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Impact of Water Deficit on Growth and Yield Performance of Two Sesame Varieties (*Sesamum indicum* L.) at Eastern Sudan

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ABSTRACT: A field experiment was conducted during summer season of 2022 on Demonstration Farm of the Faculty of Agriculture, University of Kassala, New Halfa, to study the effect of water stress on the performance of two sesame varieties namely umm shagara (V1) and Bromo(V2). The split plot experiment was carried out in a RCBD with three replicates. The water stress treatments were: irrigation (repeated) every two weeks, skipping an irrigation at the flowering stage, skipping an irrigation at the seed filling stage. The results showed that, water stress treatments led to a significant decrease in leaf area, and dry weight, which was reflected in a significant decrease in productivity and its components, and harvest index. While the (V1) was significantly superior in the leaf area, dry weight, number of pods, seeds weight per plant, the highest weight of 1000 seeds, and seed productivity compared to the (V2) which was superior in harvest index. The W1 × V1 intervention treatment led to a significant increase in the leaf area and dry weight of the plant. While W3 × V2 treatment recorded the highest relative moisture content(RWC). However, V1 under W1 is considered better for growing sesame in the New Halfa area, although the V2 has the ability to maintain the RWC under the conditions of the New Halfa area.

KEYWORDS: Sesame; water deficit; variety, leaf area, yield and RWC.

I. INTRODUCTION

Sesame (*Sesamum indicum* L., Family Pedaliaceae), also known as gingelly, beni or benne, is one of the most ancient oil crops grown mainly in dry regions of the world[1]. Sesame is the most conventional oilseed crop cultivated for its edible oil in the sub-continent. Sesame is known as the king of oil seeds due to the high oil content (50% - 60%) of its seed[2]. Many researchers reported the effects of drought on sesame plant growth yield and yield components [3-5]. In this regard,[6] stated that, water stress in sesame reduce yield by 28% and negatively affect yield attributing traits. However, water stress at flowering results in a considerable reduction in capsule production up to 90% [7]. On the other hand, [8,9]reported that sesame varieties were significantly different in growth characteristics. Also, [10] reported that, the plant height, high capsule number per plant and seeds number per capsule, number of seeds per capsule varied significantly due to varieties. Information regarding the effect of normally irrigated and water deficit environment on seed yield and yield component and of sesame is scanty. Also, the major problems facing production of sesame in Sudan are lack of adequate information about the crop under Sudan condition, distribution and s water stress at phenological stages, and high yielding cultivars. Therefore the objective of this study was to: Investigate the effects of water stress at flowering and seed-filling on yield and attributing traits of three sesame genotypes.

II. METHODOLOGY

This field experiment was conducted during the summer season of 2022 AD at the Demonstration Farm of the Faculty of Agriculture and Natural Resources, University of Kassala, in New Halfa, between latitudes 15° 18' - 15° 21' N and longitudes 35° 36' - 35° 37' E. The experiment was designed to study the effect of water stress (W1,W2,W3), where plants are irrigated every two weeks (W1), skipping irrigating plants at the flowering period (W2), and skipping irrigating plants during the grain-filling period (W3) for two varieties of sesame umm shagara (V1) and Promo(V2). The split plot experiment was carried out with three replications in a randomized complete block design (RCBD), where the main plots were allocated to water stress, while the sub-plots were allocated to the variety type. When the

crop reached the flowering stage and after applying stress treatments, ten plants were randomly selected from the two middle ridges to take following growth measurements and productivity components:- Leaf area (cm²), Plant dry weight (g) and Relative water content (RWC), The number of pods of the plant, pod Length (cm), Weight of seeds per plant (g), Weight of 1000 seeds (g) seed yield (kg/ha) and harvest index (HI). The data were statistically analyzed using a computer program (Statistix 10) for the split plot experiment according to a complete randomized block design, and then the averages were compared using the Duncan method at a significance level of 0.05.

III. RESULTS AND DISCUSSION

Analysis of variance showed significant differences for irrigation treatments (W), cultivar (V), and the interaction between them (V) × (W) on leaf area, plant dry weight, and relative water content. In this regard, water stress at the flowering period (W2) and the seed filling period (W3) led to a significant decrease in leaf area and plant dry weight compared to repeated irrigation W1 (Table 1), the Bromo variety (V2) recorded the lowest leaf area compared to the Umm Shajara variety (V1). The lowest leaf area was recorded for the V2 (×W3) treatment when the Bromo variety was grown under water stress during the seed filling period on contrast, the Bromo variety (V2) recorded the lowest dry weight of the plant particularly under water stress at seeds filling period. While the highest leaf area was recorded with the (V1×W1) treatment when the Umm Shajara variety was planted with W1 repeated irrigation (Table1). The highest relative moisture content (RWC) for the interaction treatment between water stress and the variety was recorded for the (V2×W3) treatment for growing the Bromo variety under water stress during the seed-filling period, while the lowest moisture content was recorded for the (V1×W3) treatment for growing the Umm Shagara variety under water stress during the seed-filling period (Table 1).

Water stress represents a problem for plant growth and development because it limits access to the resources needed for photosynthesis due to the closure of stomata and reduced water transport within the plant. In contrast, the availability of moisture for the plant increases the absorption of nutrients and their transfer within the plant, thus increasing the process of photosynthesis, which in turn leads to increased deposition of dry matter, which increases plant growth, as well as increasing cell filling and expansion by increasing their size and multiplying their numbers. This explains the increase seen in growth and productivity measurements. In this study, as a result of the availability of appropriate moisture when irrigating the plants periodically, as well as the lack of irrigation during the flowering period and seed filling, leads to a deficiency in these characteristics. In this study, repeated irrigation (W1) led to a significant increase in dry weight, and leaf area as a result of the availability of moisture in the root area, which leads to a high absorption of water and nutrients in the soil, and this increases the metabolism process and photosynthesis, especially when there is a large leaf area that absorbs the incident rays, which leads to the formation of a lot of dry matter and thus increases the dry weight of the plant. The results of a previous study by [11] support the effect of irrigation on sesame plants, as they reported that repeated irrigation led to a significant increase in vegetative growth measurements (plant length, number of leaves per plant, leaf area, and dry weight) compared to spaced irrigation (water stress). [12] also mentioned that in cases of water deficiency at the vegetative growth and flowering stages, it leads to a decrease in cell size expansion, proliferation, and differentiation, which leads to a deficiency in vegetative growth measurements. In this study, water stress at the seed filling stage (W3) led to a significant increase in the relative moisture content (RWC), especially in the variety (V2). This indicates the response of sesame plants to resistance to water stress by regulating the water loss process by activating physiological processes to maintain cell filling and ability to retain cells. With water, as mentioned by [13,14]. The Umm Shagara (V1) variety was distinguished by its shorter length, its branches closer to the surface of the earth, and its shorter distance from the ground's surface compared to the Bromo variety. The Umm Shagara (V1) variety was also distinguished by a greater leaf area, and a dry weight. This may be explained by the fact that this variety has adapted to environmental conditions. The environmental conditions of the New Halfa area are somewhat similar. In this regard, [15,9] reported that the cultivar difference significantly affects growth measurements. Recently, researchers [16,10] reported that they observed significant differences in growth measurements between sesame varieties.

Moreover, results showed that, there were significant differences for water stress treatments (w) and cultivar (v) on the number of pods per plant, Seed weight per plant (g), 1000-seed weight, seed yield (kg/ha) and HI. Water stress during the flowering period (W2) and the seed filling period (W3) led to a significant decrease in the aforementioned traits (Table 2). Also, the Umm Shagara variety (V1) recorded the highest number of pods on the plant compared to the Bromo variety (V2). The Bromo variety (V2) gave the lowest seed weight per plant and 1000 seeds weight compared to the Umm Shagara variety (V1). Although there were no significant differences for water stress treatments and the

variety, the highest seed weight in the plant was found for the (V1×W1) treatment for planting the variety Umm Shagara with full irrigation. Analysis of variance showed that there were significant differences for water stress (W) and cultivar (V) treatments and their interaction on seed productivity per unit area and HI. Water stress at flowering (W2) and seed filling (W3) led to a significant decrease in productivity and HI compared to the repeated irrigation W1 (Table 2), the Bromo variety (V2) recorded the lowest seed yield (kg/ha) and HI compared to the Umm Shajara variety (V1). The highest productivity was recorded for the overlap treatment (V1×W1) for planting the Umm Shagara variety under repeated irrigation, while the lowest productivity was recorded for the (V1 V2×W3) by growing the Bromo variety under water stress during the seed filling period (Table 2).

A study conducted by [7] indicated that water stress at the flowering stage causes a significant decrease in the productivity of pods and seeds of the sesame crop, and this explains the severe decrease in productivity in this study. In this study, the significant decrease in all yield components measurements (number of pods per plant, weight of seeds /plant, and weight of a thousand seeds) as a result of water stress during the flowering and seed filling periods can be attributed to the severe decrease in leaf area and dry weight as a result of the effect of water stress, which leads to the lack of productivity components of the sesame crop and thus led to a severe reduction in seed yield per unit area. [11] mentioned that water stress leads to a decrease in the number of pods in the plant, the weight of seeds in the plant, seed productivity, and harvest index.[17] also reported that, there is a significant direct correlation between the components of productivity, leaf area, and biological weight with seed productivity and harvest index of sesame plants under water stress. In this study, it was found that there was a significant superiority of the Umm Shagara variety in productivity traits: number of branches and pods, number of seeds and their weight per plant, weight of a thousand seeds, and seed productivity per unit area. This may be due to the superiority of the same variety in growth measurements (leaf area and dry weight per plant), which led to an increase in these traits. Also, the positive significant correlation between the productivity components and both leaf area and dry weight supports this interpretation. Especially the number of seeds per plant, because the number of seeds per plant is considered a very important characteristic of the productivity component that determines the complete productivity of sesame varieties in field conditions because this characteristic is directly affected by the biological weight of the plant. The results of this study are supported by the results of studies conducted by [19,10,17,18], who reported that the difference leads to a difference in the number of pods/plant, the seeds weight per plant, and seed productivity per unit area. Just as the superiority of a variety of Umm Shagara in harvest index is due to its superiority in the weight of seeds per plant.[20] concluded that, pods per plant and thousand seed weight may be most determinant and crucial agronomic traits in developing high yielding sesame varieties. In conclusion, growing a particular Umm Shagara variety under frequent irrigation is considered better for the farmers of the study area because of its superiority in productivity characteristics.

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Table(1): Mean of Leaf area (cm²), Plant dry weight(g) and relative water content RWC% as affected by water stress and sesame varieties

Treatments	Leaf area (cm ²)	Plant dry weight(g)	RWC%
W1	4467.8	150.83	77.00
W2	3773.1	136.25	76.50
W3	3300.8	115.00	75.83
LSD _{0.05}	611.24	4.73	-
V1	4003.0	158.11	75.78
V2	3691.4	109.94	77.11
LSD _{0.05}	292.63	6.16	
W1V1	4617.1	176.83	79.67
W1V2	4318.5	124.83	74.33

W2V1	3755.8	164.17	76.67
W2V2	3790.3	108.33	76.33
W3V1	3636.1	133.33	71.00
W3V2	2965.5	96.67	80.67
LSD _{0.05}	-	10.66	3.47

Table(2): Means of number of pods/plant, seed weight/plant(g), 1000-seed weight(g), seed yield(kg/ha) and harvest index(HI) as affected by water stress and sesame varieties

Treatments	Pods No/plant	Seed weight/plant	1000-seedweight	Seed yield (kg/ha)	HI
W1	50.58	10.20	364.33	2030.1	30.28
W2	41.22	9.00	351.00	1907.6	25.70
W3	37.83	7.50	321.00	1744.6	21.89
LSD _{0.05}	8.26	1.58	11.62	100.43	1.22
V1	47.62	9.61	352.89	1951.2	27.34
V2	38.80	8.19	338.00	1837.0	24.58
LSD _{0.05}	4.19	1.04	9.58	70.02	2.76
W1V1	53.37	11.00	378.00	2154.4	32.67
W1V2	47.80	9.40	350.67	1905.8	27.89
W2V1	47.43	9.83	356.00	1934.8	25.86
W2V2	35.00	8.17	346.00	1880.4	25.54
W3V1	42.07	8.00	324.67	1764.5	23.47
W3V2	33.60	7.00	317.33	1724.6	20.31
LSD _{0.05}	-	-	-	121.28	-



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