JOURNAL OF PURE AND APPLIED MICROBIOLOGY, March 2015. Vol. **9**(1), p. 23-32

Effect of Lighting on Photosporogenesis of *Exserohilum rostratum* Causing Banana Leaf Spot Disease

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(Received: 06 April 2014; accepted: 19 August 2014)

To make further understanding the vegetative growth, sporulation and conidial morphology of the fungal *Exserohilum rostratum* effect by various light resources, three tested isolates (CLER09, D087 and JL05) of *E. rostratum* causing banana leaf spot disease were characterized. Six light environments were used to evaluate the influence on the vegetative growth, sporulation and conidial morphology. The results showed that UV light was mostly suitable for the vegetative growth of isolate CLER09, and black light for isolates D087 and JL05. The UV light was the optimal light source for the sporulation of isolates CLER09 and D087, but the sporulation of isolate JL05 inhibited by all of the tested light sources. UV light had a markedly promotion effect on the conidial lengths of the tested isolate with more than 10 times to that cultured under complete darkness. The conidial lengths of isolates D087 and JL05 with less septa were extended significantly comparing than that with more septa under all of the light sources, especially UV light. Less effect of tested light treatments on the conidial width was found. The results suggested that the UV-light-induced morphological difference was not a permanently abnormality. Lighting was one of the important environment factors affecting conidial morphology of *E. rostratum*, but the inductive function could be recoverable.

Key words *Exserohilum rostratum* · conidium · morphological difference · UV irradiation.

Exserohilum rostratum is the fungus with significant difference of conidial morphology in intraspecific population. Since the conidial morphology was easily subjected to environment factors[1,2], clarifying the influence of various light sources on the sporulation and conidial morphology of *E. rostratum* facilitated the identification of taxonomic level.

Lights are known to inhibit/promote sporulation of fungi. For example, UV-light irradiation could promote sporulation of the fungi, such as *Alternaria cichorii*[3], *A. solani*[4,5], *A. tomato*[6], *Botrytis cinerea*[7], *Trichoderma viride*[8,9], *Helminthosporium oryzae*[10] and *Leptosphaerulina briosiana*[11]. Red light promoted the sporulation of *Aspergillus nidulans*[12], but blue light inhibited the sporulation of *B. cinerea*[13] and *Magnaporthe oryzae*[14]. The sporulation of *B. cinerea* was enhanced by far-red light and inhibited by blue light[15]. Moreover, the sporulation of *Pyrenophora tritici-repentis* could be changed through adjusting light cycle[16].

Except the effect on sporulation, lighting can also change fungal conidial morphology. Such

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as, lighting intensity had an influence on *A. cichorii* conidial morphology under lower temperature (15 °C) condition. The conidial length, width and beak length of *A. cichorii* would be extended under high lighting intensity, but the inhibition of *A. cichorii* conidial morphology was observed under blue light irradiation, and the impact of inhibition was increased with the enhancement of temperature. The effect of continuous irradiation of black light (310-420 nm) on conidial morphology was temporary, whereas that of continuous irradiation of blue light (360-530 nm) was permanent[17,18]. Sporulation of falciform conidia of *Fusarium globosum* was promoted, but that of global conidia was inhibited by continuous irradiation of black light, and the claviform conidia would elongate in some strains[19]. Honda and Aragaki[20,21] reported that fluorescence lighting promoted sporulation of *E. rostratum* under lower temperature condition (16 °C), the conidia with beak were produced under continuous fluorescence light irradiation and elliptic conidia were produced under darkness environment. The conidial length of *E. rostratum* incubated under continuous fluorescence lighting was three times longer than that grown under darkness. Cylindrical conidia were produced under alternation of fluorescence lighting and darkness. The sporulation and conidia length increased with the enhancement of light intensity. The conidial length of *E. rostratum* grown on vegetable medium added with glucose was shorted under fluorescence lighting condition[20]. Besides lighting conditions, sporulation of *E. rostratum* was also influenced by other environmental factors, including culture medium, carbon source, nitrogen source, temperature, pH value, and so on[1,2, 20, 22-24]. Fungal proteome differentially expressed cultured under in the dark or under light with a wavelength as well as the secondary metabolite biosynthesis[25]. Beside the growth, light is a very important signal for fungi since it influences many different physiological responses, such as mycotoxins biosynthesis[26, 27].

At present, little known was reported that the effect of various light sources on conidial morphology of *E. rostratum*. The objectives of this study were: i) to clarify the effect of various light irradiation on the morphological difference of *E. rostratum* conidia, ii) to know whether the light-induced morphological difference of the conidia has a genetic stability or not.

MATERIALS AND METHODS

Isolates and light sources

Three *E. rostratum* isolates (CLER09, D087 and JL05) were obtained from leaf spots of banana plants in Guangxi province, China[1]. Culture plates of the isolates were deposited in the China General Microbiological Culture Collection Center in Beijing, China with the accession numbers of CGMCC 3.14160, CGMCC 3.14161 and CGMCC 3.13461 for isolates CLER09, D087 and JL05, respectively. These isolates were grown on potato dextrose agar (PDA) plates and incubated at 28 °C for 5 d. A 6mm-diameter mycelial disks was cut out from colony edge and used as inocula.

Light sources: (1) ozone-free ultraviolet light (ZW20S19W, 20 W, λ=253.7 nm, Jiangsu Juguang Potoelectric Technology Co., Ltd, China); (2) fluorescent light (YZ18RR26, 18W, λ=400-750 nm, Nanjing Huadong Electronics Group, China); (3) green fluorescent light (JFL-SCT420-GT4, 20W, λ=500-565 nm, JOM Lighting Appliance Co., Ltd, China); (4) black fluorescent light (YHG20, 20 W, λ=320-390 nm, Nanjing Huadong Electronics Group, China).

Isolates incubated under different light environments

Single point central inoculations were made with 6 mm diameter disks of actively growing mycelia of the tested isolates. After being sealed with parafilm, the Petri dishes were placed in a chamber of an illuminating lamp for 5 d incubation at 24°C with a distance of 20 cm between lamp and Petri dish. The light intensity of the chamber was examined with a light intensity measurer (Victor 1010A, Shenzhen Victor Hi-Tech Co., Ltd, China). Six light environments were used to evaluate the influence of cultural conditions on conidial morphology: (1) continuous irradiation of black fluorescent light, (2) continuous irradiation of ozone-free ultraviolet light, (3) continuous irradiation of fluorescent light, (4) continuous irradiation of green fluorescent light, (5) alternating cycles of 12 h fluorescent light/12 h darkness and (6) complete darkness. There were three replicates for each treatment. Colony diameters were

measured using the cross-measurement (CM) method and the numbers of conidia per colony estimated. The CM method was based on twice measurements of the same colony performed by measuring along both the x and y axes with vernier calipers. The twice measurements were averaged to give a figure (cm) for the colony diameter. To evaluate the sporulation of the isolates, conidial suspensions were prepared by flooding 5 days-old colonies with distilled water (10 mL water per colony) and agitated with a glass rod. The concentration of the suspensions was estimated using a haemacytometer (Hausser, Horsham, PA, USA) under a light microscope and replicated three times of each colony. Conidial morphology was examined with a light microscope. More than 100 conidia per isolate were randomly checked for their morphological features under light microscope.

Effect of UV-twice-successive irradiation on conidial morphology of *E. rostratum*

Two mass-sporulation isolates (CLER09 and D087) with marked conidial morphology difference were used for successive UV treatments. The single conidium with 3 and 6 septa were separately isolated from the colony of isolate CLER09 treated by UV irradiation, and the single conidium with 3, 6 and 9 septa were separately isolated from the colony of isolate D087 treated by UV irradiation. The isolated conidia were used as potential mutants and separately transferred onto a new PDA plate. There were three replicates for each type of conidia. After being sealed with parafilm, the Petri dish was placed in a chamber with an UV illuminating lamp at 24 °C with a distance of 20 cm between the lamp and the Petri dish. Conidial morphology was examined with a light microscope after 5-days incubation. More than 100 conidia per monosporic isolates were randomly checked for their morphological characteristics.

Effect of darkness on conidial morphology of *E. rostratum* treated by UV light irradiation

The single conidium with 3 and 6 septa were separately isolated from the colony of isolate CLER09 treated by UV irradiation, and the single conidium with 3, 6 and 9 septa were separately isolated from the colony of isolate D087 treated by UV irradiation. The isolated conidia were separately transferred onto a new PDA plate. There were three replicates for each type of conidia. After being sealed with parafilm, the Petri dish was placed in a chamber and incubated under complete darkness at 24 °C. Conidial morphology was examined with a light microscope after 5-days incubation. More than 100 conidia per monosporic isolate were randomly checked for their morphological characteristics.

Effect of UV irradiation on conidial morphology of *E. rostratum* incubated under darkness

The single conidium with 3 and 6 septa were separately isolated from the colony of isolate CLER09 incubated under complete darkness, and the single conidium with 3, 6 and 9 septa were separately isolated from the colony of isolate D087 incubated under complete darkness. The isolated conidia were transferred onto a new PDA plate. There were three replicates for each type of conidia. After being sealed with parafilm, the Petri dish was placed in a chamber and illuminated with an UV lamp at 24 °C. Conidial morphology was examined with a light microscope after 5-days incubation. More than 100 conidia per monosporic isolate were randomly checked for their morphological characteristics.

Effect of successive dark incubation on conidial morphology of *E. rostratum*

The single conidium with 3 and 6 septa were separately isolated from the colony of isolate CLER09 incubated under complete darkness, and the single conidium with 3, 6 and 9 septa were separately isolated from the colony of isolate D087 incubated under complete darkness. These conidia were transferred onto a new PDA plate. There were three replicates for each type of conidia. After being sealed with parafilm, the Petri dish was placed in a chamber and incubated under complete darkness at 24 °C. Conidial morphology was examined with a light microscope after 5-days incubation. More than 100 conidia per monosporic isolate were randomly checked for their morphological characteristics.

RESULTS

Effect of light environment on the growth and sporulation of *E. rostratum*

Light environments significantly affected vegetative growths of *E. rostratum*. Among the 6 tested light environments, UV light was mostly suitable for vegetative growth of isolates CLER09, and black light for isolates D087 and JL05 compared

to complete darkness (Table 1).

Light environments also significantly affected the sporulation of *E. rostratum*. UV light had a promotion effect on the sporulation of isolates CLER09 and D087 compared to complete darkness. The black fluorescent light, fluorescent light and green fluorescent light inhibited the sporulation of isolate CLER09 with green fluorescent light was strongest. Except black fluorescent light, all of the rest light sources promoted the sporulation of isolate D087. The sporulation ability of isolate JL05 was weaker than isolates CLER09 and D087. All of the tested light sources inhibited sporulation of isolate JL05 (Table 1).

Effect of lighting on conidial morphology of *E. rostratum*

Lighting had a significant influence on conidial length of *E. rostratum*. Four lighting treatments (black fluorescent light, UV light, fluorescent light and alternating cycles of 12 h fluorescent light/12 h darkness) markedly extended conidial lengths of isolate CLER09 with the UV light as the most. The UV-light-irradiated colonies of isolate CLER09 produced the conidia with 2 times longer conidial length than those produced under complete darkness condition. Green fluorescent light had a slightly inhibitory effect on the conidial length of isolate CLER09. All of the tested light sources had a promotion effect on the conidial length of isolate D087 with the UV light as the most. The lengths of the conidia produced by the UV-light-irradiated colonies were 4 times longer than those of the conidia produced under complete darkness. Except that no sporulation of isolate JL05 occurred under the black fluorescent light treatment, the other lighting treatments had a promotion effect on extending the conidial lengths of isolate JL05 with the UV light as the most. The lengths of the conidia produced by the UV-light-irradiated colonies were approximately 6 times longer than those of the conidia produced under complete darkness (Table 2). A positive relationship between the length of conidium and the numbers of its septum was observed (Table 3, Fig. 1). In general, all of the tested light sources slightly affected on the conidial width compared to the conidial length. The response of changes in conidial width to light sources differed from one isolate to another. All of the tested light sources

Table 1. Effect of lighting on vegetative growth and sporulation of *Exserohilum rostratum*

Light sources	Colony diameter (cm)[a]			Sporulation ($\times 10^6$ conidia per colony)		
	CLER09	D087	JL05	CLER09	D087	JL05
Black fluorescent light	7.13±0.08 aA	7.12±0.10 aA	7.13±0.08 aA	10.63±2.78	3.54±0.18	0.00±0.00
UV light	7.18±0.08 aA	6.56±0.21 bB	7.08±0.13 aA	110.00±8.91	153.85±11.0	5.31±1.13
Fluorescent light	7.14±0.10 aA	6.41±0.12 bBC	7.05±0.13 aA	8.85±1.80	11.98±1.09	0.10±0.01
Green fluorescent light	6.35±0.13 bB	6.25±0.23 bcBC	6.43±0.06 bB	2.71±0.65	11.67±1.70	0.42±0.18
Alternate darkand illumination	6.32±0.17 bB	6.04±0.04 cC	6.00±0.00 cC	12.08±0.36	10.42±1.18	0.52±0.18
Darkness	5.47±0.08 cC	4.38±0.22 dD	4.84±0.04 dD	11.87±1.62	4.58±0.48	13.02±0.48

[a] Values are the means of three replicates. The lower cases and capital letters represent the significance levels of difference at 5% and 1%, respectively.

had a promotion effect on extending the conidial width of isolate CLER09 with the green fluorescent light was the most. The black fluorescent light had a promotion effect on extending the conidial width of isolate D087, while the UV light treatment had the opposite effect. Except the black fluorescent light, the other lighting treatments had a promotion effect on extending the conidial width of isolate JL05 with the alternating cycles of 12 h fluorescent light/12 h darkness was the most effective (Table 4).

Effect of UV-twice-successive irradiation on conidial morphology of *E. rostratum*

UV light had a different influence on the conidial morphology variation of *E. rostratum*. The isolates produced by 3 and 6 septa conidium, single-conidium derived respectively from isolate CLER09 treated by UV light irradiation, name as isolates CUU3 and CUU6 respectively after culture under second time UV lighting. The isolates produced by 3, 6 and 9 septa conidium, single-conidium derived respectively from isolate D087 irradiated

Table 2. Effect of lighting on conidial lengths of *Exserohilum rostratum*

Light sources	Conidial length (µm)[a]					
	CLER09		D087		JL05	
	Range	Average	Range	Average	Range	Average
Black fluorescent light	15.0-57.5	40.0	31.5-200.0	123.0	NT	NT
UV light	36.0-170.0	88.4	22.5-360.0	193.6	5.0-250.0	206.4
Fluorescent light	10.0-95.0	58.8	30.0-343.5	125.3	25.0-185.0	109.2
Green fluorescent light	12.0-65.0	37.9	29.5-299.0	136.9	35.0-153.0	84.6
Alternate dark and illumination	15.0-71.0	51.3	27.0-84.0	63.2	29.0-69.0	57.3
Darkness	17.5-65.0	38.2	20.0-78.5	47.5	14.5-67.0	35.6

[a] 'NT' denote that no sporulation occurred (the same as below).

Table 3. Effect of lighting on septum numbers of *Exserohilum rostratum* conidia

Light sources	Septum (number/conidium)					
	CLER09		D087		JL05	
	Range	Average	Range	Average	Range	Average
Black fluorescent light	2-7	5.0	4-15	10.3	NT	NT
UV light	4-15	8.9	1-25	13.6	3-21	12.0
Fluorescent light	2-9	5.6	5-20	10.6	3-12	9.5
Green fluorescent light	1-7	4.4	7-19	10.6	3-11	8.8
Alternate dark and illumination	1-7	4.8	3-15	8.2	2-11	7.6
Darkness	1-9	4.3	1-8	5.0	1-8	4.1

Table 4. Effect of lighting on conidial widths of *Exserohilum rostratum*

Light sources	Conidial width (µm)					
	CLER09		D087		JL05	
	Range	Average	Range	Average	Range	Average
Black fluorescent light	10.0-24.0	18.5	13.5-20.0	16.8	NT	NT
UV light	11.5-21.5	18.3	10.0-20.0	14.1	11.5-20.0	15.0
Fluorescent light	10.0-23.5	16.8	9.0-19.5	15.0	10.0-19.5	15.4
Green fluorescent light	10.0-24.5	18.9	10.0-19.0	15.5	11.5-17.5	14.8
Alternate dark and illumination	11.5-20.0	15.8	13.5-17.5	15.3	14.5-19.0	15.6
Darkness	7.5-21.0	15.0	10.0-21.0	15.2	10.0-19.5	13.3

by UV light, name as isolates DUU3, DUU6 and DUU9 respectively after culture under the second time UV lighting. The second time UV light had a significantly promotion influence on the length of offspring conidium of isolate CLER09 short conidium derivation (CUU3) and isolate D087 short conidium derivation (DUU3) followed by that of isolate CLER09 and D087 moderate conidium derivation (CUU6 and DUU6 respectively), and that of isolate D087 long conidium derivation (DUU9)

Table 5. Sizes of conidial offspring of the *Exserohilum rostratum* single-conidium derived original isolates cultured under continuous UV-irradiation again

Isolates of single-conidium[a]	Septum (number/conidium)		Conidial length (μm)		Conidial width (μm)	
	Range	Average	Range	Average	Range	Average
CUU3	3-11	8.3	26.5-133.0	73.7	11.0-19.0	15.0
CUU6	2-10	6.2	20.0-95.0	47.9	10.0-19.0	14.2
CLER09	0-8	5.0	15.0-63.5	41.3	11.0-20.0	15.4
DUU3	5-15	10.4	35.0-259.0	124.3	9.5-14.5	11.6
DUU6	3-13	8.5	34.0-190.0	91.0	9.0-15.0	11.2
DUU9	4-15	9.7	35.0-261.0	135.8	9.5-15.0	11.4
D087	0-20	7.4	15.0-210.0	78.9	8.0-25.0	14.3

[a] The data in the table were the size measurements of 100 conidial offspring; isolates CLER09 and D087 were the original strains (the same as below).

Table 6. Sizes of conidia of the UV-irradiated *Exserohilum rostratum* single-conidium isolates incubated under complete darkness condition

Isolates of single-conidium[a]	Septum (number/conidium)		Conidial length (μm)		Conidial width (μm)	
	Range	Average	Range	Average	Range	Average
CUB3	1-9	5.2	16.0-79.5	40.2	10.0-21.5	15.4
CUB6	1-8	4.8	14.5-60.0	38.9	9.0-20.0	15.1
CLER09	0-8	5.0	15.0-63.5	41.3	11.0-20.0	15.4
DUB3	1-9	4.9	17.0-102.0	42.1	10.0-20.0	14.9
DUB6	2-11	6.2	19.0-131.0	59.8	10.5-25.0	17.1
DUB9	1-13	6.1	20.0-149.5	59.5	10.0-21.0	14.8
D087	0-20	7.4	15.0-210.0	78.9	8.0-25.0	14.3

Table 7. Sizes of conidia of the dark-incubated *Exserohilum rostratum* single-conidium isolates incubated under continuous UV-irradiation

Isolates of single-conidium[a]	Septum (number/conidium)		Conidial length (μm)		Width of conidia	
	Range	Average	Range	Average	Range	Average
CBU3	4-9	6.4	29.0-67.0	50.5	10.0-25.0	17.7
CBU6	3-9	6.3	25.0-79.0	48.0	10.0-24.5	15.5
CLER09	0-8	5.0	15.0-63.5	41.3	11.0-20.0	15.4
DBU3	3-13	9.5	35.0-154.0	115.8	9.5-15.0	11.0
DBU6	4-20	10.0	45.0-331.5	130.0	9.5-20.0	14.5
DBU9	4-11	7.3	38.5-135.5	77.7	9.5-16.0	11.1
D087	0-20	7.4	15.0-210.0	78.9	8.0-25.0	14.3

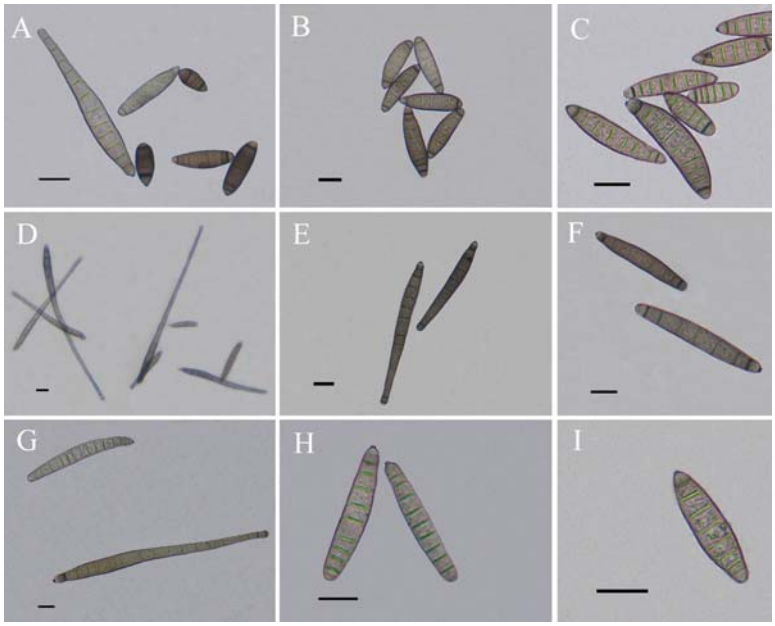
Table 8. Sizes of conidia of the *Exserohilum rostratum* single-conidium isolates after two continuous incubation under complete darkness condition

Isolates of single-conidium[a]	Septum (number/conidium)		Conidial length (μm)		Width of conidia (μm)	
	Range	Average	Range	Average	Range	Average
CBB3	1-8	4.4	15.0-60.0	37.1	12.5-24.0	17.5
CBB6	1-8	5.4	16.5-60.0	38.8	10.0-20.0	15.5
CLER09	0-8	5.0	15.0-63.5	41.3	11.0-20.0	15.4
DBB3	1-9	4.9	15.0-81.5	45.2	9.5-18.5	11.7
DBB6	3-10	6.5	25.0-107	70.4	11.0-20.0	13.5
DBB9	4-11	6.1	34.0-119.5	57.9	11.5-19.0	14.7
D087	0-20	7.4	15.0-210.0	78.9	8.0-25.0	14.3

was last. All the light sources had a slight influence on the width of three isolates (Table 5).

Effect of darkness on conidial morphology of *E. rostratum* treated by UV light irradiation

The isolates produced by 3 and 6 septa conidium, single-conidium derived from isolate CLER09 irradiated by UV light, name as isolates CUB3 and CUB6 respectively after culture under complete darkness condition. The offspring of short conidium (CUB3) irradiated by UV light would be elongated when cultured under complete darkness condition, but the offspring of long conidium (CUB6) irradiated by UV light would be shorted. The isolates produced by 3, 6 and 9 septa conidium, single-conidium derived from isolate D087 irradiated by UV light, name as isolates DUB3, DUB6 and DUB9 respectively after culture under complete darkness condition. The offspring of short conidium (DUB3) irradiated by UV light could be also elongate when the colony cultured under complete darkness condition, and the morphology of moderate size conidium (DUB6) were consisted with that of the original, but the offspring of long conidium (DUB9) would be shorten when the



A, D, G, Conidia produced under UV light environment (A, isolate CLER09; D, isolate D087; G, isolate JL05); B, E, H, Conidia produced under green light environment (B, isolate CLER09; E, isolate D087; H, isolate JL05); C, F, I, Conidia produced under complete darkness (C, isolate CLER09; F, isolate D087; I, isolate JL05), scale bar = 20 μm

Fig. 1 Shapes of *Exserohilum rostratum* conidia produced under various light environments

colony cultured under complete darkness condition. The effect of darkness on the width of offspring of isolate CLER09 conidium was slight, but could promoted extending of isolate D087 with the optimum of moderate size conidium (DUB6) (Table 6).

Effect of UV irradiation on conidial morphology of *E. rostratum* incubated under darkness

The isolates produced by 3 and 6 septa conidium, single-conidium derived from isolate CLER09 cultured under complete darkness condition, name as isolates CBU3 and CBU6 respectively after cultured under UV lighting. UV light had a promotion influence on the length of offspring of isolate CLER09 with the optimum of short conidium followed by the long conidium. The isolates produced by 3 and 6 septa conidium, single-conidium derived from isolate D087 cultured under complete darkness condition, name as isolates DBU3, DBU6 and DBU9 respectively after cultured under UV lighting. UV light had a promotion influence on the length of short and moderate conidium of isolate D087 with the optimum of moderate conidium (DBU6), but inhibited that of long conidium (DBU9). UV light had a remarkable promotion on the width of offspring of the isolate CLER09, but inhibited that of short and long conidium, and the effect on the moderate conidium was slight (Table 7).

Effect of successive dark incubation on conidial morphology of *E. rostratum*

The isolates produced by 3 and 6 septa conidium, single-conidium derived from isolate CLER09 cultured under complete darkness condition, name as isolates CBB3 and CBB6 respectively after second time cultured under darkness. Twi-darkness cultured had a promotion effect on the length of offspring of short conidium of isolate CLER09, but inhibited that of long conidium of isolate CLER09. The isolates produced by 3, 6 and 9 septa conidium, single-conidium derived from isolate D087 cultured under darkness, name as isolates DBB3, DBB6 and DBB9 respectively after second time cultured under darkness. Twi-darkness cultured had a promotion effect on the short and moderate conidium of offspring of isolate D087 with the optimum of short conidium offspring, but inhibited that of long conidium. Twi-darkness was propitious of broadening of short conidium offspring of isolate CLER09, but inhibited that of short and moderate conidium offspring of isolate D087 (Table 8).

DISCUSSION

Lighting had a promotion or inhibitory influence on many fungal vegetative growths. Honda and Aragaki[24] reported that fluorescent light promoted slightly vegetative growth of *E. rostratum* between the temperatures of 20-28 °C. In the present study, the promotion effect of vegetative growth of *E. rostratum* by the light sources tested were found to be most effective at 24 °C, however, the degree of the light-promoted vegetative growth varied from one isolate to another (Table 1). Only under lower temperature condition (16 °C), fluorescent light had a promotion effect on the sporulation of *E. rotratum*[20]. Our results indicated that, the sporulation of the isolate D087 could be significantly enhanced even at a higher temperature (24°C), which was clearly differed from the previous report[20]. Moreover, UV light significantly promoted the sporulation of isolates CLER09 and D087, while a reduced sporulation of isolate JL05 incubated under UV light was observed. The results suggested that light reaction was remarkably different among isolates of *E. rotratum*, which could be considered as another aspect of genetic diversity among the pathogen populations.

Honda and Aragaki[20] had been reported that fluorescent light promoted markedly lengthening of the length of *E. rostratum*. Our study results showed that tested light sources promoted the length of the 3 isolates conidia, except that green fluorescent light had a promotion influence to isolate CLER09 and no conidium of isolate JL05 was examined (Table 2). Moreover, whether the isolates cultured first time under darkness or UV light, all lengths of offspring of short conidium (3 septa) could be increase significantly, the lengths of offspring of moderate conidium (6 septa) increase slightly. Except the offspring of long conidium (9 septa), all other offspring conidia (3 and 6 septa) whether cultured first time under darkness or UV light were shorten at different degree under UV light environment. Moreover, all the light sources had a slightly influence on the width of conidia (Table 5, 6, 7 and 8). Twi-UV light could induce extending of

conidium of *E. rostratum* with the optimum of short conidium offspring and that of offspring of moderate and long conidia extended slightly compared with that of short conidium (Table 5). All the results suggested that the effect of lighting on the conidial morphology was temporary. Worapong et al.[28] also suggested that the rDNA-ITS sequence of original isolate was consisted with that of mutant isolates *Pestalotiopsis microspora* induced by UV light irradiation. It was indicated that morphology mutant caused by UV light irradiation was not genetic.

Moreover, UV lighting induces or inhibits production of sexual generation or sporulation of some fungi. For example, UV lighting could induce production of fruiting body, pycnidium and perithecium of *Phoma caricae-papayae* using the wave length less than 360 nm [29]. Near-UV light could inhibit production of oospore of *Phytophthora capsici*, *P. palmivora* and *P. megasperma*[30], and sclerotium of *Botrytis cinerea*[31]. On the other hand, near-UV light could inhibit the production of sclerotium of *Sclerotinia sclerotiorum*[32]. In the present study, no sexual reproduction of the tested isolates was observed during 2 months of incubation under various light sources that contained the wave lengths less than 360 nm. The results suggested that *E. rostratum* might be a heterothallic fungus or the sexual reproduction might need complex environment factors (for example, temperature, pH and nutrition) for combination[33].

Conidial morphology was the most primary characteristic in the traditional identifying of fungi. Lighting was one of the important environment factors affecting the vegetative growth, sporulation and especially conidial morphology of *E. rostratum*, but the inductive function on conidial morphology could be recoverable under complete darkness environment. Of the six tested light sources, UV light was optimal for sporulation except isolate JL05. UV light had a markedly promotion effect on the conidial lengths of *E. rostratum* with more than 10 times to that cultured under complete darkness. The conidial lengths of *E. rostratum* with less septa were extended significantly comparing than that with more septa under all of the light sources, especially UV light except isolate CLER09.

ACKNOWLEDGEMENTS

This work has been financed in part by grant from Natural Science Foundation of Guangxi (2013GXNSFBA019068), Science and Technology Development Fund of Guangxi Academy of Agricultural Sciences (2013JZ12) and the Special Scientific Research Funds of Guangxi Academy of Agricultural Sciences (Project No. 2012YZ19).

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