SUST
Journal of Agricultural and Veterinary Sciences
Journal homepage:
http:// Scientific-journal.sustech.edu

Effects of Water Stress on some Physiological Characters in Four Varieties of Alfalfa (*Medicago sativa* L.)

Hashim Awadel Karim Fadlalla[1] and Faiza Mohammed Seid Ahmed Abuswar[2]

1   Environment, Natural Resources and Desertification Research Institute, National Centre for Research. P. O. Box: 6096 Khartoum, Sudan.
2   Faculty of Education, University of Kassala, Sudan.

Abstract
Four different varieties of alfalfa (Medicago sativa L) were used to evaluate the effects of water stress on its physiological performance. These were Higazi, Srivir, Pioneer and Cuf 101. The experiment was conducted during the period February to July of 2011. A factorial experiment using a randomized complete block design with four replications was used to layout a pot experiment at the Nursery of Desertification Research Institute, National Center for Research. Four levels of water stress treatments using water interval as indicator. These were: two days, five days, ten days and fifteen days intervals between any two irrigations. The study was divided into two growth stages; before and after subjecting to water stress. Before subjecting to water stress, the plants were irrigated every two days. Data were collected on dry matter (%), protein content (%), chlorophyll content (mg/100g) and total available sugars (CHO %). Data were collected three times before water stress. These were: stage of emergence the third leaf (K_1), 45 days after sowing (K_2) and 70 days after sowing (K_3). After subjecting to water stress the data were collected four times. These were 15 days (K_4), 30 days (K_5), 45 days (K_6) and 60 days (K_7). Before starting treatments, highly significant differences were revealed for protein content, chlorophyll content and CHO among varieties in the three stages of growth (K_1, K_2 and K_3). After starting water stress treatments, most varieties of alfalfa showed tolerant under five and ten days intervals of watering treatments (W_2 and W_3, respectively). Higazi and Srivir were tolerant to drought conditions compared to the other ones. Hegazi was superior for CHO under five days (W_2) and protein content under ten days (W_3), whereas Srivir outscored for CHO under W_3. Cuf 101 was superior for chlorophyll content under ten days (W_3) and dry matter under W_2 and W_3. Pioneer outscored for protein content under two days (W_1).
Keywords: *Medicago sativa*, water stress, physiological characters.

Introduction
Alfalfa (*Medicago sativa* L.) is a major forage legume worldwide. It produces more protein per hectare than any grain or legume crops. Therefore, it is widely used for hay production and as pasture for livestock. Alfalfa is highly valued animal feed. It is a rich source of proteins, fibers, minerals and vitamins used in diet of livestock, especially

ruminants (Milic *et al.,* 2011*)*. Alfalfa is one of the most important forage crops. Besides its potential to produce large quantity and quality of forage, it enriches the soil with the biological nitrogen. This plant as a legume forage crop produces high net energy yield. The energy required for production in this forage crop is far lower than the total energy contained in the crop. This is due to biological nitrogen fixation. In addition, alfalfa ability to fix atmospheric nitrogen makes it valuable both for crop rotation and for a more sustainable and environmentally safe agriculture (Ghorttapeh *et al*., 2012). It is grown in arid and semi-arid regions. Because of its depth and straight roots, alfalfa is able to absorb even deep waters about 5 m depth and more. This advantage saves plant life in long term drought. Also, alfalfa plant which goes to stagnation status in drought and cold conditions, in good weather condition again returns to its normal life and growth (Hamidi and Safarnejad, 2010).

Environmental constraints such as drought, flooding, extreme temperature, salinity, heavy metals, photon irradiance and nutritional disturbances represent the most limiting factors for agricultural productivity and play a major role in the distribution of plant species across different types of environments. Water shortage is the major constraint affecting fodder production and yield stability in most arid and semi-arid regions (Slama *et al*., 2011). Drought stress influences plant growth and results in morphological, physiological, molecular and growth mutations. Water stress affects plants in different levels ranging from cell to a plant colony (Hamidi and Safarnejad, 2010). Decreasing water supply either temporarily or permanently affects morphological and physiological processes in plant adversely (Oraki *et al*., 2012). The situation worsens by the fact that most climate change scenarios predict a worldwide increase in arid areas. When faced with this climatic change and increasing water demand for agriculture, the selection of plant resistant to water deficit stress and particularly the identification of physiological proprieties used by crop species to cope with drought are of paramount importance. Improvement of plant drought resistance becomes urgent and should integrate with conventional breeding and biotechnological approaches (Slama *et al*., 2011).

Therefore, the objective of present study was to evaluate the effect of water stress on the performance of four forage verities of alfalfa for some physiological characters.

Materials and Methods

Four varieties of alfalfa (*Medicago sativa* L.) were used to evaluate their physiological performance under the effects of water stress. The four varieties were Higazi (V_1), Srivir (V_2), Pioneer (V_3) and Cuf 101 (V_4). Higazi is local and the other varieties are exotics. Higazi and Cuf 101 were provided from Almidinab Agri-services Company, Khartoum North. Srivir and Pioneer were obtained from Faculty of Agriculture, University of Khartoum. A factorial experiment using a randomized complete block design with four replications was used to layout the experiment in pots (35.5cm height and 17cm width) at the nursery of Desertification Research Institute, National center for research. The experiment was conducted during the period February – July of 2011. The climate of the area is semi-arid and tropical with low relative humidity (Abuswar, 2013). The pots were filled

with mixture of sand and loamy clay (1:1).

The chemical analysis was done at the laboratories of the Central Laboratory, Ministry of Science and Technology at Soba and Environment and Natural Resources Research Institute, National Centre for Research, Khartoum.

Sowing was done on the second week of February at a rate of 30 seeds/pot and 0.5cm depth. The first irrigation was applied immediately the subsequent ones were carried every two days. Weeding was done manually when needed. Thinning was performed a week after sowing to set density to 20 plants/pot. The study was divided into two growth stages; before and after subjection to water stress. Measurements were taken at stage of emergence of the third leaf (K_1), 45 days after sowing (K_2) and 70 days after sowing (K_3). For stress treatment, measurements were taken at

15 (K_4), 30 (K_5), 45 (K_6) and 60 (K_7) days. The plants were cut just above the soil surface using a sickle.

The plants were irrigated every two days before starting the treatments of water stress. The water stress treatments were imposed a week after the first cut. Four watering treatments were used. These were: tow days (W_1), five days (W_2), ten days (W_3) and fifteen days (W_4) interval between any two irrigations. For data collection, a sample of ten plants was used before and five after starting water stress treatments. Data were collected on dry matter (%), protein content (%), chlorophyll content (mg/100g) and total available sugar (CHO %). Dry matter (%) was calculated as percentage of dry weight from fresh weight. Protein content was determined following the method described by Evenhuis and Waard (1980). The nitrogen percentage was calculated as follows:

$$Nitrogen \% = ((R - B) \times 14 \times N \times 100)/ (1000 \times S)$$

Where:

R = ml of HCL equivalent to the sample titration

B = HCL equivalent to the blank titration.

N = Normality of acid (0.2).

14 = Molecular weight of nitrogen.

S = Sample weight.

$$Protein \% = nitrogen \% \times 6.25$$

The total chlorophyll content determined following AOAC (1970). The calculation was estimated according to the following formula:

$$Ch = (Cc \times 100 \times Sv \times Df))/ (1000 \times Swt)$$

Whereas:

Ch = chlorophyll content (mg/100g).

C_C = chlorophyll concentration ppm.

Sv = sample volume (100)

Df = dilution factor

Swt = sample weight

Total available sugar was determined using the method of Clogg Anthrone as described by Salama *et al.* (2011) according to following equation:

$$Total \ CHO\% = (25 \times b)/(a \times w)$$

Whereas:

$Total \ CHO\%$ = total available CHO (glucose %).

b = absorbency of dilute sample.

a = absorbency of dilute standard.

w = weight of sample.

Data collected were subjected to statistical analysis following the standard procedures describe by Gomez and Gomez (1984).

Results and Discussion

In this study, four varieties; Higazi (V_1), Srivir (V_2), Pioneer (V_3) and Cuf 101 (V_4) were used to evaluate the effects of water stress on the performance of alfalfa crop (*Medicago sativa* L). Biochemical parameters: protein content, chlorophyll content and total available sugars (CHO) were used as indicators to assess the effects of water stress on the physiological performance.

However, after a month from starting water stress treatments, all the plants were dead. So, the data were collected under four levels of water stress treatments only. This means that these varieties couldn't survive when irrigation delayed more than a moth under the conditions of Sudan. The results obtained from this study were discussed as follows:

Before water stress treatments: non-significant differences for dry matter among the undertaken varieties in all the stages before subjecting to water stress treatments. Table 1 shows the performance of the four varieties of alfalfa for dry matter (%). The means of the different varieties under the three stages ranged between 26.14 – 49.83%. The highest dry matter (49.83%) was observed for V_1 in K_2 and the lowest one (26.14%) was recorded for V_3. These results are in agreement with that of Abuswar (2013), Akmal *et al.* (2011), Berrada (2005) and Erice *et al*. (2010). On the other hand, it is in contrast with that of Faridullah *et al.* (2009). This may be due to the different materials used or different conditions under which the work has been done.

Table 1: Means of alfalfa varieties for dry matter (%) evaluated before water stress treatments at the Nursery of DRI during the period Feb. – July 2011

Treatment	K_1	K_2	K_3
Higazi (V_1)	27.09	49.83	38.07
Srivir (V_2)	28.10	42.53	33.36
Pioneer (V_3)	26.14	39.33	39.29
Cuf 101 (V_4)	30.33	40.03	34.12
Overall mean	27.92	42.93	36.21
CV%	23.89	11.86	11.33
Lsd5%	10.04	7.67	6.18
Lsd1%	13.91	10.62	8.56

- K_1 = emergence of 3rd. leaf, K_2 = after 45 days, $K3$ = after 70 days from sowing.

For protein content, there were significant differences among the four different varieties in three growth stages. The highest percentages of protein content were given for Higazi (27.13 and 20.12%) in K_1 and K_2, respectively and Pioneer (17.00%) in K_3 (Table 2). These results are in agreement with Katic *et al.* (2009) who stated that protein content in alfalfa dry matter varies from 18 to 25% depending on the growth stage, cultivar and storage methods.

Table 2: Means of alfalfa varieties for protein content (%) evaluated before water stress treatments at the Nursery of DRI during the period Feb. – July 2011

Treatment	K_1	K_2	K_3
Higazi (V_1)	27.13	20.12	11.38
Srivir (V_2)	23.63	18.63	14.00
Pioneer (V_3)	23.05	19.98	17.00
Cuf 101 (V_4)	23.05	17.19	11.38
Overall mean	24.21	18.98	13.44
CV%	0.20	5.40	5.09
Lsd5%	0.07	1.56	1.03
Lsd1%	0.09	2.14	1.43

- K_1 = emergence of 3rd. leaf, K_2 = after 45 days., K_3 = after 70 days from sowing.

For chlorophyll content/plant, significant differences were observed among the different varieties in all stages of growth before starting water stress treatments. Cuf 101 gave the largest amount of Chlorophyll content in all stages except in K_1 (Table 3). This finding in agreement with that of Ashrafuzzaman *et al*. (2009) who stated significant differences among their verities with respect to leaf chlorophyll content.

Table 3: Means of alfalfa varieties for chlorophyll content/plant (mg/100g) evaluated before water stress treatments at the Nursery of DRI during the period Feb. – July 2011

Treatment	K_1	K_2	K_3
Higazi (V_1)	20.00	72.00	96.00
Srivir (V_2)	20.00	55.00	62.00
Pioneer (V_3)	20.00	59.00	79.00
Cuf 101 (V_4)	12.50	98.00	167.00
Overall mean	18.13	71.00	101.00
CV%	6.94	4.76	2.68
Lsd5%	1.89	5.09	4.08
Lsd1%	2.62	7.04	5.65

- K_1 = emergence of 3rd leaf, K_2 = after 45 days, K_3 = after 70 days from sowing.

Before water stress, significant differences were observed among varieties for total available sugar in three stages for CHO. The overall means were 11.04, 12.43 and 14.33% with coefficient of variations 0.71, 2.40 and 1.81% in K_1, K_2 and K_3, respectively. In K_1, the highest value of CHO was 14.69% which obtained for V_4. After 45 days, the largest CHO 15.11%. It was scored by V_2. After 70 days, Srivir gave the largest amount of CHO (19.23%) and Cuf 101 gave the lowest one (11.54%) (Table 4). These results were in agreement with that of Abuswar (2013) and Samuel *et al.* (2010) in alfalfa.

Table 4: Means of alfalfa varieties for total available CHO (%) evaluated before water stress treatments at the Nursery of DRI during the period Feb. – July 2011

Treatment	K_1	K_2	K_3
Higazi (V_1)	8.97	10.90	12.78
Srivir (V_2)	12.82	15.11	19.23
Pioneer (V_3)	7.69	10.83	13.78
Cuf 101 (V_4)	14.69	12.89	11.54
Overall mean	11.04	12.43	14.33
CV%	0.71	2.40	1.81
Lsd5%	0.15	0.45	0.40
Lsd1%	0.21	0.63	0.55

- K_1 = emergence of 3rd leaf, K_2 = after 45 days, K3 = after 70 days from sowing.

After water stress treatments: there were highly significant differences among the varieties under investigation, water stress levels and the interactions between varieties and water stresses (VxW) in the four stages of growth for dry matter. After15 days from water stress (K_4), the highest values of dry matter were 35.99% observed for Srivir under W_1, 62.76% for Cuf 101 under W_2, 71.53 and 92.66% for Pioneer under both W_3 and W_4. The overall mean in stage was 55.85 and CV was 12.29%. In K_5, these were 35.50% for Pioneer under W_1, 58.40 and 51.43% for Cuf 101 under both W_2 and W_3 with overall mean 42.04 and CV 8.05%. In K_6, the highest values were 39.36% for Srivir under W_1 and 63.54 and 92.23% for Cuf 101 under both W_2 and W_3 with overall mean 50.80% and CV 4.38%. Also in k_7, these were 35.53 and 65.39 41.33% obtained for Pioneer under both W_1 and W_2 and 41.33% for Higazi under W_3 with overall mean 41.93% and CV 5.35% (Table 5). In general, the values of each variety for this character increased with the increase of water stress level. All the highest values under the different levels of water stress exceeded the overall mean. These findings were in agreement with those of Berrada (2005) who reported significant differences among alfalfa varieties for this character.

Table 5: Means of alfalfa varieties for dry matter (%) evaluated at the Nursery of DRI after different water stress treatments during the period Feb. – July 2011

Treatment	K_4	K_5	K_6	K_7
V_1W_1	33.23	31.94	36.72	33.85
V_2W_1	35.99	35.04	39.36	32.08
V_3W_1	33.45	35.50	38.26	35.53
V_4W_1	31.32	30.65	33.34	31.97
V_1W_2	55.90	43.98	58.57	46.18
V_2W_2	52.96	32.62	53.42	34.71
V_3W_2	41.71	57.62	39.92	65.39
V_4W_2	62.76	58.40	63.54	58.96
V_1W_3	52.95	40.52	50.30	41.33
V_2W_3	28.76	41.03	53.20	39.33
V_3W_3	71.53	45.76	-	-
V_4W_3	63.27	51.43	92.23	-
V_1W_4	73.27	-	-	-
V_2W_4	74.17	-	-	-
V_3W_4	92.66	-	-	-
V_4W_4	89.74	-	-	-
Overall mean	55.85	42.04	50.80	41.93
CV%	12.29	8.05	4.38	5.35
LSD5%	9.81	4.83	3.18	3.20
LSD1%	26.48	13.05	8.57	8.65

- K_4 = after 15 days, K_5 = after 30 days, K_6 = after 45 days and K_7 = after 60 days from water stress.
- V_1 = Higazi, V_2 = Srivir, V_3 = Pioneer and V_4 = Cuf 101.
- W_1, W_2, W_3, W_4 = water stress treatments2, 5, 10 and 15 days intervals between irrigations.
- - =dead plants.

For protein content/plant, significant differences were revealed among the undertaken varieties, water stress treatments and VxW interactions in all growth stages. After 15 days from water stress (K_4), the highest values of protein content were scored by V_2 (15.75%) under W_1, V_1 (17.53%) under W_2, both V_1 and V_2 (20.13%) under W_3 and V_3 (19.25%) under W_4. the overall mean in

this stage was 16.14% with CV 3.09%. In K_5, the largest percentages of protein content were obtained for Cuf 101 (22.25%) under W_1, Pioneer (25.25%) under W_2 and Higazi (20.88%) under W_3 with overall mean 17.37% and CV 2.77%. After 45 days (K_6) from staring water stress treatments, the largest values were produced by V_1 (19.25%) under W_1, V_2 (15.75%) under W_2 and V_1 (19.25%) under W_3 with overall mean 15.24% and CV 2.17%. In K_7, the highest values were 25.38% obtained for V_4 under W_1, 25.38% for V_3 under W_2 and 22.01% for V_1 under W_3 with

overall mean 20.73% and CV 1.29% (Table 6). Similarly, the protein content increased in varieties means in K_4 when water stress increased in K_5 and K_6, but in K_7 showed different trends (increase or decrease). The highest values of each variety under the different levels of water stress were exceeded the overall mean in each growth stage. Similar results were reported by Abuswar (2013) in alfalfa and Riccardi *et al* (1998) who stated that in seventy-eight genotypes out of total of 413 evaluated for protein content, showed significant quantitative variation.

Table 6: Means of alfalfa varieties for protein content (%) evaluated at the Nursery of DRI after different water stress treatments during the period Feb. – July 2011

Treatment	K_4	K_5	K_6	K_7
V_1W_1	12.25	20.75	19.25	22.75
V_2W_1	15.75	18.13	14.00	19.25
V_3W_1	14.88	20.88	15.66	20.99
V_4W_1	12.25	22.25	14.00	25.38
V_1W_2	17.53	18.75	14.88	20.13
V_2W_2	16.63	16.00	15.75	17.50
V_3W_2	15.75	25.25	10.50	25.38
V_4W_2	15.75	15.75	14.38	15.75
V_1W_3	20.13	20.88	19.25	22.01
V_2W_3	20.13	12.25	11.00	18.20
V_3W_3	14.88	7.88	-	-
V_4W_3	15.75	9.63	19.00	-
V_1W_4	18.38	-	-	-
V_2W_4	12.25	-	-	-
V_3W_4	19.25	-	-	-
V_4W_4	16.63	-	-	-
Overall mean	16.14	17.37	15.24	20.73
CV%	3.09	2.77	2.17	1.29
LSD5%	0.71	0.69	0.47	0.38
LSD1%	1.92	1.86	1.28	1.03

- K_4 = after 15 days, K_5 = after 30 days, K_6 = after 45 days and K_7 = after 60 days from water stress.
- V_1 = Higazi, V_2 = Srivir, V_3 = Pioneer and V_4 = Cuf 101.
- W_1, W_2, W_3, W_4 = water stress treatments2, 5, 10 and 15 days intervals between irrigations.
- - =dead plants.

Significant differences were revealed for chlorophyll content among the undertaken varieties, water stress levels and VxW interactions in four stages. In K_4, the maximum amounts of chlorophyll content were 134, 124, 176 and 105 mg/100g. They were obtained

for Higazi, Pioneer, Cuf 101 and Srivir under W_1, W_2, W_3 and W_4, respectively. The overall mean of this stage was 94.06 with CV 3.64%. In K_5, the largest values were 105 mg/100g for Higazi under W_1, 137 and 146 mg/100g for Cuf 101 under both W_2 and W_3 with overall mean 75.38

and CV 5.10%. In K_6, they were 142, 176 and 124 mg/100g scored by V_2 under W_1, V_1 under W_2 and both V_1 and V_2 under W_3 with overall mean 95.0 and CV 3.12%. The highest chlorophyll content in K_7, were 97 scored by V_1 under W_1, 122 for V_4 under W_2 and 45 mg/100g for V_1 under W_3 with overall mean 71.5 and CV 3.19% (Table 7). However, the concentration of chlorophyll in this crop was increased among varieties with the increase of water stress level due to the minimizing moisture in the plants. Under the four levels of water stress the highest values exceeded the overall mean. Pirzad *et al.*

(2011) reported that the irrigation had significant effects on the amount of total chlorophyll content which was reduced at high water stress when compared to better irrigated plants. In low water stress levels, chlorophyll a, b and total chlorophyll contents increased while increasing stress pressure where their values reduced to the lowest amount. The mentioned results were in agreement with these results confirming the increase in total chlorophyll in low water stress. In this study, the results were in agreement also with that of Abuswar (2013) and Oraki *et al.* (2012).

Table 7: Means of alfalfa varieties for Chlorophyll content/plant (mg/100g) evaluated at the Nursery of DRI after different water stress treatments during the period Feb. – July 2011

Treatment	K_4	K_5	K_6	K_7
V_1W_1	134.00	105.00	46.00	97.00
V_2W_1	78.00	41.00	142.00	41.00
V_3W_1	97.00	41.00	60.00	44.00
V_4W_1	78.00	60.00	105.00	65.00
V_1W_2	42.00	123.00	176.00	120.00
V_2W_2	111.00	96.00	42.00	99.00
V_3W_2	124.00	46.00	64.00	41.00
V_4W_2	60.00	137.00	51.00	122.00
V_1W_3	124.00	41.00	124.00	45.00
V_2W_3	64.00	41.00	124.00	41.00
V_3W_3	142.00	27.00	-	-
V_4W_3	176.00	146.00	111.00	-
V_1W_4	46.00	-	-	-
V_2W_4	105.00	-	-	-
V_3W_4	51.00	-	-	-
V_4W_4	73.00	-	-	-
Overall mean	94.06	75.38	95.00	71.50
CV%	3.64	5.10	3.12	3.19
LSD5%	4.89	5.49	4.24	3.25
LSD1%	13.21	14.81	11.44	8.79

- K_4 = after 15 days, K_5 = after 30 days, K_6 = after 45 days and K_7 = after 60 days from water stress.
- V_1 = Higazi, V_2 = Srivir, V_3 = Pioneer and V_4 = Cuf 101.
- W_1, W_2, W_3, W_4 = water stress treatments2, 5, 10 and 15 days intervals between irrigations.

For total available CHO after water stress, there were significant differences among varieties, water stresses and VxW interactions. In K_4, the higher values were 15.32% scored by Higazi under

W_1, 14.74% by Higazi under W_2, 19.20 by Pioneer under W_3 and 14.22% by Cuf 101 under W_4 with overall mean 13.16 and CV 3.41%. In K_5, highest values were 11.38% scored by Pioneer under W_1, 11.72% by Srivir under W_2 and

12.07 by Pioneer under W_3. The overall mean in this stage was 11.06 with CV 0.72%. In K_6, they were 12.25 for Cuf 101 under W_1, 12.49 for Higazi under W_2 and 20.30 for Pioneer under W_3 with overall mean 12.92 and CV 0.62%. In K_7, the largest amounts were 25.85 Higazi under W_1, 19.28 for Pioneer under W_2 and 11.03% scored by Srivir

under W_3 with overall mean 14.42 and CV 0.48% (Table 8). The highest values under the four levels of treatments exceeded the overall means in all growth stages. These findings, particularly in K_5, were in agreement with those of Abuswar (2013), Saeed and Elnadi (1997) and Oraki *et al.* (2012).

Table 8: Means of alfalfa varieties for total available CHO (%) evaluated at the Nursery of DRI after different water stress treatments during the period Feb. – July 2011

Treatment	K_4	K_5	K_6	K_7
V_1W_1	15.32	8.97	11.58	10.48
V_2W_1	12.87	10.69	11.32	25.85
V_3W_1	13.71	11.38	12.11	22.62
V_4W_1	12.10	10.69	12.25	11.69
V_1W_2	14.74	11.03	12.49	9.68
V_2W_2	12.82	11.38	11.84	10.89
V_3W_2	7.69	11.72	11.45	19.28
V_4W_2	8.97	11.72	12.11	13.53
V_1W_3	12.18	10.69	16.39	9.11
V_2W_3	19.20	11.72	20.30	11.03
V_3W_3	11.54	10.69	-	-
V_4W_3	13.78	12.07	10.26	-
V_1W_4	14.22	-	-	-
V_2W_4	11.69	-	-	-
V_3W_4	12.50	-	-	-
V_4W_4	17.17	-	-	-
Overall mean	13.16	11.06	12.92	14.42
CV%	3.41	0.72	0.62	0.48
LSD5%	0.64	0.11	0.12	0.10
LSD1%	1.73	0.31	0.31	0.27

- **V_1** = Higazi, **V_2** = Srivir, **V_3** = Pioneer and **V_4** = Cuf 101.
- **W_1, W_2, W_3, W_4** = water stress treatments2, 5, 10 and 15 days intervals between irrigations.
- - =dead plants.

Conclusions
Based on this study, it could be concluded that there were significant differences among the four varieties for all characters before subjecting to water stress except dry matter (%). After starting water stress, there were significant differences revealed among the investigated varieties, water stress levels and the interactions between them for most characters. Moreover, the undertaken varieties responded in

different levels to water stress treatments. When water stress treatment was increased all the characters seemed to be increased. The values of each variety were increased with increase of pants age. The highest values of each variety under the different levels of water stress exceeded the overall mean in all growth stages after starting treatments. Pioneer out scored for dry mater, Pioneer and Cuf 101 lead the varieties for protein content, Cuf 101 for

chlorophyll content and Srivir for available sugar content.

References

Abuswar, F.M.S. (2013). *Effect of Water Stress on some Morphological and Physiological Traits in Four Varieties of Alfalfa*. M. Sc. thesis, Desertification Science Programme, Sudan Academy of Sciences, Sudan.

Akmal, M., Farid, U., Asim, M., Farhatullah and Raziuddin, (2011). Crop growth in early spring and radiation use efficiency in alfalfa. *Pakistan Journal of Botany,* **43**(1): 635-641.

AOAC (1970). *Official Methods of Analysis, Association of Official Analysis Chemists*. 11th ed., 769. Washington DC.

Ashrafuzzaman, M., Rafiqul, M.D., Ialam, R., Mohd. Ismail, R., Shahidullah, S.M. and Hanafi, M. M. (2009). Evaluation of six aromatic rice varieties for yield and yield contributing characters. *International Journal of Agriculture & Biology* **11**(5): 616-620.

Berrada, A. (2005). Alfalfa response to water deficit using subsurface drip irrigation. *Agricultural Experiment Station. https://docs.google.com*

Erice, G., Louahlia, S., Irigoyenc, J. J., Sanchez D.M. and Avicea, J. (2010). Biomass partitioning, morphology and water status of four alfalfa genotypes submitted to progressive drought and subsequent recovery. *Journal of Plant Physiology* **167**: 114-120.

Evenhuis, B., and De Waard, P.W. (1980). Principle and practices in plant analysis *F.A.O. Soil Bulletin*. **38**(1): 152-163.

Faridullah, A.A., Yamamoto, S., Khan, N. and Honna, T. (2009). Screening for agronomic performance of six indigenous cultivars of alfalfa (*Medicago sativa*) at Karina Northern areas of Pakistan. *Electronic Journal of Environmental, Agricultural and Food Chemistry,* **8** (10): 950-968.

Ghorttapeh, A.H., Taherifard, E. and Gerami, F. (2012). Energy efficiency in alfalfa (*Medicago sativa* L.) production system in North West of Iran (Case study: Mahabad city). *Annals of Biological Research* **3**(5): 2469-2473.

Gomez, K. A. and Gomez, A. A. (1984). *Statistical Procedures for Agricultural Research*. John Wiley and Sons. New York.

Hamidi, H. and Safarnejad, A. (2010). Effect of drought stress on alfalfa cultivars (*Medicago sativa* L.) in germination stage. *American-Eurasian Journal of Journal of Agriculture and Environmental Sciences,* **8**(6): 705-709.

Katic, S., Milic D., Karagic, D., Vasiljevic, S., Glamocic, D. and Jajic, I. (2009). Variation of protein, cellulose and mineral contents of lucerne as influenced by cultivar and cut. *Biotechnology in Animal Husbandry,* **25**(5-6): 1189-1195.

Milic, D., Karagic, D., Vasiljevic, S. D. A., Mikic, B. Mikic, A., Mijic, B. and Katic, S. (2011). Leaf and stem chemical composition of divergent alfalfa cultivars. *Biotechnology in*

Animal Husbandry, **27**(4): 1505-1511.

Oraki**,** H., Khajani, F.P. and Aghaalikhana, M. (2012). Effect of water deficit stress on proline contents, soluble sugars, chlorophyll and grain yield of sunflower (*Helianthus annuus* L.) hybrids. *Africa Journal of Biotechnology* **11**(1):164-168.

Passero**,** K. N. D. (2003). Alfalfa Tea Benefits. *www.webcache. Gooleusercontent.com.*

Pirzad**,** A., Shakiba, M.R., Zehtab, S.S., Mohammadi, S.A., Darvishzadeh, R. and Samadi, A. (2011). Effect of water stress on leaf relative water content, chlorophyll, proline and soluble carbohydrates in *Matricaria chamomilla* L. *Journal of Medicinal Plants Research* **5**(12): 2483-2488.

Riccardi**,** F., Gazeau, P., de Vienne, D. and Zivy, M. (1998). Protein change in response to progressive water deficit in maize. *Plant Physiology* **117**(4)1253-1263.

Saeed**,** I. A. M. and Elnadi, A. H. (1997). Irrigation effects on growth, yield, and water use efficiency of alfalfa. *Irrigation Science*，**17**: 63-68.

Samuel**,** Y.S., Wayne, W.X., Tuesdays, M., Lamb, J.A.F., Jung, H.J.G., Bosch, K.A.V., Pvance, C. and Gronwald, J.W. (2010). Transcript profiling of two alfalfa genotypes with contrasting cell wall composition in stem using across-species platform: optimizing analysis by making biased probes. *webcache.gooleuser content.com*

Slama**,** I., Tayachi, S., Jdey, A., Rouached, A. and Abdelly, C. (2011). Differential response to water deficit stress in alfalfa (*Medicago sativa*) cultivars: growth, water relations, osmolyte accumulation and lipid peroxidation. *African Journal of Biotechnology* **10** (72): 16250-16259.

تأثير الإجهاد المائي علي بعض الصفات الفسيولوجية في أربعة أصناف من البرسيم
(*Medicago sativa* **L.**)

هاشم عوض الكريم فضل الله[1] و فائزة محمد سيد احمد ابوسوار[2]

1 . معهد ابحاث البيئة والموارد الطبيعية والتصحر، المركز القومي للبحوث، ص ب: 6096 الخرطوم، السودان

2. كلية التربية، جامعة كسلا، كسلا، السودان.

المستخلص:

تم تقويم أربعة أصناف من محصول البرسيم (.*Medicago sativa* L) لدراسة تاثير الاجهاد المائي علي اداء النباتات فسيولوجيا. الاصناف هي: Higazi، Srivir، Pioneer و Cuf 101. تم تنفيذ التجربة خلال خمسة شهور من فبراير حتي يوليو من عام 2011م. . أستخدمت التجربة العاملية مع التصميم ذو القطاعات كاملة العشوائيه باربع مكررات لتنفيذ التجربة علي أصص فخارية وذلك بمشتل معهد أبحاث التصحر، للمركز القومي للبحوث. أستخدمت اربعة مستويات من الاجهاد المائي هي: يومين كشاهد (W_1)، خمسة ايام (W_2)، عشرة ايام (W_3) وخمسة عشر يوما (W_4) بين كل ريتين. قسمت الدراسة الي مرحاتين هما مرحلة ما قبل ومرحلة ما بعد تطبيق الإجهاد المائي. جمعت البيانات علي صفات النسبة المئوية للوزن الجاف/الرطب، محتوي البروتين/نبات،، محتوي الكلوروفيل (ملجرام/100 جرام) وكمية السكريات المتاحة (%). جمعت البيانات ثلاث مرات قبل تنفيذ الاجهاد هي: عند ظهور الورقة الثالثة (K_1)، بعد 45 يوم من الزراعة (K_2) وبعد 70 يوم من الزراعة (K_3) واربعة مرات بعد تطبيق الاجهاد هي: بعد 15 يوم (K_4)، 30 يوم (K_5)، 45 يوم (K_6) و60 يوم (K_7) من الاجهاد. أوضحت النتائج في مرحلة ما قبل تطبيق الاجهاد المائي وجود فروق معنوية عالية لصفات محتوي البروتين، محتوي الكلوروفيل وكمية السكريات في الثلاث قراءات (K_1, K_2 and K_3). في مرحلة ما بعد تطبيق الاجهاد المائي، معظم أصناف البرسيم قاومت الاجهاد المائي تحت مستويات خمسة ايام (W_2) وعشرة ايام (W_3). الجدير بالذكر أن نمو النباتات تذبذب بين التحسن و التدهورمع زيادة مستوي الاجهاد المائي لكل الصفات. الصنفين Higazi وSrivir ظهرا كأفضل صنفين لمقاومة الاجهاد المائي مقارنة ببقية الاصناف تحت الدراسة. تفوق الصنف Higazi في صفات كمية السكريات المتاحة عند W_2 و محتوي البروتين عند W_3، بينما تفوق الصنف Srivir في صفات كمية السكريات المتاحة عند W_3. الصنف Cuf 101 تفوق في صفات محتوي الكلوروفيل ونسبة الوزن الجاف/رطب % عند W_2 وW_3. اكبر قيمة لمحتوي البروتين ظهرت للصنف Pioneer عند W_2.