

LED for Bio- Industry

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What is Bio-Industry ?

- Production, Ecology related related
 - Agriculture (Agronomy, Horticulture, etc.)
 - Aquaculture (Fishery, Shrimp, Shellfish, etc.)
 - Livestock/Animal Industry
- Life Science related
 - Bio-technology Industry
- Life/Health related
 - Bio-Medical Industry

What is LED ?

- People from different background have different point of view.



With the help of **LED**, we can **LED**.

Light

Emitting

Diode



Light up

Eco-friendly

Dream

Worldwide replacement of Incandescent Bulb with LED Bulb is the 1st step toward eco-friendly dream.



Light up Eco-friendly Dream



LED

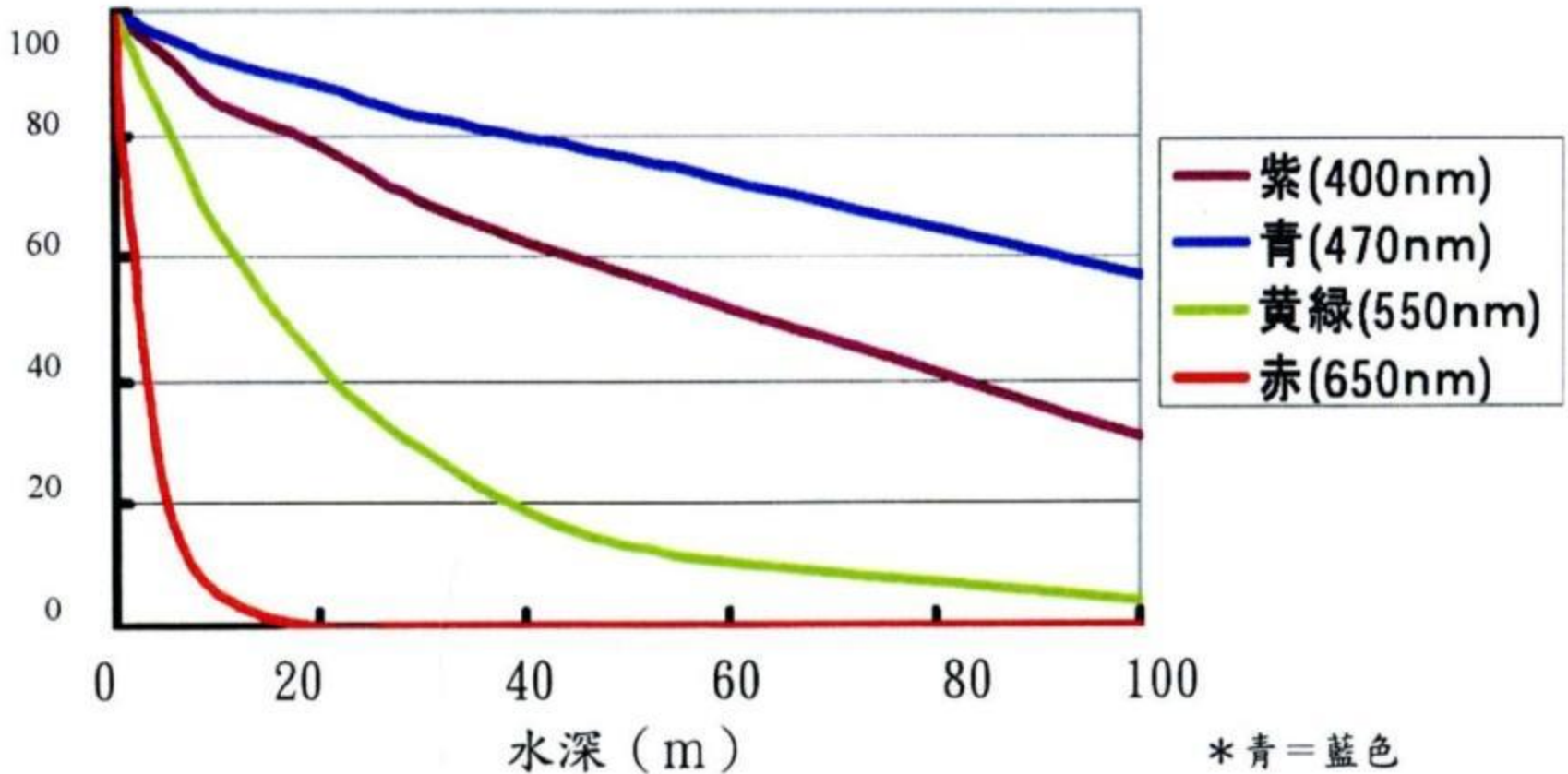
Aquaculture

Incredible fishing



● ● ● Light intensity remained @ various depth under water for various spectrum of light

光強
度



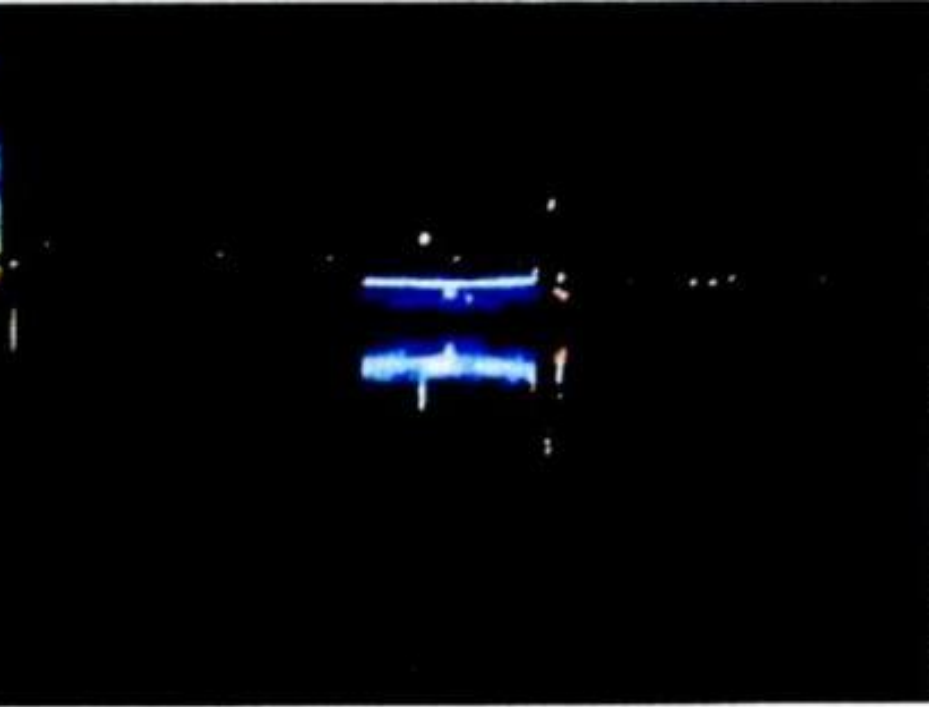
● ● ● | To observe night time behavior





水銀聚魚燈船

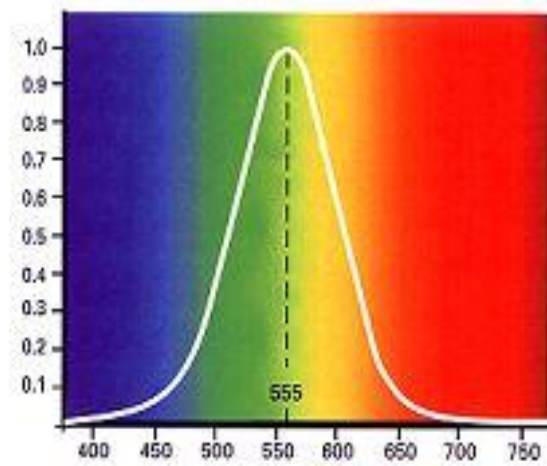
Traditional MH lamp



藍色LED聚魚燈船

Blue LED lamp

Human 555 nm



**Peak wavelength of
calamari's response
curve**

魷魚(花枝)

482 nm

金花枝

490 nm

槍花枝

494 nm

肯薩基花枝

491 nm

紅花枝

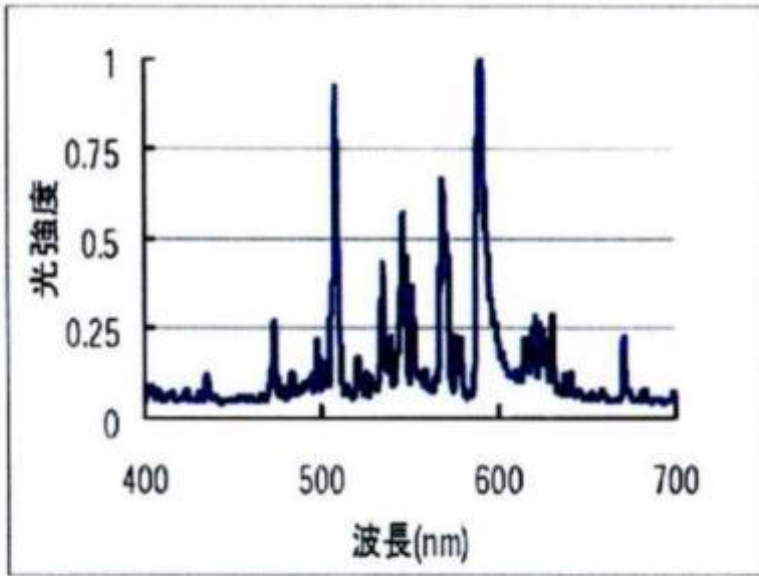
482 nm

螢光花枝

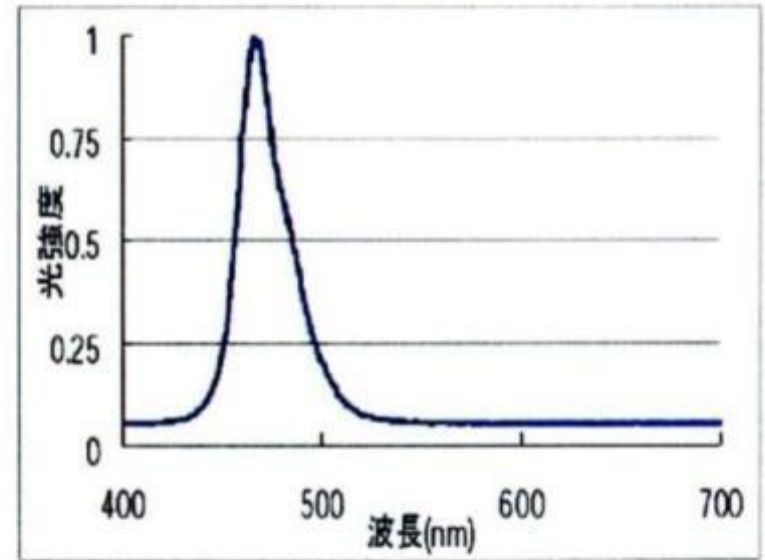
471、484、501 nm

Calamari
Squid
Cuttlefish





Metal Halide Lamp



Blue LED

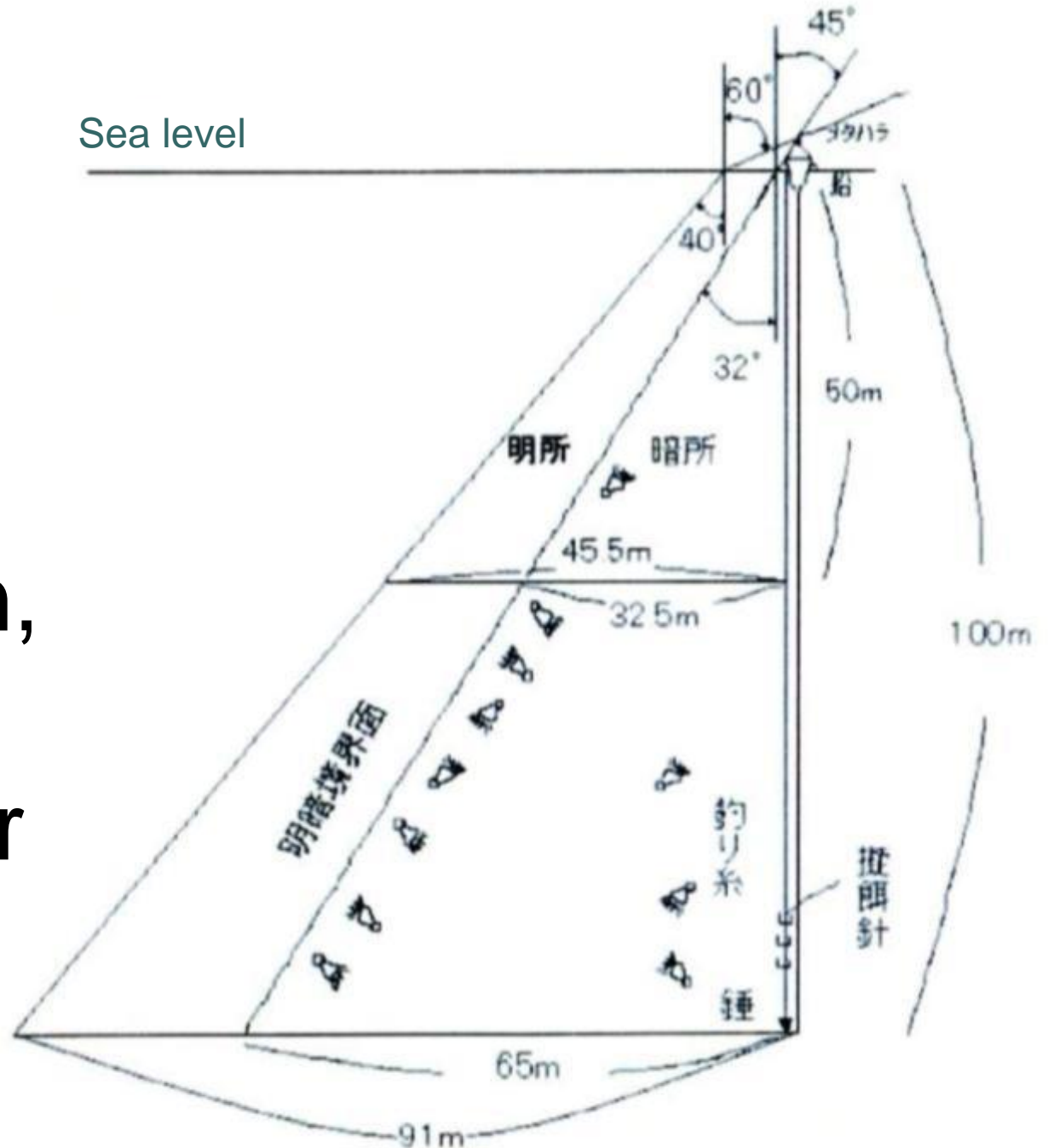
Light source	Ratio of blue portion
Sun	18.2%
Moon	9.74%
Metal Halide Lamp	7.32%
Blue LED	74.1%

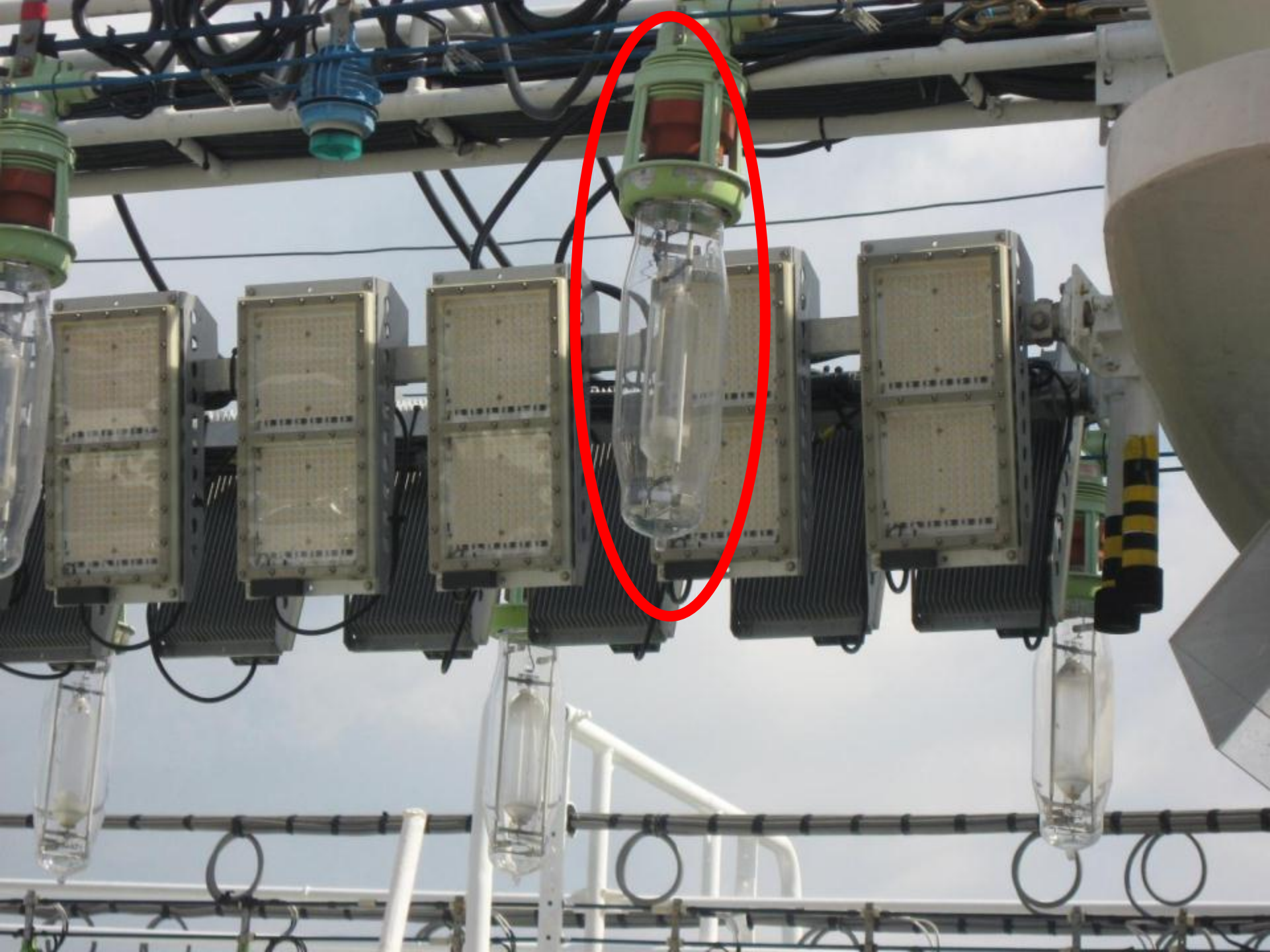
Blue portion in blue LED is 10 times of that in Metal Halide Lamp

Proper
Spectrum

Deeper
penetration,

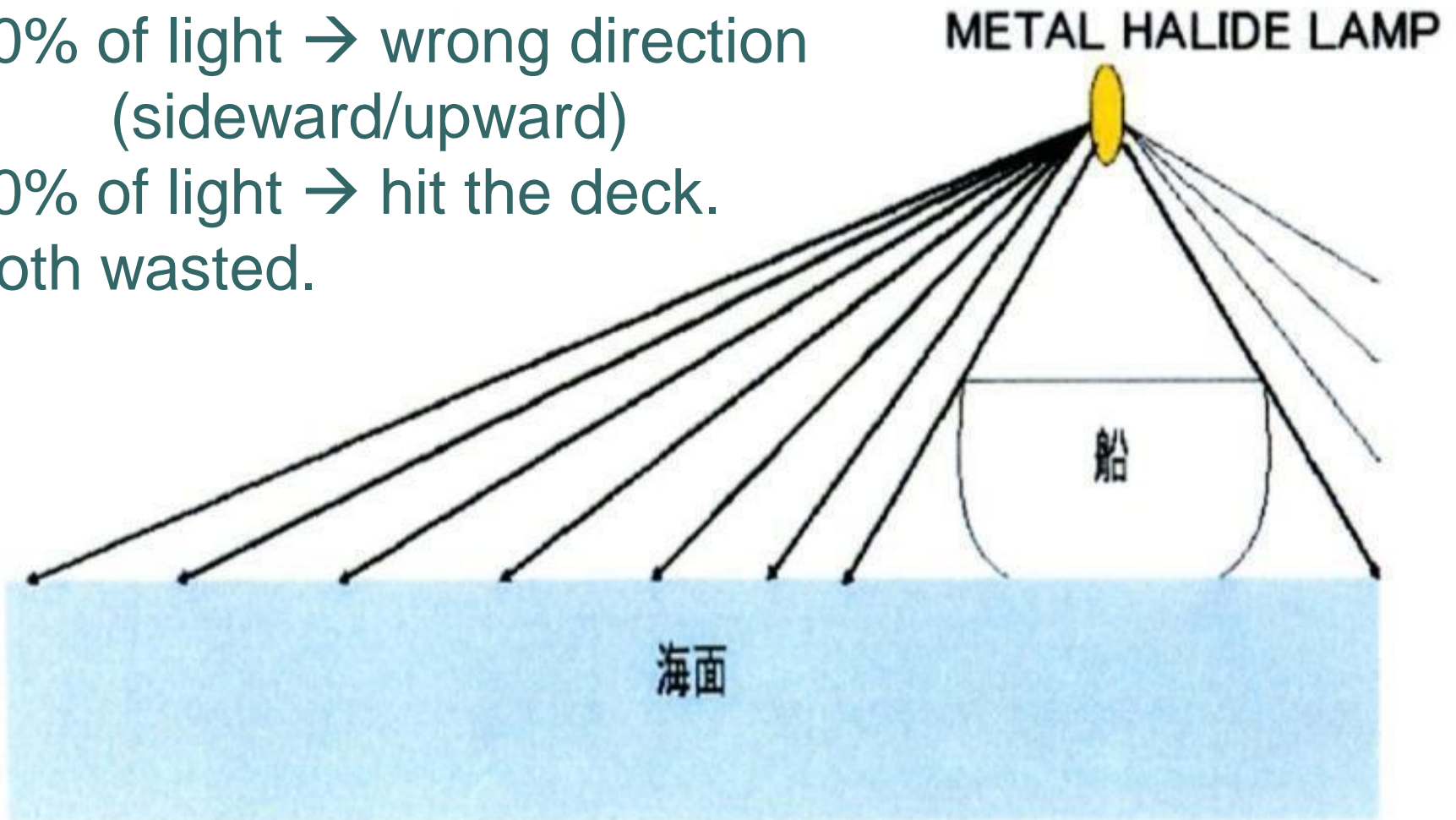
Much wider
effective
range

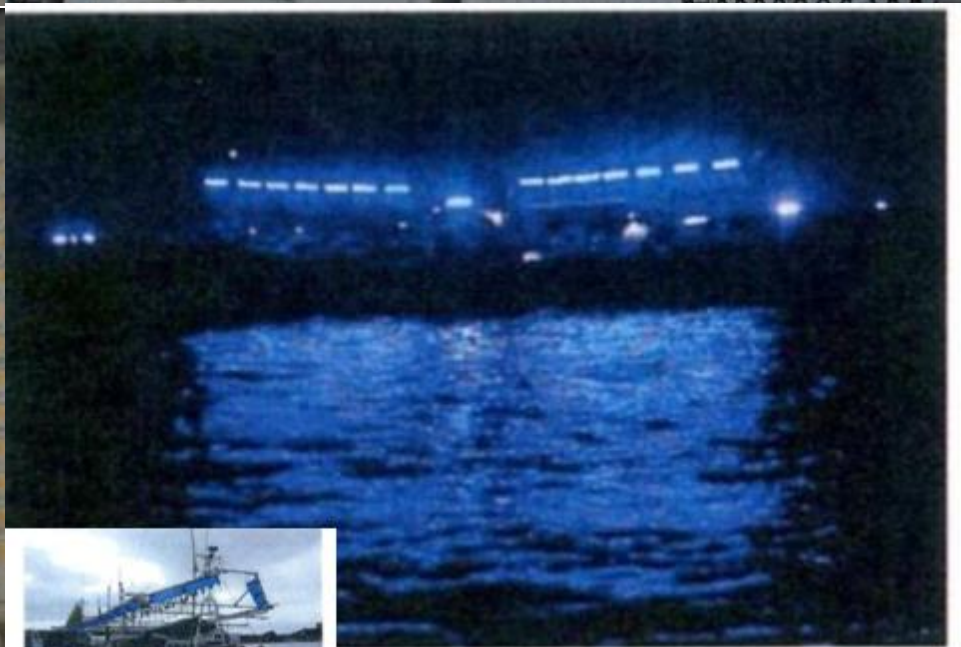




Poor installation subject to the nature of the light source

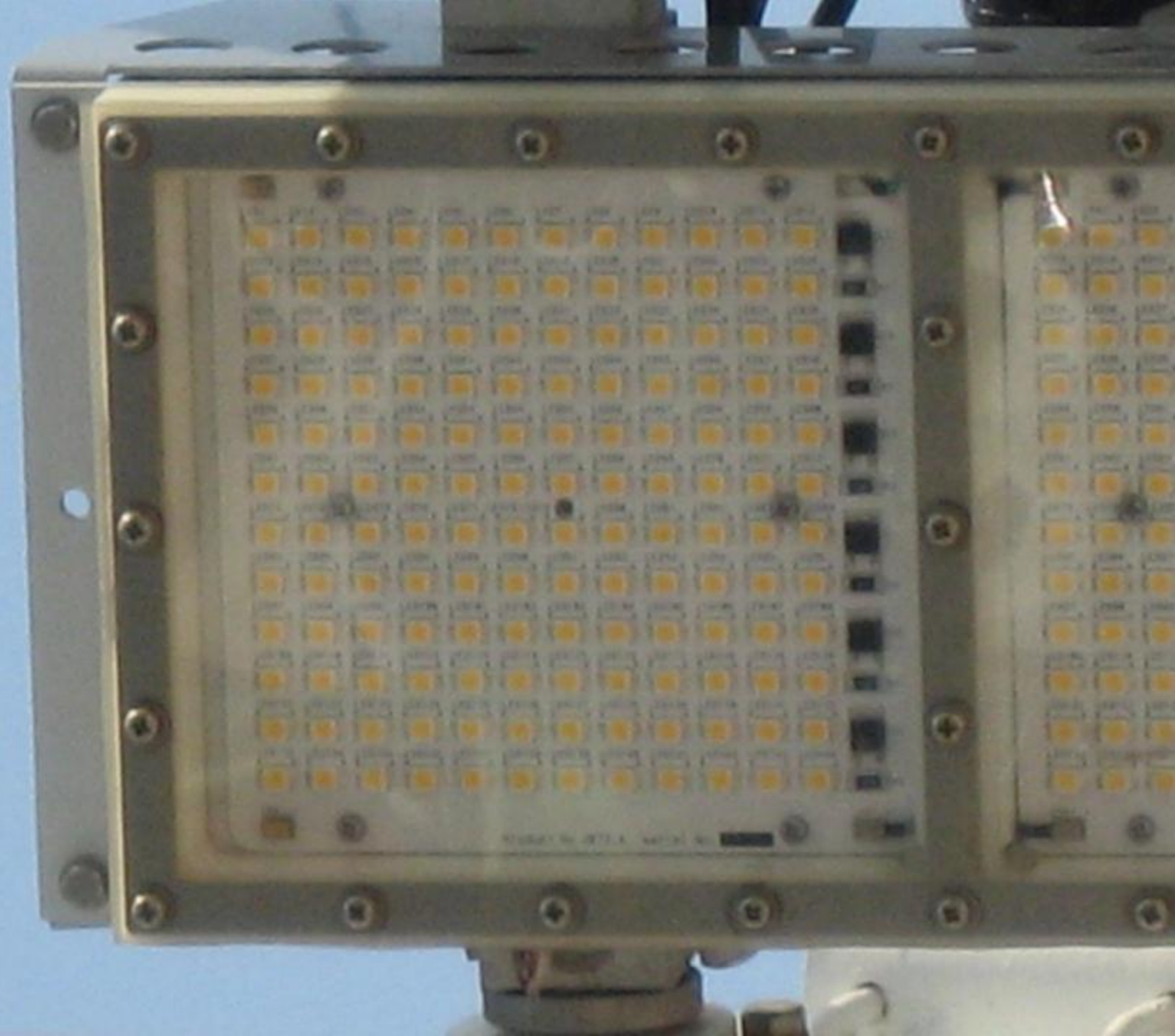
50% of light → wrong direction
(sideward/upward)
20% of light → hit the deck.
Both wasted.













96~98% of power consumption can be saved by switching to LED w/o sacrificing the yield

漁船	LED lamps	MH lamps	LED/MH	總噸數	進行試驗的海域	時間跟捕魚日數	漁獲量	評估
A	2.4kw (36 PANEL)	70kw	1/29	9.9	岩內沖	H16. 6. 8~ 7. 26 (26 日)	57,336 尾	○
B	2.68kw (40 PANEL)	99kw	1/37	13.17	佐渡沖	H16. 7. 3~28 (16 日)	16,352 尾	○
C	2.28kw (34 PANEL)	120kw	1/53	9.5	岩內沖	H15. 10. 20	4,200 尾	○
D	2.15kw (32 PANEL)	180kw	1/84	9.7	函館沖	H15. 7. 26~27 (2 日)	2,400 尾	×

註 1) 所謂的「評估」，是LED漁船和金屬鹵素燈漁船在同海域、同一時間內的漁貨量的比較，大概同等量程度的漁貨是○、比較少的則是×



Light up Eco-friendly Dream

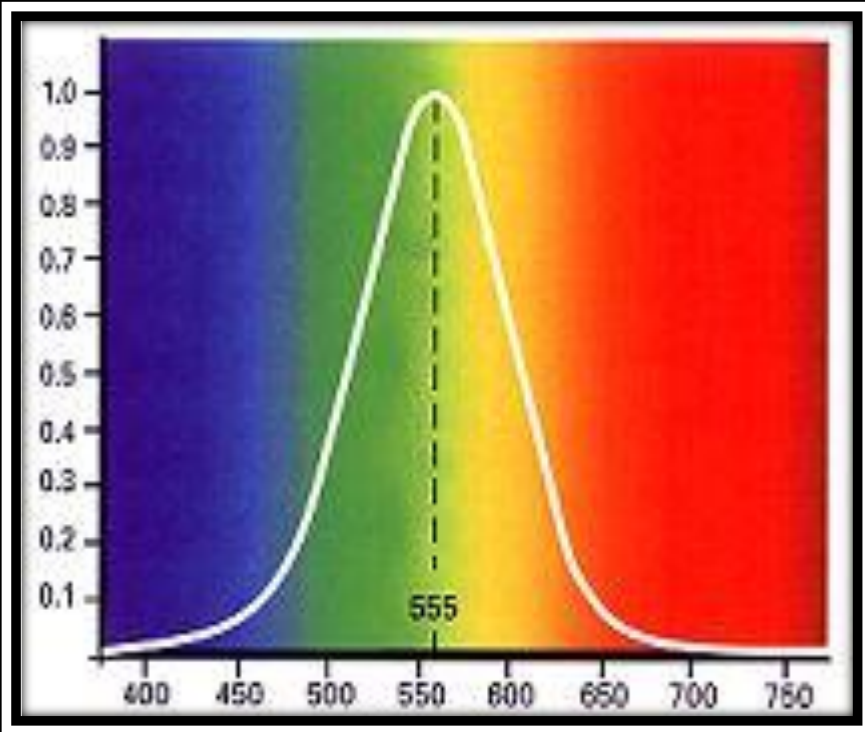


Animal

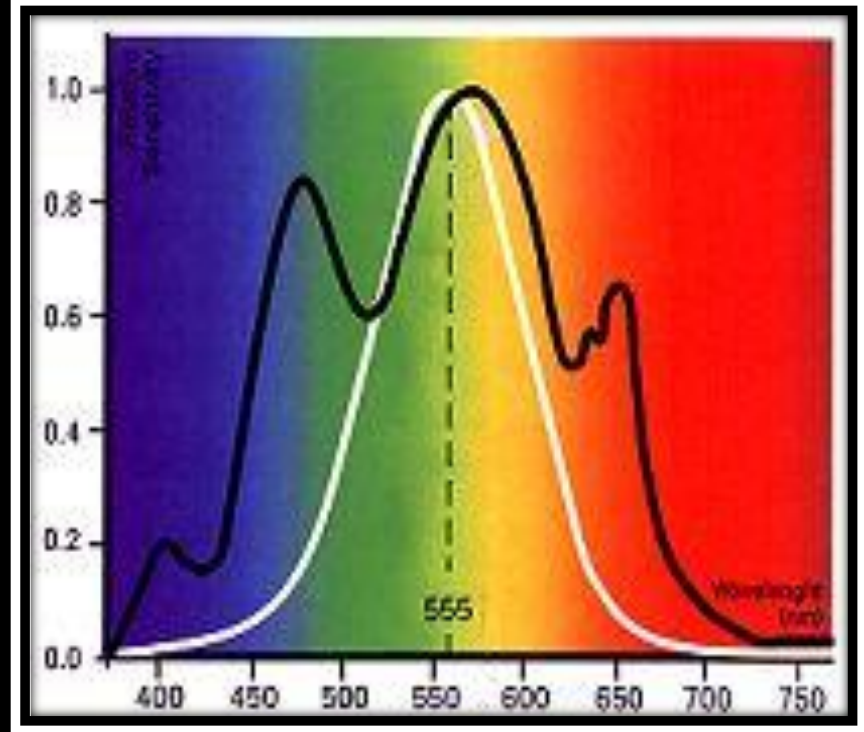
LED

Aquaculture

Different response curve



Human



Chicken

Chick for KFC ?



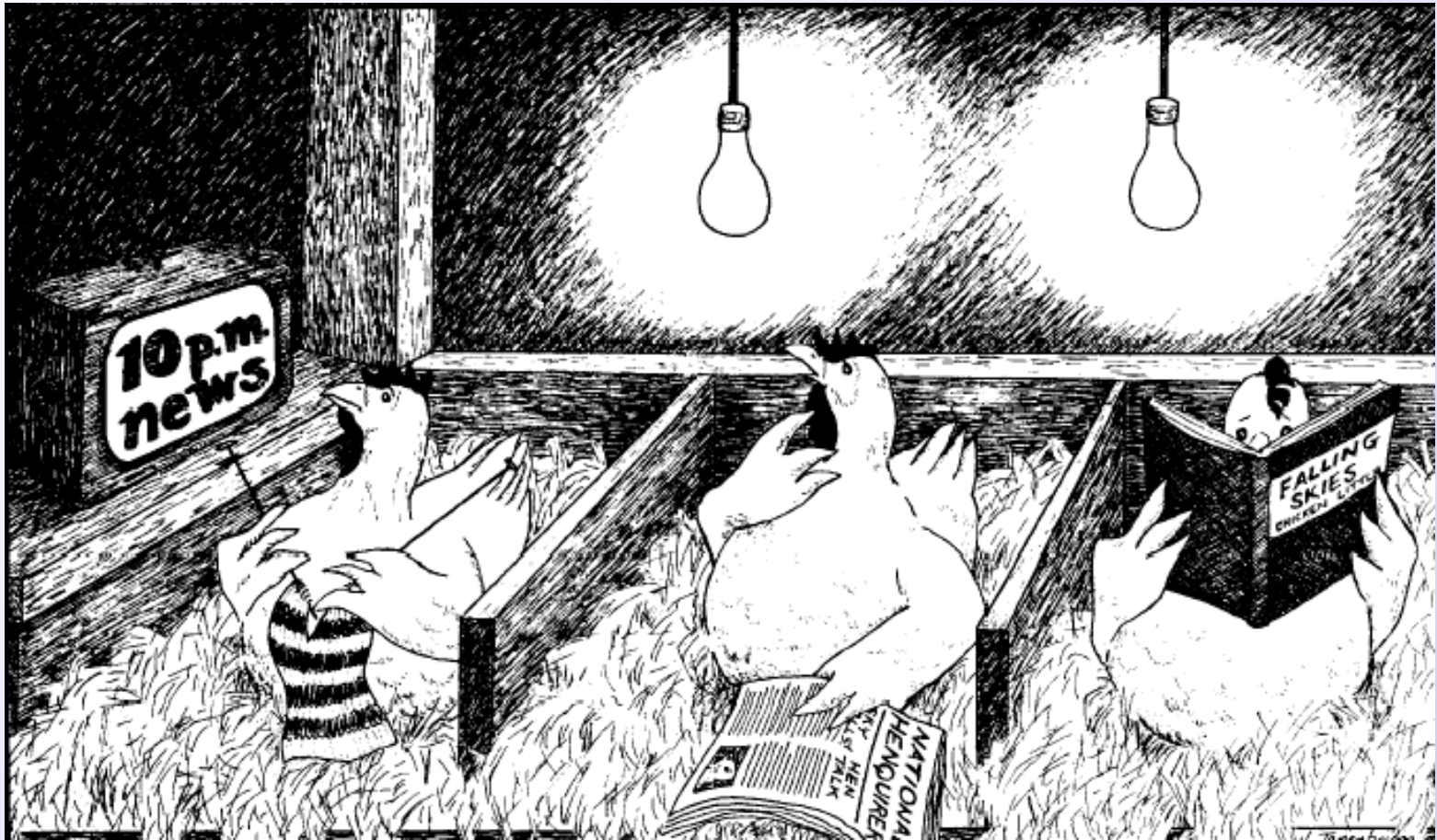
Blue and Green



Blue

綠光與藍光之LED燈泡，皆能促進白肉雞之生長，但綠光所造成的刺激是在生長前期，而藍光卻是在稍後的階段。白肉雞於孵化後，應是先照射LED綠光燈泡約10天，再接受藍光之照射。

Winter season need supplemental light (control of photoperiod)



Red light for egg production



Red LED promote estrus 催情

- Red LED (660 nm) put in the ear of **turkey and ostrich** @ **anestrus** (乏情期)
- successfully seduce male to approach and mate.
- Effect is much better than red bulb and red FL hanging overhead.
- Red LED 660 nm紅色光源，不僅可以刺激雌禽下視丘的GnRH（激性腺素刺激素）、腦下垂體的FSH（激濾泡素）、LH（排卵素）之mRNA的表現，以及與排卵相關相關內泌素如動情素、助孕素於血漿中之濃度，也抑制了與籟抱相關、位於腦下垂體的泌乳素之mRNA的表現。

Green light for egg hatching



綠光可刺激雞胚衛星細胞數目的增加，
對孵化後雛雞的生長有促進的效果。

照片提供 周楚洋



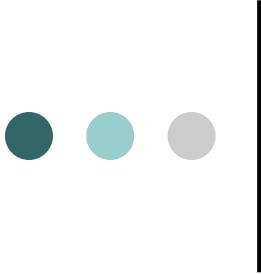
鹿茸生產

- 溫帶鹿種大多為短日生殖者：短光照促進性腺功能，長光照抑制之。
- 鹿角週期與性腺功能息息相關：辜固酮含量上升造成鹿茸骨化，辜固酮含量下降造成解角，茸角在辜固酮含量低時生長。
- 因此，鹿角之生長週期亦受光照調節。



梅花鹿之自然季節性

- 梅花鹿在五、六月解角，然後開始生長新角。
- 梅花鹿在十月完成蛻茸，變成硬角，維持至翌年五、六月。
- 梅花鹿自十月底進入配種季節，至二月底結束。
- 梅花鹿之睪丸功能自八月開始增加，在十或十一月達到巔峰，之後逐漸下降。



補充光照期對鹿茸生產之效應

- 目的：提早解角日期，並延伸茸角期。
- 處理：從冬至開始到八月中，以日光燈補充光照期至每日 14.5 h。

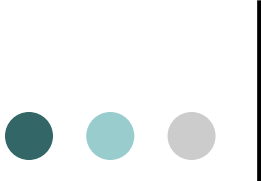
自冬至起補光對鹿茸生產之影響

表1. 自冬至起補光對鹿茸生產之影響

項目	對照組	光照組	顯著性
鹿隻頭數	10	55	
解角日期	4/30±5.0	3/23±2.4	*
鹿茸產量(g)	1,136±54	1,260±38	NS
長出再生茸頭數	0(0%)	17(30.9%)	*
再生茸重(g)	-	222±21	
再生茸總尖數	-	2.2±0.3	

*P < 0.05

資料節錄自楊與陳 (1994)



補充光照之結果顯示

- 光照週期調節梅花鹿之睪丸發育與鹿角周期。
- 長光照期抑制梅花鹿之睪丸功能。
- 在長期暴露於抑制性光照期之後，公梅花鹿對此光照期不反應(乏興奮)。

光照控制應用於鹿茸生產

- 提早補充光照期可提早溫帶鹿隻之解角與鹿茸生長，並產生再生鹿茸。
- 一個月短光照 (或自然光照) 與五個月長光照交替進行可使溫帶鹿種每年生產二次鹿茸，而使鹿茸年產量增加一倍。

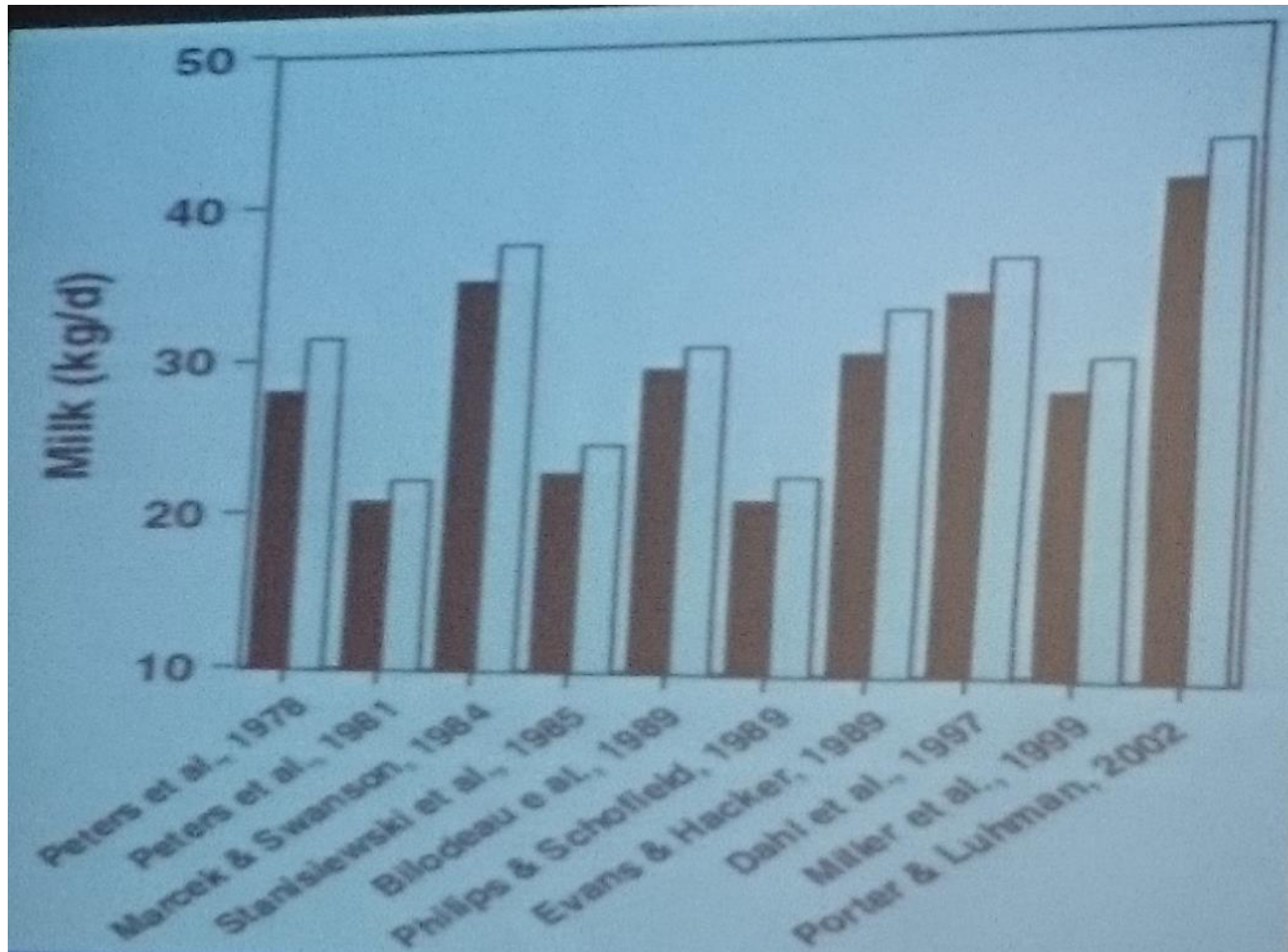
牛乳、羊乳之生產

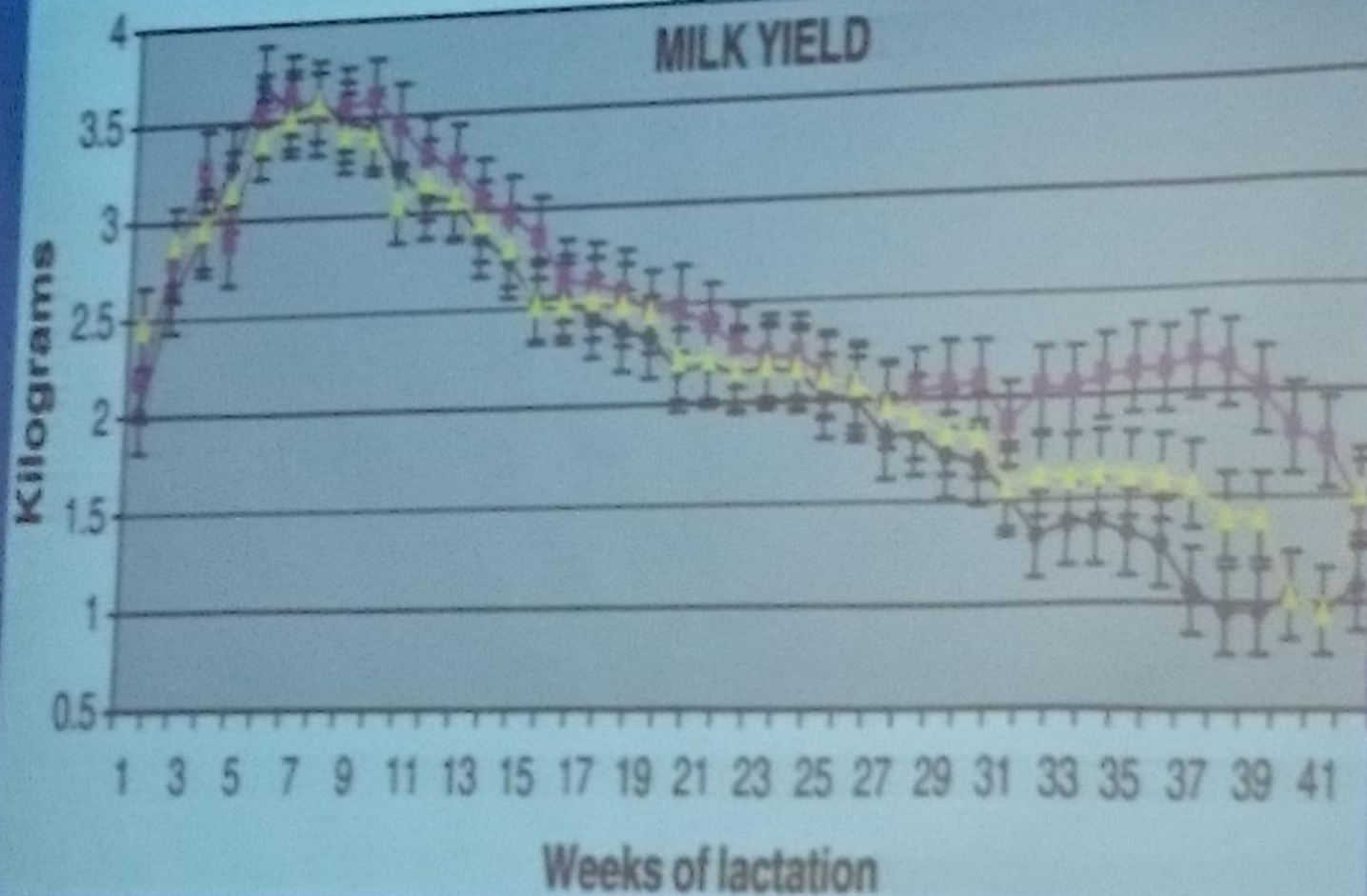
- 長光照可促進泌乳素分泌，促進乳產量。
- 但長期長光照終將引起乏興奮。
- 因此，促進乳產量有二措施：
 1. 在泌乳期間給予長光照期。
 2. 在乾乳期給予短光照期。
- 可視情況兩者聯合使用。

羊乳生產

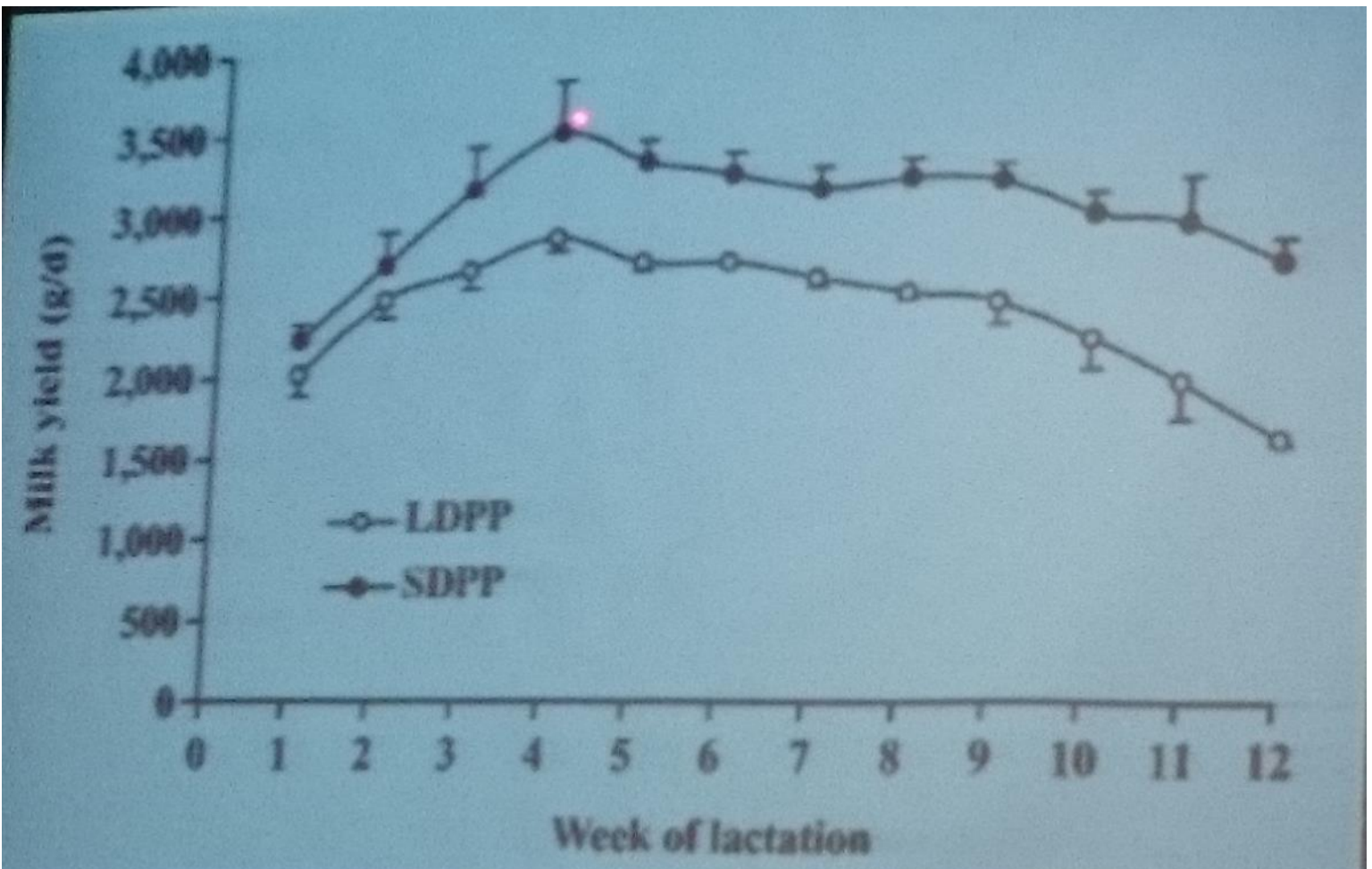
- 原理與在牛乳生產者相似。
- 光照期影響配種季節，使用光照處理需注意。

十篇研究均證實
長光照有助於提高產乳量





光照對山羊產乳之影響：黑色線為自然光照，紅色自wk 19至 wk 42 接受 20L，黃色自wk1 至 wk42 接受 20L (From Garcia-Hernandez et al., 2007)



懷孕期後三分之一之光照對山羊乳產量之影響 SDPP: 8L; LDPP: 16L (From Mabjeesh et al., 2007)



食肉生產

- ▶ 成年動物之體重與體組成具有季節性節律，年幼動物之生長速率也有季節性。
- ▶ 除營養之外，光照之影響最大。
- ▶ 一般而言，長光照期促進蛋白質堆積，短光照期促進脂肪堆積。

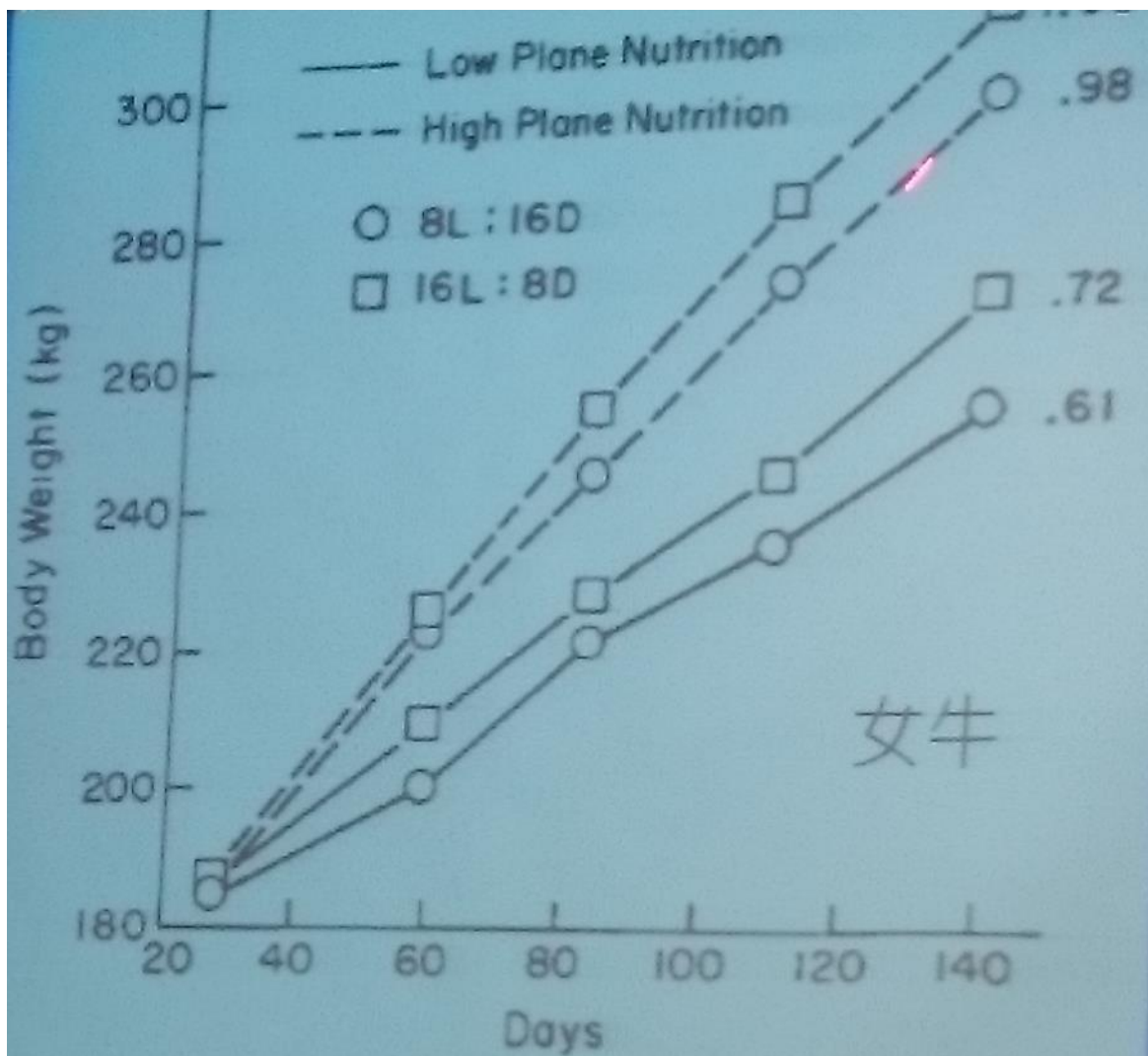


Figure 2. Live weights of heifers exposed to 16 or 8 h of light/d and fed ad libitum or restricted diets. Average daily gains are shown to the right for each treatment. From Petitclerc et al. (1983a).

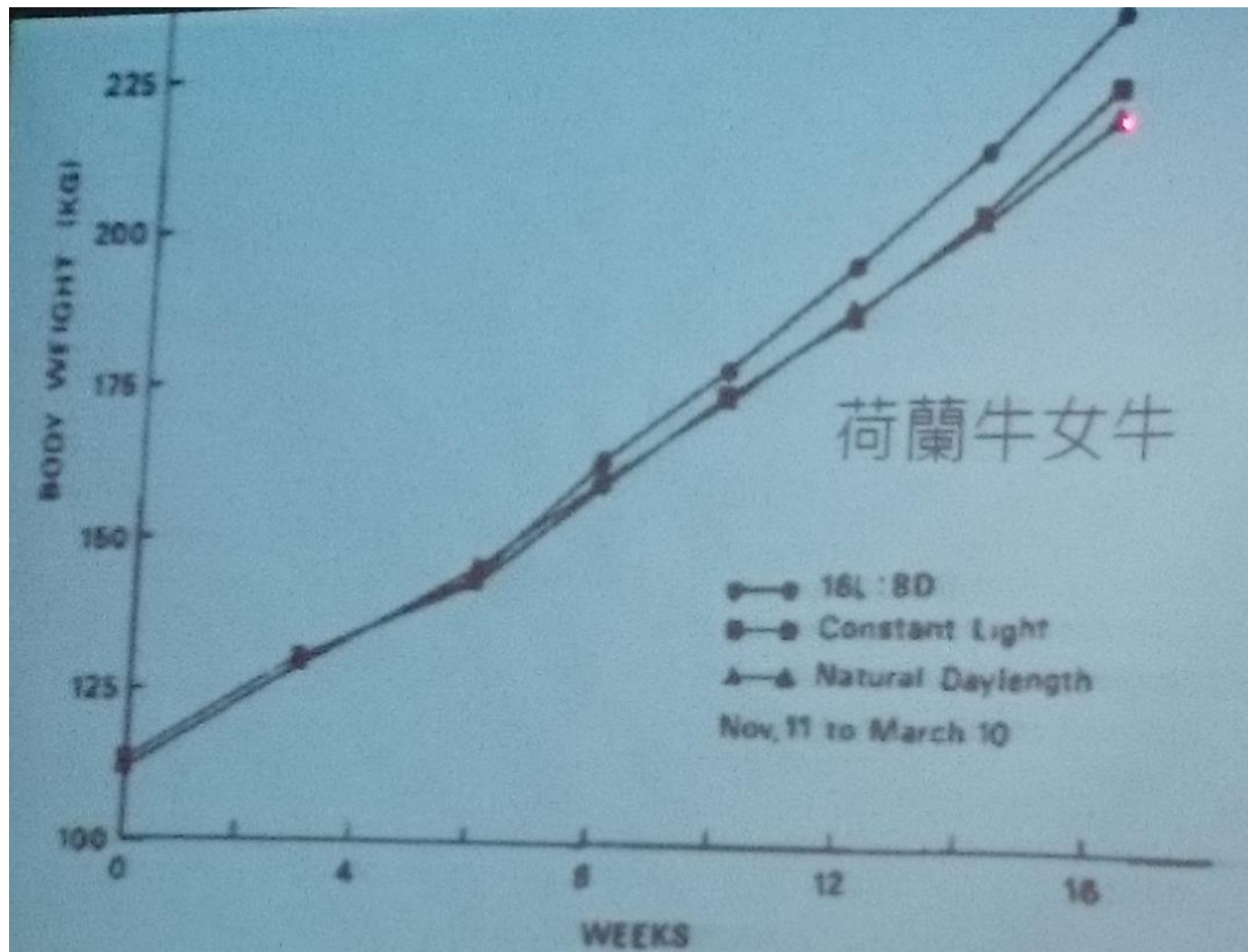


Figure 4. Live weights of Holstein heifers exposed to 16L:8D, 24L:0D or natural photoperiods between November and March. From Peters et al. (1980).

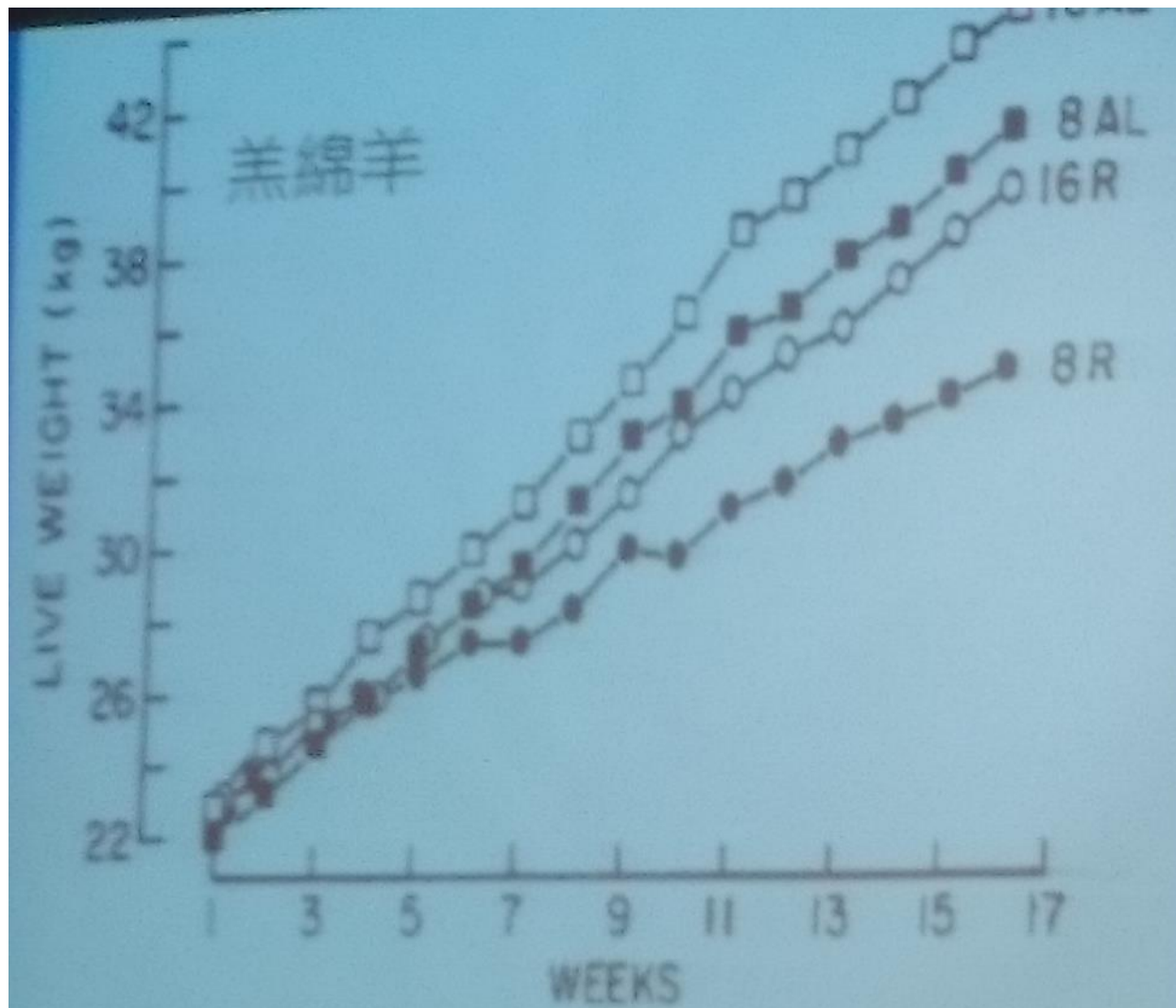


Figure 1. Live weights of lambs exposed to 16 or 8 h of light/d and fed ad libitum (AL) or restricted (R) quantities of concentrates. From Forbes et al. (1979b).

公羔羊暴露於不同光照期之 生長與採食量

光照期	日增重 (g/d)	採食量 (kg)
8L:16D	345	125
16L:8D	417	141
7L:9D:1L:7D	442	138

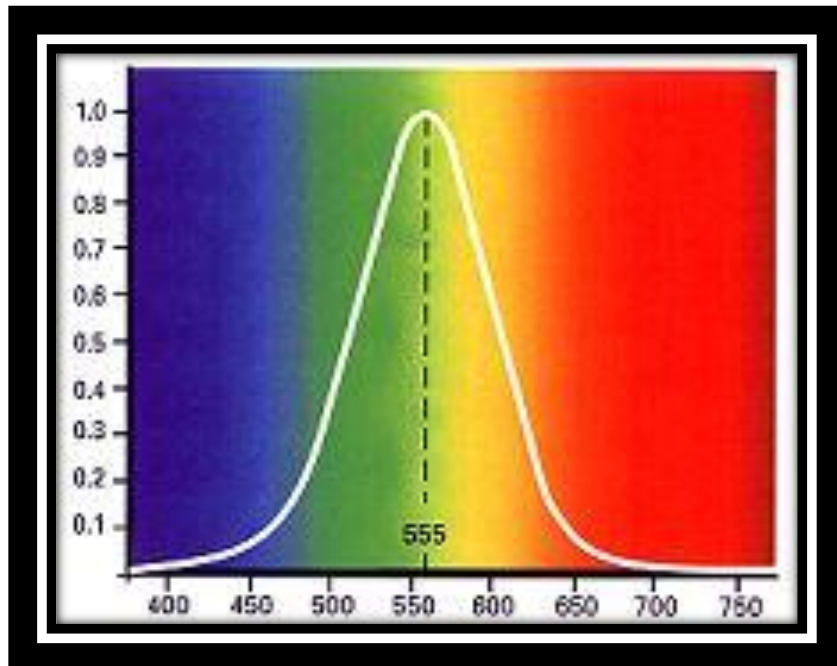
From Schanbacher and Crouse (1981)



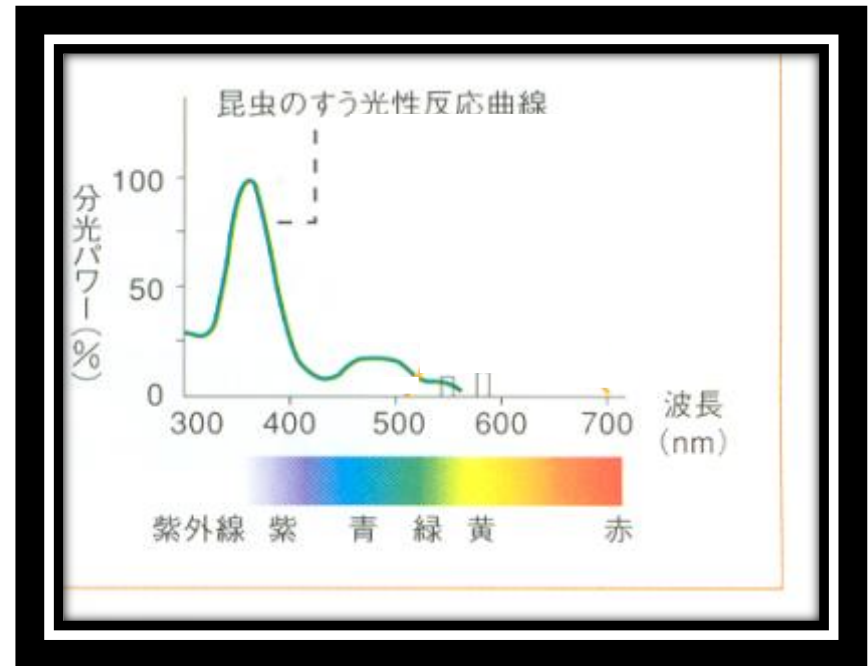
結論

- 光照對動物生理具有調節作用。
- 透過光照之操縱可以改善家畜之生產性能。
- 光照處理是一無公害、無安全顧慮之措施。
- 光照處理若能進一步結合一日節律與行為特性，則效果更可達到極致。

Different response curves



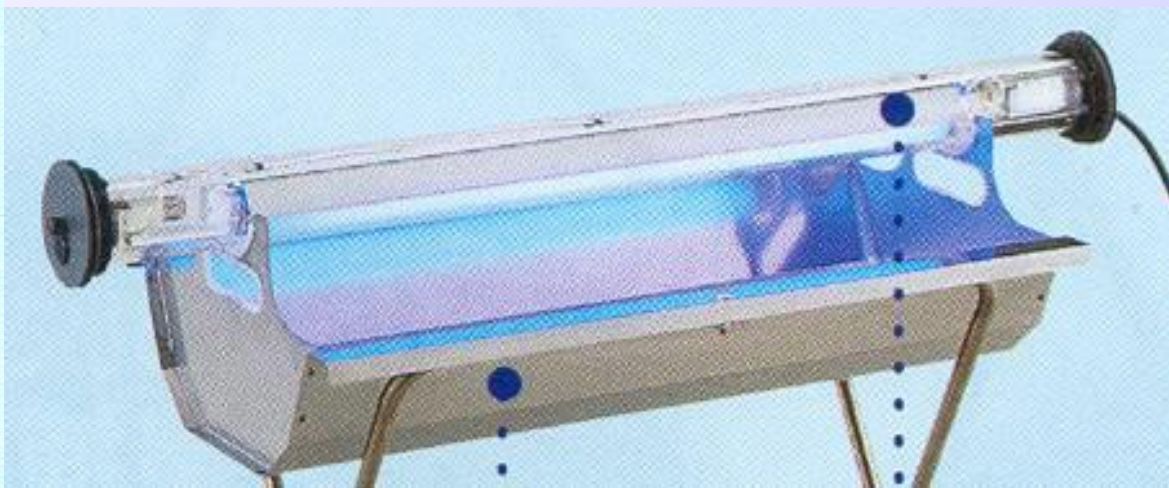
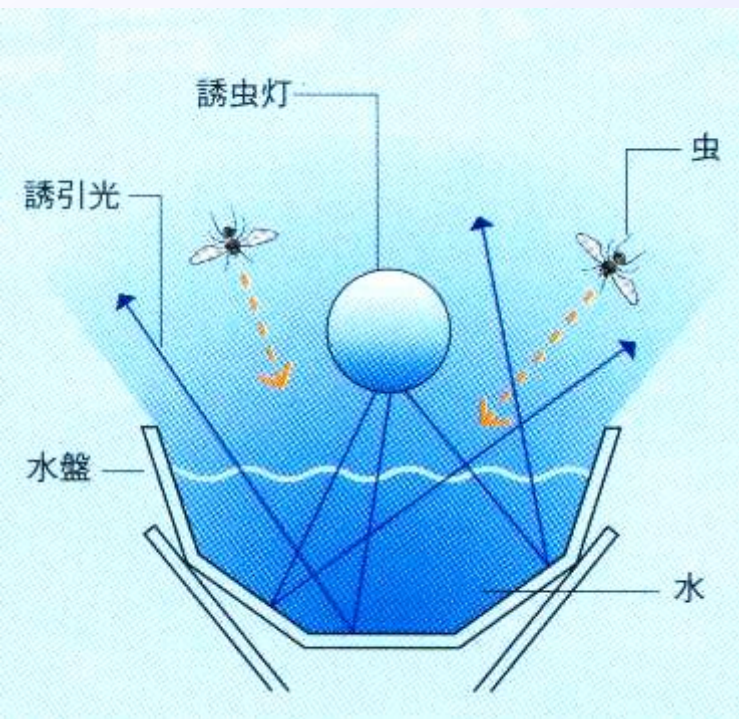
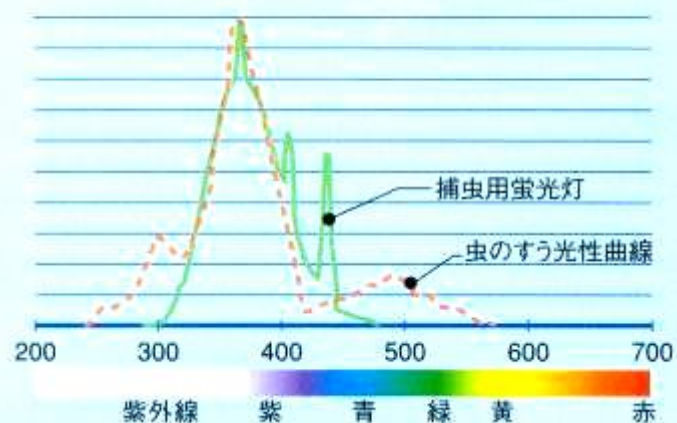
Human



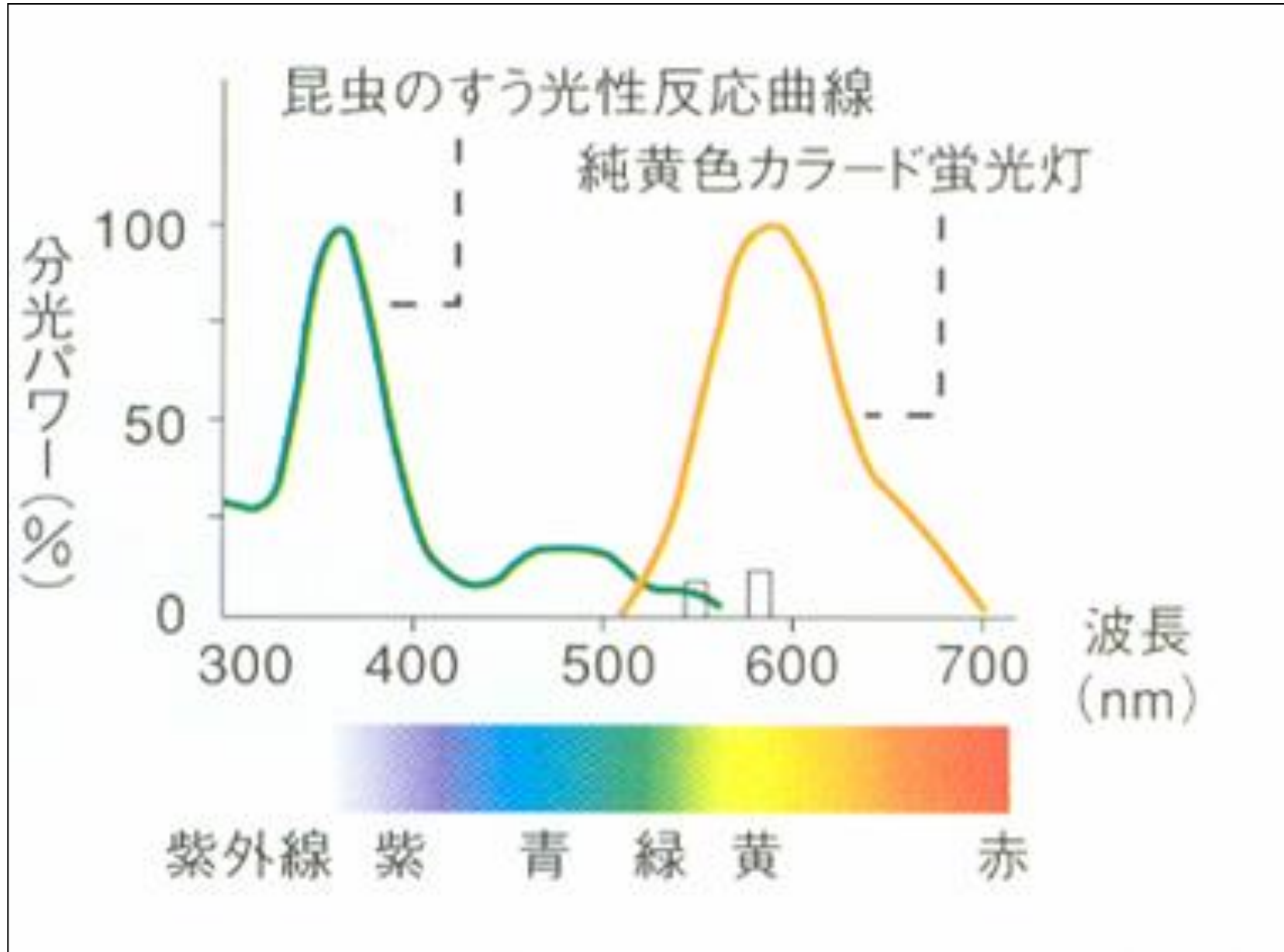
Insect

Insect Trap

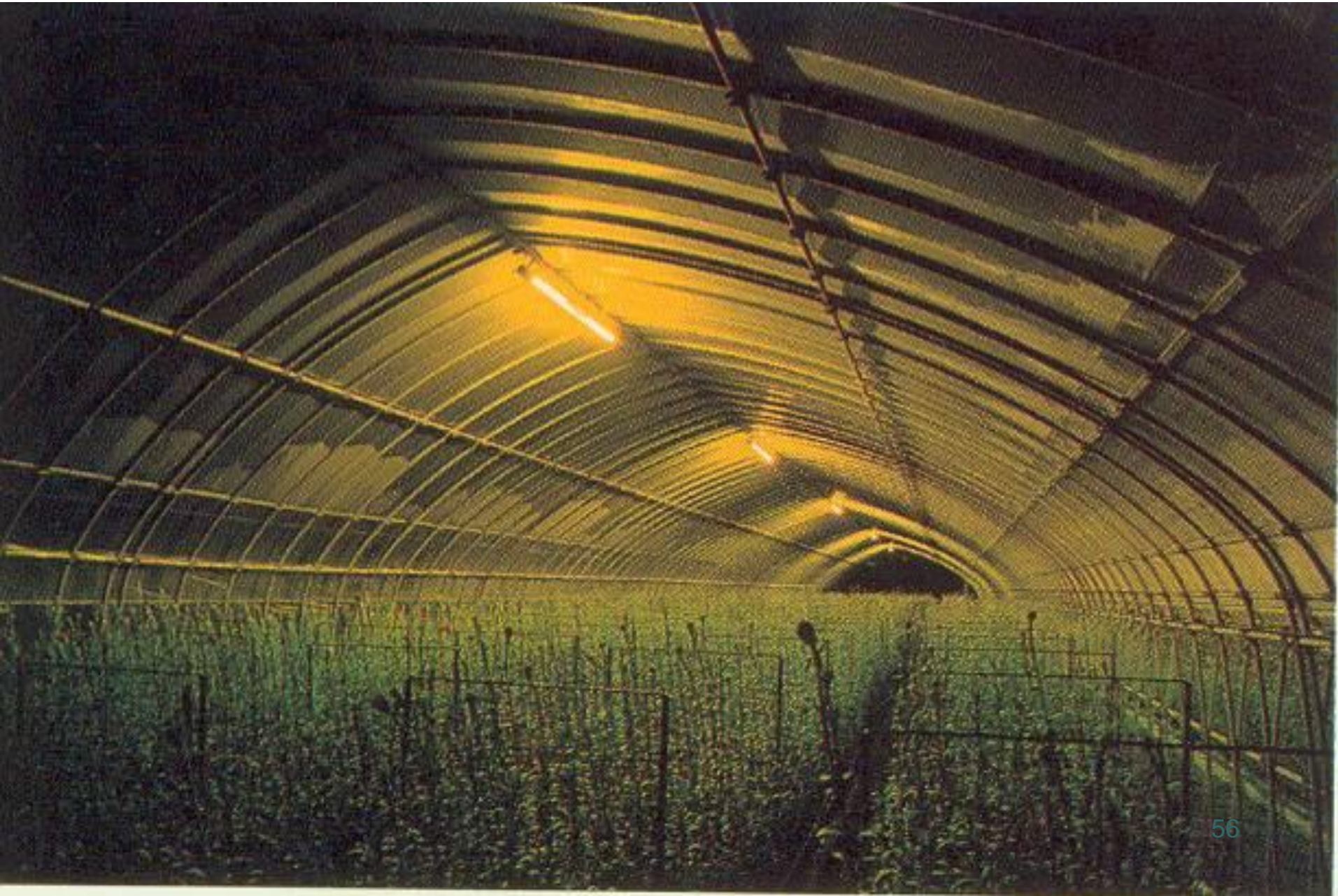
■ 虫の波長への反応曲線と捕虫器用蛍光灯の分光特性



Yellow light keep flying nocturnal insects away



Night time inside a greenhouse



Night view outside greenhouses





Light up Eco-friendly Dream



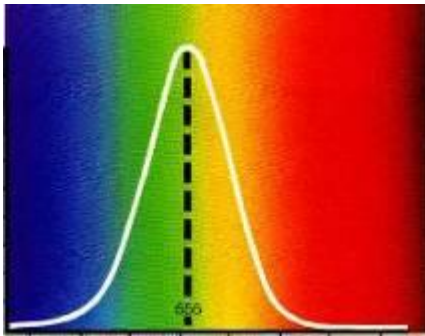
Animal

LED

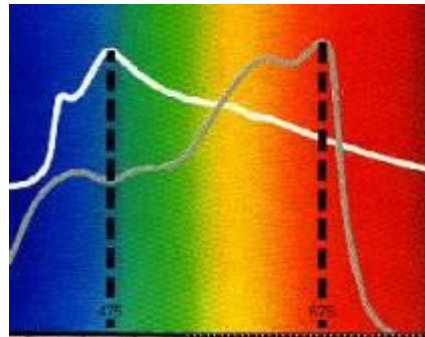
Plant

Aquaculture

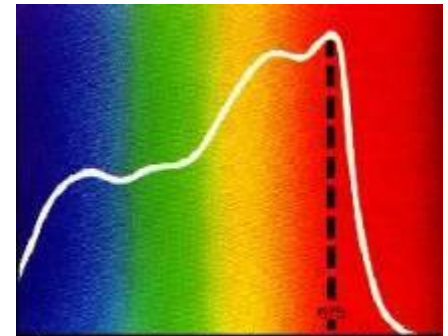
Different Response curves



Lux

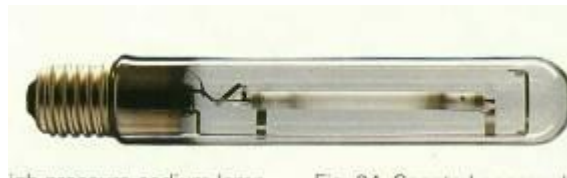
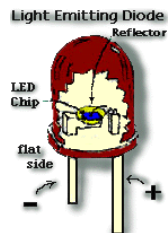
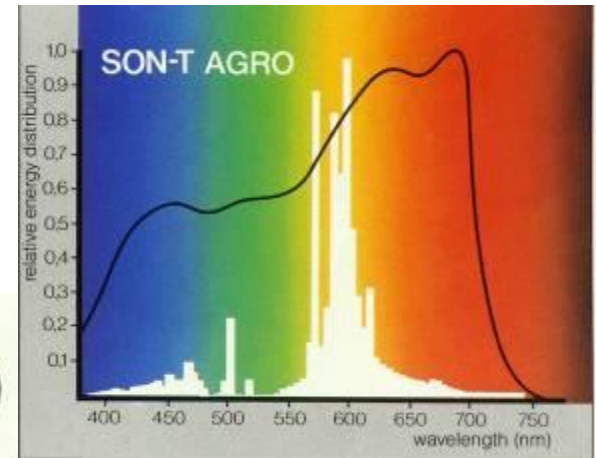
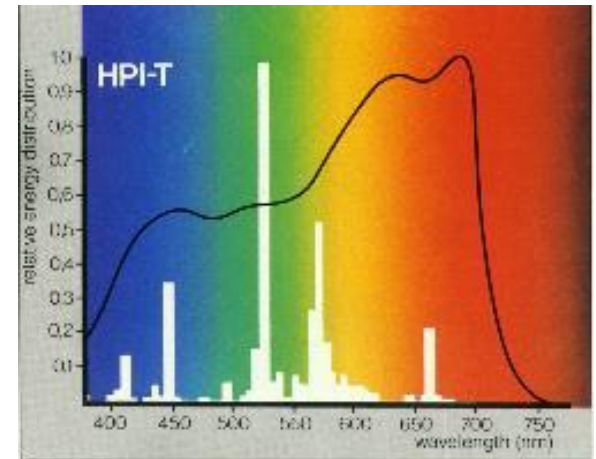
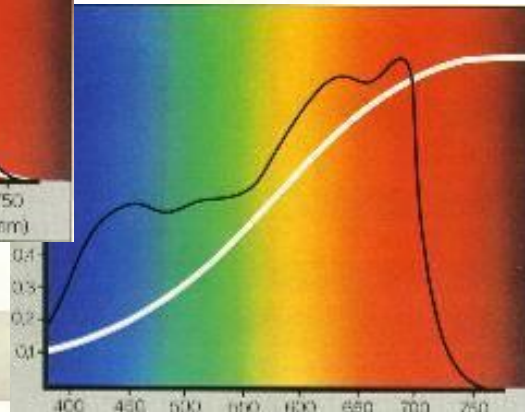
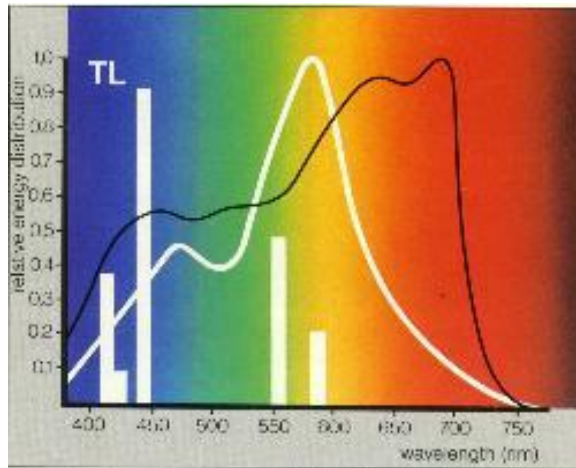


W/m²



μmol/m²/s₅₉

Artificial Light Source



Light Responses of Plant

photoperiodism



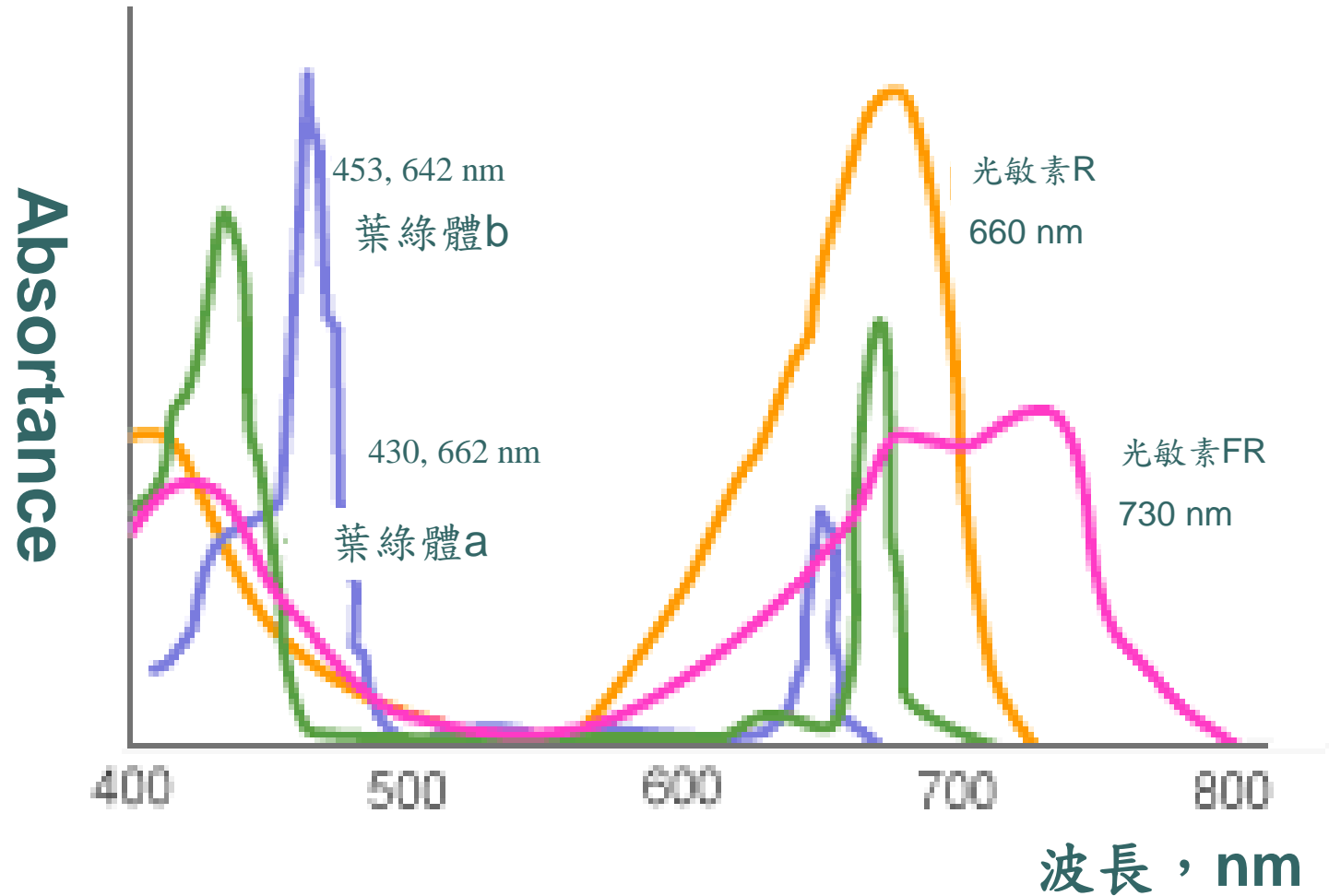
photosynthesis



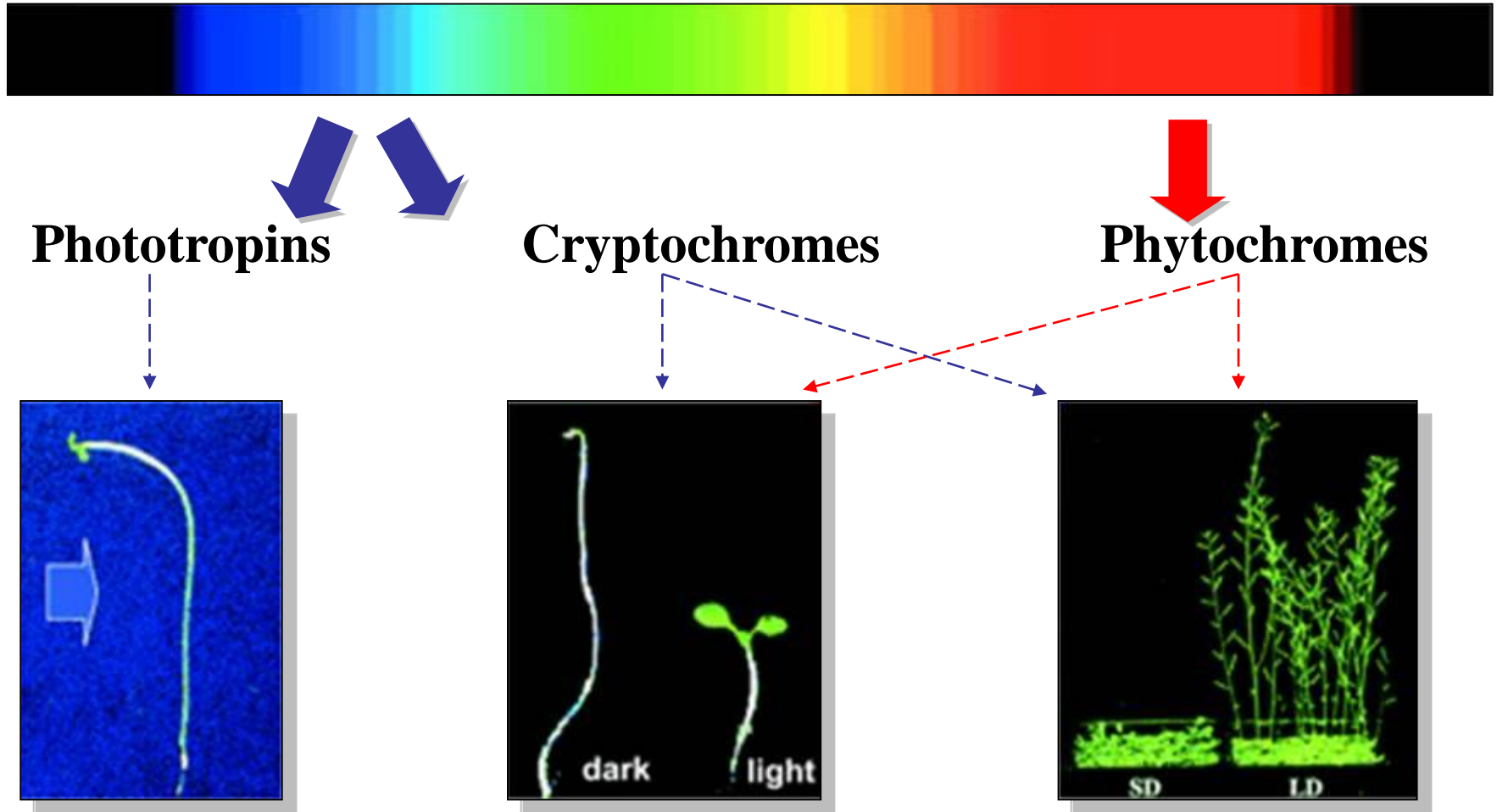
photomorphogenesis



Absorption Spectrums of Photo Receptors (Chl.a,b & Phy.r, Phy.fr)



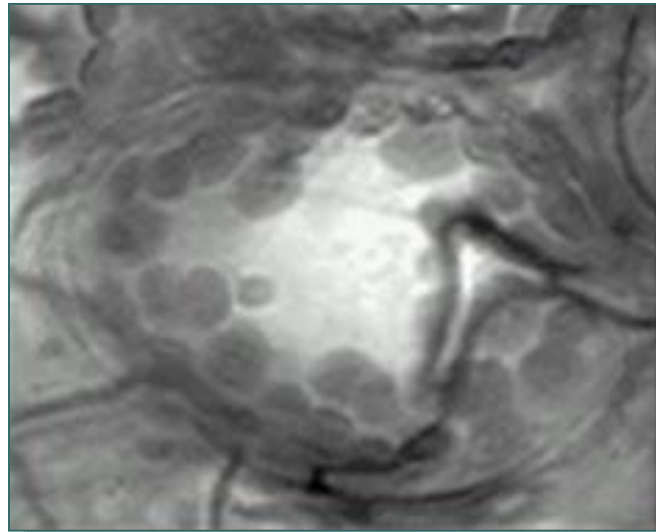
Photomorphogenesis 光形態發生



phototropins (flavin-containing) **Blue Light Photoreceptor**



向光性



葉綠體移動



氣孔開閉

LED for Horticultural Lighting

- Used to be light source for
 - Tissue Culture
 - Growth Chamber
- Recently, light source for
 - Leafy vegetables

Tissue Culture Lab.



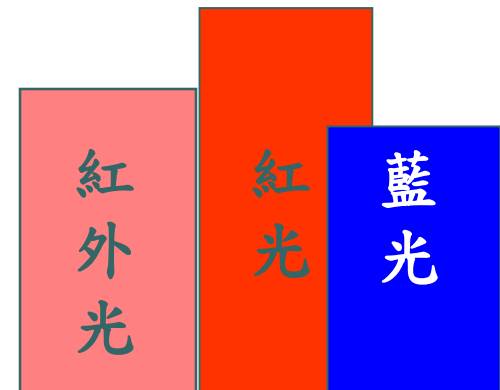
Florescent Lamps + AC

Mass production of Tissue Culture plantlets

Florescent Lamps are widely used



Adjustable Intensity, Quality, Frequency, Duty Ratio



1st Generation of LED for Tissue Culture



2nd Generation of LED for Tissue Culture



2nd Generation of LED for Tissue Culture



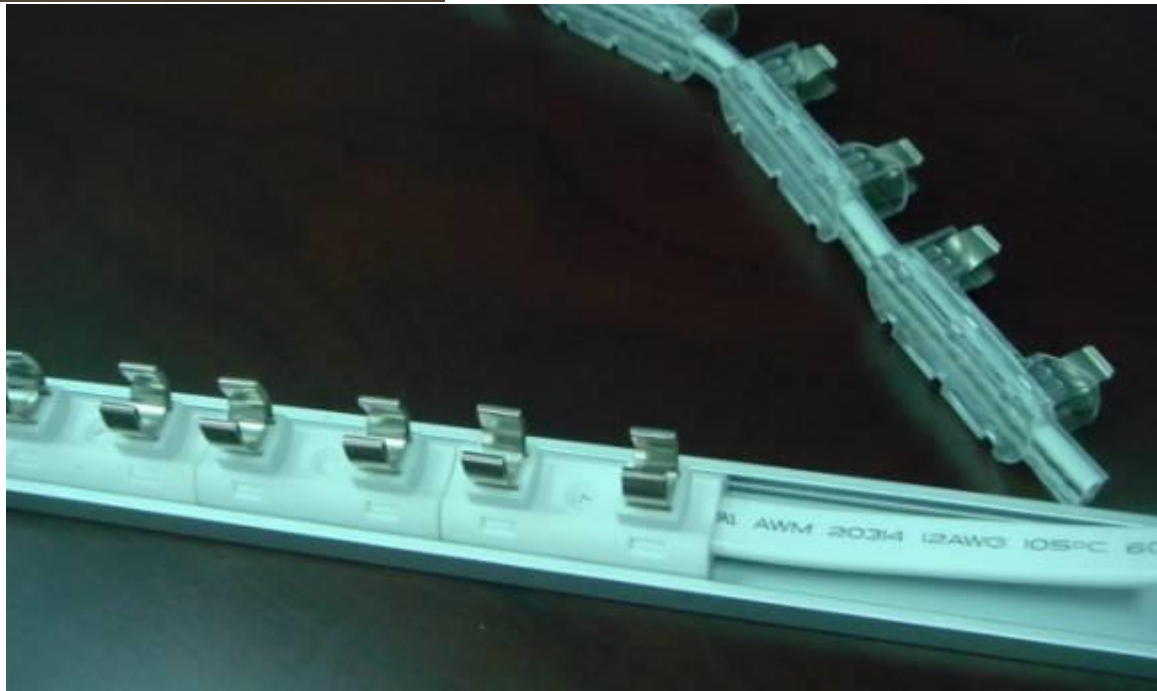
3rd Generation of LED for Tissue Culture



3rd Generation of LED for Tissue Culture



Detachable LED light (2006)

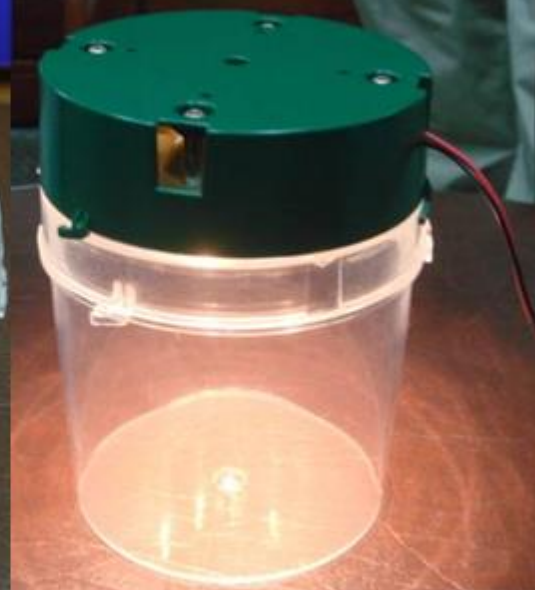


4th Generation of LED for Tissue Culture

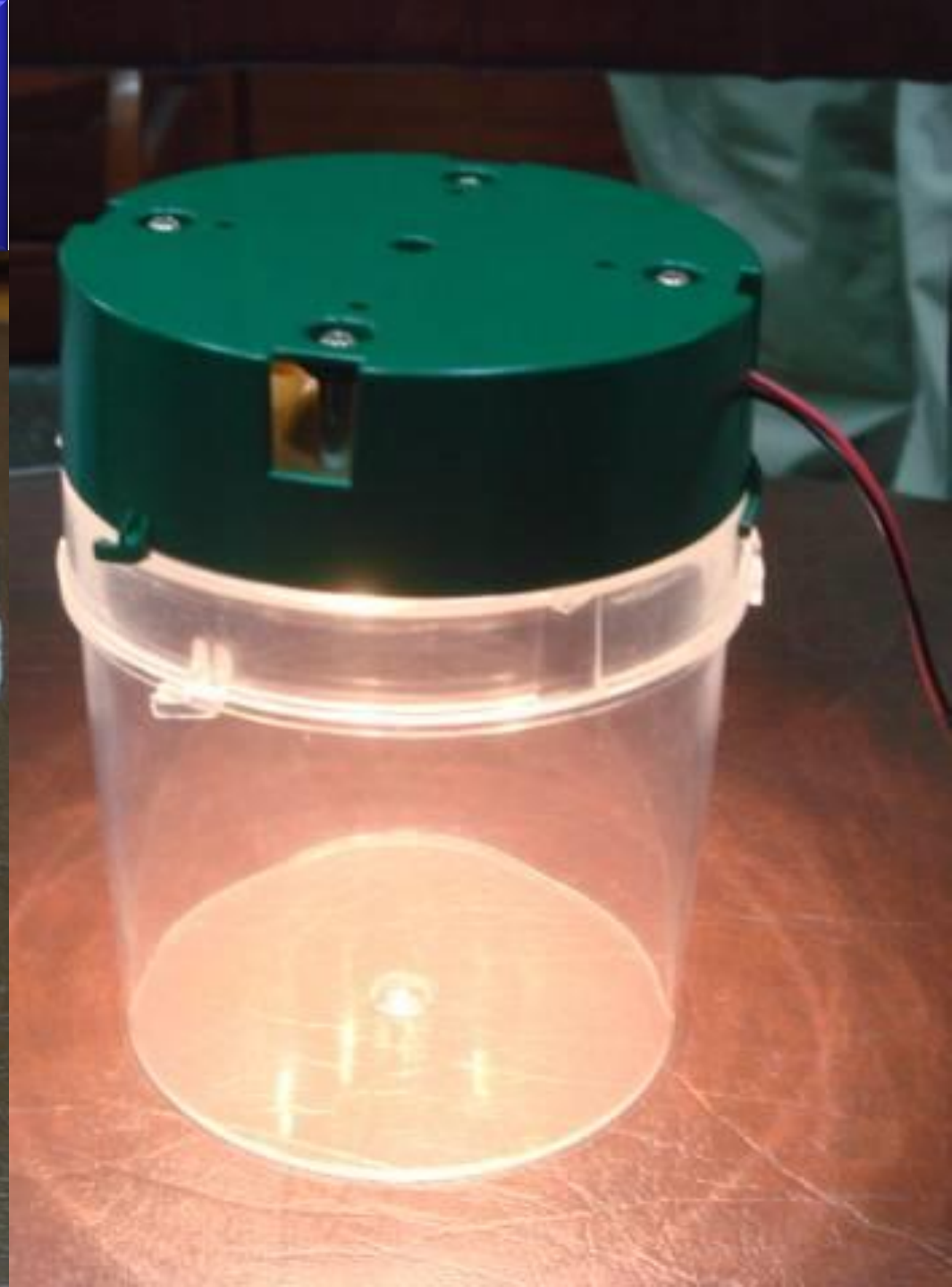
Cool White Warm White 6R 1B1G8R 1B9R 6B



4th Generation of LED for Tissue Culture



4th Generation of LED for Tissue Culture





for-E

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... (九十三) ...
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... (九十五) ...
... (九十六) ...
... (九十七) ...
... (九十八) ...
... (九十九) ...
... (一百) ...



國立臺灣大學
教職員工生
人事室
公告
日期：中華民國 107 年 1 月 12 日
地點：國立臺灣大學
公告事項：本校 107 年 1 月 12 日（星期一）
公告事項：本校 107 年 1 月 12 日（星期一）
公告事項：本校 107 年 1 月 12 日（星期一）

本校編制內專任有給教授
聘任為特聘教授：...（七）符合教
授 5 年以上，且具備各學院自訂之特
聘教授聘任之設置係為提升教學
品質特聘教授之設置係為提升教學
品質特聘教授聘任標準」及「任教授 5
特聘教授聘任標準」兩種情形
由各學院（含共教中心）特聘
規定分配名額（如名額分配表）
並請相關表件彙送相關人事單位。
特聘教授聘任標準及審議作業規定 1
一、主任、教授處、基礎科學中心請送聘

Cool White



Warm White



6R



1B1G8R



1B9R



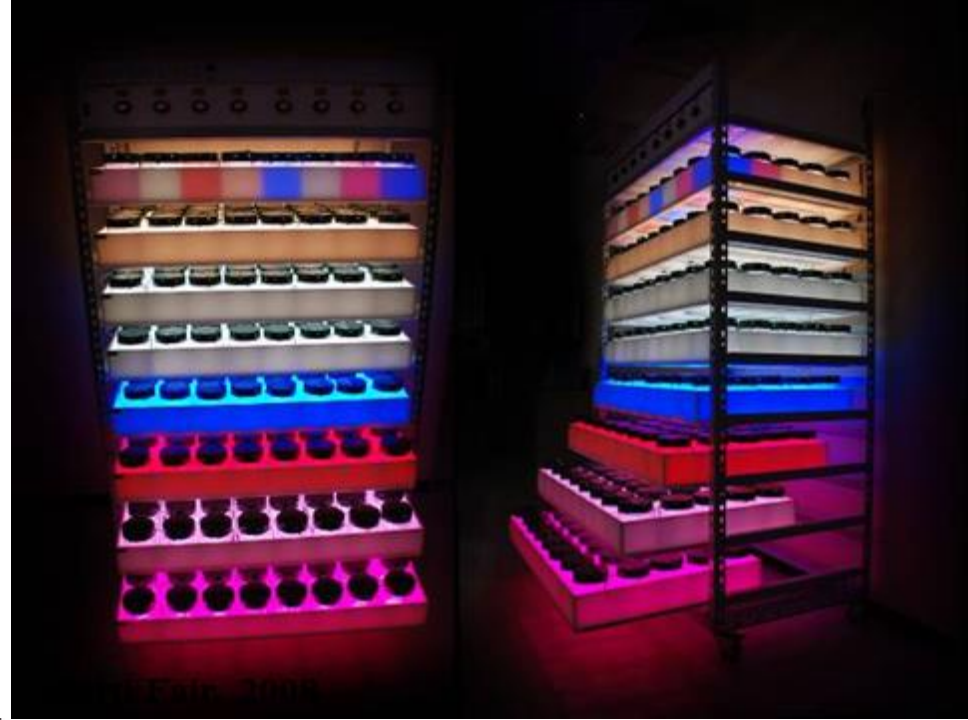
6B



TC lab of the National Natural Science Museum, Taiwan



80



80



ti-Fair, 2008



4th Generation of LED for Tissue Culture



Horti-Fair, 2008

Uniform distribution of *E Light* compare with other LED light bench

E Light

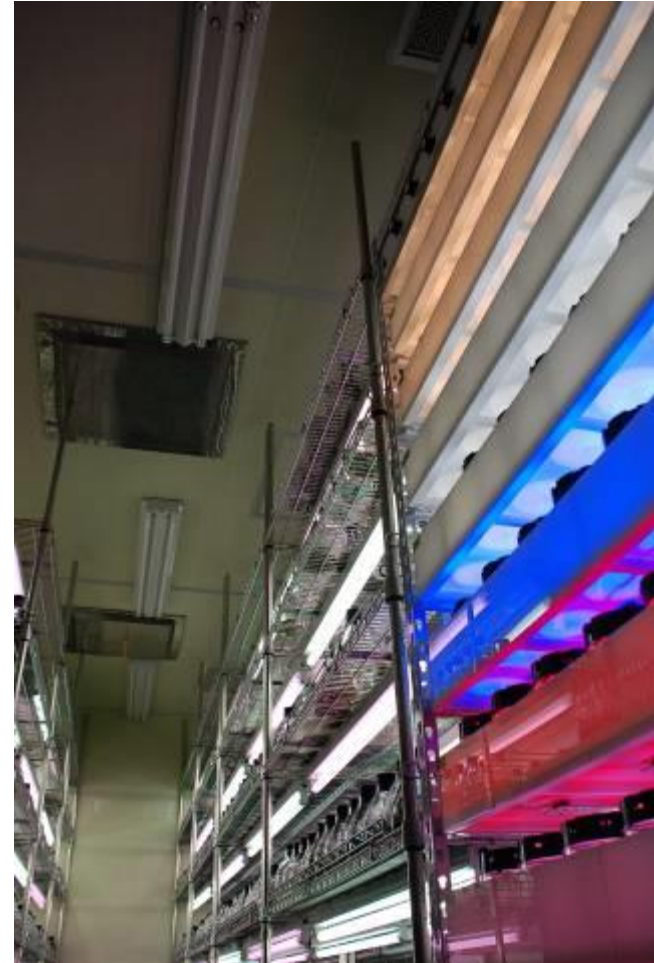


Others



Horti-Fair, 2008

TC lab of the National Natural Science Museum, Taiwan





Horti-Fair, 2008

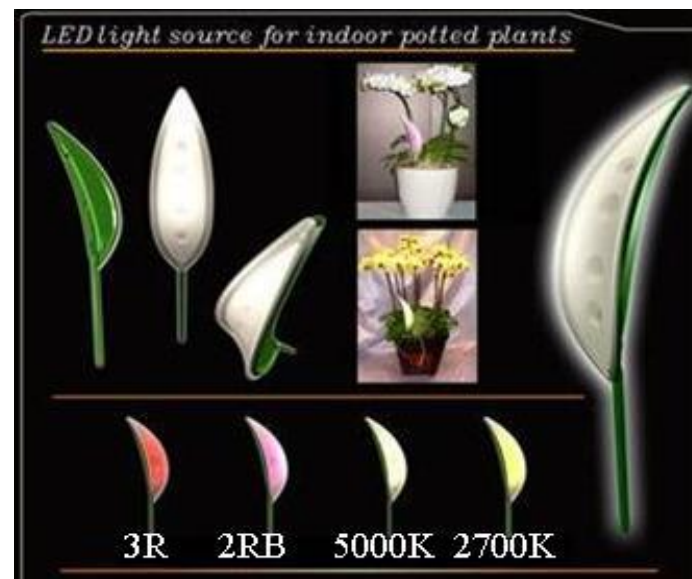
10/13/2008 10:26pm



10/13/2008 10:26pm

2008 Horti-Fair

光葉 (*i_Light*)



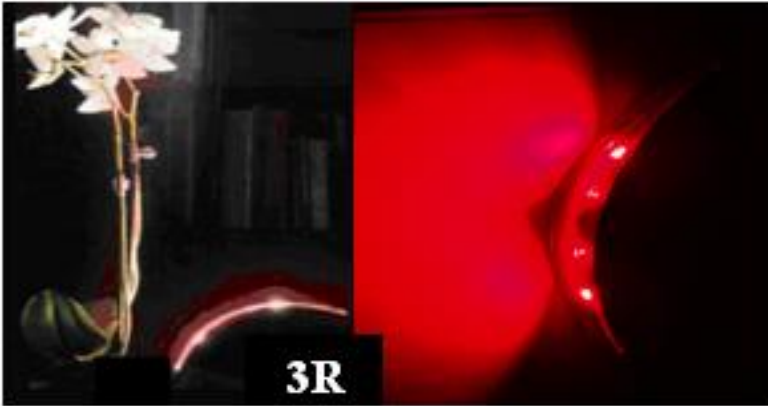
Specifications

- Voltage: 100 ~ 240 V
- Power: 1 W

- Electricity fee
 - 0.0048 US\$ per 24 hours
 - Assuming 0.2 US\$ / kW.hr



4 colors are available



Also in this issue...

- 01 | GT in Brief
 - 02 | SAF in the Lobby
 - 03 | New Products
 - 04 | Classifieds
 - 05 | Request Product Info
-
- 06 | Acres Online
 - 07 | Trade Show Calendar
 - 08 | Article Archive
 - 09 | Media Kit 2009
 - 10 | Media Kit 2008
 - 11 | Subscriptions

Featured Companies

POLYGAL U.S.A. INC.
 FOUR STAR GREENHOUSE
 BANK OF THE WEST
 ELLEGAARD A/S7
 ATLAS MANUFACTURING INC.
 PROGREEN EXPO
 FINE AGROCHEMICALS

Finally ... My favorite product

Usually it's a machine or greenhouse innovation, or perhaps some ingenious packaging. But this year it's a silly little light (three LED lights, actually in one of four colors), shaped like a leaf, and intended to be used to illuminate your indoor houseplants. It's both functional and stylish—the light actually helps the plants survive indoors. And it looks cool! Just as lighting your outdoor plants does. It's called the "I-Light," from Nano Bio Light Technology in Taiwan, and the initial estimated wholesale cost is about \$35 a pair. You can see how it lights up that orchid that's sitting next to the inventor, Dr. Fang. E-mail him at info@nano-wave.com.tw. It's brand new, and barely on the market, so I don't know how hard or easy it will be to find, but I'd buy a pair or two for my house!

See you next time,



Chris Beytes
 Editor & Publisher
 GrowerTalks & Green Profit



<http://www.ballpublishing.com/growertalks/CurrentNewsletter.aspx>





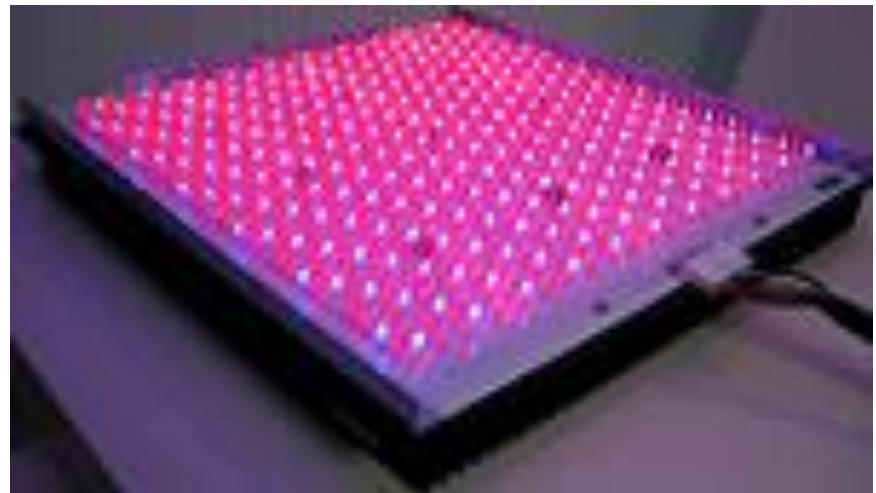
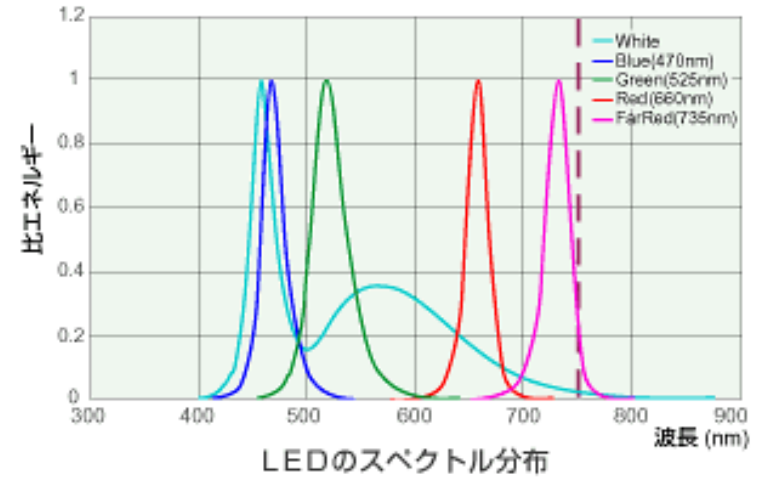
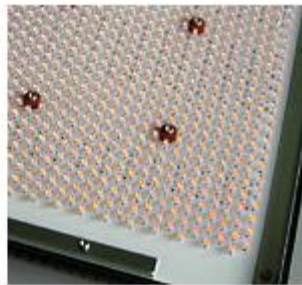
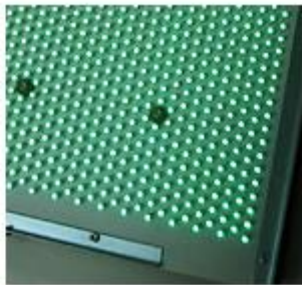
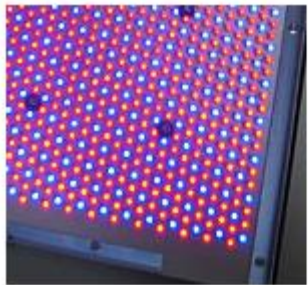


Growth Chamber



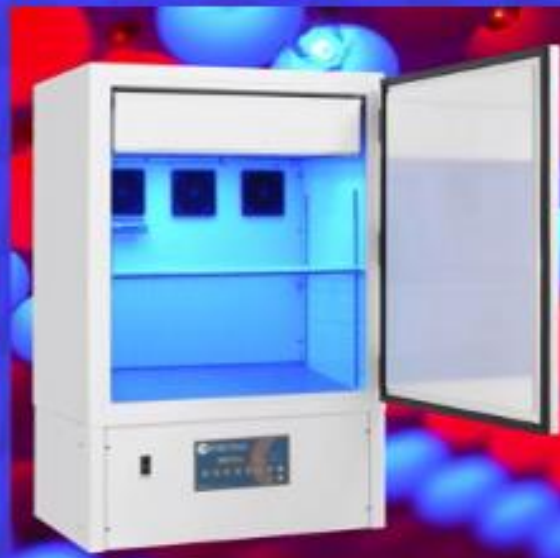
Florescent Lamp + AC

FL can be replaced by LED Panel

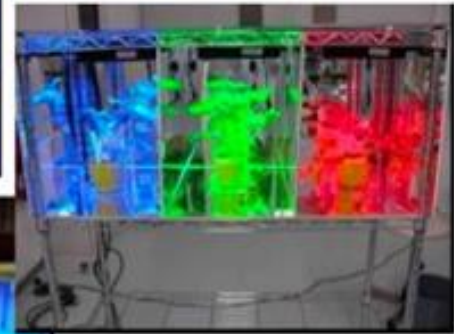


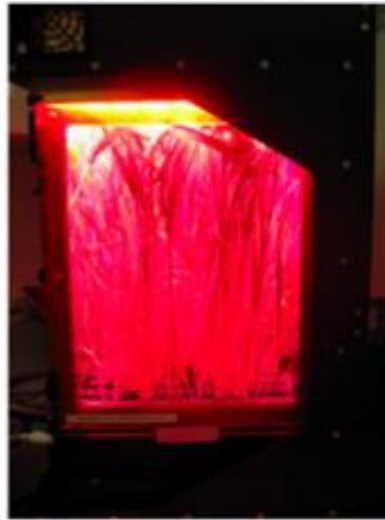
E-30 LED Lighting Options

- ◆ Trichromatic
– RED, BLUE,
FAR-RED
- ◆ RED, FAR-RED
- ◆ RED, BLUE
- ◆ BLUE ONLY
- ◆ Pulsating LEDs



各類栽培研究實驗





<http://www.metaefficient.com/archives/leds/>



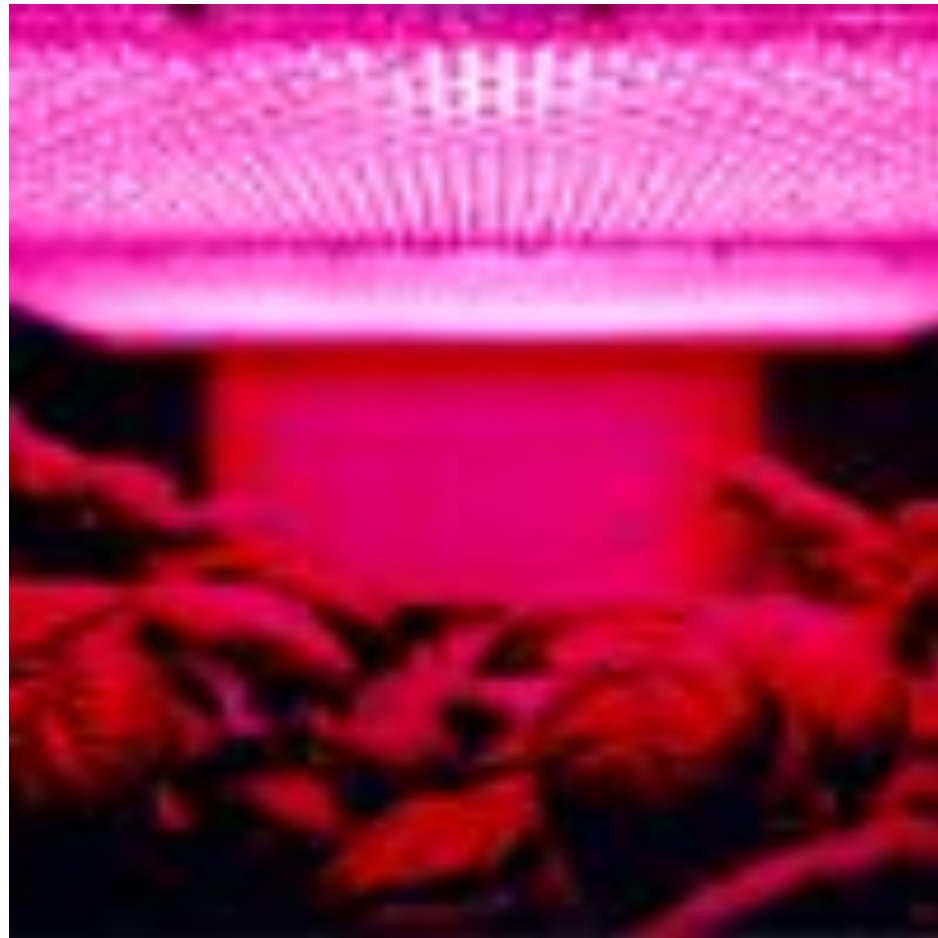
Lightsicle Array

Intracanopy

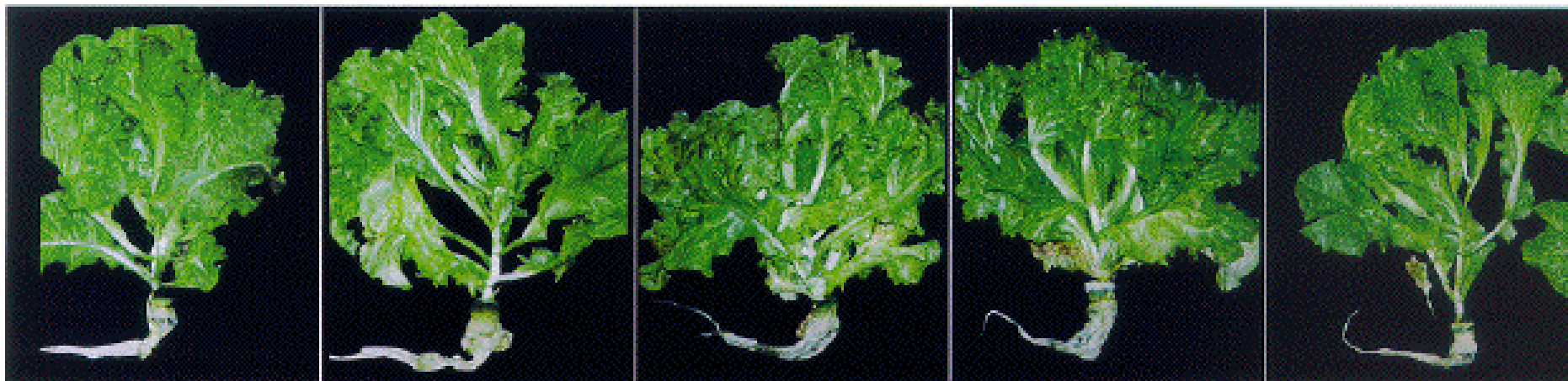
Overhead



Application of LED in growing vegetables started in 1991 NASA's mission to MARS project



LED for Leafy Green



LED-1	LED-2	LED-3	LED-4	白色蛍光灯
全光量 80	100	100	100	50
赤色/青色光 72/8	95/5	92/8	90/10	

試験区	LED-1	LED-2	LED-3	LED-4	白色蛍光灯
地上部新鮮重 (g/株)	31.1 ±6.2	61.8 ±12.5	80.9 ±14.4	82.7 ±16.9	35.7 ±8.4
地上部乾重 (g/株)	0.9 ±0.2	1.8 ±0.4	2.4 ±0.4	2.5 ±0.5	1.2 ±0.3
草丈 (cm)	32 ±3	29 ±2	25 ±1	24 ±3	30 ±2
根部乾重 (mg/株)	188 ±20	244 ±49	298 ±48	342 ±68	211 ±42

※栽培日数34日、値は22株の平均値±標準偏差。

LED with R/B = 9:1 is much better than other two



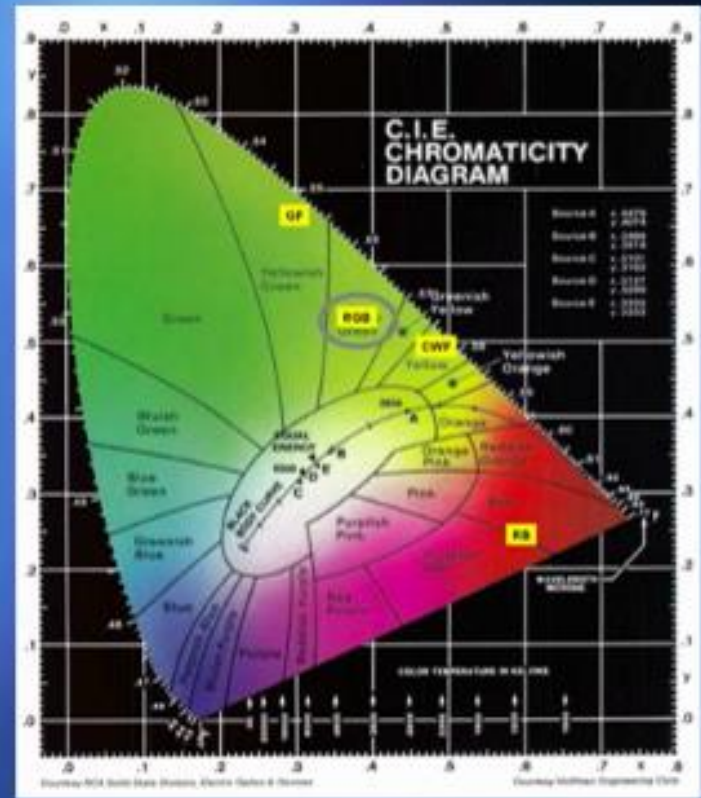
Sunlight in
Greenhouse

CW FL in
Growth Chamber

LED with R/B=9:1
in Growth Chamber



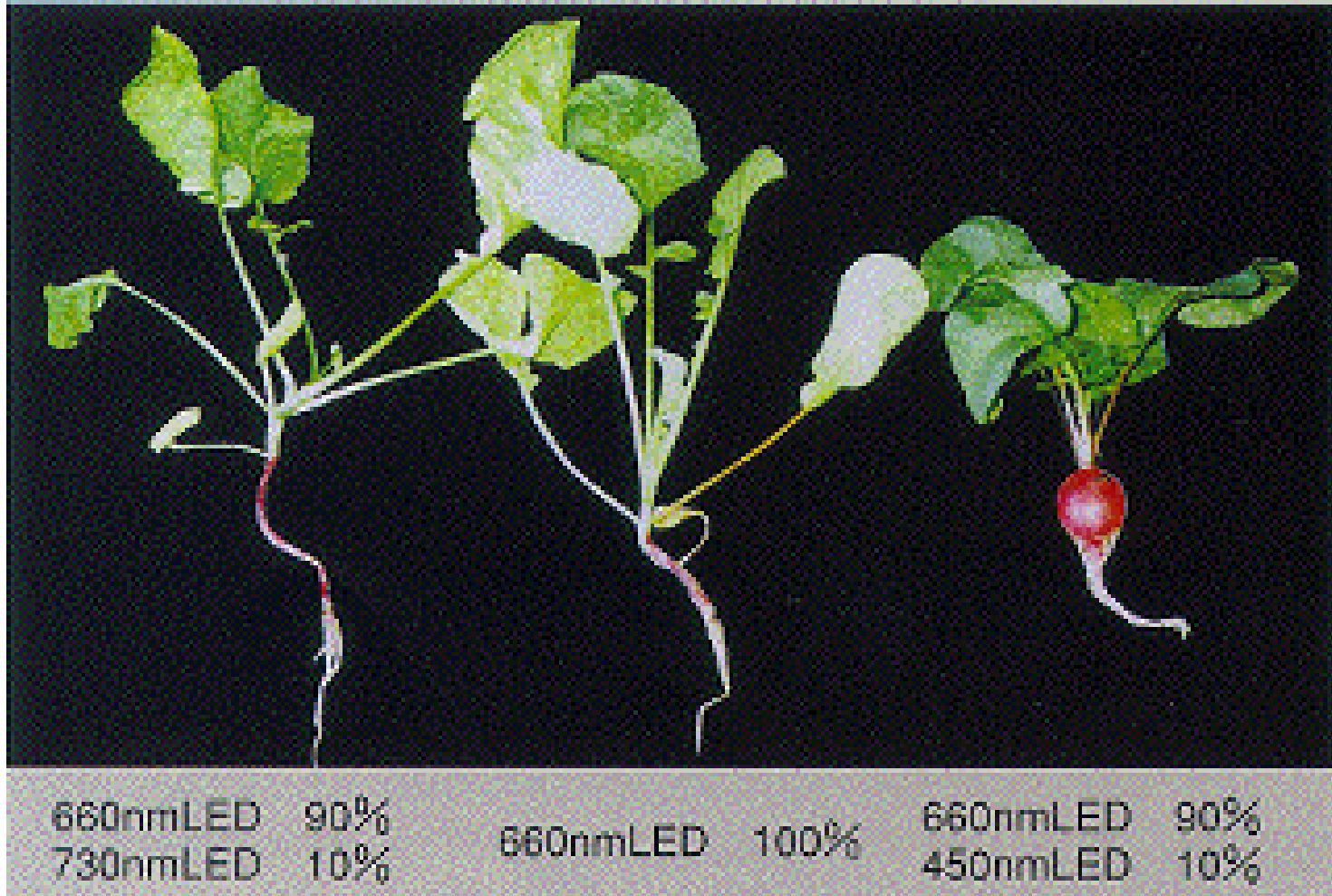
***Same plant**



The perceived color of plants

Lettuce grown using RGB lighting would have an additional aesthetic appeal of a green appearance.

Without Blue, No Harvest



Without Blue, Upper part too thin

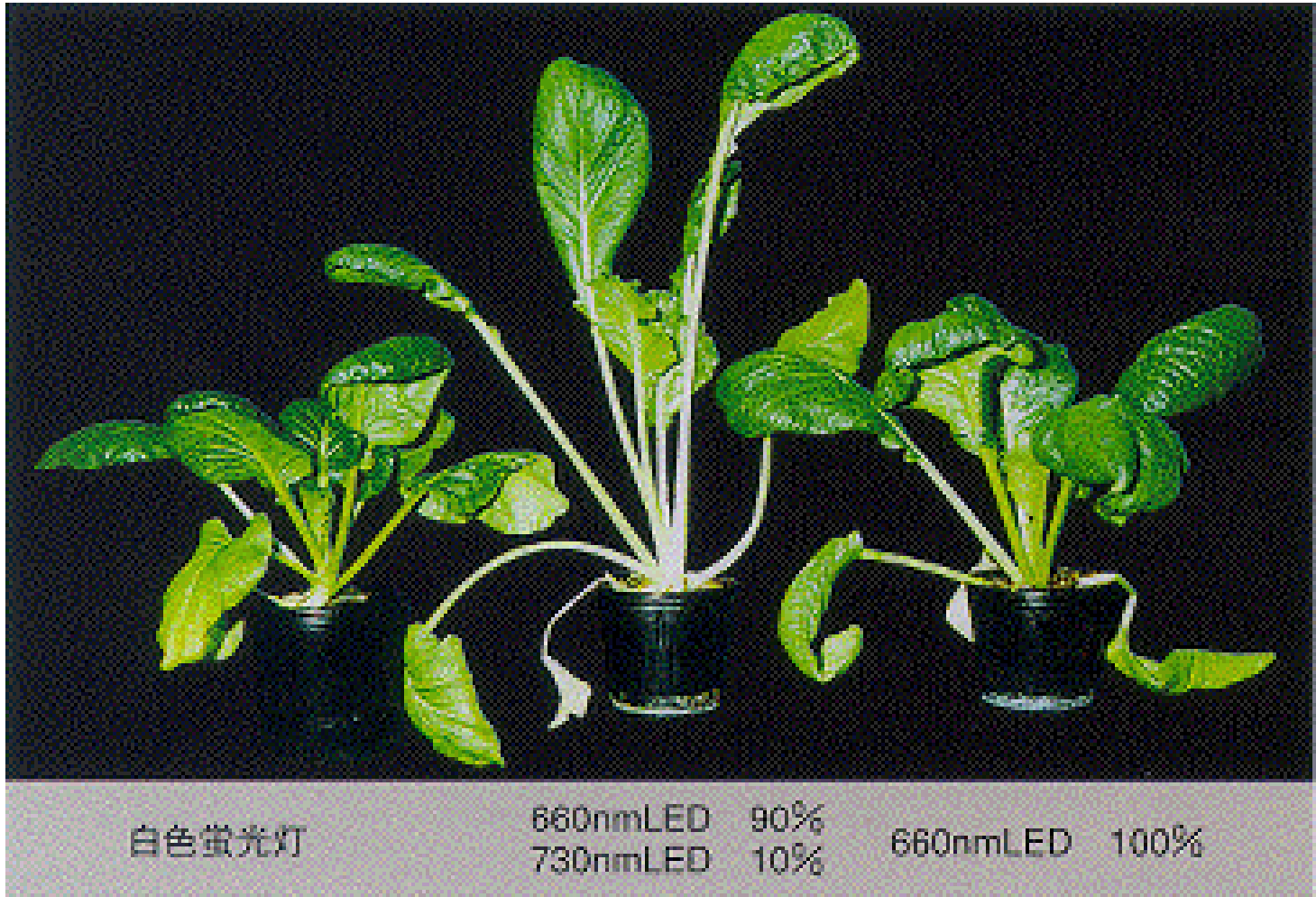


660nmLED 100%

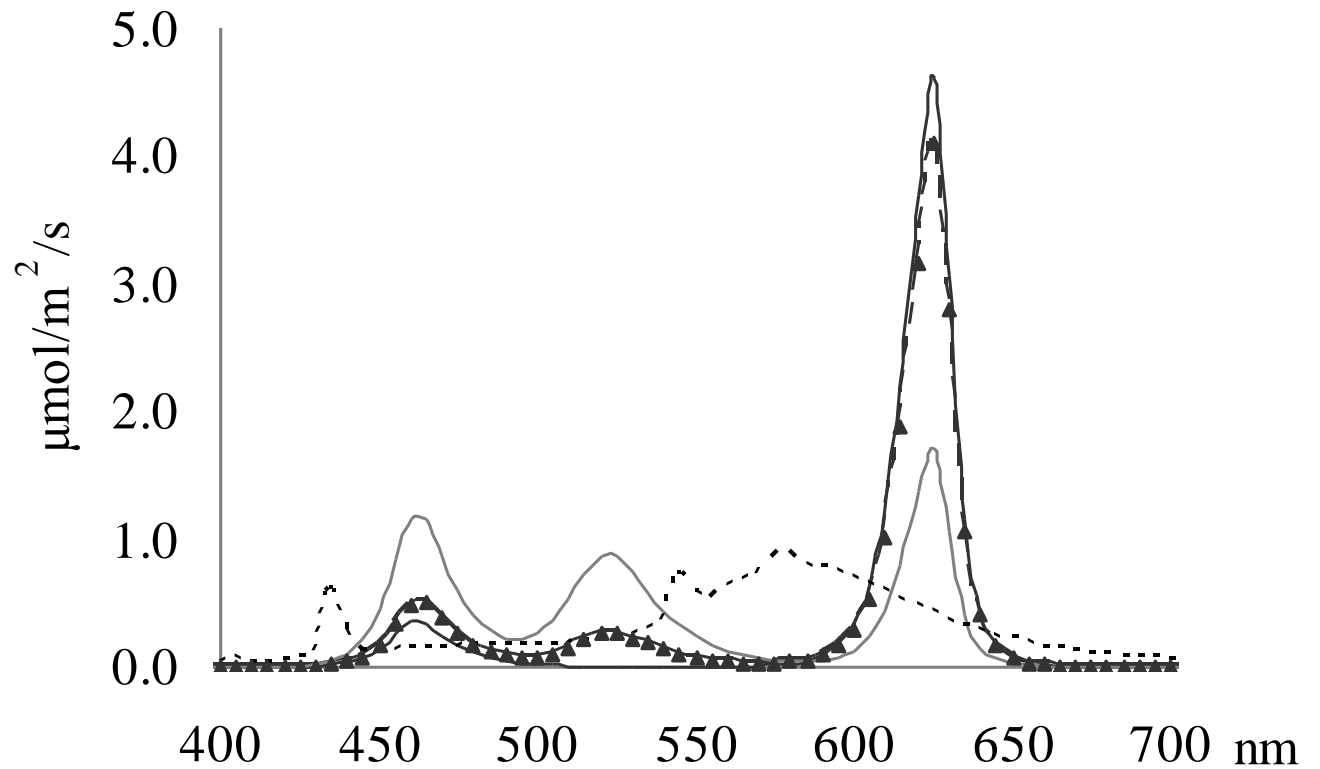
660nmLED 90%
730nmLED 10%

白色荧光灯

● ● ●
缺藍光，卻有紅外光，更纖細



LED蔬菜栽培



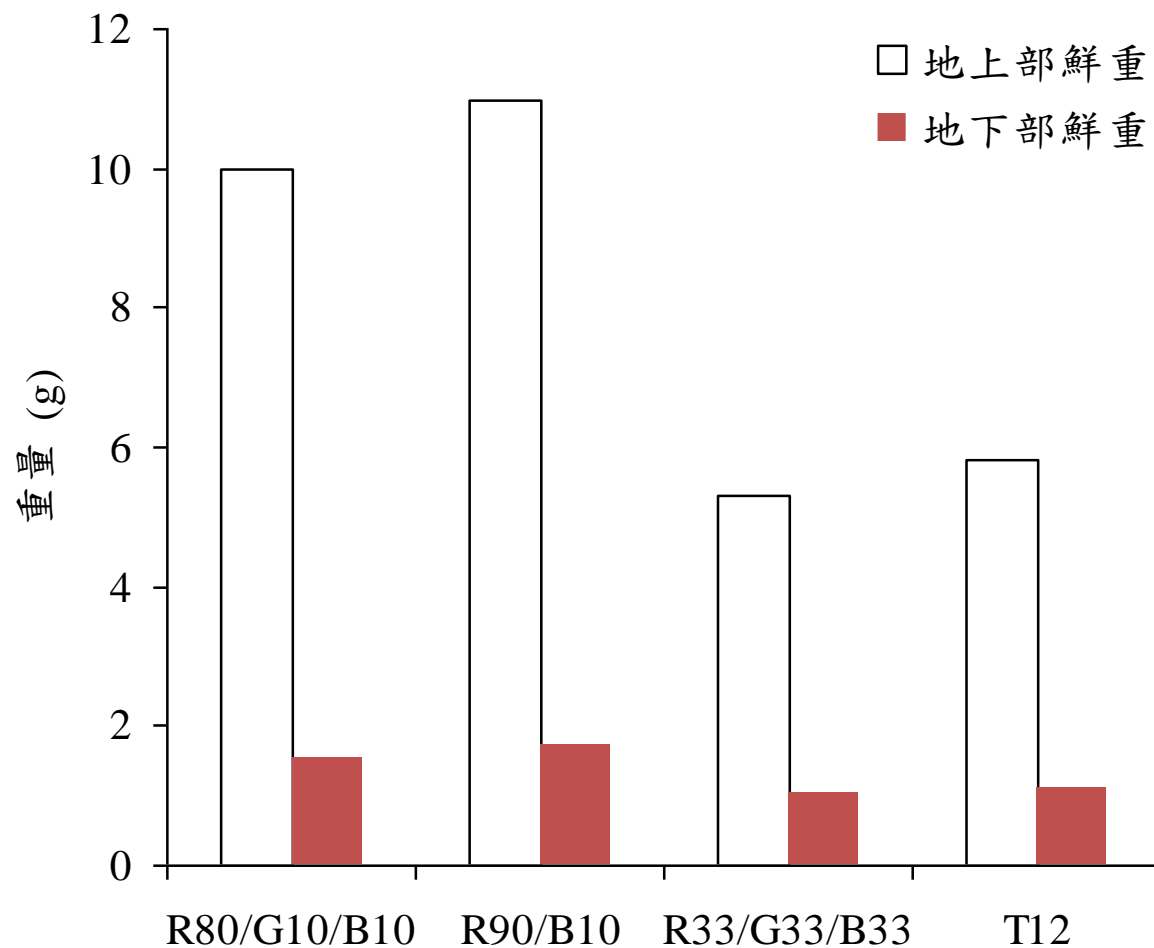
—— R90/B10

---▲--- R80/B10/G10

—— R33/B33/G33

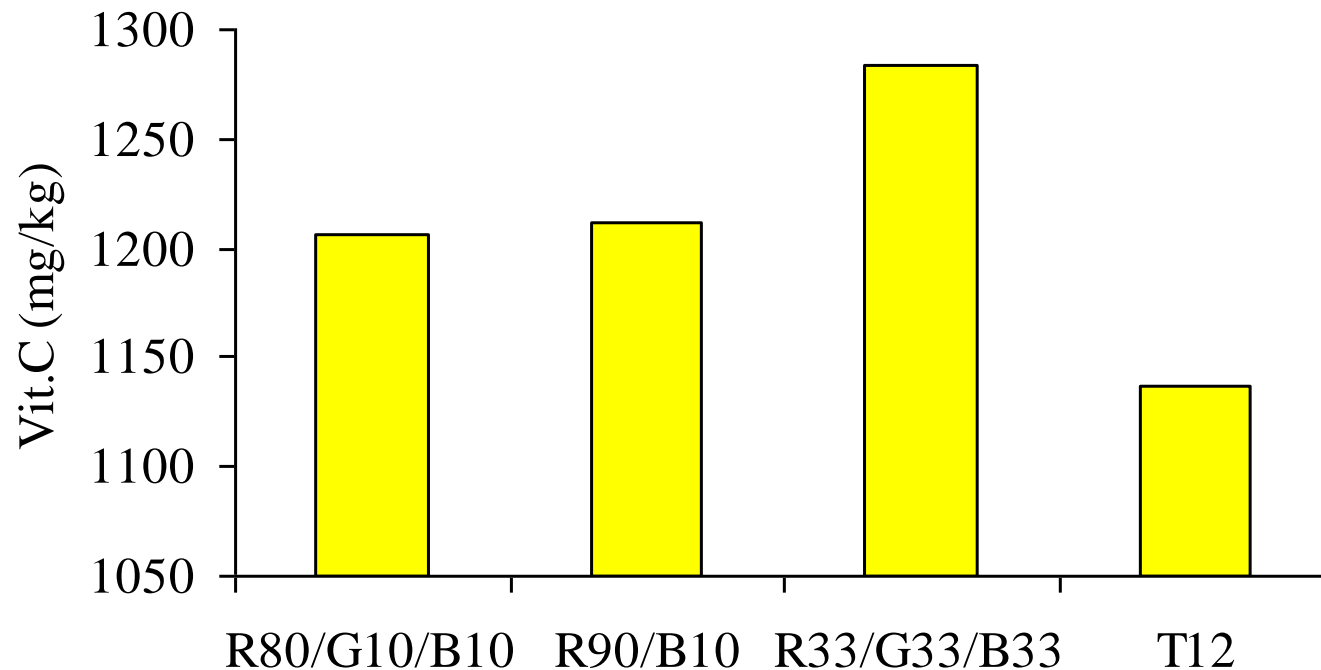
..... T12

葉萵苣14天之重量比較



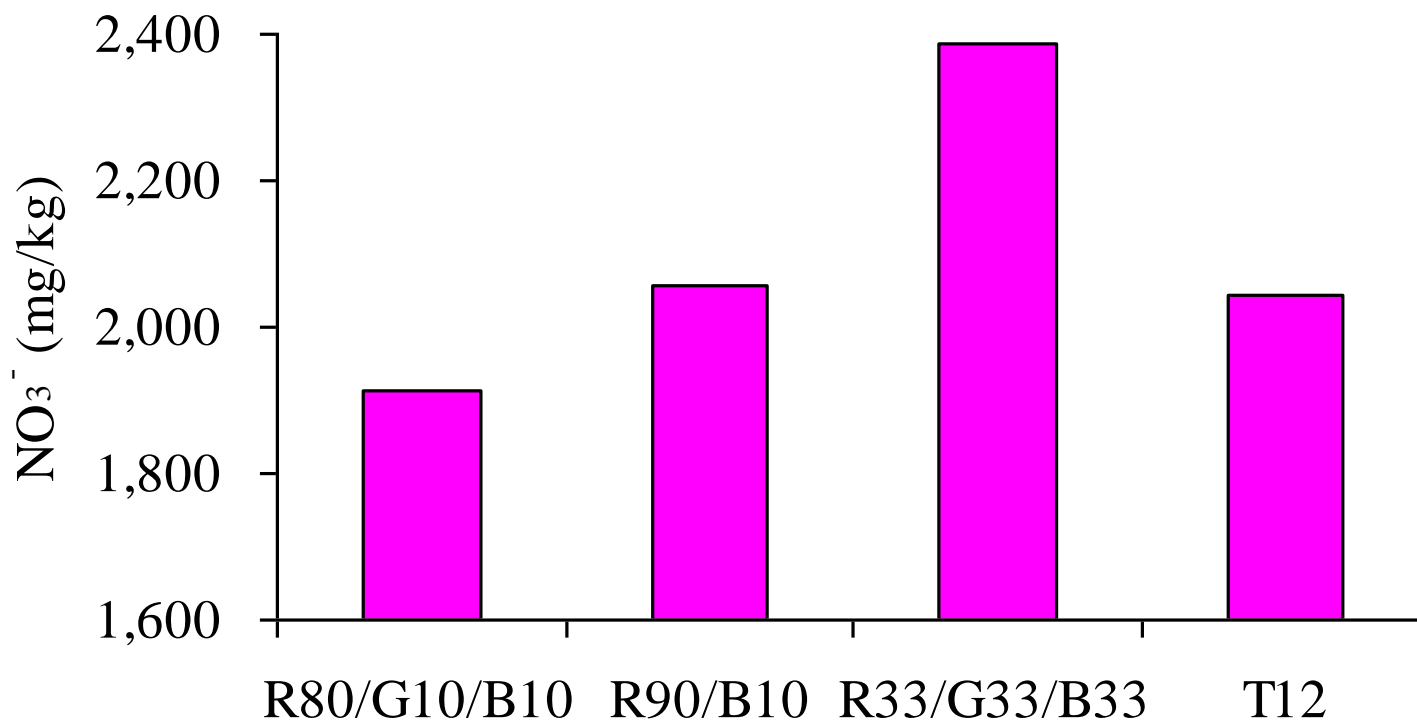
萵苣維他命C含量之比較

- LED栽培之萵苣維他命C含量均較T12栽培者含量高，尤其以等比例混光之白光最顯著

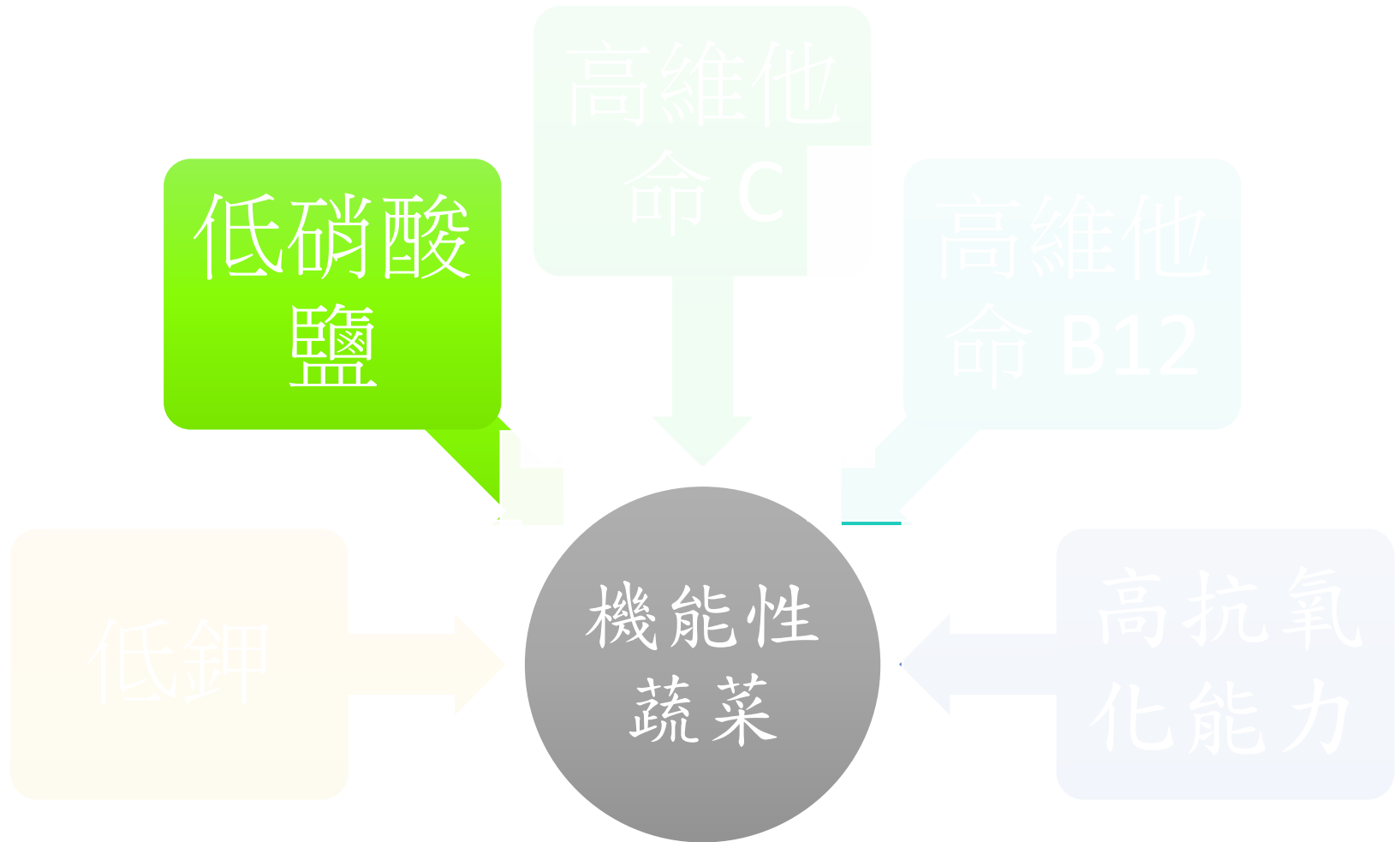


萵苣硝酸鹽含量之比較

- 加強紅光可降低硝酸鹽含量 (< 2100 ppm)
- 加入少量綠光可進一步減少硝酸鹽含量 (<2000 ppm)



如何量產低硝酸鹽蔬菜

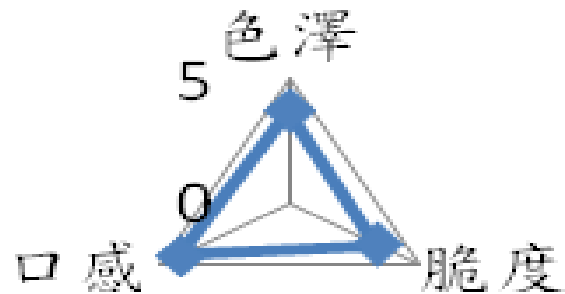


至少有一打的方法

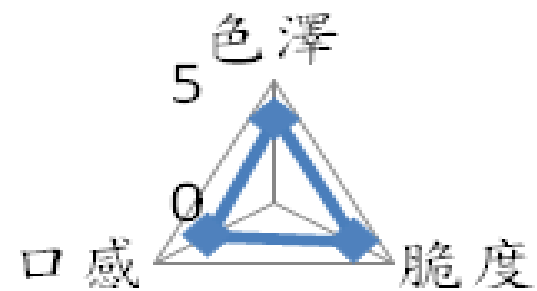
1. 降低氮肥供應
2. 提高栽培密度
3. 添加氯化銨
4. 減壓栽培 (Hypobaric)
5. 提高植株內風速
6. 介質減量
7. 選擇介質種類
8. 選擇栽培法
9. 選擇品種
10. 提高日累積光量
11. 控管採收時間點
12. 增加紅光

葉萵苣官能品評

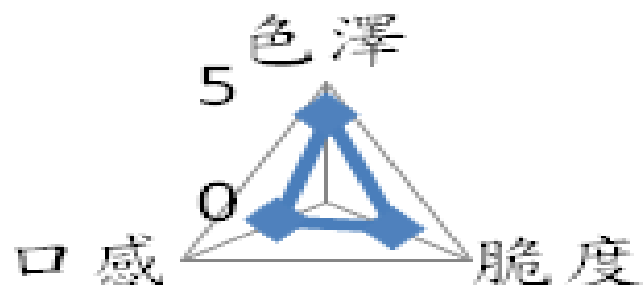
(a) R80/G10/B10



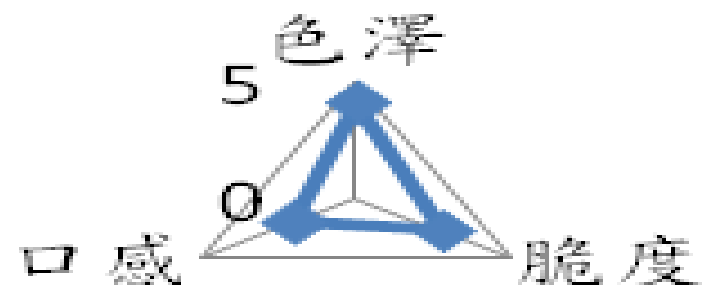
(b) R90/B10



(c) R33/G33/B33



(d) T12



機能性蔬菜

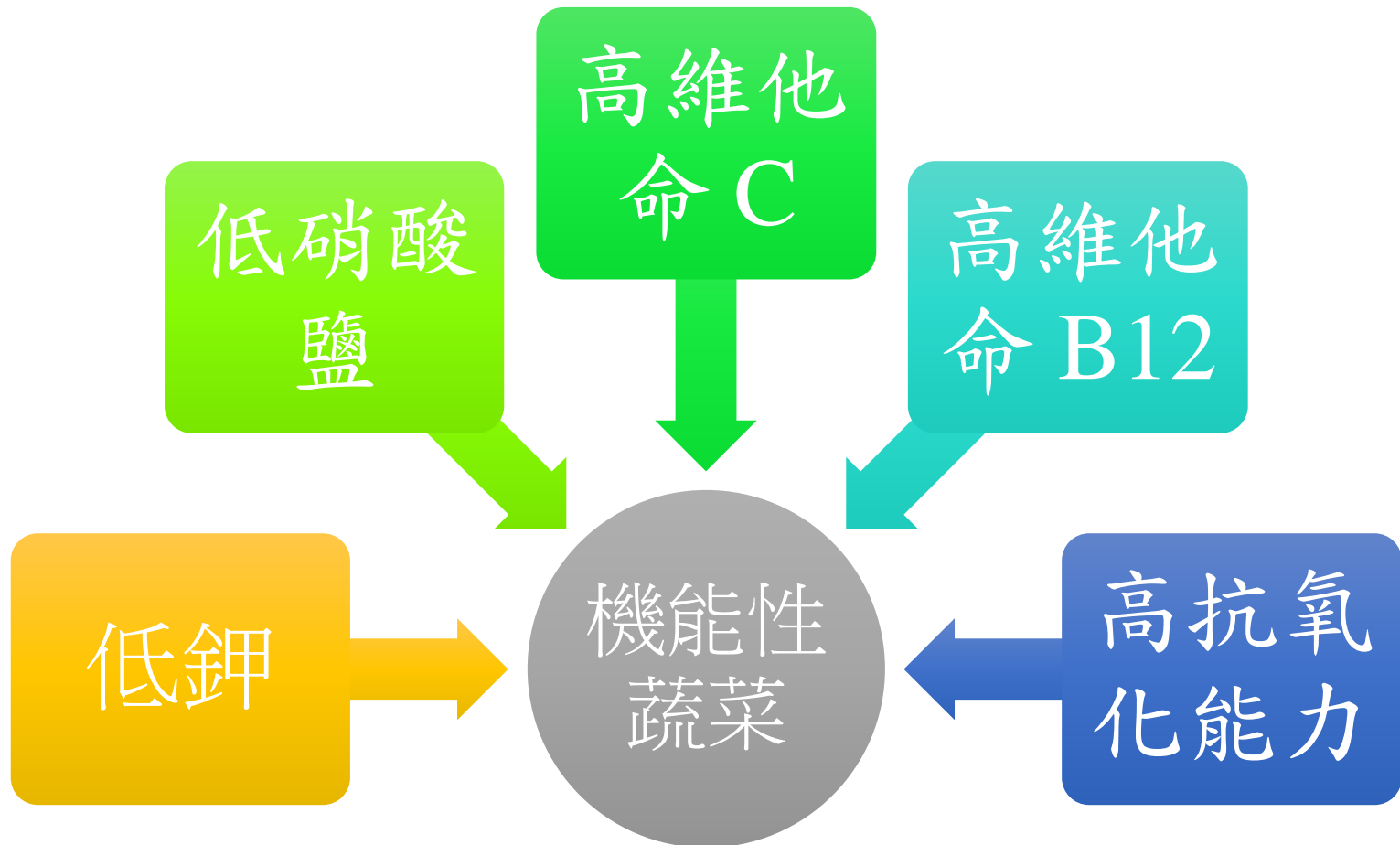
- 機能性（Functional）一詞源於日本
- 機能性蔬菜是指經過特殊栽培方式，使蔬菜具有本來沒有的營養成分，或提高/降低特定成分，使蔬菜變成專門的機能性蔬菜。
- 2015年4月，日本厚生省修正食品標籤制度法，將**生鮮具有機能性之蔬果**也納入**機能性食品**之認證。



品質？

- 安全 (可追溯)：無農藥、無塵土、無蟲(卵)、
低硝酸鹽、低生菌數 → 儲存期長
- 機能性 (可量測)：礦物質、精油、葉綠素、葉黃素、
抗氧化 (ORAC 值, DPPH 清除率)、
維生素C、類胡蘿蔔素、花青素、總酚...
- 口感、口味、外觀、色澤、形狀、新鮮度

機能性蔬菜可能具備之功效



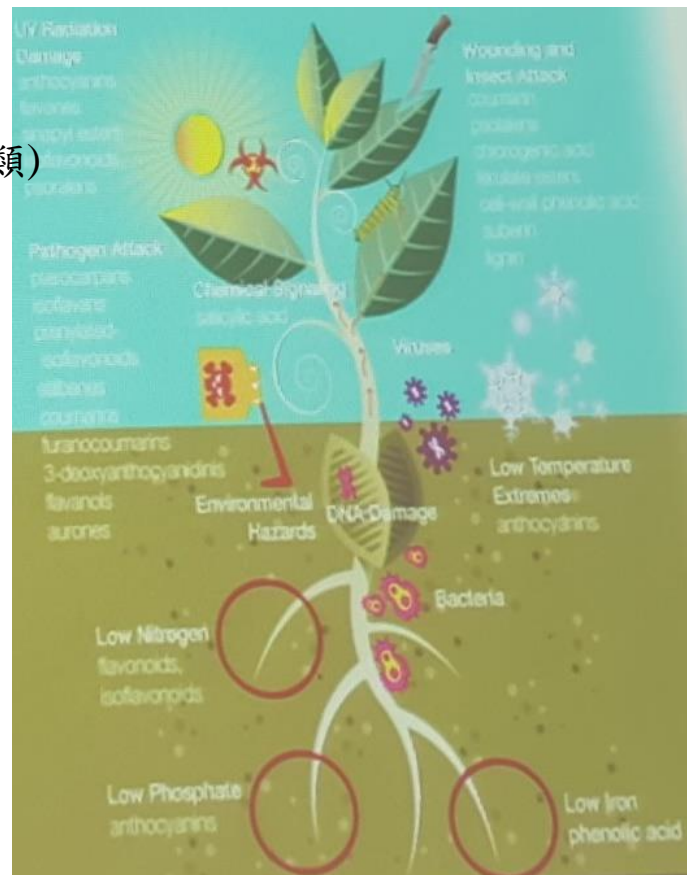
提高二次代謝物含量的方法

環境逆境 → 活性氧物質 (ROS) → 二次代謝物 (抗氧化物質)

類苯基丙烷 (苯丙酯類)

Phenylpropanoids

- 傷害
- UV
- 低溫
- 養分不足
- 化學信號
- 感染



物理誘導:

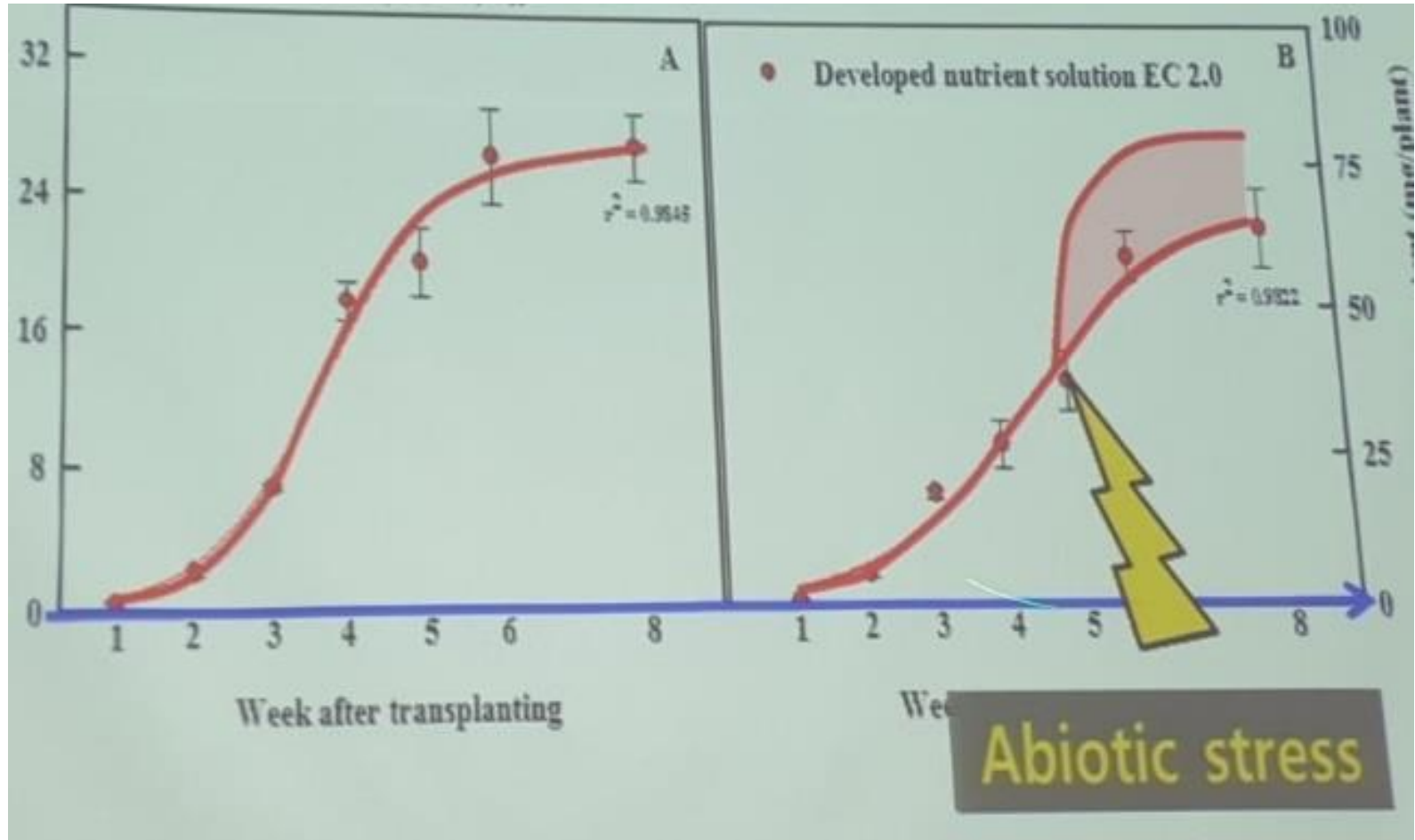
環境逆境

化學誘導

生物(感染)誘導

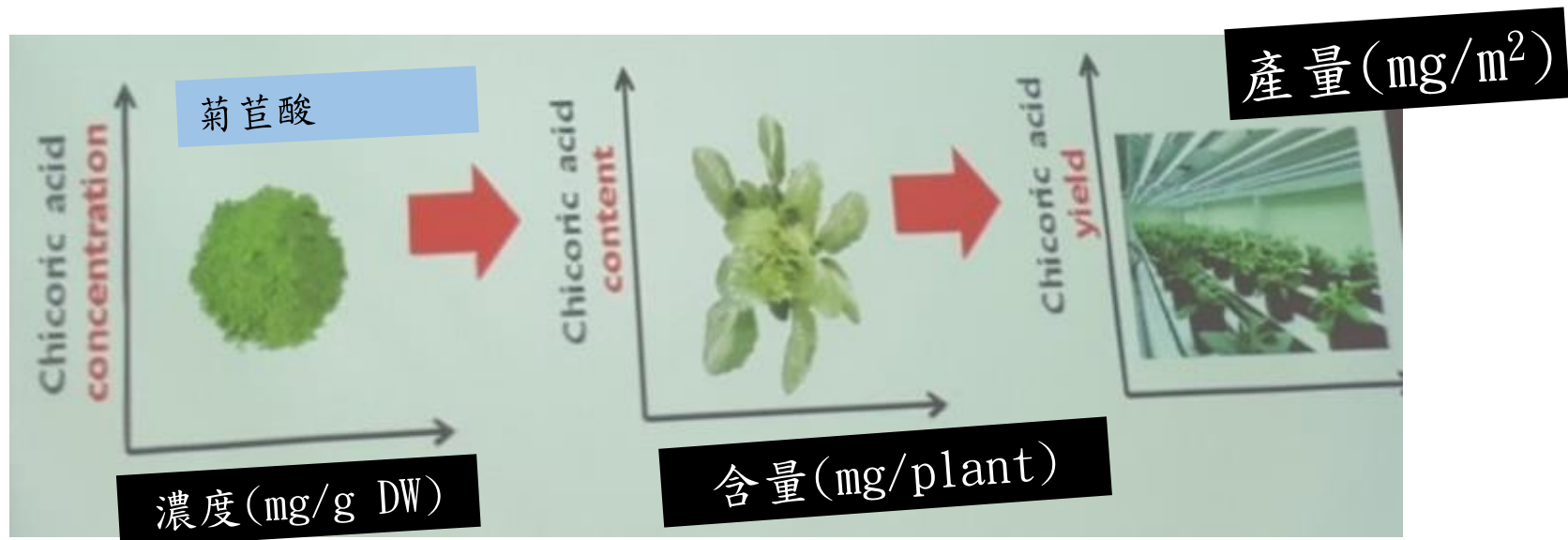
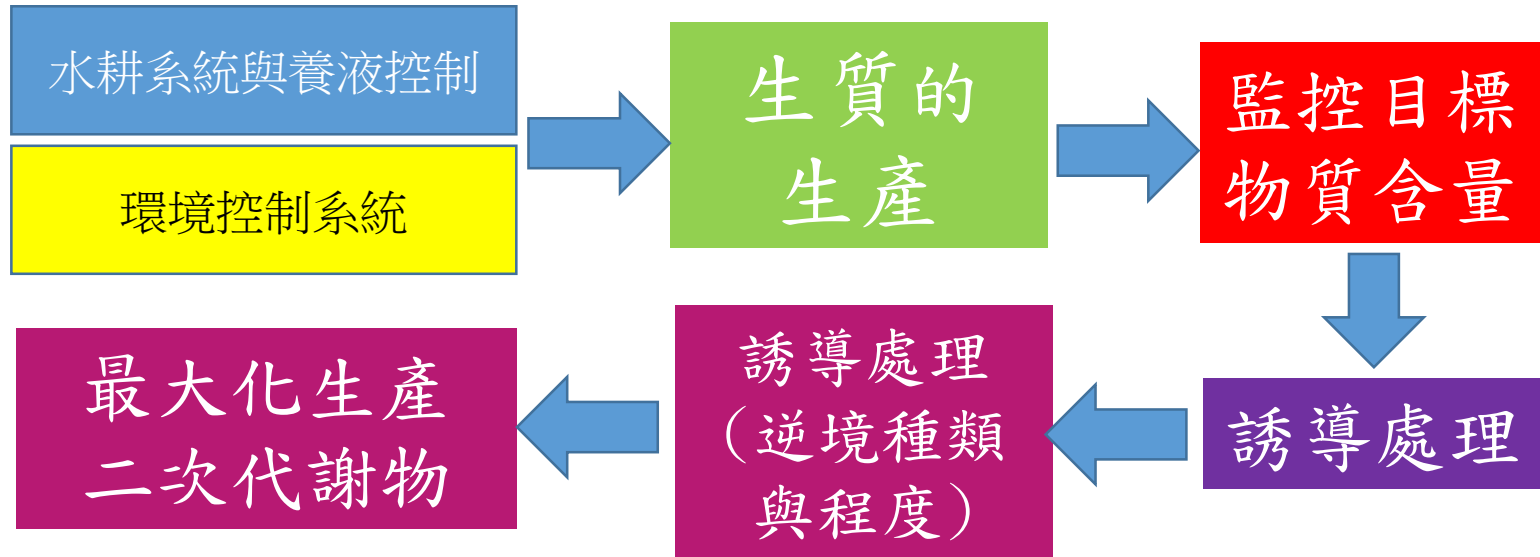
施以逆境的時機點

菊苣酸含量, g



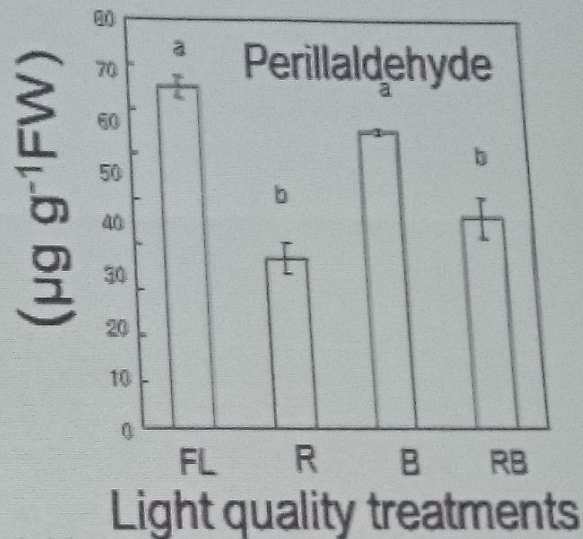
Abiotic stress

植物工廠中生產藥用作物之策略

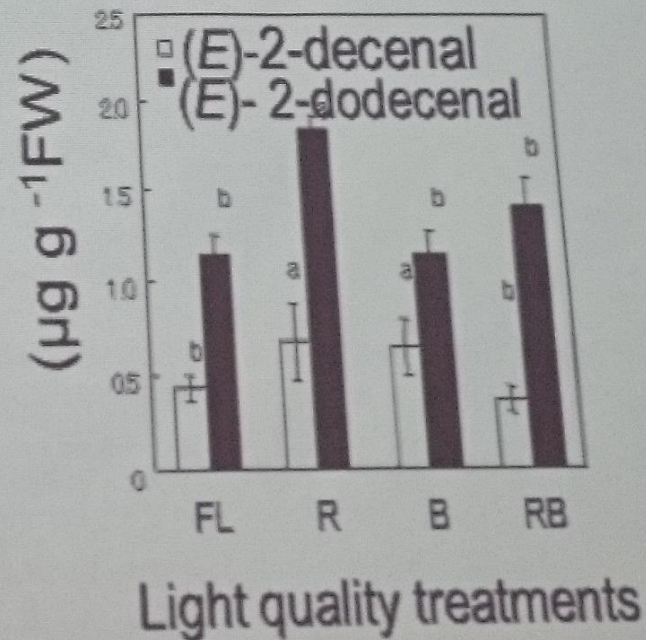
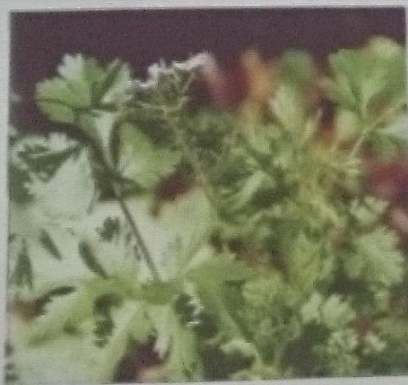


光質影響
紫蘇與
芫荽的
精油含量

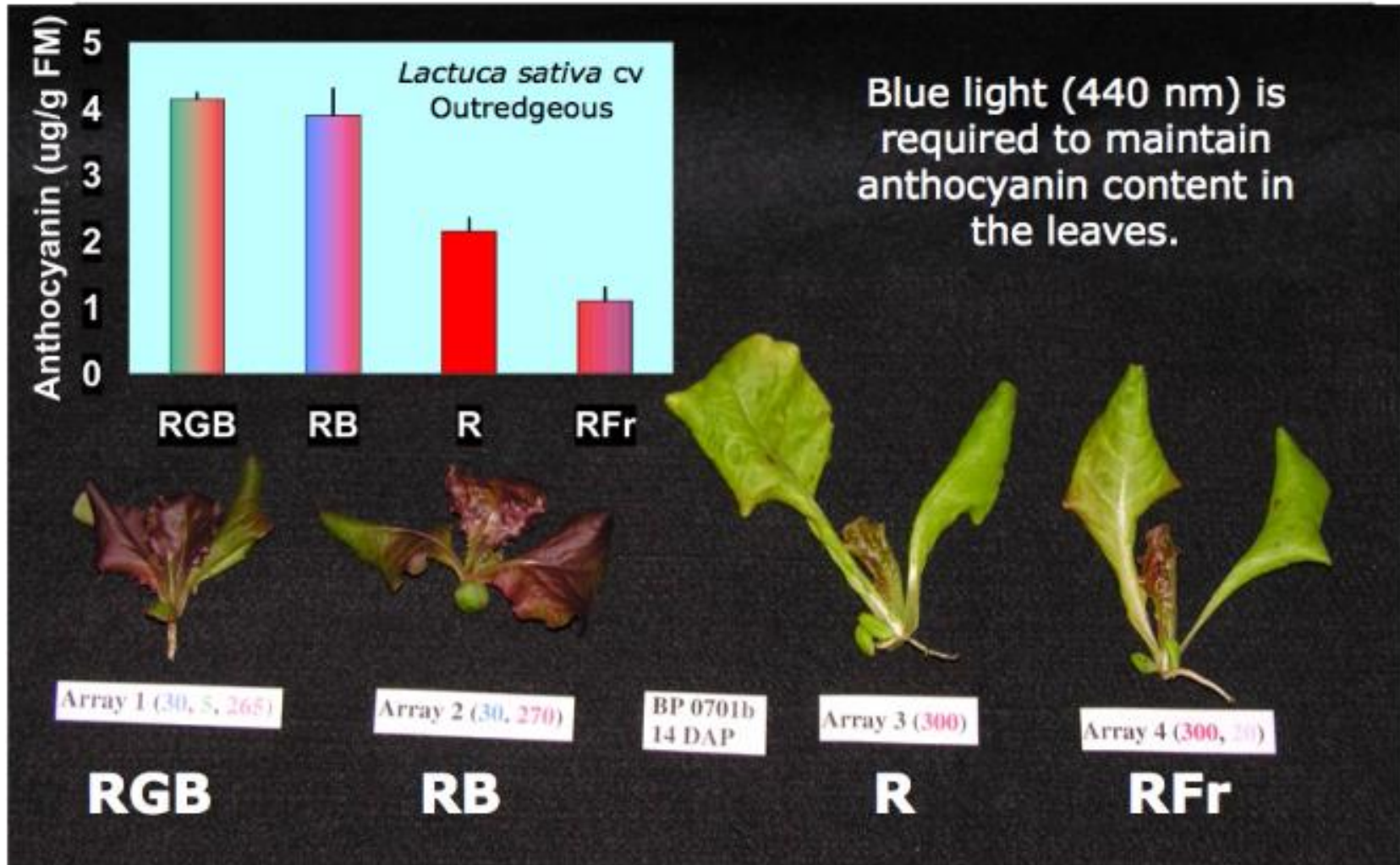
Perilla



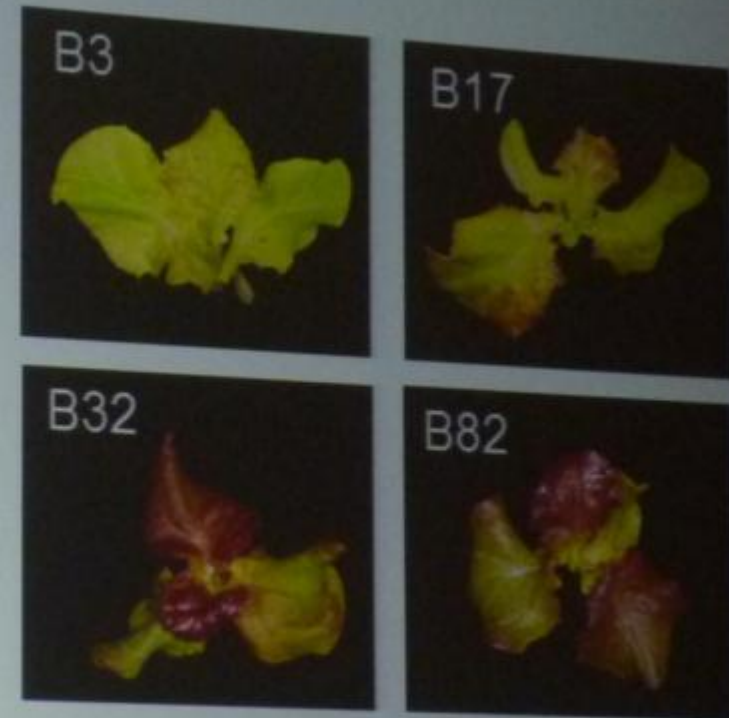
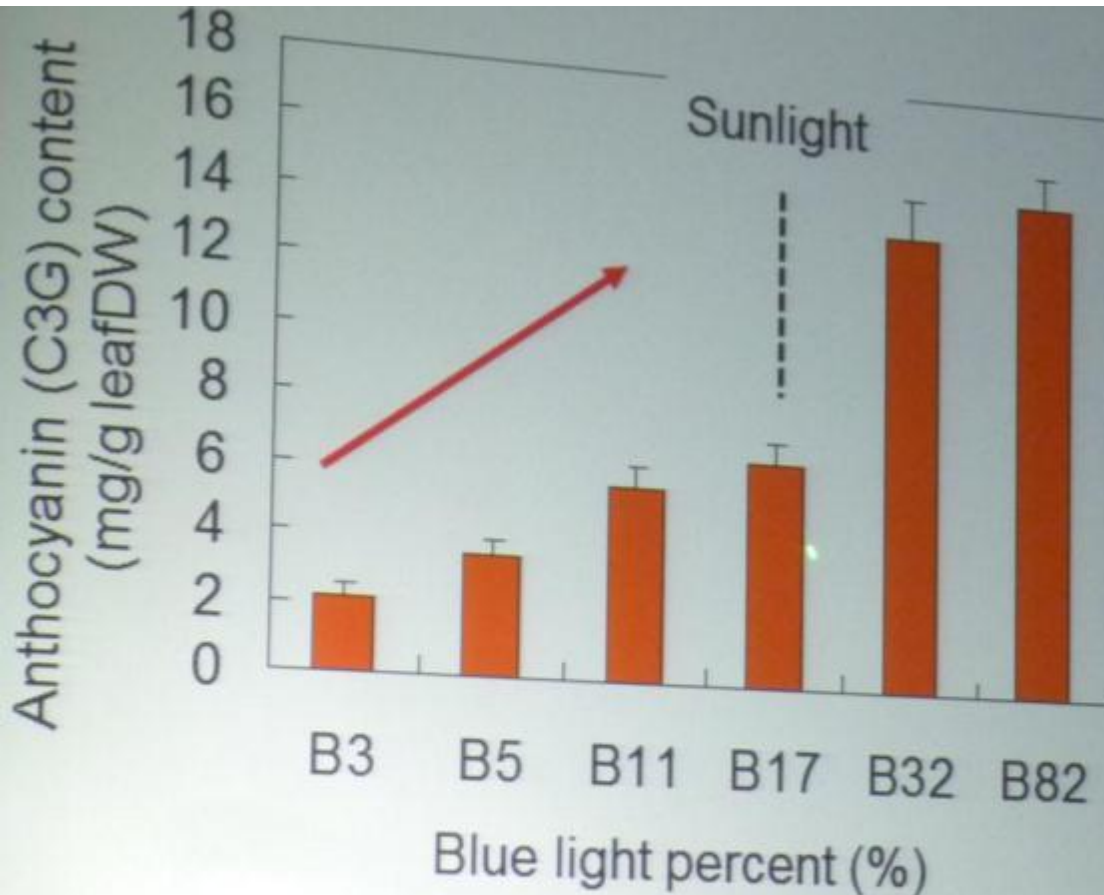
Coriander



Light quality has significant effect on anthocyanin concentration in leaves.



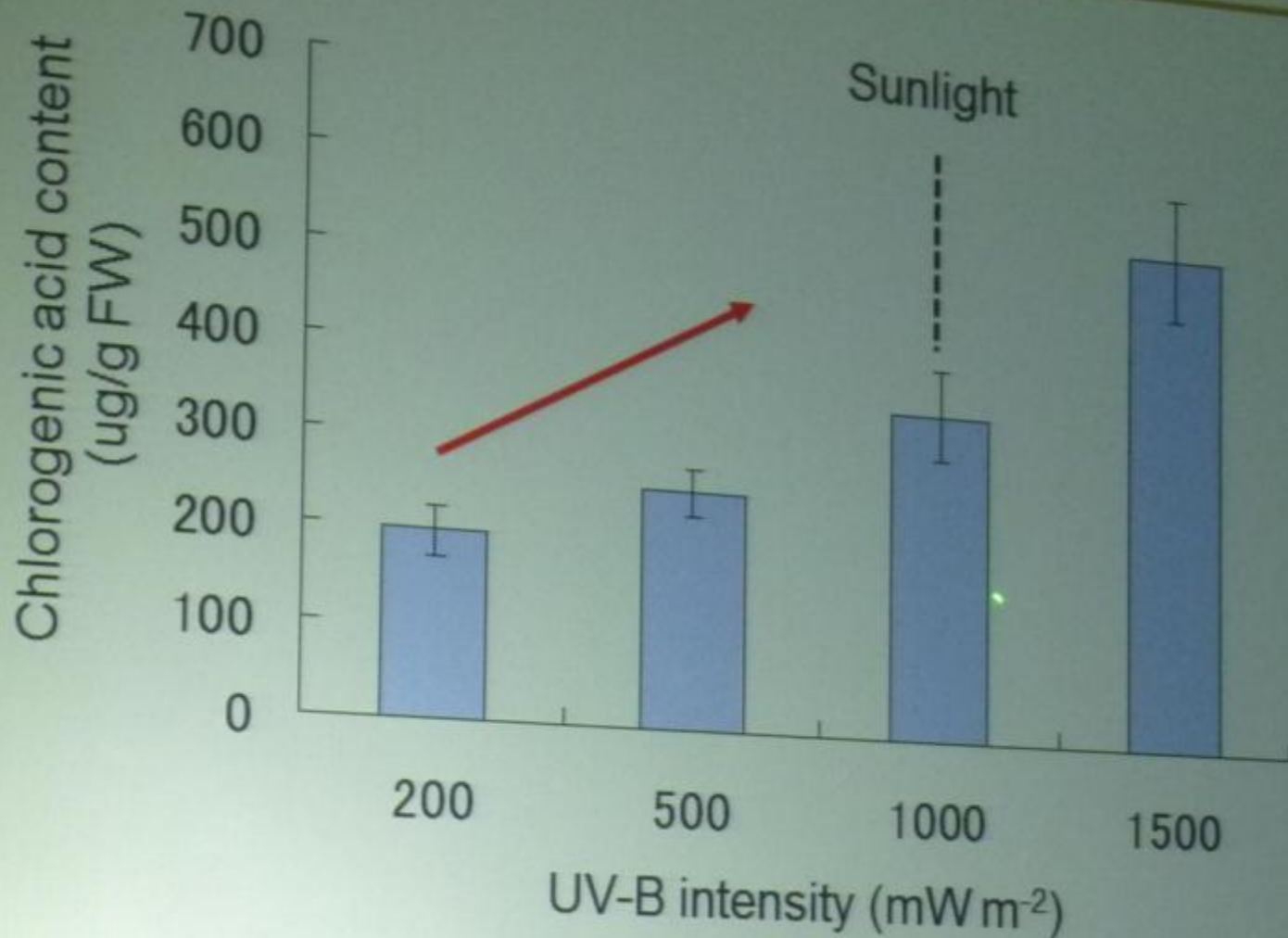
More Blue, More Anthocyanin (花青素)



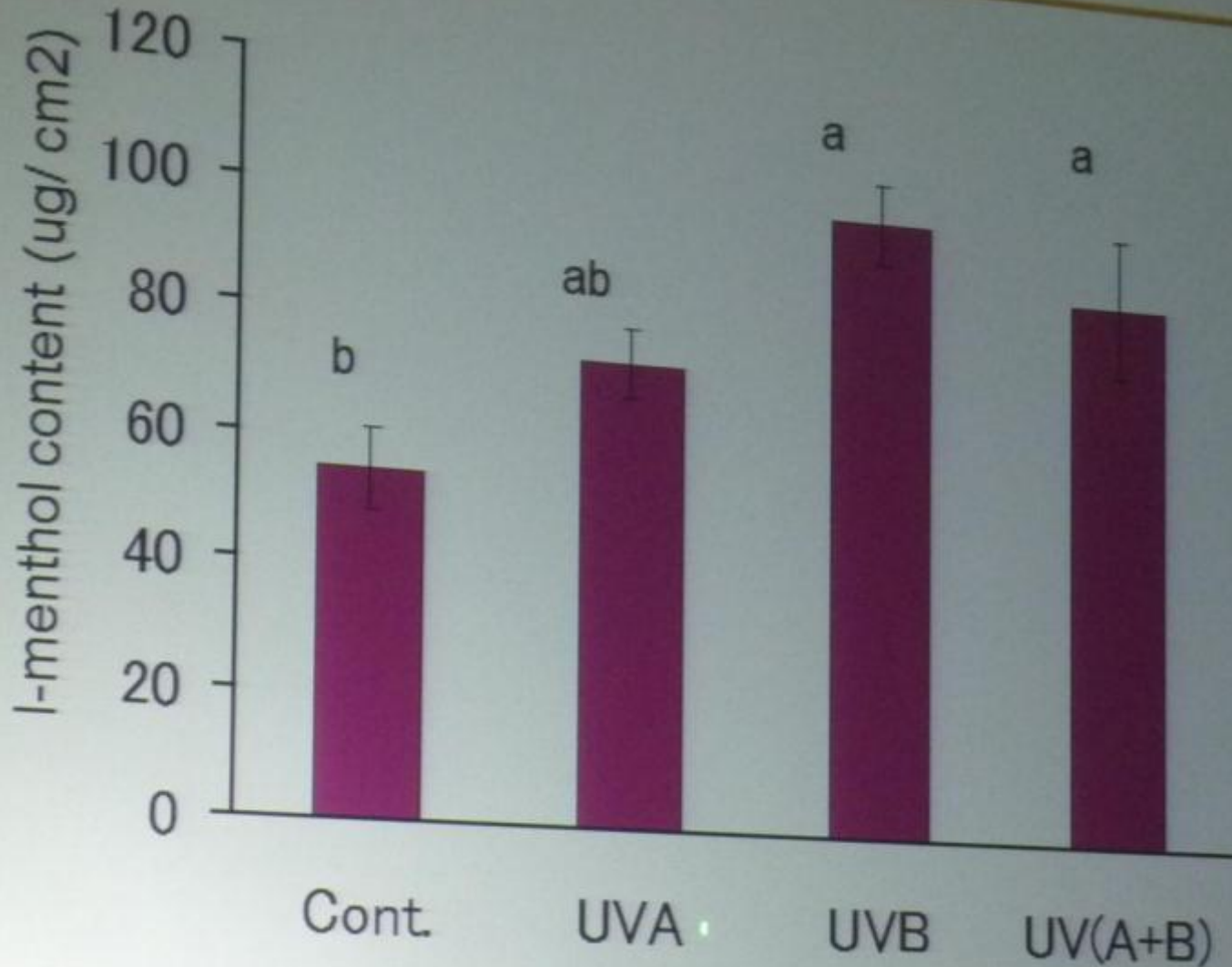
Anthocyanin content of leaf lettuce grown under different blue light conditions.

PPF = $150 \text{ } \mu\text{mol m}^{-2} \text{ s}^{-1}$ constant

More UVB, More Chlorogenic Acid (綠原酸)



UVB is better than UVA for l-menthol (左旋薄荷) production



紫甘藍芽—富含營養及抗氧化能力

- 紫甘藍富含維生素 B、C 和 E、花青素和纖維素
- Yamaguchi *et al.* (2006)
 - 使用螢光燈健化紫甘藍芽
 - 健化天數增加，抗氧化能力亦提高



不同光量對紫甘藍芽之影響



(本研究室未發表之成果) 對芽菜並非光量越高越好 127

不同光量對紫甘藍芽抗氧化力之影響

光量
($\mu\text{mol m}^{-2}\text{s}^{-1}$)

花青素
(units/g FW)

總酚
(mg/g FW)

過氧化氫酶
(units/g)

多酚類化合物存在於自然界的植物體，可強化血管管壁，抗動脈粥狀硬化和抗癌的作用。

化育素具有抗氧化、抗發炎特性，並可提升免疫力，減少氧化壓力造成組織受損，維持身體健康方面扮演重要角色

過氧化氫為代謝產物，過多對有機體造成損害，為避免損害，產生過氧化氫酶 (Catalase) 催化過氧化氫分解，亦即代表當植物遭受逆境時，植物體內過氧化氫酶的含量將增加。

(本研究室未發表之成果)

不同光量對紫甘藍芽抗氧化力之影響

DPPH 清除率: 探討抗氧化物之供氫能力，
供氫能力越強，DPPH 清除率高。

($\mu\text{mol m}^{-2}\text{s}^{-1}$)

(%)

(%)

(%)

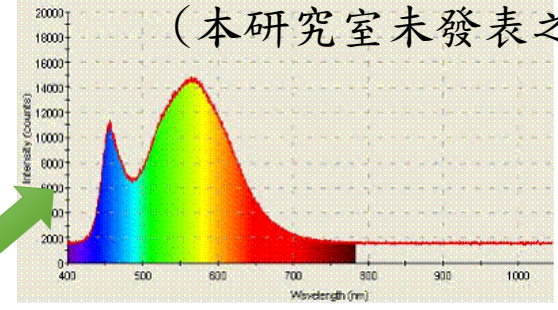
還原力: 以普魯士藍生成量作為指標，將赤血鹽還原成黃血鹽，黃血鹽再利用 Fe^{3+} 形成普魯士藍，愈藍代表抗氧化物質還原力越強。

螯合亞鐵率: 藉 Fe^{2+} 與 Ferrozine 的複合物呈色反應，測得抗氧化物對 Fe^{2+} 的螯合能力。

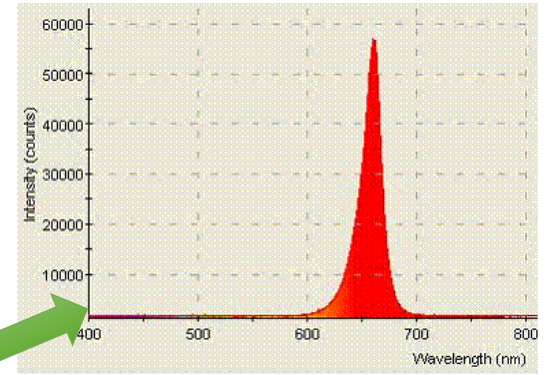
(本研究室未發表之成果)



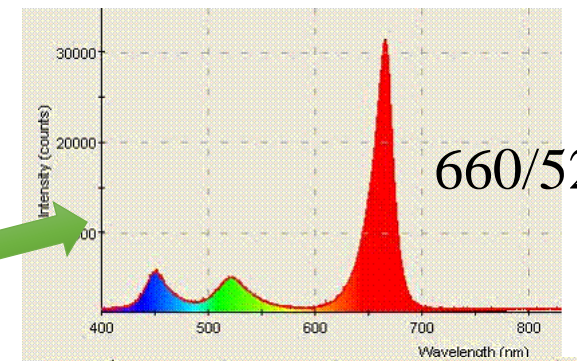
(本研究室未發表之成果)



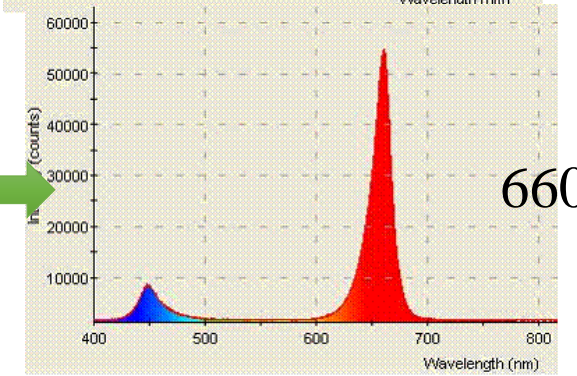
CW
5000 K



RED
660 nm



4RGB
660/525/450 nm



5R1B
660/450 nm



圖 1. 不同光環境綠化 3 天對蘿蔔嬰生長的情形

(本研究室未發表之成果)

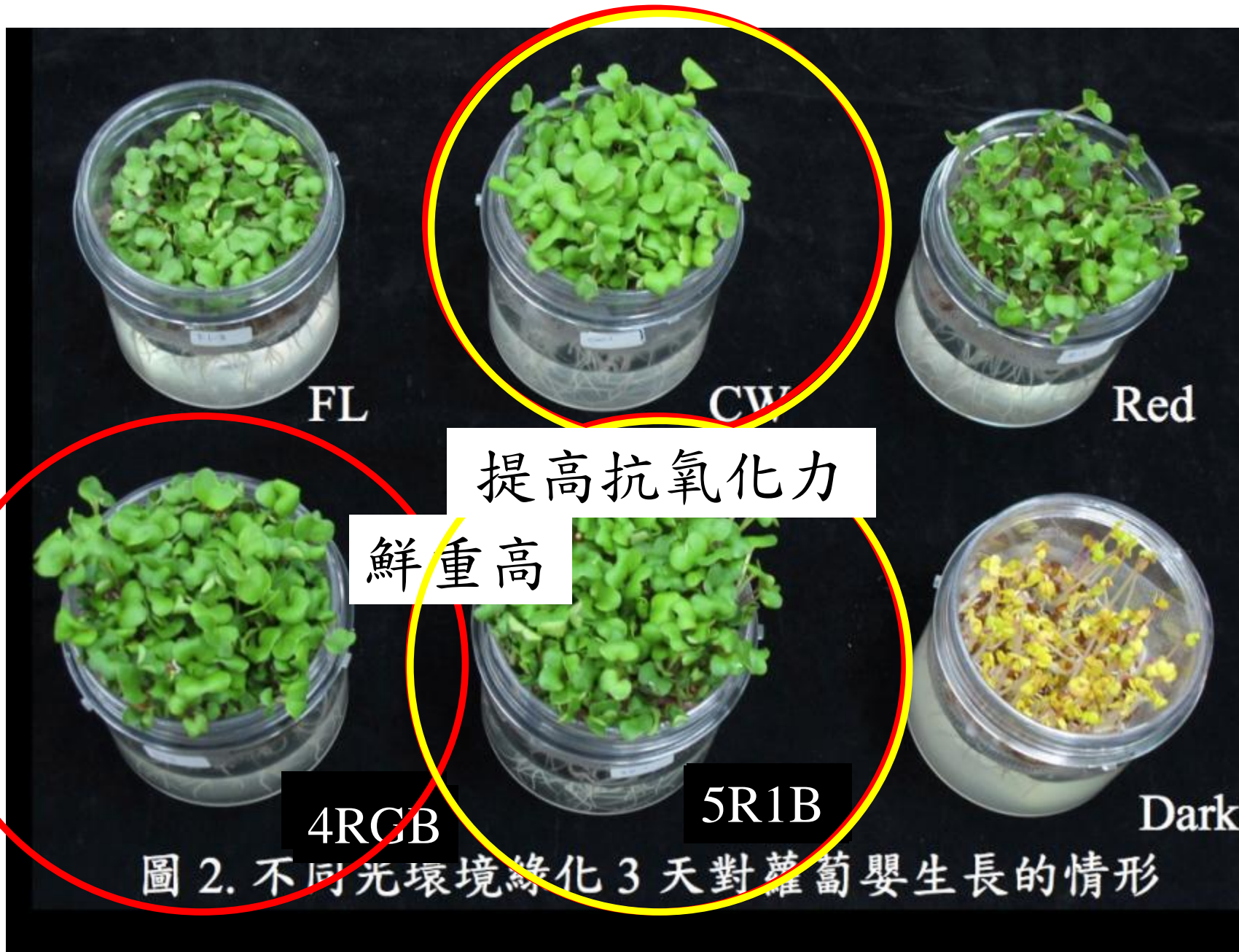
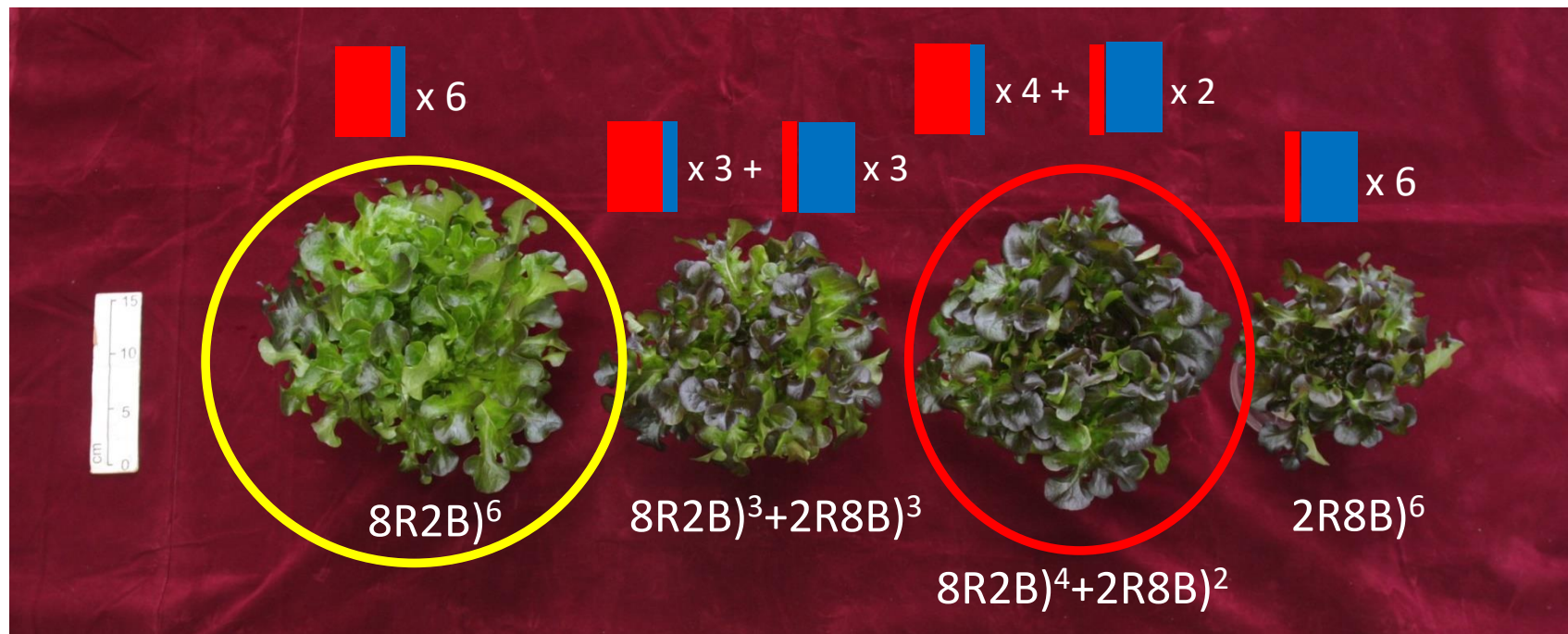


圖 2. 不同光環境綠化 3 天對蘿蔔嬰生長的情形

(本研究室未發表之成果)

不同光質下調控紅橡萵苣生長與花青素



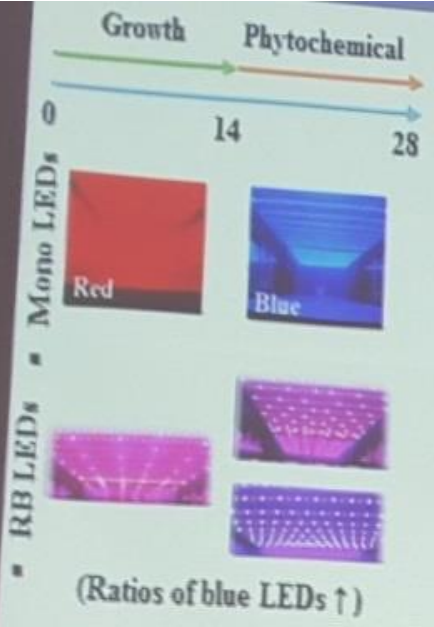
* bar = 15 cm

生長好
花青素低

生長好
花青素高

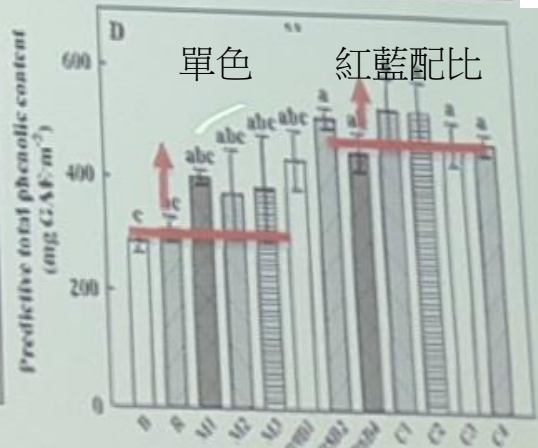
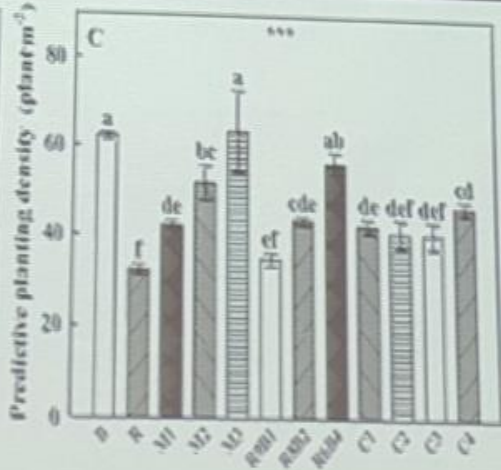
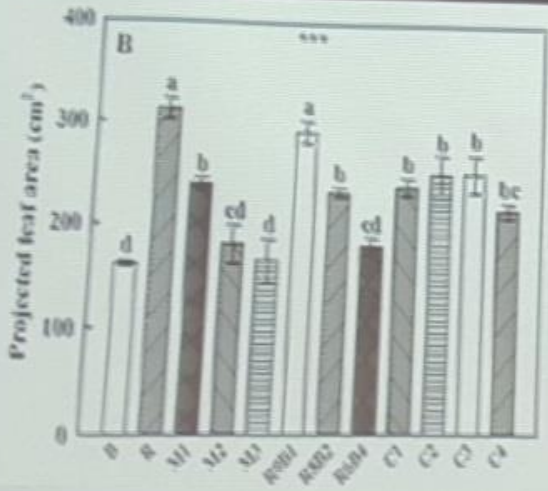
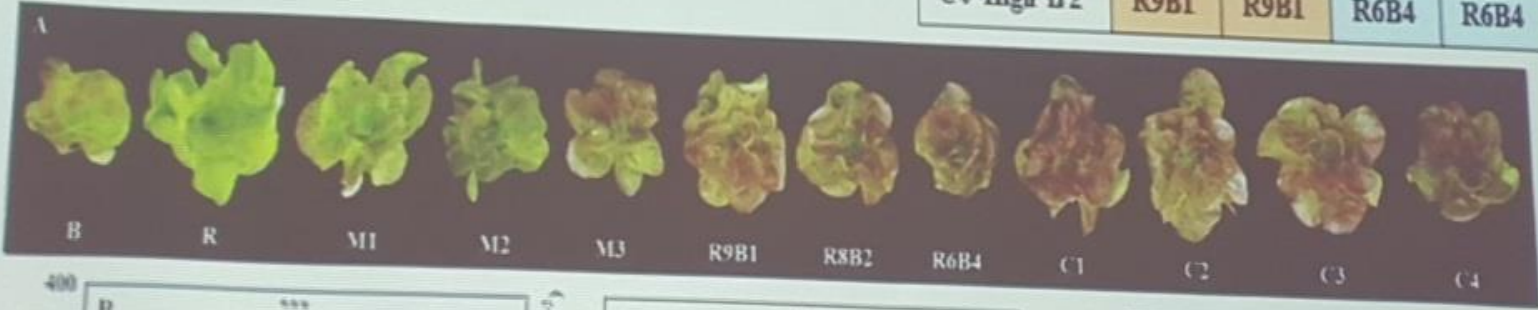
(本研究室未發表之成果)

紅藍
配比
比
單色光
更能
提高
萵苣之
總酚
含量



Mono	Weeks after treatment			
	1	2	3	4
Treatment	1	2	3	4
Con-B	B	B	B	B
Con-R	R	R	R	R
M1 - R3B1	R	R	R	B
M2 - R2B2	R	R	B	B
M3 - R1B3	R	B	B	B

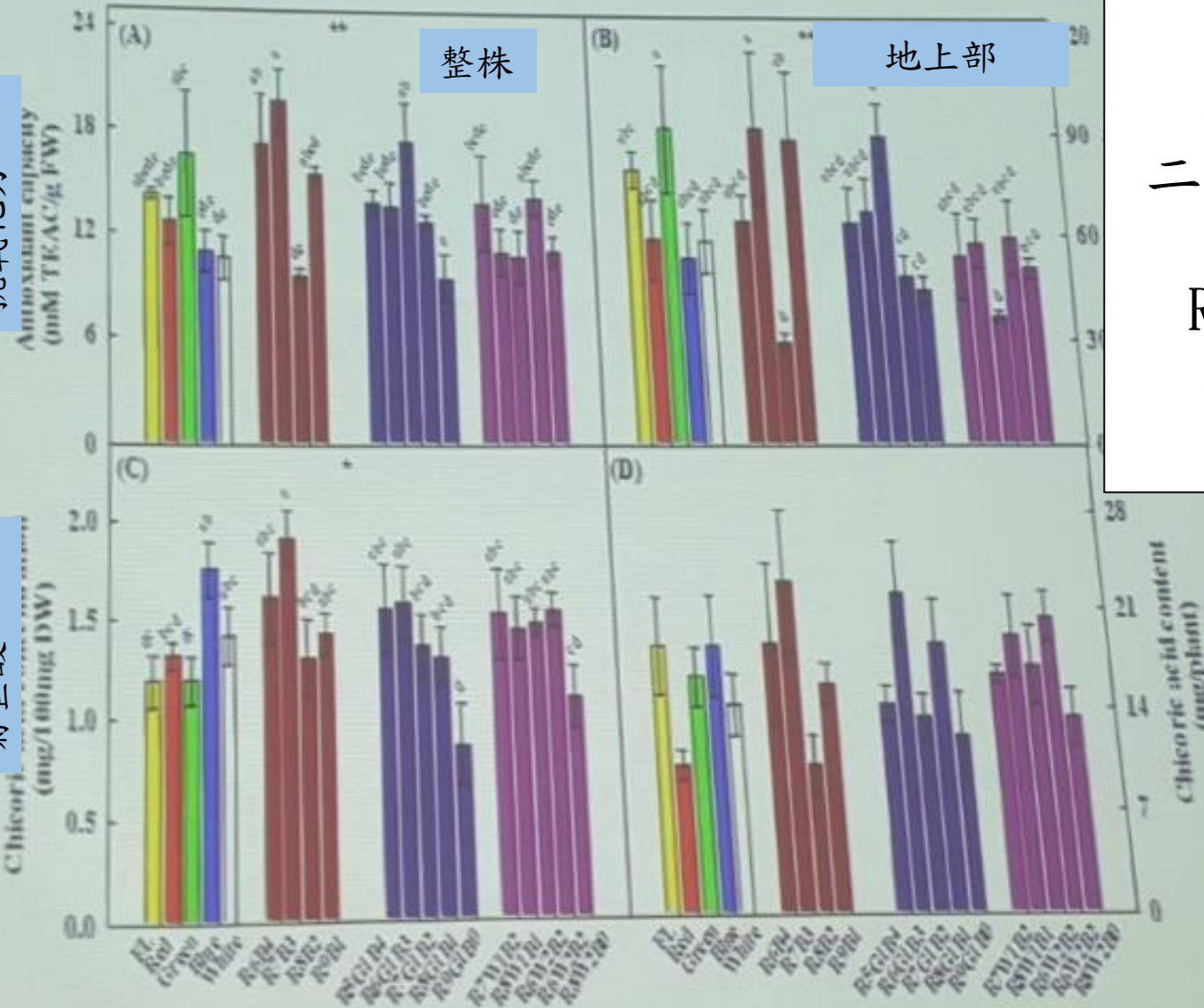
RB	Weeks after treatment			
	1	2	3	4
Treatment	1	2	3	4
Con-R9B1	R9B1	R9B1	R9B1	R9B1
Con-R8B2	R8B2	R8B2	R8B2	R8B2
Con-R6B4	R6B4	R6B4	R6B4	R6B4
C1 -Low B 1	R9B1	R9B1	R9B1	R8B2
C2 -Low B 2	R9B1	R9B1	R8B2	R8B2
C3 -High B 1	R9B1	R9B1	R9B1	R6B4
C4 -High B 2	R9B1	R9B1	R6B4	R6B4



Crepidiastrum denticulatum – RGBW LEDs

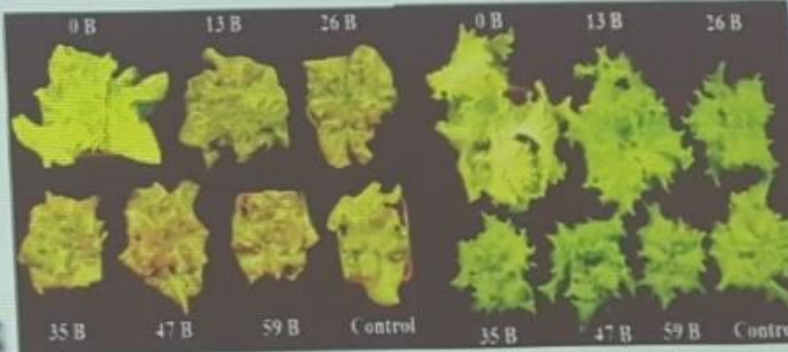
抗氧化力

菊苣酸



沒有藍光時
抗氧化力與
二次代謝物含量
會下降
R3B7 可提高
抗氧化力與
二次代謝物

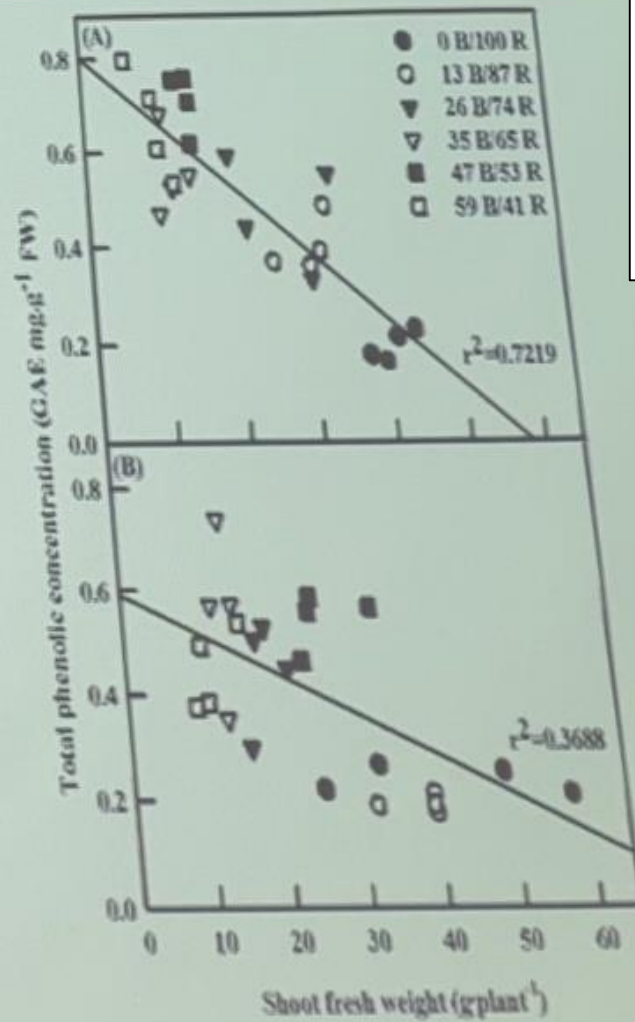
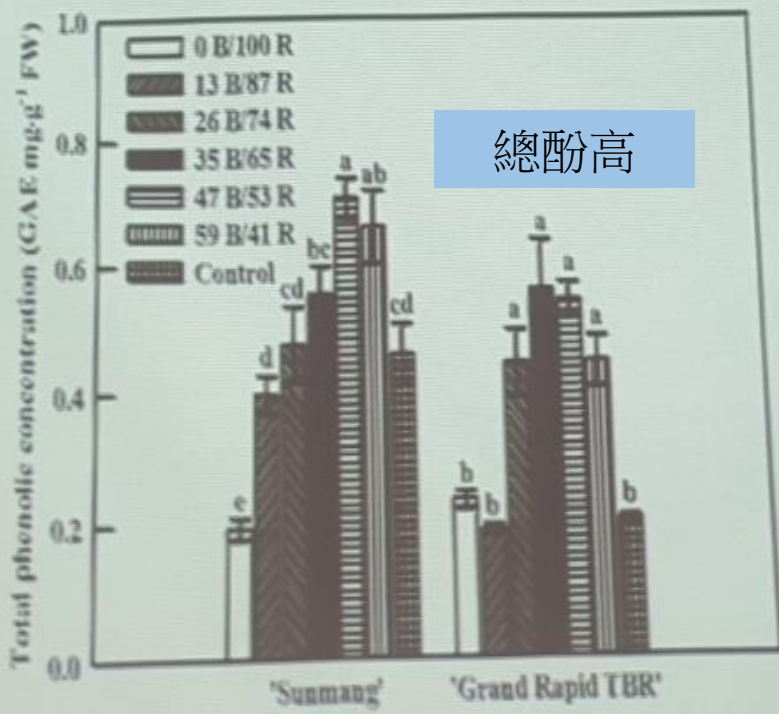
• Blue/Red ↑ →
Antioxidant phenolics



藍光提高
總酚

紅光高
提高鮮重

鮮重提高
總酚下降



Sowthistle – UV-A lamps

苦苣菜

UVA 提高
地上部鮮重、
酚醛類含量
與
抗氧化能力

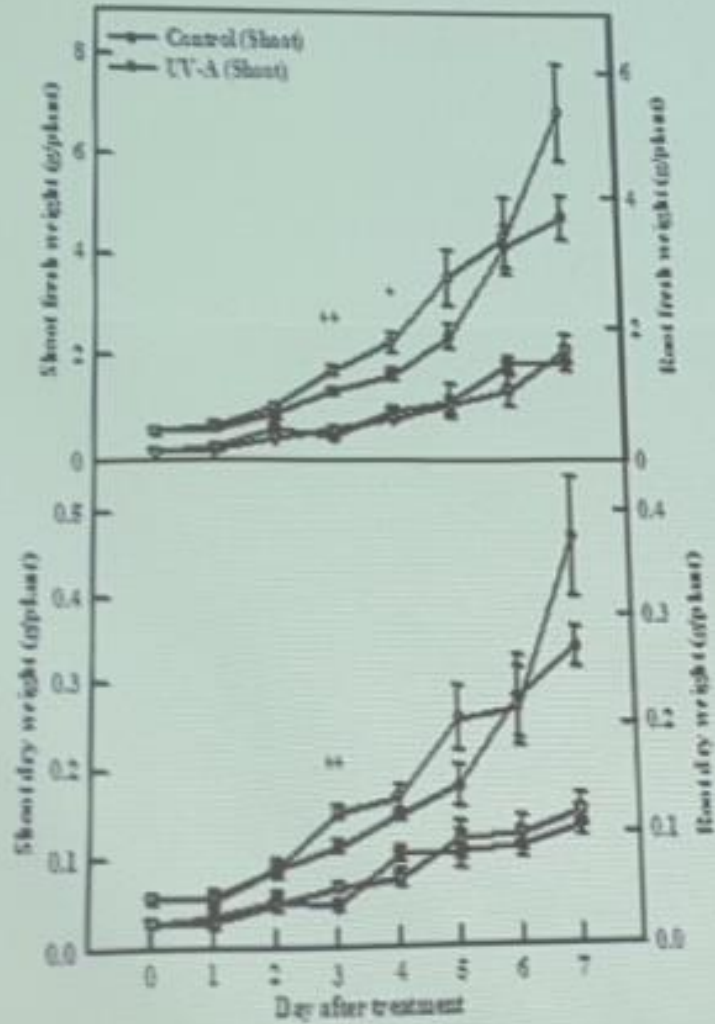


Fig. Fresh weights of shoots and roots of *Ixeris dentata* Nakai exposed to UV-A lamp.

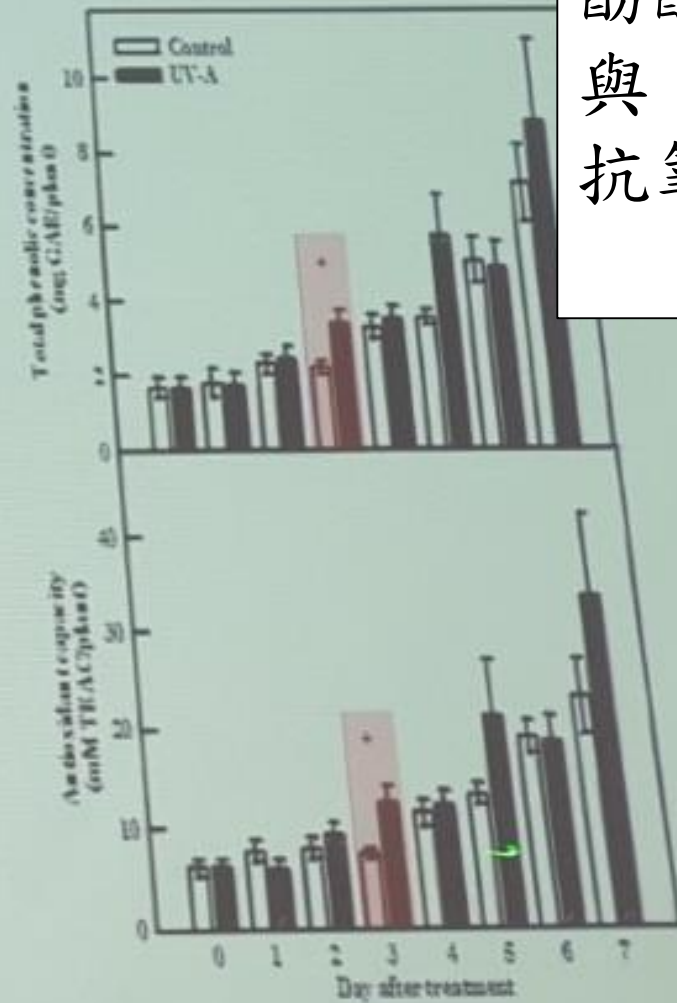
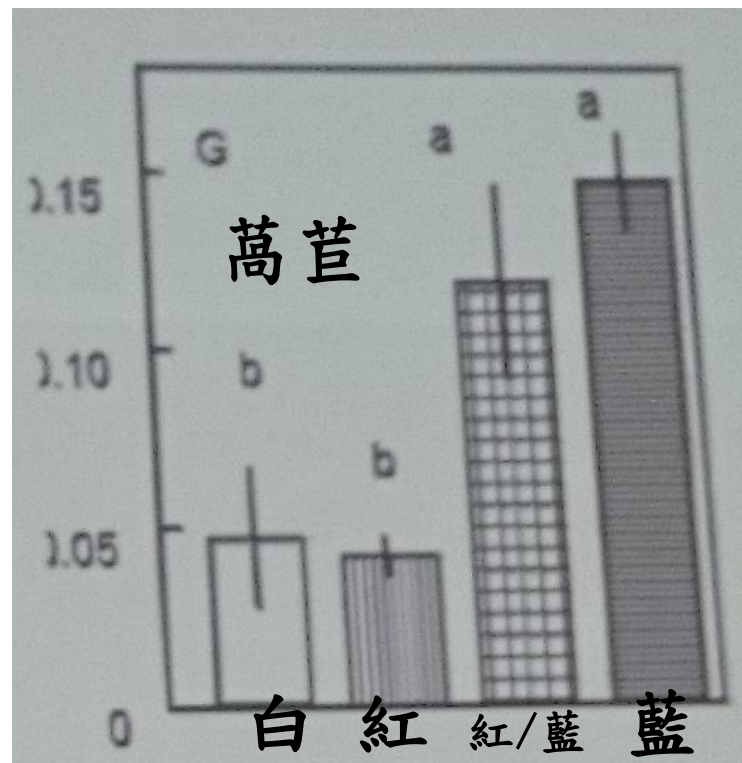
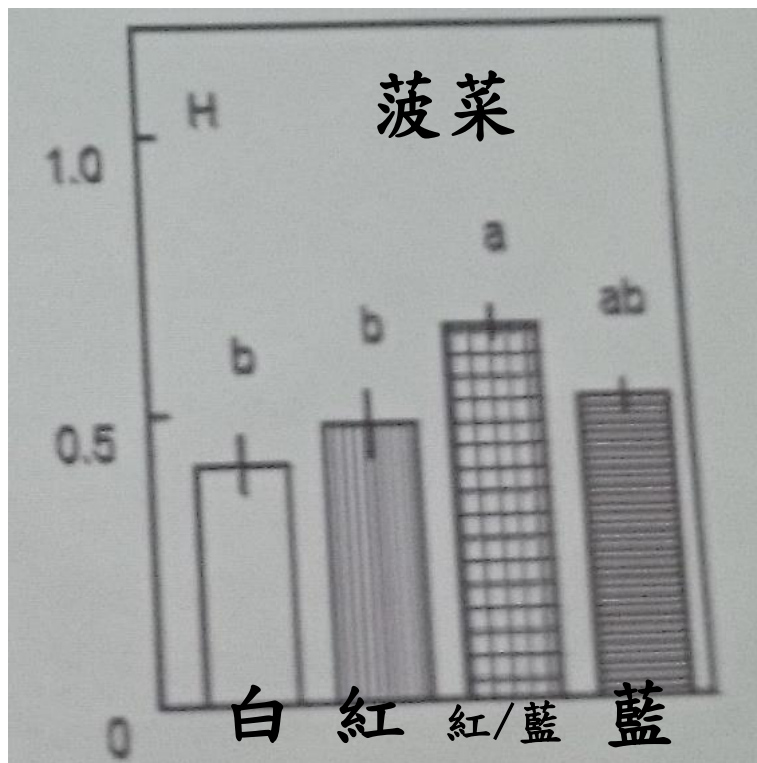


Fig. Total phenolic concentration and antioxidant capacity of *Ixeris dentata* Nakai exposed to UV-A lamp.

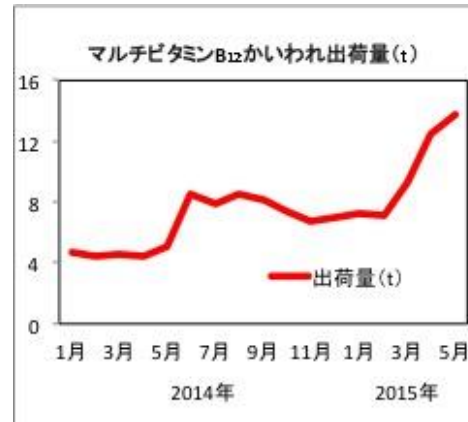
光質影響維他命C 含量 (mg/g FW)



Ohashi-Kaneko, 2015

日本村上農園高機能蔬菜

- 栽培蘿蔔嬰、青花菜、紫甘藍等苗菜。
- 商品名：B12 蘿蔔嬰
- 容量：60 g (30g 可食)
- 價格：100 JPY/包
(等於 0.83 NTD/g)
- B12 含量：22~130 $\mu\text{g}/100\text{g}$

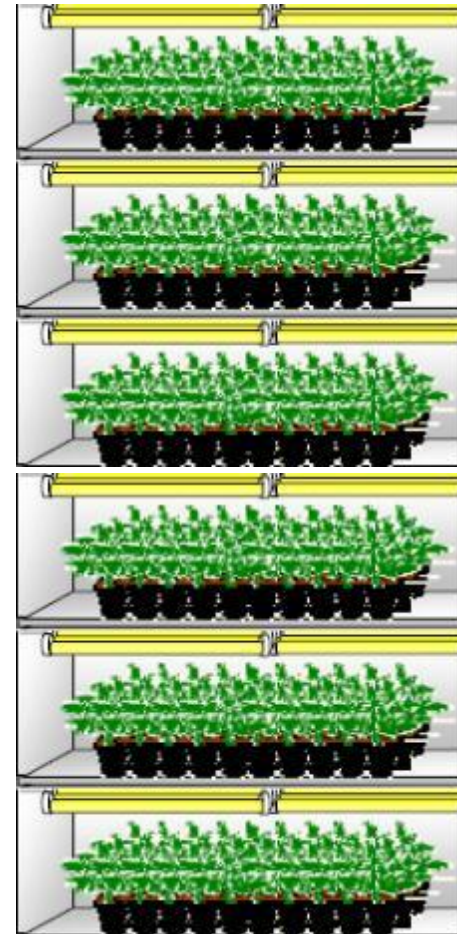


參考資料：<http://murakamifarm.com/company/release/2015/06/12/001751/>
http://www.agriculture-jp.com/news_C0zo2l7zi.html

Vertical Farming / Plant Factory



Single layer



multilayer



vue depuis le port de l'Alma















Light up Eco-friendly Dream



Animal

Medical

LED

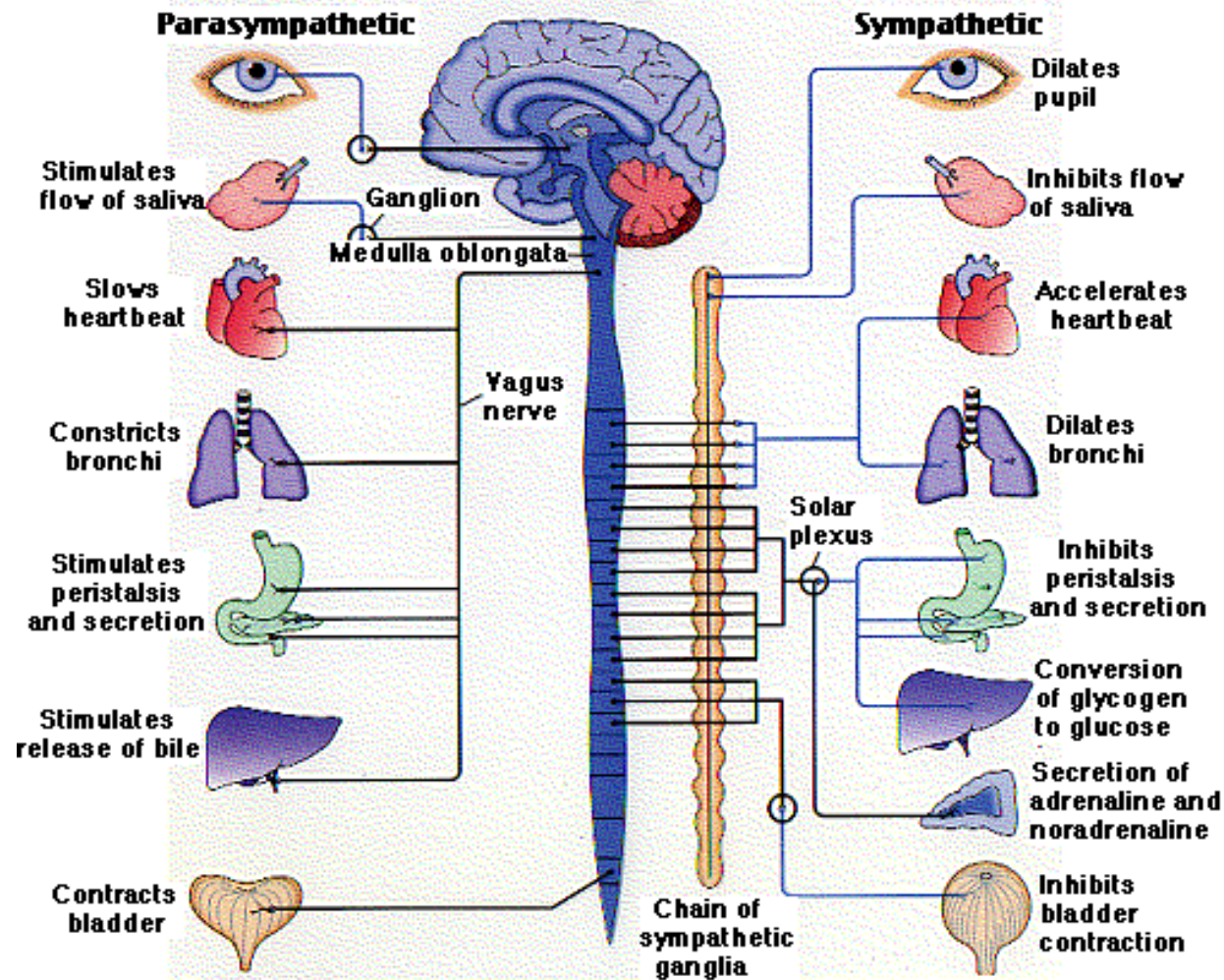
Plant

Aquaculture

autonomic nervous system (ANS)

Parasympathetic nervous system (PNS)

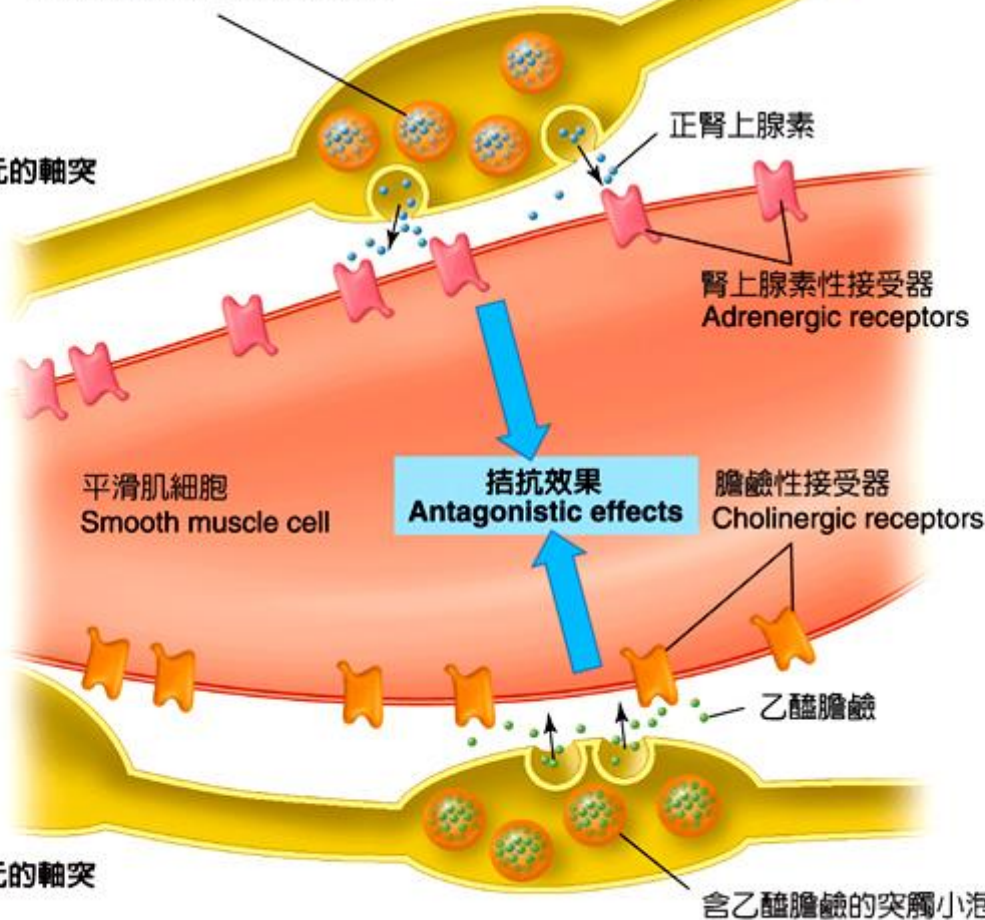
sympathetic nervous system (SNS)



The SNS activates Fight-or-flight response

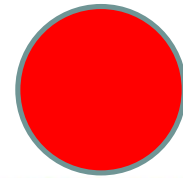
含有正腎上腺素的突觸小泡

交感神經元的軸突



副交感神經元的軸突

The PNS activates rest-or-digest response



Fight-or-flight response

戰鬥或逃跑反應



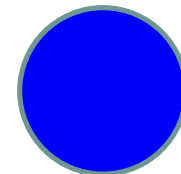
Antagonist

相互對抗



休息或消化反應

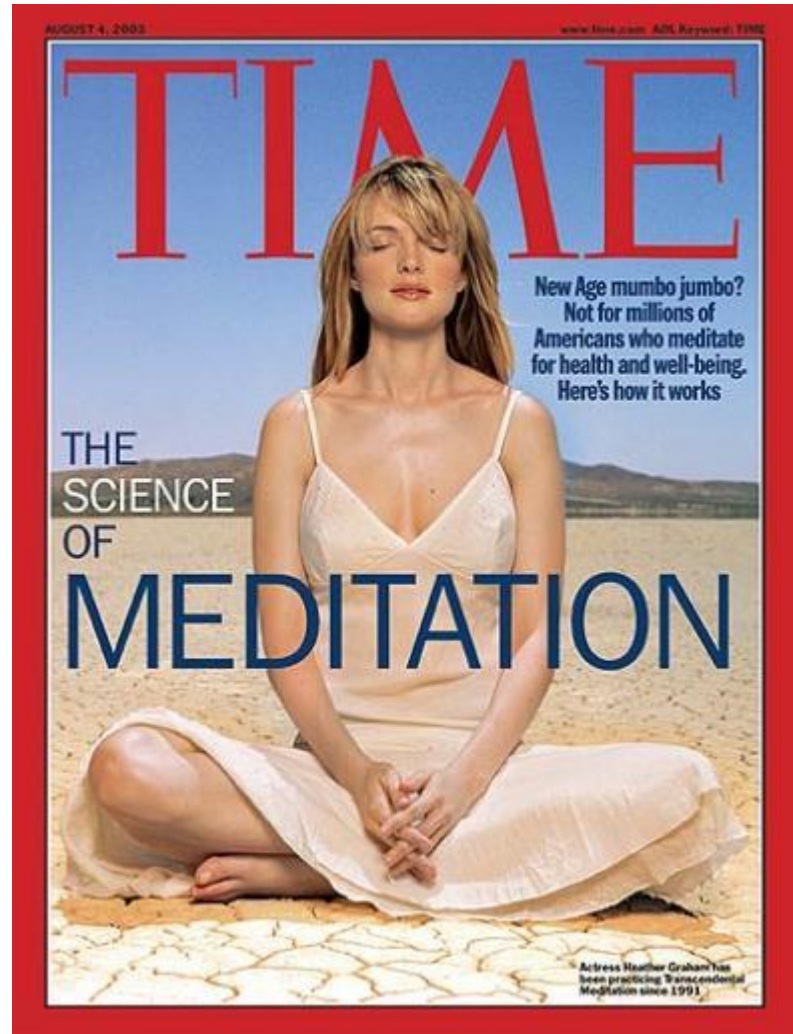
Rest-or-digest response



Meditation

PNS can be activated by meditation

- slowing down of the heartbeat
- lowering of blood pressure
- constriction of the pupils
- increased blood flow to the skin and viscera
- peristalsis of the GI tract
- 副交感神經主導的膽鹼素路徑（cholinergic pathway）可以降低細胞素並抑制不當的發炎反應，使免疫反應達到平衡的狀態。



Seasonal Affective Disorder (SAD)

- According to the National Institute for Mental Health, approximately 10% of Americans currently suffer from SAD and related disorders.
- SAD is a disorder characterized by drastic mood swings and depression that occur during the fall/winter months and diminish in the spring.
- SAD sufferers have the following symptoms :
Depression, Feeling "out of sorts", Irritability, Increased appetite, Weight gain, Excessive sleeping, Decreased energy & interest, Inability to concentrate
- SAD can be relieved by reducing melatonin in brain through Light therapy (1980, Alfred Lewy)

Light Box for SAD, jet lag and shift work fatigue

BRIGHT LIGHT BOX

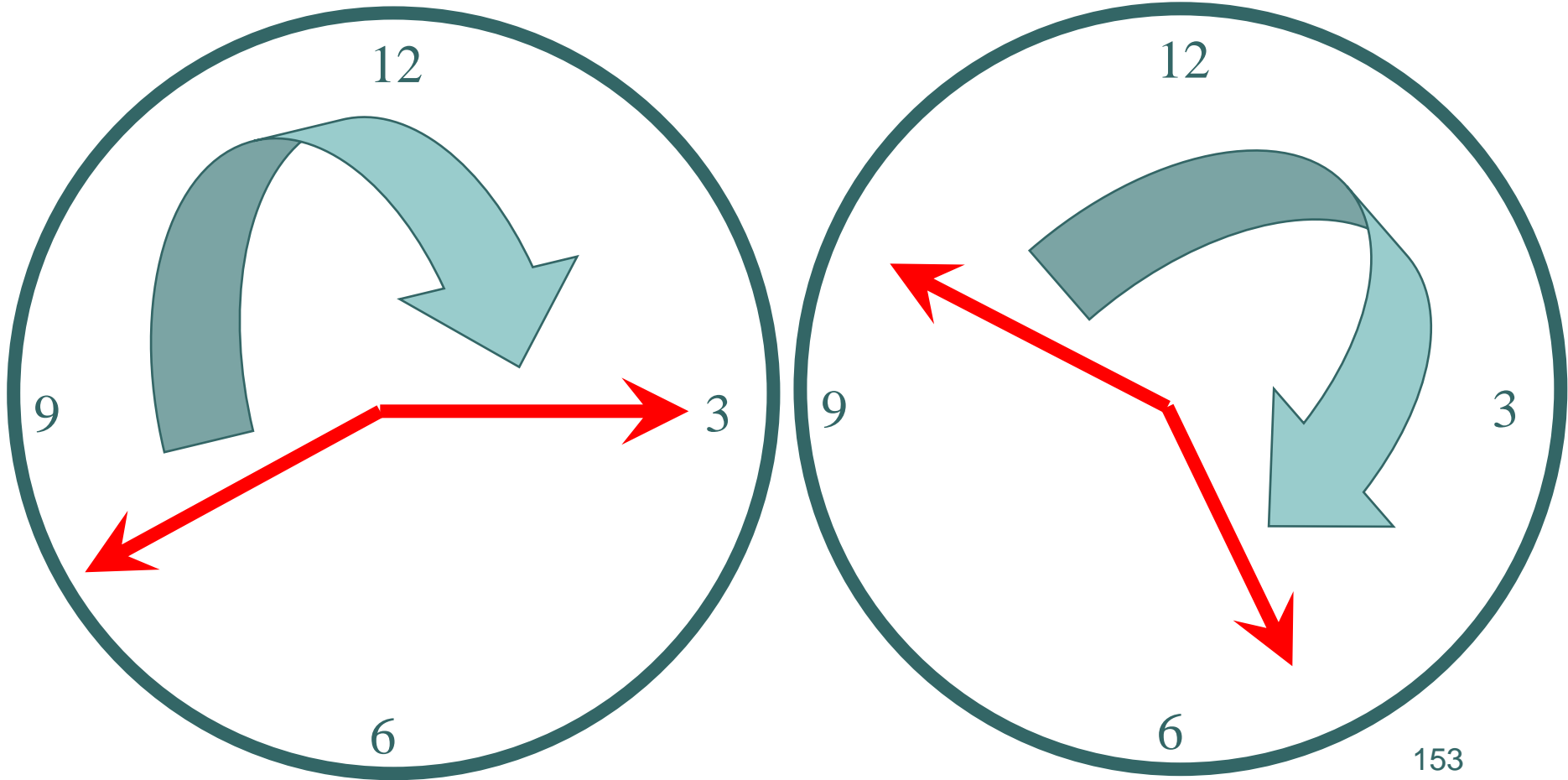


NEW!
33% Brighter
and with
Built-In Timer

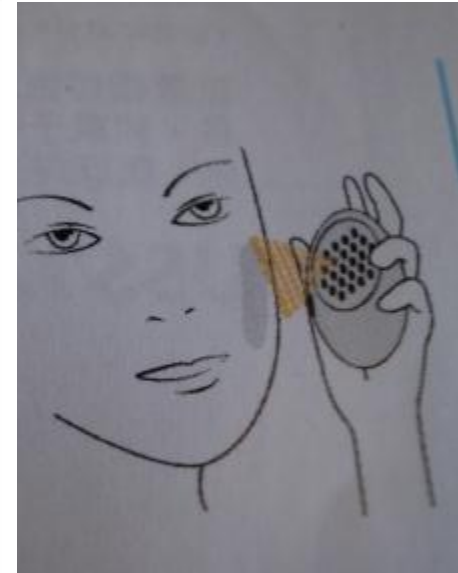
SUNSHINE SIMULATOR[®]

Although our lives, health and well-being are dependent upon the sun, most of us do not get enough sunshine everyday. Bright light is used for alleviating symptoms associated with seasonal affective disorder (SAD), jet lag, shift work fatigue, seasonal change and insomnia. Get your daily "dose" of sunshine and boost your body's sense of well-being, alertness and energy with the HappyLite Plus Sunshine Simulator.

Biological Clock



LED Photomodulation





Acne

- 3 months treatment with Blue and Red light combine to cure acne vulgaris.
 - **Blue (415nm): anti-bacterial**
 - 4.23 mW/cm², 15 min/day, in total 320 J/cm²
 - **Red (660 nm): anti-inflammatory**
 - 2.67 mW/cm², 15 min/day, in total 202 J/cm²

British Journal of Dermatology , 2000:142:973-978

青春痘最新療法 紅藍光

痤瘡桿菌的剋星!!



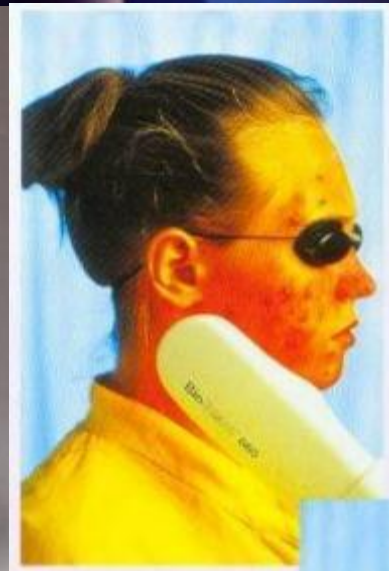
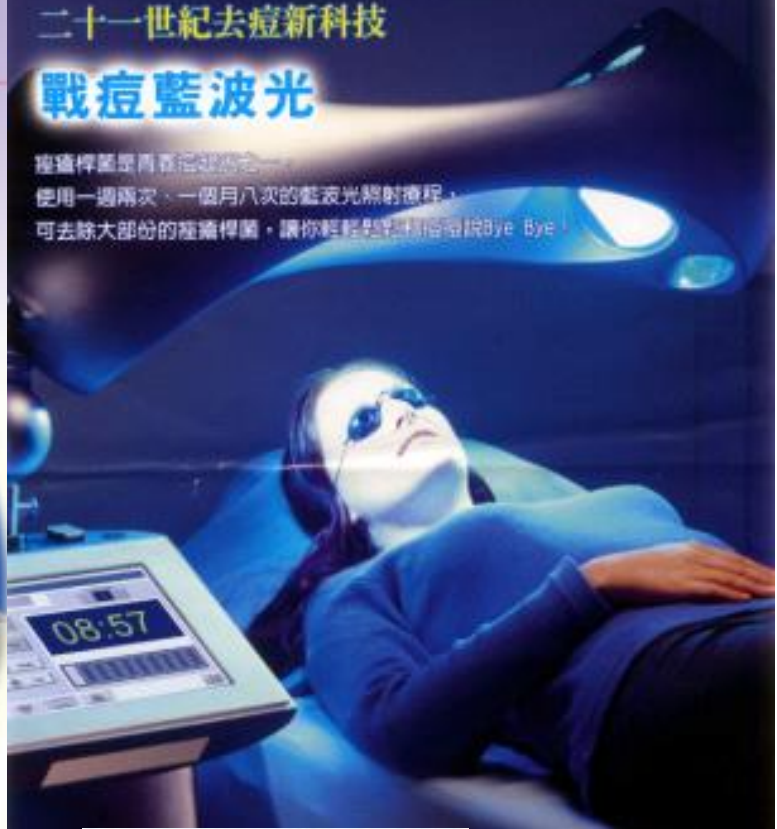
西元2000年，英國哈姆史密斯醫師，首先推出了結合紅藍光的青春痘照光機，使用波



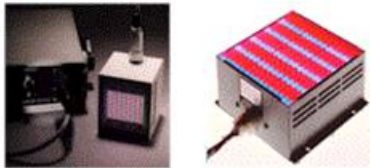
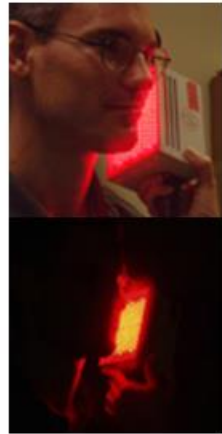
二十一世紀去痘新科技

戰痘藍波光

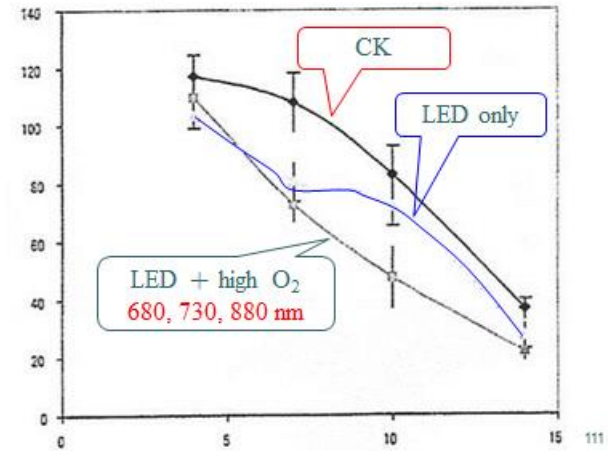
痤瘡桿菌是青春痘的剋星，使用一週兩次、一個月八次的藍波光照射療程，可去除大部份的痤瘡桿菌，讓你輕輕鬆鬆和痘痘說Bye Bye!



Red and Far-red enhance cell recovery



Relative speed of Wound healing



BioBeam 660



糖尿病患傷口潰瘍



褥瘡性潰瘍



單純性皸瘡



手術後的傷口



截肢切除的傷口

112

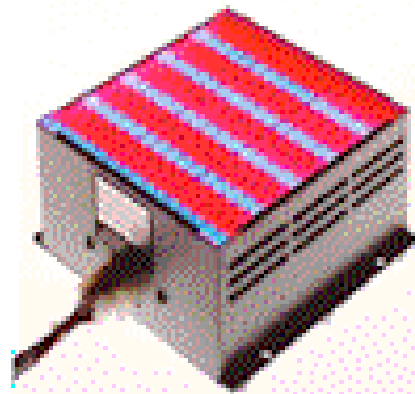
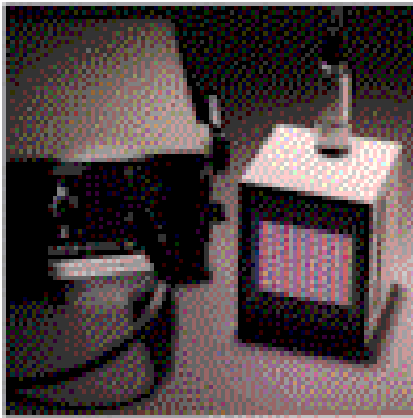
BioBeam 940

- 退化性關節炎
- 慢性肌腱炎
- 網球肘
- 風濕性關節炎
- 背痛
- 五十肩

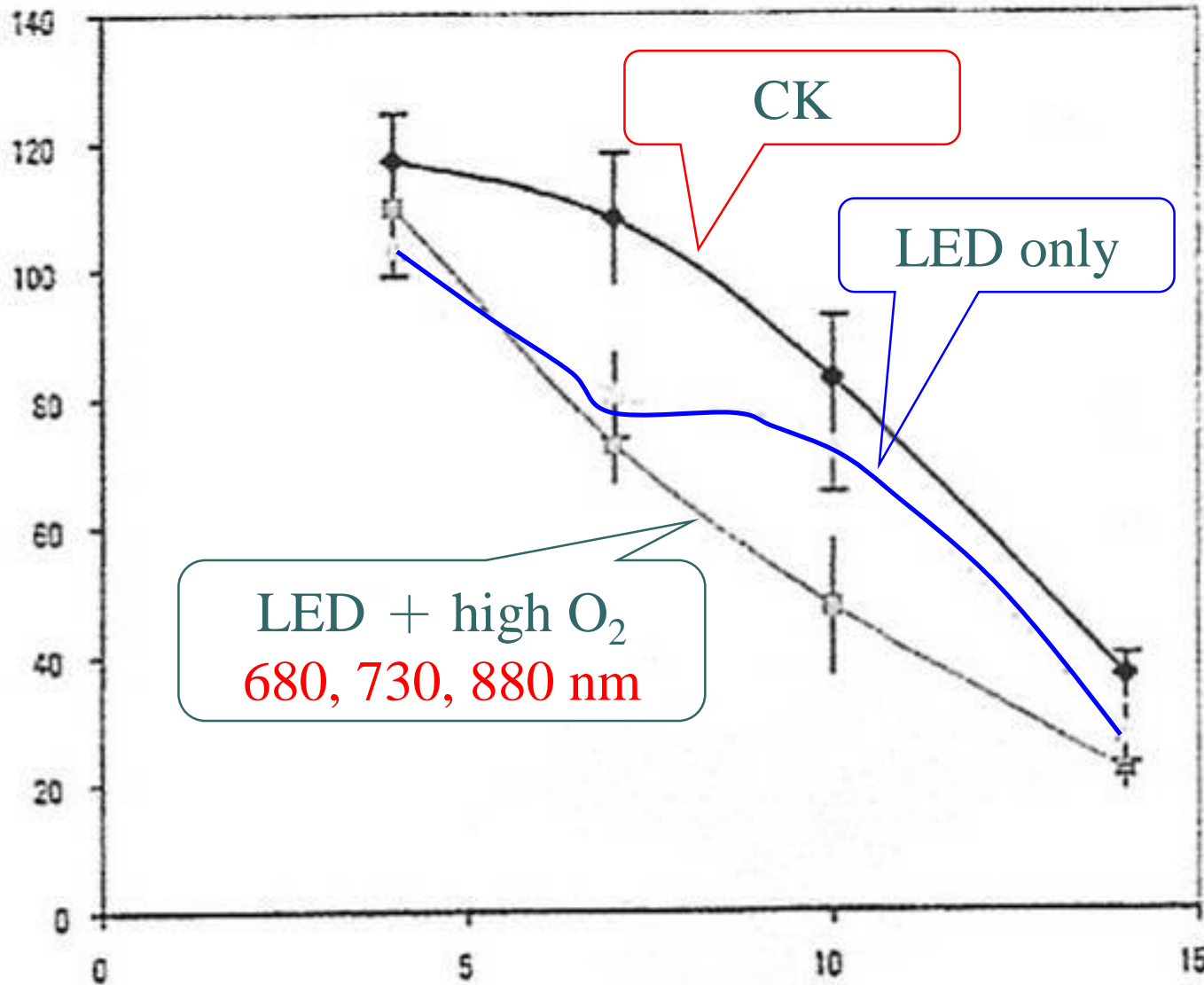


113

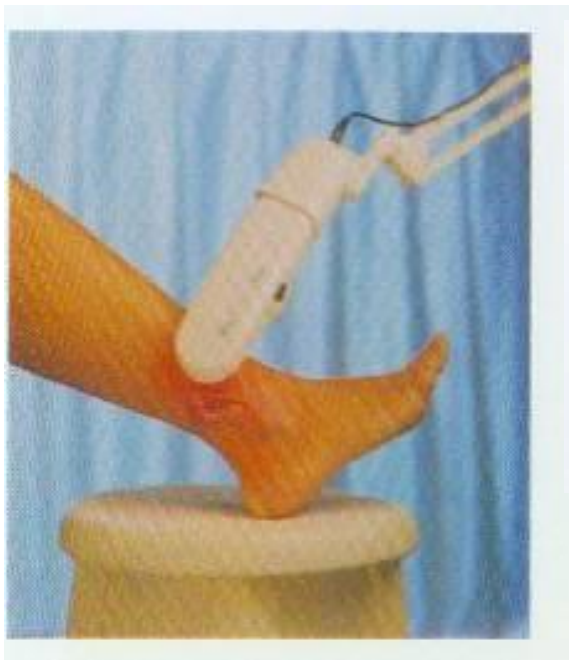
Red and Far-red enhance cell recovery



Relative speed of Wound healing



BioBeam 660



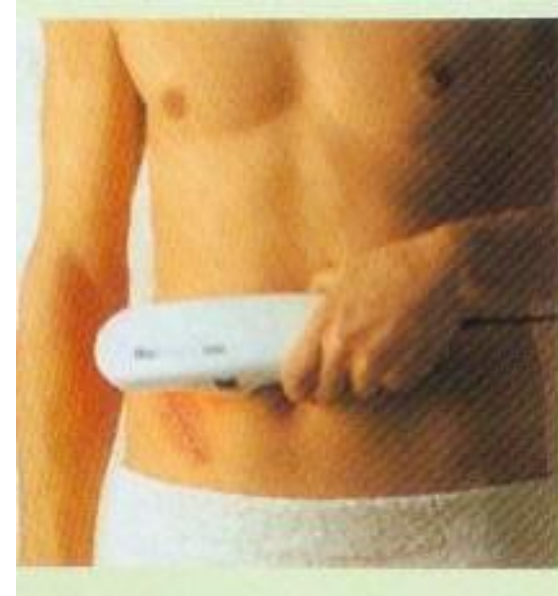
糖尿病患傷口潰瘍



褥瘡性潰瘍



單純性皰疹



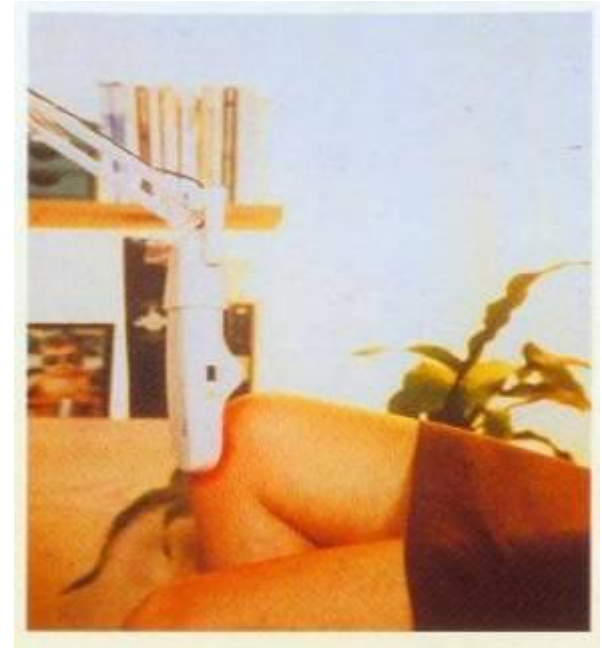
手術後的傷口



截肢切除的傷口

BioBeam 940

- 退化性關節炎
- 慢性肌腱炎
- 網球肘
- 風濕性關節炎
- 背痛
- 五十肩



BIONase

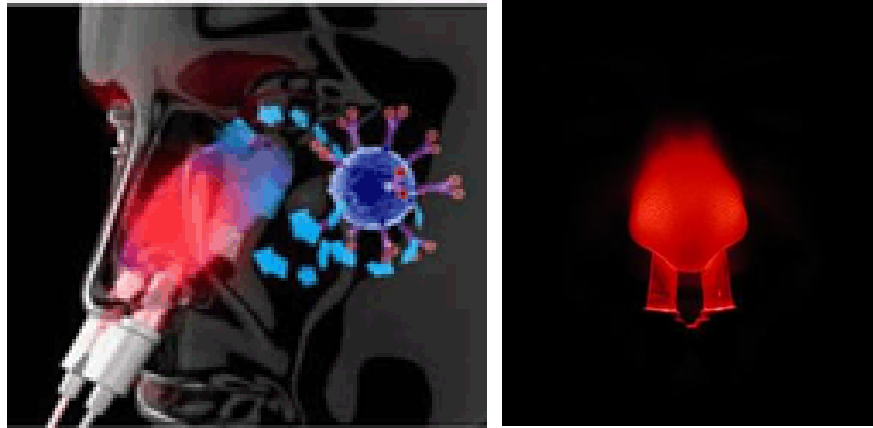
660 nm

- allergic rhinitis

過敏性鼻炎

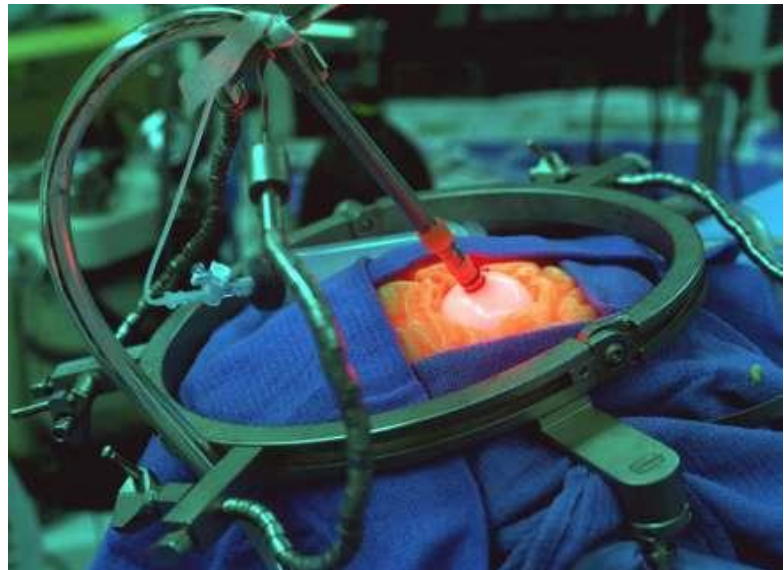
- Hay fever

花粉熱



Photodynamic Therapy (PdT)

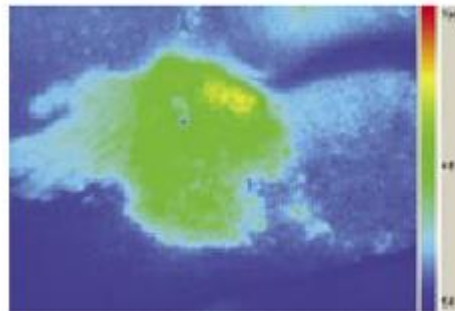
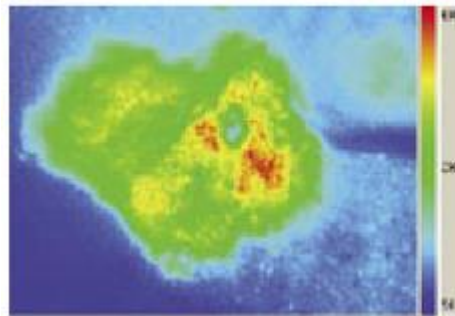
- Photofrin + Light
- To cure cancer and more
- Skin cancer can be cured by PdT



PdT for skin cancer



5 treatments



6 treatments

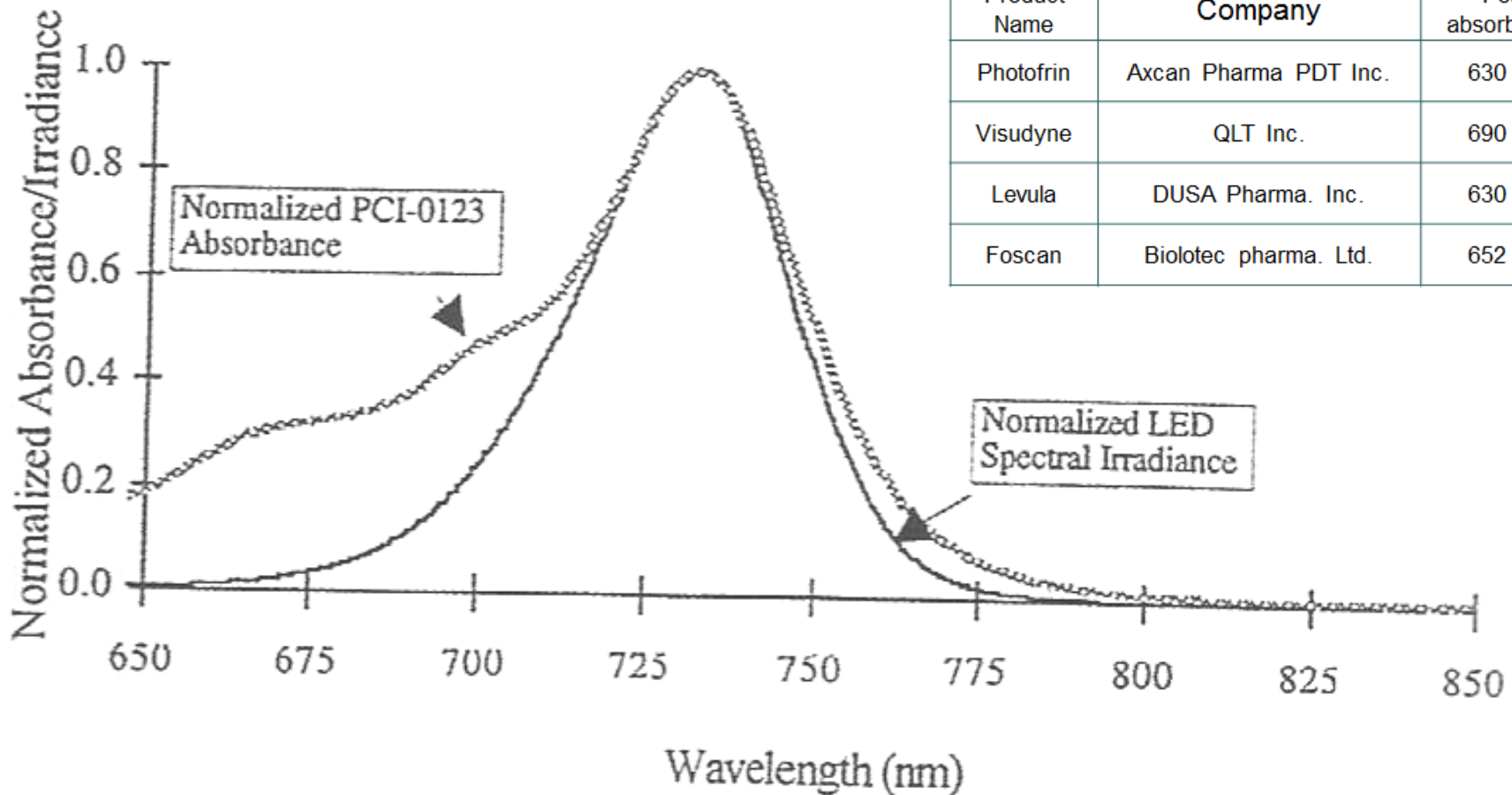
- Bowen's disease 皮膚 Bowen 氏症(原位癌)
- Actinic keratosis 日光角化症(前期癌)
- Actinic cheilitis 日光唇炎(前期癌)
- Basal cell carcinoma (基底細胞癌)
- Squamous cell carcinoma (鱗狀細胞癌)
- Cutaneous T-cell lymphoma (皮膚 T 細胞淋巴瘤)

PdT for other illness

- Age-Related Macular Degeneration
(老人退化性黃斑症)
- Coronary Artery Occlusion
(心臟冠狀動脈阻塞)
- Rheumatoid Arthritis
(類風濕性關節炎)
- Psoriasis (乾癬症)

Photosensitive pigment PCI-0123 absorbance peak @ 732 - 735 nm

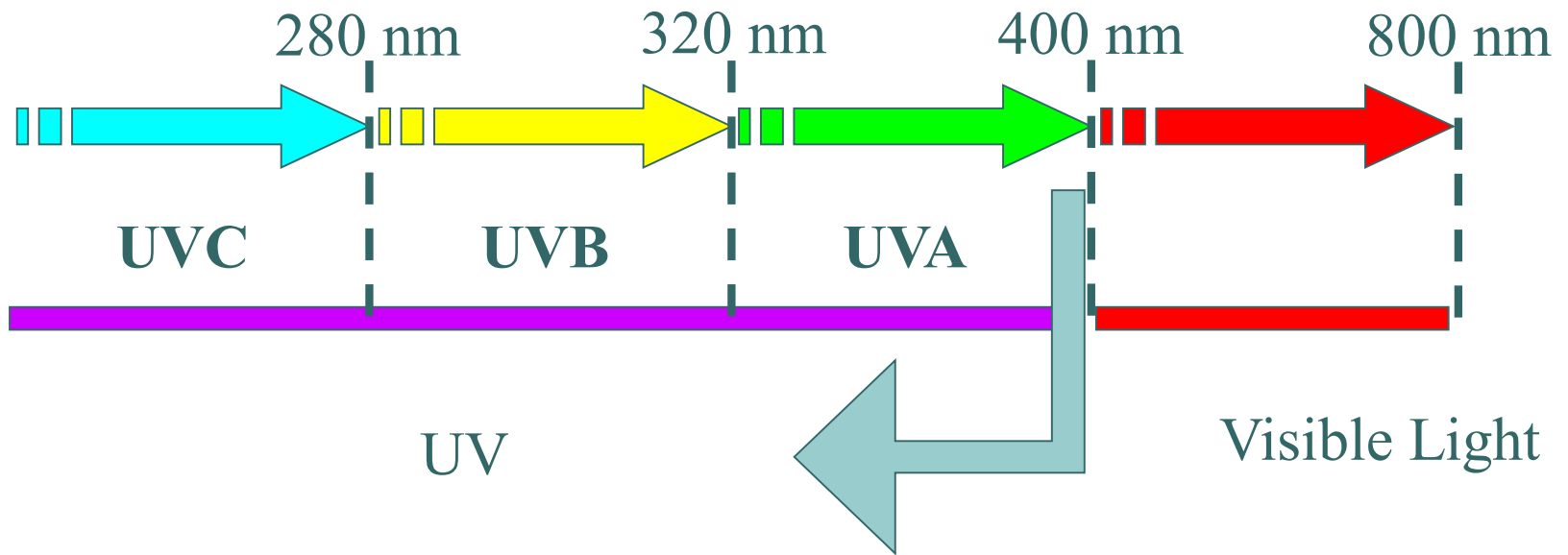
Photosensitive pigment



Photosensitive pigment

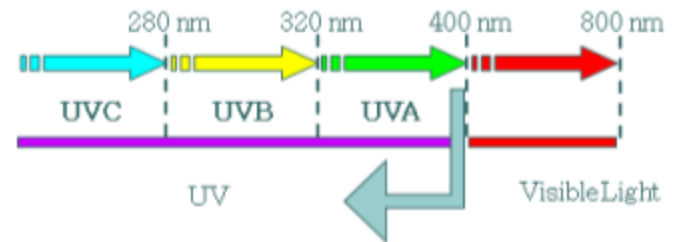
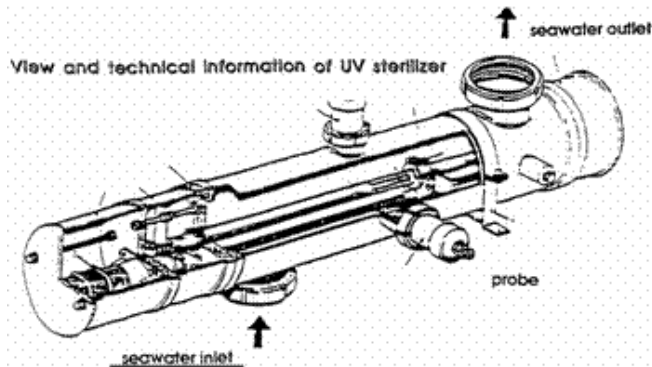
Product Name	Company	Peak absorbance
Photofrin	Axcan Pharma PDT Inc.	630 nm
Visudyne	QLT Inc.	690 nm
Levula	DUSA Pharma. Inc.	630 nm
Foscan	Biotech pharma. Ltd.	652 nm

UV A,B,C

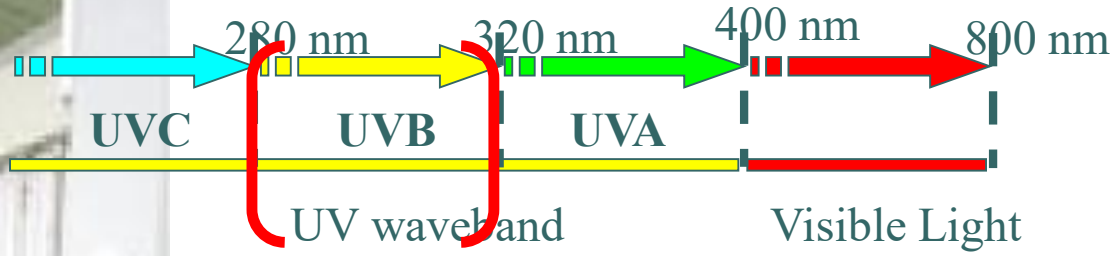


UVC for water disinfection

(菌種)	(劑量) DOSE	(菌種)	(劑量) DOSE
Bacillus anthracis 炭疽桿菌	45.2	Staphylococcus albus 白色葡萄球菌	18.4
S.enteritidis 沙門氏腸炎桿菌	40	Staphylococcus aureus 金黃色葡萄球菌	26
B.megatherium sp.(veg.) 巨大牙胞桿菌	13	Streptococcus hemolyticus 溶血性鏈球菌	21.6
B.megatherium sp.(spores)	27.3	Streptococcus lactus 乳鏈球菌	61.5
B.parathyphosus	32	Streptococcus viridans 綠色鏈球菌	20
B.suhtilis	71	Saccharomyces ellipsoideus 橢圓形釀母菌	60
B.suhtilis spores	120	Saccharomyces sp. 黃酒釀母菌	80
Corynebacterium diphteriae 白喉棒狀桿菌	33.7	Saccharomyces cerevisiae 啤酒釀母菌(麵包 酵母菌)	60
Eberthella typhosa 愛倍德氏傷寒桿菌	21.4	Brewers' yeast 啤酒釀母菌	33
Escherichia coli 大腸桿菌	30		



UVB



311 nm



Conclusion

Only part of the applications in Bio-Industry were mentioned.

With the help of **L**ight-**E**mitting **D**iode,
maybe OLED / LET later,

we can **L**ight up **E**co-friendly **D**ream.

This is part of the **L**ife **E**volution **D**esign.



Thank you for your attention!

