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INFLUENCE OF TEMPERATURE AND SHADE ON THE GERMINATION AND EARLY GROWTH OF *BOMBAX BUONOPOZENSE* P. BEAUV

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ABSTRACT

The study analyzed the influence of shade and temperature in germination and early growth rate of Bombax buonopozense. A total of 300 seeds were collected and sown in 300 polypots (3kg per pot) filled with topsoil. For the site and treatment preparation, three different light shades were selected. Two of the treatments (forest gap and dense shade) were located in the Arboretum while the third site (open shade) was located in the Nursery, both in the Department of Forest Resources and Wildlife Management. The six germination conditions/treatments and their average light levels (illumination) obtained using the Lux meter of ×10 magnification were: Open Shade/Control: 447.5 Lux (treatment 1); Medium Shade: 157.5 Lux (treatment 2); Forest gap: 12.5 lux (treatment 3); Dense Shade: 3.2 Lux (treatment 4); white cellophane: 317.5 (treatment 5); black cellophane: -0.3 lux (treatment 6). Thus, 50 seeds were sown under each treatment plot. Data was analysed using One-way analysis of variance (ANOVA) in Completely Randomized Design (CRD) while the means was separated using Duncans Multiple Range Test (DMRT). The highest germination percentage (68%) was recorded under the medium shade compared to the other shade treatments. The highest mean temperature (32.48) was recorded for the white cellophane plot with a percentage germination of 50%. The early growth stage of B. buonopozense which show highest average seedling height of 10.38cm was recorded under the white cellophane treatment while forest gap seedlings had the least average height growth of 4.42cm at 6 weeks after germination (WAG). Moderate shade and temperature are therefore recommended for the germination and early growth of B. buonopozense.

Key Words: Germination, Temperature, Early growth, Light, *Bombax buonopozense*

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INTRODUCTION

Bombax buonopozense P. Beauv. commonly known as the Gold Coast bombax or red-flowered silk cotton tree, is a tree in the Malvaceae (Bombacaceae) family (Robyns, 1963; 1970). In Nigeria, it is also known locally as Obokha in Edo, Akpu in Igbo and Eso in Yoroba (Aigbokhan, 2014). It is native primarily in West Africa, where it is found in rainforests from Sierra Leone in the northwest, east to Uganda and south to Gabon, typically at elevations of 900 to 1200 metres (Oyen, 2011). The species is a large tree; often reaches heights of 40 metres (130 feet) with buttress roots up to 6 metres (20 feet) in diameter. Various parts of *B. buonopozense* are used for medicinal purposes, as food, as a source of clothing fibre, as a building material, and as a dye (Neuwinger, 2000). The seed-floss is used for stuffing mattresses and cushions; sheets of bark have been used as roofing material for small huts while the wood is used for making dug-out canoes, troughs, quivers, stools and domestic appliances (Oyen, 2011). Although it has been proposed in the past to test *Bombax buonopozense* for the commercial production of kapok, it mainly grows wild, except for occasional planting as an avenue tree. It is also suitable as an agroforestry tree, for example staking of yams (Oyen, 2011).

When the seeds are grown in a wide range of environmental factors, it will reflect in the germination performance and the establishment

of healthy young seedlings (Bentsen, 2002). The time between the seed sowing and seedling establishment is considered to be the crucial period of any plant (Vaithiyanathan and Sundaramoorthy, 2016). The natural environment is favoured for growth and development of plant communities (Anamica and Dhaka, 2004).

Germination results in the formation of seedling, it is also the process of reactivation of metabolic machinery of the seed resulting in the emergence of radical and plumule (Oboho, 2014). Seed germination depends on both internal and external conditions (Rajjou *et al*., 2012). The most important external factors include right temperature, water, oxygen or air and sometimes light or darkness (Raven *et al*., 2005). Various plants require different variables for successful seed germination (Deno, 2014). Often this depends on the individual seed variety and is closely linked to the ecological conditions of a plant's natural habitat (Rout *et al*., 2000)

Quantitative experiments in which plant species are subjected to light and dark conditions therefore need to be examined in seed germination (Olajuyigbe and Akande, 2015). This study was aimed at evaluating the influence of temperature and shade on the germination and early growth of *B. buonopozense*.

MATERIALS AND METHODS

Study area

This study was carried out at the Nursery and Arboretum of the Department of Forest Resources and Wildlife Management, University of Benin, lying within the moist rainforest zone of Southern Nigeria. The average annual rainfall is 2500 mm while minimum and maximum temperatures range between 27˚C to 33˚C. The relative humidity is between 75% at noon to 95% at dawn (UNIBEN Master Plan, 1993). The Arboretum has spatial distribution of trees resulting to the heterogeneity of light levels due to variations in canopy structure and gap sizes.

Seed Collection and Germination

Matured fruits of *B. buonopozense* (Plate 1a) were collected from a mother tree in the Department of Forest Resources and Wildlife Management, University of Benin. The seeds (Plate 1b) were then extracted by separating it from the cotton wool like material (kapok) (Plate 1c) in the matured fruits of *B. buonopozense*. A total of 300 seeds were collected, and sown in 300 polypots of sieved top soil, each weighing 3kg. Fifty polypots of top soil were placed in each of the different treatment plots.

a: Fruits b: Seeds c: Kapok

Plate 1: Fruits, Seeds and Kapok of *Bombax buonopozense*

Site preparation

Three different light shades were selected. Two of the sites (forest gap and dense shade) were located in the Arboretum while the third site (open shade) was located in the Nursery. The open shade was divided into three temperature and light conditions; one plot was covered with black cellophane while another was covered with white cellophane. Thus, six germination conditions/treatments were created for this

study. A Lux meter was used to measure the level of illumination (Photosynthetic Active Radiation) at the different sites/germination treatments during different periods of the day. Six germination conditions/treatments and their average light levels (illumination) obtained using the Lux meter of ×10 magnification were: Open Shade/Control: 447.5 Lux (treatment 1, T1); Medium Shade: 157.5 Lux (treatment 2, T2); Forest gap: 12.5 lux (treatment 3, T3); Dense Shade: 3.2 Lux (treatment 4, T4); white cellophane: 317.5 (treatment 5, T5); black cellophane: -0.3 lux (treatment 6, T6). Each group of 50 polypots filled with topsoil was then stacked in the six treatment sites. Laboratory thermometers were used to take daily temperature readings.

Data Collection and Analysis

Data collected include number of germinant per day, total germinant per day and average daily temperature in degree Celsius (°C). Data was analysed using One-way analysis of variance (ANOVA) in Completely Randomized Design (CRD) while the means was separated using Duncan Multiple Range Test (DMRT).

Also, germination percentage for each treatment combination was calculated as follows:

$$\% \textbf{ Germinant} = \frac{\textbf{Total germinant}}{\textbf{Total seeds sown}} \times \textbf{100} \text{ ---------- [1]}$$

RESULTS

Shade Effect on Germination of *Bombax buonopozense*

Seed germination was first observed 3 Days After Sowing (DAS) under the black (2 germinant) and white (1 germinant) cellophane treatment and peaked on the 7 and 6 DAS with 6 and 5 germinant respectively. Germination was recorded for both open shade and forest gap at 4 DAS while, medium shade and dense shade germination was observed 5 Days After Sowing (DAS) (Table 1).

Observation of total germinant per day (TGPD) recorded shows a high germinant (19 and 21) under the black cellophane treatment at 7-8 DAS while the open/control shade treatment had higher germinant from 12-18 DAS. From 19- 22 DAS, medium shade had the highest total germinant per day (Figure 1).

Table 1: Germination (per day and total) of *Bombax buonopozense* under different Shade treatments

DAS	Open/Control shade		Medium Shade		Forest gap		Dense Shade		white cellophane		black cellophane	
	GP	TG	GP	TG	GP	TG	GP	TG	GP	TG	GP	TGP
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	1	1	2	2
4	2	2	0	0	1	1	0	0	1	2	2	4
5	0	2	1	1	2	3	1	1	1	3	5	9
6	5	7	3	4	2	5	2	3	5	8	4	13
7	10	17	11	15	8	13	9	11	5	13	6	19
8	2	19	3	18	1	14	3	14	1	14	2	21
9	1	20	3	21	0	14	2	16	3	17	0	21
10	1	21	1	22	1	15	1	17	0	17	1	22
11	1	22	0	22	0	15	0	17	0	17	0	22
12	1	23	0	22	0	15	1	18	1	18	0	22
13	1	24	0	22	2	17	0	18	2	20	0	22
14	1	25	1	23	1	18	1	19	1	21	0	22
15	3	28	1	24	1	19	2	21	1	22	0	22
16	1	29	2	26	2	21	1	22	2	24	1	23
17	0	29	1	27	3	24	2	24	0	24	0	23
18	0	29	2	29	1	25	1	25	1	25	1	24
19	0	29	4	33	1	26	1	27	0	25	1	25
20	2	31	1	34	1	27	0	27	0	25	0	25
21	0	31	0	34	0	27	0	27	0	25	0	25
22	0	31	0	34	0	27	0	27	0	25	0	25
Total	**31**		**34**		**27**		**27**		**25**		**25**	
Percent	62%		68%		54%		54%		50%		50%	

DAS: Days after sowing; GP: Germinant per day; TG: Total germinant per day

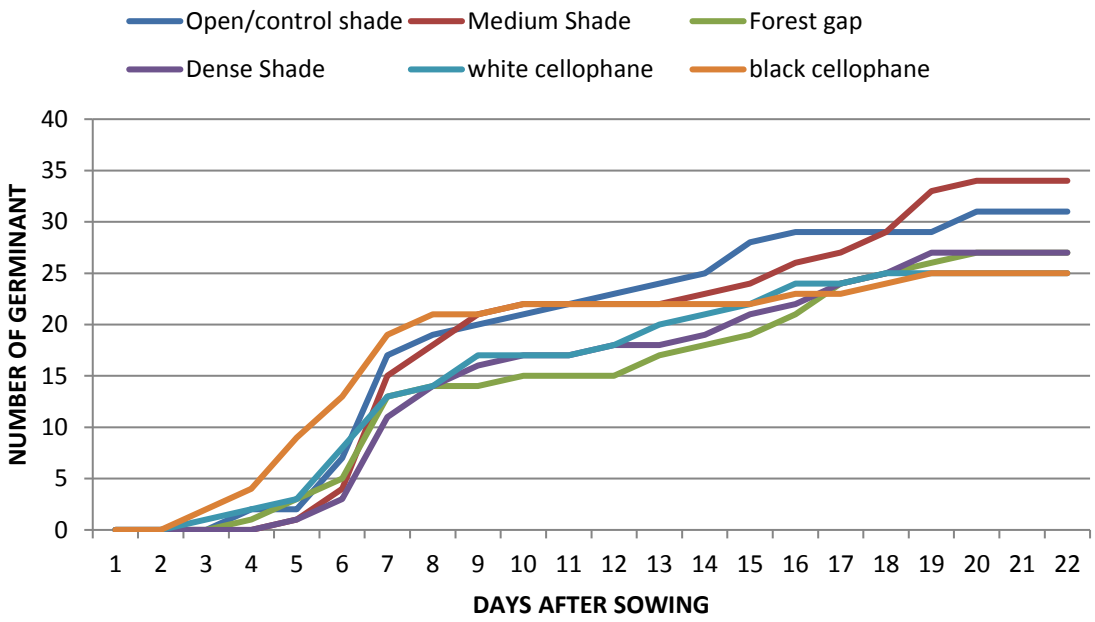

Figure 1: Germination Trend of *Bombax buonopozense*

Temperature Effect on Germination of *Bombax buonopozense*

Table 2 shows the average daily temperature reading for open/control, white cellophane and black cellophane treatments. The table reveals a mean temperature value of 29.5°C, 32.5°C, 31.5°C, 27.8°C, 28.1°C and 27.5°C was recorded for open/control, white cellophane, black cellophane, medium shade forest gap and dense shade treatments respectively. The data analysis reveals a significant effect of temperature on the germination of *Bombax buonopozense* seeds at p = 0.05.

The highest mean temperature was recorded in the white cellophane but was not significantly different from the control and black cellophane plots. However, the medium shade, forest gap and dense shade treatments did not differ significantly from each other but were significantly different from other treatments.

Table 2. Mean Temperature across Treatment Plots showing Standard Deviation and Standard Error

	Open/Control	White cellophane	Black cellophane	Medium shade	Forest gap	Dense shade
Mean (°C)	29.51^{bc}	32.48^{a}	31.52^{ab}	27.76^{c}	28.05^{c}	27.45^{c}
Standard Error	0.50	0.67	0.70	0.51	0.51	0.51
Standard Deviation	2.34	3.14	3.27	2.38	2.37	2.37

Temperature Effect on Germination of *Bombax buonopozense*

The result in Figure 2. shows that the total number of germinant (34) was highest for the medium shade temperature. Although the white cellophane plot had the highest mean temperature (32.48), followed by the black cellophane plot (32.48); both plots recorded the lowest number of germinant (25 germinant each).

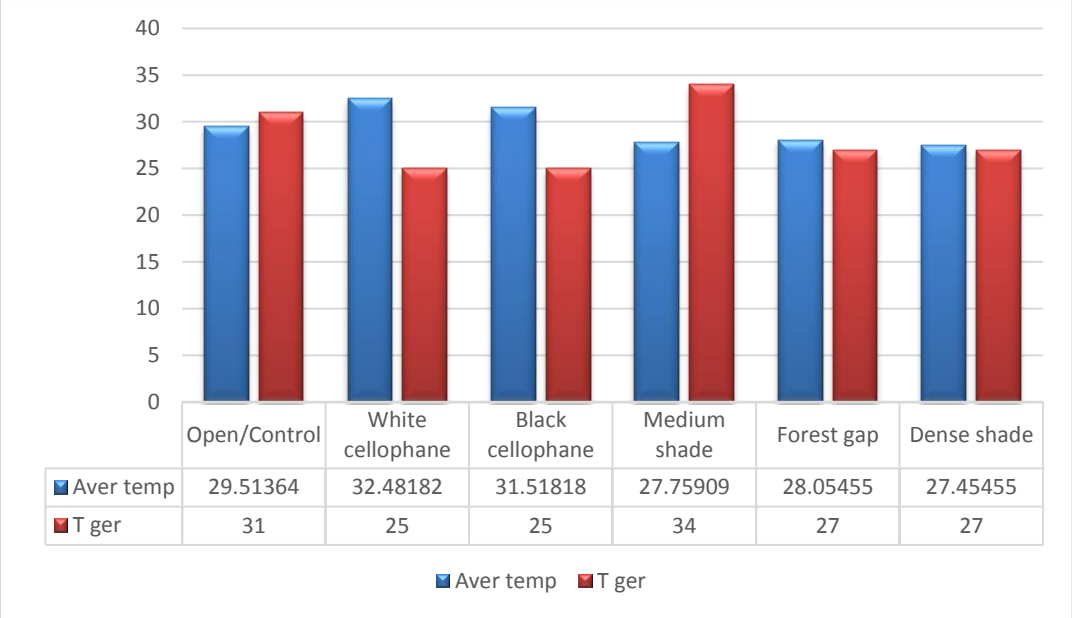

Figure 2. Effect of temperature on total number of *B. bounopozense* germinant.

Early Growth of *Bombax buonopozense*

The early growth stage of *B. buonopozense* revealed that seedlings under the white cellophane treatment performed better with highest average height of 10.38cm at 6 weeks after germination (WAG). This was followed by seedlings under open/control treatment (8.73cm) while forest gap seedlings had the least average height growth of 4.42cm (Figure 3). The data analysis shows a significant effect of the shade treatment on the seedling height growth of *B. buonopozense*.

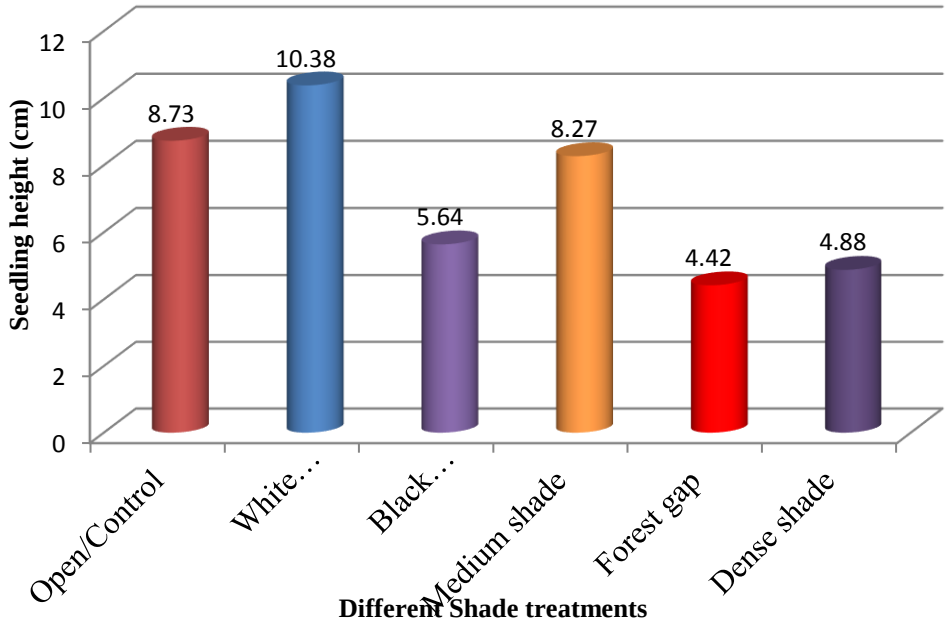

Figure 3: Average Seedling Height (cm) of *Bombax buonopozense* at 6 WAG

DISCUSSION

Seed germination of *B. buonopozense* that was first observed 3-5 Days after sowing (DAS) for all treatments disagree with 8-12 days recorded by Oyen (2011). This difference may be due to the sown depth (0.5cm) and or seed viability as different plant species have been known to have the ability to grow in a wide range of planting depth. Also, Opande *et al*. (2017) opined that deep seed sowing has a number of effects on

growth of seedlings, for instance, there may be an increase in the time between seed germination and seedling emergence.

The highest germination percentage (68%) recorded under the medium shade compared to the other shade treatments is a clear indication that seed germination of *Bombax buonopozense* is best under shade level with average PAR of 157.5 Lux. This may be due to the fact *B. buonopozense* can be classified as non-pioneer light demander (NPLD). A typical NPLD can perform its physiological functions at low light levels (i.e. compensation point) under the forest understorey but would take advantage of any opening in the canopy to maximize available illumination for growth enhancement (Isikhuemen and Oyibotie, 2018).

Also, the early seed emergence (3 DAS) under the black and white cellophane treatment with mean temperature 31.5°C and 32.5°C respectively can be attributed to the increase in temperature as compared to the open/control treatment. This result is in line with the findings of Alamu and Alabi (2015) who recorded highest effect on seed germination of *Terminalia ivorensis* treated with water at 98.4°C. Some related studies revealed that the temperature fluctuations can change the responses of seeds to light, thus seeds that germinate only under light can be able to germinate in darkness when submitted to alternating temperatures as observed by Godoi and Takaki (2004) in *Cecropia hololeuca* and Sugahara and Takaki (2004) in *Psidium guajava*. In general terms, silvicultural practices that introduce a high or optimal temperature level to seeds during sowing/pre-planting operations will ultimately enhance a favourable germination.

The early growth stage of *B. buonopozense* which show highest average seedling height of 10.38 cm recorded under the white cellophane treatment while forest gap seedlings had the least average height growth of 4.42 cm at 6 weeks after germination (WAG) is an indicator of the shade and temperature effect on growth.

CONCLUSION

Higher germination percentage was observed for seeds that were sown under light conditions, while lower germination percentage was observed for seeds under dark condition. Light enhanced growth of *B. buonopozense* but could still germinate in dark conditions. Hence the species should not be planted too deep in the soil.

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