Vol. 16(5), pp. 714-721, May, 2020
DOI: 10.5897/AJAR2019.14235
Article Number: 3AB094563752
ISSN: 1991-637X

http://www.academicjournals.org/AJAR

ACADEMIC JOURNALS
expand your knowledge

African Journal of Agricultural Research

Full Length Research Paper

Effects of variable light intensities on seedling photomorphorgenesis and field performances of tomato (*Solanum lycopersicon* 'Lindo F1)

Onyia V. N.[1], Eze S. C.[1]*, Chukwu C.[2], Awere S. U.[2], Atugwu A.[1], Agba O. A.[3] and Uzochukwu C.[1]

[1]Department of Crop Science, Faculty of Agriculture, University of Nigeria, Nsukka, Enugu State, Nigeria.
[2]Department of Agronomy and Ecological Management, Faculty of Agriculture and Natural Resource Management, Enugu State University of Science and Technology (ESUT), Enugu State, Nigeria.
[3]Department of Agronomy, Faculty of Agriculture, Cross River University of Technology, Obubra Campus, Cross River State, Nigeria.

Received 6 June, 2019; Accepted 6 January, 2020

Six tomato (*Solanum lycopersicon* 'Lindo F1) nursery shades and no shade control were evaluated for their effects on seedling photomorphogenesis and field performances as influenced by variable light transmission through the shades. The shades were constructed with wooden frames and different coloured polyethylene sheets as cover (roof). Different polyethylene colours showed varying effects on all the parameters measured. The control treatment (no shade) and green colour shade transmitted the highest light intensity while black and blue coloured shades received the highest temperature and no shade, the lowest. Early emergence and highest percentage emergence (68.8%) was observed under green shade colour compared to blue, red and non-shaded seedlings that gave 54.2, 60.4 and 52.5%, respectively. The environmental variables, light and temperature created microclimates in each of the shades that differed significantly and influenced physiological activities of the seedlings as evidenced in their yield parameters. Regression analysis revealed that light was more important than temperature in tomato plant growth and development. Evidence from the study revealed that the different coloured shades transmitted different light wave lengths to the seedlings in the nursery and consequently affected seedling performance in the field. Conclusively, tomato nursery under no shade treatment produced high quality seedlings that performed better under field conditions than those seedlings raised in the shade. If shades must be used, green and red colours which are capable of transmitting enough light waves for effective photosynthesis of the seedlings are recommended.

Key words: Light intensity, seedling, photomorphorgenesis, nursery, shade, photosynthesis.

INTRODUCTION

Tomato (*Solanum lycopersicon* L.) is one of the most widely grown vegetables in the world, an important

*Corresponding author. E-mail: simon.eze@unn.edu.ng. Tel: +234-8036419427.

condiment in most diets and a very cheap source of vitamins (Olaniyi et al., 2010). Tomato was introduced into West Africa by expatriate missionaries and civil servants (Uguru, 2011). It is a short-lived herbaceous plant with weakly woody stem that grows erect at the early stage but later slump to the ground due to the fruit weight. Usually, it grows 1 to 3 m or more above ground with well-developed taproots that branch profusely to form dense root systems (Uguru, 2011). Tomato plants are dicots, and grow as a series of branching stems, with terminal bud at the tip that does the actual growing. The vines are covered with fine short hairs that form or develop into roots whenever the plant makes contact with the ground and moisture.

Tomato products are generally stocked with vitamins (particularly vitamin C), minerals, fibers, antioxidants and phytonutrients that work together to help us stay healthy and fit. They are also a rich source of vitamin A and potassium (Jacy and Marilyn, 2003). Among their arsenal of nutrients, scientists are particularly intrigued with carotenoids, which are antioxidants that inactivate free radicals, slow progression of atherosclerosis, and protect us against cancer. Lycopene is what gives tomatoes their rich red colour. It is also what gives red colour to watermelon and pink grapefruit, but tomato and tomato products are the richest source of lycopene (Jacy and Marilyn, 2003).

Plants are capable of detecting and interpreting variety of environmental signals that influence their growth and development. Unique among these environmental signals is light. Sunlight satisfies two major important needs of biological organisms; energy and information. Radiant energy in the form of light from the sun is used by plant in manufacturing food through photosynthesis and to regulate movement, trigger developmental events and mark passage of time. Thus light is referred to as a narrow band of energy, with continuous electromagnetic spectrum emitted from the sun. In other words, it is the range of wavelength between 400 and approximately 700 nm. This range is defined as the photosynthetically active radiation (PAR), even though plants respond to other ranges of light like UV radiation (Hopkins and Huner, 2009).

The quantity and quality of light are constantly changing often in predictable ways. According to Hopkins and Huner (2009), plants are able to monitor these changes and make use of this information to direct growth and reproduction and the regulation of plant development by light is termed photomorphogenesis. The researchers further reported that plants have highly developed photo sensory systems comprised of light-sensitive photoreceptors and signal transduction pathways capable of acquiring and interpreting the information that is provided by light. A photoreceptor "reads" signal carried in the light by selectively absorbing different wavelength of light. This induces a conformational change in the pigment or an associated protein, photochemical oxidation reduction reaction, or some other form of photochemical change (Hopkins and Hunner, 2009). Whichever form the change takes, absorption of light normally induces a photochemical change that sets into motion a flow of events that ultimately results in developmental response. Therefore, manipulating any colour of the visible spectrum will influence plant developmental process.

Tomato yield is not an isolated characteristic and depends on the growth of the whole plant. If the tomato plant does not grow well after germination, then it will never give a high yield. Therefore yield is determined by the interaction between plant morphology, physiology and growth conditions (Van Der Ploeg and Heuvelink, 2005) It has been reported that different polyethylene colours used as shade reflect different spectra of the visible light and transmit some spectra of the visible light with consequent effects on physiological behaviors of plants. According to the author, varied light intensity causes varied light regulated developmental responses in plant which also influences the crop yield. Diverse light intensities applied during nursery would have an influence on different aspects of tomato growth and development, for example leaf and truss appearance, fruit growth period among other stages of developments (Van Der Ploeg and Heuvelink, 2005). Traditionally, tomato farmers adopt tree shades or constructed shades with plant materials for their nursery practices. The seedlings get indirect light transmission thereby forcing the seedlings to tilt towards the direction of sun light. Under this condition, most seedlings have their tips bent to more or less 45° during transplanting.

In the present work, we investigated the effects of diverse light intensities on growth, development and ultimately yield of tomato. We hoped to develop a nursery shade technique that farmers can employ with low demand on cost, skill and facilities to produce high yield. The specific objectives were to develop six micro climates using coloured polyethelene sheets as shade for tomato seedlings and to determine the effects of the micro climates on seedling growth in the nursery and final field growth and yield performance of tomato.

MATERIALS AND METHODS

Two experiments comprising nursery and field studies were conducted at the Department of Crop Science, University of Nigeria, Nsukka Research Farm between May and September 2017. Nsukka is located on latitude 06° 51'E and longitude 07° 29'N with an altitude of 475 m above sea level. It is characterized by lowland humid condition with bimodal annual rainfall distribution that ranges from 1155 to 1955 mm, a mean annual temperature of 29 to 31°C and a relative humidity that ranges from 69 to 79% (Uguru, 2011) in derived savanna ecology.

Nursery shades construction

The six nursery shades used were coloured polyethylene sheets comprising red, green, black, colorless, yellow and blue. The colored polyethylene sheets were of the same size and thickness. The shade for each experimental unit was constructed with 5 x 5 cm wooden bars each measuring 1.2 m long. One end of each wood was sharpened for easy pinning into the ground for support. Eight (8) pieces were used in the construction of each unit. The ground was first softened by watering before the pegs were pinned into the ground. They were driven into the ground perpendicularly by using a mallet to hammer the unsharpened end of the wooden poles until only 1 m length was left above ground (this makes for strong support). Footpath of 1 m wide was created among treatments as well as a 3 m gap between the surrounding vegetation and treatments. Each wooden frame was covered with different coloured polyethylene sheets according to the design to form a nursery shade (unit). The covering was from the top of the wooden frame to the ground in the direction of South-West wind to reduce damage to the polyethylene. However, on the other side receiving mild wind, the covering was left hanging 5 cm from the ground to allow for ventilation and to discourage influx of pest. The polyethylene sheets were fastened to each leg of the wooden frame with a twine to reduce effect of wind force on the seedlings. The top of the shade was perforated and tilted slightly to avoid collection of rain water on the top of the shade. There was a control frame without shade.

Nursery preparation

The poultry manure was dry and well cured as it was from battery cage. It was composted before use to reduce excessive heat build-up in the nursery. The medium was a conventional method prepared in the ratio of 3: 2: 1 of top soil, river sand and poultry manure respectively. The materials were thoroughly mixed and loaded into a wooden tray measuring 45 x 45 x 5 cm. About ¾ of each tray was filled with the medium materials. Seed viability test gave 98% germination before the tomato seeds were planted in grooves made on the medium in the trays. The trays were then put under each constructed shade treatment. The tomato variety used was “Lindo F1” marketed by Technisem - ZAC Anjou Actiparc de Jumelles - 49160 Longué-Jumelles – France.

Experimental design

The first experiment comprised of six coloured polyethylene shades and one control (no shade) treatment replicated three times in a completely randomized design (CRD) fashion. It was nursery experiment where each shade formed an experimental unit. The second experiment was set out in the field to evaluate the performances of the seedlings from the nursery. The land was mapped out into blocks and plots. Each plot measured 1.8 m long and 1.4 m wide with 1 m wide pathway on each side of the plot. Plant spacing was 60 cm between rows and 40 cm within rows.

Parameters measured in the experiment

Temperature (°C) and light intensity (Wm^{-2}) inside the nursery shade were measured. The temperature was measured using thermometer Model G11510 got from the Plant Pathology Laboratory of the Department of Crop Science, University of Nigeria, Nsukka. Light intensity was measured with a KIMO Solarimeter Model SAM 20:22493 obtainedfrom Energy Research Center, University of Nigeria, Nsukka. The reading was taken at daily interval for a period of four weeks and then the average was found.

Agronomic parameters such as days to seedling emergence, plant height, number of leaves, stem girth, internode lengths were measured in the nursery. Days to seedling emergence was determined by counting days between planting and plant emergence, while plant height was measured using meter rule and tailors’ measuring tape. Height measurement was taken from the growing medium surface to the top of the growing point on the stem (not the top of the leaf), number of leaves by counting; stem girth was measured with Micrometer screw gauge manufactured by Moore & Wright, Sheffield, England. A member of the NEILL group at two and four weeks after planting.

Field establishment stage

Site preparation

This stage of the experiment was to evaluate the field performance and yield of tomato seedlings raised under different coloured nursery shades. Poultry manure was applied liberally to the plots before transplanting. The manure was incorporated into the soil and allowed to further decompose for 5 days for the heat to dissipate before transplanting.

Transplanting

The seedlings were transplanted after 5 weeks in the nursery. Before transplanting, watering was reduced to a 3-day interval and the polyethylene sheets were removed 5 days before transplanting. This measure was taken to harden the seedling and reduce shock and stress after transplanting, and to gradually acclimatize them to the conditions of the field. The seedlings were well watered before transplanting to soften the soil so that the roots would not get damaged in the process.

Data collection and analysis

Parameters measured in the field were plant height at flowering, days to flowering for each sampled plant, days to fruiting, number of trusses per sampled plant at 2 and 4 weeks after transplanting (WAT), number of fruits per truss, number of fruits per plant at 2 and 4 WAT number of branches per plant, number of diseased fruits at maturity, number of fruits harvested per sampled plant, fruit length and circumference of each harvested fruit, days to fruit ripening, days to first harvest, weight of fruits harvested for each sampled plant. Fruit weight was measured using Furi Electronic Scale (Model No 7.1529) from Soil Science Laboratory, University of Nigeria.

All data collected were subjected to analysis of variance (ANOVA) following the procedures for CRD and RCBD using Genstat 4.0 Release 4.10.3DE. Treatment means were separated with F-LSD at 5% probability level. Graphical presentations were prepared with the Microsoft Excel chart wizard. Multiple linear regression analysis was done to determine the relationship between the environmental variables and yield parameters of the test crop. The backward elimination method was employed and the lower contributing variable was removed from the model in each case.

RESULTS

The amount of temperature and light intensity transmitted through the nursery shades varied (Figures 1 and 2). Generally, temperature under the polyethylene shades was higher than normal outside temperature especially during day time (Figure 1). The green polyethylene

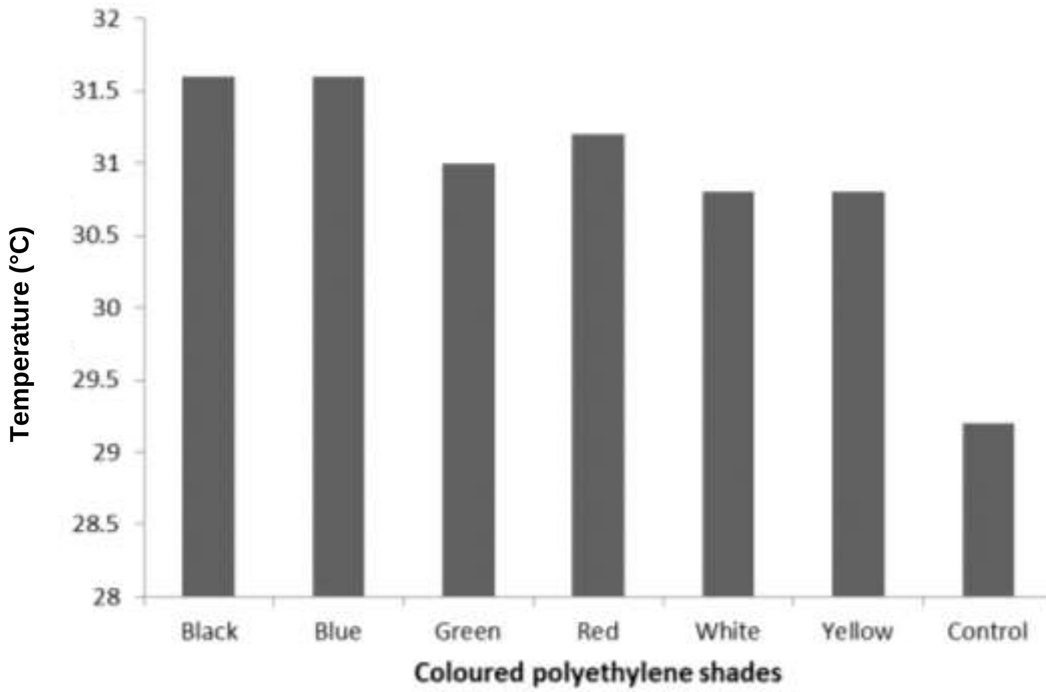

Figure 1. Average daily temperature (°C) reading inside the shades for five weeks.

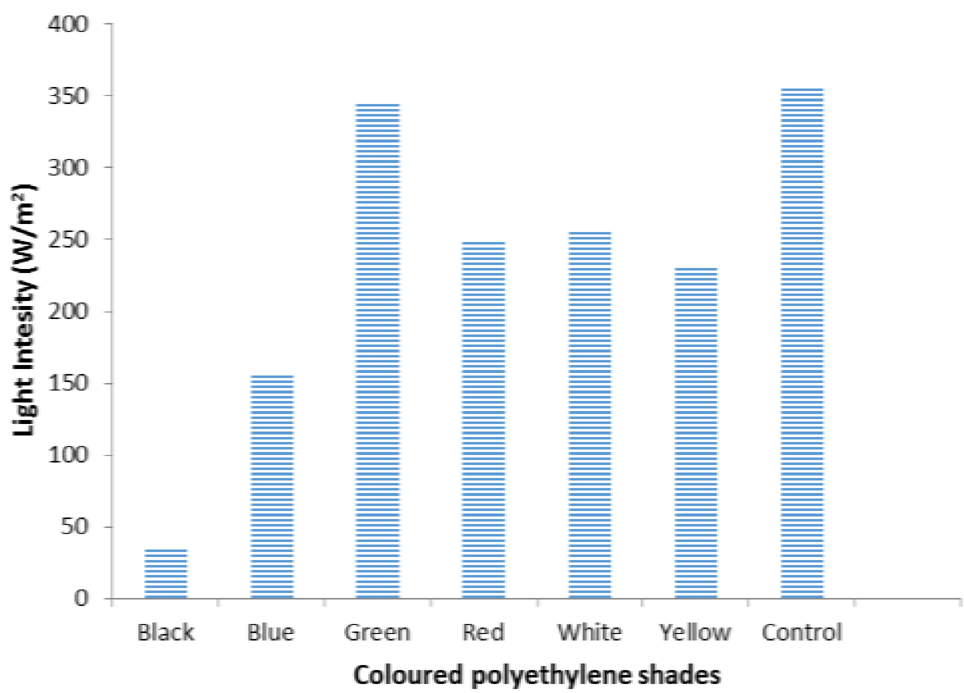

Figure 2. Average weekly light intensity (w/m^2) inside the shades for 4 weeks.

transmitted the highest light intensity, while black polyethylene transmitted by far the least light intensity of 35 w/m^2 followed by blue shade (157.5 w/m^2). The control treatment (no polyethylene shade) and green colour shade received the highest light intensity while black and blue coloured shades received the highest temperature

Table 1. Effect of nursery shade colour on seedling emergence pattern of tomato 'Lindo F1'.

Shade colour	Days to 1st emergence	Days to 50% emergence	Percentage emergence at 1st emergence	Percentage emergence at 1 week after planting	Percentage emergence at 2 weeks after planting
Black	5.67	-	9.24	-	-
Blue	5.67	9.00	12.50	25.00	54.20
Control	6.00	10.00	10.50	39.60	52.50
Green	5.67	7.00	27.10	53.80	68.80
Red	5.67	9.33	14.60	27.10	60.40
White	6.00	9.33	8.30	20.80	54.20
Yellow	5.67	8.00	29.30	41.70	66.70
LSD (0.05)	NS	1.81	17.48	27.67	21.74

Table 2. Effect of nursery shade colour on growth parameters of tomato 'Lindo F1' at 2 and 4 weeks after planting.

Shade Colour	Plant height at 2 weeks	Plant height at 4 weeks	Leaf count at 2 weeks	Leaf count at 4 weeks	Stem girth at 2 weeks	Stem girth at 4 weeks	Inter node length at 4 weeks
Black	-	-	-	-	-	-	-
Blue	6.42	12.82	8.44	21.60	2.40	4.56	3.52
Control	7.73	14.84	19.78	59.10	4.98	6.93	2.49
Green	6.99	14.50	9.44	23.30	3.17	5.15	3.97
Red	5.73	10.63	7.56	17.00	2.55	4.69	3.04
White	5.77	12.53	8.22	21.60	3.54	5.70	3.31
Yellow	7.71	16.82	11.20	30.80	3.38	5.60	4.19
LSD(0.05)	1.76	3.48	3.37	11.65	0.92	0.94	1.05

and no shade, the lowest.

The use of different polyethylene colours as nursery shade had no significant effects on seedling emergence six days after planting (Table 1). However, there was a significant ($P<0.05$) difference on the number of days to fifty per cent seedling emergence. The least number of days to fifty percent germination was recorded for seedlings grown under the green shade as it took only seven days to attain fifty percent germination. The yellow shade followed closely with less number of days, while blue, red and white colour shade seedlings showed about the same number of days to seedling emergence. The highest number of days to fifty percent emergence was recorded from the control while seeds planted under the black shade never attained fifty per cent emergence.

Seedling height, number of leaves and stem girth were significantly ($P<0.05$) affected by different polyethylene colours used as nursery shade at two weeks after planting. Seedlings grown under yellow shade and the non-shaded seedlings were the tallest compared to seedlings grown under red and white shades (Table 2). Seedlings grown under non-shaded frames had significantly ($P<0.05$) the highest number of photosynthetically active leaves of about (19.78) at this stage followed by yellow shade, while those grown under blue, green, red and white shades had the smallest which did not differ significantly. Tomato seedlings grown under different nursery shades responded differently to polyethylene colour effects at four weeks after planting. Seedlings grown under the yellow shade rapidly outgrew others and attained the tallest height and largest inter node length at four weeks after planting compared with blue colour and others (Plate 1a and b). There was no parameter measured for seedlings grown under the black polyethylene shade as the seedlings changed to a pale colour with spindle growth and died off at six days after germination.

The data regarding the field agronomic parameters of tomato plant are presented in Table 3. The seedlings raised in the green nursery shade produced the tallest plants (71.6 cm) compared to blue and un-shaded (no shade treatment). Plants from red, white and yellow shades were statistically similar to each other having heights of 68.4, 69.3 and 69.6 cm respectively. Plants from the control (unshaded) nursery flowered in a shorter period of 32 days followed closely by plants from green and white shades. Seedlings from unshaded (full sun) took the least number of days to fruit and for the fruit to get ripened compared to plants from blue shade nursery. Plants grown under the green shade significantly ($p \leq 0.05$) greater number of fruits at two weeks after transplanting while the plant grown under the blue shade consistently had the least number of flowers and fruits at two WAT. There was no significant difference in number

(a) **(b)**

Plate 1. Tomato seedling under a) yellow shade and b) blue shade.

Table 3. Effect of coloured polyethylene shade on field agronomic yield parameters of tomato ‘Lindo F1’.

Shade colour	PHF (cm)	DFL	DFrt	DFrtRip	NF2wkT	NF4wkT	NT2wk	NT4wk	NBM
Black	-	-	-	-	-	-	-	-	-
Blue	63.40	46.50	57.50	88.44	11.11	23.22	2.778	6.89	3.89
Control	46.20	32.00	41.50	71.00	9.44	18.56	3.333	8.56	4.00
Green	71.60	34.40	39.20	84.78	13.22	24.22	2.778	7.22	3.56
Red	68.40	46.20	52.20	86.00	12.17	22.17	2.667	6.33	3.33
White	69.30	38.70	51.20	83.94	11.11	23.33	3.333	8.33	4.56
Yellow	69.60	46.00	57.20	87.17	12.72	29.33	2.778	8.11	4.50
LSD(0.05)	13.34	11.90	12.74	7.70	3.04	6.66	0.66	NS	NS

PHF= Plant height at flowering, DFL= Days to flowering, DFrt= Days to fruiting, DFrtRip= Days to fruit ripening, NF2wkT= Number of fruits at two weeks after transplanting, NF4wkT= Number of fruits at four weeks after transplanting, NT2wk= Number of trusses at two weeks after transplanting, NT4wk= Number of trusses at 4 weeks after transplanting, NBM= Number of ranches at maturity.

Table 4. Effect of nursery coloured polyethylene shade on yield components of Tomato ‘Lindo F1’.

Shade colour	NDF4wk	NHF	NFL2wkT	FL(cm)	FC (cm)	TFW (g)	AvFW (g)	Yield (t/ha)
Black	-	-	-	-	-	-	-	-
Blue	4.39	4.17	9.90	5.006	14.88	252.915	61.00	3.50
Control	2.78	4.83	10.00	5.787	15.54	247.633	48.90	3.43
Green	3.00	6.00	21.70	5.965	17.24	499.348	90.20	6.94
Red	2.83	6.50	17.20	5.816	16.80	581.153	89.80	8.07
White	2.89	4.39	17.20	5.531	16.10	325.610	72.40	4.51
Yellow	3.44	6.72	16.30	5.223	15.74	452.608	71.30	6.27
LSD(0.05)	NS	NS	7.90	0.629	1.49	247.200	17.79	3.43

NDF4wk=Number of diseased fruit at 4 weeks after transplanting, NHF= Number of harvested fruit at maturity, FL=Fruit length, FC= Fruit circumference, TFW= Total fruit weight, AvFW= Average fruit weight, Yield= Yield in tons per hectare.

of fruits at two and four weeks after transplanting among the blue, white and green shaded plants. Number of trusses per plant was highest for plants grown under unshaded and white shaded frames after two weeks of transplanting compared to plants grown under blue, green, and yellow shades.

There was no significant effect on number of diseased fruits at four weeks after transplanting (Table 4). However, seedlings under control (no shade treatment) recorded the least disease incidence on the fruits in the field. Those seedlings under green shades produced fruits with the highest length and fruit circumference

Table 5. Model summary tables of multiple linear regression of environmental variables and tomato yield parameters.

Model	R	R Square	Adjusted R square	Standard error of the estimate
(a) Total fruit yield (t/ha)				
1	0.709[a]	0.503	0.255	1.517
2	0.673[b]	0.453	0.343	1.424
(b) Average fruit circumference				
1	0.732[a]	0.536	0.305	12.061
2	0.696[b]	0.485	0.382	11.371
(c) Average fruit length				
1	0.805[a]	0.647	0.471	0.249
2	0.673[b]	0.453	0.344	0.277
(d) Number of harvestable fruits				
1	0.589[a]	0.347	0.020	1.003
2	0.564[b]	0.318	0.182	0.917
3	0.000[c]	0.000	0.000	1.013

[a]Predictors: (Constant), Temp, light; [b]Predictors: (Constant), light; [c]Predictor: (constant).

(5.965 cm) and (17.24 cm) respectively compared to plants grown in blue polyethylene shade. Total fruit weight, average fruit weight and yield (t/ha) were significantly ($p \leq 0.05$) affected by different polyethylene colours shades used as nursery.

Multiple linear regression models with only 2 explanatory variables; light and temperature were entered in the model but temperature was always removed as a lower contributing variable as shown in Table 5a-c. Both light and temperature were removed from the model for number of harvestable fruits with almost the same values of R and R-Squared (Table 5d).

DISCUSSION

Factors other than light and temperature could influence seedling emergence and growth, but for this study only light and temperature were monitored. The study showed significant polyethylene colour effects on light transition, seedlings emergence, growth and development inside the nursery under the shades. Although, rate of photosynthesis was not measured in this study, seedlings in the no shade and green coloured shades that had the highest light transmission performed better in the field in terms of total yield suggesting that those seedlings had more photosynthetic activities than others. The highest and significant ($P \leq 0.05$) number of leaves produced by the no shade seedlings in this study can explain reasons for higher photosynthesis by seedlings in no shade treatment. It is also interesting here to note that active photosynthesis in the nursery had residual effects in the field performance due to good quality seedlings as influenced by different light intensity transmitted by the polyethylene colour in the nursery shades.

Variation in plant response to different light intensities is brought about by light attributes such as its intensity and wavelength (Baiyeri, 2006). It has been observed that the micro environment in which seedlings are grown has a major effect on growth and development of crops. This agrees with the findings of Hopkins and Huner (2009) which stated that the germination of seeds and survival of the seedlings that emerge are largely dictated by conditions in their immediate environment. Growth rate of crops at any instant time is related to earlier environmental effects on the plant biomass (Baiyeri 2006). Another study by Abdalbagi et al. (2010) disclosed that in the tropics, tomato is mostly produced through nursery and that good quality seedling usually leads to higher yield and early maturity in the field. It was also noted that poor quality seedling might not be improved by any means of management after being transplanted in the field. Thus seedlings that performed best in the nursery would likely grow better and faster when re-established in the field.

Observation from the study showed that emergence was poor for the black polyethylene shade, and the few plants that germinated showed a spindle growth with only two leaves which could not sustain and they finally slumped and died off after six days. This could be related to the insufficient light transmitted by the black polyethylene shade and inability of the plants to photosynthesize coupled with high temperature in the shade that made plant survival difficult. The best field performance of the plants from the green polyethelene shade could be attributed to the combination of light intensity and temperature under the green polyethylene which appeared to be the optimum for seedling development compared to other polyethylene covers. This agrees with the findings of Baiyeri (2006) in his study on pawpaw (*Carica papaya*) where he reported that the green polyethylene shade enhanced emergence and seedling quality in the nursery. Hopkins and Huner (2009) had earlier noted that absorption of light for normal photosynthesis induced a photochemical change that set into motion a flow of events that ultimately resulted in plant response to manipulation of any colour of the visible spectrum that influences plant developmental process. With respect to seedling height, leaf number and stem girth, seedlings grown under the no shade were superior in leaf number and stem girth at two and four weeks after planting while seedlings in the shade grew taller. This could be attributed to the inadequate light intensity in the shade while those outside shade received enough light intensity earlier for photosynthesis. These observations are supported by Thangam and Thangburaj (2008) who noted that plants grown under shade exhibited better growth in terms of plant height as compared to those in open field. However, the authors did not explain how they came about the result but light could be implicated.

Variation in fruit length, fruit circumference and average fruit weight of fruits from plants raised in different polyethylene sheets was observed in this study. The outstanding performances of plants raised in the green coloured nursery shade suggest that green shade possess the best microclimate for development of tomato seedlings. Tuzel et al. (2009) had earlier noted that environmental modification is important for tomato growth and development in the derived savannah agro-ecology where shading increased total yield per plant. Seedlings raised under the blue polyethylene shade had the highest number of diseased plants at four weeks after transplanting. This could be attributed to poor development of the seedlings as a result of low light intensity for adequate photosynthesis thereby making the plants weak and susceptible to disease attack (Hanson et al., 2000).

The result of regression analysis in this study showed that light is more important than temperature in tomato plant growth and development. This result corroborates Hopkins and Hunner (2009) assertion that plant utilizes light directly in biomass production through photosynthesis for all aspect of growth. It is evident in this study that tomato seedlings in the green polyethylene shades and control (no shade) that received up to 350 w/m^2 light intensities were highest in the yield parameters. The environmental parameters; light and temperature did not affect number of harvestable fruits. This is not surprising since only one variety of tomato with a particular genetic make-up was used. The result therefore, suggests that number of fruits produced by plants could be more of gene attribute than environmental effects.

Conclusion

It is evident in this study that difference in seedling morphogenesis and physiological quality of seedlings produced under the nursery shades evaluated were mainly due to variation in light intensity and temperature regimes under the shades. The higher yield parameters obtained in no treatment (no shade) nursery and green coloured shade could be accounted by the amount of light transmitted which probably resulted in greater photosynthesis of seedlings in these nurseries. It is also clear that the seedlings in the other shaded nurseries carried residual effects of low vigour to the field due to low accumulation of energy in the nursery that resulted from inadequate light transmission compared to green shade and open field. Conclusively, tomato nursery under no shade treatment gives better quality seedlings that withstand field conditions than those seedlings raised under shade. If shades must be used, green or red colour which are capable of transmitting enough light wave for effective photosynthesis to produce high quality seedlings is recommended based on our findings in this study.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Abdalbagi AH, Salih OS, Abdu EA, Ahmed M E (2010). Effect of Sowing Date and Plant Density on Growth and Yield of Tomato (Lycopersicon Esculentum, Mill.). Research Journal of Agriculture and Biological Sciences 6(5):665-669.

Baiyeri KP (2006). Seedling emergence and growth of pawpaw (*Carica papaya*) grown under different coloured shade polyethylene. International Agrophysics, pp. 77-84.

Hanson P, Chen J, Kuo C, Morris R, Opena R (2000). International Cooperator's Guide-Suggested Cultural Practices for Tomato. Shanhua: AVRDC-Asian Vegetable Research and Development Center. Retrieved from http://www.avrdc.org.tw

Hopkins WG, Huner NP (2009). Introductaion to plant physiology. John Wiley & Sons, Inc.

Jacy W, Marilyn OW (2003). Nutrition For Older Adults' Health. Athens: Department of Food and Nutrition, The University of Georgia.

Olaniyi J, Akanbi W, Adejumo T, Akande O (2010). Growth, fruit yield and nutritional quality of tomato varieties. African Journal of Food Science 4(6):398-402.

Thangam M, Thamburaj S (2008). Comparative perfromance of tomato varities and hybrids under shade and open conditions. Indian Journal of Horticulture 4:65.

Tuzel Y, Oztekin G, Meric M (2009). Influence of shading screens on microclimate, growth and productivity of tomato. Acta Horticulturae, pp. 97-102.

Uguru MI (2011). Crop Production: Tools, Techniques and Practice. Enugu: Fulladu Publishing Company.

Van Der Ploeg A, Heuvelink E (2005). Influence of sub-optimal temperature on tomato growth and yield: a review. Journal of Horticultural Science and Biotechnology, pp. 652-659.