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Influence of Coloured LED Lights on the Occurrence of Fusarium Wilt in Pigeonpea

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A B S T R A C T

The present investigation was conducted in green house to study the effect of different coloured LEDs (Red, green, White, Blue and UV light) on the subsequent occurrence of Fusarium wilt in Pigeonpea seedlings whose the seeds were treated with different coloured lights prior to sowing. The seeds treated with red LEDs for 12 and 24 hrs and blue light for 24 hrs prior to sowing reduced the Fusarium wilt by upto 71 percent over control. The disease incidence was recorded after 45 days of inoculation with *Fusarium udum* culture was 14.58 per cent in Asha and 46.94 per cent in TAT-10 respectively.

Introduction

Pigeonpea production is greatly constrained by numerous biotic and abiotic stresses. The major biotic stresses affecting legumes are fungal diseases although insects, nematodes, viruses, bacteria and parasitic weeds can also drastically decrease pigeonpea production. Wilt caused by *Fusarium udam* Butler is the major constrain to pigeonpea production worldwide (Kannaiyan *et al.*, 1984). The incidence of disease has been reported from 30 to 60 per cent at flowering and crop maturity stages (Kannaiyan and Nene, 1981), however it can cause yield losses up to 100 per cent in susceptible cultivars. In nature plants are exposed to light of different wavelengths from ultraviolet to far-red regions. Light of certain wavelengths (290-320 nm) may affect certain host-pathogen interactions (Honda, 2000; Kumagai, 1988). Induction of plant defence against pathogen attack is regulated by a complex network of different signals. Interaction between *Fusarium udum* and host plants was found to enhance defence responses against wilt disease in resistant cultivars of pigeonpea. Light was reported as one of the important factors affecting disease development by inactivating toxins of pathogens in certain plant-pathogen interactions (Kohmoto *et al.*, 1989). The development of light-emitting diodes (LEDs) in the last few decades has introduced growers to a new source of lighting that provides many superior advantages. LEDs represent an innovative artificial lighting source for plants both as supplemental or sole-source lighting, not only owing to their intensity, spectral and energy advances but also via the possibilities for targeted manipulation of metabolic responses in order to optimize plant productivity and quality. Plants have light receptors that detect visible light and generate a response. There are certain photoreceptors which get activated at specific wavelength of light. LED light is one of the sources which produce a constant source of light with specific wavelength. The hypothesis of this study is whether the wilt tolerance of pigeonpea seedlings could be improved with a light treatment.

Materials and Methods

Seed material

In this experiment, seed of two genotypes viz. Asha and TAT-10 were treated with fungicide solution for 5 minutes. Then washed with tap water for several times and were soaked in distilled water for 24 hours. Seeds were counted out in specific quantities (15 seeds for each treatment) and placed in standard sized (20 cm diameter) glass petri dishes lined with two layers of Whatman's filter paper. Filter papers were moistened with distilled water and seeds were randomly dispersed over the triangles formed by partitions in Petridishes by thin layer of cardboard. The petri dishes containing seeds were then placed in box, 15 cm wide at the top 22 cm at the bottom with a distance of 25 cm from bottom to top internally covered with the appropriate plastic filter according to color. One LED light with specific colour was fitted at the top of each box which was 20 cm above the level of the petri dish. After 12, 24 and 36 hrs seeds were sown in pots.

Light treatment

For irradiation different coloured Light Emitting Diodes (LEDs) such as Red, Green, White, Blue and UV light were used. Light intensities for the various colored were measured by a Digital Lux Light Meter (LX-101, Lutron). The intensities of different coloured LEDs are given in Table 1.

Fungus inoculation

Seven days after sowing, the seedlings were inoculated with spore suspension culture of F. udum. The culture of Fungus *Fusarium udum* which affects the pigeon pea plant by causing *Fusarium* wilt disease was obtained from the Microbial Type Culture Collection and Gene Bank (MTCC) Chandigarh. The *Fusarium udum* culture was maintained on Potato Dextrose Agar (PDA) plates with timely sub-culturing.

This culture was used for infection to the seedlings grown in plastic pots. Seedlings with no pathogen infection (un-inoculated plants) treated as control. The pathogenicity assays were conducted in triplicates. In one replication 5 plants were grown. Two discs of *F. udum* about five mm diameter were cut, and suspended in 20 ml distilled water and was shaken thoroughly to get good and uniform spore suspension. One drop of this spore suspension was placed on a haemocytometer and numbers of spores in 5 squares of haemocytometer at random were counted. The number of spores per ml was calculated with haemocytometer, using the formula given by Pathak (1984).

$$\text{No. of spores per ml} = \frac{N \times 1000}{X}$$

Where,

N = Total no. of spores counted/ no. of squares

X = Volume of mounting solution between the cover glass and above the squares counted

After irradiation with different coloured LEDs the seeds were sown in pots and diseases incidence was recorded after 45 days. Per cent Disease incidence (PDI) was calculated by using formula given by Anjaneyareddy and Saifulla, (2005)

$$PDI = \frac{\text{Number of plants wilted}}{\text{Total number of plants}} \times 100$$

Statistical Analysis

Statistical analysis for data was carried out in a FCRD (Factorial Completely Randomized Design). The analysis of sixteen treatments for assessing the different coloured lights effect on two pigeonpea genotypes was done taking V_1 and V_2 as main treatments and T_1 to T_{16} as sub treatments. The level of statistical significance to the experimental data was carried out as per procedure described by Gomez and Gomez (1984).

Results and Discussion

Effect of genotypes

Genotype Asha showed less wilt incidence as compared to susceptible genotype TAT-10 (Table 2). The disease incidence was 14.58 per cent in Asha whereas 46.94 per cent plants of TAT-10 were infected after 45 days of inoculation with *Fusarium udum* culture.

Effect of light treatments

Data regarding the effect of different coloured LEDs on wilt incidence is recorded in Table 2. From this data, it is observed that in red LEDs for 12 and 24 hrs and blue LEDs for 24 hrs, only 14.4 per cent plants infected with wilt and blue light for 36 hrs were found at par with the superior treatment red LEDs for 24 hrs. This decrease was 71 per cent over control and may be due to the red light irradiation that induces the production of anti-fungal substance(s) in plants.

Similar results were reported by various scientists while working on different plants. Certain wavelengths could be used to eliminate or maximize the abilities of fungi to proliferate or insects to navigate to host species (Mass *et al.,* 2008). Irradiation with red light induced the accumulation of an antifungal substance in leaf tissue of broad bean leaves. This substance prohibited germination of spores of several fungal pathogens including soil borne fungi as reported by Islam *et al.*, (1999). Islam and babadoost (2002) reported that the application of red light treatment induced disease resistance against *Phytophthora capsici* in pumpkin, pepper and tomato seedlings. Irradiation of *Nicotiana benthamiana* especially with blue and red wavelengths of light induced resistance against wildfire disease (Ahn *et al.*, 2013).

Genotype x light interaction effects

The data in respect of disease incidence is given in Table 2 and graphically represented in Figures 1. Treatment of red LEDs for 12 hrs and blue LEDs for 24 hrs showed significant reduction in the occurrence of *Fusarium* wilt in Asha (4.4 %) followed by red 24 hrs and blue LEDs for 36 hrs (6.6 %).

In Asha, red light treatment decrease disease incidence by 78 per cent over the control (20 %). The disease incidence percentage of TAT-10 genotype is presented in Table 2 and depicted in Figure 1. Red LEDs for 24 hrs treatment reduced the percentage of wilt in TAT-10. In this treatment 20 per cent plants were infected with wilt. Whereas in control in which the seeds were not irradiated with any light source 82.2 per cent plants showed wilt infection. This decrease in percentage in red LEDs treatment was 72 per cent over control.

Table.1 Details of light emitting diodes used to illuminating seeds

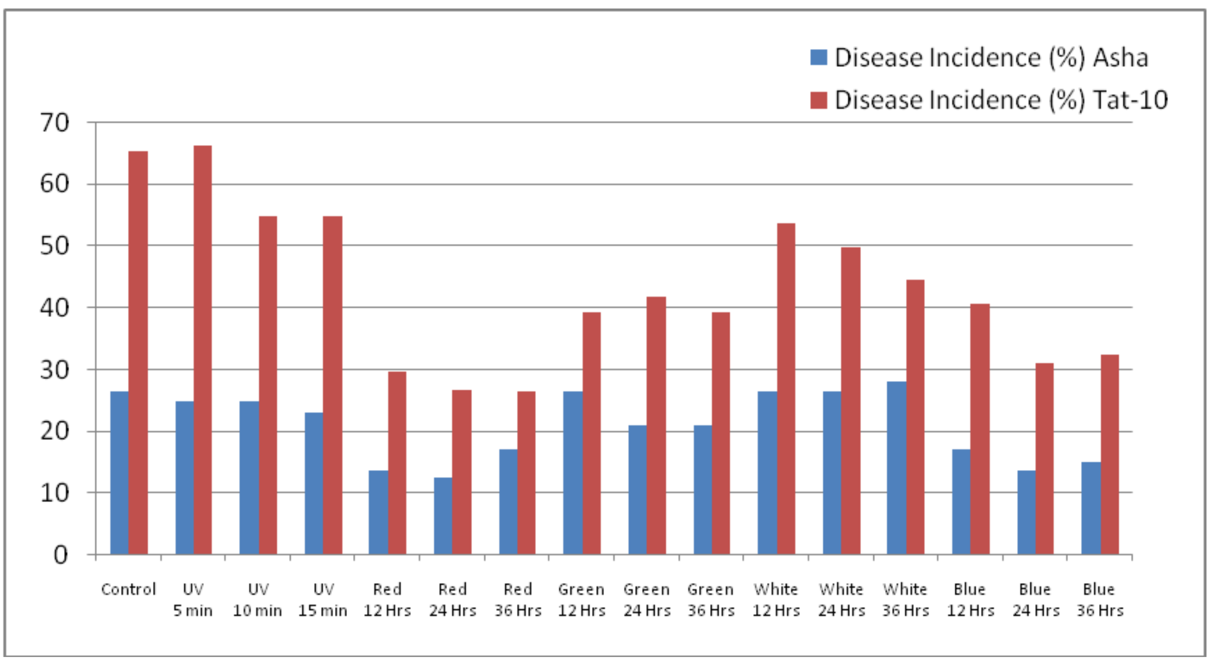
Sr. No.	Light Emitting Diodes	Intensity of Light (μmol $m^{-2}s^{-1}$)	Wavelength (nm)	Time duration
1	Ultraviolet Light	2.5	10-380	5, 10 and 20 mins
2	Blue LEDs	5	450-495	12, 24 and 36 hrs
3	Green LEDs	80	495-570	12, 24 and 36 hrs
4	Red LEDs	25	620-750	12, 24 and 36 hrs
5	White LEDs	25	-	12, 24 and 36 hrs

Table.2 Effect of different coloured LEDs on incidence of *Fusarium* wilt

Genotypes		**Disease Incidence (%)**
Asha	V1	14.58 (21.08)
TAT-10	V2	46.94 (43.44)
S. E. (m) ±		0.62
C. D. at 5%		1.75
Light treatments		
Control	T1	51.11(45.75)
UV 5 min	T2	50.0(45.48)
UV 10 min	T3	42.0(39.83)
UV 15 min	T4	41.1(38.97)
Red 12 hrs	T5	14.4 (21.64)
Red 24 hrs	T6	14.4(19.50)
Red 36 hrs	T7	21.1(21.74)
Green 12 hrs	T8	30 (32.78)
Green 24 hrs	T9	28.8 (31.39)
Green 36 hrs	T10	26.8 (30.09)
White 12 hrs	T11	42.2(39.94)
White 24 hrs	T12	38.8(38.00)
White 36 hrs	T13	35.5(36.22)
Blue 12 hrs	T14	23.3 (28.82)
Blue 24 hrs	T15	14.4(22.34)
Blue 36 hrs	T16	17.7(23.72)
S. E. (m) ±		1.76
C. D. at 5%		4.96
Control (Asha)	V1T1	20.0(26.36)
UV 5 min	V1T2	17.78(24.85)
UV 10 min	V1T3	17.78(24.85)
UV 15 min	V1T4	15.56(23.13)
Red 12 hrs	V1T5	4.4(13.70)
Red 24 hrs	V1T6	6.6 (12.43)
Red 36 hrs	V1T7	22.2 (17.11)
Green 12 hrs	V1T8	20.0 (26.36)
Green 24 hrs	V1T9	13.3 (20.98)

Green 36 hrs	V1T10	13.3 (20.98)
White 12 hrs	V1T11	20.0 (26.36)
White 24 hrs	V1T12	20.0(26.36)
White 36 hrs	V1T13	22.2 (28.07)
Blue 12 hrs	V1T14	8.89 (17.11)
Blue 24 hrs	V1T15	4.44 (13.70)
Blue 36 hrs	V1T16	6.67(14.96)
Control (TAT-10)	V2T1	82.2(65.15)
UV 5 min	V2T2	82.2(66.12)
UV 10 min	V2T3	66.67(54.80)
UV 15 min	V2T4	66.67 (54.80)
Red 12 hrs	V2T5	24.4 (29.58)
Red 24 hrs	V2T6	20.0(26.36)
Red 36 hrs	V2T7	22.2(27.57)
Green 12 hrs	V2T8	40.0(39.19)
Green 24 hrs	V2T9	44.4(41.80)
Green 36 hrs	V2T10	40.0(39.19)
White 12 hrs	V2T11	64.4(53.52)
White 24 hrs	V2T12	57.7(49.64)
White 36 hrs	V2T13	48.4(44.36)
Blue 12 hrs	V2T14	37.7(40.52)
Blue 24 hrs	V2T15	24.4(30.97)
Blue 36 hrs	V2T16	28.8 (32.48)
S. E. (m) ±		2.48
C. D. at 5%		7.02

Fig.1 Effect of different coloured LEDs on incidence of *Fusarium* wilt



Furthermore, Wang *et al.,* (2010) found that disease resistance to *Sphaerotheca fuliginea* in cucumber plants was induced by red light. Red light was also reported to suppress the lesion development of *P. capsici* on detached leaves of eggplant, pepper, pumpkin, and watermelon (Umezu *et al.,* 1999). Induced resistance in plants by red light against *Alternaria tennuissima* has also been reported by Rahman *et al.,* (2001). Khanam *et al.,* (2005) reported that enhanced catalase activity under red light treatment contributes to the inhibition of lesion formation and fungal development on broad bean leaves infected with *Botrytis cinerea*. Kim *et al.,* (2013) suggested that Blue LEDs suppresses the development of gray mold of *B. Cinerea* in tomato via enhanced accumulation of proline and antioxidative response. Thus numerous studies have suggested that physiological resistance of plants to environmental stresses including pathogen attack is closely connected with specific light treatments.

In conclusion, current study suggests that red and blue LEDs are highly efficient to protect crop plants from fungal attacks. This may be due to the increased production of osmoprotectants and antioxidants, including ROS scavenging enzymes.

References

Ahn, S.Y., S. Kim, K.H. Baek and H. Yun, 2013. Inhibiting wildfire and inducing defense-related gene expression by LED treatment on *Nicotiana benthamiana*. J. Plant Pathol. 95: 477-483.

Anjaneyareddy, B. and M. Saifulla, 2005. Evaluation of Promising Pigeonpea Genotypes and Host Differentials Against *Fusarium udum* Butler. Karnataka J. Agric. Sci., 18(3): 691-693.

Gomez K A and A A Gomez (1984). Statistical procedure for Agriculture Research. A Wiley- Interscience publication. John. Wiley and sons. New Yark.

Honda, Y., 2000. UV-B radiation decreases resistance and red light enhances it in certain combination of plant and pathogen, p. 21–23. Proc. COE-IGE Intl. Symp.: Plant and ultraviolet-B radiation—Effects of increasing ultraviolet-B radiation on ecosystem and resistance of plant to ultraviolet-B radiation. Tohoku Univ., Japan.

Islam, S.Z. and M. Babadoost, 2002. Effect of Red Light Treatment of Seedlings of Pepper, Pumpkin, and Tomato on the Occurrence of Phytophthora Damping off. Hort. Science. 37(4): 678-681.

Islam, S.Z., Y. Honda and S. Arase. 1999. Some characteristics of red light-induced substance(s) against *Botrytis cinerea* produced in broadbean leaflets. J. Phytopathol. 147: 65-70.

Kannaiyan J. and Y. L. Nene, 1981. Influence of wilt at different growth stages on yield loss in Pigeonpea. Trop. Pest Manage. 27: 141.

Kannaiyan, J., Y.L. Nene, M.V. Reddy, J.G. Ryan and T.N. Raju, 1984. Prevalence of pigeonpea disease and associated crop losses in Asia Africa and America. Trop. Pest Manage 30: 62-71.

Khanam, N.N., M. Ueno, J. Kihara, Y.M. Honda and S. Arase, 2005. Suppression of red light-induced resistance in broad beans to *Botrytis cinerea* by salicylic acid. Physiol. Mol. Plant, 66: 20-29.

Kim, K., H.S. Kook, Y.J. Jang, W.H. Lee, S.K. Kannan, J.C. Chae and K.J. Lee, 2013. The Effect of Blue-light-emitting Diodes on Antioxidant Properties and Resistance to *Botrytis cinerea* in Tomato. J Plant Pathol Microb. 4:9. http://dx.doi.org/10.4172/2157-7471.1000203.

Kohmoto, K., H. Otani, M. Kodama and S.

Nishimura, 1989. Host recognition: Can accessibility to fungal invasion be induced by host specific toxins without necessitating necrotic cell death, pp 249–265.

Kumagai, T., 1988. Photocontrol of fungal development. Photochem. Photobiol. 47: 889–896.

Massa, G.D., H.H. Kim, R.M. Wheeler and C.A. Mitchell, 2008. Plant productivity in response to LED to lighting. Hort. Science. 43: 1951-1956.

Pathak, V.N., 1984. Laboratory Manual of Plant Pathology. Second edition. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, 11-12.

Rahman, M.Z., N. Muroguchi, S. Arase and Y. Honda, 2001. Effect of red light on the development of leaf spot disease in broadbean caused by *Alternaria tenuissima*. Proc. Annu. Mtg. Phytopathol. Soc. of Japan, Sendai.

Umezu, H., S.Z. Islam and Y. Honda, 1999. Red lightinduced resistance in some plants. Bul. Assoc. Plant Protect. Shimane Pref., Japan 24:55–57.

Wang, H., Y.P. Jiang, H.J. Yu, X.J. Xia and K. Shi, 2010. Light quality affects incidence of powdery mildew expression of defence-related genes and associated metabolism in cucumber plants. Eur. J. Plant Pathol. 127: 125-135.

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