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Influence of Light on the Germination of Seeds and Growth of Plantlets: An Experimental Study

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ABSTRACT: Light is a very important factor in a plant's life. Plant uses different colors which are present in visible light to perform different aspects of their growth. Plant development is strongly influenced by light quality which refers to the colors or wavelengths reaching a plant's surface. Due to the advancement of technology, lighting systems play an important role in the commercial greenhouse productions. The aim of this study was to investigate the effect of red, blue, green, yellow and natural light on the plant growth of *Vigna radiata* and *Trigonella foenum-graecum.* The effects of blue, red, green and yellow light were performed as a pot experiments under controlled conditions, repeated three times. The characters studies include seed germination percentage, seedling growth, shoot length and root length. Both negative and positive values were recorded as a result of light treatment. The results showed that application of different lights affects the morphological characters, as compared to the plants grown under sunlight. Compare to the control sample, the maximum seedling length was recorded in both the plants under blue light. The presence of lighting systems is very important for expanding and increasing the plant quality. The results indicate the possibilities of better yield through proper selection and the improved commercial production will help farmers to achieve maximum production.

Keywords: *Trigonella, Vigna,* light quality, seedling growth, germination percentage.

I. INTRODUCTION

Pulses belong to the family Fabaceae. They are commonly known as legumes; they have high protein content and are easily digestible [1]. Pulses are said to be the poor's man meat and are grown worldwide for consumption due to their high nutrition and low-cost aiding in overcome protein malnutrition in developing countries like India [2]. They are rich in carbohydrates, vitamins and minerals. They have capability to restore soil fertility and climate change through their N_2 fixation properties. India is the largest producer, consumer and importer of pulses in the world.

Trigonella foenum-graecum and *Vigna radiata* is an annual herb which comes under leguminous crops. *Trigonella foenum-graecum,* commonly known as methi/fenugreek, is mostly found in India, Africa, North America and Australia. Among them India is a leading producer of *Trigonella foenum-graecum* in the world. It is famous spices in human food. The seeds and green leaves of *Trigonella foenum-graecum* are used in food as well as in medicinal application that is the old practice of human history, hence it is called "an old-world crop for the new world" [3-4]. It is an important medicinal plant use in certain women health disorders and hepatotoxicity as traditional remedy [5-6].

Among pulses, *Vigna radiata* is known as mung bean/green gram. It is cultivated in India, China, Thailand, Indonesia, Burma, South Europe and US [7]. It is rich in carbohydrate, protein, minerals, vitamins and fat. *Vigna radiate* seeds are invaluable source of digestible protein for vegetarians. It plays key role in various cropping systems and sustainable agriculture production due to N_2 fixation ability and low water requirement [8-9].

The growth of a plant might see like a simple and straight forward process. The plant needs to be watered, the soil needs to have certain nutrients and it needs to be in an environment where it receives light for a certain period of time. A crucial component in the growth of a plant besides water and oxygen is sunlight. Light is such an important environmental parameter, plants have evolved numerous biochemical and developmental responses to light that help to optimize photosynthesis and growth, plant development, flowering and usage of water. Experiments by Hoover [10] on photosynthesis efficiency curves over the light spectrum served as the foundation for the relative quantum efficiency. Curves established by McCree [11] are cited in most current research related to photobiology and light quality. Managing light is obviously critical to the production of crop grown in controlled environments [12-14]. Several processes such as photosynthesis, germination, flowering, and biomass accumulation can be controlled and optimized via adjusting light wavelengths [15-17]. A specific light quality can be used to improve the nutritional quality of vegetables and yields in commercial production [18-19]. Plant responses are different based on the lighting environment, season, genotype, cultivation practices and many others [20]. Light contain the entire colors visible light spectrum from red to violet. Each color has a different wavelength. Red has the longest wavelength and violet has the shortest wavelength. When all the waves have seen together, they make white light. Light is essential in a plant's life. Without light a plant can't grow, reproduce and photosynthesize. Plants utilize the different colors found in visible light to control different aspects of their growth. The nature and wavelength of the light has different influence on the different physiological plant processes depending on the species and their development stage or studied organ [21]. To increase the production capacity, controlled growing systems using artificial lighting have been taken into consideration by Darko *et al*., [22]. A closed system for plant production with artificial light is an innovative method of plant cultivation [23]. Joshi *et al.,* [24] also reported that LED-interlighting products most commonly consist of blue- and red- LED chip combinations, specifically targeted for excitation of the chlorophyll pigments and thus for enhancing photosynthetic activity. The aim of this study was to investigate the effects of red, blue, green, yellow and natural light on the seedling growth of *T. foenumgraecum* and *V. radiata.*

II. MATERIALS AND METHODS

Plant material: the seeds of *V. radiate* and *T. foenumgraecum* were procured from local market in Jaipur, Rajasthan. The experiment was conducted in laboratory conditions. Seeds were air dried and stored in room temperature. Stored seeds were surface sterilized and sown in pots.

Light treatment: four color, (red, blue, green and yellow), cellophanes were taken. Tape two layers of the desired color of cellophane on four pots. One pot was without any cellophane and used as control. Place all the pots in light and observe them for one week.

Plant growth measurement: main measured quantities in this study were germination percentage, seedling length, root length, shoot length and seedling vigor index. Environmental conditions for all treatments were controlled to maintain the same temperature and relative humidity.

III. RESULT AND DISCUSSION

The effects of light quality treatments on *Trigonella foenum-graecum* and *Vigna radiata* were monitored by measuring changes in germination percentage, seedling length, root length and shoot length at 10 days of germination. Table 1 and 2 presents all the measured components of growth parameters. The present study examined the effects of different lightening conditions on growth parameters. Plants showed distinct growth responses to different light quality treatments. Results from Table 1 and 2 showed that light quality influenced the growth of seedlings.

In *Vigna radiata* germination % varied from 85-100% and in *Trigonella foenum-graecum* it was ranged from 90-100%. Among all four different color filtrations blue, green and red light showed 95-100% germination, respectively. In each experiment, plants grow in red light have used less water than other plants. The values showed that *V. radiata* grew more rapidly in the presence of yellow light than the natural light (Table 1 & Fig 1). Selective filtration of the yellow light increased the seedling length. Seedling length was also increased by blue light filtration in both the plants. Same results were given by Surducan *et al*., [25]. Randall and Lopez [26] investigated that the application of red and blue light improves the growth of plant. The blue light increased the height of basil medicinal plant [27]. Nguayen *et al.,* [28] also reported that the plant height, leaf number, leaf area, photosynthetic capacity and productivity of Spinach changed due to the different light intensities. In *Trigonella foenum-graecum* red and green light also showed better growth than the natural light (Table 2 & Fig 2). Kim [29] suggested that green supplemented light could also offer benefits, since green light can better penetrate the plant canopy and potentially increase plant growth.

Root length of both the plants was significantly shorter under red, blue, green and yellow lightening environments. Different light quality treatments inhibited the elongation of roots. This agrees with the reports of Guo *et al.,* [30] and Nhut *et al*., [31] and Chen *et al*., [32]. Liu *et al.,* [33] reported that a different red to blue ratio affected root morphology. Shoot length was not significantly different among all lightening environments in *Trigonella foenum-graecum.* In *Vigna radiata* different light quality treatments affected the growth of shoot length and red light likely inhibited the elongation of shoot. Glowacka [34], found tomato cultivars placed under blue light showed shorter height compared to those kept in day natural light. In roses and poinsettia blue light was known to reduce stem elongation [35-36]. In *Petunia* blue light promotes stem elongation on the contrary red light suppresses plant height [37]. Ajdanian *et al.,* [38], reported that blue and red light had considerable effects on the vegetative traits compared to the control treatment and presence of blue and red wavelengths are necessary for a better growth of the plant.

A growth retarding effect might be caused by an insufficient quality of light. The seedling health index was greatest under blue light. The higher health index under the blue light environment contributed to the shorter shoot height and larger stem diameter which can provide a higher loading resistance potential. Blue LED light was an effective light source for plant growth and development and light spectra, intensities and duration can easily be controlled by growers in artificial growing environment [30, 32]. Lighting system play an important role in the commercial greenhouse productions.

IV. CONCLUSION

Light is the original source of energy for plant photosynthesis and growth. A wide range of signals and information for morphogenesis and many other physiological processes is triggered by light. Different characteristics of light such as spectral composition (wavelengths), intensity, duration and direction can influence plant growth and development. From the findings of present study, it was concluded that different colors of light or different wavelengths affects the germination percentage and seed growth. Plants react differently to different colors of light. Different color light helps plants achieve different goals. Many plant functions can be enhanced and promoted just by knowing what light color they react and respond. All the above-mentioned parameters of *Vigna radiata* and *Trigonella foenum-graecum* were influenced by different lights. The results indicate the possibilities of better yield through proper selection. It is hoped that the different light treatments, induce variability, may have further scope in *Vigna radiata* and *Trigonella foenum-graecum* improvement through its incorporation in breeding programs.

Table 1: Values for *V. radiate.*

S.No.	Characters	Control	Red light	Blue light	Green light	Yellow light
1.	Germination %	100	90	90	87	85
2.	Seedling length (cms)	3.08	2.04	3.84	2.63	3.23
3.	Root length (cms)	3.52	1.43	2.00	2.34	2.43
4.	Shoot length (cms)	0.50	0	0.40	0.16	0.14
5.	SVI	3.08	1.84	3.46	2.29	2.75

Table 2: Values for *T. foenum graecum.*

S.No	Characters	Control	Red light	Blue light	Green light	Yellow light
1.	Germination %	90	100	95	95	90
2.	Seedling length (cms)	9.60	10.60	11.61	10.21	8.84
3.	Root length (cms)	5.69	4.52	3.87	4.69	3.48
4.	Shoot length (cms)	5.55	6.08	6.87	5.34	5.36
5.	SVI	8.64	10.60	11.03	9.70	7.96

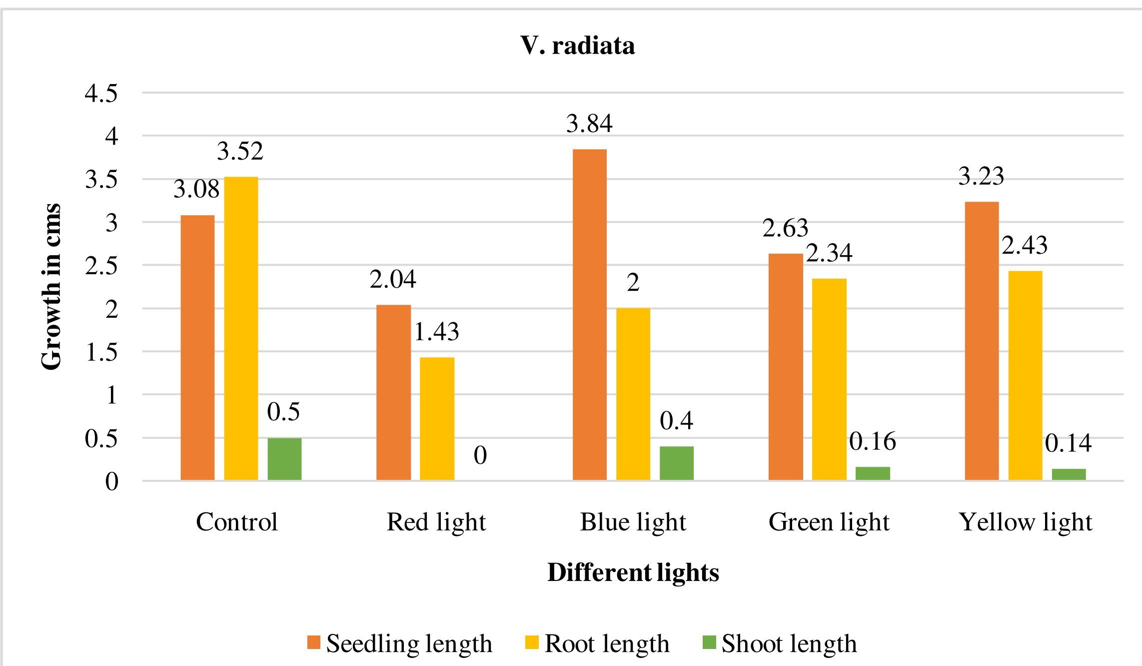

Fig. 1. Values of *V. radiate.*

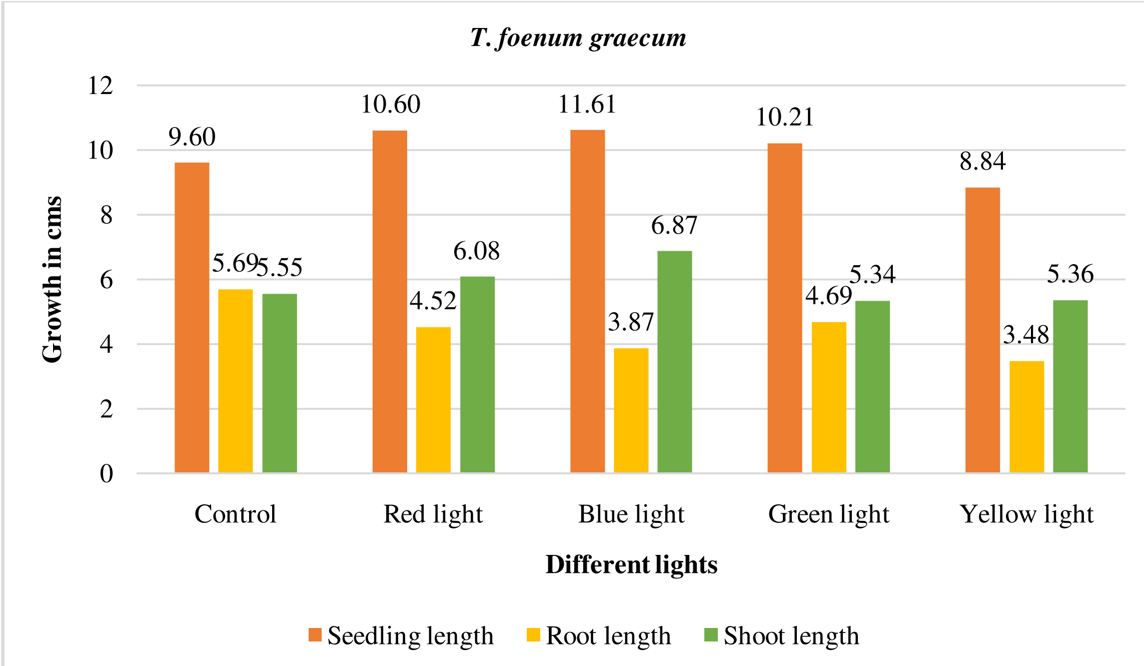

Fig. 2. Values of *T. foenum graecum.*

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