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Effect of Led Lights on Fodder Production in Pipe Framed Hydroponic Structure

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A B S T R A C T

The study entitled "Effect of LED Lights on Fodder Production in Pipe Framed Hydroponic Structure". The field experiments were laid out in factorial randomized block design with 19 treatments and 3 replications for maize crop. The treatments consisted of two LED's reddish purple and white, three durations viz., 4 h, 8 h and 12 h and three LED light intensity levels viz., 480 lux, 740 lux and 930 lux along with control treatment. The maximum plant height, fresh weight and chlorophyll content of maize using reddish purple LED was found to be 23.807 cm, 2.672 kg and 25.226 mg/g, respectively. The maximum plant height, fresh weight and chlorophyll content of maize using 12 h LED duration was found to be 24.144 cm, 2.749 kg and 25.356 mg/g, respectively. The maximum plant height, fresh weight and chlorophyll content of maize using LED light intensity of 930 lux was found to be 24.689 cm, 2.843 kg and 26.006 mg/g, respectively. It was found that reddish purple LED, 12 h duration of LED and LED light intensity of 930 lux showed better desirable results compared to white LED and control, 4 h and 8 h duration of LED and light intensity of 740 lux and 480 lux.

Introduction

The word hydroponics has been derived from the Greek word 'water working'. Hydro means 'water' and ponic means 'working' and it is a technology of sprouting grains or growing plants without soil, but only with water or nutrient rich solution. However, hydroponic fodder can be well produced with the use of fresh water only and the use of nutrient rich solution is not obligatory. Fodder crops produced through hydroponics technology are also known as hydroponics fodder, sprouted fodder or sprouted grain. Sprouting of the grains is made inside a shade net house within a short period of approximately seven days.

Lighting is factor that affects the growth and development of plants. Because light is an important factor in building a food or photosynthesis of plants with chlorophyll this

sensor uses energy to change carbon dioxide and water into carbohydrates and oxygen exposure other factors that affect the growth of plants, including wavelength, light intensity, duration of the light on the crop are features that affect the growth of plants (Luechai, 2015). The length of light waves at 430-460 nm and 630-660 nm estimated that due to the length of the light wave is ideal for the photosynthesis of plants and also help in the growth. The benefits of blue light (Wavelength 430-460 nm) is the light waves chlorophyll a, b can absorb more. Chlorophyll makes plants can stimulate the production of light even more. Extending photoperiod can produce more carbohydrate, increase growth, and stimulate the photosensitive pigments in lettuce for inducing relative gene expression and improved nutrient absorption for better quality (Gaudreau *et al.,* 1994).

The difference in light intensity and photoperiod, as each plant had its optimal light intensity and appropriate photoperiod for growth and development. LED had variable effects on different plant species (Li *et al.*, 2012). LED light intensity and photoperiod effected on the leaf number, leaf length and leaf width (Morrow, 2008). The leaf number, leaf length and leaf width play an important role on photosynthesis and production. The fresh weight increased depending on the red: blue intervals (Shimokawa *et al.,* 2014). Chlorophyll is an extremely important molecule in photosynthesis which allows plants to absorb energy from light and it would affect on the growth and development of plant.

Materials and Methods

Experimental site

The experiments were conducted at Instructional Farm, Department of Farm Structures, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the month of January 2019 to March 2019.

Hydroponic structure

The hydroponic structure developed at Department of Farm Structures was used for experiment purpose. Hydroponic structure was constructed using unplasticized polyvinyl chloride (U-PVC) pipes with external dimensions such as 3 m (height) x 2 m (width) x 3 m (length) and it consist of six internal rack structure with size of 0.45 m (height) x 0.45 m (width) x 0.8 m (length). The internal structure was equipped with 54 hydroponic trays with size of 0.45 m (length) × 0.30 m (width) × 0.15 m (height), which was equipped with semi-automated sprayer irrigation.

Hydroponic structure was covered with 50% ultraviolet (UV) stabilized shade net. In order to control the internal temperature of hydroponic structure, proper spraying of water was carried out at regular interval per day automatically to get a range of 25-30^{0}C temperature and 65-70% relative humidity (Gebremedhin, 2015).

Treatment details

The field experiments were laid out in factorial randomized block design with 19 treatments and 3 replications of each treatment with maize crop.

Factor A: Different colour of LED

C_1 – White
C_2 – Reddish purple

Factor B: Duration of LED

D_1 – 4 h
D_2 – 8 h
D_3 – 12 h

Factor B: Intensity levels of LED

L_1 – 480 lux (1 LED)
L_2 – 740 lux (2 LED)
L_3 – 930 lux (3 LED)

Experimental details

The treatment details of experiments are given in Table 1.

Biometric observations

In order to observe growth, yield and quality of maize following biometric observations were recorded.

Plant height

The plant height (cm) was measured by using measuring scale. The average plant height of each treatment was worked out.

Fresh weights

The fresh weight of green fodder from plot in every treatment was observed after harvesting. The total fresh weight of the fodder harvested from plot was recorded by fresh weight per tray and expressed in kg per tray.

Chlorophyll content

Chlorophyll content of maize was measured by chlorophyll meter before harvesting of crop. This meter gives the direct reading of chlorophyll content. The leave from the top was taken for the measurement of chlorophyll content and expressed in mg/g.

Results and Discussion

Biometric observations of hydroponic maize

The biometric observations on various growth characters like plant height and weight was taken and analyzed. The results are discussed below.

Plant height

During the periods of present investigation of experiment plant height was found to be recorded at harvesting. The data obtained in respect to the plant height were statistically analyzed, tabulated and presented in Table 2 and graphically depicted in Fig. 1.1.

Effect of colour of LEDs

Data presented in Table 2 indicated the significant difference in plant height of maize using different colour LEDs. Plant height of 23.80 cm was found to be significantly higher under reddish purple LED treatment followed by plant height of 23.08 cm under white LED treatment and 20.76 cm under control treatment. The length of light waves of reddish purple LED was estimated to be ideal for the photosynthesis of plants and also helped in the growth of plants. Similar results were also reported by Morrow (2008) and Long *et al.*, (2016).

Effect of duration

Data presented in Table 2 indicated the significant difference in plant height of maize using different durations of LEDs. It revealed that plant height was found to be increased significantly with increased durations of LEDs. The 12 h duration of LED was found to have significantly more plant height (24.14 cm) followed by 8 h duration (23.58 cm) and 4 h duration (22.61 cm) of LEDs. Extending photoperiod produced more carbohydrate, increased growth, and stimulated the plant height. It was observed that by increasing the duration of LED then increases height of maize crop was found to be increased. The similar results were recorded by Long *et al.*, (2016).

Effect of light intensity

From the data presented in Table 2 indicated the significant difference in plant height of maize using different intensity levels of LEDs. It revealed that plant height was found to be increased significantly with increased intensity levels of LEDs. It was observed that when maize was produced under high intensity LEDs of 930 lux (24.68 cm), it gave better result than the maize produced under 740 lux (23.394) and 480 lux (22.256) of LEDs. Using high intensity LEDs photosynthesis of maize produced more carbohydrate and stimulated plant height. The findings are in accordance with Long *et al.,* (2016).

Fresh weight

The data obtained in respect to the fresh weight were statistically analyzed, tabulated and presented in Table 2 and graphically depicted in Fig. 1.2.

Effect of colour of LEDs

Data presented in Table 2 indicated the significant difference in fresh weight of maize using different colour LEDs. Fresh weight (2.67 kg) was found to be significantly higher under reddish purple LED followed by white LED (2.59 kg) and control treatment (2.19 kg). This might be due to reddish purple LED maize absorbs more chlorophyll than white LED and control treatment and so produce more carbohydrates and helps to maximize productivity and accelerate root growth. Similar results were also reported by Long *et al.,* (2016) and Shimokawa *et al.,* (2014)

Effect of duration

Data presented in Table 2 indicated the significant difference in fresh weight of maize using different durations of LEDs. It revealed that fresh weight was found to be increased significantly with increased durations of LEDs. It was observed that 12 h duration of LED was found to have significantly more fresh weight (2.74 kg) than 8 h duration (2.60 kg) and 4 h duration (2.54 kg) of LEDs. Extending photoperiod produced more carbohydrate, increased growth of maize and produced more fresh weight. The similar results were recorded by Long *et al.,* (2016) and Cope *et al.,* (2011).

Table.1 Treatment details

Sr. No.	Particulars	Specifications
1	Name of the crop	Maize
2	Scientific name	*Zea mays*
3	Variety	Pioneer 3396
4	Planting time	Winter season
5	Design	Factorial randomized block design
6	Number of treatment	19
7	Number of replication	03
8	Total no of racks	18
9	No of trays	55
10	No of seed per tray	350 g
11	Duration of crop	14 days

Table.2 Effect of LED colour, duration and intensity on plant height, fresh weight and chlorophyll content of maize

	Plant Height (cm)	Fresh Weight (kg)	Chlorophyll Content (mg/g)
A) Colour of LED			
C_1 – White	23.085	2.593	22.537
C_2 - Reddish purple	23.807	2.672	25.226
F Test	Sig	Sig	Sig
SE(m)	0.042	0.009	0.088
CD (P=0.05)	0.121	0.025	0.254
B) Duration of LED			
D_1- 4 h	22.611	2.541	22.394
D_2- 8 h	23.583	2.608	23.894
D_3- 12 h	24.144	2.749	25.356
F Test	Sig	Sig	Sig
SE(m)	0.051	0.011	0.108
CD (P=0.05)	0.148	0.031	0.311
C) Intensity Levels of LED			
L_1- 480 lux	22.256	2.381	21.611
L_2- 740 lux	23.394	2.674	24.028
L_3- 930 lux	24.689	2.843	26.006
F Test	Sig	Sig	Sig
SE(m)	0.051	0.011	0.108
CD (P=0.05)	0.148	0.031	0.311
Interaction Effect			
Colour X Duration (C X D)			
F Test	Sig	Sig	Sig
SE(m)	0.073	0.015	0.153
CD (P=0.05)	0.209	0.044	0.439
Colour X Intensity (C X L)			
F Test	Sig	Sig	Sig
SE(m)	0.073	0.015	0.153
CD (P=0.05)	0.209	0.044	0.439
Duration X Intensity (D X L)			
F Test	Sig	Sig	Sig
SE(m)	0.089	0.019	0.187
CD (P=0.05)	0.256	0.054	0.538
C X D X L			
F Test	Sig	Sig	Sig
SE(m)	0.126	0.026	0.265
CD (P=0.05)	0.362	0.076	0.761
Control	20.767	2.190	17.800
F Test	Sig	Sig	Sig
SE(m)	0.153	0.044	0.346
CD (P=0.05)	0.886	0.289	1.448
CV	0.940	1.706	2.214

Fig.1 Effect of LED colour, duration and intensity on plant height of maize

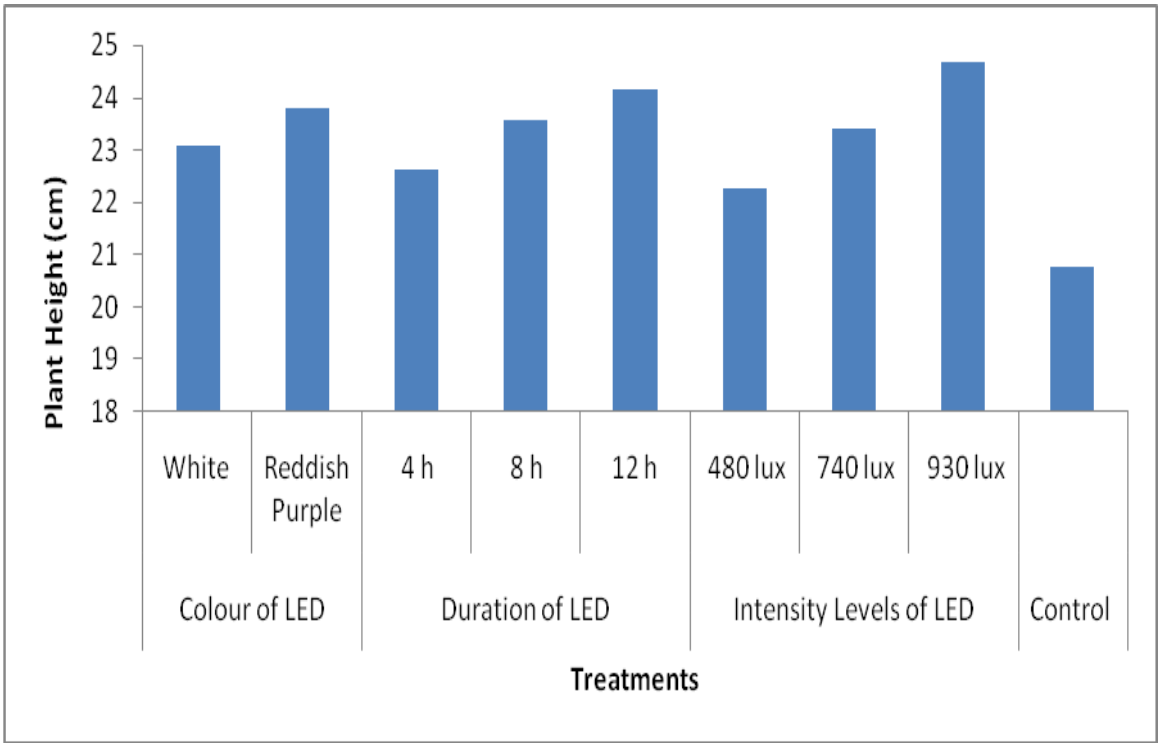


Fig.2 Effect of LED colour, duration and intensity on fresh weigh of maize

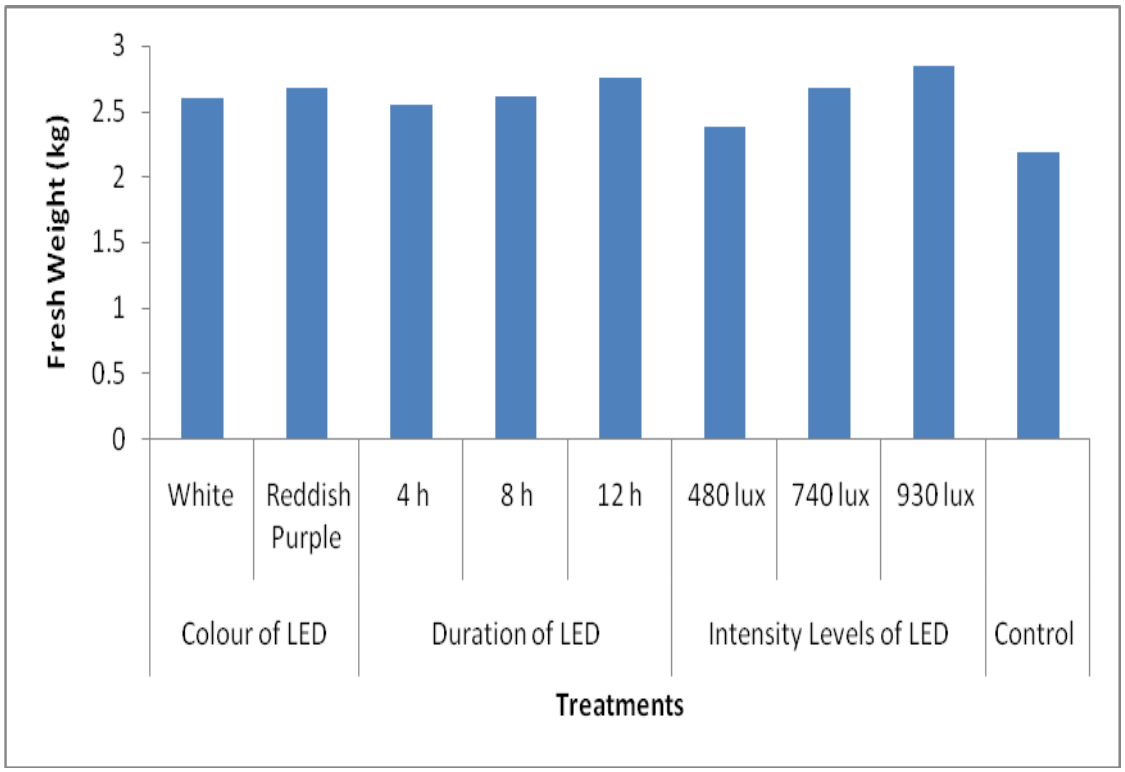
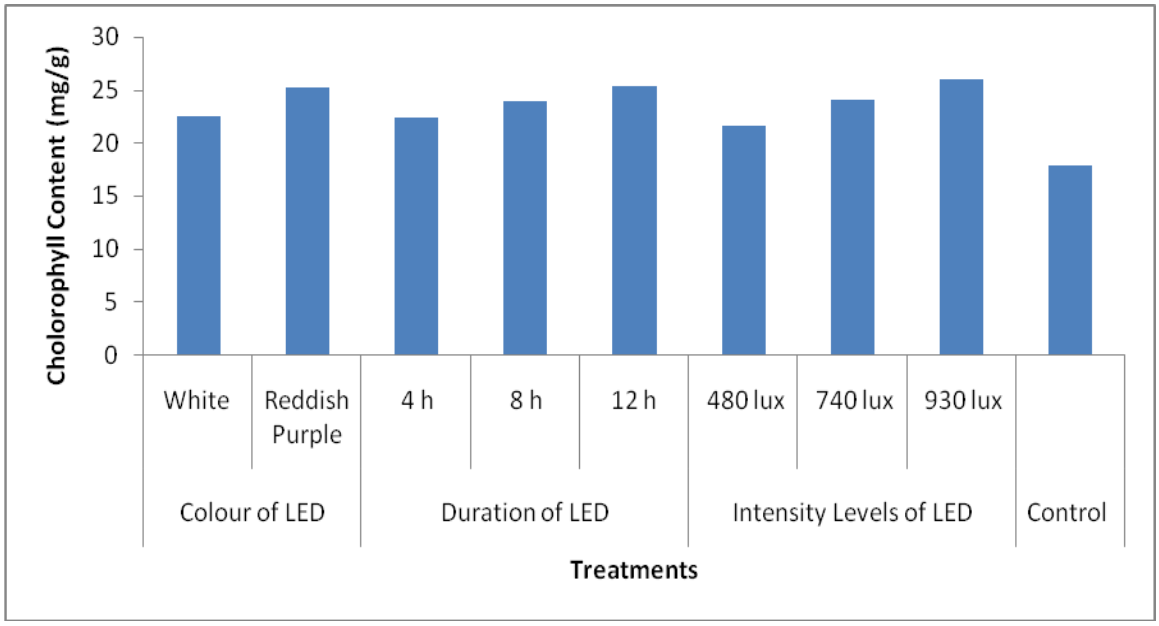


Fig.3 Effect of LED colour, duration and intensity on chlorophyll content of maize



Effect of light intensity

From the data presented in Table 2 indicated the significant difference in fresh weight of maize using different intensity levels of LEDs. It revealed that fresh weight was found to be increased significantly with increased intensity levels LEDs.

It was observed that when maize was produced under high intensity LEDs of 930 lux (2.84 kg), it gave better result than the maize produced under 740 lux (2.67 kg) and 480 lux (2.38 kg) of LEDs. It was found that, the light intensity affected the growth of maize.

The use high intensity LED's produced higher fresh weight than low and medium LEDs intensity. The findings are in accordance with Long *et al.*, (2016) and Cope *et al.*, (2011).

Chlorophyll content of hydroponic maize

The data obtained in respect to the chlorophyll content were statistically analyzed, tabulated and presented in Table 2 and graphically depicted in Fig. 1.3.

Effect of colour of LEDs

Data presented in Table 2 indicated the significant difference in chlorophyll content of maize using different colour LEDs.

Chlorophyll content (25.22 mg/g) was found to be significantly higher under reddish purple LED followed by white LED (22.53 mg/g) and control treatment (17.80 mg/g).

The reddish purple LED light waves were absorbed chlorophyll a, b more than white LED. It was observed that chlorophyll content in maize found maximum under reddish purple LED treatment than white LED treatment and control treatment. Similar result was also reported as Long *et al.*, (2016).

Effect of duration

Data presented in Table 2 indicated the significant difference in chlorophyll content of maize using different durations of LEDs.

It revealed that chlorophyll content was found to be increased significantly with increased durations of LEDs. The 12 h duration of LED

was found to have significantly high chlorophyll content (25.35 mg/g) followed by 8 h duration (23.89 mg/g) and 4 h duration (22.39 mg/g) of LEDs. When duration of photosynthesis increased then plant absorbs more chlorophyll. It was observed that 12 h duration of LED more chlorophyll content followed by 8 h and 4 h duration of LED. The similar results were recorded by Long *et al.*, (2016).

Effect of light intensity

From the data presented in Table 2 indicated the significant difference in chlorophyll content of maize using different intensity levels of LEDs. It revealed that chlorophyll content was found to be increased significantly with increased intensity levels of LEDs.

It was observed that when maize was produced under high intensity LEDs of 930 lux (26.00 mg/g), it gave better result than the maize produced under 740 lux (24.02 mg/g) and 480 lux (21.61 mg/g) of LEDs. This might be due to intensity of light affected on chlorophyll absorption by plant. It was observed that high LEDs intensity of 930 lux absorbed more chlorophyll than 740 lux and 430 lux. The findings are in accordance with Long *et al.*, (2016).

It was found that reddish purple LED, 12 h duration of LED and LED light intensity of 930 lux showed better desirable results compared to white LED and control, 4 h and 8 h duration of LED and light intensity of 740 lux and 480 lux.

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