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Presentation of the Content

In the first chapter we present, *Varietal descriptors of sorghum varieties (Sorghum bicolor L. Moench) for registration and breeder's rights*, by SANCHEZ-MARTINEZ José, AVENDAÑO-LOPEZ Adriana Natividad, PADILLA GARCIA José Miguel Padilla and ARELLANO-RODRIGUEZ Luis Javier, with adscription in the Universidad de Guadalajara, as a second article we present, *Biocontrol activity of microoganisms on Botrytis isolates from vineyards*, by JUÁREZ-CAMPUSANO, Yara-Suhan, CHÁVARO-ORTÍZ, María del Socorro, SOTO-MUÑOZ, Lourdes and PACHECO-AGUILAR, Juan-Ramiro, with adscription in the Universidad Autónoma de Querétaro, as the following article we present, *Physical and technological characterization of the wood of candidate clones of Eucalyptus urophylla*, by ORTEGA-RAMIREZ Marynor Elena, TORRES-LAMAS, Secundino, MENDEZ-ARCOS, Jorge Luis and ARCOS RAMIREZ, Jorge Alexys, with adscription in the Universidad Autónoma de Chiapas, El Colegio de la Frontera Sur Unidad Villahermosa and Forestaciones Operativas de México S.A de C.V., as the following article we present, *Effect of Potassium Iodide and Salicylic Acid in the Cultivation of Hydroponic Strawberries (Fragaria L)*, by SILVA-MARRUFO, O., MARÍN-TINOCO, R. I., and CASTAÑEDA-VENEGAS, J.A., with adscription in the Universidad Tecnológica de Rodeo.

Content

Article **Journal-Agrarian and Natural Resource Economics**
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Varietal descriptors of sorghum varieties (*Sorghum bicolor* L. Moench) for registration and breeder's rights

Caracterización varietal de dos variedades de sorgo (*Sorghum bicolor* L. Moench) con fines de registro y derecho de obtentor

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Abstract

The registration and breeder's rights of varieties and hybrids in our country is very low compared to developed countries, however, the generation of this technology is frequent and they are marketed without an official registration. That is why the objective of this work is to characterize two pre-commercial varieties of sorghum, one with white grain and another with red grain in order to obtain the breeder's right. The characterization was carried out in the experimental fields of the University Center for Biological and Agricultural Sciences of the University of Guadalajara in the spring summer cycle of 2019 on two sowing dates. The methodology that was considered was the technical guide for varietal characterization approved by the International Union for the Protection of New Varieties of Plants UPOV. Central tendency analyzes were performed, the variation within materials was statistically analyzed using dispersion measures for grouped data such as range, variance, standard deviation, coefficient of variation and mean. Which provided the information for the decision of compliance with the main characteristics that allow each variety to be differentiated and to comply with the precepts that it is a new, homogeneous and stable variety.

Varietal character, Variety register, Varietal description

Resumen

El registro y derechos de obtentor de variedades e híbridos en nuestro país es muy bajo comparado con los países desarrollados, sin embargo, la generación de esta tecnología es frecuente y se comercializan sin un registro oficial. Es por ello que el objetivo de este trabajo es caracterizar dos variedades precomerciales de sorgo una de grano blanco y otra de grano rojo con el fin de obtener el derecho de obtentor. La caracterización se realizó en los campos experimentales del Centro Universitario de Ciencias Biológicas y Agropecuarias de la Universidad de Guadalajara en el ciclo primavera verano de 2019 en dos fechas de siembra. La metodología que se consideró fue la guía técnica de caracterización varietal aprobada por la Unión Internacional para la Protección de las Obtenciones Vegetales UPOV. Se realizaron análisis de tendencia central, la variación dentro de materiales se analizó estadísticamente mediante las medidas de dispersión para datos agrupados como son el rango, varianza, desviación estándar, coeficiente de variación y media. Los cuales proporcionaron la información para la decisión de cumplimiento de los caracteres principales que permiten diferenciar cada variedad y dar cumplimento a los preceptos de que es una variedad nueva, homogénea y estable.

Carácter varietal, Registro de variedades, Descripción varietal

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Introduction

The cultivation of sorghum is important in Mexico due to the area that is planted, occupying the fifth place worldwide, despite this, self-sufficiency is not achieved as it has to import around 700 thousand tons to cover the demand of 5 million 100 thousand tons (SADER, 2020). The area dedicated to cultivation oscillates in the million 200 thousand ha. That to cover the sowing, 16,800 tons of seed are required, the same as 95% if you have to import since you do not have the production of this important input by the companies that produce in Mexico. On the other hand, the research of the official body the National Institute of Agricultural and Livestock Forestry Research (INIFAP), as well as other institutions such as Universities have reduced their budgets for research and as a consequence the low generation of technology, in this case the generation of new varieties and hybrids of sorghum (Moreno GT and Hernández EL A 2011)

An improved variety is defined as the set of uniform plants, product of the application of a genetic improvement technique, with defined characteristics and that meets the condition of being different from others, stable and uniform, generally presenting higher yield potential, as well as various favorable conditions of quality, earliness, resistance to pests and diseases (Tadeo and Espinosa, 2004). According to Copeland and McDonald (2001), the seeds of improved varieties are the means to increase the yield and quality of crops, by serving as a bridge between genetic improvement (research) and the producer, the adoption of improved seeds allows reach competitive levels in production. Poey (1982), mentions that the differences between varieties are increasingly useful, which makes it necessary to identify the varietal characters in which they differ to determine their identity, uniformity and stability. The morphological or varietal description is a way of identifying the genetic purity, the degree of genetic advancement and the stability of the material; even define the degree of diversity between sorghum genotypes (Mohammed *et al*., 2015).

To carry out the varietal description, technical guides are proposed, which are issued by national and international organizations such as the National Seed Inspection and Certification Service (SNICS) and the International Union for the Protection of New Varieties of Plants (UPOV).

The guides include the set of descriptors and observations that allow characterizing a plant variety for its identification and distinction, which is an essential part for the registration of plant varieties or to request the issuance of a breeder's title before official agencies (SNICS, 2002; UPOV, 2012). The description of a variety must be made from the seed stage to maturity, for this an adequate sampling of plants must be achieved and their behavior must be observed in the appropriate environments; In this process, plants of other varieties and segregates of the same variety must be eliminated based on a reference pattern, which allows reliably to decide which phenotypes belong to the variety. This will allow the seed producer to maintain the genotypes that identify a variety after release (Poey, 1982).

Regarding the genetic quality of a plant variety, patterns of distinction, uniformity and stability are observed that identify it as having a high varietal purity, which is synonymous with a seed with quality in the genetic component. These patterns are based on morphological characteristics shown by the population, classified according to the form of evaluation in qualitative and quantitative characters (Kelly, 1988). Eberhart and Russell (1966) consider that a genotype is stable when the regression coefficient (bi) is equal to 1 and the regression deviations (S2di) equal to zero. Therefore, genotypes that do not interact with environmental factors will show zero slope and could be stable. Genotypes that show a medium response to environmental changes will have slopes equal to 1, and the most stable genotype will be the one that shows the S2di value closest to zero.

The breeder's title grants temporary exclusivity in the use of the plant variety, thus recognizing the intellectual property of whoever develops a new plant variety. In order to obtain registration before the National Seed Inspection and Certification System (SNICS), it is necessary to have a varietal description to demonstrate that the genotype is new and different, this examination is carried out after the breeder has concluded his work of improvement. SNICS, 2019.

Objectives

Characterize the sorghum genotypes Xochitl and Violeta on two sowing dates

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Compare the varietal descriptors of the two genotypes, using the qualitative and quantitative descriptors recommended by the International Union for the Protection of New Varieties of Plants (UPOV).

Methodology

The phenotypic characteristics of two new sorghum genotypes (Sorghum bicolor L. Moench) were described, which were generated in the genetic improvement program of the University Center for Biological and Agricultural Sciences CUCBA of the University of Guadalajara. Named Violeta and Xochitl. The evaluation was established in the experimental fields of Las Agujas, Zapopan, Jal. Under irrigation and seasonal conditions, two contrasting sowing dates were established. The crop was managed as commercial sowing; fertilization was 180-80-80 and density of 370,000 plants ha-1. A pre-emergent herbicide atrazine 3 L ha-1 was applied to control broadleaf grasses. The sample size used for each character was 20 plants per variety. The characterization of the varieties Xochitl and Violeta was carried out in the experimental fields of the University Center for Biological and Agricultural Sciences in the spring summer 2019 cycle, sowing 12 rows of 30 m long and 0.75 m wide and placing 25 seeds per meter with a population density of approximately 300 thousand plants per hectare. For each of the varieties with sowing date June 23, 2019 and replicating the lots on a second sowing date in the same experimental field on July 23, 2019. The agronomic management of land preparation and fertilization was the same for both sowing dates. To carry out the description, the technical guide for varietal characterization approved by the International Union for the Protection of New Varieties of Plants UPOV was used, which includes 36 characters between quantitative and qualitative. The data from the two planting dates were integrated to determine the total variation.

Results

The results of the description of the varieties allowed to establish the differences and similarities of the materials under study. Likewise, it was possible to identify the characters of the phenotypes in which a greater interaction with the environment was expressed, through the coefficient of variation that was presented in the analysis.

Characteristic	Level	Violet	Xochitl
Seedling: coleoptile anthocyanin pigmentation	Absent or very weak	x	x
Leaf: anthocyanin pigmentation of the blade	Absent or very weak	x	x
Plant: number of tillers	Null or very low	x	x
Leaf: intensity of green color	Medium	x	x
Leaf: midrib color	Light green	x	x
Leaf: discolored area of the midrib	Little	x	x
Plant: time of appearance of panicles	Half		x
	Late	x	
Glume: anthocyanin pigmentation	Absent or very weak	x	x
Stigma: anthocyanin pigmentation	Absent or very weak	x	x
Stigma: anthocyanin pigmentation	White		x
Stigma: anthocyanin pigmentation	Medium yellow	x	
Stigma: color	Short	x	x
Flower with pedicel: flower length	Short		x
	Median	x	
Flower: self-fertility	high	x	x
Glume: color at the end of flowering	Medium green	x	x
Absent or very weak	Half	x	
Absent or very weak	Dense		x
Null or very low	Absent or very short	x	x
Medium	Oranged Red	x	x
Light green	Median	x	x
Little	Medium	x	x
Half	Medium		x
Late	Long	x	
Absent or very weak	Width	x	x
Absent or very weak	Median	x	x
White	Short		x
Medium yellow	Long	x	
Short	Medium	x	x
Short	Dense	x	x
Median	Half	x	x
high	Medium yellow		x
Medium green	Light yellow	x	
Absent or very weak	Short	x	
Absent or very weak	Median		x
Null or very low	Yellowish white		x
Medium	Light brown	x	
Light green	Little	x	
Little	Medium		x
Half	Oval	x	
Late	Circular		x
Absent or very weak	Median	x	
Absent or very weak	Big		x
White	Null or very low		x
Medium yellow	Medium	x	
Short	Vitreous in its 3/4 parts		x
Short	Farinaceous in its 3/4 parts	x	
Median	Yellow	x	x
high	Insensitive	x	x

Table 1 Varietal descriptors evaluated in sorghum varieties, during 2019

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Regarding the characters that presented a greater variation measured by C.V. Table 2 presents the values for the Violeta variety. The most variable characters are those that experience the greatest interaction with the environment.

Character	C V %
1. coleoptile pigmentation	30
3. No. of stains	30
4. sheet int. Colour	15
5.central nerve color	11
6. zone desc. Central	17
10. this color	28
11. stigma length	34
12.Long flower	21
14. glume color	12
15. panicle density	11
16. lemma log. Edge	57
17. anther dry color	11
25. dens. maturity	15
27.gluma mad color.	10
28. glua long	9
32. germ brand size	9
34. endosperm type	16

Table 2 Percentage values of the Coefficient of variation presented by the characters in the Xochitl variety

The values presented were within the range of 9 to 57%, unlike the Violeta variety where coefficient of variation values were presented within the range of values of 5 to 40%.

Character	C.V %
1.colleoptile pigmentation seedling	40
4. Sheet int. Green color	14
5.central nerve color	12
6. Zone desc. Central	14
10. This color	5
14. Glume color	7
15. Panicle density	9
17. Anther dry color	7
20. Log sheet.	6
22. Panicle length	9
23 long. Neck	5
24. Lon rami primaries	9
25. Dens. Maturity	6
26. Wide part position	11
27. Gluma mad color.	8
28. Glume long	26
29. Grain color	2
31. Dors view form.	7
32. Germ brand size	14
35. Vitria endos color	11

Table 3 Characters of the Violeta variety that presented greater variation

These results, in addition to describing the materials under study, are the basis to establish whether it is necessary to carry out a purification in the materials or to establish the ranges of variation that will be considered within range due to the genetic composition of the materials**.**

Conclusions

Based on the evaluated variables, it is concluded that the varieties are different from each other,

The varietal description of the sorghum varieties is the technical document that will integrate the application for registration of the evaluated materials

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Biocontrol activity of microoganisms on *Botrytis* isolates from vineyards

Actividad de biocontrol de microorganismos sobre aislados de *Botrytis* provenientes de viñedos

JUÁREZ-CAMPUSANO, Yara-Suhan†, CHÁVARO-ORTÍZ, María del Socorro, SOTO-MUÑOZ, Lourdes and PACHECO-AGUILAR, Juan-Ramiro*

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Abstract

Botrytis cinerea causes postharvest fruit rot of an infinity of crops, the infective capacity is due to its physiological diversity that shown, even inside the same crop. For its control, the use of antagonistic microoganisms is emerging as a sustainable option. In the present work, 40 *Botrytis* isolates from three vineyards were characterized by their ability to infect grape fruit (Thomson Seedless), the results showed that all produced lesions diameters from 6.5 to 22.2 mm. Ten of these isolates that presented differences in terms of their virulence, were subject to *in vitro* antagonism test, using the yeasts *Metschnikowia* sp. NB9 and FLL17 (*Kodamaea* sp. FLL17 and the bacteria FR4B12 *Bacillus* sp. R4B12 from must and flower and fruit, respectively. The results showed that, on average, FRB412 had the highest inhibitory activity on the growth of *Botrytis* strains, exhibiting mycelial growth inhibition percentages from 51 to 81 %, followed by FLL17 (21 to 53 %) and NB9 (15 to 51 %). In conclusion, the three study strains have different ranges of biocontrol on *Botrytis*, whose application could reduce gray rot in grapes.

Gray rot, Vineyards, Virulence

Resumen

Botrytis cinera causa la podredumbre de frutos poscosecha de una gran cantidad de cultivos, su capacidad infectiva es debido a la diversidad fisiológica que presenta, inclusive dentro del mismo cultivo. Para su control, el uso de microorganismos antagonistas, se perfila como una opción sustentable. En el presente trabajo, se caracterizaron 40 aislados de *Botrytis* provenientes de tres viñedos, por su capacidad para infectar frutos de uva de mesa (Thompson Seedless), encontrando que todos generaron diámetros de lesión en un rango del 6.5 a 22.2 mm. Diez de estas cepas, seleccionadas por presentar diferencias en cuanto a su virulencia fueron sujetas después a ensayos de antagonismo *in vitro*, empleando las levaduras: *Metschnikowia* sp. NB9 y FLL17 *Kodamaea* sp. FLL17 y, la bacteria *Bacillus* sp. FR4B12 provenientes de mosto, flor y fruto, respectivamente. Los resultados mostraron que, en promedio, FRB4B12 tuvo la mayor actividad inhibitoria sobre el crecimiento de las cepas de *Botrytis*, exhibiendo porcentajes de inhibición del micelio en un rango de 51 al 81 %, seguido por FLL17 (21 al 53 %) y NB9 (15-51 %). En conclusión, las tres cepas de estudio poseen diferentes rangos de biocontrol sobre *Botrytis*, cuya aplicación pudiera reducir la podredumbre gris en uva.

Podredumbre gris, Viñedos, Virulencia

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Introduction

Gray rot is a disease caused by the *Botrytis cinerea* fungus, which is widely distributed worldwide, and has caused the loss of a variety of crops at the post and pre-harvest level (Keller, 2015, Khazaeli *et al*., 2012). During the infective process, the *B. cinerea* conidia produce a germ tube that penetrates the host's cuticle, then through the enzymatic production of pectinases, cellulases and hemicellulases they begin to degrade the plant tissues (Nakajima, & Akutsu, 2014; Abo -Elyousr *et al*., 2020), which can include stems, leaves and fruits (Fillinger and Elad, 2016),

It is worth mentioning that *Botrytis* during infection is capable of taking advantage of reactive oxygen species, produced as the first defense response in plants, in order to generate a greater degree of damage (Dean *et al*., 2012). Among the factors in the microenvironment of the infection, the pH is decisive for the development of the disease, this fungus being able to modify its environment through the production of organic acids, which gives this fungus the ability to infect, from grapes with a pH of 3 to 4, to pumpkins with a pH of 6 to 7 (Rascle *et al*., 2018).

The environmental isolates obtained from *Botrytis* exhibit variability in the damage they exert on their hosts, Acosta *et al*. (2018), report different degrees of severity in vine leaf and fruit infection, using *Botrytis* isolates from vineyards of six wine-producing regions. This variability may be due to intrinsic and extrinsic factors of the strains and of the hosts. Which allows to continue investigating the physiological differences that it presents in each particular crop.

Biological control (biocontrol) has been implemented in recent years, as an alternative tool to chemical control, in order to reduce the negative impact caused by the latter on agroecosystems, human health and soil fertility (Lemanceau *et al*., 2015).

Biological control uses biotic interactions that naturally occur between pathogenic and beneficial microorganisms, which are coexisting in plant tissues.

Among the most frequent interaction is antagonism, in which one organism prevents the development or growth of another (Bagnères & Hossaert-McKey, 2020; Janisiewicz and Korsten, 2002), either through the production of enzymes, antibiotics, lipopeptides, siderophores, or by competition for space and nutrients, properties that have been observed in most biocontrol agents (Bagnères & Hossaert-McKey, 2020; Calvo-Garrido *et al*., 2013; Bernard *et al*., 2012).

In the present work, *Botrytis* strains from three vineyards in the state of Querétaro, Mexico, were isolated and characterized. In order to find differences in terms of their ability to infect fruits and their susceptibility to biocontrol, using two yeast strains and one bacterium, as antagonists.

Materials and methods

Microbial antagonists

The antagonist microorganisms used in the present study were the yeasts *Metschnikowia* sp. NB9 and *Kodamaea* sp. FLL17 obtained from a fermentation must and apple blossom, respectively. Additionally, the bacterium *Bacillus* sp. FR4B12, isolated as apple epiphyte. All the isolates belong to the Laboratory of Plants and Agricultural Biotechnology of the Faculty of Chemistry of the Autonomous University of Querétaro, and have been tested against *Botrytis* strains in previous trials (Barcenas and Pacheco, 2019; Juárez-Campusano et. al., 2020).

Obtaining isolates of *B. cinerea*

During 2017, three vineyards located in the state of Querétaro, Mexico, were sampled. One vineyard located in the Municipality of El Marqués (A) and two more located in the Municipality of Ezequiel Montes (B and C). From the three vineyards, grape samples of three varieties ('Merlot', 'Tempranillo' and 'Syrah') were taken at random, later, the fruits were taken to the laboratory and were placed in humid chambers at 4 °C for 15 days to isolate the *Botrytis* strains, which were subsequently subcultured in Petri dishes with potato dextrose agar (PDA) until obtaining a pure culture. Consecutively, the fungus species was determined through the morphology of the mycelium and spores according to Khazaeli *et al*., (2012).

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Virulence of *isolates*

From the isolates obtained from *B. cinerea*, fruit tests were carried out to determine the infective capacity on table grape cv. `Thompson Seedless´. For this, the fruits were washed, disinfected and dried as indicated by Sandoval-Chávez *et al*., (2011). For the infection test, wounds were made in the grape fruits where 10^3 spores or active mycelium of 72 h (three groups of three fruits) were inoculated. At the end of the seven-day period, the size of the lesion was recorded using a vernier, classifying the strains according to their virulence. *Botrytis* BC152 was used as a control strain, which is an isolate from commercial table grape 'Thompson Seedless'.

Biocontrol tests

Of the *Botrytis* isolates, ten were selected for their differences in the degree of infection-virulence, to perform *in vitro* antagonism assays by dual culture.

A 7 mm disc of active mycelium was placed in the center of a yeast nutrient dextrose agar (NYDA) and allowed to grow 24 h at 35 °C. Subsequently, a roast of each antagonist was inoculated 1 cm from the edge of the Petri dish. Inhibition measurements were performed with a T&O Model 57-016-220 Digital Vernier until the control was fully grown. All tests were performed in triplicate.

Statistical analysis

All data were subjected to a test of normality and homoscedasticity, and subsequently subjected to an analysis of variance. (ANOVA). In the biocontrol tests, the values obtained were expressed as the percentage of inhibition of the mycelium, according to the formula proposed by Chen et, al. (2018). The data were transformed to angular degrees to submit them to an analysis of variance, and to a Tukey test of means analysis with 99% confidence. All analyzes were carried out in the R program version 4.0.3.

Results

Obtaining isolates of *B. cinerea*

40 *Botrytis* isolates were characterized. From the different vineyards, 15 were obtained from A, 11 from B and 14 from C, there were no significant differences in number between them.

Although initially it was considered that, due to the cultural and chemical management in the different places, there would be differences, it seems that it was not a relevant factor. On the other hand, when comparing according to the grape variety, it was found that 27 of these came from the 'Merlot' variety, 11 from 'Syrah' and the rest from 'Tempranillo'. This shows, in part, that, despite being the same type of host, the responses can be variable due to particular factors in them (Nakajima, & Akutsu, 2014).

Virulence of isolates

Regarding the degree of damage produced by the different isolates on grape fruits, it was found that most caused lesions in a range of 6.5 to 22.2 mm in diameter, with differences between the strains (ANOVA, Tukey $p < 0.01$). In general, it was found that the BC136 isolate obtained from the 'Syrah' grape from vineyard C, was the one that showed the greatest damage to the grape, with an average 22.2 mm, in contrast to BC154 isolated from the 'Merlot' grape, from Vineyard B , which produced a minimal lesion of 6.5 mm. This shows the variety of degrees of damage that a species of fungus can have, since different types of characters can be found among the isolates, such as the production of enzymes, the capacity and speed of conidia formation, and the same response of the host to intervene in the virulence process (Rascle *et al*., 2018; Nakajima, & Akutsu, 2014).

Biocontrol tests

Of the strains resulting from the fruit injury test, ten isolates that presented varying ranges of injury were selected and subjected to a dual antagonism test in vitro with the yeast NB9 and FLL17 and the bacterium, FR4B12. Fig. 1 shows the differences that the microorganisms exerted on the Botrytis strains (Figure 1). FR4B14 inhibited the different strains in a greater amount in a range from 51 to 81^{a}%, and FLL17 and NB9 yeasts, in ranges of 21-53^{b}% and 15-51^{c}% respectively (ANOVA, Tukey $p < 0.01$, ^{a}, ^{b}, ^{c} Same letters, no significant differences) (Graph 1).

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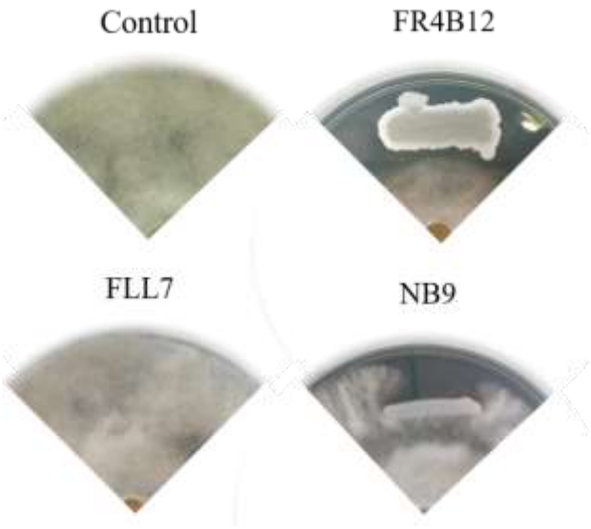
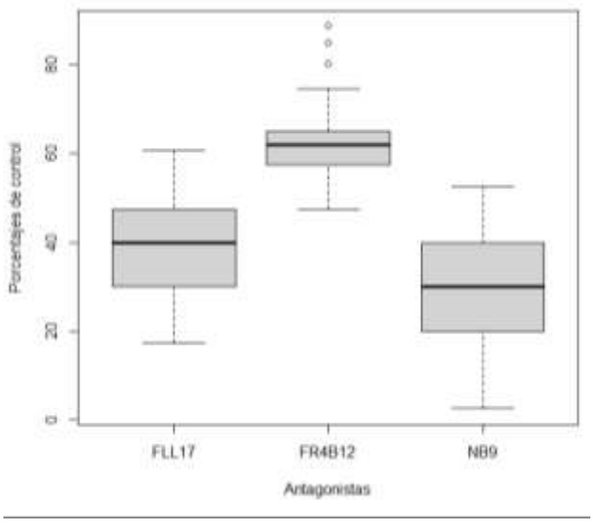
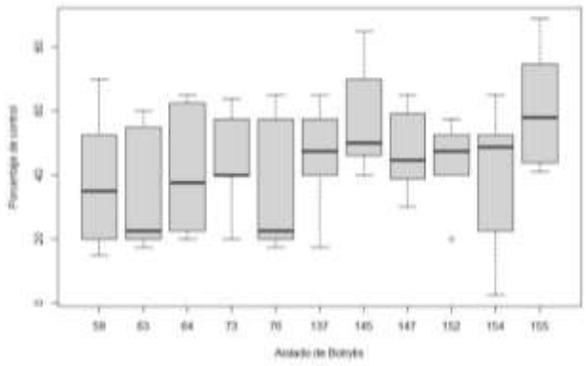


Figure 1 Biocontrol in dual culture of *Botrytis* BC155 using the different antagonists

On the other hand, it was also observed that the degree of biocontrol varies for each strain, of which were used for this test, BC76 (isolated from 'Merlot' grape, from vineyard A) resulted with the lowest percentages of inhibition (35%[b]), while BC155 (isolated from Merlot, from vineyard B) exhibited the highest percentages of inhibition (81%[a]). The remaining BC59, 63, 64, 73, 137, 145, 147, 152 and 154 were intermediate and similar to each other ab (ANOVA, Tukey p <0.01, [a], [b], [c] Equal letters, no significant differences) (Graph 2).



Graphic 1 Biocontrol effectiveness of antagonist microorganisms tests on *Botrytis* isolates



Graphic 2 Biocontrol among *Botrytis cinérea* isolates

Comparing the results of both trials, we found that although BC76 showed minimal lesions in fruit (9.76 mm), it was the least inhibited in the antagonism trials, while BC155 showed higher lesion values (14.5 mm) compared to BC76, was mostly inhibited by antagonists.

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Conclusions

This study shows that different *Botrytis* isolates from three vineyards in the state of Querétaro, present physiological variations in terms of their infective capacity of table grapes (Thompson Seedless'), finding highly infective isolates in the three study sites.

The biocontrol capacity on the *Botrytis* isolates was mainly carried out by the bacteria obtained from apple fruit, which indicates the versatility of the biocontrol agents to act in cultures other than those that were isolated.

The *Botrytis* isolates that caused the least lesions in the fruit, showed in biocontrol tests, low and intermediate inhibition values, which could indicate the establishment of resistant strains.

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Physical and technological characterization of the wood of candidate clones of *Eucalyptus urophylla*

Caracterización física y tecnológica de la madera de clones candidatos de *Eucalyptus urophylla*

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Abstract

The aim of this work was to evaluate the basic density of wood from candidate clones of *Eucalyptus urophylla*, in Huimanguillo, Tabasco. Eleven different genotypes of five and 12 years old were studied. Two methodologies were used, the empirical method and by water displacement. The density of wood in the genotypes ranged from 0.38 to 0.63 g cm-3 which is catalogued as light to very light. The variation in basic density between clones and the methodologies used was not significant.

Clones, Density, *Eucalyptus*

Resumen

El presente trabajo tuvo como objetivos evaluar la densidad básica de la madera de clones candidatos de *Eucalyptus urophylla*, en Huimanguillo, Tabasco. Se estudiaron 11 genotipos diferentes de cinco y 12 años de edad. Se emplearon dos metodologías, el método empírico y por desplazamiento en agua. La densidad de la madera en los genotipos osciló entre 0.38 y 0.63 g cm^{-3} que es catalogada como liviana a muy liviana. La variación de la densidad básica entre clones y las metodologías empleadas no fue significativa.

Clones, Densidad, *Eucalyptus*

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Introduction

The genus *Eucalyptus* is one of the most used in commercial forest plantations (PFC) due to the goodness of the wood for various uses that several species of this genus present. The municipality of Huimanguillo, Tabasco presents favorable conditions for the development of *Eucalyptus* species with a warm climate. *Eucalyptus urophylla* has been one of the most widely planted in recent decades due to its good growth in the region. Its use has been mainly in the pulp industry and currently for the production of medium density fibreboard (MDF, for its acronym in English).

Generally, in genetic improvement programs, the traits of greatest interest that are selected are those linked to growth and the shape of the trees, since they are directly linked to the productivity and economic performance of PFCs (Alarcón *et al*., 2018). However, there has been an interest on the part of forest managers to increase the range of end products that can be obtained from the wood produced in PFCs. This would increase the profitability of the plantations since the wood would be given greater added value with products of higher economic value.

One of the characteristics that define the quality of the wood, and that has taken on greater relevance, is the basic density, regardless of the final destination, either for the production of pulp or solid wood. The basic density is an indicator of the quality and performance of wood and its derivatives (Arango *et al*., 2001). In addition, it is a coefficient that allows the transformation of the volume of green wood to dry matter, this is important, since it is a starting point to estimate carbon stores in standing trees (Muñoz *et al*., 2019).

It has been found that the basic density varies due to various factors such as management, species, genotype, and even position within the tree (Muñoz *et al*., 2019). Omonte *et al*., (2019) found that the basic density in Eucalyptus nitens trees was generally lower in the upper part of the trees and in wood close to the bark. Eufrade-Junior *et al*., (2017) evaluated the effect of planting density and fertilization on the basic density of Eucalyptus urograndis. The authors found that the basic density was higher in the plots with less dense spacing, and in those where the fertilization dose was higher.

Eucalyptus urophylla in Huimanguillo achieve + growth rates in volume greater than 30 m3 ha-1 year-1 (CONAFOR and AMEPLANFOR, 2016). Despite the fact that most of this wood is used to make MDF, previous studies mention that *E. urophylla* wood has excellent characteristics as structural wood for construction (Lahr *et al*., 2017), cellulose for paper (Souza *et al*., 2017), and to obtain coal (Marchesan *et al*., 2020).

In Mexico, few studies have been done that address the physical properties of *Eucalyptus urophylla* wood, especially those related to basic density. Due to the good growth that the species shows and the goodness of its wood, it is possible to expand the range of final products, however, it is necessary to characterize the wood physically and anatomically to assess the alternative uses to MDF that can be achieved with wood from *E. urophylla* in Huimanguillo.

Objective

The objective of the work was to evaluate the basic density of the wood of *Eucalyptus urophylla* clones in forest plantations in Huimanguillo, Tabasco.

Materials and methods

The material used in the study was obtained from two clonal tests of *E. urophylla*, one of 12 years of age located in the Miguel Alemán ranch and the other of five years of age located in the Valle Verde ranch in Huimanguillo, Tabasco.

11 different genotypes were selected. The basic density of seven five-year-old genotypes was obtained by the empirical method through the extraction of wood chips with a Pressler drill. Density was estimated for the four remaining genotypes with the water displacement method.

Empirical method

The empirical method described by Valencia-Manzo and Vargas-Hernández (1997) is a simple and highly reliable method to estimate the density of wood in samples that have a geometric shape. Each wood (chip) sample was considered a perfect cylinder. Wood samples were obtained from side to side of the stem with a Pressler drill with an internal diameter of 5 mm.

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In the clones of five, samples were obtained at the height of the normal diameter at 1.30 m from the ground (DN), and in those of 12 years, chips were obtained at different heights of the tree: 0.30 m, 1.30 m, 50% and 75% of the total height.

Each sample was measured for length when the moisture content of the sample was above the saturation point of the fiber, immediately after being collected. The length was measured with a graduated ruler to the nearest millimeters. Each sample was stored in a plastic straw and transported in a cooler to the laboratory in order to avoid dehydration.

With the length of the sample and the internal diameter of the hole (5 mm), the green volume was obtained with the equation 1: 1

$$V_v = \pi * D^2 * (L/4) \quad (1)$$

Where,
V_V = volume of the wooden cylinder (cm3)
D = inner diameter of pressler drill (0.5 cm)
L = length of the wood sample (cm)

The anhydrous weight (Po) of the samples was obtained on an analytical balance after dehydrating the wood chips in an oven at 70 ° C until constant weight.

With the data of anhydrous weight (Po) and green volume (Vv) the value of basic density of the wood (Db) was obtained, according to equation 2:

$$D_b = P_o/V_v \quad (2)$$

Where,
D_b = basic density (g cm-3)
P_o = anhydrous weight (g)
V_V = Wooden cylinder volume (cm3)

Water displacement method

The green volume was estimated with mode III of method B of the ATSM D2395-14 standard, which establishes the guidelines for making standard tests of density and specific gravity of wood and wood-based materials (ASTM, 2014).

Destructive sampling was made for the wood analysis. The trees were measured for total height (AT) and DN, later they were knocked down, from each tree slices of 5 cm thick were obtained at the height of the stump (0.30 m), DN, 50 and 75% of the height total to see the variation in density along the stem. The slices were taken to the laboratory of the company Forestaciones Operativas de México S.A de C.V to obtain small samples of 3 x 3 x 3 cm. The samples were immersed in water for a period of five days to saturate the fibers.

After this period, they were weighed on a scale with a precision of 0.001 g to obtain their green weight. The green volume was obtained by displacement of water as indicated in mode III of method B of the international standard D2395-14.

After obtaining the volume, they were placed in a drying oven to dehydrate the sample at 70 ° C until constant weight. With the green volume value and the dry weight of the sample, the density was obtained, which is the relationship between mass and volume (Equation 3).

$$\rho = {}^{m}/_{v} \quad (3)$$

Where,

ρ = basic density (g cm-3)
m = dry mass of the sample obtained in the drying oven (g)
v = volume of the sample obtained by water displacement (cm3)

Results and Discussion

Empirical method

Of the clones evaluated at 5 years (Table 1), the density ranged between 0.38 and 0.53 g cm-3. Clone 5 had the lowest density of all. Based on the NBR 11941 standard (ABNT, 2003), the density of the wood for the seven clones evaluated by the empirical method is classified from light to very light. These results are very similar to those obtained for other *Eucalyptus* species. Alarcón *et al*., (2018) estimated an average basic density of 0.42 g cm-3 for *Eucalyptus grandis* in Argentina, with a range of 0.34 to 0.52 g cm-3 as minimum and maximum values, respectively.

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Clone	Length (cm)	Green volume (cm3)	Dry weight (g)	Density (g cm-3)
1	16.30	3.17	1.47	0.46
2	14.63	2.87	1.53	0.53
3	16.40	3.23	1.43	0.45
4	14.15	2.75	1.25	0.45
5	16.90	3.30	1.25	0.38
6	16.40	3.20	1.50	0.48
7	20.80	4.10	1.67	0.40

Table 1 Basic density obtained in wood chips in five-year-old *E. urophylla* clones

In the 12-year-old clones (Table 2), the wood sample obtained at different heights of the tree yielded densities that ranged between 0.51 and 0.72 g cm-3, although the vast majority of densities were in a range of 0.52 to 0.53 g cm-3. There is no density trend at the different heights sampled. Both at the height of 0.30 m and at 75% of the height of the trees the densities are very similar. The density obtained by the empirical method in 12-year-old trees (Table 2) was slightly higher than that obtained in five-year-old trees (Table1).

Clone	Section	Green volume (cm3)	Dry weight (g)	Density (g / cm3)
1	0.30	6.56	3.38	0.52
	1.30	5.99	3.12	0.52
	50%	3.46	1.96	0.57
	75%	1.98	1.01	0.51
2	0.30	6.95	4.34	0.62
	1.30	4.59	2.45	0.53
	50%	3.97	2.51	0.63
	75%	2.49	1.56	0.63
3	0.30	0.00	0.00	0.00
	1.30	5.71	3.01	0.53
	50%	3.93	2.13	0.54
	75%	2.63	1.42	0.54
4	0.30	6.58	4.73	0.72
	1.30	6.75	3.69	0.55
	50%	4.01	2.20	0.55
	75%	2.47	1.47	0.59

Table 2 Basic density obtained from wood chips of 12-year-old *E. urophylla* clones

This characteristic may be associated with a greater amount of juvenile wood in the five-year-old clones compared to a greater amount of late wood in the 12-year-old clones (Blanco-Flórez *et al*., 2014).

Water displacement method

The wood density of the clones estimated by this method ranged from 0.49 to 0.63 g cm-3. However, the large proportion of the density fluctuated between 0.54 and 0.56 g cm-3 at 12 years of age of the trees.

Taking the NBR 11941 (ABNT, 2003) standard as the reference, the density values at the different heights of the tree are classified from light to very light.

Clone	Section	Green Weight (g)	Green volume (cm3)	Dry weight (g)	Density (g / cm3)
1	0.3 m	32.70	29.22	15.12	0.52
	1.3 m	33.58	30.98	15.88	0.51
	50%	33.85	31.53	17.42	0.56
	75%	27.25	25.67	13.80	0.54
2	0.3 m	31.33	29.13	18.35	0.63
	1.3 m	32.22	31.45	16.93	0.54
	50%	27.00	27.50	15.18	0.55
	75%	28.82	28.90	16.20	0.56
3	0.3	34.90	36.17	19.77	0.54
	1.3	29.65	30.65	15.85	0.53
	50%	21.00	21.73	11.90	0.55
	75%	21.90	22.83	16.20	0.56
4	0.3	37.15	35.25	18.25	0.52
	1.3	34.50	35.00	16.75	0.49
	50%	26.95	27.00	13.10	0.49
	75%	26.90	26.00	13.95	0.54

Table 3 Basic wood density of *E. urophylla* clones from the 12-year trial obtained using the water displacement technique

In general, the results of the basic density of *Eucalyptus urophylla* clones obtained in Huimanguillo is similar to that obtained in other eucalyptus studies. Omonte *et al*., (2019) obtained densities between 0.41 and 0.56 g cm-3 in 18-year-old *Eucalyptus* nitens trees in Chile. Igartúa and Monteoliva, (2010) estimated densities between 0.42 to 0.61 g cm – 3 in *Eucalyptus* globulus trees in Argentina. The range of basic density obtained in this study was similar to that obtained by Alarcón *et al*., (2018), who obtained values of 0.32 to 0.70 g cm-3 of basic density using three different methods in three *Eucalyptus* species in Argentina.

The results obtained in this study are comparable with almost all those carried out for eucalyptus as mentioned above, however, when they are compared with other forest species the results are inferior. Muñoz *et al*., (2019) estimated the basic density for 59 forest species with a warm climate in Brazil. The authors entered that 48 species had densities that oscillated above 0.60 g cm-3, reaching values of up to 1.25 g cm-3. The eleven remaining species evaluated by the authors ranged between 0.38 and 0.59 g cm-3, very similar to those of *E. urophylla* obtained in this study.

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In general, the density obtained in both the five and 12-year-old clones fall within the range of light to very light woods according to the NBR 11941 standard (ABNT, 2003). However, even being light wood, these results encourage the production of *Eucalyptus urophylla* wood in Huimanguillo because the density ranges obtained in this study corroborate what was found by other authors on the diversity of uses of the wood of this species.

Since, in addition to being suitable for the production of MDF, they are also suitable for the production of pulp for paper with optimal densities ranging from 0.4 g cm – 3 to 0.6 g cm-3 (Downes *et al*., 1997; Alarcón *et al*., 2018), particularly the five-year-old clones that show the best densities for this use. Also, the densities obtained in 12-year-old trees are ideal for carbon production, since the wood is slightly denser than the five-year-old clones, this characteristic has direct implications since it improves the energy mass and the mechanical resistance of the charcoal (Marchesan *et al*., 2020).

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Conclusions

The average basic density of all the clones obtained with the empirical method is 0.45 g cm-3. Most of the clones showed similarity for the basic density, with values between 0.40 and 0.48 g cm-3.

With the water displacement method, the basic density ranged between 0.49 and 0.63 g cm-3, obtaining an average of 0.54 g cm-3.

The basic density obtained by the two methods is classified as liavian to very light, however, it presents ideal characteristics for the manufacture of MDF, pulp for paper, and the wood of the older clones can be used to obtain charcoal.

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Effect of Potassium Iodide and Salicylic Acid in the Cultivation of Hydroponic Strawberries (*Fragaria* L)

Efecto del Ioduro de Potasio y Ácido Salicílico en el Cultivo de Fresas Hidropónicas *(Fragaria* L*)*

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Abstract

The fortification of essential foods that the majority of the population consumes has a very great advantage in nutrition; Since it is one of the most effective ways to fill some deficiencies, the objective of this work is to increase the nutritional value of strawberry cultivation under hydroponic conditions, the methodology started with the disinfection with 10% chlorine of the hydroponic system, it was located In the basket, to place the seedlings, the nutrition was implemented with the initial Steiner's solution at 50% and later at 100%, three salicylic acid (AS) treatments were carried out: 0.0012 g / L, 0.0030 g / L, 0.0070 g / L and control (0 salicylic acid) and Potassium Iodide (KI) with treatments of 0.0014g / L, 0.0016g / L and 0.0018g / L and control (0 iodine). In soluble solids, a total of three fruits were selected per treatment, it was shown that (T3), repetition 1 (0.0014 g / L) with KI, obtained an average of 8 fruits, the (T1), repetition 2 (0.0030 g / L) with AS (Salicylic Acid) with an average of 23.3 g of fruit weight, repetition 1 (0.0014 g / L) with IK, obtained an average of 8.8000 ºBrix, the ANOVA analysis shows in AS a P value of 0.034, in the control has a P value of 0.054 and in IK a P value of 0.040, which tells us that there is a positive significance in relation to the control towards the weight of the fruits, for which treatment number three is suggested for subsequent work . Keywords: Salicylic acid, potassium iodide, strawberry, NFT system and refractometer.

Salicylic acid, Iodine, Strawberry, NFT system, Refractometer

Resumen

La fortificación de alimentos esenciales que consume la mayoría de la población, tiene una ventaja muy grande en la nutrición; ya que es una de las maneras más eficaces de suplir algunas deficiencias, el objetivo del presente trabajo es incrementar el valor nutricional del cultivo de la fresa bajo condiciones hidropónicas, la metodología inicio con la desinfección con cloro al 10% del sistema hidropónico, se ubicó en la canastilla, para colocar las plántulas, la nutrición se implementó la solución de Steiner inicial al 50% y posteriormente al 100%, se realizaron tres tratamientos ácido salicílico (AS) fueron: 0.0012 g/L, 0.0030 g/L, 0.0070 g/L y testigo (0 ácido salicílico) y el Ioduro de Potasio (KI) con tratamientos de 0.0014g/L, 0.0016g/L y 0.0018g/L y testigo (0 yodo). En solidos solubles se seleccionó un total de tres frutos por tratamiento, se demostró que el (T3), repetición 1 (0.0014 g/L) con KI, obtuvo una media de 8 frutos, el (T1), repetición 2 (0.0030 g/L) con AS (Ácido Salicílico) con media de 23.3 g de peso en frutos, repetición 1 (0.0014 g/L) con IK, obtuvo una media de 8.8000 ºBrix, el análisis ANOVA arroja en AS un valor de P de 0.034, en el testigo un valor de P de 0.054 y en IK un valor de P de 0.040, lo cual nos dice que hay una significancia positiva en relación al testigo hacia el peso de los frutos, por lo cual se sugiere el tratamiento número tres para posteriores trabajos.

Ácido salicílico, Yoduro de Potasio, Fresa, Sistema NFT, Refractómetro.

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Introduction

The *Fragaria* x *ananassa* Duch. Strawberry is a fruit appreciated worldwide for its aroma, bright red color and juicy texture (Khoshnevisan *et al*., 2013). The incorporation of this crop in the municipality of Rodeo, Dgo, may be developed under two protected conditions; one is the greenhouse for better pest control and the hydroponic system that helps control the application of nutrient solutions in a safe and efficient way.

Seedling development under NFT conditions and under greenhouse conditions is a great tool for the control of pests that affect the development of fruits, flowers and plants. On the other hand, the introduction of soilless crops or hydroponic crops are techniques used for the optimal development of the crop in which its root system develops without soil (Nieto, 2013).

This process is generated without soil, giving the plants the appropriate conditions (oxygenation and the assimilation of nutrients in an ionic way), in addition, according to Ruíz (2012), he estimated the amount of fruit of the first and second qualities are the most commercialized. So more production is generated in less space by using production tools properly.

Theoretical Foundation

Strawberry in Mexico

Strawberry cultivation was confined until 1990 in the regions of Irapuato, Gto.; Zamora, Michoacán; and neighboring municipalities (central Mexico). Starting in 1991, it spread to the San Quintin, Baja California area. The expansion of the crop occurred in 1994, with the entry into force of the North American Free Trade Agreement. In 2009, a sown area of 6,131 ha was reported, located in Michoacán, 3,561 ha in Baja California and 1,543 in Guanajuato, which covered 92% of the total area (SADER-SIAP, 2019).

Today Michoacán and Guanajuato concentrate 4,588 ha, which represents 69% of the cultivated area in the country (Cruz, 2014).

Strawberry cultivation

Strawberry is a perennial type vegetable that can live for several years, however, it lasts two years in economic production, in older plantations they are weaker, with low yield and lower quality fruits (Cruz, 2014).

Strawberry reproduction

The plants are propagated by stolons, and are generally distributed by bare roots. The crop follows one or two models, annual plasticulture, or a perennial system of rows or mounds (Sánchez, 2017).

Strawberry marketing

In national terms, strawberry production is important due to the generation of foreign exchange for exportation since Mexico is the main strawberry exporter to the US market (Villegas, 2017).

Nutritive solution

The concentration at which the different ions are found can be expressed in different ways, being millimole / L or meq / L in soilless cultivation systems, the most common in the case of ppm macro elements, and micro elements. To arrive at the formulation of the nutrient solution, it is important to take into account factors such as the hydrogen potential (pH), electrical conductivity (EC), which lead to good plant nutrition (Steiner, 1984).

NFT hydroponic system

This system forms a crop layer along the channels with a slope, where plants, especially vegetables, keep their roots moist and necessary nutrients. The greenhouse strawberry production with this system is used in temperate zones; since with excess temperature stress is caused in the plant, which requires greater care and nutritional treatment (González, 2008).

Iodine in agriculture

In the programs fortification of table salt with iodine, and with the purpose of ensuring the recommended daily intake of 150-300 μg of iodine day-1 (Risher and Keith, 2009).

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Various efforts are carried out to add iodine to terrestrial plants (especially medicinal plants and vegetables) to give them greater therapeutic or nutritional value (Cui *et al*., 2003).

Salicylic acid (AS) applied in agriculture Recent research indicates that AS stimulates the biosynthesis of phenolic compounds and the antioxidant capacity in fruits that, when consumed, improve public health (Khalili *et al*., 2010; Khandaker *et al*., 2011).

Methodology to be developed

Description of the study area

The present work was developed within the facilities of the Technological University of Rodeo in the municipality of Rodeo, Dgo, (Figure 1). It is located in the center of the state of Durango. It borders to the north with the municipality of San Pedro del Gallo; to the northeast with San Luis del Cordero; to the east with Nazas; to the south San Juan del Río. Its municipal seat is located at the coordinates 25º11 'of north latitude and 104º34' of west longitude, at an altitude of 1,340 meters above sea level.

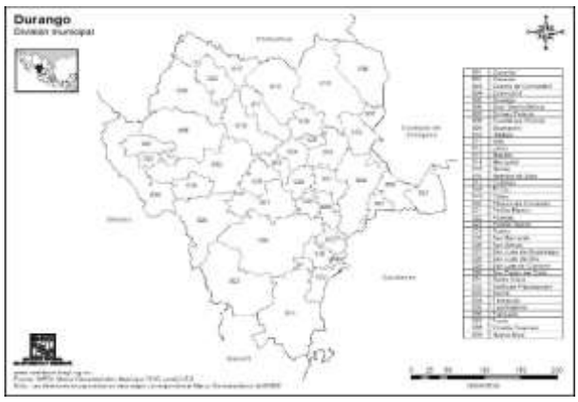

Figure 1 Location of study area
Source: Silva, 2020

Washing and disinfecting the NFT system

To wash the NFT system, the equipment was uninstalled for greater efficiency when cleaning, in addition to having a better reach in and out of the tubes with the help of a wire or cable that is flexible enough to place a sponge. or rag to push back and forth.

Chlorine was used for disinfection, in a concentration of 1 ppm

Water circulation in the NFT system

For the water circulation a submersible pump of 19 L / hour is used to give fluidity to the system, in order to oxygenate the roots and plants as much as possible, as well as to promote fertilization.

Strawberry seedling transplant

To place the seedlings in the NFT system, the baskets that hold the plants over the tube hole are disinfected with the same dosage with which the system and the pump were disinfected.

Sponge placement in baskets

A sponge was placed around the root and placed in the basket to prevent light rays from penetrating the root, leaving out the propagation of pests inside the tubes, preventing good oxygenation.

Vegetal Nutricion

In the nutrition process, it was carried out with a Steiner solution at 50% and later at 100%, with fertilizers being represented (Table 1).

Agrochemicals	Amount of g for 50 L of water
Nitric acid (HNO_3)	2.2 mL
Phosphoric acid	6.15 mL
Calcium nitrate (CaNO3)	22 g
Potassium nitrate (KNO3)	13.65 g
Potassium sulfate (K2SO4)	10 g
Magnesium MgSO47H2O	17.2 g
Micros	2 g

Table 1 Amount of fertilizers applied for the 100% Steiner solution in 50 L of water

Application of micro-nutrients in water

A quantity of 2 g of microphones was applied, which has iron as an essential element. Once the strawberry plant was observed, the leaves turned green-brown; this in order that the plant does not absorb the alkaline from the recirculating water.

Foliar application of iodine

The first foliar application of potassium iodide was carried out 15 days after transplantation, with 4 foliar applications being made throughout its cycle, with 15-day intervals. The treatments were iodine in quantities of 0.0014 g / L, 0.0016 g / L and 0.0018 g / L, as well as a control (0 iodine) with the same applications as the previous treatments.

The foliar sprays were carried out with one atomizer per plant to reduce the danger of contamination in the other treatments. The concentrations being represented in the following Table 2.

Treatment	Weight in mg	Division by 1000	Weight in g / L
0 UM	0	/1000	Witness
5 UM	1.40 mg/L	/1000	0.0014 g/L
10 UM	1.60 mg/L	/1000	0.0016 g/L
15 UM	1.80 mg/L	/1000	0.0018 g/L
*UM= Millimolar units			

Table 2 Concentration of each of the iodine applications by treatment

Foliar application with salicylic acid

The first foliar application of salicylic acid was carried out 15 days after transplantation, with 4 foliar applications being made throughout its cycle, with 15-day intervals. The treatments were 0.0012 g / L, 0.0030 g / L, 0.0070 g / L, and a control (0 salicylic acid) with the same applications as the previous treatments. The foliar sprays were carried out with the help of a one-liter atomizer to facilitate the application per plant and reduce the danger of contamination in the other treatments than in subset, as expressed by Sariñana-Aldaco (2019), in an investigation that I performed with Salicylic Acid, which showed a good response of the tomato crop, the application was directly in the nutrient solution, in the present experiment the concentrations were represented in the following Table 3.

Treatment	Weight in mg	Division by 1000	Weight in g / L
0 UM	0	/1000	Witness
5 UM	1.20 mg/L	/1000	0.0012 g/L
10 UM	3.07 mg/L	/1000	0.0030 g/L
15 UM	7.05 mg/L	/1000	0.0070 g/L
*UM= Millimolar units			

Table 3 Concentration of each of the salicylic acid applications per treatment

Determination of total soluble solids in fruit

For the determination of soluble solids, a total of 3 fruits were selected per treatment, gloves made of latex material were used in order not to contaminate the samples, which consisted in the extraction of the aliquot of the fruit in order to deposit it in the orifice of the manual refractometer (Master Refractometer Automatic Atago), for later the values were expressed in degrees brix and temperature taken.

Fruit weight

In this activity, 3 fruits per treatment were taken as a reference in order to compare the weight in grams, for this a gramera scale with a capacity of 1000 g was used.

Number of sheets

For the number of leaves, it was completely at random observing the new leaves per plant of each treatment; this in order to relate the fruits with the other applications of potassium iodide and salicylic acid.

Experimental design

A completely randomized experimental design was used with five treatments and six repetitions per treatment, with a total of 30 experimental units (each plant is considered an experimental unit), this was carried out a statistical analysis using SPSS Version 15.0 software, with an analysis variance (ANOVA) and mean comparison using the single-sample test ($P \leq 0.05$).

Results and Discussion

Analysis of variance and comparison of mean using the test of a single sample ($P \leq 0.05$), for number of fruits. For the analysis of variance, it was determined in the SPSS version 15.0 program, with a single sample test ($P \leq 0.05$), which showed that treatment 3 (T3), repetition 3 with KI (Potassium Iodide), with addition of 0.0070 g / L obtained an average of 8 fruits. In an investigation with strawberry plants, cultivar Camarosa, the foliar application of gibberellic acid in a range of 0 to 40 mg / L increased the production of fruits per plant (Pérez de Camacaro *et al*., 2013).

These data do not agree in the present investigation; Since it was handled in units of g / L, in the case of the other treatments (salicylic acid and Control) the treatments are statistically equal in comparison of means, the same results were obtained (Table 4 and 5).

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Treatments	Number	Mean	Standard deviation	Typ. Error of the average
AS	3	6.6667	2.08167	1.20185
TES	3	6.0000	1.00000	0.57735
KI	3	8.6667	4.16333	2.40370
* AS = Salicylic Acid, KI = Potassium Iodide, TES = Control				

Table 4 Comparison of means using the test of a single sample (P≤0.05), in numbers of fruits

Treatments	gL	Sig. (Bilateral)	Difference of means	95% Confidence interval for the difference	gL	Sig. (Bilateral)
	Lower	Higher	Lower	Higher	Lower	Higher
AS	5.50	2	0.031	6.6166	1.4455	11.7878
TES	10.3	2	0.009	5.9500	3.4659	8.4341
KI	3.58	2	0.070	8.6166	-1.7256	18.9590
* AS = Salicylic Acid, KI = Potassium Iodide, TES = Control						

Table 5 Statistics for a sample analysis of variance (ANOVA), for numbers of fruits

Analysis of variance and comparison of mean using the single sample test (P≤0.05), for fruit weight

For the fruit weight variable, the analysis of variance and with a single sample test (P≤0.05), it was shown that treatment 1 (T1), repetition 2 with AS (Salicylic Acid) with the addition of 0.0030 g / L obtained An average of 23.3 g with fruit weight, in an investigation by Domínguez-Morales (2012), evaluated the variety 'Aguedilla' of strawberry cultivation presented the highest average fruit weight throughout the campaign, with average values of 29.5 g fruit -1, these results do not agree in the present investigation (Table 6).

Treatments	Number	Mean	Standard deviation	Typ. Error of the average
AS	3	23.3333	7.63763	4.40959
TES	3	18.3333	7.63763	4.40959
KI	3	22.6667	8.08290	4.66667
* AS = Salicylic Acid, KI = Potassium Iodide, TES = Control				

Table 6 Comparison of mean using single sample test (P≤0.05), fruit weight

On the other hand, in the case of the other treatments (salicylic acid and potassium iodide), the ANOVA analysis shows a P value of 0.034 in AS, (salicylic acid), a P value of 0.054 in the control and in IK (Potassium iodide) a P value of 0.040, which tells us that there is a positive significance in relation to the control towards the weight of the fruits (Table 6 and 7).

Treatments	gL		Sig. (Bilateral)	Difference of means	95% Confidence interval for the difference	gL
	Lower	Higher	Lower	Higher	Lower	Higher
AS	5.280	2	0.034	23.28333	4.3104	42.2562
TES	4.146	2	0.054	18.28333	-.6896	37.2562
IK	4.846	2	0.040	22.61667	2.5376	42.6957
* AS = Salicylic Acid, KI = Potassium Iodide, TES = Control						

Table 7 Statistics for a sample analysis of variance (ANOVA), for fruit weight

Analysis of variance and mean comparison using the single sample test (P≤0.05), for total soluble solids

For the variable total soluble solids, the analysis of variance and with a single sample test (P≤0.05), which showed that treatment 3 (T3), repetition 1 with IK (Potassium Iodide), with the addition of 0.0014 g / L obtained an average of 8.8000 ºBrix, in the case of the other treatments (salicylic acid and Control), they are statistically equal in comparison of means, the same results were obtained, in an investigation by Casierra-Posada *et al*. (2011b), who mention that under the transparent cover, the strawberry plants showed a Net Assimilation Rate, higher than that presented by the strawberry plants grown under covers of other colors and obtained a higher content of TSS (Total soluble solids) , (Table 8 and 9). On the other hand, Petran *et al*. (2017), reported a difference in the SST values in fruits of different harvests. Likewise, it is mentioned that climatic conditions influence the total concentration of soluble solids.

Pokhrel *et al*. (2015), found that at higher temperatures the concentration of sugars increased in strawberry fruits.

Treatments	Number	Mean	Standard deviation	Typ. Error of the average	Treatments
AS		3	7.4333	0.51316	0.29627
TES		3	7.7000	0.36056	0.20817
IK		3	8.8000	0.69282	0.40000
*AS=Ácido Salicílico, KI=Ioduro de Potasio, TES=Testigo					

Table 8 Comparison of mean using the single sample test (P≤0.05), for total soluble solids (Brix degrees)

Treatments	Lower s	Degrees of freedom	Sig. (Bilateral)	Difference of means	95% Confidence interval for the difference	
	Inferior	Superior	Inferior	Superior	Lower	Higher
AS	24.921	2	0.002	7.38333	6.1086	8.6581
TES	36.749	2	0.001	7.65000	6.7543	8.5457
IK	21.875	2	0.002	8.75000	7.0289	10.4711
* AS = Salicylic Acid, KI = Potassium Iodide, TES = Control						

Table 9 Estadísticos para una muestra análisis de varianza (ANOVA), para solidos solubles totales (Grados brix)

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The main authors thank the Technological University of Rodeo, for the facilitations in the area of NFT systems and the general microbiology laboratory area.

Conclusions

Based on the results, it was shown that potassium iodide surpassed in at least 2 variables with number of fruits and in total soluble solids with the addition of 0.0014 g / L, between the two variables evaluated. In the case of AS, (Salicylic acid), in variable fruit weight stood out with the addition of 0.0030 g / L.

Recomendations

Perform quantification of total flavonoids, antioxidant capacity and phenolic compounds with this to perform a more in-depth investigation.

Treatment number three is suggested for further work.

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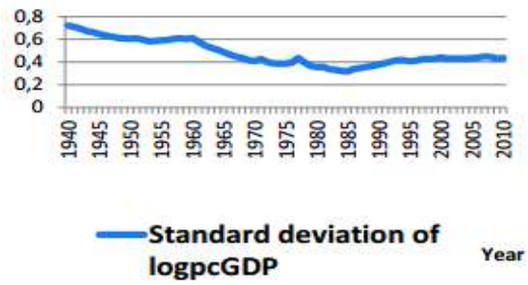

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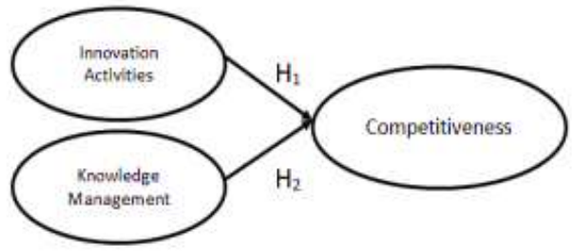

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