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Morphological and Biochemical Assessment of *Basella alba* Linn. and *Basella rubra* Roxb under Drought Stress

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Abstract

This research investigated the biochemical and morphological responses of *Basella alba* and *B. rubra* to drought stress. The research was performed in the screen house, sandy-loamy soil was collected and four levels of drought regime was used as treatment and a control experiment was set up for the two vegetables. Drought interval of 5, 10, 15 and 20 days were used as treatments while a control experiment which was not starved of water at any point. Five replicates were set up for each treatment. The stress was introduced at 12 Weeks after planting (WAP). Results showed that reduction in selected morphological characteristics. Number of leaves per pot(4.33), plant height(10.76cm), leaf area(12.87m^2m^{-2}) and stem girth(0.72cm) were higher in the control than in the drought-exposed groups. For the index of tolerance (STI), the shoot fresh weight STI at day 5(152.50%) was observed to be higher, the root fresh weight STI 5(151.00%) and 10(34.05%) significantly ($p<0.05$) increased when compared with day 15(32.05%) and 20(31.70%); in *Basella rubra*, the stomata of the control group are few compared to other treatments both at the adaxial and the abaxial surface (75.75;70.37) of the leaf. There was increase in carotene levels for both plants after 20 days exposure. The study revealed the variation in the ability of these two vegetables to survive various water shortage regime which explains why the vegetables goes into hibernation during extreme drought, it also showed water stress effects on the biochemical contents of these vegetables.

Keywords: *Basella alba*, *Basella rubra*, drought stress, vegetables, underutilized crops

Introduction

Ability to take in a lot of vegetables and fruit is of great attention lately due to the fact that several studies has shown a direct relationship of natural food products and the great reduction in diseases. A lot of fold medicines are important and useful apart from the nutritional value they have but also has several compounds [1].

Healthy feeding helps in improving food security and reduces ailment and diseases especially in developing countries, several works show potential synergy of local African vegetables and also the fact that there is healing power in these vegetables [2]. Good meal that is balanced gives different range of bioactive substances that is of plant nature and this protects body from ailment and regulate body processes that is dependent on regular good meal. Presence of vegetables in every diet is very important to maintaining good health due to the presence of nutritional and phytochemical property in them [3].

Different response viz a viz morphological, biochemical and physiological to drought helps plant to adapt and ultimately survive drought conditions. The singular problem of insecurity that arose from food scarcity in the world is drought which is a strong catalyst to great famines and because there is reduction in the production and supply of water in the world, there is a demand on food supply due to the increase in population and which will effectively aggravate drought [4]. Another researcher [5] revealed the three major mechanisms involved in the reduction of crop produce as a result of low supply of water which include canopy absorption reduction in radiation that actively participates in photosynthesis, reduction in the use of radiation efficiency lastly reduction in yield [6].

Although response of plant to lack of water is common, its performance in multi stressed condition environment has not been well looked into, these multi stressed condition can include low or no water supply, high heat and light which may interact negatively on the field. Study using a singular factor is not enough for these type of investigation [7]. It is vital to increase the level of tolerance of crops to drought under different and varying circumstances. Currently, it is expensive to use technology to facilitate tolerance to drought in crops although this might be a very good approach with a favourable future due to the fact that it will ultimately improve food demand. This requires huge understanding of genetic control and mechanisms that are physiological in nature of the contributing traits at various stages of plant development.

Recent reviews have shown several areas of response of plant to drought and its tolerance [8,9,10]. This study involves a general view of latest research that report several effects and drought tolerance mechanism in some higher plants and the vital strategies used in the management of the effects of droughts especially on field crops.

The study was designed to assess both the morphological and biochemical responses of *Basella alba* and *rubra* under drought stress and to establish the extent at which different regulatory processes which include growth and photosynthetic responses are induced under drought in the two species.

Materials and Methods

Study area

The research study was designed and carried out the in the screen of Plant Science and Biotechnology Department, Federal University Oye Ekiti located at latitude 7.80^0N and longitude 5.21^0E Oye Ekiti while Laboratory analyses were carried done at the Laboratory.

Seeds collection

Seeds of both *Basella* (*alba* and *rubra*) used in the study were collected from a well-established *Basella* farm and planted in the screen house. Sandy loamy Soil were collected within the University community, pH of the soil was measured using a pH metre and was observed to be 6.5. Forty (40) Planting pots were set up with 20 pots for each species, these pots were set up to have five replicates per treatment.
Stress interval of five (5), ten (10), fifteen (15) and twenty (20) days were used as the treatments while a control experiment was set up, the control was not starved of water at any point. The following data were obtained.

Morphological Parameters

Plant height was determined using a meter rule, the metre rule was placed on the soil surface and the height was measured from there to the stem tip while Stem girth was measured using a Vernier Caliper.

Leaf area was calculated with (Length x Width x 0.75), while number of leaves per plant were counted on each plant. Weights of shoot were obtained by using a digital weighing balance. Relative Growth Rate RGR was obtained as described by [11]

RGR = (In W_2 - In W_1)/(t_2 - t_1)
In is the natural logarithm
t_1 is the initial time which is measured in days
t_2 is the final time, measured in days
W_1 is the size at the t_1
W_2 is the size at t_2
NAR (Net assimilation rate) is the rate of increase whole plant dry weight per unit leaf area and this was obtained using this formula:

$$\frac{\text{In}L_2 - \text{In}L_1}{t_2 - t_1}\frac{W_2 - W_1}{L_2 - L_1}$$

W_1 is the total dry matter while L_1 is the leaf area at time t_1 and W_2 and L_2 at time t_2, respectively.
Leaf Area Ratio (LAR) was obtained using $F = \frac{(L_1/W_1) + (L_2/W_2)}{2}$

Stress Tolerance Index (STI)
This is used to obtain the potential of stress tolerance and to determine high yield of various plant genotypes.
STI for Root length = (root length of stressed plant / control plant root length) × 100
STI of shoot length = (shoot length of plant stressed/control) × 100
Fresh Weight of Root STI = (fresh root weight of stressed plant/control) × 100
Fresh Weight of Shoot STI = (Fresh weight of shoot of stressed plant / control) × 100
Weight of Dry Root STI = (Weight of Dry Root of stressed plant /control plant) × 100
Weight of Dry Shoot STI = (weight of dry shoot of stressed plant /control) × 100

Biochemical Parameters

Chlorophyll Pigment Extraction and Measurement of Chlorophyll (a and b) Fluorescence
Leaves that were removed from the control experiments and stressed treatments were processed to obtain the chlorophyll measurement. Using a mortar and pestle that were prechilled on ice, leaves of 0.05g in weight were measured and homogenized in ice cold buffered aqueous acetone of 5ml which is composed of 80% aqueous acetone and Sodium Phosphate buffer. The resultant homogenate was then centrifuged at 10000rpm for 5 min at 4^0C.

The particle was thrown away, and buffered acetone was used to increase the supernatant's volume to 5 ml. A UV-VIS spec. and 80% buffered acetone as a blank was used, the optimal absorbance of the supernatants was measured at 480, 645, and 663 nm. According to the method of [12], the estimated amounts of chlorophyll and carotenoid pigments were reported.

Determination of Protein Content
Reagents that were used for protein content determination include:
2% Na_2CO_3 in 0.1N Sodium hydroxide which is classified as Reagent A
0.5% of $CuSO_4$. $5H_2O$ in 0.1% Sodium potassium tartrate classified as Reagent B
Alkaline copper sulphate solution: 50 ml of reagent A was mixed with 1ml of reagent B classified as Reagent C
Folin's-Phenol reagent classified as Reagent D
By using the method of Waterborg [11], the protein in the enzyme extract was measured. 0.1 ml of the enzyme extract was obtained this was then scaled up to 1 ml using distilled H_2O. Each sample, including the control, received 5 ml of solution C as well, at room temperature for 10 minutes, Folin's reagent (0.5 ml) was later added

to the test tubes. Samples were then incubated for around 30 mins under no light. Absorbance was measured using a UV-VIS double beam spectrophotometer.

Lipid Peroxidation Determination

The acid used to measure the production of Malon-dia-aldehyde is Thiobarbituric acid, which is a common indicator of lipid peroxidation. A homogenizer was used to combine 0.4g of the material with 5 ml of 1% (w/v) (TCA). Following centrifugation, 4 ml of 20% (w/v) TCA with 0.5% (w/v) TBA was added to 1 ml of the supernatant, it was incubated at 95°C for 30 minutes, the mixture was then allowed to cool down immediately to 4°C to halt the process. In order to calculate the concentration of MDA, the absorbance at 532 nm and 600 nm were measured.

Estimation of Proline Content

0.1 ml of 3% (aq.) sulpho-salicylic acid was used to extract 0.5 mg of fresh plant material. Whatman No. 1 filter paper was used to filter the homogenate. In 0.2 ml of the resulting filtrate, a volume of 2.0 ml glacial acetic acid was added to 2.0 ml Ninhydrin acid. The reaction mixture was then heated for an hour using a bain-marie of boiling water. For five minutes, the test tubes were submerged in an ice bath to stop the reaction. Additionally, a total volume of 4.0 ml toluene was then added to the mixture and thoroughly agitated for 20 to 30 seconds. The toluene layer was removed, and at 520 nm, the intensity of the red color was also measured. A stock solution of pure proline (0.1 mg/1 ml) was made, and its serial dilutions were utilized to create the calibration curve. It was described as mg proline/g wt.

Results

Morphological Studies

Table 1 displays how *Basella rubra* leaves per pot, height, leaf area, and stem girth are affected by drought. The control group had considerably (p0.05) more leaves per pot than the groups that had been subjected to drought stress. The number of leaves per pot of *B. rubra* after treatment at various day intervals did not differ significantly (p0.05); however, the least value was recorded at day 20.

When the exposed groups and control groups were compared to each other at various days apart, there was no discernible change in plant height ($p>0.05$). The height of the control plant was discovered to be greater or taller than the groups exposed to drought stress at different day interval. After being exposed to drought stress, the group at day 20 had the smallest height or were the shortest overall. When compared to the groups that were subjected to drought stress at various day intervals, the leaf area of *B. rubra* in the control group rose significantly. At various day intervals, the leaf area decreases in a concentration-dependent way. Leaf area was lowest on day 20. Following exposure to drought stress, the stem girth of *B. rubra* decreased in a concentration-dependent manner over a range of day intervals. The stem girth of exposed groups on various days did not differ from the control in a way that was statistically significant (p 0.05).

Table 1: Effect of drought stress on the Number of leaves/pot, plant height, leaf area and stem girth of *Basella rubra*

Treatments	Leaf number per Pot	Height of plant (cm)	Area of Leaf (cm^2)	Stem Girth (cm)
Control	4.40 ± 0.24^{a}	6.88 ± 1.24^{a}	8.19 ± 1.49^{a}	0.50 ± 0.03^{a}
Day 5	1.00 ± 0.63^{b}	6.88 ± 1.64^{a}	3.44 ± 2.11^{b}	0.59 ± 0.08^{a}
Day 10	1.40 ± 0.60^{b}	3.24 ± 1.05^{a}	2.15 ± 1.80^{c}	0.51 ± 0.13^{a}
Day 15	1.20 ± 0.58^{b}	3.42 ± 1.71^{a}	1.73 ± 1.60^{c}	0.41 ± 0.11^{a}
Day 20	0.40 ± 0.35^{b}	2.12 ± 0.94^{ab}	1.34 ± 0.86^{c}	0.26 ± 0.12^{ab}

Means assigned with the same letter(s) within the columns are of no significant difference at $P<0.05$

Table 2: Effect of drought stress on the weight of root, weight of shoot and length of root of *Basella rubra*

Treatments	Shoot Weight (g)	Root weight (g)	Root length (cm)
Control	3.71 ± 1.19[a]	3.13 ± 2.60[a]	5.82 ± 2.02[a]
Day 5	2.25 ± 0.49[ab]	0.52 ± 0.19[b]	3.04 ± 1.42[a]
Day 10	1.72 ± 0.62[ab]	0.40 ± 0.18[b]	4.96 ± 1.63[a]
Day 15	1.36 ± 0.58[ab]	0.44 ± 0.12[b]	5.60 ± 1.59[a]
Day 20	0.72 ± 0.30[b]	0.38 ± 0.24[b]	5.70 ± 3.81[a]

Means assigned with the same letter(s) within the columns are of no significant difference at $P<0.05$

Following exposure to drought stress, both *Basella rubra*'s shoot and root weight including the length of the root are displayed in Table 2. After being subjected to drought stress, *Basella rubra's* shoot weight decreases as the treatment days increases. However, control group's shoot weight was considerably (p 0.05) larger than that of the groups that had been subjected to the drought. In a similar way, the exposed groups' root weights similarly decline in a concentration-dependent manner. The root length of the *Basella rubra* drought stress exposed groups and the control groups did not differ significantly.

Table 3: Effect of drought stress exposure on Leave Area Ratio, Net Assimilation Rate, Relative Water Content and Relative Growth Rate on *Basella rubra*

Treatments	Leave area Ratio	NAR	RGR	Relative water content
Control	3.83 ± 1.38[a]	0.13 ± 0.08[a]	0.08 ± 0.02[a]	60.21 ± 4.99[a]
Day 5	1.02 ± 0.62[a]	0.01 ± 0.00[a]	0.05 ± 0.01[a]	21.20 ± 5.10[cd]
Day 10	0.67 ± 0.55[a]	0.12 ± 0.05[a]	0.09 ± 0.04[a]	16.79 ± 6.79[d]
Day 15	2.74 ± 2.49[a]	0.16 ± 0.14[a]	0.11 ± 0.04[a]	26.12 ± 7.77[c]
Day 20	1.40 ± 0.86[a]	0.01 ± 0.00[a]	0.12 ± 0.03[a]	40.90 ± 6.94[b]

Means assigned the same letter(s) within the columns are of no significant difference at $P<0.05$

Following exposure to drought stress, *Basella rubra*'s leave area ratio, net assimilation rate, relative water content, and relative growth rate are shown in Table 3. *Basella rubra*'s LAR and NAR decreased at various day intervals when it was exposed to drought stress. Despite being greater, the leaf area ratio between the exposed groups and the control groups was not substantially different. On day 15, it was found that the group's net assimilation rate was higher than the control groups.

When compared to plants that had been exposed to drought stress, the relative water content of the control group increased significantly. There was no significant difference in values obtained for RGR between the groups exposed to drought stress and the controls, although there was a concentration-dependent increase in relative growth rate among the exposed groups with day 20 being the highest. The relative water content at day 20 was also found to be significantly higher than day 5 to day15.

SFWSTI was higher at day 5 compared to days 10 and 15, however no significant difference was observed at $p<0.05$. SFWSTI, however, considerably increased at day 5 compared to day 20. When compared to days 15 and 20, RFWSTI at days 5 and 10 considerably increased. After being exposed to drought, *Basella rubra*'s SLSTI and RLSTI both dramatically declined at various day intervals. SLSTI was higher on day 5 than it was on days 10 to 20.

Table 5 demonstrates that the amount of leaves produced per pot is greatest in the control and significantly different from the values observed at 5, 10, 15, and 20 days. The amount of leaves produced per pot was lowest at the 20-day treatment and significantly different from the values in the control, 5 and 10-day treatments. In a related variation, the control's plant height is highest and substantially different from the 10 days treatment; conversely, the control's plant height was lowest and also significantly different from the other treatments at 5 days. The leaf area for the 20-day treatments and the control is vastly dissimilar from one another. For the 10, 15, and 20 days, there is also the Leaf area which are close and not significantly different to each other. For the stem girth, values obtained are relatively close to each other.

Table 4: Tolerance index of *Basella rubra* after exposure to drought stress

Treatments	Shoot fresh weight STI (SFWSTI)	Root fresh weight STI (RFWSTI)	Shoot length STI (SLSTI)	Root length STI (RLSTI)
Day 5	99.16 ± 6.94[a]	65.73 ± 7.38[a]	77.96 ± 1.03[a]	70.40 ± 6.80[a]
Day 10	92.23 ± 6.23[ab]	69.83 ± 3.17[a]	62.50 ± 5.50[b]	60.00 ± 0.00[b]
Day 15	96.39 ± 4.86[ab]	26.20 ± 0.00[b]	67.86 ± 7.86[b]	62.40 ± 0.00[b]
Day 20	48.82 ± 4.03[c]	1.70 ± 0.00[c]	54.38 ± 8.13[c]	33.60 ± 0.00[c]

Means assigned with the same letter(s) within the columns are of no significant difference at P<0.05

Table 5: Effect of drought stress on the No of Leaves/Pot, Plant Height, Leaf Area and Stem Girth of *Basella alba*

Treatments	Number of Leaves/Pot	Plant Height (cm)	Leaf Area (cm)	Stem Girth (cm)
Control	4.33 ± 0.33[a]	10.76 ± 3.61[a]	12.87 ± 0.21[a]	0.72 ± 0.06[ab]
Day 5	2.80 ± 0.20[b]	10.44 ± 1.47[a]	11.86 ± 2.06[a]	0.91 ± 0.03[a]
Day 10	2.25 ± 0.25[b]	5.66 ± 1.08[ab]	3.83 ± 1.37[b]	0.67 ± 0.03[ab]
Day 15	2.00 ± 0.32[bc]	8.44 ± 1.25[a]	0.92 ± 0.25[b]	0.54 ± 0.10[b]
Day 20	1.00 ± 0.00[c]	8.00 ± 2.73[a]	0.70 ± 0.30[b]	0.43 ± 0.13[b]

Means with the same letters within columns are not significantly different at P< 0.05

Table 6: Drought stress effect on the shoot weight, root weight and root length *of Basella alba*

Treatments	Weight of Shoot (g)	Weight of Root (g)	Length of Root (cm)
Control	4.69 ± 0.50[ab]	1.68 ± 0.65[a]	11.38 ± 3.63[a]
Day 5	5.27 ± 0.72[a]	1.85 ± 0.25[a]	10.47 ± 1.39[a]
Day 10	2.94 ± 0.48[bc]	0.60 ± 0.10[b]	6.46 ± 1.05[b]
Day 15	2.37 ± 0.15[c]	0. 56± 0.07[ab]	5.00 ± 0.95[b]
Day 20	1.63 ± 0.44[c]	0.43 ± 0.14[b]	4.42 ± 1.20[b]

Means assigned with the same letter(s) within the columns are of no significant difference at P<0.05

The shoot weight of *B. alba* was shown to decrease in this study after exposure at various day intervals. Except for day 5, when it was higher and not substantially different from the control, the shoot weight of the control group was relatively higher when compared to that of the water stress-exposed groups. The exposed groups' root weight and root length also diminish in a concentration-dependent manner. At day 5, it was shown that the control group's root weight and root length were significantly higher than those of other water stress-exposed groups, but not significantly different from the exposed group.
This study revealed that *B. alba's* leaves area ratio was decreased at various days after being exposed to water stress. At days 5 and 15, the water stress-exposed groups' Leave Area Ratio, despite being greater in the control group, did not statistically differ from that of the control group. Following exposure to water stress*, B. alba's* NAR and RGR both increased in a concentration-dependent way. RGR and the rise in Net Assimilation Rate did not differ significantly from the control. On day 5, it was found that the group subjected to water stress had a

larger relative water content than the control group. The control, however, had a considerably greater Relative Water Content than all other groups.

According to the study's findings, compared to the other exposed groups, SFWSTI at day 5 considerably rose. At day 20, the exposed group was found to have the lowest SFWSTI. At various days apart, the RFWSTI decreased significantly in a concentration-dependent way. The exposure group's RFWSTI was highest on day 5 while it was lowest on day 20. The SLSTI and RLSTI, which are concentration dependent, both significantly (p0.05) decline at various days apart. The exposure group's SLSTI was highest at day 5 and lowest at day 20 (Table 8).

Table 7: Effect of water stress exposure on Leave Area Ratio, NAR, Relative Water Content and RGR of *Basella alba*

Treatments	LAR	NAR	RGR	Relative water content
Control	2.76 ± 0.34[a]	0.03 ± 0.01[a]	0.04 ± 0.01[a]	77.23 ± 4.64[a]
Day 5	2.38 ± 0.44[a]	0.03 ± 0.00[a]	0.12 ± 0.07[a]	78.25 ± 2.49[a]
Day 10	1.35 ± 0.45[ab]	0.12 ± 0.06[a]	0.05 ± 0.01[a]	43.33 ± 3.33[b]
Day 15	2.23 ± 0.21[a]	0.91 ± 0.26[a]	0.15 ± 0.00[a]	55.34 ± 3.43[b]
Day 20	0.81 ± 0.28[b]	1.37 ± 0.91[a]	0.15 ± 0.00[a]	55.00 ± 5.00[b]

Means assigned with the same letter(s) within the columns are of no significant difference at P<0.05

Table 8: Tolerance index of *Basellaalba* after exposure to water stress

Treatments	SFWSTI	RFWSTI	SLSTI	RLSTI
Day 5	152.50 ± 0.50[a]	151.00 ± 1.50[a]	159.94 ± 3.90[a]	75.66 ± 7.67[a]
Day 10	74.33 ± 1.29[b]	34.05 ± 0.55[b]	137.20 ± 1.98[b]	50.03 ± 7.92[b]
Day 15	86.50 ± 1.50[b]	32.05 ± 8.55[b]	116.50 ± 8.50[c]	48.16 ± 5.72[b]
Day 20	60.00 ± 7.00[c]	31.70 ± 2.44[b]	83.35 ± 6.65[d]	48.74 ± 4.99[b]

Means assigned with the same letter(s) within the columns are of no significant difference at P<0.05

According to preliminary findings, *Basella rubra* and *alba* flourish in humid environments with greater water availability because they utilise the C_3 metabolic pathway. Figures 1, 2, and 3 depict the effect of stress as a result of drought on the chlorophyll content of the vegetable utilized in this study. It was found that the amount of chlorophylls a, b, and carotene decreased as the length of the drought increased. Additionally, Figures 4, 5, and 6 showed how these drought stress intervals affected the biochemical components of the study's vegetables. These outcomes differ across the two species and rely on the length of the drought stress period. The amount of soluble protein increases as the length of the drought stress interval lengthens, but the amounts of proline and lipid peroxidation in *Basella alba* decrease as the length of the drought stress interval lengthens.

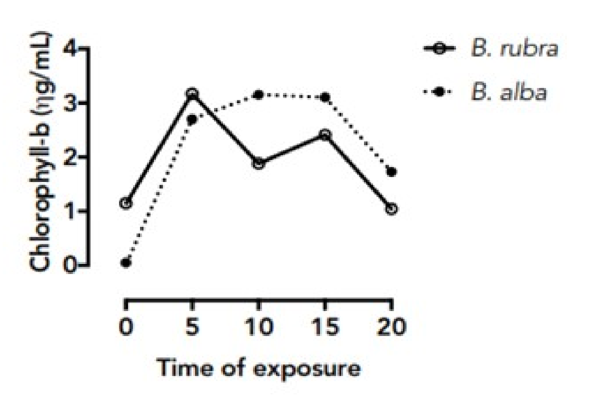

Fig 1: Drought stress effect on the chlorophyll-b content of *B. rubra* and *alba*

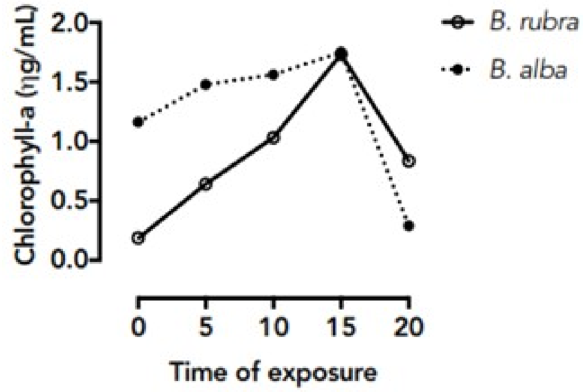

Fig 2: Effect of drought stress on chlorophyll-a of *B. rubra* and *alba*

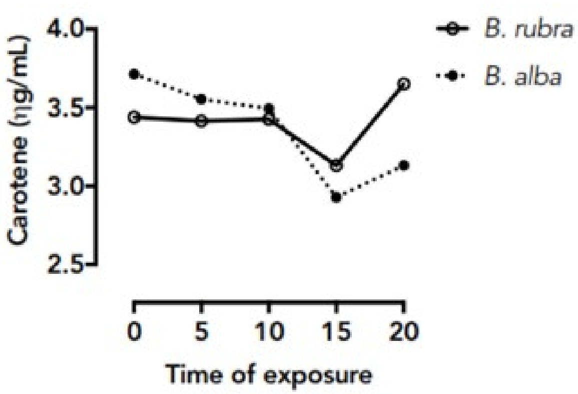

Fig 3 :Effect of drought stress on carotene content of *B. rubra* and *alba*

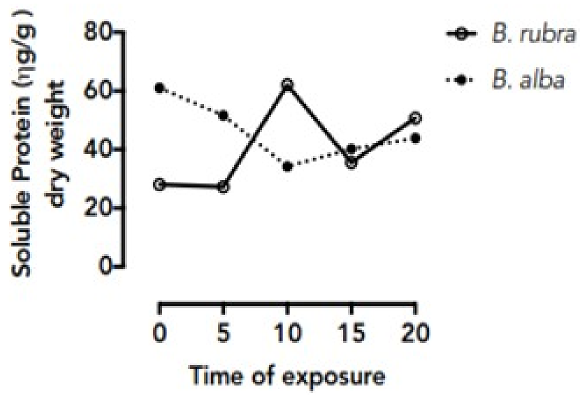

Fig 4: Effect of drought stress on soluble protein of *B. rubra* and *alba*

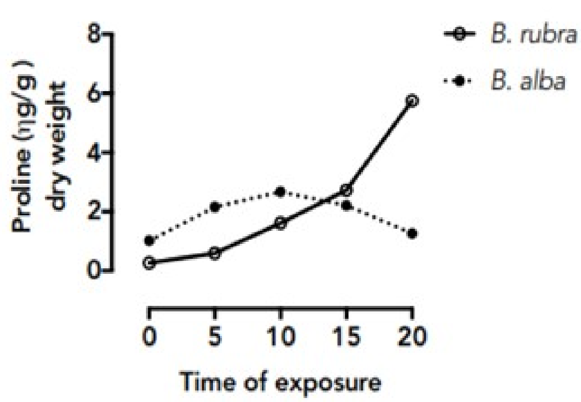

Fig 5: Effect of drought stress on proline of *B. rubra* and *alba*

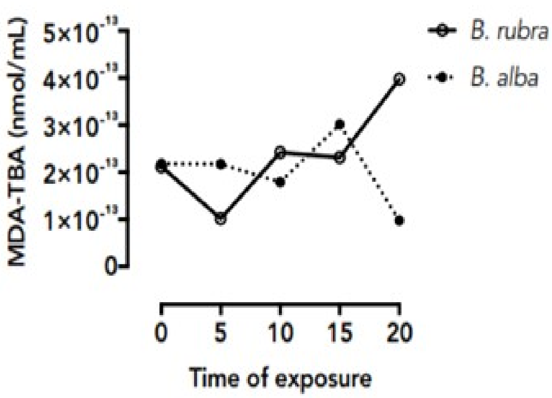

Fig 6: Effect of drought stress on lipid perodixidation as observed in *B. rubra* and *alba*

Discussion

Drought is known as the major factors that limits performance in crops and can eventually lead to low yield. Drought tolerance ability is a major character that is directly proportional to yield and to increase this character, major improvement in the set of important attributes requires breeding.[12]
This study gives strong evidence of response of *Basella rubra* and *alba* to drought stress, the morphological parameters reduced than the control group with increase in the number of days of stress, showing the potential of drought on certain phenomena such as leaf growth, shoot growth and photosynthetic rate which is in line with the submission of Heidaiy and Moaveni [13].

This study also gives a strong evidence of response of *Basella alba* to water stress, the analysis on the data collected on the morphological parameters reveals that the morphological characters of the plants exposed to drought showed reduction when compared to the control, which is in concordance with the findings of Agarwal et al [10]. Furthermore, analysis on the weights of the shoot and the roots shows that accumulation of matter in the root and shoot decreases as the number of stress day increases. The control has the highest Relative Water Content compared to the stressed plants which reduced significantly with increase in the number of days of stress, which result in high Net Assimilation Rate as observed in the stressed plant which is in accordance to the work of Farooq et al [14].

Drought stress [14], in addition to several changes can reduce chlorophyll contents concentrations, this is in accordance with the findings in this research work especially as regards chlorophyll's a, b and carotenoids pigments which showed that there is a significant reduction in these pigments as the drought stress exposure time increases when compared to other treatments, this was majorly evident in chlorophylls a and b.

As previously established [15], drought is a vital factor that limits initial plant growth phase, it was also established that there is a proportional decrees in the values of the aforementioned as the drought stress interval increases. In addition to this, Specht et al. [16] observed that when soybean is exposed to drought stress, there is a great decrease in the stem length. Wu et al. [17] also worked on water stressed citrus seedlings and reported that there was a significant decrease in its plant height when exposed to drought, all these varying characters were observed [18, 19] in *Abelmoschus esculentus* [14] and *Petroselinim crispum* in [20] these are in line with my findings which shows a significant decrease in all the growth parameters both in *rubra* and *alba.*
Another significant reduction was observed in the Leaf Areas of both plants used in this study which is due to the fact that there is a great suppression of cell expansion and growth due to low turgor pressure.

As observed in the study also that there is an increase in the root length of the drought treatments when compared to lower drought treatments, it was confirmed by Tahir et al. [21] that there is an increase in root growth of sunflower due to stress related to drought, this is due to the fact that stressed plant must develop a root system that will enable them uptake water and other nutrients because of non-availability water. As reported by Farooq et al. [22] that the disadvantage of drought is the low biomass production of both fresh and dry plants, this was also observed in this study where the shoot and root weights were reduced as the stress interval increases.

Generally, the water deficit induced in this study, shows varying effects on almost all the parameters observed in this study and shows that *Basella alba* and *rubra* has an ability to survive a period of drought which may explain its ability to germinate even after observing its hibernating character during a period of water deficit.

Authors' contribution

Author OKS designed, supervised the research and edited the article, Author ATO wrote the article and participated in the research while Author OAO worked on the planting, supervised the entire the field research and participated in the writing of this article

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Declaration of Competing Interest
There is no conflict of interests

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