OZONUV CANNABIS

Green Health Colombia

Producción **eficiente,** sostenible y con **responsabilidad social,** contruyendo la mejor **reputación empresarial** del sector

OZONUV Tecnologías en Desinfección

OZONUV Tecnología Limpia en Desinfección

P2G PARTNERS TO GROW

BIENVENIDOS A PARTNERS 2 GROW

OZONUV -TECNOLOGÍA EN

RADIACIÓN UVC PARA DESINFECCION EN PROCESOS INDUSTRIALES Y AGROINDUSTRIALES

Servicios con RPA´s (Drones)

FOTOGRAMETRÍA E INGENIERÍA CON DRONES

TECNOLOGÍA SOLAR Y LED

SISTEMAS LED DE ALTA INTENSIDAD

Somos una empresa Colombiana especializada en manejo de proyectos y tecnologías limpias, tenemos experiencia en procesos industriales, acompañados de un grupo profesional multidisciplinario especializado con experiencia nacional e internacional, contamos con licencia de salud ocupacional registrada ante el ministerio de salud para diseñar y ejecutar protocolos en Sistemas de seguridad, medio ambiente y Salud y somos miembros de la Asociación Internacional Ultravioleta

- Diagnósticos de acuerdo a las necesidades de su proceso
- Certificamos los efectos UVC y ozono con instrumentos certificados
- Disponemos de laboratorios de microbiología asociados
- Asesoría en normatividad y protocolos
- Desarrollos soluciones con ingeniería sin afectar su presupuesto
- Diseñamos y fabricamos los equipos de acuerdo a su necesidad

Asociación Colombiana de Industrias de Cannabis asocolcanna

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OZONUV ULTRAVIOLETA Y OZONO By P2G

P2Grow es una empresa colombiana registrada en la Cámara de Comercio de Bucaramanga. Contamos con un **portafolio especializado en soluciones sostenibles de ingeniería** con base en análisis de procesos y aplicación de tecnologías innovadoras limpias, sin químicos para aportar en la producción orgánica en la agroindustria y plantas de cultivo de cannabis.

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OZONUV
Tecnología Limpia en Desinfección

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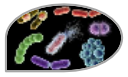
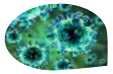
ENFERMEDADES

Bacterias



Virus

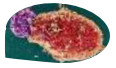


O3 -AIRE

O3 -AGUA

AIRE AGUA

SUPERFICIES



Protozoos

Hongos

UVC -AIRE

UVC - AGUA

Mal olor

CE´s

UVC SUPERFICIES

OZONUV

Las enfermedades son una combinación que hace parte de los en elementos básicos de la producción: El agua, el aire y las superficies. Por lo general, solo se necesita una combinación letal de mala ventilación, flujo de aire pobre, condiciones húmedas y calientes, malas prácticas de trabajo para que las esporas de los hongos se formen y dispersen

REPORTES CIENTÍFICOS

The Journal of Animal & Plant Sciences, 30(5): 2020, Page: 1082-1091
ISSN (print): 1018-7081; ISSN (online): 2309-8694

REVIEW ARTICLE

APPLICATION OF ULTRAVIOLET C IRRADIATION FOR THE INCREASED PRODUCTION OF SECONDARY METABOLITES IN PLANTS

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ABSTRACT

Ultraviolet C (UV-C) irradiation is an excellent method for the induction of secondary metabolites in many plants. Thus far, various types of secondary metabolites have been induced by the application of different doses of UV-C irradiation

CANNABIS GROW FACILITIES

FEATURED ARTICLE

Opportunities for Application of UV-B and UV-C Devi in Cannabis Grow Facil

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partner,
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There are several potential opportunities for manufacturers of UV LED devices specifically targeting improved crop yield, product quality and product safety within the cannabis industry. To better identify these potential applications, one needs to understand what negatively impacts agricultural crops in general and cannabis crops specifically. Mold and bacteria attack and destroy plants and, in many cases, decimate entire crops. Microorganisms cause more crop loss than all other organisms combined.[2] It is estimated there are more than 8,000 species of mold that affect plants.[3]

Cannabis crops are highly susceptible to damage caused by microorganisms. The most common losses are attributed to mold, with the most problematic species being *Botrytis cinerea* or "gray mold" and *Sphaerotheca macularis* or "powdery mildew." Agricultural practices have historically used fungicides, such as demethlation inhibitors (DMI) and sterolbiosynthesis inhibiting (SI), to protect crops from pathogenic mold.

The negative impact from the use of chemicals, in addition to extra costs, can include plant stress, pathogen resistance to chemical treatments and interference with biocontrol of diseases that are kept in check by naturally occurring microflora. More importantly, they are not eco-friendly. There is a movement within the cannabis growing industry to develop more sustainable and eco-friendly agricultural practices, with the intention of

look at the links in the chain where these microorganisms are introduced. Once the chain is established, protocols and technology can be applied to break the chain of poor yields and unsafe product. For this, there are three points of critical process: the growing room, postharvest drying room and product storage facility (Image 2).

At each critical point in the process the suggested potential solutions are as follows:

1. Growing room
   - UV-C for growing room's heating, ventilation and air conditioning (HVAC)
   - UV-B for direct exposure to cannabis plants
2. Postharvest cannabis bud drying rooms
   - UV-C for drying room's heating, ventilation and air conditioning (HVAC)
   - UV-C for direct exposure of drying room's surfaces and drying cannabis buds
3. Finished product storage
   - UV-C for storage room's heating, ventilation and air conditioning (HVAC)

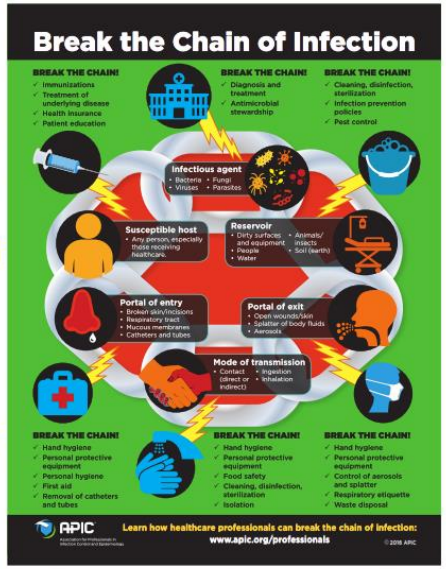

Image 1. This infographic shows the chain of infection. Image courtesy of APIC.

Growing rooms

Climatic conditions within cannabis growing rooms are ideal for the reproduction and spread of pathogenic mold and bacteria (Image 3). The humid conditions found in these environments helps proliferate the growth of pathogens on plants and surfaces. Once a plant becomes infected, the mold will release spores into the air where air movements from the ventilation/air conditioning systems can spread spores to other plants rapidly.

In addition to the spread of spores, the HVAC system further compounds the problem with the development of an internal biofilm that proliferates at the condensate cooling coils and filters. This, in turn, becomes a significant reservoir of mold. If left untreated, the ventilation system will continuously grow mold, spread its spores within the growing room and potentially infect and decimate the entire crop. Many of the microorganisms cultured from the HVAC systems of cannabis growing facilities are threats to their crops (Table 1 and Image 4).

The suggested steps to reduce the growing room microbial pathogens are two-fold. The first deals with treating the air delivered by the room's HVAC system with UV-C. The application of UV-C in HVAC has become an accepted and

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UV AND PLANT VACCINES

FEATURED ARTICLE

UV Technology Lights the Way to Plant Vaccines: Boosting Plant Defenses to Extend Shelf Life of Fruits and Vegetables

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As scientists and companies rush to find a vaccination for SARS-CoV-2, there is an emerging field of modulating plant defenses to protect against plant pathogens that lead to crop failure or premature spoilage. Traditionally, plant protection during preharvest is via applying pesticides and to keep pathogens at bay. At postharvest, attempts are made to reduce the spoilage microflora via washing coupled with maintaining optimal storage conditions (Ali et al. 2018).

Yet, plants have developed defense systems to protect against invasion by would-be pathogens that could be exploited to extend the shelf life in a natural way. Several biological, chemical and physical approaches to modulating plant-defense mechanisms fall under the term *hormesis*, which is derived from Greek for "to set in motion." Essentially, hormesis is applied to describe a process that, when administered at a low dose, will elicit a protective effect – that is, what doesn't kill you makes you stronger.

There are several biological, chemical and physical approaches to modulating plant-defense mechanisms that fall under the term *hormesis* that is derived from Greek for "to set in motion."

stresses (sun, heat, draught). Obviously, the defense systems in plants are very different than those of humans, although in some ways they are similar in terms of different levels of activation. Specifically, plants have an innate defense system that is constitutive and includes physical barriers (for example, cell walls, waxy coating), in addition to antimicrobials, such as essential oils.

The second layer of defense is the localized induced resistance (LIR) that functions to defend against

Figure 2. Visual appearance of strawberries that had been treated with gas-phase advanced oxidation process (1.5% hydrogen peroxide, UV-C 64 kJ/cm² and ozone) then stored at 4°C for 15 days. For comparison, untreated strawberries were stored in parallel.

UV-C, although it should be noted nucleic acids of plants also can be affected, leading to negative effects on plant health.

The effect of UV-C on inducing plant defenses remains to be elucidated, and there is debate if it follows UV-B or is distinct (Zhang and Jiang 2019). It has been reported that the same ROS burst, along with up regulation of redox enzymes and induction of SAR, occurs with UV-C exposure as with UV-B (Arrouft and Urban, 2020).

However, unlike UV-B, the duration of UV-C is measured in seconds rather than days. From studies performed to date, the UV-C intensity is more critical than the total dose, with 1 kJ/m² being effective. In addition, plants also need to be held for a four-hour dark period following the UV-C exposure (Janisiewicz et al. 2016).

By applying the UV-C treatment to tomatoes or lettuce inoculated with *Botrytis cinereal*, it was possible to reduce lesion formation by the plant pathogens by 35% and 17% respectively (Arrouft and Urban, 2020). In a further example,

Indeed, there is evidence that UV-C inhibits mold spore germination, thereby effectively making the microbe nonviable (Zhu et al. 2019). It is theorized that the four-hour holding period following UV-C exposure prevents photo-repair of damaged DNA, although the mechanism remains unclear (Takeda et al. 2019). One can envision that future research likely will discover the mildew-protecting effect is a combination of UV-C mediated physiological changes in plants and mildew causing mold.

UV-C treatment of crops (strawberries, tomatoes, basil, lettuce) to control mildew is being researched in Europe, Florida and California, with a view of eliminating, or at least reducing, the use of chemical fungicides. Similar to UV-B, overexposure of plants to UV-C results in detrimental effects, with doses >230 J/m² or excessive treatment repetitions, resulting in damage, delayed flowering and stunted growth. The overdosing effect of UV-C is more critical compared to UV-B, although it is likely to depend on plant type and physiological condition.

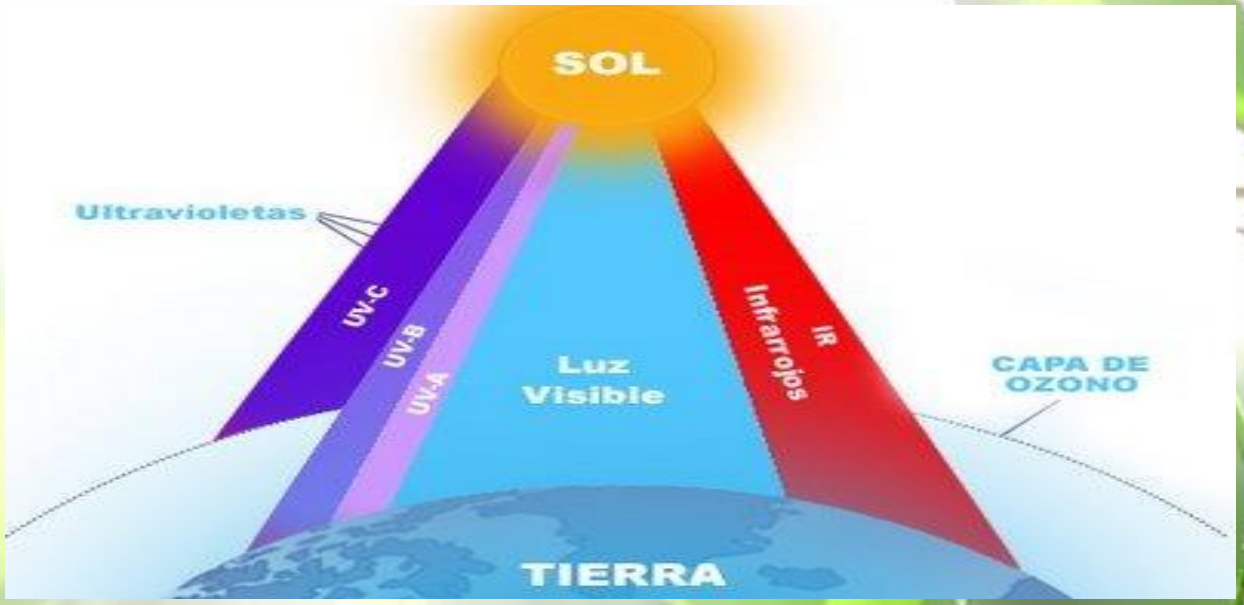
Postharvest UV-B and UV-C treatment

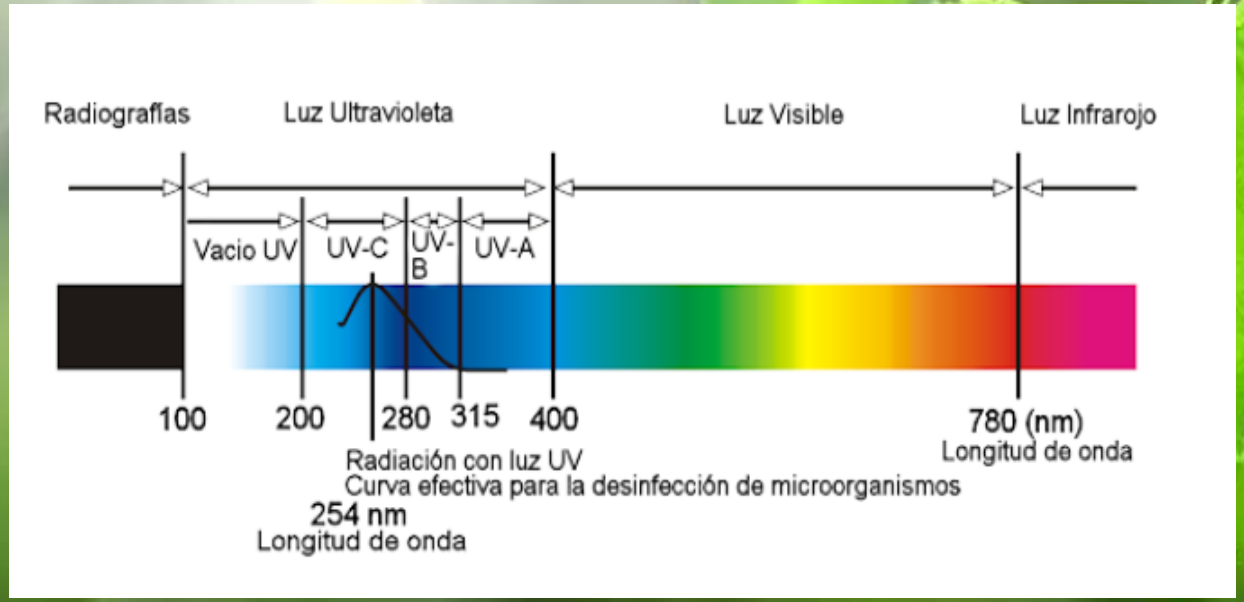
There have been relatively few studies of the effect of UV-B on postharvest of fresh produce, probably due to the long exposure times required. However, studies have been performed with UV-C, both in terms of microbial inactivation and effect on plant physiology.

With regard to the latter, it has been demonstrated that spinach plant exposure to UV-C (1.5 kJ/m²) immediately before harvest increased the antioxidant content and shelf life at postharvest (Martinez-Sanchez et al. 2019). In a similar manner, preharvest apples exposed to UV-C had enhanced malic acid dehydrogenase activity and reduced concentration of malate (sharp apple flavor) during storage (Onik et al. 2019).

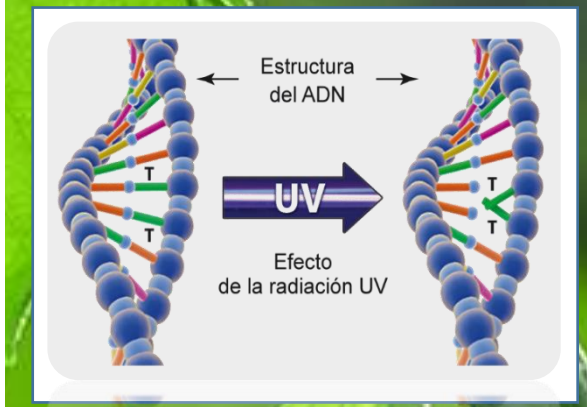
UV light has been shown to increase the rate of ripening in banana, tomato and citrus fruit (Hu et al. 2019). The increase

PRINCIPIOS RADIACIÓN ULTRAVIOLETA



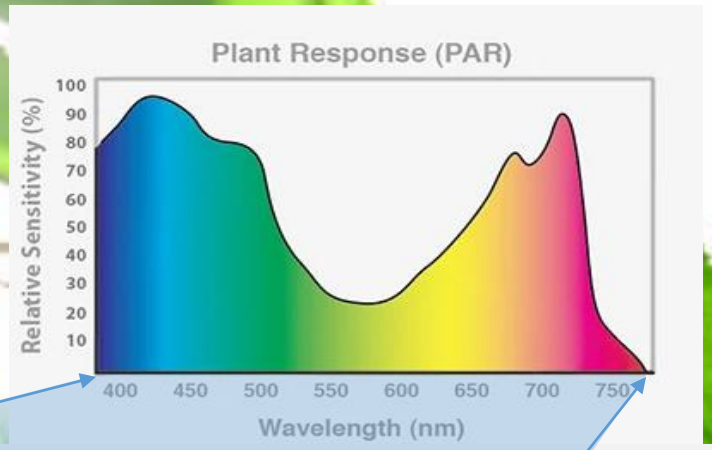


Sin UVC CON UVC



Typical LD90 Doses*	[mJ/cm²]
Viruses	
PRRS Virus	1,8
Influenza A Virus	2,1
Herpes Virus	4,3
Hepatitis A Virus	6,7
Rota Virus SA11	7,5
Bacteria	
Campylobacter spec.	2,2
Legionella spec.	2,3
Escherichia coli	2,5
Salmonella spec.	4,3
Pseudomonas spec	4,5
Streptococcus spec.	4,5
Staph. Aureus	4,8
Listeria spec.	5,0
Bacillus subtilis (Sp.)	6,8
Yeasts	
Saccharomyces. Ellip.	3,5
Sacch. Cerevisiae	6,2
Sacch. Carlsbergensis	7,5
Candida albicans	11,0
Mold spores	
Penicillium roquefortii	13
Mucor mucedo	18
Penicillium digitatum	38
Aspergillus glaucus	44
Aspergillus niger	98

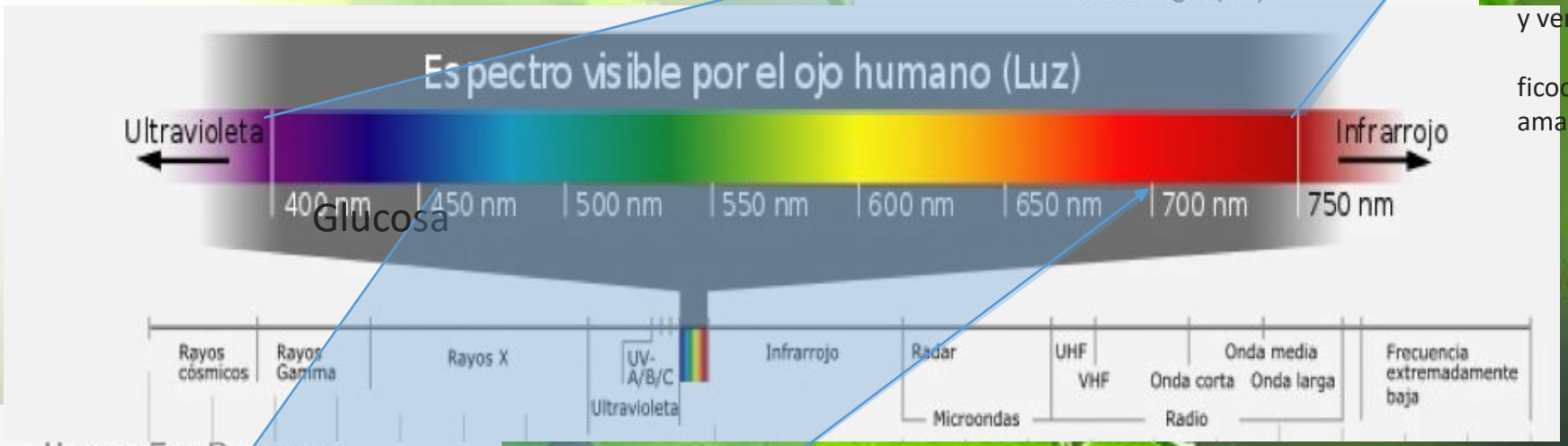
Esta imagen muestra por un lado la respuesta fotópica que percibimos los seres humanos y por otro lado el **PAR**, la **radiación activa fotosintética** dentro del rango de absorción de las plantas

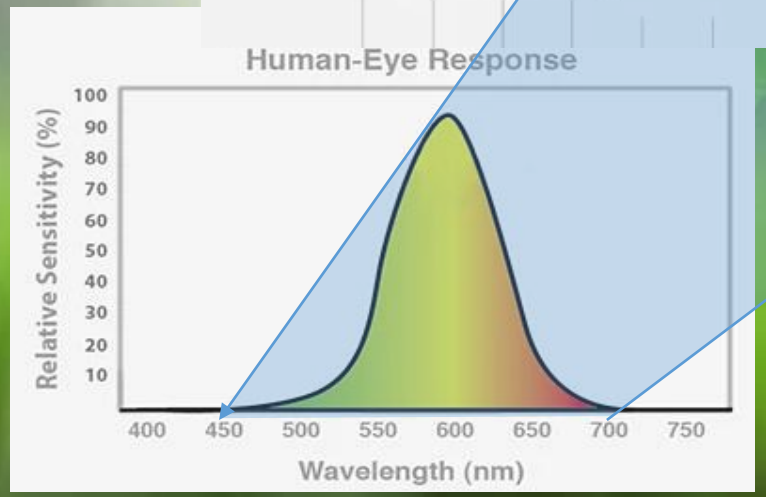


Clorofila absorbe luz violeta, azul y roja y produce el verde

Carotenoides (Vit A) absorben luz azul y verde y produce el naranja y rojo

ficocianinas absorben luz verde y amarilla y produce el azul





Glucosa

48 Fotones

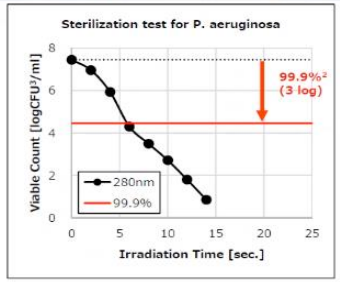
Luz + agua + dióxido de carbono

Hidrògeno + Carbono + Oxìgeno

1 mol Glucosa

Part No. NCSU334A
Sterilization Test (P. aeruginosa/280nm)

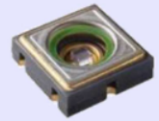
Part No.			NCSU334A	Unit
Wavelength Rank			280	nm
Test Condition	Number of LED		1	pc.
	I_F		350	mA
	Peak Wavelength		280	nm
	Radiant Flux		59	mW
	Working Distance		50	mm
Irradiation[1] Time	Gram Negative Bacteria	E. coli	14	sec.
		P. aeruginosa	6	
	Gram Positive Bacteria	S. aureus	11	



Note: This data has been tested by an external agency.
[1] Irradiation time for 99.9% sterilization.
[2] 3 log (10^3) decrease = 99.9% sterilization
[3] CFU = Colony Forming Unit

Irradiation Time	0 sec. (10,000 dilution)	2 sec. (10,000 dilution)	4 sec. (10,000 dilution)	6 sec. (10,000 dilution)	8 sec. (10,000 dilution)
P. aeruginosa Peak Wavelength 280nm Radiant Flux 59mW					

Note: This data is a reference value, hence Nichia cannot make guarantee these results. Please treat this data the as reference.

U280	6.8x6.8mm Package	3.5x3.5mm Package
Super High Power	Upcoming 4in1 Package	
High Power	 Part No. NCSU334B 70mW I_F=350mA	Upcoming
Middle Power		 Part No. NCSU434A 17mW I_F=100mA

OZONUV® Tecnología Limpia en Desinfección

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Independent 3rd Party Disinfection Tests

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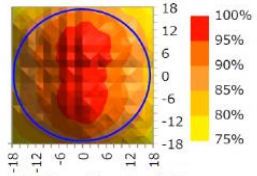
UV Dose for 99.9% Sterilization

Part No.	Peak Wavelength [nm]	Number of LED [pc.]	Radiant Flux [mW]	Working Distance [mm]	Peak Irradiance [mW/cm²]	Types of Bacteria	Irradiation Time [sec.]	UV Dose[1] [mJ/cm²]
NCSU334A	280	1	59	50	0.5	E. coli	14	7
						P. aeruginosa	6	3
						S. aureus	11	6
			58	50	0.5	B. atrophaeus	30	15
						A. brasiliensis	900	450

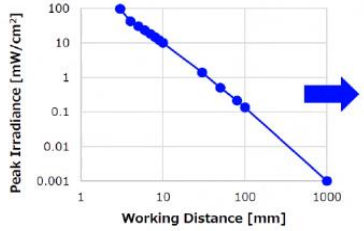
[1] UV Dose [mJ/cm²] = Peak Irradiance [mW/cm²] × Irradiation Time [sec.]

Distribution of Irradiance



Note: Inner Diameter of 35mm

Peak Irradiance Simulation Result (NCSU334A U280 1pc. @350mA)



Estimated Irradiation Time[2] for 99.9% Sterilization (NCSU334A U280 1pc. @350mA)

Types of Bacteria	Estimated Irradiation Time for 99.9% Sterilization [sec.] (For each Working Distance)							
	3 mm	5 mm	10 mm	30 mm	50 mm	80 mm	100 mm	1000 mm
E. coli	0.1	0.2	0.7	5	14	33	52	7,000
P. aeruginosa	0.03	0.1	0.3	2	6	14	22	3,000
S. aureus	0.1	0.2	0.6	4	11	26	41	5,500
B. atrophaeus	0.2	0.5	2	11	30	71	111	15,000
A. brasiliensis	5	15	45	325	900	2,133	3,333	450,000

[2] Irradiation time was estimated based on the sterilization test results of NCSU334A U280 1pc. and the peak irradiance simulation result.

Note: This data is a reference value, hence Nichia cannot make guarantee these results. Please treat this data the as reference.

334 Deep Dive – Why 280nm?

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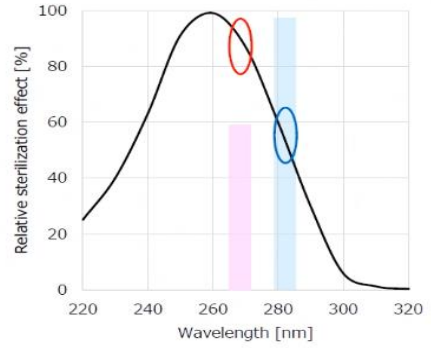
Sterilization Effect



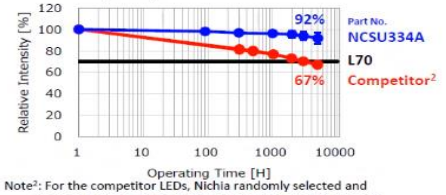
Sterilization Effect
280nm: 70mW x 60% = 42pt.
265nm: 40mW x 95% = 38pt.

Benchmark

Part No.	Nichia's NCSU334x	Competitor[1]
Peak Wavelength	280nm	265nm
I_F	350mA	350mA
Radiant Flux	70mW	40mW
V_F	5.5V	6.8V
Efficacy	3.6%	1.7%
Reliability	Major Advantage	

Note[1]: The value in right is based on a competitor's specification and adjusted to be the same conditions.

Test Condition: T_A=25°C, I_F=500mA



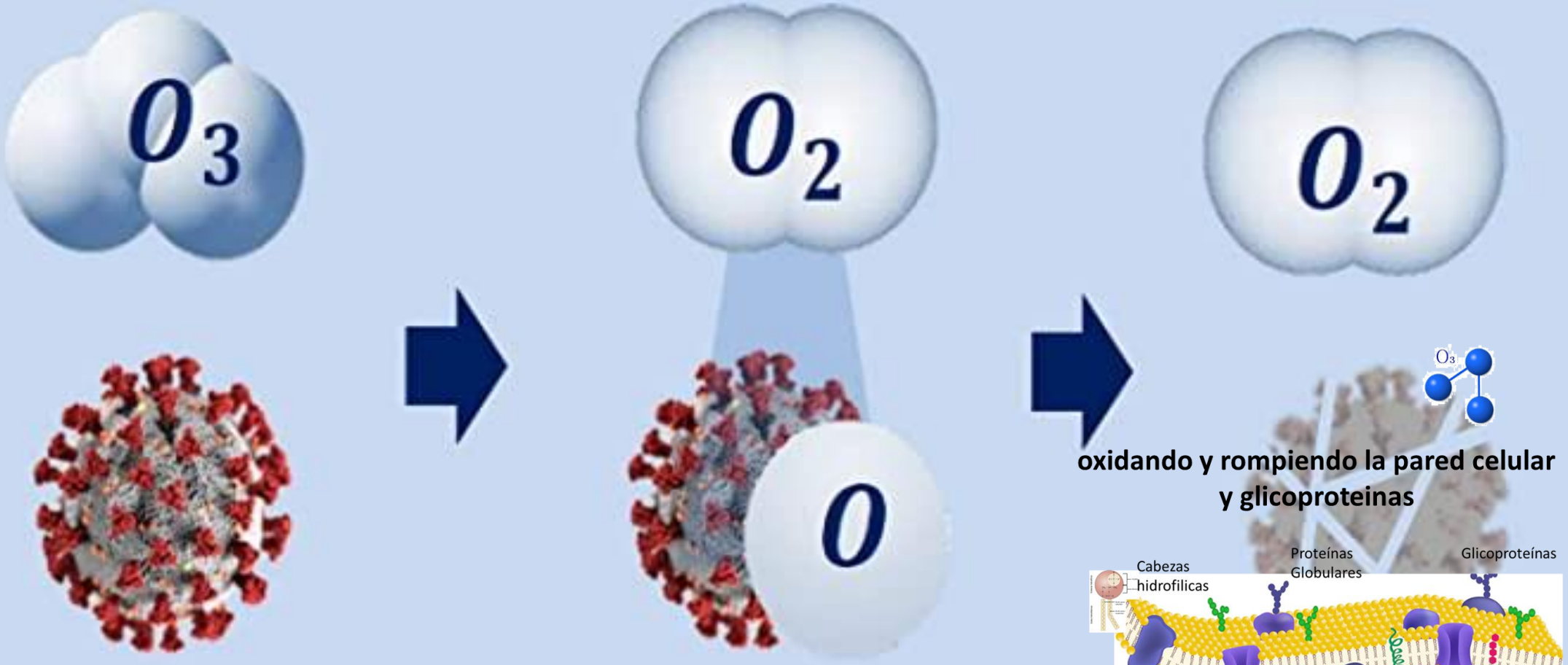
Note[2]: For the competitor LEDs, Nichia randomly selected and evaluated samples under Nichia's conditions/environments.

The sterilization effect of Nichia's 280nm is better than other commercially available 265nm LEDs. Additionally, the efficacy AND reliability are significantly better at 280nm vs. 265nm

Table 1. Summary of plant secondary metabolites induced by UV-C irradiation

PSMs	Source	Treatment Condition	UV-C elicitation dose	Induced by	References
Ergosterol	*Agaricus bisporus*	UV-C	14.71 kJ/m^2	3.31 fold	(Mau *et al.*, 1998; Taofiq *et al.*, 2017)
Resveratrol	*Vitis vinifera* cv. Beihong	UV-C	6 J/m^2	90 fold	(Wang *et al.*, 2015)
Trans-resveratrol	*V. vinifera* berry skin	UV-C	0.0025 J/m^2	355 fold	(Suzuki *et al.*, 2015)
Trans-resveratrol	*V. vinifera* cv. Okuzgozu calli	UV-C	25.2-57.6 kJ/cm^2	8 fold	(Cetin, 2014)
Resveratrol	*V. vinifera* cv. Napoleon	UV-C, stored at 0°C	510 J/m^2	10 fold	(Cantos *et al.*, 2001)
Total phenolic	*V. vinifera* cv. Okuzgozu calli	UV-C	25.2-57.6 kJ/cm^2	2.15 fold	(Cetin, 2014)
Total flavonol	*V. vinifera* cv. Okuzgozu calli	UV-C	25.2-57.6 kJ/cm^2	24.55 fold	(Cetin, 2014)
Flavonoid	Maradol papaya	UV-C, stored at 5°C and 14°C	1.48 kJ/m^2	2.5% and 26%	(Rivera-Pastrana *et al.*, 2014)
Flavonoids	*Capsicum annuum* L.	UV-C+SA	5.7 J/m^2	1.5-2 fold	(Mahdavian *et al.*, 2008)
Catechin	*V. vinifera* cv. Redglobe	UV-C, stored at 4°C	4.1 kJ/m^2	1.5 to 2 fold	(Crupi *et al.*, 2013)
Catechin	*V. vinifera* cv. Okuzgozu calli	UV-C	50.4-115.2 kJ/cm^2	7.28 fold	(Cetin, 2014)
Cis and *trans* piceid	*V. vinifera* cv. Redglobe	UV-C, 4°C	2.4 kJ/m^2	3 fold	(Crupi *et al.*, 2013)
Piceid	*V. vinifera* cv. Napoleon	UV-C, 0°C	17.8–23.0 J/m2	3 fold	(Cantos *et al.*, 2000)
Cyanidin-3-O-glucoside, peonidin-3 O-glucoside	*V. vinifera* cv. Redglobe	UV-C, 4°C	4.1 kJ/m^2	1.5 to 2 fold	(Crupi *et al.*, 2013)
Carthamin	*Carthamus tinctorius* L. cv. Benibana	UV-C, 23°C	50 J/m^2	13.9 fold	(Fukushirna and Saito, 2000)
Anthocyanins	*C. annuum* L.	UV-C+SA	5.7 J/m^2	2 fold	(Mahdavian *et al.*, 2008)
Rutin	*C. annuum* L.	UV-C+SA	5.7 J/m^2	3 fold	(Mahdavian *et al.*, 2008)
UV absorbing compounds	*C. annuum* L.	UV-C+SA	5.7 J/m^2	2 fold	(Mahdavian *et al.*, 2008)
Artemisinin	*Artemisia annua L.*	UV-C	5.7 kJ/m2	15.7%	(Rai *et al.*, 2011)
Lycopene	*Lycopersicon esculentum* L.	UV-C, stored at 25°C	3.0 kJ/m^2	2 fold	(Bravo *et al.*, 2012)
Lycopene	*Lycopersicon esculentum L*	UV-C and ultrasound	2.15 kJ/m^2	90%	(Esua *et al.*, 2019)
Glucosinolate	*Brassica oleracea L. cv. italica*	UV-C, stored at 4°C	1.2 kJ/m^2	N/A	(Nadeau *et al.*, 2012)
Lignans (Di-glucoside)	*Linum usitatissimum L.*	UV-C	3.6 kJ/m^2	1.86 to 2.25 fold	(Anjum *et al.*, 2017)
Total phenolic	*Linum usitatissimum L*	UV-C	3.6 kJ/m^2	2.82 fold	(Anjum *et al.*, 2017)
Polyphenols	*Lepidium sativum L.*	UV-C	3 J/m^2	2.5 fold	(Ullah *et al.*, 2019)

¿Cómo actúa el Ozono contra los microorganísmos?



El ozono es uno de los mayores oxidantes y desinfectantes conocidos.

El Ozono reacciona con la pared celular de los patógenos oxidándola y provocando su rotura. Además causa daños en su ADN y ARN lo que implica la desactivación de todo tipo de virus y microorganismos.

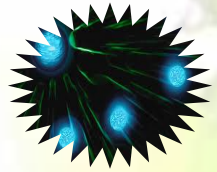
oxidando y rompiendo la pared celular y glicoproteinas

En la reacción que produce la muerte microbiana la molécula de Ozono se descompone liberando moléculas de Oxígeno.

Luz + agua + dióxido de carbono

Hidrógeno + Carbono + Oxígeno

48 Fotones



1 mol Glucosa

Rayos UVC

100nm a los 280nm
4.43 a 12.40
son totalmente absorbidos por la atmósfera.
son nocivos para la salud humana y sin adecuado control tampoco son buenos para las plantas.
Son de un alto **efecto germicida** y provee un especial beneficio en la satanización de aire de invernaderos para combatir virus, bacterias y hongos

Rayos UVB

280nm y los 315n
energía por fotón de 3.94 a 4.43
parcialmente absorbidos por la atmósfera Por lo que llegan en menor cantidad que los UVA.
Al tener más energía **dañinos para los humanos y plantas**, en niveles elevados pueden provocar quemaduras e incluso cáncer.

Rayos UVA

315nm a los 400nm,
energía por fotón de 3.10 a 3.94
responsables de que los humanos nos bronceemos.
Es la más abundante por ser la menos absorbida por la atmósfera. Todas son bloqueadas en sistemas de invernaderos

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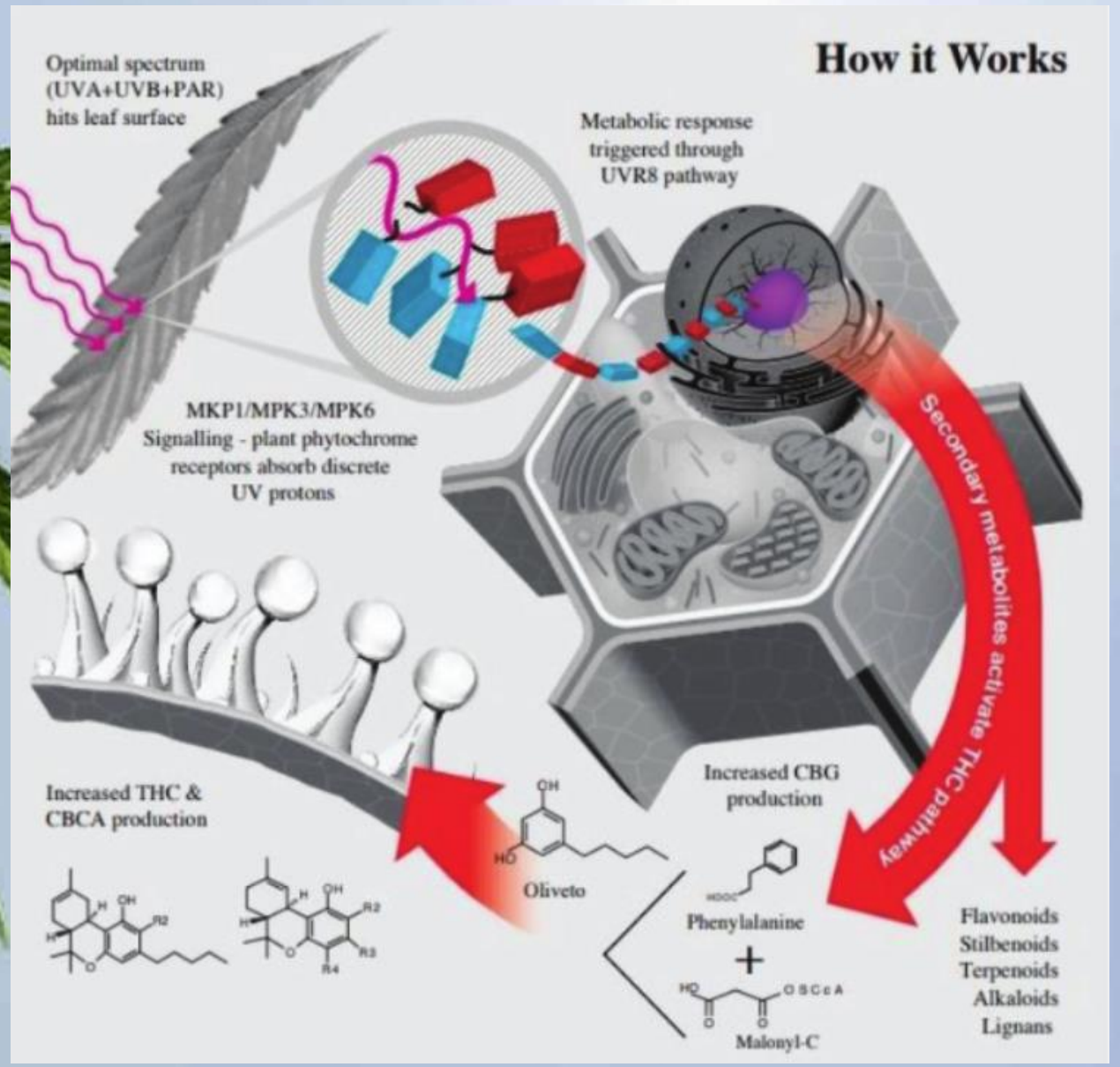
Luz + agua + dióxido de carbono

Hidròġeno + Carbono + Oxìgeno

48 Fotones

1 mol Glucosa



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DONDE Y PORQUÈ APLICARLO?

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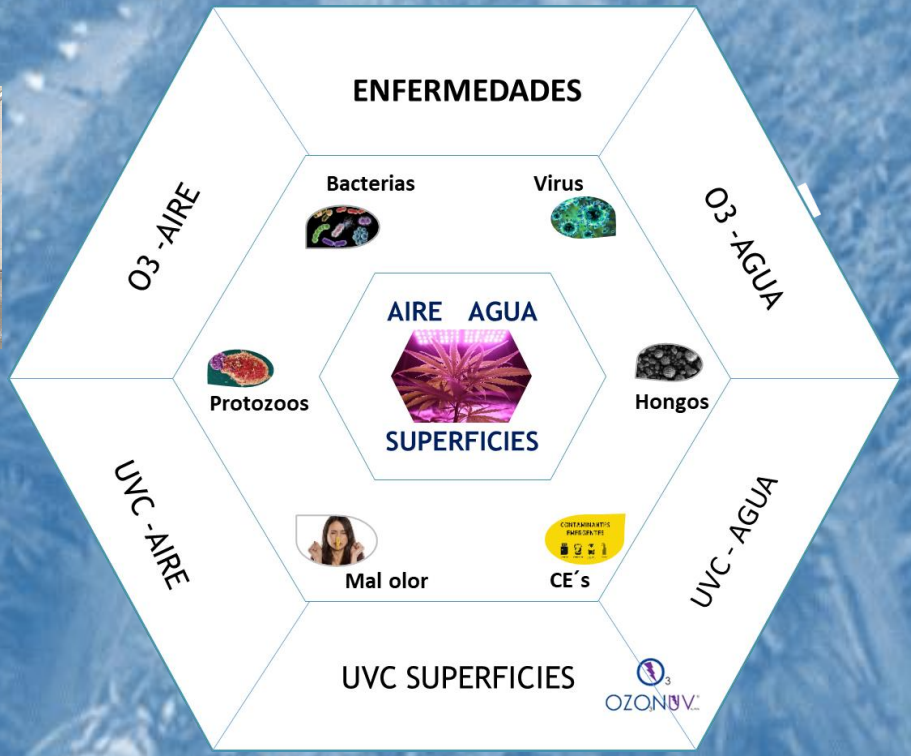
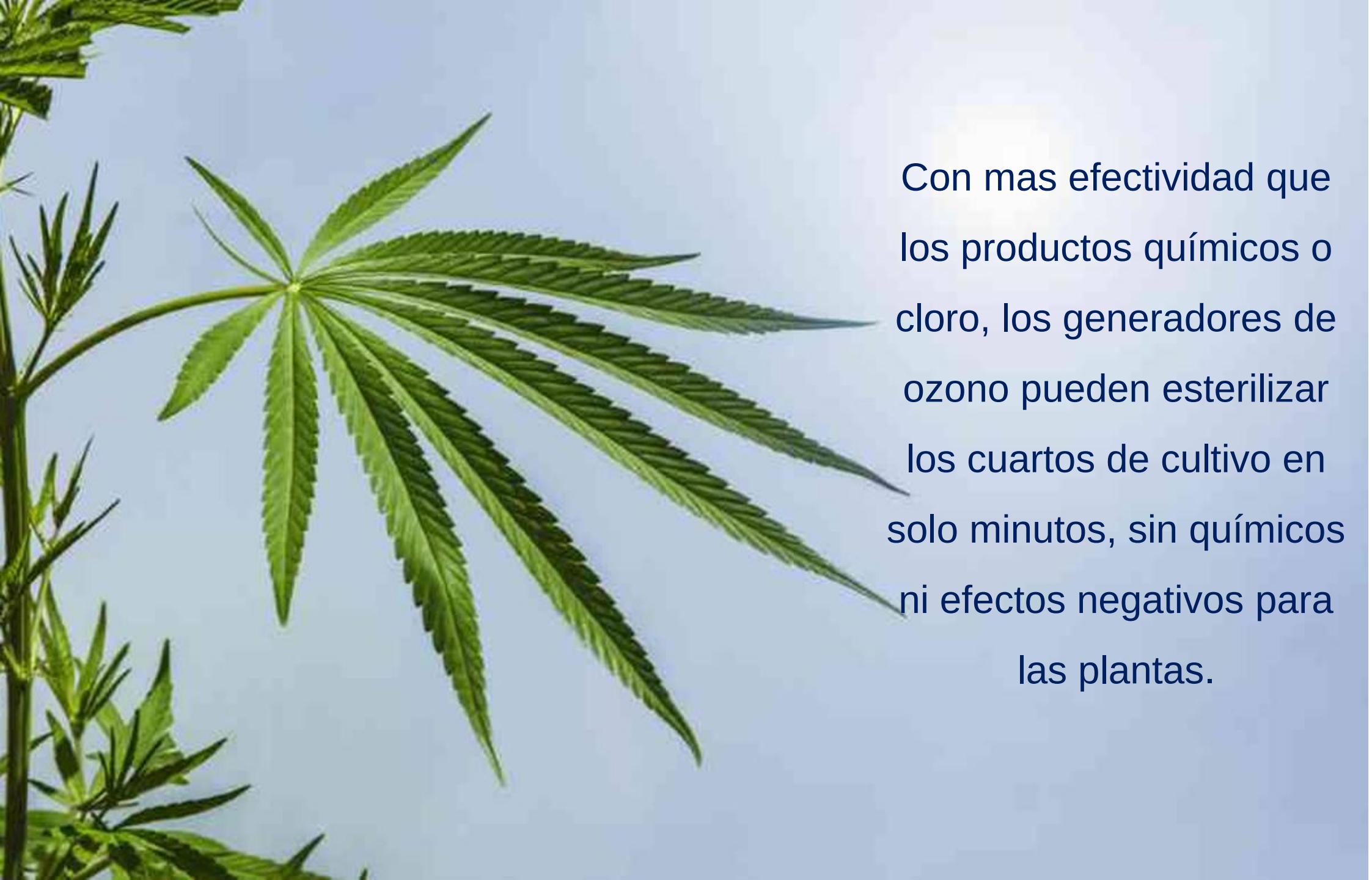


Green Health Colombia



Con mas efectividad que los productos químicos o cloro, los generadores de ozono pueden esterilizar los cuartos de cultivo en solo minutos, sin químicos ni efectos negativos para las plantas.

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