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Effect of Watering Frequency on Growth and Physiological Response of Okra

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ABSTRACT

This research investigated the effect of watering frequency on the growth and physiological responses of okra varieties (Clemson Spineless and Raining Season Okra). The watering regimes were daily watering, watering three days a week and watering once a week. The effect of watering frequency on different parameters such as plant height, number of leaves, relative water content and chlorophyll test was investigated. There was an effect on the relative water content of the plant as watering daily recorded the highest (93%) and watering once a week recorded the lowest (88%) for Clemson Spineless okra variety while, Raining Season Okra variety watered weekly recorded the highest (85%) and the one watered three days a week had the lowest (66%), chlorophyll content also showed a difference as Clemson Spineless variety had the highest amount of chlorophyll (39.0µmolm^{-2}) when watered once a week and the lowest (30.4µmolm^{-2}) when watered three days in a week while, Raining Season Okra variety had the highest (43.9µmolm^{-2}) for daily watering and the lowest (35.1µmolm^{-2}) watered three days a week. Statistical analysis (ANOVA) indicated that there was no significant difference in plant height and number of leaves at 30, 36, 42 and 48 days after planting between regimes and among all varieties. This shows that watering frequency affects the morphological and physiological characteristics of the plant. Further research should be carried out by Agronomist to ascertain the effect of watering frequency on sowing rates of rates of okra and daily or weekly irrigation of okra should be practiced by farmers.

Keywords: Effect, Watering Frequency, Okra Growth.

INTRODUCTION

Water is an important natural resource that supports life and growth of plants, but there is a growing concern on water availability. With the effects of climate change, water will become

increasingly scarce in most geographical zones of the world. Availability of permanent water supply has been one of the major challenges, especially in the drier regions of the tropics and sub-tropics [1]. Water supply is a major constraint to crop production. With the effect of global warming causing weakening of water resources, drought, desertification and ecological degradation, arid and semi-arid areas of the world have been expanding continuously [2].

Okra (*Abelmoschusesculentus L.*) is an annual vegetable crop, belonging to the Malvaceae family [3]. It is widely cultivated in the tropics for its young fresh leaves and fruits [4]. It requires warm growing condition and is sold in almost every market all over Africa [5]. In Nigeria it is produced predominantly by peasant farmers' usually in home gardens or in mixture with other cereal crops [6]. It is been considered as a marginal crop mostly used in traditional cooking particularly in rural areas but of recent times it is used in dietary habits of urban dwellers [7]. The economic importance of okra cannot be overemphasized, as all parts of the okra plant is useful, it leaves and tender shoots are equally rich in nutrients, the pods are either consumed in fresh or dried form [8]. Okra seeds are also used as protein source can also be dried and used as alternative for coffee in some Asian and African countries. Okra units contain adhesive in which is contained a blend of pectin and sugar that is utilized as a thickener [9]. Like other field crops, Okra is also faced with the problem of short supply of irrigation water [10].

The production and economic importance of okra as a vegetable in Nigeria has rapidly increased in recent years. Different varieties are used by farmers in order to meet the demand of okra by consumers[5]. Okra is a vegetable crop that is a good source of vitamins, proteins and carbohydrate [11]. The seasonal supply of this vegetable to a large extent affects how much of it is consumed by majority of the people [5]. In Nigeria, there are two distinct seasons for okra production the dry and the raining seasons, during the dry season, okra fruit are produced in low quantities, scarce and expensive to get [8]. However, cultivation of okra faces several constraints and the main one is the lack of rainfall which limits severally potential production of different varieties [7]. This study is carried out with the aim of evaluating the effect of watering frequency on the growth and physiological responses of okra plant.

MATERIAL AND METHOD

Study Area

This study was carried out at the Biological science screen house Benue State University Makurdi, located at the Biological science Laboratory. The site is located at latitude 7°41'N and longitude 8°35'E at an elevation of about 205 meters above the sea level. The location, falls within the Southern Guinea Savanna, Agro-ecological Zone of Nigeria.

Materials

Seeds of okra varieties Clemson Spineless from Agro-stores located at high –level, Makurdi, Benue State and a local variety of the Raining Season Okra from Wurukum Market, Makurdi, Benue State, were used other materials used for this research included: planting bags/pots, ruler, screen house, sandy-loam soil, organic fertilizer (poultry manure), oven, electronic weighing balance, chlorophyll meter (SPAD).

Experimental Design

The experiment was a potted experiment conducted in a screen house and the experimental design was laid out in a 3 × 2 factorial in completely randomized design (CRD) having two (2) varieties, three (3) treatments and was replicated four (4) times.

Treatments

Treatment was started seven (7) days after planting (DAP) and included: Daily application of water, application of water three days in a week and application of water once in a week.

Experimental Procedures

Prior to planting, sandy – loam soil was collected from a farm located at the Benue State University, Makurdi, behind the ultra-modern hostel. The sands where packed into 72 planting pots, application of organic fertilizer (Poultry manure) was carried out three days before planting, seed were also soaked two days before planting and this was done to speed up germination and to check for seed viability. Four (4) plants were planted per pot which was later thinned to two (2) per pot leaving a total of 144 plants. After planting the seeds were watered until seven (7) days after germination and were subjected to watering regimes of daily water, watering three days in a week and watering once a week and this was done ten (10) weeks.

Data Collection

Determination of plant growth traits

Plant height was taken from the soil surface level until the first internodes located at the top of plant shoots using measuring tape. The number of leaves was measured by counting each leaf on the plant. The data where measured every six (6) days for 4 weeks.

Relative Water Content

The fourth leaf from top (fully expanded young leaf) of the plants representing each treatment was harvested and weighed to determine their fresh weight (FW). The leaves were submerged separately in distilled water for 24 hours in the dark, removed and the water mopped dry using an absorbent and weighed to get the Turgid weight (TW). The leaves were placed in paper bags and dried in an oven at 65 °C for 72 hours and then weighed to get the dry weight (DW). Relative water Content was calculated as follows:

$$\text{RWC (\%)} = \frac{(\text{FW}-\text{DW})}{(\text{TW}-\text{DW})} \times 100$$

Where, FW, DW and TW are fresh weight, dry weight, and turgid weight, respectively.

Determination of total chlorophyll content (SPAD)

The chlorophyll content of the okra leaves was measured by "Konica Minolta SPAD – 502" portable chlorophyll – meter. Readings were taken from four leaves of each replication at each treatment.

Data Analysis

Data were subjected to Analysis of Variance (ANOVA) after which mean that showed significant f-test value was separated by least significant difference at 5% level of probability.

RESULTS

The result of the effects of watering frequency on plant height of okra, are summarized in Tables 1 and 2. Table 1 shows the plant height With regards to the varieties, at 30 days after planting the two varieties varied in height with the variety Clemson Spineless being the tallest 33.03cm and Raining Season Okra variety the shortest with a height of 10.99cm at 36 days after planting there was also a difference in their height as Clemson Spineless variety remained the highest with a plant height of 37.62cm and Raining Season Okra variety had the shortest height of 16.88cm, 42 days after planting Clemson Spineless still had the highest height of 44.08cm and the Raining Season Okra variety had the least plant height of 20.99cm, at 48 days after planting Clemson Spineless did better with a plant height of 47.53cm and the Raining Season okra variety had the shortest plant height of 30.49cm at 48 days after planting. Watering frequency significantly ($P > 0.05$) had an effect on the plant height of both varieties as Clemson Spineless did better than the Raining Season Variety. The Mean separation was also significantly different. When considering the watering regimes, we found that at 30 days after planting the plants that were watered daily had the highest plant height of 24.01cm, followed by the plants that were

watered once a week which had a plant height of 21.57cm, the plants watered three days in a week had the shortest height of 20.44cm, at 36 days after planting the plants watered daily still had the highest plant height followed by the plants watered three days in a week which had the plant height of 27.42cm, and the plants watered once a week became the shortest with a plant height of 23.93cm. at 42 days after planting there was still an increase in height as the plants watered daily remained the tallest with a plant height of 38.04cm and the plants watered once a week with the shortest height of 28.98cm. The plant had the highest plant height of (41.47cm) for daily watering at 48 days after planting and the lowest plant height (37.23cm) for plants watered once a week. There was a significant difference at 36 and 42 days after planting ($P < 0.05$, $F = 0.038, 0.005$, LSD = 6.282, 7.267) and no significant difference at 30 and 48 days after planting ($P > 0.05$, $F = 0.374, 0.399$, LSD = No significant difference in population mean).

Table 1: Plant Height

Variety	**30**	**36**	**42**	**48**	**(Days)**
Clemson Spineless	33.03	37.62	44.08	47.53	
Raining Season Okra	10.99	16.88	20.99	30.49	
F	443.345	324.893	237.181	58.541	
P-value	0.000	0.000	0.000	0.000	
LSD (0.05)	2.901	3.190	4.156	6.176	
Watering Regimes					
Daily watering	24.01	30.40	38.04	41.47	
Watering three days a week	20.44	27.42	30.57	38.33	
Watering once a week	21.57	23.93	28.98	37.23	
F	0.991	3.336	5.571	0.925	
P-value	0.374	0.038	0.005	0.399	
LSD (0.05)	NS	6.282	7.267	NS	

NS – No significant difference (p>0.05)

Table 2: Plant Height Treatment Interaction

Variety	Watering Regimes	30	36	42	48	(Days)
Clemson Spineless	Daily Watering	37.88	43.98	53.15	58.38	
	Watering three days in a week	28.60	35.48	40.10	42.08	
	Watering once a week	32.60	33.40	38.98	42.15	
Raining Season Okra	Daily Watering	10.15	16.81	22.94	24.56	
	Watering three days in a week	12.27	19.35	21.04	34.58	
	Watering once a week	10.54	14.46	18.98	32.31	
	F	0.026	0.093	0.168	0.045	
	P-value	0.974	0.914	0.853	0.957	
	LSD (0.05)	NS	NS	NS	NS	

NS – No significant difference (p>0.05)

Table 2 shows the plant height treatment interaction and it was noted that plant height of Clemson Spineless Variety at 30 days after planting had the highest plant height of 37.88cm when it was watered daily while the Raining Season Okra variety had the highest plant height of 12.27cm when watered three days in a week. At 36 and 42 days after planting in the Clemson Spineless variety, the plants watered daily still maintained the highest plant height of 43.98cm and 53.15cm followed by the plants watered three days a week which had the plant height of 35.48cm and 40.10cm while, the plants watered once a week had the shortest height of 33.40cm and 38.98cm respectively. The Raining Season Okra variety at 36 days after planting had the highest plant height of 19.35cm and the shortest plant height of 14.46cm when watered once a week as compared to 42 days after planting where it had the highest plant height of 22.94cm when watered daily followed by a height of 21.04cm when watered three days in a week and a height of 18.98cm when watered once. Clemson Spineless had the highest plant height of 58.38 cm at 48 days after planting for daily watering and the lowest 42.08 cm when the plants were watered three days in a week. The Raining Season variety had the highest plant height of 34.58 cm when watered three days in a week and had the lowest plant height of 24.56cm when watered daily. However, the analysis of variance At 30, 36, 42 and 48 days after planting showed no significant difference ($P > 0.05$, $f = 0.026, 0.093, 0.168, 0.045$, LSD = No significant difference between the population mean) in the plant height between watering regimes and among varieties.The number of leaves where significantly ($P < 0.05$, 0.000, 0.000, 0.000, 0.000, $F = 126.880, 130.841, 110.350, 35.946$, LSD = 0.872, 0.892, 0.931, 1.271) affected by the varieties as the Clemson Spineless variety had the highest number of leaves at 30, 36, 42 and the overall highest of 10.17cm at 48 days after planting while Raining Season Okra had the lowest at 30, 36, 42 and the lowest of 7.42 at 48 days after planting. In the watering regimes the plants watered

three days in a week had the highest number of leaves of 6.75 followed by the plants watered once a week 6.69 and then the plants watered daily had the least number of leaves of 6.63, at 36 and 42 days after planting the plants watered daily had the highest number of leaves of 7.83 and 8.63 followed by the plants watered three days in a week 7.63 and 8.44 with the plants watered once a week having the least number of leaves of 7.60 and 7.85 at 48 days after planting the plants watered once a week did better having the highest number of leaves of 8.92 followed by the plants watered three days in a week 8.79 and the plants watered daily performed less with the least number of leaves 8.67. However, the watering regimes had no significant difference on the number of plant leaves (P > 0.05, F = 0.028, 0.107, 1.084, 1.084, LSD = No significant difference in mean population) as shown in Table 3.

Table 3: Number of Leaves

Variety	**30**	**36**	**42**	**48**	**(Days)**
Clemson Spineless	8.46	9.53	10.07	10.17	
Raining Season Okra	4.92	5.85	6.54	7.42	
F	126.880	130.841	110.350	35.946	
P-value	0.000	0.000	0.000	0.000	
LSD (0.05)	0.872	0.892	0.931	1.271	
Watering Regimes					
Daily Watering	6.63	7.83	8.63	8.67	
Watering three days in a week	6.75	7.63	8.44	8.79	
Watering once a week	6.69	7.60	7.85	8.92	
F	0.028	0.107	1.084	1.084	
P-value	0.973	0.899	0.341	0.341	
LSD (0.05)	NS	NS	NS	NS	

NS – No significant difference (p>0.05)

Interactive effect between the okra varieties and watering regimes were not significant (P > 0.05, F = 0.001, 0.005, 0.051, 0.007, LSD = No significant difference) as shown in table 4. However, at 30 and 36 days after planting Clemson Spineless variety had the highest number of leaves of 8.63 and 10.00 plant leaf when it was watered daily followed by 8.38 and 9.29 plant leaf for both watering once a week and watering three days in a week. At 42 days after planting it had the highest number of leaves 10.63 plant leaf when watered daily followed by 9.83 plant leaf when watered three days in a week, with the least number of leaves of 9.75 plant leaf when watered once a week, and at 48 days after planting it maintained the total number of leaves of 10.63 plant leaf when watered daily followed by 10.29 plant leaf when watered once a week and the least number of leaves of 9.58 plant leaf when it was watered three days in a week. While, the Raining Season Okra variety at 30 days after planting had the highest number of leaves of 5.13 plant leaf when watered three days in a week, followed by 5 plant leaf when watered once a

week and the least number of leaves of 4.63 plant leaf when watered daily. At 36 days after planting it had the highest number of leaves of 5.96 plant leaf when it was watered three days in a week, followed by 5.92 plant leaf when watered once a week and the least number of leaves of 5.67 plant leaf when it was watered daily. At 42 days after planting the plants watered three days in a week had the highest number of leaves of 7.04 plant leaf, followed by the plants watered daily 6.63 plant leaf, and the plants watered once a week had the least number of leaves of 5.96 plant leaf. At 48 days after planting the plants watered three days in a week performed better having a total number of leaves of 8.00 plant leaf, followed by the plants watered once a week 7.54plant leaf and the least number of leaves occurred in the plants watered daily 6.71 plant leaf. This is shown in Table 4.

Table 4: Number of Leaves Treatment Interaction

Variety	Watering Regimes	30	36	42	48	(Days)
Clemson Spineless	Daily Watering	8.63	10.00	10.63	10.63	
	Watering three days in a week	8.38	9.29	9.83	9.58	
	Watering once a week	8.38	9.29	9.75	10.29	
Raining Season Okra	Daily Watering	4.63	5.67	6.63	6.71	
	Watering three days in a week	5.13	5.96	7.04	8.00	
	Watering once a week	5	5.917	5.958	7.542	
	F	0.001	0.005	0.051	0.007	
	P-value	0.999	0.995	0.951	0.993	
	LSD (0.05)	NS	NS	NS	NS	

NS – No significant difference (p>0.05)

The biomass production of okra in different varieties following three watering regimes are shown in Table 5. The results showed that the highest mean fresh leaf weight occurred in Clemson Spineless Variety at watering once a week (6.53g). The least value for fresh leaf weight occurred at daily watering (5.05g). For the Turgid weight, the highest mean value occurred in watering once a week (7.20g). The least Turgid weight occurred at daily watering. For the dry leaf weight, the highest mean value occurred at watering once a week (1.78g). The least occurred at watering three days a week (1.08g).For the Raining Season Variety the fresh leaf weight was highest for watering daily (6.93g). The least value for fresh leaf weight occurred at watering three days in a week (5.68g). For the Turgid weight, the highest mean value occurred in daily watering (8.43g). The least Turgid weight occurred at watering once a week (7.30). For the dry leaf weight, the highest mean value occurred at watering three days in a week (2.25g). The

least occurred at watering daily (1.83g). Statistical analyses ($P < 0.05$, F = 0.473, 0.046, 0.307, LSD = No significant difference) showed that there were no significant differences in the fresh, turgid and dry leaf weights of okra for the different watering regimes.

Table 5: Biomass Production

	FRESH WEIGHT	TURGID WEIGHT	DRY WEIGHT
VARIETY ONE (CLEMSON SPINELESS)			
Daily watering	5.05	5.3	1.18
Watering three days in a week	5.93	6.5	1.08
Watering once a week	6.53	7.2	1.78
VARIETY TWO (RAINING SEASON OKRA)			
Daily watering	6.93	8.43	1.83
Watering three days in a week	5.68	7.4	2.25
Watering once a week	6.53	7.3	2.1
F	0.473	0.046	0.307
P-value	0.663	0.955	0.756
LSD (0.05)	NS	NS	NS

NS- No Significant Difference

The effect of relative water content (RWC) varied between varieties and watering regimes for example Clemson Spineless showed a slight decrease in relative water content as it has the highest relative water content when watered daily (93%) followed by when watered three days in a week (89%) and the least relative water content when it was watered once a week (88%). The Raining Season Okra variety had a fluctuating increase and decrease in the relative water content as it was highest when watered once a week (85%) followed by when watered daily (77%) and the least when watered three days in a week (66%).

Table 6: Relative Water Content

RELATIVE WATER CONTENT	Clemson Spineless	Raining Season Okra
Watering daily	93%	77%
Watering three days in a week	89%	66%
Watering once a week	88%	85%

Table 7: Chlorophyll Test

Variety One: (Clemson Spineless)	1	2	3	4		Mean Value
Daily watering		30.4	36.9	35.0	29.4	32.9
Watering three days in a week		38.6	31.1	27.1	24.7	30.4
Watering once a week		36.6	40.7	47.1	31.4	39.0
Variety two: Raining Season Okra						
Daily Watering		44.5	58.5	48.2	24.5	43.9
Watering three days in a week		32.9	27.6	34.8	45.0	35.1
Watering once a week		45.5	38.0	43.3	33.3	40.0

The total of four leaves where taken from each treatment and the chlorophyll amount of okra plants in respect to the watering regimes and varieties was taken. The highest total chlorophyll amount in Clemson Spineless variety was obtained from the plants watered once in a week (39.0 SPAD) followed by a total of (32.9 SPAD) from plant watered daily and the lowest total chlorophyll amount was found in the plants watered three days in a week (30.4 SPAD). For the

Raining Season Okra variety the highest total chlorophyll was obtained from the plants watered daily (43.9 SPAD) followed by the plants watered once in a week (40.0 SPAD) and the lowest was obtained from the plants watered three days in a week (35.1 SPAD).

The varieties varied in height as Clemson Spineless had the tallest height of 47.53cm at 48 days after planting and the Raining Season Okra variety had the shortest plant height of 30.49cm, among the regimes the plants that were watered daily had the highest plant height of 41.47cm followed by the plants watered three days in a week, the plants watered once a week had the shortest height of 37.23cm. This showed a significant decrease in the plant height as the watering frequency decreased. This is in accordance to the research carried by [12] in 2010 who did a research on the effect of water stress on the growth and water use efficiency of some Wheat cultivars (*Triticum durum*) grown in Saudi Arabia where they found out that there was an effect of water stress on plant growth and this effect depends on the level of water stress and the length of time to which the plants were subjected to stress [12].

This result is different from the result gotten by [13] who worked on Effect of irrigation intervals on growth, flowering and fruits quality of okra *Abelmoschusesculentus* (*L*.) Monech, they found that the results of vegetative parameters are had no significant influence of the cultivars ontheheight of the plant and the irrigation every three days significantly gave the highest plant[13].The interaction of the plant height showed that Clemson Spineless Variety had the highest plant height of 58.38cm at 48 days after planting for daily watering and the lowest plant height of 42.08cm when the plants were watered three days in a week. The Raining Season Okra variety had the highest plant height of 34.58cm when watered three days in a week and had the lowest plant height of 24.56cm when watered daily. However, at 30, 36, 42 and 48 days after planting there was no significant difference ($P > 0.05$) in height between watering regimes and among varieties. This was also different from the work done by [13] who worked on Effect of irrigation intervals on growth, flowering and fruits quality of okra *Abelmoschusesculentus* (*L*.) Monech, and found that the interaction of vegetative parameters between experimental factors. The local cultivar and irrigation every three days gave the highest value of plant height as compared to the plants from same cultivar which were irrigated every seven days [13].

The number of leaves where significantly ($P < 0.05$) affect by the varieties as the Clemson Spineless variety had the highest number of leaves 10.17 at 48 days after planting and Raining Season Okra had the least 7.42 at 48 days after planting. The watering regimes had no significant difference on the number of plant ($P > 0.05$). This is in accordance with the work on Effect of irrigation intervals on growth, flowering and fruits quality of okra *Abelmoschusesculentus* (*L*.) Monech carried out by [13] where it was noticed that there is a significant influence of the cultivars on the number of leaves as the cultivar (V2) gave the highest number of leaves as compared with the local cultivar (V1). The irrigation every three days significantly gave the highest number of leaves as compared with plants that where irrigated when needed [13].

Interactive effect between the okra varieties and watering regimes were not significant ($P > 0.05$, $F = 0.001, 0.005, 0.051, 0.007$, LSD = No significant difference) as shown in table 4. However, at 30 and 36 days after planting Clemson Spineless variety had the highest number of leaves of 8.63 and 10.00 plant leaf when it was watered daily followed by 8.38 and 9.29 plant leaf for both watering once a week and watering three days in a week. At 42 days after planting it had the highest number of leaves 10.63 plant leaf when watered daily followed by 9.83 plant leaf when watered three days in a week, with the least number of leaves of 9.75 plant leaf when watered once a week, and at 48 days after planting it maintained the total number of leaves of 10.63 plant leaf when watered daily followed by 10.29 plant leaf when watered once a week and the least number of leaves of 9.58 plant leaf when it was watered three days in a week. While, the Raining Season Okra variety at 30 days after planting had the highest number of leaves of 5.13 plant leaf when watered three days in a week, followed by 5 plant leaf when watered once a

week and the least number of leaves of 4.63 plant leaf when watered daily. At 36 days after planting it had the highest number of leaves of 5.96 plant leaf when it was watered three days in a week, followed by 5.92 plant leaf when watered once a week and the least number of leaves of 5.67 plant leaf when it was watered daily. At 42 days after planting the plants watered three days in a week had the highest number of leaves of 7.04 plant leaf, followed by the plants watered daily 6.63 plant leaf, and the plants watered once a week had the least number of leaves of 5.96 plant leaf. At 48 days after planting the plants watered three days in a week performed better having a total number of leaves of 8.00 plant leaf, followed by the plants watered once a week 7.54plant leaf and the least number of leaves occurred in the plants watered daily 6.71 plant leaf. This result is agreement with the carried out by [13] on Effect of irrigation intervals on growth, flowering and fruits quality of okra *Abelmoschusesculentus* (*L.*) Monech where it was recorded that the plants from the cultivar copra and irrigation every three days gave the highest number of leaves per plant as compared to the local cultivar and irrigated when needed which gave the least number of leaves [13].The biomass production of okra in different varieties following three watering regimes are shown in Table 5. The results showed that the highest mean fresh leaf weight occurred in Clemson Spineless Variety at watering once a week (6.53g). The least value for fresh leaf weight occurred at daily watering (5.05g). For the Turgid weight, the highest mean value occurred in watering once a week (7.20g). The least Turgid weight occurred at daily watering. For the dry leaf weight, the highest mean value occurred at watering once a week (1.78g). The least occurred at watering three days a week (1.08g).For the Raining Season Variety the fresh leaf weight was highest for watering daily (6.93g). The least value for fresh leaf weight occurred at watering three days in a week (5.68g). For the Turgid weight, the highest mean value occurred in daily watering (8.43g). The least Turgid weight occurred at watering once a week (7.30). For the dry leaf weight, the highest mean value occurred at watering three days in a week (2.25g). The least occurred at watering daily (1.83g). Statistical analyses ($P< 0.05$, $F = 0.473, 0.046, 0.307$, LSD = No significant difference) showed that there were no significant differences in the fresh, turgid and dry leaf weights of okra for the different watering regimes.

The relative water content (RWC) parameter is considered as one of the easiest agricultural parameters that can be used to screen for plants drought tolerance [12]. The effect of relative water content (RWC) varied between varieties and watering regimes for example Clemson Spineless showed a slight decrease in relative water content as it has the highest relative water content when watered daily (93%) followed by when watered three days in a week (89%) and the least relative water content when it was watered once a week (88%). The Raining Season Okra variety had a fluctuating increase and decrease in the relative water content as it was highest when watered once a week (85%) followed by when watered daily (77%) and the least when watered three days in a week (66%), this result is similar to that of [2] who worked on the effect of water deficit on some physiological properties of *Abelmoschusesculentus (L.)*Moench cv. "Sultani" as there was a direct relationship between the different watering rates applied to the plants and the leaf – proportional water content as it was found that the relative water content reduced as the drought stress increased [2].

The total of four leaves were taken from each treatment and the chlorophyll amount of okra plant in respect to the watering regimes and varieties was taken. The highest total chlorophyll amount in Clemson Spineless variety was obtained from the plants watered once in a week (39.0 SPAD) followed by a total of (32.9 SPAD) from plant watered daily and the lowest total chlorophyll amount was found in the plants watered three days in a week (30.4 SPAD). For the Raining Season Okra variety the highest total chlorophyll was obtained from the plants watered daily (43.9 SPAD) followed by the plants watered once in a week (40.0 SPAD) and the lowest was obtained from the plants watered three days in a week (35.1 SPAD). This is similar to the work of [7] whoworked on the response of okra (*Abelmoschusesculentus (L.)* Moench to water

stress in the soil, who found that there was an increase in the chlorophyll content of stressed plants [7].

CONCLUSION

In this study, there was an effect of watering frequency on the growth performance of okra as the water stress reduced the growth parameters of plant height and number of leaves. The physiological parameters of relative water content were also affected by the frequency of watering but the effect varied among treatments in varieties. The chlorophyll also varied among varieties as there was an increase in the chlorophyll content of variety one (Clemson Spineless), and a decrease in the chlorophyll content of variety two (Local Raining Season Variety).

REFERENCES

[1]. Mekonnen H. D., Adisu E. T. (2017). Estimation of Optimum Water Requirement and Frequency of Watering for Different Tree Seedlings at Bako Agricultural Research Center Nursery Site, *Journal of Health and Environmental Research*, 3 (6): 90 - 97.

[2]. Murat, D., Evren, C., Levent, A. and Ozcan, Y. (2017). The Effect of Water Deficit on some Physiological Properties of *Abelmoschusesculentus (L.) Moench* cv. "Sultani". *Journal of Tekirdag Agricultural Faculty,* 1 (2): 48 - 54

[3]. Farhan, A. A. and Hawrez, A. N. (2018). Effect of Water Stress on Okra Yield at Vegetative Stage. *AgricJurnal ILMU PERTANIAN,* 30 (2): 111 - 116.

[4]. Henry, A. and Victor, O. (2018). Response of Three Varieties of Okra (*Abelmoschusesculentus L. Moench*) to ArbuscularMycorrhizal Fungi (*Gigasporagigantea*) in the Humid Tropics. *International Journal of Agriculture and Earth Science*, 4 (1): 16 – 21.

[5]. Jamala, G. Y., Boni, P. G., Abraham, P. and Musa, A. M. (2011). Soil status and yield response of different varieties of okra (*Abelmoschusesculentus (L.) Moench*) grown at Mubi floodplain, North Eastern, Nigeria. *Journal of Agricultural Biotechnology and Sustainable Development*, 3 (7): 120 – 125.

[6]. Iyagba, A. G., Onuegbu, B. A. and Ibe, A. E. (2012). Growth and Yield Response of Okra (*Abelmoschusesculentus (L.) Moench)* Varieties to Weed Interference in South-Eastern Nigeria. *Global Journal of Science Frontier Research Agriculture and Veterinary Sciences,* 12 (l7): 23 - 31.

[7]. Rasmata, N., Mahamadou, S. and Zoumblessé T. (2014). Response of okra (*Abelmoschusesculentus (L.) Moench)* to water stress in the soil. *African Journal of Biotechnology,* 13 (35): 3591 - 3596.

[8]. Nwalieji, H. U., Okeke, M. N. and Uzuegbunam, C. O. (2015). Comparative Profit Analysis of Dry and Rainy Season Okra (*AbelmoschusEsculentus*) Production among Women in Ayamelum Local Government Area of Anambra State, Nigeria. *IOSR Journal of Agriculture and Veterinary Science* (*IOSR-JAVS*), 8 (7): 69 - 74.

[9]. Romaisa, A., Khalid, H., Ujala, M., Khalid, N., Naima, M. and Ejaz, H. S. (2015). Effect of Different Levels of Drought on Growth, Morphology and Photosynthetic Pigments of Lady Finger (*Abelmoschusesculentus).World Journal of Agricultural Sciences,* 11 (4): 198 - 201.

[10]. Abdul, N., Asif, A. K. and Iftikhar, A. K. (2009). Generation Mean Analysis of Water Stress Tolerance in Okra (*Abelmoschousesculentus* L.), *Pakistan Journal of Botany*, 41 (14), 195 – 205.

[11]. Habtamu, F. G., Negussie, R., Gulelat, D. H., Ashagrie, Z. W., Fekadu, B. (2014). Nutritional Quality and Health Benefits of Okra (*AbelmoschusEsculentus*): A Review, *GlobalJournalofMedicalResearch*, 14 (5): 2249 – 4618.

[12]. Tahar, B., Abdellah, A., Abdulkhaliq, A. A. and Ali, M. A. (2010). Effect of water stress on growth and water use efficiency (WUE) of some wheat cultivars (*Triticum durum*) grown in Saudi Arabia. *Journal of Taibah University for Science*, 3: 39 - 48

[13]. Al-Ubaydi, R. M., Al-Shakry, E. F., Al-Samara, M. A., Al-Mohmadawy, S. M. (2017). Effect of irrigation intervals on growth, flowering and fruits quality of okra *Abelmoschusesculentus* (*L.)*Monech, *African Journal of Agricultural Research,* 12 (23): 2036-2040.