No. 20 to 197.56 cm for genotype No. 10 with an average of 177.96 cm. Also plant height under water stress varied from 93.63 for genotype No. 18 to 131.9 cm for genotype No. 19 with an average of 110.42 cm. Moreover, eight genotypes exceeded significantly the general mean over both water treatments on 2019 (Table 5).

In 2020 season, plant height under normal irrigation ranged from 152.83 for genotype No. 19 (New Valley variety) to 215.59 cm for genotype No. 6 with an average of 182.79 cm. Also, plant height under water stress condition varied from 118.47 for New Valley variety to 172.22 cm for genotype No. 18 with an average of 148.6 cm. Seven geno-

types surpassed significantly the general mean over both water treatments on 2020. The results clear that the shortest genotype was genotype No. 20 (131.36), but the longest genotype was genotype No. 10 (175.45) as done overall treatments for plant height. Generally, all genotypes were decreased by water stress. The decrease of plant height caused by water stress compared to normal irrigation accounted values of 37.95, 18.74 and 28.20% overall genotypes for first, second season and over the two seasons, respectively (Table 5).

Such decreased ranged from 18.98 for genotype No. 19 to 47.58% for genotype No. 4 in 2019 season. Also, the decrease in second season ranged from 6.18 for genotype No. 10 to 33.67% for genotype No. 2. As well as the combined over two seasons showed decreased values ranged from 16.81 for genotype No. 5 to 35.35% for genotypes No. 2.

Table 5. Mean plant height (cm), reduction % (R) and drought susceptibility index (DSI) for all genotypes during the two and over the two seasons under normal and water stress irrigation.

Genotypes	2019					2020					Average				
	Normal	Drought	Mean	R%	DSI	Normal	Drought	Mean	R%	DSI	Normal	Drought	Mean	R%	DSI
GEN1	176.11	103.70	139.91	41.12	1.08	175.22	154.96	165.09	11.56	0.62	175.67	129.33	152.50	26.38	0.85
GEN2	182.41	114.96	148.69	36.98	0.97	197.05	130.30	163.68	33.87	1.81	189.73	122.63	156.18	35.37	1.39
GEN3	185.37	114.26	149.82	38.36	1.01	188.70	139.63	164.17	26.00	1.39	187.04	126.95	156.99	32.13	1.20
GEN4	194.37	101.89	148.13	47.58	1.25	158.70	140.61	149.66	11.40	0.61	176.54	121.25	148.89	31.32	0.93
GEN5	167.60	125.85	146.73	24.91	0.66	190.00	171.65	180.83	9.66	0.52	178.80	148.75	163.78	16.81	0.59
GEN6	195.18	108.78	151.98	44.27	1.17	215.59	170.56	193.08	20.89	1.12	205.39	139.67	172.53	32.00	1.14
GEN7	178.52	115.00	146.76	35.58	0.94	174.72	158.72	166.72	9.16	0.49	176.62	136.86	156.74	22.51	0.71
GEN8	185.37	127.78	156.58	31.07	0.82	209.00	155.94	182.47	25.39	1.36	197.19	141.86	169.52	28.06	1.09
GEN9	167.59	101.67	134.63	39.33	1.04	177.78	147.11	162.45	17.25	0.92	172.69	124.39	148.54	27.97	0.98
GEN10	197.56	122.07	159.82	38.21	1.01	197.18	185.00	191.09	6.18	0.33	197.37	153.54	175.45	22.21	0.67
GEN11	182.59	104.63	143.61	42.70	1.13	196.02	151.91	173.97	22.50	1.20	189.31	128.27	158.79	32.24	1.16
GEN12	173.15	96.15	134.65	44.47	1.17	188.94	168.61	178.78	10.76	0.58	181.05	132.38	156.71	26.88	0.87
GEN13	165.93	113.70	139.82	31.48	0.83	176.17	129.00	152.59	26.78	1.43	171.05	121.35	146.20	29.06	1.13
GEN14	194.81	106.67	150.74	45.24	1.19	185.84	142.81	164.33	23.15	1.24	190.33	124.74	157.53	34.46	1.22
GEN15	174.44	115.55	145.00	33.76	0.89	176.39	131.57	153.98	25.41	1.36	175.42	123.56	149.49	29.56	1.12
GEN16	172.41	114.44	143.43	33.62	0.89	167.57	134.72	151.15	19.60	1.05	169.99	124.58	147.29	26.71	0.97
GEN17	184.08	101.30	142.69	44.97	1.18	157.41	143.80	150.61	8.65	0.46	170.75	122.55	146.65	28.23	0.82
GEN18	169.44	93.63	131.54	44.74	1.18	213.45	172.22	192.84	19.32	1.03	191.45	132.93	162.19	30.57	1.11
GEN19	162.78	131.89	147.34	18.98	0.50	152.83	118.47	135.65	22.48	1.20	157.81	125.18	141.49	20.67	0.85
GEN20	149.44	94.45	121.95	36.80	0.97	157.19	124.37	140.78	20.88	1.12	153.32	109.41	131.36	28.64	1.04
Mean	177.96	110.42	144.19	37.71		182.79	148.60	165.69	18.54		180.37	129.51	154.94	28.09	
F test Irrigation	**H.S**					**H.S**									
RLSD (G)			**3.09**					**1.32**							
RLSD (IxG)	**4.58**					**1.61**									

Nine, eight and ten genotypes were less susceptible or tolerant to drought as measured by drought susceptibility index (DSI) in the first, second and over the two seasons, respectively, because these genotypes had the DSI less than unity.

It is remarkable result that the genotypes No. 10 was lowest reduction for plant height under water stress (6.18) and possessed DSI equal 0.669.

The obtained results revealed the genetic differences for the studied genotypes of pearl millet. These results are in line with these obtained by Khairwal *et al*., 2007; Kholova *et al*., 2010; Saifullah *et al*. (2011).

I.2- Number of tillers/plant

Number of tillers/plant is an essential factor in determining the forage yield for forage crops. Means of number of tillers/plant for twenty pear millet genotypes under normal and water stress in both seasons were given in Table 6.

Number of tillers/plant of the different genotypes differed in rank from normal irrigation to water stress and from season to season.

In 2019 season, number of tillers/plant under normal irrigation ranged from 4.30 for genotype No. 19 (New Valley variety) to 7.03 for genotype No. 1 with an average of 6.07. Two and eight genotypes were significantly surpassed the average overall genotypes and genotype No. 20 (check cultivar Shandaweel-1), respectively. Meanwhile, under water stress, it ranged from 2.43 for check cultivar Shandaweel-1 to 3.71 for genotype No. 10 with an average of 2.91. One and six genotypes were significantly surpassed the average overall genotypes and check cultivar Shandaweel-1, respectively. Moreover, two and eleven genotypes were significantly surpassed the mid genotypes and check cultivar overall water stress treatments in 2019, respectively (Table 6).

In 2020 season, number of tillers/plant under normal irrigation ranged from 5.93 for genotype No. 1 to 9.83 for genotype No. 11 with an average of 7.69 overall genotypes. Seven and nine genotypes were significantly surpassed the average overall genotypes and check cultivar Shandaweel-1, respectively. Meanwhile, under water stress condition, it ranged from 3.34 for genotype No. 4 to 6.29 for genotype No. 11 with an average of 4.39 overall genotypes. Six and nine genotypes were significantly surpassed the average overall genotypes and check cultivar Shandaweel-1, respectively. Moreover, six genotypes surpassed significantly both of average overall genotypes and check cultivar over 2020 season.

Table 6. Mean number of tillers/plant, reduction % (R) and drought susceptibility index (DSI) for all genotypes during the two and over the two seasons under normal and water stress irrigation.

Genotypes	2019					2020					Average				
	Normal	Drought	Mean	R%	DSI	Normal	Drought	Mean	R%	DSI	Normal	Drought	Mean	R%	DSI
GEN1	7.03	2.71	4.87	61.45	1.18	5.93	4.14	5.04	30.19	0.70	6.48	3.43	4.95	45.82	0.94
GEN2	6.70	3.33	5.02	50.30	0.97	6.77	3.71	5.24	45.20	1.05	6.74	3.52	5.13	47.75	1.01
GEN3	6.57	3.29	4.93	49.92	0.96	6.33	3.41	4.87	46.13	1.08	6.45	3.35	4.90	48.03	1.02
GEN4	5.93	3.26	4.60	45.03	0.86	7.33	3.34	5.34	54.43	1.27	6.63	3.30	4.97	49.73	1.07
GEN5	5.47	2.60	4.04	52.47	1.01	6.03	4.31	5.17	28.52	0.67	5.75	3.46	4.60	40.50	0.84
GEN6	6.67	3.10	4.89	53.52	1.03	8.67	3.74	6.21	56.86	1.33	7.67	3.42	5.55	55.19	1.18
GEN7	6.03	2.86	4.45	52.57	1.01	6.73	4.14	5.44	38.48	0.90	6.38	3.50	4.94	45.53	0.95
GEN8	6.53	3.02	4.78	53.75	1.03	9.20	4.86	7.03	47.17	1.10	7.87	3.94	5.90	50.46	1.07
GEN9	6.30	2.71	4.51	56.98	1.09	8.17	4.19	6.18	48.71	1.14	7.24	3.45	5.34	52.85	1.11
GEN10	6.87	3.71	5.29	46.00	0.88	9.30	5.74	7.52	38.28	0.89	8.09	4.73	6.41	42.14	0.89
GEN11	6.27	2.69	4.48	57.10	1.10	9.83	6.29	8.06	36.01	0.84	8.05	4.49	6.27	46.55	0.97
GEN12	5.67	2.60	4.14	54.14	1.04	8.97	5.33	7.15	40.58	0.95	7.32	3.97	5.64	47.36	0.99
GEN13	5.70	2.79	4.25	51.05	0.98	6.23	3.64	4.94	41.57	0.97	5.97	3.22	4.59	46.31	0.97
GEN14	5.87	2.83	4.35	51.79	0.99	8.17	5.03	6.60	38.43	0.90	7.02	3.93	5.48	45.11	0.95
GEN15	6.07	2.55	4.31	57.99	1.11	7.77	4.05	5.91	47.88	1.12	6.92	3.30	5.11	52.93	1.11
GEN16	5.93	2.90	4.42	51.10	0.98	7.86	4.31	6.09	45.17	1.05	6.90	3.61	5.25	48.13	1.02
GEN17	6.53	2.74	4.64	58.04	1.11	7.00	4.64	5.82	33.71	0.79	6.77	3.69	5.23	45.88	0.95
GEN18	5.53	3.12	4.33	43.58	0.84	9.50	5.71	7.61	39.89	0.93	7.52	4.42	5.97	41.74	0.88
GEN19	4.30	2.93	3.62	31.86	0.61	6.60	3.43	5.02	48.03	1.12	5.45	3.18	4.32	39.95	0.87
GEN20	5.50	2.43	3.97	55.82	1.07	7.47	3.88	5.68	48.06	1.12	6.49	3.16	4.82	51.94	1.10
Mean	6.07	2.91	4.49	51.72		7.69	4.39	6.04	42.67		6.88	3.65	5.27	47.19	
F test Irrigation	H.S					H.S									
RLSD (G)			0.46					0.17							
RLSD (IxG)	**0.67**					**0.36**									

In general average overall environments revealed that the genotype No. 10 was the first rank (6.41) followed by the genotype No. 11 in the second rank (6.27). In the same time the genotype No. 10 was the best under water stress which number of tillers/plant (4.72) revealing to possess the gene tolerance for water stress.

These results are in agreement with this obtained by Khairwal *et al*. (2007) who found that there was a good amount of variation among 169 genotypes of land races of pear millet at arid and semi-arid in India. Also, Gebre (2014) found that genotype by environment interaction was statistically significant for productive tillers/plant.

Generally, water stress reduced number of tillers/plant overall genotypes by 52.11, 42.89 and 47.50% compared to normal irrigation in the first, second season and over the two seasons, respectively (Table 6). Drought susceptibility index (DSI) of some genotypes varied from season to season. Nine, ten and eleven genotypes were less than unity for drought susceptibility index in first, second and over the two seasons, respectively, and could be considered tolerant to drought respect to number of tillers/plant (Table 6). It is clear result that genotype No. 10 was the best under water stress (4.72) and recorded DSI of 0.888.

I.3- Mean leaves/stem ratio

Leaves/stems ratio is one of the essential factors in determining the forage quality and palatability in forage crops. Means of leaves/stems ratio as affected by irrigation treatments and genotypes in 2019 and 2020 seasons were presented in Table 7. In the first season, leaves/stem ratio under normal irrigation ranged from 0.556 for genotype No. 8 to 0.797 for genotype No. 13 with an average of 0.665. Under water stress leaves/stems ratio ranged from 0.394 for genotype No. 17 to 0.618 for genotype No. 3 with an average of 0.502.

Table 7. Mean leaves stem ratio, reduction % (R) and drought susceptibility index (DSI) for all genotypes during the two and over the two seasons under normal and water stress irrigation.

Genotypes	2019					2020					Average				
	Normal	Drought	Mean	R%	DSI	Normal	Drought	Mean	R%	DSI	Normal	Drought	Mean	R%	DSI
GEN1	0.690	0.577	0.633	16.404	0.669	0.723	0.543	0.633	24.815	1.333	0.706	0.560	0.633	20.707	1.001
GEN2	0.695	0.524	0.609	24.527	1.000	0.656	0.490	0.573	25.305	1.359	0.675	0.507	0.591	24.905	1.180
GEN3	0.715	0.618	0.666	13.621	0.555	0.691	0.547	0.619	20.849	1.120	0.703	0.582	0.643	17.173	0.837
GEN4	0.739	0.602	0.671	18.450	0.752	0.712	0.583	0.648	18.071	0.971	0.725	0.593	0.659	18.264	0.861
GEN5	0.738	0.610	0.674	17.368	0.708	0.627	0.577	0.602	7.979	0.429	0.682	0.593	0.638	13.056	0.568
GEN6	0.681	0.508	0.595	25.500	1.040	0.664	0.530	0.597	20.181	1.084	0.673	0.519	0.596	22.875	1.062
GEN7	0.584	0.397	0.491	31.966	1.303	0.667	0.593	0.630	11.000	0.591	0.625	0.495	0.560	20.790	0.947
GEN8	0.556	0.471	0.513	15.257	0.622	0.613	0.480	0.547	21.739	1.168	0.584	0.475	0.530	18.658	0.895
GEN9	0.667	0.481	0.574	27.815	1.017	0.667	0.640	0.653	4.000	0.215	0.667	0.561	0.614	15.908	0.616
GEN10	0.641	0.521	0.581	18.788	0.893	0.629	0.490	0.560	22.140	1.189	0.635	0.505	0.570	20.448	1.041
GEN11	0.701	0.436	0.569	37.779	1.540	0.605	0.490	0.548	19.053	1.023	0.653	0.463	0.558	29.102	1.282
GEN12	0.587	0.532	0.560	9.260	0.378	0.688	0.490	0.589	28.779	1.546	0.637	0.511	0.574	19.794	0.962
GEN13	0.797	0.531	0.664	33.361	1.360	0.621	0.467	0.544	24.893	1.337	0.709	0.499	0.604	29.652	1.349
GEN14	0.640	0.450	0.545	29.706	1.211	0.630	0.590	0.611	6.340	0.341	0.635	0.520	0.577	18.118	0.776
GEN15	0.626	0.497	0.562	20.545	0.838	0.699	0.450	0.574	35.592	1.912	0.662	0.474	0.568	28.480	1.375
GEN16	0.667	0.539	0.603	19.232	0.784	0.627	0.430	0.528	31.383	1.686	0.647	0.484	0.566	25.119	1.235
GEN17	0.588	0.394	0.491	32.948	1.343	0.669	0.540	0.605	19.323	1.038	0.628	0.467	0.548	25.692	1.191
GEN18	0.691	0.418	0.555	39.468	1.609	0.616	0.560	0.588	9.091	0.488	0.654	0.489	0.571	25.153	1.049
GEN19	0.617	0.481	0.549	22.053	0.899	0.632	0.507	0.569	19.831	1.065	0.624	0.494	0.559	20.928	0.982
GEN20	0.684	0.453	0.568	33.869	1.381	0.579	0.523	0.551	9.562	0.514	0.631	0.488	0.560	22.732	0.947
Mean	0.665	0.502	0.584	24.396		0.649	0.526	0.588	18.996		0.658	0.514	0.586	21.878	
F test Irrigation	H.S					H.S									
RLSD (G)			0.010					0.020							
RLSD (IxG)	0.050					0.040									

In the second season, under normal irrigation, leaves/stems ratio ranged from 0.579 for genotype No. 20 to 0.723 for genotype No. 1 with an average of 0.65. Moreover, under water stress condition, it varied from 0.43 for genotype No. 16 to 0.64 for genotype No. 9 with an average of 0.53. Eight and ten genotypes surpassed significantly the mean overall genotypes and check cultivar over water treatments in 2019, respectively. Moreover, six and thirteen genotypes possessed the same trend in 2020, respectively. Some genotypes surpassed average leaves/stems ratio overall seasons and irrigation system conditions. These superior genotypes could to improve number of leaves/stems ratio in pear millet breeding programs.

The reduction in leaves/stems ratio due to water stress in the first, second and over the two seasons were 24.40, 18.99 and 21.88%, respectively, compared to normal irrigation.

Generally, water stress reduced leaves/ stems for all genotypes compared to normal irrigation in the two seasons.

Drought susceptibility index (DSI) for some genotypes varied from season to season. Ten, seven, and ten genotypes were less than unity for drought susceptibility index in first, second and over two seasons, respectively and could be considered tolerant to drought stress (Table 7).

I.4- Total fresh forage yield (kg/plant)

Total fresh forage yield (kg/plant) as influenced by treatments of irrigation and genotypes in the two seasons and over seasons were presented in Table 8.

In 2019 season, total fresh forage yield/plant under normal irrigation conditions ranged from 0.776 for variety New Valley to 1.831 for genotype No. 18 with an average of 1.408 kg/plant. Eight and fifteen genotypes were surpassed significantly average total fresh forage yield and check variety Shandaweel-1, respectively. Under drought conditions, total fresh forage yield/plant varied from 0.466 for variety New Valley to 1.246 kg/plant for genotype No. 8 with an average of 0.910 kg/plant. Nine, fifteen genotypes were surpassed significantly the average of total fresh forage yield/plant and check cultivar Shandaweel-1, respectively. Concerning to average of studied genotypes over the water treatments, nine and fifteen genotypes surpassed significantly the average overall genotypes and check cultivar, respectively (Table 8).

In 2020 season, total forage yield/plant under normal irrigation conditions ranged from 0.784 for genotype No. 13 to 2.004 for genotype No. 11 with an average of 1.297 kg/plant. Nine and thirteen genotypes were significantly surpassed the average total fresh forage yield/plant and check cultivar Shandaweel-1, respectively (Table 7). Under drought conditions, total fresh forage yield/plant ranged from 0.565 for genotype No. 3 to 1.456 for genotype No. 11 with an average of 0.877 kg/plant. Six genotypes were significantly surpassed both of average total fresh forage yield/plant and check cultivar Shandaweel-1. Overall water stress, eight and eleven genotypes exceeded significantly the average overall genotypes and check cultivars, respectively (Table 8).

Table 8. Mean Total fresh forage yield (kg/plant), reduction % (R)and drought susceptibility index (DSI) for all genotypes during the two and over the two seasons under normal and water stress irrigation.

Genotypes	2019					2020					Average				
	Normal	Drought	Mean	R%	DSI	Normal	Drought	Mean	R%	DSI	Normal	Drought	Mean	R%	DSI
GEN1	1.535	1.057	1.296	31.149	0.881	1.096	0.788	0.942	28.094	0.868	1.315	0.922	1.119	29.621	0.875
GEN2	1.641	1.081	1.361	34.108	0.964	0.985	0.726	0.856	26.307	0.813	1.313	0.904	1.109	30.208	0.889
GEN3	1.824	1.137	1.480	37.659	1.065	0.883	0.565	0.724	36.072	1.115	1.354	0.851	1.102	36.865	1.090
GEN4	1.749	1.187	1.468	32.145	0.909	1.198	0.753	0.976	37.132	1.148	1.474	0.970	1.222	34.638	1.028
GEN5	1.075	0.636	0.856	40.807	1.154	1.229	0.788	1.009	35.848	1.108	1.152	0.712	0.932	38.328	1.131
GEN6	1.685	1.212	1.448	28.072	0.794	1.391	0.681	1.036	51.048	1.578	1.538	0.946	1.242	39.560	1.186
GEN7	1.609	1.028	1.319	36.065	1.020	0.931	0.660	0.795	29.123	0.900	1.270	0.844	1.057	32.594	0.960
GEN8	1.719	1.246	1.482	27.515	0.778	1.512	1.061	1.287	29.829	0.922	1.616	1.154	1.385	28.672	0.850
GEN9	1.494	0.907	1.201	39.273	1.110	1.356	0.968	1.162	28.591	0.884	1.425	0.938	1.181	33.932	0.997
GEN10	1.601	1.160	1.380	27.526	0.778	1.795	1.246	1.521	30.578	0.945	1.698	1.203	1.451	29.052	0.862
GEN11	1.309	0.746	1.027	42.995	1.216	2.004	1.456	1.730	27.346	0.845	1.657	1.101	1.379	35.170	1.030
GEN12	1.507	0.852	1.179	43.459	1.229	1.653	1.115	1.384	32.536	1.006	1.580	0.984	1.282	37.997	1.117
GEN13	0.911	0.581	0.746	36.223	1.024	0.784	0.566	0.675	27.816	0.860	0.847	0.573	0.710	32.020	0.942
GEN14	1.084	0.802	0.943	26.031	0.736	1.333	0.849	1.091	36.294	1.122	1.209	0.826	1.017	31.163	0.929
GEN15	0.998	0.608	0.803	39.000	1.103	1.032	0.694	0.863	32.747	1.012	1.015	0.651	0.833	35.874	1.057
GEN16	1.483	0.902	1.193	39.204	1.109	1.488	0.813	1.150	45.362	1.402	1.486	0.857	1.171	42.283	1.255
GEN17	1.415	0.802	1.109	43.370	1.226	1.328	0.950	1.139	28.484	0.880	1.372	0.876	1.124	35.927	1.053
GEN18	1.831	1.183	1.507	35.373	1.000	1.867	1.383	1.625	25.902	0.801	1.849	1.283	1.566	30.637	0.900
GEN19	0.776	0.466	0.621	39.910	1.128	0.984	0.655	0.819	33.459	1.034	0.880	0.560	0.720	36.685	1.081
GEN20	0.922	0.611	0.767	33.722	0.954	1.092	0.831	0.961	23.907	0.739	1.007	0.721	0.864	28.815	0.846
Mean	1.408	0.910	1.159	35.680		1.297	0.877	1.087	32.324		1.353	0.894	1.123	34.002	
F test Irrigation	H.S					H.S									
RLSD (G)			0.070					0.020							
RLSD (IxG)	0.110					0.040									

The reduction in total fresh forage yield/plant due to water stress in the first, second and over two seasons were 35.68, 32.32 and 34.00% compared to normal irrigation, respectively. The obtained results indicating that some of the high forage yield/plant genotypes under normal irrigation performed well under water stress (Table 8). Moreover, some genotypes gave highly significantly fresh forage yield/ plant. These genotypes could be used to improve fresh forage yield/plant.

In general, the obtained results reflect the genetic variabilities among the studied genotypes of pearl millet. These results are in line with those obtained by Brocke *et al*., 2003; Saifullah *et al*., 2011; Yadav and Kumar, 2013, who found that significant differences between genotypes were observed. Also, the forage yield was significantly higher under irrigated condition than rained environment. Drought susceptibility index (DSI) indicated that eight, eleven and ten were tolerant to drought and some of them low fresh forage yield/plant in 2019, 2020 and over both of them (Table 7). These results are in line with this obtained by Yadav (2008 a & b).

I.5- Total dry forage yield/plant (g)

Total dry forage yield/plant as influenced by water irrigations conditions and genotypes in the two seasons were presented in Table 9.

The results revealed that the maximum total dry forage yield/plant were 289.46 for genotype No. 18, 328.4 for genotype No. 11 and 279.4

g/plant for genotype No. 20 with an average of 209.85, 209.68 and 209.76 g/plant for 2019, 2020 and over two seasons, respectively, under normal irrigation conditions. Seven and nine genotypes were significantly surpassed the average of dry forage yield/plant of 2019 and 2020 seasons, respectively (Table 9).

Table 9. Mean total dry forage yield (g/plant), reduction % (R)and drought susceptibility index (DSI) for all genotypes during the two and over the two seasons under normal and water stress irrigation.

Genotypes	2019					2020					Average				
	Normal	Drought	Mean	R%	DSI	Normal	Drought	Mean	R%	DSI	Normal	Drought	Mean	R%	DSI
GEN1	222.35	195.52	208.94	12.07	0.75	168.29	136.90	152.60	18.65	0.76	195.32	166.21	180.77	15.36	0.75
GEN2	242.02	208.33	225.17	13.92	0.86	141.74	115.82	128.78	18.29	0.75	191.88	162.07	176.98	16.11	0.80
GEN3	253.04	203.33	228.18	19.65	1.22	134.61	93.56	114.09	30.49	1.24	193.83	148.45	171.14	25.07	1.23
GEN4	250.73	208.91	229.82	16.68	1.04	160.33	115.87	138.10	27.73	1.13	205.53	162.39	183.96	22.20	1.08
GEN5	159.50	119.96	139.73	24.79	1.54	207.32	148.25	177.79	28.49	1.16	183.41	134.11	158.76	26.64	1.35
GEN6	267.27	241.96	254.61	9.47	0.59	242.55	130.68	186.61	46.12	1.88	254.91	186.32	220.61	27.80	1.23
GEN7	265.68	220.86	243.27	16.87	1.05	170.59	139.56	155.08	18.19	0.74	218.13	180.21	199.17	17.53	0.89
GEN8	237.90	232.12	235.01	2.43	0.15	227.10	195.19	211.14	14.05	0.57	232.50	213.65	223.08	8.24	0.36
GEN9	232.45	175.62	204.04	24.45	1.52	253.95	218.79	236.37	13.85	0.56	243.20	197.20	220.20	19.15	1.04
GEN10	232.62	227.33	229.98	2.27	0.14	284.79	218.61	251.70	23.24	0.95	258.71	222.97	240.84	12.76	0.54
GEN11	192.98	159.13	176.05	17.54	1.09	328.40	258.77	293.59	21.20	0.86	260.69	208.95	234.82	19.37	0.98
GEN12	210.47	151.90	181.19	27.83	1.73	236.96	175.72	206.34	25.84	1.05	223.72	163.81	193.76	26.84	1.39
GEN13	133.37	122.19	127.78	8.38	0.52	109.89	96.84	103.36	11.88	0.48	121.63	109.51	115.57	10.13	0.50
GEN14	164.49	150.06	157.28	8.77	0.54	249.17	174.63	211.90	29.91	1.22	206.83	162.35	184.59	19.34	0.88
GEN15	147.24	114.95	131.10	21.93	1.36	198.00	129.60	163.80	34.54	1.41	172.62	122.28	147.45	28.24	1.38
GEN16	217.70	165.97	191.84	23.76	1.47	292.04	170.95	231.50	41.46	1.69	254.87	168.46	211.67	32.61	1.58
GEN17	222.39	160.21	191.30	27.96	1.74	185.41	156.60	171.01	15.54	0.63	203.90	158.41	181.15	21.75	1.18
GEN18	289.46	265.03	277.25	8.44	0.52	269.38	224.75	247.06	16.57	0.68	279.42	244.89	262.16	12.50	0.60
GEN19	122.07	85.23	103.65	30.18	1.87	122.15	92.89	107.52	23.95	0.98	122.11	89.06	105.58	27.07	1.42
GEN20	133.15	112.16	122.65	15.77	0.98	210.88	170.93	190.90	18.94	0.77	172.01	141.54	156.78	17.35	0.88
Mean	209.85	176.04	192.94	16.66		209.68	158.25	183.96	23.95		209.76	167.14	188.45	20.30	
F test Irrigation	H.S					H.S									
RLSD (G)			16.87					4.70							
RLSD (IxG)	23.93					8.51									

Under drought water stress condition, the results in Table 9 revealed that the maximum total dry forage yield/plant were 265.03 for genotype No. 18, 258.8 for genotype No. 11, and 244.9 g for genotype No. 18 with an average of 176.04, 158.25 and 167.14 g/plant for 2019, 2020 and over the two seasons, respectively. Eight genotypes were significantly and surpassed the average dry forage yield/plant for both of 2019 and 2020 seasons. It is clear results that eight and nine genotypes were significantly surpassed the average of all genotypes over the water treatments, respectively. These results may be due that the normal irrigation produce more metabolites required for increasing all agronomical traits than the water stress condition. Also, the role of water encouraging metabolite processes, consequently it will be effective for all agronomical traits. Moreover, some genotypes gave significantly total dry forage yield/plant. These genotypes could be used to improve total dry forage yield/plant.

The reductions in total dry forage yield/plant due to water stress in the first, second and over two seasons

were 16.66, 23.95 and 20.3% compared to normal irrigation conditions, respectively (Table 9). Bidinger *et al*. (1994) reported that dry fodder yield was low for the arid zone environments. Also, Saifullah *et al*. (2011) found that dry fodder yields were significantly higher for double irrigation than single or no irrigation. Also, Yadav *et al*. (2014) reported that irrigated condition recorded significantly higher dry matter accumulation and yield of pearl millet than rained condition.

Drought susceptibility index indicated that nine, twelve and ten genotypes were tolerant to water stress in first, second and over the two seasons, respectively. Some of these genotypes were low dry forage yielding. The other genotypes could be considered susceptible to drought. Also, some of these genotypes differed from season to season for DSI.

I.6- Total forage protein yield, g/plant

Total of forage protein yield as affected by water irrigations condition sand pear millet genotypes in first (2019) and second (2020) seasons and over two seasons were shown in Table 10.

In 2019 season, total forage protein yield under normal irrigation ranged from 22.42 for genotype No. 19 to 61.24 for genotype No. 18 with an average of 42.13 g/plant. Eight genotypes were significantly out-yielded than the main overall genotypes. Moreover, sixteen genotypes were significantly and surpassed the check cultivar Shandaweel-1 under normal irrigation condition. Under water stress, total forage protein yield varied from 18.25 for genotype No. 19 to 57.05 for genotypes No. 18 with an average of 37.7 g/plant. Seven genotypes surpassed significantly the average overall genotypes. Moreover, sixteen genotypes surpassed significantly the check cultivar Shandaweel-1 (Table 10). Nine and sixteen genotypes surpassed significantly the average of all genotypes and check cultivar, respectively.

Table 10. Mean total forage protein yield/plant (g), reduction % (R) and drought susceptibility index (DSI) for all genotypes during the two and over the two seasons under normal and water stress irrigation.

Genotypes	2019					2020					Average				
	Normal	Drought	Mean	R%	DSI	Normal	Drought	Mean	R%	DSI	Normal	Drought	Mean	R%	DSI
GEN1	50.92	50.00	50.46	1.80	0.17	38.54	35.01	36.77	9.16	0.62	44.73	42.50	43.62	5.48	0.39
GEN2	41.88	41.36	41.62	1.24	0.12	24.53	23.00	23.76	6.25	0.42	33.21	32.18	32.69	3.74	0.27
GEN3	47.70	42.59	45.14	10.72	1.03	25.37	19.60	22.49	22.77	1.53	36.54	31.09	33.81	16.74	1.28
GEN4	56.40	52.35	54.38	7.18	0.69	36.07	29.04	32.55	19.49	1.31	46.23	40.69	43.46	13.33	1.00
GEN5	26.25	20.99	23.62	20.06	1.92	34.13	25.94	30.03	24.00	1.61	30.19	23.46	26.83	22.03	1.77
GEN6	43.95	40.35	42.15	8.19	0.78	37.16	23.41	30.28	37.00	2.49	40.55	31.88	36.22	22.59	1.64
GEN7	53.22	53.06	53.14	0.30	0.03	34.08	33.62	33.85	1.34	0.09	43.65	43.34	43.49	0.82	0.06
GEN8	42.59	35.10	38.85	17.59	1.68	35.51	31.82	33.66	10.40	0.70	39.05	33.46	36.25	13.99	1.19
GEN9	46.98	40.05	43.51	14.75	1.41	51.32	49.89	50.61	2.78	0.19	49.15	44.97	47.06	8.77	0.80
GEN10	47.58	45.48	46.53	4.41	0.42	55.68	45.76	50.72	17.82	1.20	51.63	45.62	48.62	11.12	0.81
GEN11	37.43	34.10	35.76	8.89	0.85	63.69	55.46	59.57	12.93	0.87	50.56	44.78	47.67	10.91	0.86
GEN12	48.81	37.57	43.19	23.02	2.20	54.95	43.46	49.21	20.90	1.41	51.88	40.52	46.20	21.96	1.80
GEN13	24.55	21.61	23.08	11.95	1.14	19.45	17.80	18.63	8.47	0.57	22.00	19.71	20.85	10.21	0.86
GEN14	37.57	28.52	33.05	24.09	2.30	47.22	39.89	43.55	15.53	1.04	42.39	34.20	38.30	19.81	1.67
GEN15	30.33	28.14	29.24	7.23	0.69	40.79	31.73	36.26	22.22	1.49	35.56	29.93	32.75	14.72	1.09
GEN16	50.14	43.54	46.84	13.17	1.26	67.26	44.84	56.05	33.33	2.24	58.70	44.19	51.44	23.25	1.75
GEN17	50.26	42.62	46.44	15.19	1.45	41.90	41.66	41.78	0.57	0.04	46.08	42.14	44.11	7.88	0.75
GEN18	61.24	57.05	59.15	6.84	0.65	53.09	51.93	52.51	2.20	0.15	57.17	54.49	55.83	4.52	0.40
GEN19	22.42	18.25	20.33	18.58	1.78	22.43	19.89	21.16	11.32	0.76	22.43	19.07	20.75	14.95	1.27
GEN20	22.44	21.82	22.13	2.77	0.27	35.54	33.25	34.40	6.44	0.43	28.99	27.54	28.27	4.61	0.35
Mean	42.13	37.73	39.93	10.90		40.94	34.85	37.89	14.25		41.53	36.29	38.91	12.57	
F test Irrigation	N.S					H.S									
RLSD (G)			**3.49**					**1.04**							
RLSD (IxG)	**4.70**					**1.81**									

In 2020 season, total forage protein yield under normal irrigation ranged from 19.45 for genotype No. 13 to 67.26 for genotype No. 16 with an average of 40.94 g/plant. Seven genotypes were significantly outyielded than the mean overall genotypes. Moreover, nine genotypes were significantly and surpassed the check cultivar shandaweel-1 under normal irrigation condition. Under water stress conditions, total forage protein yield varied from 17.80 for genotype No. 13 to 55.46 for genotype No. 11 with an average of 34.85 g/plant. Eight genotypes surpassed significantly the average overall genotypes. Moreover, eighteen genotypes surpassed significantly the check cultivar Shandaweel-1 (Table 10). Overall water treatments, eight and ten genotypes exceeded significantly the mid-genotypes and check cultivar, respectively. These genotypes could be used to improve total forage protein yield in breeding programs. The decrease by water stress accounted for 10.45, 14.87 and 12.66% in the first, second and combined over the two seasons, respectively and revealing the large effects on total forage protein yield/plant by water stress (Table 10).

These results are in agreement with those reported by some author's i.e. Gebre (2014) who reported that significant variation among genotypes were observed for all traits. Drought susceptibility index (DSI) indicating that ten, eleven and eleven

genotypes were tolerant to drought and gave DSI less than unity in the first, second and over the two seasons, respectively. But, the others genotypes could be considered susceptible to drought and gave DSI large than unity.

I.7- Total chlorophyll content:

In 2019 season, the average of total chlorophyll content under normal irrigation ranged from 305.6 for Shandaweel-1 cultivar to 396.86 for genotype 7 with an average of 354.7 mg/m^2. Meanwhile, under water stress conditions, it ranged from 265.8 for genotype No. 6 to 351.7 for genotype No. 7 with an average of 300.9 mg/m^2 (Table 11).

Table 11. Mean chlorophyll content (mg/m^2), reduction % (R) and drought susceptibility index (DSI) for all genotypes during the two and over the two seasons under normal and water stress irrigation.

Genotypes	2019					2020					Average				
	Normal	Drought	Mean	R%	DSI	Normal	Drought	Mean	R%	DSI	Normal	Drought	Mean	R%	DSI
GEN1	371.69	343.31	357.50	7.63	0.51	330.34	277.68	304.01	15.94	1.31	351.01	310.50	330.76	11.54	0.91
GEN2	369.54	284.27	326.91	23.07	1.55	385.43	314.62	350.03	18.37	1.51	377.49	299.45	338.47	20.67	1.53
GEN3	371.39	305.43	338.41	17.76	1.20	360.23	270.95	315.59	24.78	2.04	365.81	288.19	327.00	21.22	1.62
GEN4	342.73	282.32	312.52	17.63	1.19	427.41	351.83	389.62	17.68	1.45	385.07	317.07	351.07	17.66	1.32
GEN5	349.96	294.85	322.40	15.75	1.06	324.46	265.93	295.20	18.04	1.48	337.21	280.39	308.80	16.85	1.27
GEN6	324.13	265.82	294.97	17.99	1.21	276.07	228.81	252.44	17.12	1.41	300.10	247.31	273.71	17.59	1.31
GEN7	396.86	351.66	374.26	11.39	0.77	251.03	232.63	241.83	7.33	0.60	323.95	292.15	308.05	9.82	0.68
GEN8	339.14	327.66	333.40	3.38	0.82	251.52	228.17	239.85	9.28	0.76	295.33	277.92	286.62	5.90	0.79
GEN9	376.76	287.39	332.08	23.72	0.66	244.46	212.59	228.53	13.04	0.84	310.61	249.99	280.30	19.52	0.75
GEN10	316.20	287.92	302.06	8.94	0.60	236.93	198.90	217.92	16.05	1.53	276.57	243.41	259.99	11.99	1.07
GEN11	362.62	297.31	329.96	18.01	1.21	210.31	186.44	198.38	11.35	0.93	286.47	241.87	264.17	15.57	1.07
GEN12	329.42	295.36	312.39	10.34	0.70	224.30	183.39	203.85	18.24	1.50	276.86	239.38	258.12	13.54	1.10
GEN13	353.57	299.04	326.31	15.42	1.04	414.14	391.37	402.76	5.50	0.45	383.86	345.21	364.53	10.07	0.75
GEN14	372.95	299.42	336.19	19.72	1.33	388.04	308.81	348.42	20.42	0.75	380.50	304.11	342.30	20.07	1.04
GEN15	380.01	334.63	357.32	11.94	0.80	447.42	436.23	441.82	2.50	0.21	413.72	385.43	399.57	6.84	0.50
GEN16	335.06	298.69	316.88	10.85	0.73	366.55	326.18	346.37	11.01	0.91	350.81	312.44	331.62	10.94	0.82
GEN17	387.55	307.06	347.31	20.77	1.40	297.83	287.65	292.74	3.42	0.28	342.69	297.36	320.02	13.23	0.84
GEN18	349.85	280.58	315.22	19.80	1.33	445.59	349.88	397.73	21.48	1.77	397.72	315.23	356.48	20.74	1.55
GEN19	358.89	294.38	326.64	17.97	1.21	353.44	317.91	335.68	10.05	0.49	356.17	306.14	331.16	14.04	0.85
GEN20	305.60	280.79	293.20	8.12	0.55	427.87	332.52	380.19	22.28	0.26	366.73	306.66	336.69	16.38	0.40
Mean	354.70	300.89	327.80	15.01		333.17	285.12	309.15	14.19		343.93	293.01	318.47	14.71	
F test Irrigation	S					H.S									
RLSD (G)			44.22					9.12							
RLSD (IxG)	48.66					11.09									

In 2020 season, the average of total chlorophyll content under normal irrigation ranged from 210.3 for genotype No. 11 to 447.4 for genotype No. 15 with an average overall genotypes 333.2 mg/m^2. While, under water stress conditions it ranged from 183.4 for genotype No. 12 to 436.2 for genotype No. 15 with an average of 285.1 mg/m^2.

Overall means of water treatments, one and seven genotypes exceeded significantly the average of overall genotypes in 2019 and 2020, respectively. Generally, the total chlorophyll content was decreased by 15.17, 14.42 and 14.81% under water stress compared to normal irrigation in the first, second and over the two seasons, respectively (Table 11).

Total chlorophyll contents of all the estimated genotypes were higher under the normal irrigation than those of the water stress. This trend was

observed in each season and in combined over the two seasons. The importance of chlorophyll came from widely use for the biosynthesis of a large variety of nitrogenous materials, i.e. pigments, vitamins, coenzymes, purine and pyrimidine bases. Studies have proved that amino acids can directly or indirectly influence the physiological activities in plant growth and yield (Mohamed, 2005). El-Nabarawy (2001) mentioned the importance and role of chlorophyll are very important for growth and protein synthesis. Drought susceptibility index indicated that nine, eleven and ten genotypes were tolerant to water stress in first, second and over the two seasons, respectively. Some of these genotypes were high yielding and these genotypes could be used under water stress conditions. The other genotypes could be considered susceptible to drought. Also, some of these genotypes differed from season to season for drought susceptibility index (DSI).

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Assiut J. Agric. Sci., 52 (5) 2021 (45-63) *ISSN: 1110-0486*
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أداء بعض التراكيب الوراثية للدخن للمحصول العلفي ومكوناته تحت الري العادي والاجهاد المائي

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الملخص

أجري هذا البحث في موسمي ٢٠١٩، ٢٠٢٠ بهدف تقييم عشرون تركيب وراثي مختلفة من الدخن لصفات ارتفاع النبات وعدد الأفرع / للنبات ونسبة الأوراق / السيقان والمحصول العلفي الطازج والجاف والبروتين ونسبة الكلوروفيل وذلك بمزرعة قسم المحاصيل – كلية الزراعة – جامعة أسيوط، وذلك في تجربتين الأولي تحت ظروف الري العادي والثانية تحت ظروف الاجهاد المائي وأستخدم تصميم الشرائح الكاملة العشوائية لكل تجربة وفي ثلاث مكررات وكانت أهم النتائج المتحصل عليها:

١- كانت هناك فروق معنوية في معاملات الري لكل الصفات فيما عدا المحصول البروتين العلفي في السنة الأولي – كذلك وجد اختلاف بين التراكيب الوراثية لكل الصفات تحت الدراسة في كلا الموسمين. وكان التفاعل بين معاملات الري والتراكيب الوراثية معنوي لكل الصفات فيما عدا محتوي الكلوروفيل في السنة الأولي.

٢- تأثرت جميع الصفات المدروسة في كلا الموسمين بمعاملة الجفاف وأدت إلى الانخفاض النسبي لجميع الصفات المدروسة وكان مقدار هذا الانخفاض ٢٨،١، ٤٧،٢، ٢١،٩، ٣٤،٠، ٢٠،٣، ١٢،٩، ١٧،٤% لصفات طول النبات، عدد الأفرع/للنبات، نسبة الأوراق/السيقان، المحصول العلفي الطازج، والجاف والبروتين، ومحتوي الكلورفيل على التوالي وذلك كمتوسط للموسمين.

٣- أظهرت التراكيب الوراثية اختلافاً في تحملها للجفاف وباستخدام دليل معامل الحساسية للجفاف وقد أعطت بعض التراكيب الوراثية معامل حساسية للجفاف أقل من ١ (متحملة للجفاف) بينما التراكيب الوراثية الأخرى أعطت معامل الحساسية للجفاف أكبر من واحد (غير متحملة للجفاف) وبعض هذه التراكيب الوراثية اختلفت من سنة إلى أخرى في نسبة النقص وكذلك دليل الحساسية للصفات المدروسة.

٤- كانت التراكيب الوراثية أرقام ١، ٢ أكثر تحملاً للجفاف للمحصول العلفي الطازج والجاف والبروتين في كلا الموسمين.