Chapter 4 Application of homeopathic preparations and biofungicides to prevent and control anthracnose (*Colletotrichum gloeosporioides*) in Haas avocado crops

Capítulo 4 Aplicación de preparados homeopáticos y biofungicidas para prevenir y controlar la antracnosis (*Colletotrichum gloeosporioides*) en los cultivos de aguacate Haas

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Abstract

Avocado production in Mexican territory is considered the most important in the world because it contributes 45.95% of agri-food exports, various states contribute to position Mexico as the main producer, approximately 175 thousand hectares with fruits of different sizes are counted that are cultivated in the states of Michoacán, Jalisco and Nayarit to later be commercialized nationally and internationally to Guatemala, Canada, Japan and El Salvador.The import and export process is restricted to the phytosanity variable as a consequence of the appearance of pests and the lack of control for the elimination or reduction of the main sources that cause them, the consumer states / countries demand a continuous application of plant health measures in the field and in the shipping processes to ensure that the systems of prevention, growth, elimination of pests are supported and evidenced in a scientific and technical way; seeking to provide the Mexican countryside with the best techniques for the preservation, control and sale of the fruit. Within the implemented techniques, Agrohomeopathy manages the reduction of pests and diseases, considering economic and ecological effects, this research shows the application of homeopathic preparations and commercial biofungicides, to prevent and control the presence of anthracnose (*Collectotrichum gloeosporioides*) in the cultivation of hass avocado, the experimental process was established with 64 trees infected with anthracnose; Through a random sampling, 10 treatments and a control of homeopathic preparations and biofungicides were applied, placing the foliage by means of aspersion., The effect was observed by means of the decrease in the number of pustules in leaves and fruit, decrease in the length of the pustule (cm), pustule width (cm) both in fruits and leaves. The treatments used showed an effective control in the development of the *C. gloeosporioides* infection: the agrohomepathic doses of the *C. gloeosporioides* preparation at 10 CH showed an influence on the parameter of length by width in fruit and leaf; The microbiological product formulated from 5 strains of bacillus Fungizar 5B controlled the damage in the parameter of length by width in leaf, through the described implementation the effectiveness of Agrohomeopathy for the preservation of avocado and the reduction of the treated plague was verified.

Avocado, Agrohomeapatia, Homeopathic Preparations, Anthracnose

Resumen

La producción de aguacate en el territorio mexicano es considerada la más importante del mundo ya que aporta el 45.95% de las exportaciones agroalimentarias, diversos estados contribuyen a posicionar a México como el principal productor, se contabilizan aproximadamente 175 mil hectáreas con frutos de diferentes tamaños que se cultivan en los estados de Michoacán, Jalisco y Nayarit para posteriormente ser comercializados a nivel nacional e internacional a Guatemala, Canadá, Japón y El Salvador. El proceso de importación y exportación está restringido a la variable fitosanidad como consecuencia de la aparición de plagas y la falta de control para la eliminación o reducción de los principales focos que las provocan, los estados/países consumidores exigen una aplicación continua de medidas fitosanitarias en el campo y en los procesos de embarque para asegurar que los sistemas de prevención, crecimiento, eliminación de plagas estén sustentados y evidenciados de manera científica y técnica; buscando dotar al campo mexicano de las mejores técnicas para la conservación, control y venta de la fruta. Dentro de las técnicas implementadas, la Agrohomeopatía logra la reducción de plagas y enfermedades, considerando los efectos económicos y ecológicos, esta investigación muestra la aplicación de preparados homeopáticos y biofungicidas comerciales, para prevenir y controlar la presencia de antracnosis (*Collectotrichum gloeosporioides*) en el cultivo de aguacate hass, el proceso experimental se estableció con 64 árboles infectados con antracnosis; A través de un muestreo aleatorio, se aplicaron 10 tratamientos y un control de preparados homeopáticos y biofungicidas, colocando el follaje mediante aspersión, El efecto se observó mediante la disminución del número de pústulas en hojas y frutos, disminución de la longitud de la pústula (cm), ancho de la pústula (cm) tanto en frutos como en hojas. Los tratamientos utilizados mostraron un control efectivo en el desarrollo de la infección por *C. gloeosporioides*: las dosis agrohomeopáticas del preparado de *C. gloeosporioides* a 10 CH mostraron influencia en el parámetro de longitud por ancho en fruto y hoja; El producto microbiológico formulado a partir de 5 cepas de bacilo Fungizar 5B controló el daño en el parámetro de longitud por ancho en hoja, a través de la aplicación descrita se comprobó la efectividad de la Agrohomeopatía para la conservación del aguacate y la reducción de la plaga tratada.

Aguacate, Agrohomeapatia, Preparados Homeopáticos, Antracnosis

1 Introducción

The avocado harvest (*Persea americana Mill*) is an economic factor of great importance for the country, so its consumption and marketing has grown considerably, both in the national and international markets.

Londoño et al., (2007) comment that anthracnose (*Collectotrichum spp*.) Affects various foods for human consumption, pastures and crops, including fruit trees. Among the fruit trees most affected by anthracnose, the mango (*Mangifera indica L*.), the avocado (*Persea americana Mill.*), The tree tomato (*Cyphomandra betacea Cav*.) Stand out, indicating that the pathogen belongs to the domain; Phylum Eukaryota; Ascomycota, of class Ascomycetes (III) and the (NCBI, 2007) mentions that it is of the genus; *Colletotrichum* (in the amorphous state) and *Glomerella* (in the Telemorphic state). This infestation was observed by Zamora-Magdaleno, et al., (2001) in various plantations where C. *gloeosporioides* appeared in the growing fruits through round translucent spots in an interval of 0.5 - 1.0 mm; Later an elevation of orange color is formed that changes to dark brown (Figure 4.1 Interval of round translucent spots in fruit with anthracnose affectation), the lesions did not multiply, but they were numerous in the fleshy body of the avocado causing that during the phases of harvesting and packing will increase injuries due to the handling process**.**

The need to generate sustainable and economic means or alternatives that avoid or reduce the appearance of conditions such as anthracnose (*C. gloeosporioides*) in Hass avocado crops (*P.americana*), brings with it the development of the present research implemented an Agrohomeopathic process through the placement of various preparations by means of spraying to 64 trees in a plantation made up of 370 trees corresponding to the aforementioned fruit genus, the process was observed through the decrease in the number of pustules in leaves and fruit, decrease in the length of the pustule (cm), pustule width (cm) in both fruits and leaves.

In the first instance, a review of the existing literature regarding anthracnose (*C. gloeosporioides*) was carried out, considering the morphology and symptoms presented in avocado; in addition to establishing the existing advances with the use of biopreparations, organic and chemical preparations for the treatment of fungi. The methodology used is based on 2 phases: phase 1 is considered as the stage of identification and assurance of the work system detailing the environment and conditions of the area in which the experimental research will be applied; It is made up of 3 stages characterized by the application of the exploitative analysis; Phase 2 contemplates the development of the experimental process, describing in a specific way each one of the compounds used and the study of the different factors that intervene in the process of eradication of the condition. Subsequently, the results obtained are detailed, this for each study period, making a comparison of the results obtained from the analysis with those resulting from other investigations, finally, the conclusions obtained and the existence of present and future benefits with the application of the homeopathic preparations and biofungicides in the avocado plantation.

Figure 4.1 Interval of round translucent spots in fruit with anthracnose affectation

Consultation Source: Own Elaboration

1.1 Literature review
1.2 Generalities of anthracnose (*C. gloeosporioides*)
1.3 Taxonomy of *C. gloeosporioides*

(Agrios, 2005) It indicates that the pathogen belongs to the domain; *Eukaryota del Phylum*; Ascomycota, of class Ascomycetes (III) and the (NCBI, 2007) mentions that it is of Genus; *Colletotrichum* in (amorphous state) and *Glomerella* in (Telemorphic state).

(Villanueva-Arce,2006) They argue that the representative symptoms of anthracnose (*C. gloeosporioides*) of naturally infected fruits are characterized by sunken, circular or irregular necrotic lesions, with well-defined raised edges and masses of orange conidia. (Lopez, 2008) Indicates that the different stages of development of *Colletotrichum* species can be separated into: 1) deposition on the surface of the host, 2) subjection of the conidium on the surface, 3) germination of the conidia, 4) production of the appressorium, 5) penetration of the epidermis of the plant, 6) growth and colonization of the host tissue and 7) production of acérvalos and sporulation.

1.4 Symptoms of *C. gloeosporioides* in avocado fruits

(Garcia, 2009) Describes that avocado fruits with symptoms of anthracnose presented variation in the color of the colonies, which contrasts with the description of dark gray colonies for *C. gloeosporioides*, as well as the variation in size and shape of the conidia. that have served to separate species of Colletotrichum spp. in strawberry. (Rodriguez Lopez, 2013) He mentions that in the field, the fruits present symptoms called "smallpox" and "clove". In reference to the first one, it begins with small light brown spots and, later, dark and sunken brown. Consequently, the lesion takes on a dry and brittle appearance, in the shape of a crater, becoming detached.

1.5 Use of biopreparations for the control of fungi

The way of administering medicines in homeopathy is directly related to the fundamental principles of this. After having taken that into account, the scale of dynamization of the remedies will be defined, then the potency and, later, the frequency of administration. Let us point out at this moment that we do not speak of dose itself, since this word traditionally refers to quantity or volume and in homeopathy, thanks to abundant clinical experience, we know that usually ten drops or globules do not have more effect than five (Eizayaga, 1991, p. 284 cited by Meneses, 2020). The most used dynamization scales are: decimal (X), centesimal (CH) and fifty-thousandth (LM). Each scale obeys defined pharmaceutical techniques and basically differs in the method of preparation.

Potency refers to the degree of dynamization (dilution + succussion). The higher the dilution and succussion, the higher the potency. Thus, 30 CH is more powerful than 24 CH since more dilutions and, therefore, more succussions have been involved in its preparation process. The frequency refers to the initial shot and its subsequent repetitions. The single, non-repeated dose, or single dose, is preferred when one is very sure of the remedy and when the state of the vital force does not make its frequent administration necessary (Meneses, 2020).

(Vargas Toledo, 2016) It demonstrated that the in vitro fungitoxicity against *Alternaria solani* by the homeopathic medicines *Propolis*, *Isotherapic* of *A. solani* and *Isotherapic* of ash, at 6, 12, 30 and 60 CH (centesimal hahnemaniana) dynamizations, and Sulfur , *Silicea Terra*, *Staphysagria*, *Phosphorus*, *Ferrum sulphuricum* and *Kali iodatum* at dynamizations 6, 12, 30 and 100CH, in which I use distilled water and a 30% hydroalcoholic solution as controls at 12, 30, 60 and 100CH dynamizations, in which the mycelial growth, sporulation and conidial germination of *A. solani* were evaluated. The results indicated that for mycelial growth only in *Sulfur* and *Staphysagria* 100CH it showed a suppressive effect in comparison with both controls. For sporulation, Propolis 6, 30 and 60CH and *Ferrum sulphuricum* 6 and 30CH caused inhibition and differed from both controls. Isotherapeutic of A. *solani* 6CH, *Isotherapeutic* of ash 6CH and *Ferrum sulphuricum* 30CH reduced the germination of the spores of the pathogen. (Hanif, Shahnaz, Tariq, & Imtiaz, 2015) They affirm that in the in vitro experiment, homeopathic granules of *Árnica montana* and *Thuja occidentalis* (100, 75 and 50%). v / w conc.) the result obtained was the inhibition of the fungi that infect the roots, such as *Fusarium oxysporum*, *Macrophomina phaesolina* and *Rhizoctonia solani*. The granules of *T. occidentalis* and *A. montana* (100% v / w conc.) However, the granules *T. occidentalis* (75% v / w conc.)

Transmitted a significant suppression of the mycelium of *R. solani* followed by *F. oxysporum* and *M. phaseolina* but *A. montana* (75% v / w conc.) It showed a greater zone of inhibition in the mycelial growth of *F. oxysporum* and maximum inhibition in *R. solani* and *M. phaseolina*. Both *A. montana* and *T. occidentalis* granules (50% v / w conc.) In which minimal inhibition occurs in the test fungi. The results show that *T. occidentalis* in all concentrations was considered effective for the inhibition of root rot fungi followed by *A. montana*. Therefore, the use of homeopathic granules has shown a positive effect in reducing the intensity of the root attacked by the pathogen in the field and improving the growth of the plant. Therefore, it is suggested that it should be applied on a large scale, as it is cheap, easily accessible, non-dangerous and environment-friendly.

1.6 Use of organic preparations for the control of fungi

(Eguívar, 2006) Describes that agroecological fungicides are normally preventive, so they must be applied before the onset of the disease. That is why agroecological fungicides function as "fungistatic" agents, since they primarily inhibit the germination of fungus spores. (Rodriguez, 2007) He comments that in response to the selection pressure due to the high doses and continuous applications of chemical products, it causes great economic losses. He adds that an economic and efficient dilemma for disease control is in this case the use of natural products emanating from plants.

1.7 Application of chemical products to reduce diseases caused by fungi

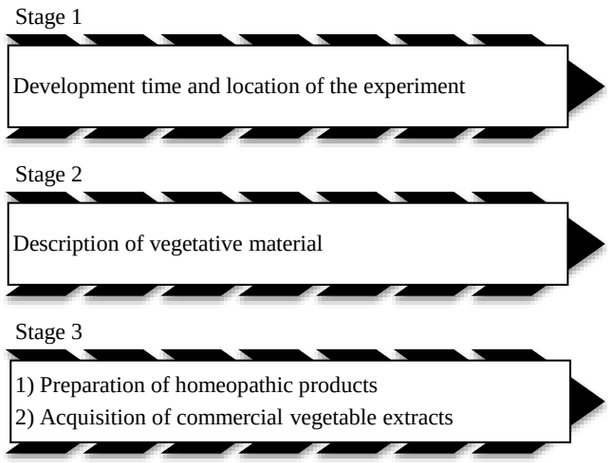
(Gutiérrez-Alonso, 2003). It evaluated the firmness to benomilo and thiabendazole in isolates of *Colletotrichum gloeosporioides* acquired from mango fruits cv. They have been affected by anthracnose in the producing regions of Veracruz, Guerrero, Michoacán, Sinaloa and Chiapas, Mexico. The fungicides were added to potato-dextrose-agar culture medium, at a rate of 0.1, 1, 5, 10, 50, 100, 200 and 400 ppm to evaluate their effect on the mycelial growth rate (TCM) and the germination of conidia, to estimate the mean lethal concentration (LC50) using a Pro bit analysis. Most of the isolates presented a TCM <0.5 mm / day at 50 ppm in both fungicides, except Mich; however, Ver-1, Sin and Mich presented an CL50> 20 ppm in benomilo and thiabendazole, being considered as resistant. Ver-2 and Gro did not exceed the 20 ppm threshold, except Gro with thiabendazole. Chia presented an CL50 <6 ppm in both fungicides, indicating sensitivity. Therefore, both fungicides did not deprive the germination of conidia *in vitro* and caused excessive deformation of germ tubes.

1.8 Methodology to be developed

The methodological process is made up of 2 phases; Phase 1 is called recognition and validation of the experimentation process and is analyzed through 3 stages (Figure 4.2 Stages that constitute Phase 1), in Phase 2 homeopathic preparations were applied through a series of experiments in the avocado plantation (application of experimental processes).

I. Phase 1: Recognition and validation of the experimentation process

Figure 4.2 Stages that constitute Phase 1



Consultation Source: Own Elaboration

1.9 Stage 1) Development time and location of the experiment

The experiment was developed in a period of 11 months in the community of Tlaxpanaloya, municipality of Naupan Puebla (Figure 4.3 Avocado fruit plantations). In this community, Hass Avocado plantations have been recently introduced, so far there are a total of 20 producers, with an area of 1.5 hectares planted. The experiment was established in the property called "Tantlahua" which is located between the coordinates 20.219353 ° North, -98.111944 ° West, at 1810 meters above sea level.

Figure 4.3 Avocado fruit plantations

Consultation Source: Own Elaboration

1.10 Stage 2) Description of vegetative material

The avocado trees that were used for the establishment of the experiment, had the following characteristics: average age 8 years, height 7 m, with 10 production cycles. Which had anthracnose damage with light brown spots on the leaves, and the presence of small circular lesions of black to brown color in the first stages of the fruit until its commercial maturity (Figure 4.4 Vegetative material).

Figure 4.4 Vegetative material

Consultation Source: Own Elaboration

1.11 Anthracnose (*C. gloeosporioides*)

The fungus *C. gloeosporioides* was obtained from the damaged leaves and fruits of avocado (Figure 4.5 Fruit with anthracnose affection), in which 0.05 g was taken to grind and 1/3 of the 5 g of sugar was added in a mortar, in which it was ground in a circular fashion for 6 min. At the end, the surface of the mortar was scraped with a stainless steel spoon for 4 min, the procedure was repeated, the second 2/3 was added and another 6 min was ground, then it was scraped again for 4 min, it was repeated again the procedure, the third third of sugar was added, ground for 6 min. It was scraped for 4 min. And the procedure was repeated. At the end, 1 C of the Triturado was obtained.

Figure 4.5 Fruit with anthracnose affection

Consultation Source: Own Elaboration

To obtain the 2 C of the crushed, 0.05 grams of the 1C of the crushed and 5 g of sugar were added to the mortar, to carry out the same procedure of obtaining the 1 C, obtaining the 2 C crushed. To obtain the 4 centesimal and the mother tincture of the anthracnose fungus, 0.05 g was added to a 30 ml amber glass bottle with 50 drops of distilled water and 50 drops of pure undenatured cane alcohol, it was succussed for two minutes and Two more were allowed to settle, resulting in 4 CH, likewise repeating the procedure until obtaining 10 CH and 30 CH. The rest of the homeopathic products were purchased at Dr. Arroyo's Homeopathic Pharmacy at the address of Aldama 110, Centro 56100, Texcoco de Mora, Mex. obtained at 6 CH.

1.12 Stage 3) Preparation of homeopathic products

The experiment consisted of the application of agronosodes such as:

1. *Árnica montana* 6CH and 20 CH
2. *Calcarea carbónica* 6CH, 20CH
3. *Chamomilla* at 6CH and 30CH
4. *Ferrum phosphoricum* at 6CH and 30C (Figure 4.6 Homeopathic products)
5. Anthracnose Agronosode (*C. gloeosporioides*) obtained from avocado fruit and leaves at 10 CH and 30 CH (Figure 4.7 Fruit with Anthracnose for Agronosode)

Figure 4.6 Homeopathic products

Consultation Source: Own Elaboration

Figure 4.7 Fruit with Anthracnose for Agronosode

Consultation Source: Own Elaboration

1.13 *Calcarea carbónica* 6CH

It contains no less than 85 percent of calcium carbonate calculated with reference to the dry substance, considered one of the most widely used polychrests in agro-homeopathy, it functions in the structure of the plant as a static factor, providing rigidity to the trunk and leaves as well it also generates the consistency of the epidermis of plants and fruits. From the mother tincture at 6 CH, 1 drop was added in a 30 ml amber glass bottle, 99 drops of pure undenatured cane alcohol were added, it was succussed for two minutes and left to rest for another two minutes. Obtaining the 7 CH. The same procedure was carried out until 20 CH was obtained (Figure 4.6: Homeopathic products).

1.14 *Árnica montana* 6CH

The substance is extracted directly from the fresh whole plant including the root, useful as a reestablishing agent in damage to the plant either by cuts, pruning or pest conditions; The preparation consisted of: from the mother tincture to 6 CH, 1 drop was added in a 30 ml amber glass bottle, 99 drops of pure undenatured cane alcohol were added, it was succussed for two minutes and left to rest for another two min. Obtaining the 7 CH. The same procedure was carried out until 20 CH was obtained (Figure 4.6: Homeopathic products).

1.15 *Chamomilla* 6CH

For the extraction of the substance, the entire plant is occupied when it is in bloom, the primary function is carried out by means of absorption in the root of the fruit, the preparation was carried out in the following way: from the mother tincture to 6 CH is 1 drop was added to a 30 ml amber glass bottle, 99 drops of pure undenatured cane alcohol were added, it was succussed for two minutes and left to rest for another two minutes. Obtaining the 7 CH. The same procedure was carried out until 30 CH was obtained (Figure 4.6: Homeopathic products).

1.16 *Ferrum phosphoricum* 6CH

It contains no less than 47 percent of ferrous salts expressed as ferrous sulfate octahydrate, it allows the improvement in the roots and the capillary system, optimizing the circulation of liquids in the extremities of the plant to avoid the generation of rotting processes, the preparation methodology was the following: from the mother tincture to 6 CH, 1 drop was added in a 30 ml amber glass bottle, 99 drops of pure undenatured cane alcohol were added, it was succussed for two minutes and left to rest for another two minutes. Obtaining the 7 CH. The same procedure was carried out until 30 CH was obtained (Figure 4.6: Homeopathic products).

1.17 Stage 3) Acquisition of vegetable extracts and commercial chemical products

1.18 Fungize 5B

It is a microbiological product formulated from 5 strains of *Bacillus*. (Complex of sporulated rhizobacteria, *Bacillus subtillis*, *B. amylillquefaciens*, *B. licheniformis*, *B. megaterium* and *B. mycoides*) Bacteria in Fungizar 5B compete for space and food with pathogenic fungi, in addition to producing compounds with fungicidal activity.

1.19 Clean Culture LT Extract of Gobernadora, (*Larrea tridentada*)

It is an organic bactericide - fungicide (Figure 4.8 Clean Crop LT) that inhibits or deactivates the enzymes of bacteria, mycelia and the fruiting bodies of fungi through the morphological denaturation caused by the components of this natural extract of Gobernadora (*L. tridentada*).

Figure 4.8 Clean Crop LT

Consultation Source: Own Elaboration

1.20 Commercial chemical

1.21 Benomilo

It is a commercial fungicidal product with radical and foliar absorption, with preventive and curative contact fungicidal activity for the control of fungal diseases.

Phase 2) Application of experimental process

1.22 Bioassay

Each concentration of the homeopathic product was succussed before its application, in a plastic container of 2 L capacity, 1.5 L of water was added and then a drop of the homeopathic preparation was added, it was succussed for a time of 2 min. After 2 min of rest, it was applied in a spray form and so on for the other treatments. For the application of Fungizar 5B (Figure 4.9 Application of Fungizar) it was every eight days at a rate of 3.7 ml in 1.5 liters of water, in the same way for the case of Clean Crop LT the applications were every eight days at a rate of 3.7 ml in 1.5 liters of water. In the combination of both products, 1.8 ml of each product were added in 1.5 liters of water. These products were applied in a conventional manner. In addition to homeopathic products, benomilo, organic products, water sucked as a control, and it was applied with pure water without succussion

Figure 4.9 Application of Fungizar

Consultation Source: Own Elaboration

The experiment was established in a 1.8 hectare plot, with a total of 370 trees of which 64 trees were selected by random sampling that showed damage caused by anthracnose. The applications were made to the foliage, throughout the tree, by spraying. (1.5L) (Figure 4.10 Bioassay applied by spraying system), every 8 days for *Árnica montana* 6CH, *Calcarea carbónica* 6 CH, *Chamomilla* 6 CH, *Ferrum phosphoricum* 6 CH, biopreparation of Anthracnose (*C. gloeosporioides*) obtained from fruit and leaves of avocado. 10 CH and every 15 days for *Árnica montana* 20 CH, *Calcarea carbonica*, 20 CH, *Chamomilla* 30 CH, *Ferrum phosphoricum* 30CH, biopreparation of Anthracnose (*C. gloeosporioides*) obtained from avocado fruit and leaves 30CH.

Figure 4.10 Bioassay applied by spraying system

Consultation Source: Own Elaboration

The experimental analysis was randomly completed with ten homeopathic products, two organic products and the combination of both, the benomilo fungicide applied in a conventional way pure water and succussed water that was considered as another treatment. Conforming 4 repetitions for each treatment and a control; succussed water, which was also considered as one more treatment. What make up 16 treatments. The parameters to be measured were the number of pustules, length, and width of the pustule in fruit as well as in leaf, for this one of the branches damaged by tree was selected.

A fruit and a leaf were selected which were monitored every eight, fifteen days for their analysis (Figure 4.11 Application of homeopathic preparations and biofungicides).

Figure 4.11 Application of homeopathic preparations and biofungicides

Consultation Source: Own Elaboration

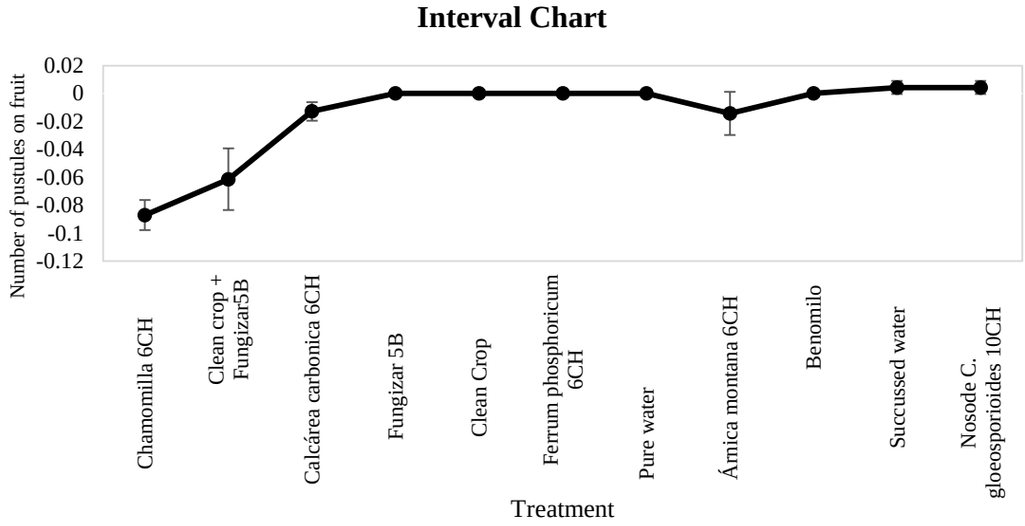
1.23 Results

Assumptions tests were performed on the data to find out if they met normality and homogeneity of variance, for which an analysis of variance was carried out. If no significance was found between the treatments, the Tukey test was used. If the assumptions were not met, a non-parametric analysis was performed.

1.24 Reduction of the fruit pustule implemented every 8 days

According to the data obtained from the reductions of the parameter of length by width in the fruit, in which 11 treatments including the control were evaluated in a period of eight days, where it was carried out that in all the reductions there are no significant differences between treatments compared to the control, in which statistically a minimal reduction of the pustule surface is appreciated in the last evaluation; and that *Chamomilla* 6CH in the reductions from 1 to 7 the growth was to a lesser extent compared to the control considering that different letters in the columns indicate significant differences between the means of the Kruskal Wallis ranges, $p \leq 0.05 \pm$ and of the Tukey treatments, $p \leq 0.05$ (Table 4.1 Abstract of significant LxA tests of the pustule in fruit, testing every eight days); *C. carbónica* 6CH increased the pustule to a lesser extent in reductions 2,4 and 7, on the other hand, both products in the first data collection showed that it did reduce, however, it increased for the other repetitions; and that the biopreparation of *C. gloeoporioides* 10CH did reduce the length by width of the fruit pustule in the last measurement in contrast to the witness (Graph 4.1 Tukey test for LxA of the pustule in fruit experienced every eight days).

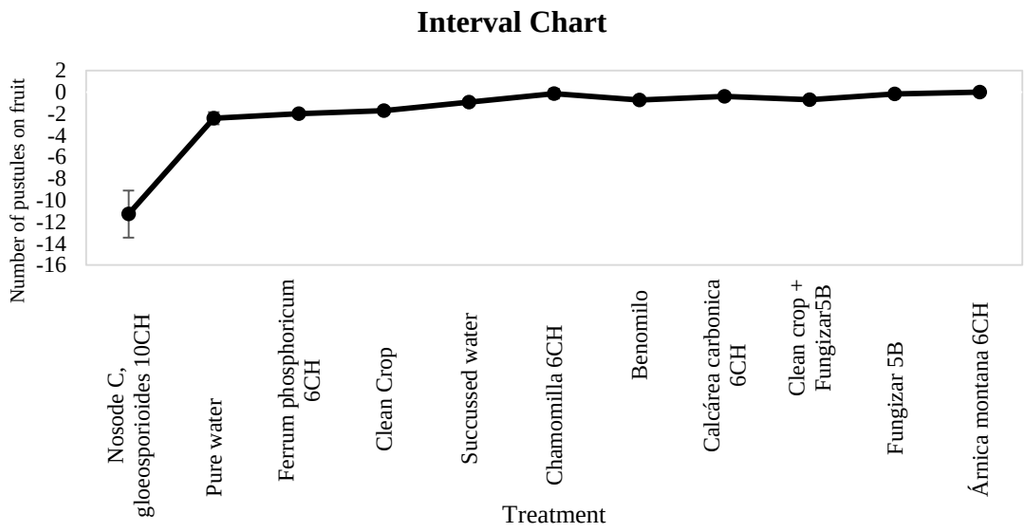
Graph 4.1 Tukey test for LxA of the pustule in fruit experienced every eight days



Consultation Source: Own Elaboration

The data shown in the parameter of the number of pustules in fruit evaluated every eight days, it can be seen that in reduction 2 there are no significant differences between treatments, and that in reductions 3,4, 5, 6 and 7 the nosode of *C. gloeoporioides* 10 CH presented significantly higher number of pustules with respect to the control of sucked water; in reduction 1 *Chamomilla* 6CH, *C. carbónica* 6CH, the combination of Clean crop + Fungizar 5B, Fungizar 5B did not reduce or increase the appearance of new pustules, on the other hand *Á. montana* 6CH in all measurements did not reduce or increase the appearance of new pustules in fruit (Graph 4.2 Tukey's test for Number of pustules in fruit).

Graph 4.2 Tukey's test for Number of pustules in fruit

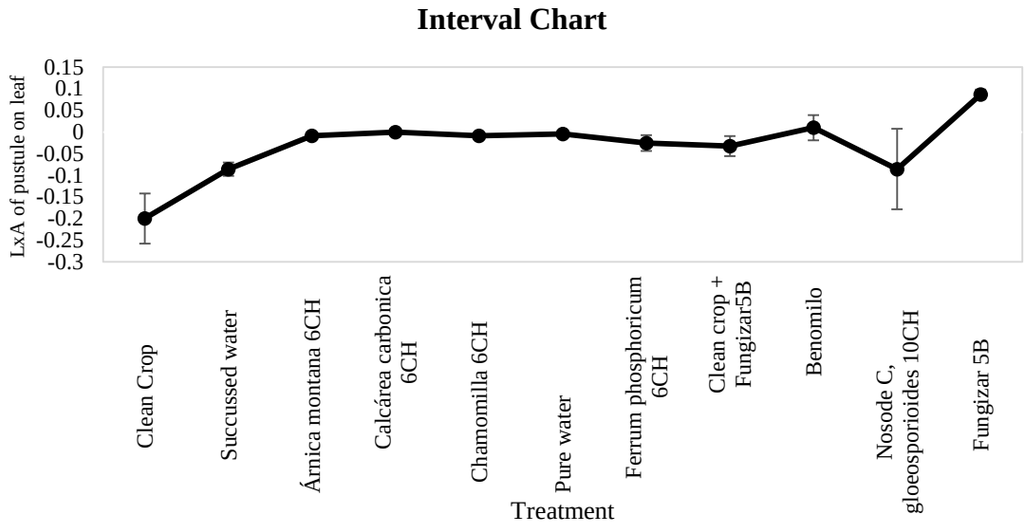


Consultation Source: Own Elaboration

1.25 Reduction of the leaf pustule evaluated every 8 days

The reductions measured every eight days in length by width of the leaf pustule are shown, where it is observed that in the reduction 1,2 and 7 considering that different letters in the columns indicate significant differences between the means of the ranges as shown In reduction 4, establishing a Kruskal Wallis test, $p \leq 0.05 \pm$ and of the treatments (Tukey, $p \leq 0.05$) (Table 1.2 Abstract of significant tests of the number of pustules in leaf evaluated every eight days) there are no differences between the treatments, and that benomilo in reductions 5 and 6 and that *C. gloeosporioides* 10CH 3, 5 and 6 and that Fungizar 5B in 3,4, 5 and 6 did not significantly reduce the pustule, on the contrary this parameter was higher in comparison to the control of sucked water (Graph 4.3 Tukey's test for LxA of the leaf pustule evaluated every eight days).

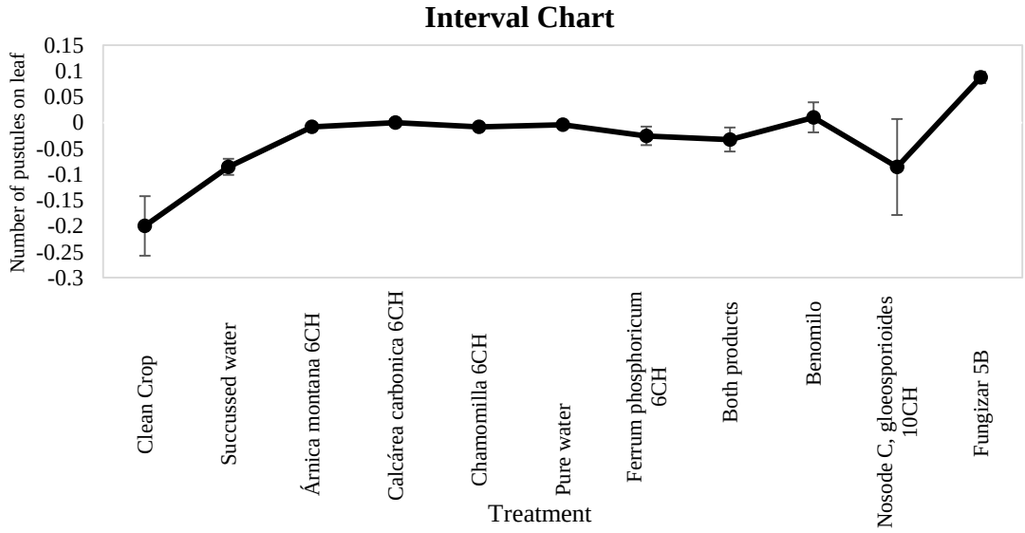
Graph 4.3 Tukey's test for LxA of the leaf pustule evaluated every eight days



Consultation Source: Own Elaboration

The results shown were evaluated every eight days, which shows the parameter of the number of pustules in the leaf, it is observed that in reduction 1 and 2 there were no differences between treatments, the nosode of *C. gloeosporioides* 10CH in reductions 3,4,5 , 6 and 7 increased the appearance of new pustules with respect to the control, *Chamomilla* 6CH, the combination of Clean crop + Fungizar 5B, fungizar 5B, F. *phosphoricum* 6CH, pure water, in reduction 3, the emergence of new pustules was with "less slowness", in reduction 4 with both products, Fungizar 5B and pure water, the appearance of new pustules was slow, on the other hand *C. carbónica* in reduction 7 did reduce compared to the witness (Graph 4.4 Tukey's test for number of leaf pustules evaluated every eight days).

Graph 4.4 Tukey's test for number of leaf pustules evaluated every eight days

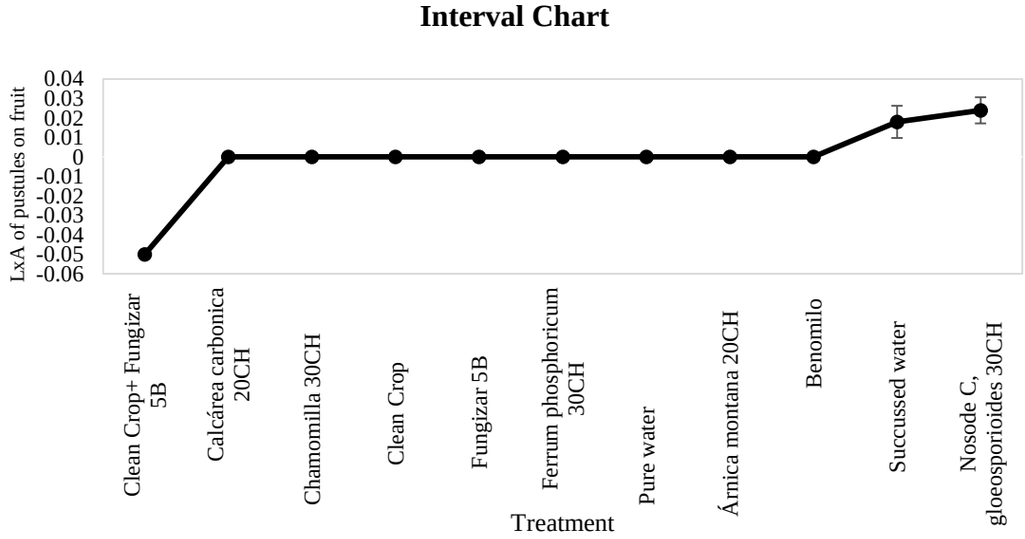


Consultation Source: Own Elaboration

1.25 Reduction of the fruit pustule implemented every 15 days

According to the data obtained in the reductions in the parameter of the number of pustules in fruit evaluated every 15 days, it is observed that in the reductions 1,2,3,4 (Table 1.3: LxA of the pustule in fruit evaluated every 15 days), there are no significant differences between treatments, however the combination of Clean crop + Fungizar 5B, Fungizar 5B, F. *phosphoricum* 30CH and *Chamomilla* 30CH in the reduction of one 1 without having significant differences between treatments did not decrease or increase the presence of new pustules in fruit, and that in the reduction 5 *Chamomilla* 30CH grew to a lesser extent compared to the witness (Graph 4.5 Tukey test for LxA of the pustule in fruit performed every 15 days).

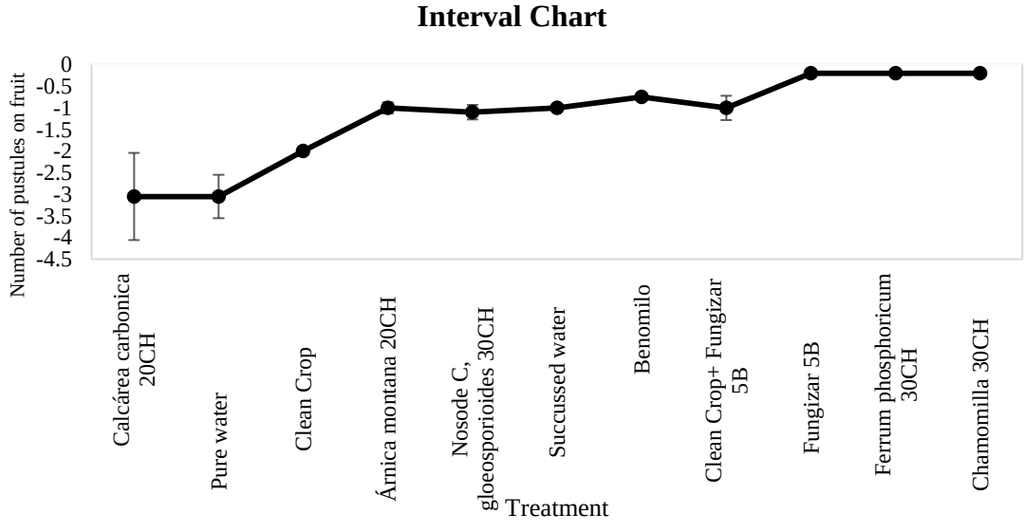
Graph 4.5 Tukey test for LxA of the pustule in fruit performed every 15 days



Consultation Source: Own Elaboration

The data shown on the reductions in length by width in fruit shows that there is no significant difference between treatments in the applications of every 15 days, so that the combination of Clean crop + Fungizar 5B did not stop the growth of the pustule in contrast with the values of the control of sucked water, and that the nosode of *C. gloeosporioides* 30CH in a similar way with the control of sucked water reduced the length by width of the fruit pustule less (Graph 4.6 Tukey's test for number of pustules in fruit evaluated every 15 days).

Graph 4.6 Tukey's test for number of pustules in fruit evaluated every 15 days

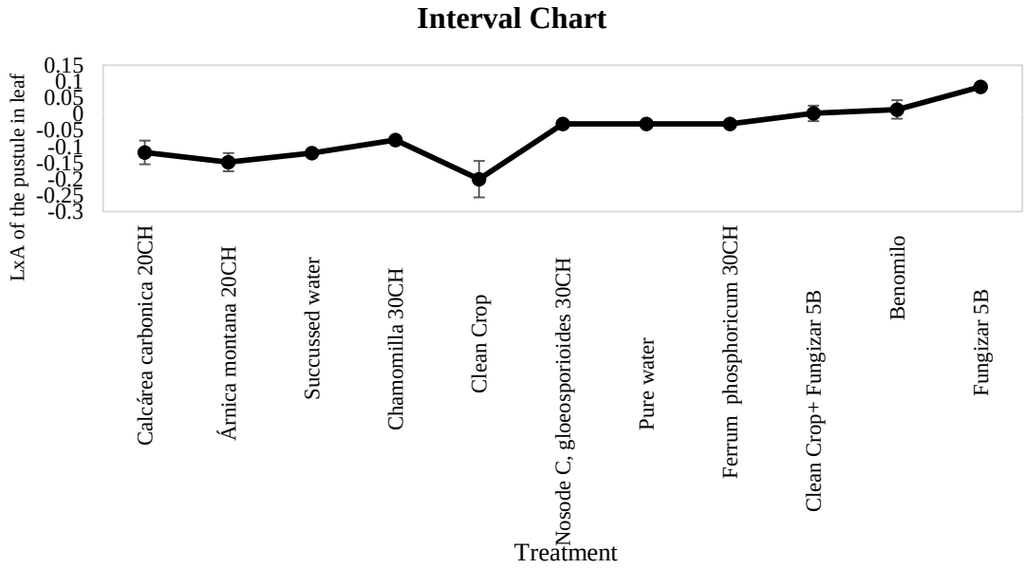


Consultation Source: Own Elaboration

1.26 Pustule reduction in update sheet every 15 days

In the reductions with the parameter number of pustules on the leaf, which were evaluated every 15 days, it is observed that there were no significant differences in the reductions 2, 3, 4 and 5 (Table 1.4: LxA of pustules on the check sheet every 15 days) ; However, in reduction 1, the treatments that slowly increased the appearance of new pustules were the combination of Clean crop + Fungizar 5B, Fungizar 5B, pure water and *F. phosphoricum* 30CH (Graph 4.7 Tukey's test for LxA of the pustule in leaf tested every 15 days).

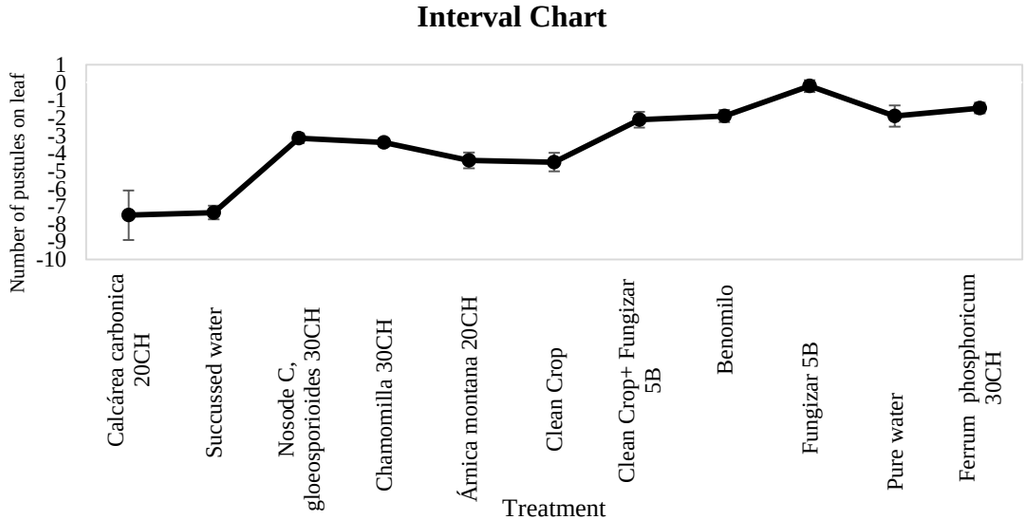
Graph 4.7 Tukey's test for LxA of the pustule in leaf tested every 15 days



Consultation Source: Own Elaboration

The results with parameter length by width in leaf evaluated every 15 days, it is observed that *C. carbonónica* 20 CH, *Á. montana* 20 CH in reduction 5 and 5 did not control the increase in the dimensions of the pustule with respect to the control of succussed water; Fungizar 5B considerably reduced the dimensions of the pustules compared to the control of sucked water (Graph 4.8 Tukey's test for the number of pustules in leaf evaluated every 15 days).

Graph 4.8 Tukey's test for the number of pustules in leaf evaluated every 15 days



Consultation Source: Own Elaboration

1.27 Annexes

Table 4.1 Abstract of significant LxA tests of the pustule in fruit, testing every eight days

* Kruskal Wallis test; * Tukey's test									
L x A of pustule on fruit									
Treatment	Reduction 1			Reduction 2			Reduction 7		
	Prom	R		Prom	R		Prom	R	
Chamomilla 6CH	-0.03	17.13	a	-0.08	18.13	a	-0.1	13.25	A
Clean crop + Fungizar5B	0.05	27.88	a	-0.05	18.5	a	-0.08	13.5	a
Calcárea carbónica 6CH	0	22.5	a	-0.03	18.88	a	-0.03	19	a
Fungizar 5B	0	22.5	a	0	24	a	0	24	a
Clean Crop	0	22.5	a	0	24	a	0	24	a
Ferrum phosphoricum 6CH	0	22.5	a	0	24	a	0	24	a
Pure water	0	22.5	a	0	24	a	0	24	a
Árnica montana 6CH	0	22.5	a	0	24	a	0	24	a
Benomilo	0	22.5	a	0	24	a	0	24	a
Succussed water	0	22.5	a	0	24	a	0.03	28.88	a
Nosode *C. gloeosporioides* 10CH	0	22.5	a	0	24	a	0.03	28.88	a

Consultation Source: Own Elaboration

Table 4.2 Abstract of significant tests of the number of pustules in leaf evaluated every eight days

* Kruskal Wallis test; * Tukey's test												
L x A of leaf pustule												
	Reduction 1			Reduction 2			Reduction 3			Reduction 7		
Treatment	Prom	R		Prom	R		Prom	R		Prom	R	
Clean Crop	0	23.5	a	0.0	27.5	a	-0.2	20.5	ab	-0.3	15	a
Succussed water	0	23.5	a	-0.1	16.63	a	-0.1	12.25	a	-0.1	15.5	a
Árnica montana 6CH	-0.03	18.38	a	0.0	22.75	a	-0.03	22.5	ab	0.0	21.13	a
Calcárea carbónica 6CH	0	23.5	a	0.0	22.75	a	0	27	ab	0.0	21.13	a
Chamomilla 6CH	-0.03	18.38	a	0.0	22.75	a	-0.03	22.5	ab	0.0	21.13	a
Pure water	0	23.5	a	0.0	22.75	a	-0.03	22.5	ab	0.0	21.13	a
Ferrum phosphoricum 6CH	0	23.5	a	-0.1	16.63	a	-0.08	16.75	ab	0.0	23.63	a
Clean crop + Fungizar5B	0	23.5	a	-0.1	20.88	a	-0.13	15	ab	0.0	24.38	a
Benomilo	-0.03	22.88	a	-0.1	16.63	a	0	26.38	ab	0.0	25.25	a
Nosode *C. gloeosporioides* 10CH	-0.03	18.38	a	0.0	26.63	a	0.03	30.88	b	0.0	29.25	a
Fungizar 5B	0.03	28.5	a	0.1	31.63	a	0.08	31.25	b	0.1	30	a

Consultation Source: Own Elaboration

Table 4.3 LxA of the pustule in fruit evaluated every 15 days

* Kruskal Wallis test; * Tukey's test															
L x A of pustule on fruit															
	Reduction 1			Reduction 2			Reduction 3			Reduction 4			Reduction 5		
Treatment	Prom	*R		Prom	*R		Prom	*R		Prom	*R		Prom	*R	
Clean Crop+ Fungizar 5B	-0.05	17.5	a	-0.05	17.13	A	-0.05	16.75	a	-0.05	16.75	a	-0.05	16.75	a
Calcárea carbónica 20CH	0	23	a	0	22.5	A	0	22	a	0	22	a	0	22	a
Chamomilla 30CH	0	23	a	0	22.5	A	0	22	a	0	22	a	0	22	a
Clean Crop	0	23	a	0	22.5	A	0	22	a	0	22	a	0	22	a
Fungizar 5B	0	23	a	0	22.5	A	0	22	a	0	22	a	0	22	a
Ferrum phosphoricum 30CH	0	23	a	0	22.5	A	0	22	a	0	22	a	0	22	a
Pure water	0	23	a	0	22.5	A	0	22	a	0	22	a	0	22	a
Árnica montana 20CH	0	23	a	0	22.5	A	0	22	a	0	22	a	0	22	a
Benomilo	0	23	a	0	22.5	A	0	22	a	0	22	a	0	22	a
Succussed water	0	23	a	0	22.5	A	0.03	27.38	a	0.03	27.38	a	0.03	27.38	a
Nosode *C. gloeosporioides* 30CH	0	23	a	0.03	27.88	A	0.03	27.38	a	0.03	27.38	a	0.03	27.38	a

Consultation Source: Own Elaboration

Table 4.4 LxA of pustules on the check sheet every 15 days

* Kruskal Wallis test; * Tukey's test															
L x A of pustule on fruit															
	Reduction 1			Reduction 2			Reduction 3			Reduction 4			Reduction 5		
Treatment	Prom	*R		Prom	*R		Prom	*R		Prom	*R		Prom	*R	
Calcárea carbónica 20CH	-0.03	23.63	ab	-0.05	21	ab	-0.15	15.13	ab	-0.18	13.25	a	-0.18	13.25	a
Árnica montana 20CH	-0.05	22.13	ab	-0.15	16.5	ab	-0.18	13	a	-0.18	13.25	a	-0.18	13.25	a
Succussed water	-0.08	17.25	ab	-0.13	13	a	-0.13	13.75	a	-0.13	14.13	ab	-0.13	14.13	ab
Chamomilla 30CH	-0.08	13.88	a	-0.08	16.75	ab	-0.08	18	abc	-0.08	18.38	abc	-0.08	18.38	abc
Clean Crop	0	28.5	ab	-0.25	18.13	ab	-0.25	18.75	abc	-0.25	18.88	abc	-0.25	18.88	abc
Nosode *C. gloeosporioides* 30CH	-0.03	23.63	ab	-0. 03	24	ab	-0.03	24.63	abc	-0.03	24.88	abc	-0.03	24.88	abc
Pure water	-0.03	23.63	ab	-0.03	25.25	ab	-0.03	26	abc	-0.03	26.13	abc	-0.03	26.13	abc
Ferrum phosphoricum 30CH	-0.03	23.63	ab	-0.03	25.25	ab	-0.03	26	abc	-0.03	26.13	abc	-0.03	26.13	abc
Clean Crop+ Fungizar 5B	-0.08	21.63	ab	0	26.38	ab	0.03	27.25	abc	0.03	27.38	abc	0.03	27.38	abc
Benomilo	-0.08	17.25	ab	0	28.25	ab	0.05	31.63	bc	0.05	31.75	bc	0.05	31.75	bc
Fungizar 5B	0.1	32.38	b	0.08	33	b	0.08	33.38	c	0.08	33.38	c	0.08	33.38	c

Consultation Source: Own Elaboration

1.28 Discussion

Farmers' limited knowledge of the identity of plant diseases, routes of transmission, and appropriate management methods is a key but little-exposed problem. Islam et al., (2020) conducted a sample of 260 farmers who produce chili in Bangladesh to explain their knowledge, perceptions and working methods in relation to chili anthracnose, a fungal disease caused by *Colletotrichum*.Total crop yield was reduced by 4% for the average farmer. However, only 22% of farmers knew it was a fungal disease and only 25% could tell how the disease spreads in the field. In a study of students in general, students show interest in learning about Homeopathy, however they expressed difficulty in understanding its philosophy. Some of the factors that influence this ignorance of homeopathy is the scarcity of reliable and updated information, reliable and updated materials. This contributes to the spread of misleading information, generating disbelief and low demand for this type of treatment. Therefore, it is necessary to reflect on the importance of explaining about homeopathy within the University (Zen *et al*., 2021).

The works that have been carried out in the last decades in Mexican lands to use Homeopathy in favor of the health of animals and crop plants deserve a special mention (Rodríguez and Pérez, 2020). With regard to agrohomeopathy, the most notable efforts have come from the Chapingo Autonomous University, where several researchers have conducted studies on the effects of homeopathic medicines on crops, with very positive results. Dr. Felipe Ruiz Espinoza explained that a central part of agro-homeopathy is safety, and its non-toxicity (Ponce, 2015).

As Paracelsus stated: "any substance can be a poison or a medicine, the difference is the dose." In the same way, it can also be said that every substance is a medicine until proven otherwise. Homeopathy is a therapeutic method that is based on principles such as "the similar cures the similar", experimentation in the healthy man and unique medicine, in addition to dilution and dynamization (Zen et al., 2021). Homeopathy was developed on the principle of individuality and firmly believes that only one remedy at a time, sourced from our peers in nature, has the essential energy to be able to heal us. By applying only one remedy at a time, it is easy to see if and what a reaction occurs. In the same way, it can be verified if an improvement occurs, something other than applying several remedies together or at the same time because the common thread is lost many times and it is not known which remedy has produced what (Meneses, 2020).

The use of homeopathic preparations in horticultural crops allows to restore their homeostasis and reduce production losses caused by biotic and abiotic factors (Lösch, *et al*., 2021).

In this investigation for the applications that were evaluated every eight days in a curative way, in the parameter length by width in fruit, Chamomilla 6CH and C. carbonónica 6CH during 48 days, constants were maintained regarding the damage by the fungus, not registering the increase of the pustule. In the parameter number of pustules in fruit, the nosode of *C. gloeosporioides* at 10CH at 24 days showed a lower presence of pustules. For the parameter of number of pustules on the leaf, the nosode of *C. gloeosporioides* at 40 days reduced the damage. In the record of measurements, length by width of the leaf, Clean crop at 32 days registered less control compared to the other treatments.

Ishwarya et al., (2018) used a combination of lemongrass oil, cinnamon oil and thyme oil for the management of postharvest anthracnose of pomegranate caused by *Colletotrichum gloeosporioides* and tested at a concentration of 0.1% *in vitro*. The new formulation THYCILEM 30 EC based on essential oils completely (100%) inhibited the growth of the pathogen at a concentration of 0.1%. In vivo results revealed that pre-harvest spraying with the new THYCILEM 30 EC (0.1%) followed by a subsequent immersion with the new THYCILEM 30 EC (0.1%) for 5 minutes was more effective in reducing anthracnose. of pomegranate, which had the minimum PDI of 13.43 after 24 days of treatment under harvest conditions, compared with 87.50 PDI in the untreated control.

Taking into account the data obtained in the parameter of length by width in fruit, the nosode of *C. gloeosporioides* 10CH 56 days reduced the damage as did *Á. montana* 6CH at 32 days, but the number of pustules in fruit remained constant. The length per width parameter in the leaf, the treatments that reduced the damage caused by the fungus were, benomilo® at 40 days, the nosode of *C. gloeosporioides* 10 CH at 40 days and Fungizar 5B at 24 days began to control damage by the fungus. Situation that may coincide with Rodrigues, et al. (2020) who carried out an investigation to evaluate the fungitoxicity of high dilutions of tectone extract (*Tectona grandis*) in the mycelial growth, sporulation and germination of the fungus *Colletotrichum gloeosporioides* and concluded that the variables relative percentage of mycelial development (PRD) and sporulation varied according to dynamization, with a maximum reduction of 7% in PRD (33 CH) and a 70% increase in sporulation (3 and 21 CH).

Likewise, Rissato et al., (2018) demonstrated the control of white mold (*Sclerotinia sclerotiorum*) in common beans (*Phaseolus vulgaris L*.) using extremely dilute aqueous solutions of Phosphorus and *Calcárea carbónica*, at 6CH, 12CH, 24CH, 36CH and 48CH dynamizations. These results indicate the potential of *Phosphorus* 12CH, *Phosphorus* 48CH, *Calcárea carbónica* 12CH, and *Calcárea carbónica* 48CH to control *S. sclerotiorum* in common beans. In addition to slowing the progression of the disease up to 83%, reducing the number of dead plants up to 90%. While, for this research, in the parameter of number of pustules in leaf, the treatment that began to reduce the damage of the fungus was *C. carbónica* 6 CH at 56 days.

Lösch, et al., (2021) found that in sweet pepper the homeopathic preparation Sulphur allowed positive increases in the development of plants and production and diameter of fruits under field cultivation. *Calcárea carbónica* showed significant results at the height of plants grown in greenhouse. During the cultivation the presence of caterpillars, ants, aphids, mites, fungi and bacteria was found. Homeopathic preparations did not show evident effects in reducing the populations of these pathogens in attacked plants and fruits, but they can favor the resilience of plants affected by these parasites, helping in growth after damage. *Calcárea carbónica* showed a tendency to lower amounts of fruits with signs of anthracnose.

Analyzing the results of the evaluations applied preventively every 15 days, the treatments that reflected a greater control of the fungus is the nosode of C. gloeosporioides 30CH at 30 days after the application in the parameter of length by width in fruit and Fungizar 5B. Which contrasts with the evaluation of the effectiveness of Bacillus subtilis, Rhodotorula minuta and its combination compared to benomilo with pre-harvest applications, for post-harvest control of anthracnose, coinciding with Martínez et al., (2019) when evaluating in the Municipality of Zimatlán de Álvarez Oaxaca 14 homeopathic treatments and four controls, to obtain Capsicum annuum fruits without Anthonomus eugenii. They found that the preparations of Lachesis trigonocephalus T (Crushing) 7 CH (Centesimal Hannemaniana) and Allium cepa Ø (Tincture) 6 CH effectively preserved the weight of the fruits, presenting 40% less chopped areas per fruit, while the Weevil field treatments T 6CH, Strychninum T 6CH, and T 200CH greenhouse weevil moderately protected the fruit weight of C. annuum plants against this condition, 50% fewer weevils per fruit. Therefore, it is confirmed that the use of different homeopathic preparations are an effective alternative to protect plants and crops, which will contribute to reducing the use of chemical elements and protecting the environment.

1.29 Appreciation

To the Universidad Xicotepetl A.C. for financing this research project.

1.30 Conclusions

In the evaluation of 10 homeopathic products, *Á. montana* 6CH and 20CH, *C. carbónica* 6CH, 20CH., *Chamomilla* at 6CH and 30CH, *F. phosphoricum* at 6CH and 30CH, and a biopreparation of Anthracnose (*C. gloeosporioides*) obtained from fruit and avocado leaves at 10 CH Y 30 CH, 2 organic products Fungizar 5B, Clean Crop and the combination of both products as well as a commercial chemical Benomilo®, suctioned water and pure water as a witness. The treatments that showed effective control over the infection of *C. gloeosporioides* were the agrohomepathic doses of the *C. gloeosporioides* preparation at 10 CH, in which the parameter length by width in fruit stood out at 56 days for its control applying it every eight days, as well as in the parameter of length by width in leaf at 40 days, in the same way for the applications evaluated every 15 days at 30CH at 30 days after application.

The microbiological product formulated from 5 strains of Bacillus Fungizar 5B being applied every eight days demonstrated to have a control of the damage in the parameter of length by width in leaf at 24 days at a dose of 3.7 ml of the product per 1.5 liters in water. The parameter length by width in leaf evaluated every 15 days, controlled the damage 30 days after its application in doses of 3.7 ml of the product per 1.5 liters of water.

It should be noted that homeopathic products offer longevity, this aspect is important because in an unsystematic way to foods of plant origin, when applying these products, they have a longer shelf life. At the end of the experiment, it is experienced that the treatment of *Á. montana* 6CH lengthened the days to maturity with an advantage of 8 days compared to the fruits where the treatment was not applied, in addition to observing that it statistically stopped the damage of the fungus in the parameter of the number of spots on the fruit at 32 days. However, it was found that for the fruits that were not treated with any product, the damage of the fungus was just during the ripening of the fruit.

This is why agrohomeopathy and particularly with the use of low or high dynamisations of agronosodes will depend on the degree of progression of the disease or pest damage, in addition to the timely choice of the centesimal dose and application frequency, the recovery of the plant's health in a tangible and permanent way, since in the case of diseases, agronosodes and high homeopathic dynamisations eliminate the damage caused by pathogenic organisms. Ultimately, this represents a real economic possibility for producers and the environment, being able to show its specific incidence on pests and independent diseases that affect the agricultural sector.

In other words, Agrohomeopathy is scientific knowledge that complements traditional agriculture, considering itself as an alternative for agricultural production, which is currently in constant evolution, with great scientific advances and at the same time taking advantage of ancestral knowledge, to mitigate the high levels of contamination, the irrational use of pesticides, making alternatives a reality with natural, simple, viable and economic means.

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