

Azospirillum brasilense and *Glomus intraradices* co-inoculation stimulates growth and yield of cherry tomato under shadehouse conditions

La co-inoculación con *Azospirillum brasilense* y *Glomus intraradices* estimula el crecimiento y rendimiento de tomate cherry

Lira-Saldivar RH¹, A Hernández¹, LA Valdez², A Cárdenas¹, L Ibarra¹, M Hernández³, N Ruiz⁴

Abstract. The response of cherry tomato to biofertilization with beneficial microorganisms was evaluated under shadehouse conditions. Seeds were inoculated and/or co-inoculated with *Azospirillum brasilense* (Az) and/or *Glomus intraradices* (Gi). Thereafter, seedlings of six treatments received two applications of a suspension containing Az + Gi at 15 and 30 days after the transplant, and were compared against a non-inoculated treatment which only received conventional inorganic fertilization. Seed co-inoculation with *A. brasilense* and *G. intraradices* plus two applications of Az + Gi at 15 and 30 days after transplant increased on average 6% plant height, 11% leaf area, 10.5% dry biomass and 16% yield of cherry tomato in comparison to traditional fertilization.

Keywords: Arbuscular mycorrhiza; PGPR; Biofertilizers; *Solanum lycopersicon*.

Resumen. Se evaluó la respuesta del cultivo de tomate cherry a la biofertilización con microorganismos benéficos bajo condiciones de casahombra. Las semillas fueron inoculadas y co-inoculadas con *Azospirillum brasilense* (Az) y/o *Glomus intraradices* (Gi); después del trasplante, las plántulas de seis tratamientos recibieron dos aplicaciones de una solución conteniendo Az + Gi, y fueron comparadas contra el tratamiento testigo que solo recibió fertilización tradicional (NPK). La co-inoculación de las semillas con *A. brasilense* y *G. intraradices* más dos aplicaciones de Az + Gi a los 15 y 30 días después del trasplante, incrementaron en promedio 6% la altura de plantas, 11% el área foliar, 10,5% la biomasa seca y 16% el rendimiento de tomate cherry en comparación con la fertilización tradicional.

Palabras clave: Micorrizas arbusculares; PGPR; Biofertilizantes; *Solanum lycopersicon*.

¹Departamento de Agroplasticultura. Centro de Investigación en Química Aplicada. Saltillo, Coah., Mexico. C.P. 25294.

²Departamento de Horticultura, Universidad Autónoma Agraria Antonio Narro, Buenavista, Saltillo, Coah., Mexico. C.P. 25315.

³Departamento de Parasitología, Universidad Autónoma Agraria Antonio Narro, Buenavista, Saltillo, Coah., Mexico. C.P. 25315.

⁴Departamento de Tecnología de Semillas, Universidad Autónoma Agraria Antonio Narro, Buenavista, Saltillo, Coah., Mexico. C.P. 25315.

Address Correspondence to: Dr. R. Hugo Lira-Saldivar, e-mail: hugo.lira@ciqa.edu.mx

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Extensión de la vida de poscosecha en frutos de tomate por efecto de un látex polimérico comestible

Extension of postharvest shelf-life of tomato fruits using biocompatible synthetic latex

Ramos G¹, RH Lira¹, RD Peralta², GY Cortez², A Cárdenas¹

Resumen. Los frutos de tomate son productos perecederos que requieren tratamientos para prolongar su vida útil, como pueden ser las películas para recubrimientos. Debido a esto y con el propósito de evitar el uso de agroquímicos sintéticos para evitar el deterioro físico durante poscosecha, se evaluaron los efectos de un recubrimiento comestible de látex polimérico poli (acetato de vinilo-co-alcohol vinílico), P (VAc-co-VA), a tres concentraciones (0, 50 y 100%) en frutos de tomate. El ensayo se realizó en condiciones de temperatura ambiente (31 ± 4 °C; con HR de $30 \pm 5\%$) y bajo temperatura controlada (12 ± 1 °C; con HR de $75 \pm 5\%$). Los frutos tratados con recubrimiento de P (VAc-co-VA) al 100 y 50% fueron significativamente superiores, al conservar por más tiempo sus características físicas (peso y firmeza) en comparación con los tratamientos sin el recubrimiento. En cuanto a sólidos solubles totales (°Brix), los resultados revelaron que los tomates conservados a temperatura controlada y los tratados con 100 y 50% del recubrimiento polimérico presentaron valores de grados Brix significativamente más elevados que los frutos mantenidos a temperatura ambiente o no recubiertos. De acuerdo con nuestros resultados el látex de P (VAc-co-VA) tiene buen potencial para su uso como recubrimiento protector de frutos de tomate durante poscosecha.

Palabras clave: Hortalizas; Poliactato de vinilo; Poscosecha; Recubrimiento comestible.

Abstract. Tomato fruits are perishable products that require treatments such as coating films to extend their shelf life. Because of this and to avoid use of synthetic chemicals to prevent physical deterioration during postharvest, we evaluated the effects of an edible coating polymer latex poly (vinyl acetate-co-vinyl alcohol), P (VAc-co-VA), at three concentrations (0, 50 and 100%) in tomato fruits. The trial was conducted at room temperature conditions (31 ± 4 °C; with RH of $30 \pm 5\%$) and temperature-controlled (12 ± 1 °C; with RH of $75 \pm 5\%$). Fruits coated with P (VAc-co-VA) at 100 and 50% showed significantly higher physical properties (weight and firmness) after storage than fruits without the coating. Total soluble solids (° Brix) were also significantly higher in fruits either stored at controlled temperature or coated with P (VAc-co-VA) at 100 and 50% than in fruits stored at room temperature or without coating. Our results suggest that P(VAc-co-VA) coatings are suitable agents to preserve tomato fruit shelf life for a longer time.

Keywords: Vegetables; Vinyl polyacetate; Postharvest; Polymeric edible coating.

¹Departamento de Plásticos en la Agricultura.

²Departamento de Procesos de Polimerización. Centro de Investigación en Química Aplicada (CIQA). Saltillo, Coah., México. CP. 25294.

Address Correspondence to: Dr. R. Hugo Lira-Saldivar, e-mail: hugo.lira@ciqa.edu.mx; rene.peralta@ciqa.edu.mx; Tel. 844 4389830. Fax: 844 4389839.

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**RESPUESTAS DEL PEPINO A LA FERTILIZACIÓN BIOLÓGICA Y MINERAL
CON Y SIN ACOLCHADO PLÁSTICO EN CONDICIONES DE CASA SOMBRA**

Vasquez-Santiago, E.^a, Lira-Saldivar, R.H.^b, Valdéz-Aguilar, L.A.^a, Cárdenas-Flores, A.^b, Ibarra-Jiménez, L.^b,
González-Sandoval, D.C.^b.

^aDepartamento de Horticultura; Universidad Autónoma Agraria Antonio Narro; C.P. 25280, Saltillo,
Coahuila. México. ^bDepartamento Plásticos en la Agricultura; Centro de Investigación en Química Aplicada;
C.P. 25294, Saltillo, Coahuila. México

e-mail autor(es): hugo.lira@ciqa.edu.mx; estevan_b75@yahoo.com.mx.

Biofertilización en pepino, agricultura protegida y producción sustentable.

Biotecnología, fertilización, sistemas de producción hortícola y agricultura orgánica.

Resumen

El cultivo de pepino es de gran importancia a nivel global ya que esta hortaliza se siembra en más de dos millones de hectáreas, siendo fertilizado casi en su totalidad con fertilizantes tradicionales, debido a eso, se realizó un trabajo experimental con el objetivo de determinar el efecto de biofertilizantes fúngicos y bacterianos, así como fertilización mineral en el crecimiento y rendimiento del pepino, bajo condiciones de casa sombra en suelo con y sin acolchado plástico. Los dos biofertilizantes comerciales evaluados fueron: Azotón (a base de esporas de *Azospirillum brasilense*, *Azotobacter* spp., y *Bacillus* spp.) y Ecorriza, (conteniendo el hongo *Glomus intraradices*), suplementados con dos porcentajes de

EFFECTO DEL SISTEMA DE RIEGO Y CLIMA EN LA EFICIENCIA DEL USO DE AGUA DE NOGAL PECANERO

Effect of Irrigation System and Climate on Water Use Efficiency of Pecan Trees

Alejandro Zermeño González^{1‡}, Claudia Ivette Cruz Santes¹, Juan Plutarco Munguía López², Ernesto Alonso Catalán Valencia³, Santos Gabriel Campos Magaña⁴ y Javier de Jesús Cortés Bracho¹

RESUMEN

El nogal pecanero (*Carya illinoensis* K.) es una especie frutícola de gran importancia para México, su cultivo se realiza en regiones de clima semidesértico donde el agua es el factor limitante de la producción, por lo que es necesario obtener la máxima eficiencia del uso de este recurso, que es función del sistema de riego y de las condiciones climáticas de la región. Sobre esta base, el objetivo de este estudio fue evaluar la eficiencia del uso del agua de dos huertas de nogal pecanero bajo dos sistemas de riego y diferentes condiciones climáticas. El estudio se realizó en el verano de 2008, en dos huertas de nogal pecanero del noreste de México: una de ellas ubicada en el sureste del estado de Coahuila (Mieleras, municipio de Matamoros) con riego por goteo subsuperficial, y la otra en el norte del mismo estado (Zaragoza) regada con aspersión. La eficiencia del uso del agua de las huertas del nogal pecanero se definió como la relación entre moles de CO₂ asimilados por mol de agua evapotranspirada por el dosel de los árboles. Los resultados del estudio mostraron que aunque la asimilación de CO₂ promedio diaria en la huerta de Mieleras (441.68 mmol m⁻²) fue estadísticamente igual a la observada en la huerta de Zaragoza (489.04 mmol m⁻²); la eficiencia promedio diaria del uso del agua (mmol CO₂ mol⁻¹ H₂O) fue mayor ($P \leq 0.05$) en la huerta de Zaragoza (1.82) que la que se obtuvo en la huerta de Mieleras (1.42). Esto se debió a que las condiciones climáticas en Matamoros fueron de un

mayor déficit de presión de vapor y una mayor tasa de evapotranspiración, que tuvieron un efecto mayor en la eficiencia del uso del agua que el sistema de riego utilizado en cada huerta.

Palabras clave: riego por goteo subsuperficial, riego por aspersión, CO₂ asimilado, H₂O evapotranspirada.

SUMMARY

Pecan (*Carya illinoensis* K.) is an important fruit tree for Mexico. It is grown in arid regions where water availability is the limiting factor for its production. Therefore, it is necessary to obtain the highest possible water use efficiency, which is a function of the irrigation method and the climate conditions of the region. Thus, the objective of this study was to evaluate the water use efficiency of two pecan orchards, with different methods of irrigation and different climate conditions. The study was done during the summer of 2008 in two pecan orchards in northeastern Mexico. One of them is located in southeastern Coahuila (Mieleras, Municipality of Matamoros) irrigated with a subsurface drip irrigation system. The other in northern Coahuila (Zaragoza) has a sprinkler irrigation system. Water use efficiency of the two orchards was defined as the ratio between moles of CO₂ absorbed and moles of water vapor evapotranspired by the tree canopies. The results of this study showed that, although average daily CO₂ assimilation rate of the Mieleras orchard (441.68 mmol m⁻²) was statistically equal to that observed in the Zaragoza orchard (489.04 mmol m⁻²), the average daily intrinsic water use efficiency (mmol CO₂ mol⁻¹ H₂O) was higher ($P \leq 0.05$) in the Zaragoza orchard (1.82) than that in the Mieleras orchard (1.42). This was due to the climate conditions of Mieleras that caused a higher water vapor pressure deficit and a higher evapotranspiration rate, whose effect on water use

¹ Departamento de Riego y Drenaje; ⁴ Departamento de Maquinaria Agrícola, Universidad Autónoma Agraria Antonio Narro. Calzada Antonio Narro 1923. 25315 Buenavista, Saltillo, Coahuila, México.

[‡] Autor responsable (azermeno@uaaan.mx)

² CIQA. Blvd. Enrique Reyna 140. 25250 Saltillo, Coahuila, México.

³ CENID-RASPA-INIFAP. Canal principal Sacramento km 6.5. 35140 Gómez Palacio, Durango, México.

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**Prevención de la Enfermedad Causada por *Botrytis cinerea* en Frutos de Tomate
Durante Poscosecha Mediante un Recubrimiento Polimérico**

Lira-Saldívar RHa., Ramos-Hernández Ga., Peralta-Rodríguez, RDa., Cortez-Mazatan GJa., Vera-Reyes Ia.,
Solis-Gaona, Sc, Méndez-Arguello, Ba.

aDepartamento Plásticos en la Agricultura, Centro de Investigación en Química Aplicada (CIQA). Saltillo
Coahuila., México. CP. 25294. bDepartamento Procesos de Polimerización, CIQA. cDepartamento de
Parasitología, Universidad Autónoma Agraria Antonio Narro, Buenavista. Saltillo. Coahuila C.P. 25315.
México. cArysta-GBM. Fracc. Europa, C.P. 25290. Saltillo, Coahuila, México.

e-mail autor(es): hugo.lira@ciqa.edu.mx, geraaardo@hotmail.com

Resumen

En este estudio se evaluaron los efectos del recubrimiento con el polímero biocompatible poli (acetato de vinilo-co-alcohol vinílico) (PVAc-co-VA) en la prevención y/o control sustentable del hongo *B. cinerea* causante de la enfermedad moho gris en frutos de tomate, así como en diversas variables físicas y químicas relacionadas con la calidad en poscosecha de estos frutos. La aplicación del copolímero se hizo a partir de látex preparado mediante polimerización en heterofase, diluyendo el látex original para lograr las siguientes concentraciones: 0 (sin recubrimiento), diluido a 50, 75 y 100 % (sin diluir). Los tomates se almacenaron a temperatura controlada de 19 ± 1 °C y humedad relativa de 75 ± 5 %. El diseño experimental fue completamente al azar con arreglo factorial de 2x4 con tres repeticiones. Los tratamientos con recubrimiento del látex de PVAc-co-VA al 100 y 75 % conservaron mejor las características físico-químicas de los tomates en comparación con aquellos que no fueron tratados con el recubrimiento polimérico; sin embargo, no fue capaz de impedir la infección de *B. cinerea* cuando este hongo fue inoculado deliberadamente en los frutos, pero sí logró retardar el efecto de la enfermedad.

Palabras clave: actividad enzimática, *Botrytis cinerea*, frutos de tomate, látex polimérico.

Abstract

In this study were evaluated the coating effects on tomato fruits by means of using a biocompatible polymer of poly(vinyl acetate-co-vinyl alcohol) (PVAc-co-VA), on the sustainable prevention and/or control of the fungi *B. cinerea* that cause the grey mold disease on tomatoes, as well on various physical and chemical variables related to post-harvest life of this vegetable. Application of the copolymer was made from latex prepared by polymerization in heterophase diluting the original latex (PVAc-co-VA), to achieve various concentrations: 0 (no coating or control), 50, 75 and 100 % (undiluted latex). Tomato fruits were stored at controlled temperature (19 ± 1 °C) and relative humidity was set at 75 ± 5 %. The experimental design was completely randomized with factorial arrangement of 2 x 4 with three replicates. Coating latex treatments with PVAc co-VA at 100 and 75 %, promoted better physicochemical characteristics, compared to uncoated tomatoes. However, it did not prevent the infection of *B. cinerea* when this fungus was inoculated to fruits, but retarded the effect of the disease.

Key Words: *Botrytis cinerea*, polymer latex, tomato fruit, enzyme activity.

1. Introducción

Botrytis cinerea es un hongo fitopatógeno causante de la enfermedad conocida como moho gris, la cual es de gran importancia económica ya que infecta una amplia variedad de cultivos haciendo uso de diferentes mecanismos de infección para invadir la planta huésped (Jia *et al.*,

2007). Aunque se ha observado cierta variabilidad genética en algunas especies en cuanto a su resistencia a *B. cinerea*, en ningún caso se ha encontrado una relación gen a gen. El patógeno puede atacar al cultivo en cualquier estado de desarrollo del mismo y puede infectar cualquier parte de la planta. Debido a la



Desempeño de una película foto-biodegradable para acolchado de suelo en el cultivo de calabacita.

Field Performance of a Foto-biodegradable Film for Soil Mulching in Zucchini crop

López-Tolentino, G.¹, Cárdenas-Flores, A.^{1*}, Ibarra-Jiménez, L.¹, Guerrero-Santos, R.²

¹Departamento de Plásticos en la Agricultura. ²Departamento de Síntesis de Polímeros. Centro de Investigación en Química Aplicada (CIQA). C.P. 25294. Septiembre de 2015, Saltillo, Coahuila, México. *correspondencia: antonio.cardenas@ciqa.edu.mx

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Resumen

El desarrollo y utilización de películas degradables para acolchado de suelo es una tendencia que busca reemplazar a las películas de polietileno de baja densidad (LDPE) ya que posterior a la cosecha son un serio problema debido a que se deben recolectar y disponer de alguna forma para evitar la contaminación de los suelos y medio ambiente. En este estudio se evaluó una película color negro semi-opaca con características foto-biodegradables (Crown1) para su aplicación en el cultivo de calabacita. El cultivo se realizó bajo agricultura convencional y con cuatro tratamientos. Se cuantificó en cada tratamiento la tasa fotosintética, peso seco de planta, concentración de clorofila y rendimiento total, variables que resultaron estadísticamente similares entre tratamientos. Además se evaluaron la tensión máxima y resistencia a la elongación de la película Crown 1 para medir su integridad durante el desarrollo del cultivo, y el contenido de Fe (detonador de foto-degradación). La película Crown 1 se degradó más aceleradamente en la parte expuesta al sol, (94%) que en la parte cubierta por el suelo (10%) que fijó la película. Estos resultados indican que las películas se desintegraron evitando el problema de recolección y disposición. Sin embargo, aunque la película Crown 1 tiene potencial para

Gas exchange, yield and fruit quality of *Cucurbita pepo* cultivated with zeolite and plastic mulch

R.H. LIRA-SALDIVAR^{1,*}, B. MÉNDEZ-ARGÜELLO¹, M. FELIPE-VICTORIANO¹, I. VERA-REYES^{1,2}, A. CÁRDENAS-FLORES¹, L. IBARRA-JIMÉNEZ¹

¹Departamento de Plásticos en la Agricultura. Centro de Investigación en Química Aplicada (CIQA), 25294 Saltillo, Coahuila, México

^{1,2}Catedrática Consejo Nacional de Ciencia y Tecnología (CONACYT) - CIQA, 25294 Saltillo, Coahuila, México

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Keywords: *agroplasticulture, biofortification, photosynthesis, vegetables, zucchini*

SUMMARY. - The incorporation of 0, 10, 20 and 40 t ha⁻¹ of zeolite clinoptilolite (ZC) to the soil, with and without plastic mulch (PM) was analyzed on *Cucurbita pepo*. Zucchini plants had significantly higher yields when soil was amended with 40 t ha⁻¹ of ZC than those growing in soil without ZC. ANOVA showed that there was a significant interaction between both factors (ZC and PM), with the highest yield when plants were cultured in bare soil plus 40 t ha⁻¹ ZC. Vitamin C concentration in fruits was reduced by 30.0, 53.6 and 38.8%, and chlorophyll index by 5.45, 7.20 and 5.84% with the incorporation of 10, 20 and 40 t ha⁻¹ ZC, respectively. PM significantly improved biomass production (29.9%), leaf area (35.3%) and yield (22.3%). Fruits from the PM treatments reduced by 24% the vitamin C concentration. Gaseous exchange in *C. pepo* plants did not show significant changes due to ZC or PM.

INTRODUCTION. – Natural zeolites are a group of minerals of volcanic origin with approximately 40 species, of which zeolite clinoptilolite (ZC) is the most abundant. These hydrated aluminosilicates have a rigid three-dimensional crystal structure, with voids and channels of molecular size and a high cation exchange capacity (CEC) arising from the substitution of Al for Si in the silicon oxide tetrahedral units that constitute the mineral structure (CHAWAKITCHAREON *et al.*, 2016). Additionally, they show a high water and NH₄⁺ holding capacity, and increased adsorption of other plant nutrients (SALAS-CRUZ *et al.*, 2013). According to SANGEETHA and BASKAR (2016), zeolites could act as soil amendments since their structure gives them the capability to hydrate-dehydrate and to interact with nutrients improving soil fertility.

* Corresponding authors: hugo.lira@ciqa.edu.mx; bulmaro.mendez@ciqa.edu.mx

Influence of colored plastic mulch on soil temperature, growth, nutrimental status, and yield of bell pepper under shade house conditions

Claudio Ezequiel Canul-Tun^a, Luis Ibarra-Jiménez^a, Luis A. Valdez-Aguilar^b,
A. Javier Lozano-del Río^c, Antonio Cárdenas-Flores^a, Alejandro Zermeño-González^d,
Carlos J. Lozano-Cavazos^c, José H. Valenzuela-Soto^a, and Vicente Torres-Oliver^a

^aDepartamento de Plásticos en la Agricultura, Centro de Investigación en Química Aplicada, Saltillo, Coahuila, Mexico;

^bDepartamento de Horticultura, Universidad Autónoma Agraria Antonio Narro, Saltillo, Coahuila, Mexico;

^cDepartamento de Fitomejoramiento, Universidad Autónoma Agraria Antonio Narro, Saltillo, Coahuila, Mexico;

^dDepartamento de Riego y Drenaje, Universidad Autónoma Agraria Antonio Narro, Saltillo, Coahuila, Mexico

ABSTRACT

The aim of this study was to determine if plastic mulch films may have positive effects on bell pepper plants grown under shade house conditions. The experimental design was split-plot, where large plots contained four plastic mulch films (black, aluminum, silver, and white) compared to bare soil and small plots contained two bell pepper cultivars. Plant shoot dry weight was higher in plastic mulch treatments than in bare soil. The net photosynthesis rate in the cultivar SWG-46 exceeded in net photosynthesis with respect to the cultivar SWG-42 in one of three sampling dates. Nutrients in leaf showed a similar behavior in plastic mulch treatments than the control but the total content of nitrogen (N), potassium (K), and sulfur (S) was increased. The total yield was higher in black plastic mulch than in the other plastic mulch colors and lowest in the control.

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KEYWORDS

plasticulture; photosynthesis;
shoot dry weight; leaf area;
soil temperature; fruit yield

Introduction

Bell pepper (*Capsicum annuum* L.) is one of the main horticultural products cultivated in Mexico and it is used mainly to be exported to the United States and Canada. Approximately 5,800 ha are planted throughout the country and the exports peaked 24,000 tons in 2006 (Castellanos and Borbón 2009). The cultivation of plants under shade house conditions is reported to reduce transpiration and water demand (Cohen et al. 1997) and improve plant growth and development by providing physical protection against damage by birds, hail, and pests. Shade houses also reduce excessive radiation, modify environmental conditions (humidity and temperature), and affect light quality by increasing the proportion of diffusive light and absorbing various spectral bands, impacting the growth and yield of cultivated plants (Stamps 2009). The effect of the color, shading intensity, and the transmittance of radiation of shading nets on disease control and yield in pepper is well documented (Elad et al. 2007; Díaz Pérez 2013). Mulching with plastic films in combination with drip irrigation is also favorable as it increases early production and higher yields along with the production of cleaner fruits of better quality; in addition, mulching of soils is associated with more water and fertilizer use efficiency and decreased incidence of pests, diseases, and weeds (Lamont 2005). The effect of colored plastic mulches in open field conditions in bell pepper is also well documented (Díaz-Pérez 2010); studies in Israel

Poly(vinyl acetate) as bell pepper (*Capsicum annuum* L.) fruit coating during postharvest

G. ORTIZ-HERNÁNDEZ¹, M. DEL-ROSARIO ABRAHAM-JUÁREZ³, V. OLALDE-PORTUGAL⁴, G. YAKELINE CORTEZ-MAZATÁN², L. SORIANO-MELGAR^{1,5}, R.H. LIRA-SALDÍVAR¹, R.D. PERALTA-RODRÍGUEZ^{2,*}, A. CÁRDENAS-FLORES^{1,*}

¹Departamento de Plásticos en la Agricultura

²Departamento de Procesos de Polimerización, Centro de Investigación en Química Aplicada, Saltillo, Mexico

³Departamento de Alimentos, División Ciencias de la Vida, Universidad de Guanajuato Campus Irapuato-Salamanca, Irapuato, Mexico

⁴Departamento de Biotecnología y Bioquímica, Centro de Investigación y de Estudios Avanzados del IPN, Irapuato, Mexico

⁵Investigadora de Cátedras CONACYT

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Keywords: *Capsicum annuum*, edible coatings, fruit physiology, polyvinyl acetate, shelf life

SUMMARY. – Edible coatings are an attractive strategy to protect vegetables during postharvest. Poly(vinyl acetate-covinyl alcohol, P(VAc-co-VA)) is a synthetic polymer potentially appropriate for fruit cover. Here, we report the postharvest quality of green pepper protected with P(VAc-co-VA). For this purpose, bell pepper fruits - in commercial maturity - were coated with P(VAc-co-VA) and physically (weight loss, firmness and CIE Lab color), chemically (total soluble solids (TSS), citric and ascorbic acid content, and pH), enzymatically (pectin methylesterase (PME) and polygalacturonase (PG) activity), and physiologically (respiration rate) characterized during postharvest, and compared against uncoated fruits. Fruits were stored at controlled temperature (5°C). Related to uncoated fruits, the P(VAc-co-VA) coating reduced weight loss, preserved fruit firmness, modified color, increased citric and ascorbic acid concentrations, but not TSS; additionally, the P(VAc-co-VA) reduced PME and PG activity as well as respiration rate. Our findings support that P(VAc-co-VA) is a synthetic polymer suitable to assist in bell pepper postharvest protection.

INTRODUCTION. – Bell pepper is an important vegetable in human diet either fresh or processed, providing a number of nutrients (amino acids, carbohydrates, lipids, proteins and minerals), and a number of pharmacological benefits (anti-inflammatory, antimicrobial and antioxidant activities) (KHAN *et al.*, 2014). World market of fresh pepper demands high postharvest fruit quality and its preservation. When bell

* Corresponding authors: antonio.cardenas@ciqa.edu.mx; rene.peralta@ciqa.edu.mx

ORIGINAL ARTICLE

Cultivation of potato – use of plastic mulch and row covers on soil temperature, growth, nutrient status, and yield

Luz María Ruíz-Machuca^a, Luis Ibarra-Jiménez^{a*}, Luis Alonso Valdez-Aguilar^b,
Valentín Robledo-Torres^b, Adalberto Benavides-Mendoza^b and Marcelino Cabrera-De La Fuente^b

^aDepartamento de Plásticos en la Agricultura, Centro de Investigación en Química Aplicada, Saltillo, Coahuila, 25294 México; ^bDepartamento de Horticultura, Universidad Autónoma Agraria Antonio Narro, Saltillo, Coahuila, 25315 México

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Potato is one of the most important crops in the world because of its high nutritional value; however, traditional cultivation in bare soil may render low yields and poor quality. Crop production efficiency can be increased by using plastic mulching and row covers to modify root zone temperature and plant growth, in addition to reduction in pest damage and enhance production in cultivated plants. However, there is little information demonstrating the effect of row covers in combination with plastic mulch on potato. The aim of this study was to assess the change in root zone temperature and its effect on growth, leaf nutrient, and yield of potato using plastic mulch of different colors, in combination with row covers. Seed of cultivar Mondial was planted in May 2012. The study included four plastic films: black, white/black, silver/black, aluminum/black, and a control with bare soil, which were evaluated alone and in combination with row covers removed at 30 days after sowing in a split-plot design. Higher yields were obtained when no row cover (43.2 t ha^{-1}) and the white/black film (42.2 t ha^{-1}) were used. Leaf nitrogen, sulfur, and manganese concentration were higher in plants when row cover was used; in contrast, no-row cover plants were higher in Fe and Zn. Mulched plants were higher in Mn concentration than control plants. There was a quadratic relationship between mean soil temperature and total yield ($R^2 = 0.94$), and between plant biomass and total yield ($R^2 = 0.98$), between leaf area with total yield ($R^2 = 0.98$).

Keywords: leaf area; soil temperature; plasticulture; *Solanum tuberosum*; total yield

Introduction

Potato, considered by some scientists as “the food of the future,” is grown in more than 100 countries and is an integral part of the global food system. It is the world’s number one non-grain food commodity, reaching a record production of 320 million tons in 2007. Consumption of potato has expanded strongly in developing countries and accounts for more than a half of the foods harvested in the world (FAO 2008).

Crop production efficiency and productivity can be increased by mulching the soil with plastic films as it improves soil conditions for plant growth, including the effect on root zone temperature, weed control, reduction in soil compaction and leaching of

fertilizers, allowing a better assimilation of nutrients (Lamont 2005; Ibarra-Jiménez et al. 2008). Mulching of soils with black plastic combined with drip irrigation (Kumari 2012) were associated with a decrease in evaporation of water from soil and plant transpiration, increase in water use efficiency, higher formation of stolons, higher leaf area, and higher yield in potato.

Row covers protect plants from high radiation without affecting soil moisture (Lamont 2010), reduce the incidence of pests, reduce the use of insecticides (Ibarra et al. 2002; Qureshi et al. 2007), and render earlier and higher yield. The loss of radiant and convective heat is reduced under the

*Corresponding author. Email: luis.ibarra@ciqa.edu.mx

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Effect of colored plastic mulch on growth, yield and nutrient status in cucumber under shade house and open field conditions

Vicente Torres-Olivar^a, Luis Alonso Valdez-Aguilar^b, Antonio Cárdenas-Flores^a, Hugo Lira-Saldivar^a, Marcela Hernández-Suárez^c, and Luis Ibarra-Jiménez^a

^aDepartamento de Plásticos en la Agricultura, Centro de Investigación en Química Aplicada, Coahuila, Mexico;

^bDepartamento de Horticultura, Universidad Autónoma Agraria Antonio Narro, Coahuila, Mexico; ^cDepartamento de Parasitología, Universidad Autónoma Agraria Antonio Narro, Coahuila, Mexico

ABSTRACT

The aim of this study was to realize whether soil mulching, with different plastic mulch colors, is a suitable practice under shade house (SH) conditions for the culture of cucumber. To do so, cucumber was cultured mulched or not with black, blue, red or white-on-black plastic films under SH, and contrasted against mulched cucumber in open field (OF). Red mulch produced the highest shoot dry weight per plant and bare soil the lowest. However, it was the white mulch which produced the highest commercial yield per plant. Contrastingly, bare soil plants produced the lowest commercial yield. SH plants two folded photosynthetic rates compared to OF plants. Mulch color mainly impacted leaf phosphorus (P) and magnesium (Mg) content while the SH affected nitrogen (N), calcium (Ca) and magnesium (Mg). Our results confirm that soil mulching, and shading positively impact the cucumber yield and quality but also show that soil mulching under SH enhances cucumber crop.

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KEYWORDS

Plasticulture; photosynthesis; mineral nutrition; PAR; plant; biomass; yield

Introduction

Consumers are increasingly demanding higher quality of horticultural products, imposing on growers the cultivation of plants under improved climatic conditions in order to achieve better produces. Compared to the cultivation in open field (OF), shade houses (SH) are an alternative for protected cultivation that allows the plants to escape from stressful factors that significantly affect the production and quality of vegetables. Shade houses partially regulate the microenvironment and are suggested for areas of low humidity, high irradiance, and elevated temperature. Compared to greenhouses, SH are low-cost efficient structures used to moderate the effects of excessive irradiance on plants and to protect them from wind and hail damage; in addition, SH improve the temperature and humidity regimes, increase irrigation water use efficiency, and prevent pest and bird damage (Tanny et al., 2006). Shade house affect the quality of light by increasing the relative proportion of diffusive light as well as absorbing different spectral bands; affecting the cultivated plants and other organisms associated with them (Stamps, 2009). The use of shade cloths of different color, or aluminized nets, dramatically changes both the irradiance and the spectral balance of the transmitted irradiation, modifying plant performance (Ganelevin, 2008).

Mulching of soils with plastic films increases crop efficiency in the use of nutrients, irrigation water, and agrochemicals, however, the main objective of this technique is to maximize yield, increase fruit

CONTACT Luis Ibarra-Jiménez ✉ luis.ibarra@ciqua.edu.mx 📍 Centro de Investigación en Química Aplicada, 25294 Coahuila, Mexico.

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Photosynthesis, growth, and fruit yield of cucumber in response to oxo-degradable plastic mulches

Gorgonio López-Tolentino^a, Luis Ibarra-Jiménez^a, Adrián Méndez-Prieto^b, A. Javier Lozano-del Río^c, Ricardo H. Lira-Saldivar^a, José H. Valenzuela-Soto^a, Carlos J. Lozano-Cavazos^c and Vicente Torres-Oliver^a

^aDepartamento de Plásticos en la Agricultura, Centro de Investigación en Química Aplicada, Saltillo, Coahuila, México; ^bDepartamento de Procesos de Transformación de Plásticos, Centro de Investigación en Química Aplicada, Saltillo, Coahuila, México; ^cDepartamento de Fitomejoramiento, Universidad Autónoma Agraria Antonio Narro, Saltillo, Coahuila, México

ABSTRACT

The use of plastic mulch is associated with a higher increase in yield of vegetables. However, at the end of the growing season for each crop, plastic mulching can create environmental pollution that can cause negative impacts on the environment that could be solved by the use of degradable plastics. The aim of this study was to determine the effect of oxo-degradable plastic mulches on soil temperature, growth, gas exchange, and cucumber crop yield. The study was conducted in two locations in the northeast of Mexico during the spring and summer of 2013. The plastic mulch colors with additives were blue, green, and red and each color having 8% and 12% of pigment and 22% and 23% of Titanium dioxide (Rutile). The resultant treatments were compared with the black plastic mulch, which is the standard plastic in the world, and bare soil in a randomized complete block design with three replications in two locations. The mean soil temperature at both locations was statistically higher in black plastic mulch, followed by the oxo-degradable plastics mulches and lowest in the control. Gas exchange was not affected by plastic mulches. SPAD units as the index of chlorophyll content in leaves were very little affected by plastic mulch. Both, commercial and total yield were statistically similar in the oxo-degradable plastic mulches and the black plastic mulch, and lowest in the control. Plastics with higher concentrations of pigment registered higher degradation in both locations. Our results suggest that different plastic mulches impact positively on the yield of cucumber crop. The benefit in yield by the different plastic mulches in the conditions of this study was due to their soil warming ability that results in improved soil temperature, leaf area, and plant dry weight.

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KEYWORDS

Cucumis sativus; leaf area; shoot dry weight; photosynthesis; plasticulture; yield

Introduction

The use of plastic mulch with low-density polyethylene (LDPE) permit increases in early and total yields, reduces weed pressure, increases fertilizer use efficiency, increases efficient use of water, and reduces soil compaction (Lamont 2005). The effect of colored plastic mulches on the production of vegetables is well documented (Ibarra-Jimenez et al. 2008a; Díaz-Pérez 2009; Kasirajan & Ngouajio 2012). In Mexico, the main colors of plastic mulch used in the production of vegetables are black, white/black, and silver/black. The use of conventional LDPE plastic mulch is permitted and widely accepted by the farmers in the production of vegetables. Black plastic has been the standard plastic in the world, perhaps because of its low price in comparison with other coextruded plastic mulches. However, one of the main disadvantages of plastic mulch at the end of the growing

season is the disposal of the plastic. The use of plastic mulch films in agriculture is a major environmental problem because of the hydrophobic properties of polyethylene. These films require about 100 years for completing their decomposition. The biodegradable mulch has the convenience of reducing this source of environmental pollution (Tsia et al. 2009).

Currently, one of the main forms of disposal of plastic includes incineration. One alternative to incineration is the use of biodegradable plastic mulches, but their use in the US, for example, remains prohibited for organic production. However, perhaps the use of these materials for organic production may be permissible under certain degradation standards in the near future (Greene & Tonjes 2014). This latter point is a reflection of the fact that more research is needed.

In Mexico, no studies have been carried out on the environmental impact of plastic mulch materials on soil and their disposal. However, considering the