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Full Length Research Article

EFFECT OF VARYING SHADE LEVELS ON VEGETATIVE PERFORMANCE AND CHLOROPHYLL CONTENTS OF GROUNDNUT (*ARACHIS HYPOGEA* L.) SHOOTS

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ABSTRACT
Groundnut, also commonly known as peanut (*Arachis hypogaea*), is a tropical legume mainly grown to produce oil and for human and animal consumption. Light has been the most important factor influencing plant growth, with changes in irradiance having impacts on plant growth, morphology, and anatomy. This research was aimed to evaluate the effect of varying levels on vegetative performance and chlorophyll contents of groundnut shoots. This experiment was conducted in the Botanical Garden of the Department of Biology, Kaduna State University, Kaduna State Nigeria. Healthy seeds of *Arachis hypogaea* were procured from Institute for Agricultural Research (IAR), Samaru, Zaria. The seeds of *A. hypogea* were sown in polythene bags containing garden soil. This experiment was laid under Randomized Complete Block Design (RCBD), each treatments were replicated three (3) times. Growth parameters were measured using ruler and digital weighing balance. It was observed that, seeds germinated after 9 days. From the results obtained, shade affected all growth parameters studied. *A. hypogea* grown under shade showed reduction in number of leaves, root length, leaves fresh weight and dry weight, stem fresh and dry weights, root fresh and dry weight respectively. Results of chlorophyll composition showed the lowest content of chlorophyll in groundnut shoots grown under shade. It is recommended that, planting of groundnut under shade should be avoided because it ffects growth and chlorophyll compositions in *A. hypogea* shoots.

Keywords: Shade, vegetative performance, chlorophyll content, *Arachis hypogea*.

INTRODUCTION
Groundnut, also commonly known as peanut (*Arachis hypogaea*), is a tropical legume mainly grown to produce oil and for human and animal consumption. Peanut is grown in about 120 countries in the world in a total area of 24.6 million ha, with a world production of 38.2 million tonnes (Mt) (Grosso *et al*., 2016). Light has been the most important factor influencing plant growth, with changes in irradiance having impacts on plant growth, morphology, and anatomy, various aspects of physiology and cellular biochemistry, and, ultimately, flowering time and plant productivity (Dai *et al*., 2009; Deng *et al.,* 2012). In the light reactions of photosynthesis, light energy is used to produce ATP and NADPH, which are then used for carbon fixation to carbohydrates and production of oxygen during the light-independent phase (Variath *et al*., 2016). Shading effects are not just about the plants growth and development, but through which, it also has a major impact on plant photosynthesis. Normal plant growth needs optimal light irradiance because excessively high and low irradiances would result in photo inhibition and light deficiency respectively, and therein the growth of plant was restricted severely. Under high irradiance conditions, photo inhibition takes place: the photosynthetic apparatus absorbs excessive light energy, resulting in the inactivation or impairment of the chlorophyll-containing reaction centers of chloroplasts and consequent depression of photosynthetic activity (Bertaminia *et al*., 2006; Chen and Murata, 2011). In contrast, under low irradiance conditions, insufficient ATP is produced to allow for carbon fixation and carbohydrate biosynthesis. This leads to a reduction in plant growth.

Though light is very important for photosynthesis, too much light can also damage the photosynthetic apparatus. To avoid the photo damage caused by high light, plants have developed several mechanisms to deal with excessive irradiance (Bertaminia *et al*., 2006; Chen and Murata, 2011 Deng *et al.,* 2012). Among these photoprotective mechanisms, one of the most important is thermal dissipation relying on xanthophyll cycle (Raveh, 1998). Despite the existence of this mechanism for releasing excessive excited energy, the production of reactive oxygen species is still unavoidable during photosynthesis, especially under strong irradiance. To counteract the toxicity of reactive oxygen species, plants have developed a highly efficient antioxidant enzymic defense system (Schapendonk *et al*., 1997), mainly comprising superoxide dismutase, ascorbate peroxidase, catalase, peroxidase, and glutathione reductase. Many studies have proved that sun leaves are insensitive to strong light, while shade leaves grown under low light have a weak photo protection capacity and enhanced sensitivity to high light (Zhang, 2009; Chen, 2011). However, most of the evidence is derived from simulation experiments, in which there were striking differences in light intensities between plant growth and treatment. Chloroplasts are the sole organelles of photosynthesis. A close relationship between photosynthesis and chlorophyll content in different species under shading conditions has been reported (Pasupeleti *et al*., 2013). Abiotic factors such as changes in climate enclosed most plants to shade conditions, thereby affecting chlorophyll content and subsequently their photosynthesis (Abdalla *et al*. 2019). This eventually affects their productivity. This project will provide information to plant breeders willing to develop shade resistant varieties *Arachis hypogaea*. It will also provide information especially to the regions that experience short-day length of sunlight on the suitability or otherwise of propagating *Arachis hypogaea.* This research was aimed to evaluate the influence of different shading levels on growth performance and chlorophyll contents of groundnut shoots.

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MATERIALS AND METHODS

Study area
The experiment was conducted in the Botanical Garden of the Department of Biology, Kaduna State University, which is located on latitude 10^0 31^l North and longitude 7^0 26^l East and 6.14m above sea level.

Experimental Design
The experiment was laid under Randomized Complete Block Design (RCBD). Each treatment was replicated three (3) times.

Germplasm Collection
Healthy seeds of *Arachis hypogaea* were sourced from Institute for Agricultural Research (IAR), Samaru, Ahmadu Bello University, Zaria. The seeds of groundnut were identified and authenticated by expert in Herbarium of Biology Department Kaduna State University, the voucher number obtained is: KASU/BSH/659.

Planting and Treatments
Seeds were planted in pots containing neutral sandy loamy soil pH of 6.9 at 4inches depth.
The germinated plants were subjected to four different shade treatments for 70 days.
Treatments consist of 2h 4h 6h and 8h exposure to sunlight.
Each treatment consist of 10 pots with a control exposed to sunlight throughout the day.
All plants were kept well-irrigated and protected from weed competition.
Three samples were harvested from each period (a, b, c).

Observations of Growth Parameters
The following were observed:
Number of days taken to germinate after planting.
Plant height, root, length and number of leaves were also observed at a week interval using harvesting method. The biomass of plant, stem, leaf, and root were measured before and after flowering.

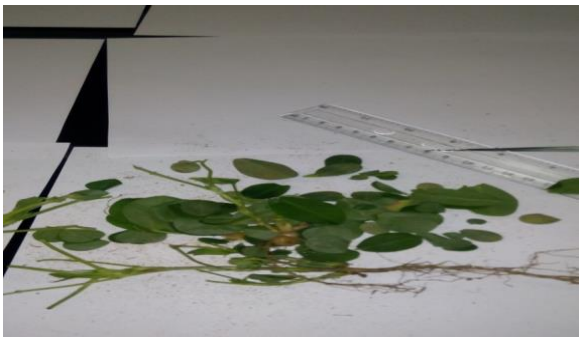

Plate 1: Fresh leaves of *A. hypogea*

Data Analysis
The data generated from the work were analysed using Analysis of Variance (ANOVA), SAS (2002) statistical package to determine the chlorophyll content of *A.hypogea*. Least significance difference (LSD) was also used to compare/separate treatment means ($P<0.05$).

RESULTS

Effects of shade on growth of *Arachis Hypogaea*
The plants started germinating between 9 to 14 days after planting. Plants grown under the shade grew less than those grown under the sunlight. Plant height, number of leaves, length of root and weight of plant before and after drying were found to be significantly higher under the sunlight (Table 1).

Effects on the plant height
The tallest plants were obtained at 8h duration of sunlight (13.39cm) and closely followed by the 6h duration of (12.73cm) and the shortest height was obtained at 2h duration (11.28cm) as shown on Table 1. When compared with the control of 13.39cm, it revealed that the longer the duration of stay under sunlight, the more the height.

Effects on the number of leaves
The plants produced more leaves under the sunlight than those under shade. Table1 shows how the number of leaves increased in relation to the duration of the sunlight. The highest number of leaves recorded (91 leaves) was from the control that stayed throughout under sunlight followed by 8hours duration with 83 leaves and the lowest number of leaves obtained at 2h duration with 63 leaves. This revealed that shade has significant effect on the growing and development of *A. hypogaea*.

Effects on the Roots Length
The longest roots were found at the control with 18.85cm, followed by 8hours duration with 16.90cm. The shortest roots were obtained at the 2h duration with 11.58cm. This revealed that the longer the duration under sunlight, the more the length of the roots.

Effects of Shade on Fresh and Dry Weight of *A. hypogea*
Weight of the plants was measured before and after flowering to determine the effect of shade on the weight of the leaves, stem and roots. From the experiment as reported on Table1, it revealed the variation of weight at different duration of stay under sunlight and was measured before and after drying. The longer the duration of stay under sunlight, the more the weight.

Leaves Fresh and Dry Weight
Treatment with 8hours duration had the heaviest weight of fresh leave before flowering with 23.16g, followed by control with 18.60g weight and the least is 2h duration with 14.32g weight. The weight of the fresh leaves decreased slightly after flowering with the heaviest at 6hours treatment 13.01g, followed by control with 12.27g weight and the least is 2 hours and 4hours with 11.95g weight. The leave dry weight before flowering as shown on the table, control has the highest with 7.76g, followed by 8hours treatment with 3.21g and the least is 2h treatment with 1.99g. Control had the highest weight of dry leave after flowering with 4.82g, followed by 4hours treatment with 3.01g and the least weight was the 6hours treatment with 2.22g.

Stems Fresh and Dry Weight
The fresh weights of plant's stem were measured before and after flowering. Before flowering, control had the highest weight with 47.78g, followed by 4hours treatment with 13.26g and the lowest weight was the 8hours treatment with 11.78g (Table 1). The highest fresh weight of the stem was obtained at 2hourss duration with

12.92g, followed by control with 12.88g and the least was 8hours treatment with 12.15g. Stem dry weight before flowering was measured and 2hours duration had the highest weight of 9.75g, followed by control with 8.88g and the least is 8hours duration with 3.97g. The dry weight of stem after flowering as revealed by the table, shows 8hours treatment as the heaviest in weight with 9.99g, followed by 6hours duration with 8.57g and the lowest was 4h duration with 5.78g.

Roots fresh and dry weight

The weights of roots were also measured before and after drying which revealed significant increase in relation to duration of stay under sunlight. The heaviest weight of fresh root before flowering was obtained at control with 9.14g, followed by 8hours treatment with 7.53g weight and the least is 4hours treatment with 4.69g as shown on the table. The weight of fresh root after flowering had control with the highest weight of 9.17g, followed by 6hours duration with 6.52g and the least is 2hours duration with 4.99g. The weight of dry root before flowering has 6hours duration as the heaviest with 12.16g, followed by 8hours duration with 11.84g and the least weight was obtained at the control with 10.53g. The weight of dry roots after flowering had control as the heaviest in weight with 13.31g, followed by 8hours duration with 12.54g and the lowest is 4hours duration with 11.00g.

Table 1: Effects of Shade on Growth of *A. hypogea*

TREATMENT	PH	NL	RL	LFWA	LFWB	LDWA	LDWB	SFWA	SFWB	SDWA	SDWB	RFWA	RFWB	RDWA	RDWAB
Control	13.39^{a}	91.33^{a}	18.85^{a}	18.60^{a}	12.27^{a}	7.76^{a}	4.82^{a}	47.78^{a}	12.88^{a}	8.88^{a}	8.35^{a}	9.14^{a}	9.17^{a}	10.53^{a}	13.31^{a}
2h	11.28^{e}	63.00^{e}	11.58^{d}	14.32^{a}	11.95^{a}	1.99^{b}	2.68^{b}	13.23^{a}	12.92^{a}	9.75^{a}	6.44^{a}	5.96^{bc}	4.99^{a}	11.32^{a}	11.98^{ab}
4h	12.24^{d}	69.33^{d}	13.84^{cc}	17.66^{a}	11.95^{a}	3.00^{b}	3.01^{ab}	13.26^{a}	12.28^{b}	8.08^{a}	5.78^{b}	4.69^{c}	6.06^{a}	10.99^{a}	11.00^{b}
6h	12.73^{c}	77.33^{c}	13.88^{c}	16.41^{a}	13.01^{a}	2.20^{b}	2.22^{b}	13.01^{a}	12.36^{a}	5.88^{a}	8.57^{a}	6.47^{bc}	6.52^{a}	12.16^{a}	11.21^{b}
8h	13.39^{b}	82.67^{b}	16.90^{b}	23.16^{a}	12.18^{a}	3.21^{ab}	2.57^{b}	11.78^{a}	12.15^{ab}	3.97^{a}	9.99^{a}	7.53^{ab}	5.56^{a}	11.84^{a}	12.54^{ab}

Key:
PH = Plant height, NL = Number of leaves, RL = Root length, LFWA = Leaves Fresh Weight After Flowering
LFWB = Leaves Fresh Weight Before Flowering, LDWA = Leaves Dry Weight After Flowering
LDWB = Leaves Dry Weight Before Flowering, SFWA = Stem Fresh Weight After Flowering, SFWB = Stem Fresh Weight Before Flowering,
SDWA = Stem Dry Weight After Flowering, SDWB = Stem Dry Weight Before Flowering, RFWA = Root Fresh Weight After Flowering,
RFWB = Root Fresh Weight Before Flowering, RDWA = Root Dry Weight After Flowering, RDWB = Root Dry Weight Before Flowering

Results of chlorophyll contents revealed that exposure to sunlight for 8 h after flowering had the highest weight with 0.51g, followed by 8 hours duration before flowering with 0.38g and the least in weight was obtained at 6hours duration after flowering with 0.09g. With respect to mass of extract, exposure to sunlight for 8h after flowering had the highest mass of chlorophyll extract of 0.08g, followed by 8h duration before flowering with 0.01g and 2h duration before flowering had the lowest chlorophyll extract. Control after flowering had the highest mass of chlorophyll absorbance of 1.48mg/L, followed by 8hours before and after flowering with 1.47mg/L each while the least extract absorbance was produced by 4h after flowering, 2hours before and after flowering (Table 2).

Table 2: Effects of Shade on Chlorophyll Content of *A. hypogea*

	Treatment	MS (g)	ME (g)	AE (1000mg/L)
1.	Control	0.16^{c}	0.01^{c}	1.48^{b}
2.	8h before flowering	0.38^{bc}	0.01^{b}	1.47^{b}
3.	8-h after flowering	0.51^{ab}	0.08^{a}	1.47^{b}
4.	6-h before flowering	0.13^{c}	0.01^{d}	1.45^{b}
5.	6-h after flowering	0.09^{a}	0.01^{cd}	1.46^{b}
6.	4-h before flowering	0.12^{c}	0.01^{c}	1.45^{b}
7.	4-h after flowering	0.13^{c}	0.01^{c}	1.43^{b}
8.	2-hbefore flowering	0.22^{c}	0.01^{d}	1.43^{b}
9.	2-h after flowering	0.23^{c}	0.01^{cd}	1.43^{b}

Key: MS = Mass of Sample in gram. ME = Mass of Extract in gram, AE = Extract absorbance

DISCUSSION

The plants under long period of sunlight grew taller than the ones planted under shades. This revealed that, long exposure of plant to sunlight lead to increase in height. Similarly, the result showed that, number of leaves increased in relation to the increased duration of the sunlight exposure. The best numbers of leaves (91) were recorded from the control that had the maximum sunlight, and the least number of leaves (63) were recorded in 2h duration under sunlight. The chlorophyll content of control after flowering had the highest content of 1.48mg/L, while the 2h duration before and after flowering absorbed the least chlorophyll with 1.43mg/L. The sample with 8h duration after flowering had the highest weight result of 0.08g which is similar to the chlorophyll absorbance of 1.47mg/L. this indicated that there is significant relationship between the mass of extract and the chlorophyll absorbance. This result is in agreement with Noerjahni *et al*. (2020) work, and they observed that, Plants grown under shade grew smaller than those in the open field (exposed to sunlight).

Meanwhile, the tallest plants were obtained from 8h duration (12.71 cm) closely followed by control (12.30 cm). Plants grown in more shades were found to be shorter than those grown under sunlight resulting in taller plants under more sunlight (Kiniri *et al*., 2015). Significantly maximum number of leaves (83), and leave fresh weight before and after flowering 13.82g and 12.76g respectively were recorded from 8h duration, and for lower duration, they declined. Fresh yield increased gradually as the duration of stay in sunlight increased. For further increment of shade level, the yield

increased. The highest chlorophyll absorbance was recorded from the control (1.36mg/L), significantly the lowest yield was recorded 2hours duration (1.29mg/L). Chlorophyll increased progressively with the increase of sunlight. The maximum amount of chlorophyll was recorded at control followed 6h duration, this was in accordance with findings of Yajuan *et al*. (2019) work, and they observed that, chlorophyll contents increased with increased of sunlight. It has been reported that, shading decreased the quantity of chlorophyll and thus decreased the growth efficiency of the plants and ultimately the yield decreased (Abdalla *et al*., 2019).

Conclusion and Recommendation

It has been concluded that, *A. hypogea* grown under different shade levels showed reduction in growth performance and chlorophyll contents, and those exposed to sunlight showed increased in growth and chlorophyll contents. Therefore, it is recommended that, planting of groundnut under shade should be avoided, because shade affects growth and chlorophyll contents of groundnut.

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