POTENTIAL OF MADRE DE CACAO *(Gliricidia sepium)* LEAF EXTRACT AS A PESTICIDAL CONTROL AGENT AGAINST COFFEE GREEN SCALES *(Coccus viridis)*

A Research Study
Submitted to the Faculty of the
Laboratory Science High School, College of Education
Cavite State University
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In partial fulfillment
of the requirement for Research II

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INTRODUCTION

On a global level, coffee is becoming a popular beverage. Coffee is a highly coveted product that many people enjoy in a variety of ways, making the industry worth billions of dollars. As a result of their growing understanding of how profitable coffee farming is, farmers and businesses all around the world are beginning to plant coffee varieties including *arabica*, *liberica*, *robusta*, and *excelsa*. Since its discovery, coffee has drawn the interest of travelers and botanists from all over the globe, particularly in the second half of the 19th century, when numerous new species were found due to the wide range of coffee plant and seed varieties.

For Filipino farmers, particularly those in highland Cavite, coffee harvests are one of the most important sources of revenue. Currently, as stated in the Philippine Coffee Roadmap 2022, 37,000 tons of coffee are produced annually in the Philippines. By 2022, we can produce up to 214,626 metric tons of coffee, increasing our level of self-sufficiency from the current 41.6 percent to 161 percent. Coffee is a vital crop that must be given attention in its development and harvesting by farmers, as it is considered a crop with poor management. Due to poor management, the production of coffee decreases, and one of these causes is pests and diseases that result in low-quality plants and beans, such as coffee leaf rust, stem borer, and mostly, coffee green scales.

According to Singson (1999), scale insects are the most frequent insect pest found attacking foliar plants. On leaves, their feeding activities typically cause stains and discoloration. In addition, a high infestation causes the plant's crown to dry up, which causes defoliation and ultimately plant death. The toxicity of their saliva, in addition to the fact that they consumed sap, is what caused the plant to be destroyed. Additionally, *C. Viridis* is most likely to create toxins that weaken plants, cause leaves to fall, and lower yields (Laureles, 2003). The sooty mold that frequently forms on the honeydew of the scales contains these poisons (Sarwar, 2006).

In the meantime, Madre de cacao is a plant that is utilized medicinally, as a ripening agent, and as a shade for cacao and coffee farms, among other things. As a result, it includes coumarins, which are potent botanopesticides with non-toxic insecticidal qualities that work against a variety of pests. Instead of utilizing dangerous commercial insecticides, Madre de cacao leaf extract can be used to manage pests. This research seeks to ascertain the effectiveness of Madre de cacao (*Gliricidia sepium*) leaf extract as a pesticide against coffee green scales (*Coccus viridis*).

Statement of the Problem

Generally, this study mainly focused on the capabilities of Madre de cacao (*Gliricidia sepium*) leaf extract as a pesticidal control agent against coffee green scales (*Coccus viridis*) on green coffee plant.

This study specifically answered the following questions:

1. What are the various treatments utilizing Madre de cacao leaf extract on mitigating coffee green scales?
2. What are the responses of coffee green scales and the effects of the extract on the plant after applying each treatment?

3. Which among the treatments of Madre de cacao is the most effective against coffee green scales on coffee plants in terms of its:
    a. leaf appearance
    b. mitigating effect
4. What is the economic analysis of the utilization of the solution?

Objectives of the Study

In general, this study aimed to determine the potential of Madre de cacao (*Gliricidia sepium*) leaf extract as a pesticidal control agent against coffee green scales (*Coccus viridis*) on green coffee plant.

In specific, the goal of this study is to:

1. determine the various treatments with the use of Madre de cacao leaf extract in controlling coffee green scales;
2. observe the response of the coffee green scale and the effects of the extract on the plant after applying each treatment;
3. identify the most effective treatment of Madre de cacao leaf extract against coffee green scales in terms of its:
    a. leaf appearance
    b. mitigating effect; and
4. figure out the economic analysis of utilizing the solution.

Conceptual Framework

INPUT		PROCESS		OUTPUT
- Madre de Cacao Leaves (*Gliricidia sepium*) - Distilled Water - Coffee Green Scales (*Coccus viridis*) - Coffee Plants	→	- Making the Decoction of Madre de Cacao Leaves - Applying the Pesticidal Spray every Three Days - Observation of Application within One Month - Documentation of the Observation - Analysis of Observed Data	→	The Potential of Madre de Cacao as a Pesticidal Agent Against Coffee Green Scales

Figure 1. Conceptual framework of the study

Figure 1 presents the conceptual framework of this study. The researchers used the IPO model or the Input-Process-Output model in making the framework. It includes the variables that were used, the processes that were made, and the expected outcome of the study. This framework shows the materials that were used and the required process to have the desired outcome of this study.

For input, it includes the materials that were used to make the independent variable and the basis for the dependent variable. Madre de cacao leaves and distilled water are the materials that were used in developing the leaf extract which serves as the independent variable while the coffee green scales on coffee plants were the basis for the dependent variable.

For process, it consists of the processes that were used to conduct the study. First, the process of extraction of Madre de cacao leaves, which was the making of the decoction. Second, the application of the said extract to the coffee leaves, which happened every three days. Next, the observation of the application of the developed treatment, which lasted for a month. In addition, the documentation of the observation that was made by the researchers and the analysis of the data that were observed. Therefore, the output that the researchers aimed was the potential of Madre de cacao leaf extract as a pesticidal spray against the coffee green scales in coffee plants.

Significance of the Study

Coffee farmers who are dealing with pests, particularly the coffee green scales in coffee plants, will gain the most from this study, which aimed to create a Madre de Cacao (*Gliricidia sepium*) pesticidal spray. Pests are one of the most common problems that farmers face. We can employ this most basic and common herb, which is typically disregarded, as a pesticide in place of commercial ones that include various fake and harmful chemicals. This study may help farmers to increase the production rate of coffee without the harm of pests. It is also quite convenient and accessible from most residences. Farmers can create their own whenever they come across that particular problem. It would also be a big help in decreasing the budget for spending on commercial pesticides since not all farmers are privileged when it comes to funding their crops.

This study may benefit the researchers to fill the gap of knowledge in the field of research. Also, this study may be used by the other researchers as their enlightenment for their future studies that are deeper and broader. Lastly, other researchers may also use this study as a basis since there's a chance to create an enhanced version of this leaf extract in the future since some methods and variables will not be used in this study.

Scope and Limitations of the Study

This study mainly focused on the development and creation of pesticides made from Madre de cacao extract against coffee green scales. The pesticide was made through the decoction of Madre de cacao combined with water. The researchers also observed the effectiveness of the pesticide in repelling coffee green scales in an open area for a particular period. The study was conducted on November 2022 – July 2023.

The development of the leaf extract was conducted in Indang, Cavite as well as the identification of the best treatment of Madre de cacao extract against *coccus viridis* in terms of leaf-appearance and mitigating effect, observation of responses of coffee green scales, and computation of economic analysis with the use of the produced treatments.

Because the study was conducted in an open area, variables like the weather and temperature may have an impact on the development of the study. The observation time is also limited, therefore, the long-term effects of the pesticide on *coccus viridis* and coffee plants were not tracked. These variables were not included in the researchers' goals which may serve as the limitations of this study. Also, the shelf life of the decoctions was not known since it was not included in the objectives of this study.

Time and Place of the Study

This study was conducted during November 2022 to July 2023 at Cavite State University particularly in National Coffee Research, Development and Extension Center in Indang, Cavite.

REVIEW OF RELATED LITERATURE

This chapter contains the compiled related literature and studies found by the researchers. The analyses and literature in this chapter discourse different ideas, concepts, generalizations, conclusions, and development of various studies from past to present that are related to this present study. The information in this chapter will help the researcher answer questions related to this study by acquiring the details of each different work of literature. Furthermore, this guided the researchers in developing and conducting this study since it has never been undertaken before.

Coffee

According to Bittenbender (2008), the term “coffee” is used to refer to a number of plant species in the *genus Coffea (family Rubiaceae)*, including *C. coffee and C. canephora*, which are plants that are grown for their beans, or seeds, which are used to manufacture the stimulating beverage. Small, smooth-leaved, evergreen trees or shrubs, coffee plants may have many stems. The leaves are oval-shaped and lustrous, dark green. Coffee bushes also produce clusters of cream-white flowers and a fruit known as a berry that typically has two seeds. Initially green, the fruit ripens to a ruby-red color before turning black when dried. The trees have a lifespan of 20–30 years. African-born coffee is also known as robusta coffee (*C. centephora*) and Arabian coffee (*C. arabica*). Before being brewed with hot water to create the coffee beverage, coffee beans are typically cured, roasted, and ground. For the production of instant coffee, ground beans are frequently dehydrated. Warm, humid climates promote the optimum growth of coffee plants. The leaves will instantly die in frigid conditions since the plants cannot withstand the cold. Although the plants are capable of growing in a variety of soils, they typically favor a deep, well-draining loam with a pH of between 5 and 6.

Coffee is becoming a commonly consumed beverage on a global scale. Because coffee is a highly sought-after good that many people enjoy in various ways, its industry is worth billions of dollars. All throughout the world, farmers and businesspeople are starting to grow coffee varieties including *arabica*, *liberica*, *robusta*, and *excelsa* as a result of their increased awareness of how profitable coffee cultivation is. The yearly harvesting season of newly planted coffee trees can last up to two to three months after they begin to bear fruit, with the plants producing about 2,000 coffee cherries, or 4,000 coffee beans, on average (Taculao, 2021).

Coffee is an important commodity in the country that must be given enough attention, especially to the insects related to it. Coffee crops are one of the most sources of income for Filipino farmers, especially in upland Cavite (Panganiban 1998; Laureles, 2003). It is a valuable agricultural expert commodity and is one of the most important beverage crops in the world. Arabica Coffee holds 70% of the world's coffee production. It is cultivated in over 80 countries and particularly in tropical and subtropical regions of the world like Africa, Asia, and Latin America (Melsese and Kolech, 2021). They also added that coffee production is mostly affected by poor crop management practices, poor soils, diseases, low yields, limited access to market information, and pests.

Coffee Diseases

Coffee farmers need to be concerned about a variety of hazardous factors in addition to pests. Another thing to be on the lookout for is diseases like rust, anthracnose, and coffee berry disease, since these may prevent coffee trees from growing properly.

Several other species in the *genus C.* are responsible for anthracnose. *Gloeosporioides complex* is the name for the dark brown sunken patches on green berries and the broken marks on leaves. It affects weak, improperly maintained trees. Farmers must cut and burn the affected areas, apply fertilizer, and spray copper fungicide to control this (Taculao, 2021). In Puerto Rico, it was reported that fertilization and fungicides reduced the anthracnose in coffee berries (Mignucci et al. 1985). Anthracnose symptoms can appear on seedlings, flowers, fruit, leaves, nodal regions, and branches. The growth and spread of this disease are restricted by low humidity and a lack of precipitation. Small “spots or lesions” on ripening berries, dark browning of the lateral or vertical stem(s), vertical tip die-back, and premature berry death are some early symptoms. Leaf yellowing and drops of leaves that are found mid-branch are other possible early symptoms. This disease issue can be reduced with the use of approved fungicides and good plant nutrition. Reduce the likelihood of pesticide resistance by rotating fungicides from several classes (Hawaii Coffee Ed, n.d.).

By boring galleries and feeding, coffee berry disease (CBD) harms coffee beans. The direct injury to the beans encourages secondary bacterial and fungal diseases. CBD offers negatively affect both the hygienic quality of coffee and its organoleptic quality by encouraging the formation of fungal toxins (Taniwaki, 2007). It can be mistaken for other illnesses, such as “brown blight,” and subsequent infections from other illnesses may exacerbate the damage. The main cause of yield declines is the growth of CBD on young berries, which makes them rot and fall off (Muller, 1980). On immature and ripe berries, diseases can both degrade quality.

Rust, a widespread epidemic that affects almost all coffee-growing regions worldwide, is the most common and harmful illness to affect coffee. It nearly destroyed the booming coffee industry in 1891. Farmers must thoroughly inspect and quarantine imported varieties in order to control them. They also must choose suitable resistant strains or varieties, cultivate their land well, and apply the appropriate fertilization. However, if these do not seem to be effective, they can turn to apply chemicals (Taculao, 2021). Small, pale, yellow dots that gradually grow in diameter are the earliest signs of CLR and appear before the differentiation of orange-colored uredinia on the lower leaf surface. When the rust infection is severe, the leaves develop pustules that cause them to fall off early, reducing the photosynthetic area of the plant. Continual infections weaken the plant and may result in branch dieback (Sera, de Carvalho, Bartelega, et al., 2021).

Coffee Pests

According to Cao (2022), the influence of coffee pests is only noticeable once they are pervasive. Coffee trees are frequently visited by four main pests. These include ants, scale insects, stem borers, and coffee berry borers.

Insects called coffee berry borers drill holes into developing berries to lay their eggs. The Coffee Berry Borer (*Hypothenemus hampei Ferrari*), which is present in all of the world's major coffee-growing regions and is the most significant pest that negatively impacts the quality of coffee beans, develops from the eggs into larvae. Coffee bean quality may be affected by CBB infestations, even at low infestation levels. An African native, Scolytinae, is the CBB. Although Arabica is likely its primary host, CBB also infects Robusta (Damon, 2000). In the 16th and 17th centuries, CBB spread throughout much of the world. Except for Papua New Guinea and Nepal, it is now present in all major coffee-producing nations (Vega et al., 2009). CBB was discovered in Hawaii in 2010 despite stringent importing regulations, which included quarantine fumigation. Farmers need to ensure a clean harvest and culture, use insecticide, and quickly dry diseased beans to prevent them from attacking coffee trees (Taculao, 2021).

The stem borer is another coffee blight. These long-horned insects attack the roots and main stems of coffee trees by boring into the bark. Fortunately, these are easily controlled by using insecticides, removing and burning sick trees, and maintaining good cleanliness (Taculao, 2021). Young plants (7 to 8 years old) attacked by the borer may perish within a year, and infested plants exhibit noticeable ridges around the stem as well as yellowing and wilting of the leaves (TNAU, 2015).

Ants are regarded as pests of coffee trees. Although they do not directly impact the tree, they make it uncomfortable for workers and coffee pickers to be close to the trees that are afflicted. Malathion can be used to manage ants (Taculao, 2021). Also, according to Ribeyre and Avelino (2012), scale insects with mealybugs attack certain parts of coffee plant species that includes the leaves, stems, and fruiting branches. Scales, when they found a feeding place, are almost immobile.

Ribeyre and Avelino (2012) also stated that these pests and diseases can be controlled using chemical insecticides that can help to improve the quality of coffee as it prevents the invasion of pests and diseases that can severely affect the coffee quality. However, the repeating usage of these chemical insecticides can contaminate soils and plants, and may result to high Cu content in coffee beans that could produce a possible toxicity problem (Loland and Singh, 2004)

Coffee Green Scales

The green coffee scale, *Coccus viridis*, which is classified as a soft scale, is often found feeding along the main vein at the leaf and near the tips of green shoots (Uma Narashimham, 1987). According to Dekle (2001), green scales are insect pests of citrus and other plants found outdoors and in greenhouses. It usually targets green stalks, woods, and leaves as its host. It pervades fruit stalks and green shoots, culls the fruit, and may hinder the normal development of fruits (Swirski et. al., 1997). Unlikely most other soft-scaled insects, adult green scales can move around their plant host. Scales produce excessive amounts of honeydew that attract ants, one of the natural enemies of coffee. It is usually found on the upper and lower surfaces of the leaves. The female scales are parthenogenetic and oviparous and lay eggs on suitable green leaves and hatches a few moments after it is laid.

Singson (1999) reported that scale insects were observed to be the most common insect pest attacking foliage plants. Their feeding activities usually result in discoloration and spots on leaves. Moreover, when there is heavy infestation the plant crown dries up which results in defoliation and eventually death of the plant.

According to Le Pelley (1986), the green soft scale (*Coccus viridis Green*) is a serious pest of coffee in many countries. Its infestation was so devastating at times, that coffee production ceased throughout the tropics except for Australia. Laureles (2003) reported that green coffee scales (*coccus viridis*); *saisettiaa coffeae*; *ferrisia virgata*; and black aphids cause the leaves of a coffee to tree fall off prematurely due to these insects' sap-sucking behavior.

Coffee green scales suck the saps of its host which results in reduced growth and crop yield. According to Sarwar (2006), the reason for the destruction of the plant is not only because they fed on saps but also the toxicity of their saliva. *C. Viridis* is also most likely to produce toxins that weaken the plant, falling of leaves, and reduction of yield. These toxins are called sooty mold that often develops on the scales' honeydew.

Coffee green scales, with the scientific name of *Coccus viridis*, are one of the prevalent pests on coffee plants. According to Fernandes et. al. (2011), it is a generalist pest with a host of several perennial cultivated plant species that can cause severe damage to *Coffea arabica* and *Coffea canephora*. In a coffee bush, one can find scale insects here and there and, importantly, small beetle species that are visibly feeding on it (Vandermeer et. al., 2019).

The life cycle of green coffee scales starts with an egg. According to Fredrick (1943), the eggs of green coffee scales are whitish green in color and are elongate-oval in shape. The eggs are laid and hatch beneath the female where they are protected until they are born. The eggs hatch from a few minutes up to several hours after being laid. Before becoming an adult, green coffee scales have to first go through three stages of maturity called the nymphal stages. Immature green coffee scales that are currently going through maturity are called nymphs. Nymphs are oval, yellowish green in color and have six short legs (Mau and Kessing, 1992). After reaching maturity, Cheng and Tao (1963) stated that blackish brown narrow marks can be observed from the adult green coffee scales. Their shape is still oval and their body color are now pale green. Meanwhile, the death of adult green coffee scales can be determined by having a brown color and no visible movements from their spot (Hara et al., 2001).

Madre de Cacao

Gliricidia sepium is a leguminous tree in the *Fabaceae* family. *Gliricidia*, which originated in Central America, is used as a live fence in many tropical and subtropical countries. That is, it is planted along the edges of fields, and the trunks are used as fence posts. According to Matel and Torres (2004), it is a multi-purpose plant that can be used as a medical plant, ripening agent, and shade for coffee and cacao plantations. It also has non-toxic insecticidal properties that are effective against different kinds of pests.

Kakawate is well-known among farmers for its nutritious content and pesticidal ability. *Kakawate* is commonly found along rice paddies in the Philippines, and some farmers believe it can help reduce rice insect pests in their fields. Farmers claim to have had fewer pest problems. These farmers' observations have not been validated in order to elucidate the field's working mechanism.

Gonzales and Daquioag (2021) stated that the organic compound of *Kakawate* (*Gliricidia sepium*) is an effective insecticide. Also, Fortunato de la Peña (2021) further noted that The Intellectual Property Office (IPO) patent database states that the compounds of *Kakawate* can be used to repel insects and reduce oviposition in the field mating season to the host plant. Dr. Alfredo R. Rabena (2010) found that the leaves of the *Kakawate* tree or Mexican Lilac (*Gliricidia Sepium*) contain coumarins, which is an effective botanopesticide. He experimented with Flora Cely Rodilias in Ilocos Sur and Vigan City, where *Kakawate* leaves botanopesticide effectively eliminated rice weevils, rice bugs, and worms in rice fields.

Also, according to Matel and Torres (2004), Madre de cacao extract was found to be effective in repelling asparagus pests like mealy bugs and shows a significant effect on controlling adult squash beetle. In some Latin American countries, farmers use Madre de cacao as an insect-repelling agent. The natural eco-toxicological properties of natural insecticides and species selectivity and biodegradability have almost been replaced by synthetic insecticides as the standard method of controlling detrimental insects, ticks, and mites. Some farmers claim that the spray application of a solution prepared from the concentrated water extract of Madre de cacao leaves mixed with kerosene, detergent and water is effective in controlling the tobacco budworm and *Helicoverpa armigera* (Martinez and Morallo-Rejesus, 1976). Also, according to Doctor (2019), the mortality of snails are determined and it was reported that all the snails were dead in the container applied with the *Gliricidia sepium* extract and in conclusion, it is effective as a molluscicide.

Kakawate has a variety of biological properties like antiviral, anti-inflammatory, antimicrobial, antioxidant, and others (Maulion et. al., 2021). They also said that the phytochemicals present in *Kakawate* leaf extract show antioxidant properties which are present in biological pesticides. Stewart (1996) found out in a certain experiment that intercropped *Gliricidia sepium* hedges were involved with reduced rust and leafspot in groundnuts. Wiersum and Nitis (1997) further added that *Gliricidia sepium* is also associated with lower stem-borer damage in rice. Madre de cacao has different medical treatment aid for itch, fever, headache, skin soreness, prickly heat, and wounds. In Guatemala, the bark and leaves of Madre de cacao are used for treating human skin diseases (Matel and Torres, 2004).

To encourage sustainability and lessen reliance on synthetic insecticides, *kakawate* planted along fields might be promoted for insect pest management, for instance in the cultivation of rice. It might be a good pest control method (Navasero et al., 2014). Botanicals, which are non-pollutant, eco-friendly, and cost-effective, have emerged as an effective alternative to chemical pesticides in recent times. Also, according to Rint (1996), small-scale farmers who generally cannot afford commercial synthetic insecticides should use botanical pesticides, which are inexpensive, environment-friendly, and easy to prepare.

Coffee is a vital crop here in the Philippines. It has a total production rate of 23% in the year 2019. Its primary use is for brewing and blending beverages. Coffee is a valuable agricultural raw product and one of the most principal crops in the world when it comes to beverages. However, it is also considered one of the several crops that has poor management. In these cases, the coffee production is severely affected. Also, its production is affected by climatic changes, poor soil, crop diseases, and infestation of pests, and one of those pests that affect coffee production is *coccus viridis* or the green coffee scales. *Coccus viridis* is a common pest of several perennial plant species, especially citruses. It usually targets the stalks and leaves of its host. Coffee green scales are prevalent among coffee species. *C. viridis* fed on the saps of its host and produces toxins that cause suppression of growth, wilting of the plant, and reduced crop yield. Meanwhile, Madre de cacao (*Gliricidia sepium*) is popularly known for its nutritious content and its pesticidal control activity. It is commonly found in rice paddies as it is believed to help reduce rice insects in fields. *G. sepium* has coumarins, which are considered an effective botanopesticide. It is also promoted to plant along crop fields to lessen the crop pests and insects and also to avoid chemical-based insecticides. The use of pure Madre de cacao leaf extract can eliminate ants with a mortality rate of 18.7778 which is not significantly different from commercial insecticides with a mean score of 20.0000 (Matel and Torres, 2004). In this case, Madre de cacao (*Gliricidia sepium*) can help coffee plants to lessen its pest and produce more coffee beans that are valuable and vital in the world.

METHODOLOGY

This chapter contains and discusses the materials, research design, treatments, experimental layout, and the methods that were used for the gathering of materials, process of extraction, and observation of effectiveness. Also, this chapter contains the data gathering processes and the statistical treatments that were used for conducting this research study.

Materials

The following are the materials that were used in this study:

- 180 g fresh mature madre de cacao leaves
- 1000 ml distilled water
- (10) 900 ml mist-type spray bottles
- Coffee plants

Tools and Equipment

The following are the tools and equipment that were used for this study to become possible:

- Kitchen thermometer
- Stainless kettle
- Stove top
- Beaker
- Weighing scale
- Camera

Experimental Design

In this study, there were three groups of independent variables. The concentration of each extract was the independent variable while the response of the green scales was the dependent variable. Now, the dependent variables were compared using the design that was used, which is the three-group experimental design. The researchers aimed to determine the best treatment in controlling *C. viridis* on coffee. The treatments differed by its concentration which depends on the amount of Madre de cacao leaves on each treatment. The completely randomized design or called as the CRD was used in this study where it was used for assignment of treatments on the four (4) *excelsa* trees selected.

Methods

Gathering of Materials. The fresh mature Madre de cacao leaves were gathered and plucked in its plant. The leaves that were gathered are from the plants found in Indang, Cavite. The distilled water was bought in a local store in Indang, Cavite. The spray bottles were bought through commercial stores also in Indang, Cavite. The tools and equipment that were used to conduct this study such as the kitchen thermometer, beaker, stove top, stainless kettle, and weighing scale was provided by the researchers.

Process of Extraction. Figure 2 presents the process of extraction of the Madre de cacao leaves as it was used as a spray extract against coffee green scales.

The procedures that were made is as it follows:

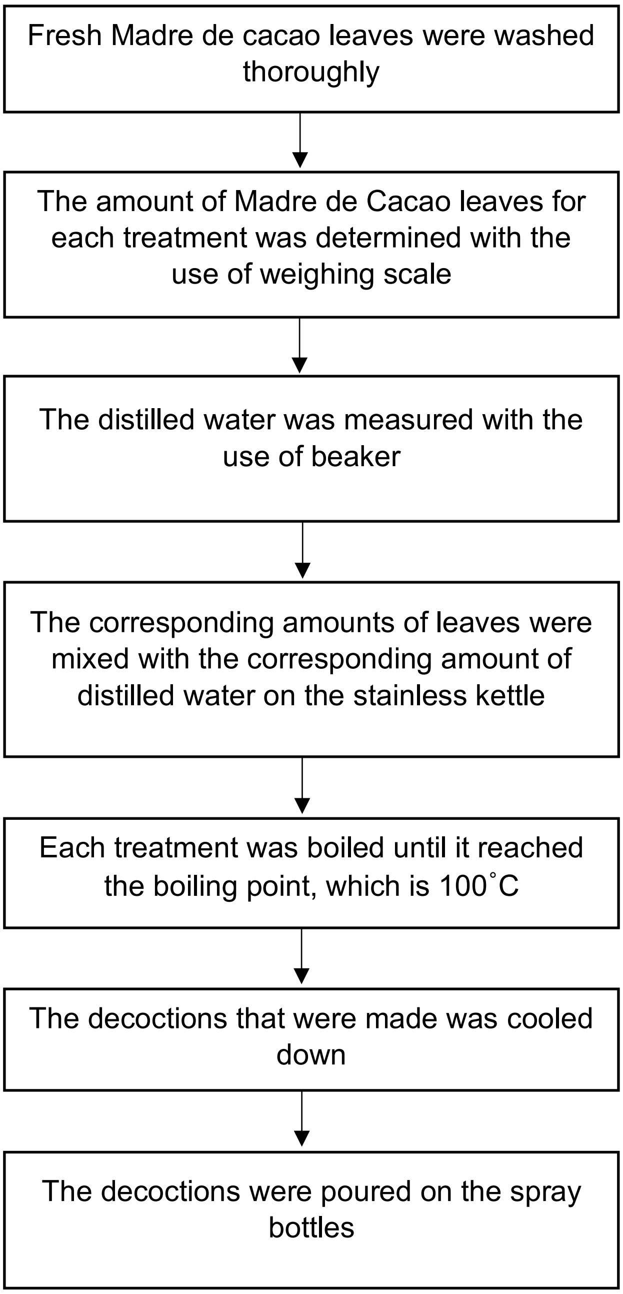


Figure 2. Process of extraction

Observation of Effectiveness. In the coffee bushes, the spray extract was used directly on the coffee green scales (*Coccus viridis*). The researchers observed the responses of the *c. viridis* upon the direct contact with the extract within 30 minutes and it was documented with the use of a phone camera of the researchers. The observation process lasted within one month, where the extract was used every after three days. The material or instrument that was used for the observation process is the provided checklist made by the researchers.

Experimental Treatments

This study had three treatments varying in the amount of Madre de cacao leaves. The three treatments of this study had three replicas. The observation was tested in the following treatments which indicate the composition of each decocted spray that was made:

T_0 = 100ml distilled water

T_1 = 10g Madre de cacao leaves, 100ml distilled water, 100˚C

T_2 = 20g Madre de cacao leaves, 100ml distilled water, 100˚C

T_3 = 30g Madre de cacao leaves, 100ml distilled water, 100˚C

The amount of the Madre de cacao leaves on each treatment was based on the study published by Escalona et. al (2010) where the doses they employed on their treatments were 10g of *Tamarindus Indica* leaves and 100ml of distilled water and 30g leaves and 100ml of distilled water for a concentrated treatment were decocted to determine its antimicrobial activity whereas a wide range of antimicrobial activity was shown.

Similar to this, in a study published by Duran-Lara et. al. (2020), a decoction of rue was made by mixing 100g of leaves with a liter of water. This study’s treatments are similar as they used the decoction method and utilized 10 percent of their volume as the basis for their amounts of leaves.

Experimental Layout

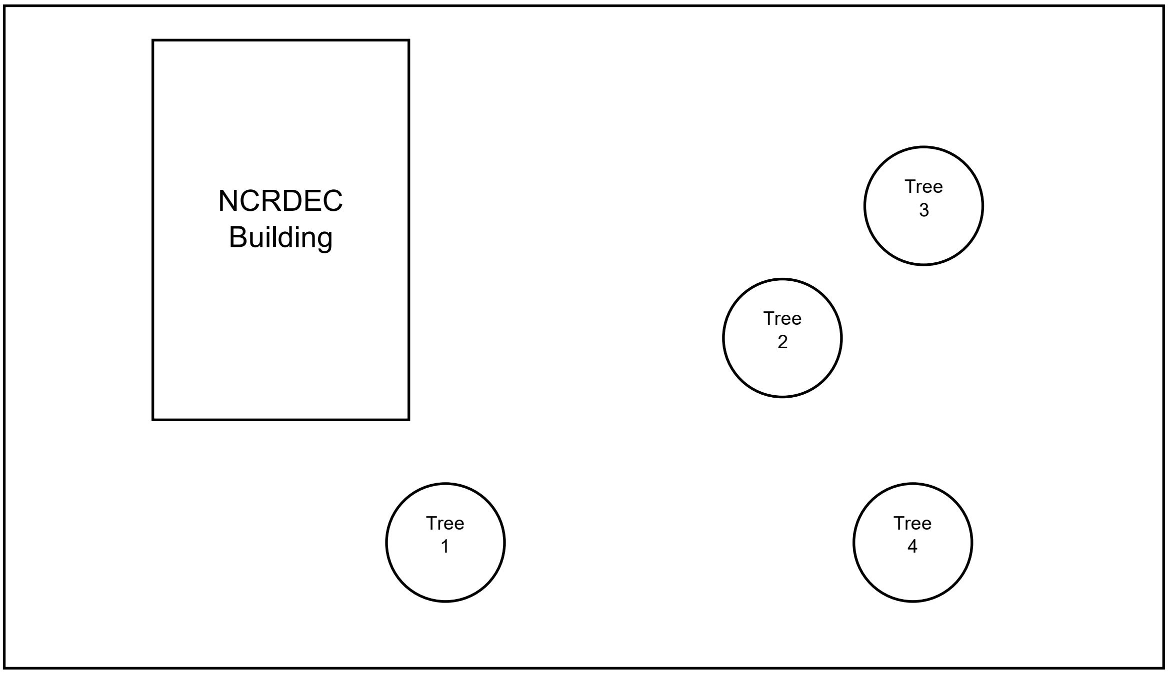


Figure 3. Selected coffee trees in the field

Figure 3 represents the location of the selected coffee trees in the field at the National Coffee Research, Development and Extension Center. All the selected trees have the same variety of coffee, which is excelsa (*Coffea excelsa*), since it is the most abundant in the field. Also, it gets the same amount of sunlight since it is planted in the open-field. The selected trees were used for each treatment where it was applied using a mist-type spray bottle since that is the commonly used spraying technique in insecticides and pesticides as stated by the United States Environmental Protection Agency (2022). The extract was applied to the selected leaves of each tree, where the basis that was used to select the leaf is the amount of sooty mold present in it. Signages and ribbons were used as the red tag, where signages were attached to the selected trees and the red ribbons for the selected leaves. Tree 1 was assigned with the replicas of treatment 3. Tree 2 was the selected tree that has the leaves where the replicas of treatment 2 was applied. Meanwhile, Tree 3 has the leaves of the treatment 1 and the treatment 0 was applied on a leaf of the tree 4.

Data Gathering Procedures

The response of the coffee green scales (*c. viridis*) in terms of its mitigating and the effect of the extract on the plant, such as the discoloration of the leaf, was the data that were gathered in this study with the use of the observation checklist that was provided by the researchers evert after application. Also, the best treatment in controlling the coccus viridis and the economic analysis of the utilization of the developed treatments were gathered in this study. These data were gathered during the observation process that was conducted by the researchers in Indang, Cavite. Appendix 1, leaf appearance observation checklist, presents the checklist that was used by the researchers as the basis of the changes in leaf appearance of the leaves that were treated while Appendix 2, response of green scales observation checklist, was used by the researchers as the basis for determining the mitigating effect of the leaf extract on coffee green scales.

Statistical Analysis and Treatment of Data

The statistical analysis that was used in this study is the Cost-Benefit Analysis. This treatment was used to determine the economic analysis of the developed extract, one of the given objectives by the researchers.

RESULTS AND DISCUSSION

This chapter contains the results that were gathered in this study as well its presentation, analyses, and its interpretation. It discusses the obtained data such as the various treatments that uses Madre de Cacao leaf extract as a mitigating agent against green coffee scales, the responses of coffee green scales and the effects of the leaf extract on the plant after applying each treatment, the most effective treatment against coffee green scales on coffee plants in terms of its leaf appearance and its mitigating effect, as well as the economic analysis of the developed spray extract.

Responses of Coffee Green Scales and Effects of the Leaf Extract on the Plant After Applying Each Treatment

Table 1. Effects of spray extract every after 30 minutes during the first application

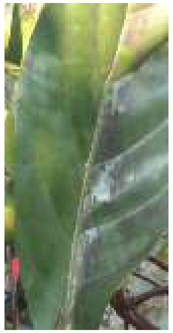
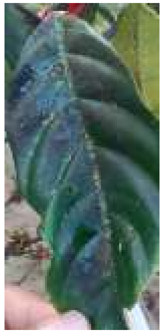
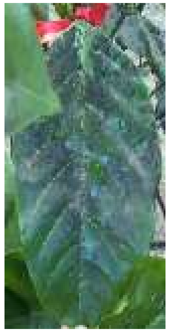
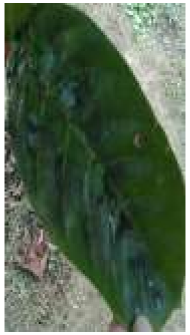
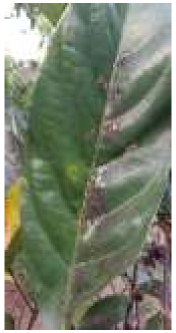
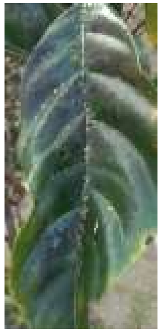
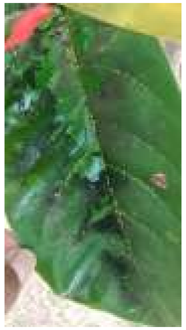
	T0	T1R1	T1R2	T1R3	T2R1	T2R2	T2R3	T3R1	T3R2	T3R3
Before										
After 30 minutes										

Table 1 presents the results obtained after 30 minutes from observing the before and after-thirty-minute observation of each treatment and their respective replicas. Treatment 0 showed no difference after 30 minutes of observation, as well as the replicas of Treatment 1. Meanwhile, T2R1 showed some differences in the amount and color of the green coffee scales. In the other hand, T2R2 and R3 showed no visible difference after the observation. Also, all replicas of treatment 3 showed no visible changes after the observation. In addition, compared to the after-thirty-minute observation of the first application, the second application did not show any visible changes after the observation.

Table 2. Effects of spray extract every after 30 minutes during the second application

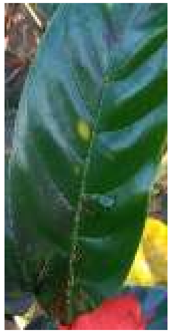
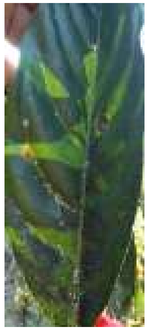
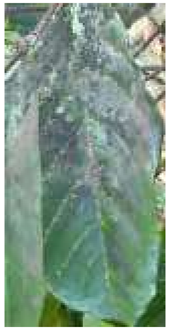
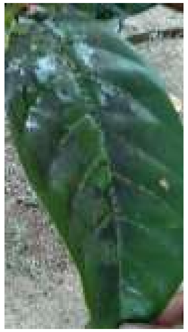
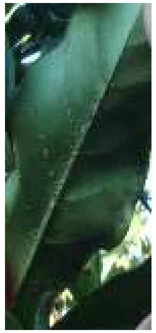
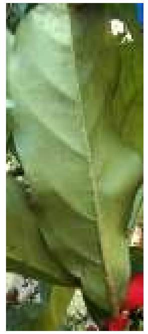
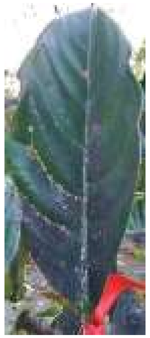
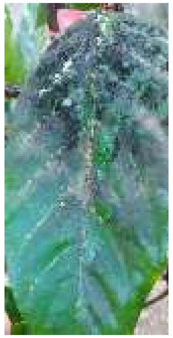
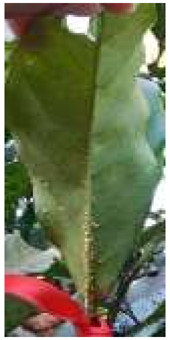
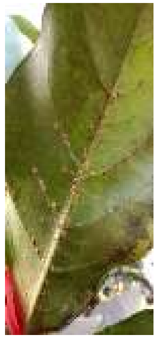
	T0	T1R1	T1R2	T1R3	T2R1	T2R2	T2R3	T3R1	T3R2	T3R3
Before										
After 30 minutes										

Table 2 presents the second day results obtained from observing the before and after-thirty-minute observation of each treatment and their respective replicas. Treatment 0 showed no difference after 30 minutes of observation. All the replicas of treatment 1 also showed that there were no differences after the observation. Moreover, all the replicas of treatment 2 had no changes after the observation as well as the replicas of treatment 3. Also, aside from the visible changes in the leaf color, there are no other observable changes after comparing this application to the last application.

Table 3. Effects of spray extract every after 30 minutes after a week of application

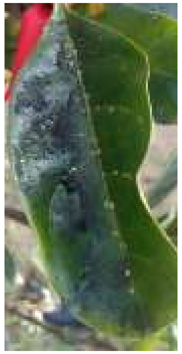
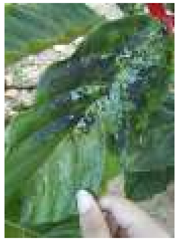
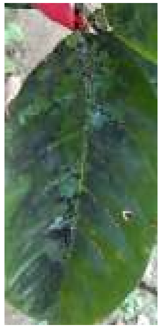
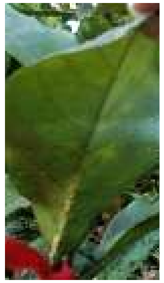
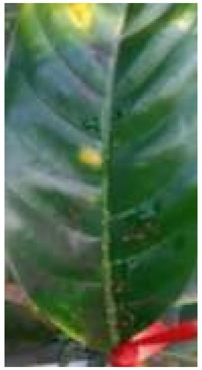
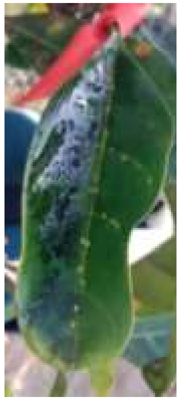
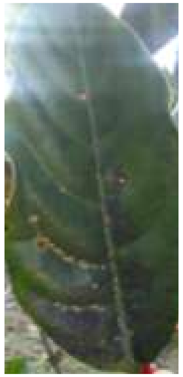
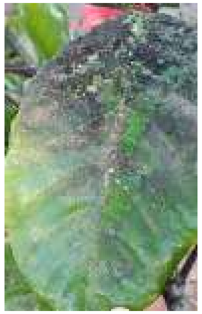
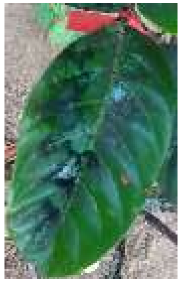
	T0	T1R1	T1R2	T1R3	T2R1	T2R2	T2R3	T3R1	T3R2	T3R3
Before			The leaf died and did not perform any application from this day.							
After 30 minutes										

Table 3 presents the results obtained after a week from observing the before and after-thirty-minute observation of each treatment and their respective replicas. Treatment 0 showed no changes after 30 minutes of observation. T1R1 and R3 had no changes after the observation. Meanwhile, T1R2 was found to have fallen before conducting the application. All the replicas of treatment 2 showed no changes after the observation as well as the replicas from treatment 3. Lastly, when comparing the fourth application to the last application, there are no other visible changes besides the changes in color of the two replicas of T2.

Table 4. Effects of spray extract every after 30 minutes during the fourth application

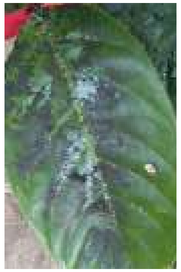
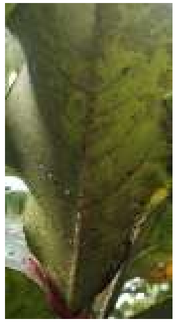
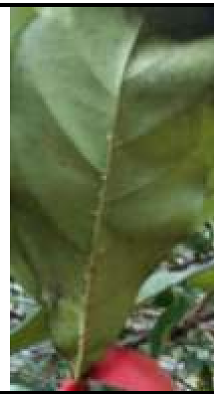
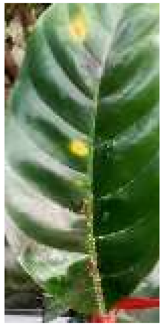
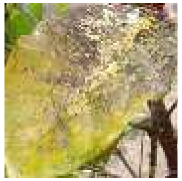
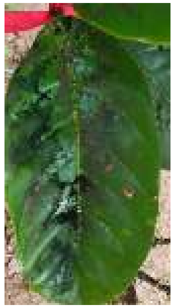
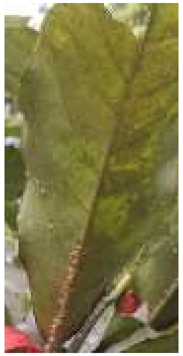
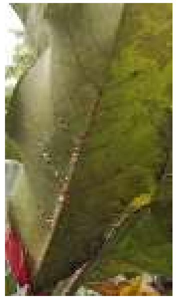
	T0	T1R1	T1R2	T1R3	T2R1	T2R2	T2R3	T3R1	T3R2	T3R3
Before			The leaf died and did not perform any application from day 3							
After 30 minutes										

Table 4 presents the fourth day of application results obtained from observing the before and after-thirty-minute observation of each treatment and their respective replicas. Treatment 0 showed no changes after 30 minutes of observation. Also, all the replicas of treatment 1 showed no changes after the observation as well as the replicas from treatment 2. Finally, all the replicas of treatment 3, just like the other treatments, showed no changes after the observation. Therefore, similar to the previous one, which was after a week of application and showed no changes even after 30 minutes, this fourth day of application also showed no evident changes either after 30 minutes or after the application in all replicas of each treatment.

Table 5. Effects of spray extract every after 30 minutes after two weeks of application

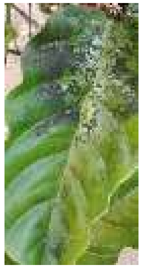
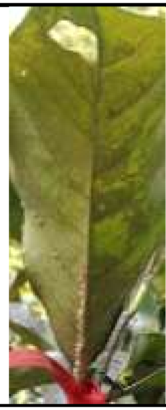
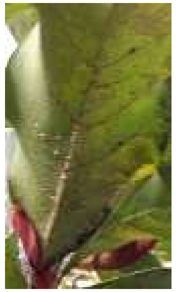
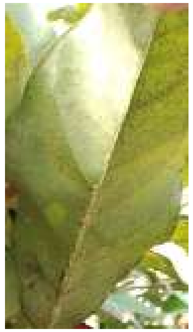
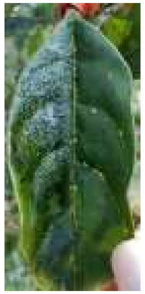
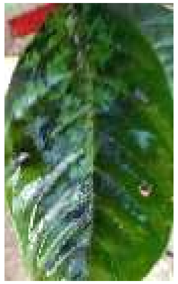
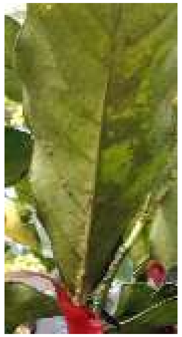
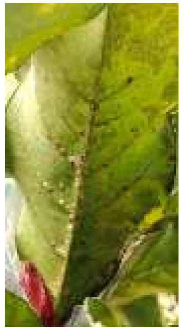
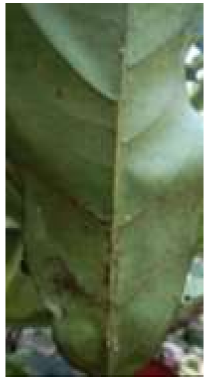
	T0	T1R1	T1R2	T1R3	T2R1	T2R2	T2R3	T3R1	T3R2	T3R3
Before			The leaf died and did not perform any applicati on from day 3							
After 30 minutes					The leaf died and did not perform any application from this day					

Table 5 presents the results obtained after two weeks from observing the before and after-thirty-minute observation of each treatment and their respective replicas. T0 showed no difference after 30 minutes of observation. All the replicas of treatment 1 also showed that there were no changes after 30 minutes of observation. T2R1 was brown in color before conducting the application. In the other hand, T2R2 was also found to have changed its color from light green to yellow green. Meanwhile, T2R3 showed no changes after 30 minutes of observation. Lastly, all the replicas of treatment 3 also showed no changes after the observation. Thus, these results show that changes in color occur in some of the treatments and replicas after two weeks of application compared to the fourth application, which had no impact at all.

Table 6. Effects of spray extract every after 30 minutes during the sixth application

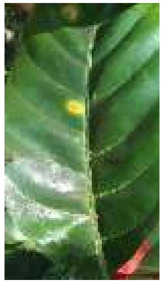
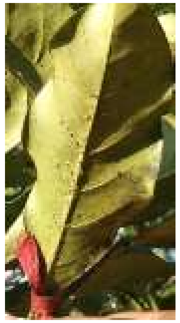
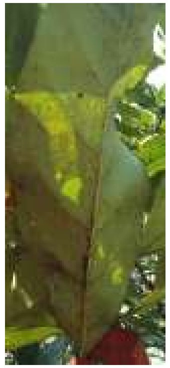
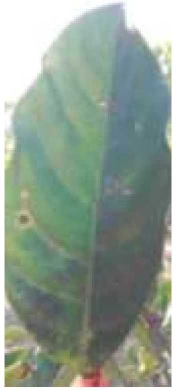
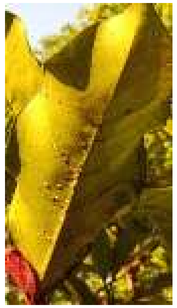
	T0	T1R1	T1R2	T1R3	T2R1	T2R2	T2R3	T3R1	T3R2	T3R3
Before			The leaf died and did not perform any application from day 3		The leaf died and did not perform any application from day 5					
After 30 minutes										

Table 6 presents the sixth day of application results that were obtained from observing the before and after-thirty-minute observation of each treatment and their respective replicas. Treatment 1, treatment 2, treatment 3 and their replicas had the total visibility of green coffee scales reduced by half. Treatment 0 showed no changes after 30 minutes of observation. All the replicas of treatment 1 had no changes after the observation. All the replicas of treatment 2 also showed that there were no changes after the observation as well as the replicas of treatment 3. Comparing to the sixth application, wherein the visibility of green coffee scales from all replicas of treatments 1 to 3 was reduced by half, in this case after two weeks of application, it is the same as it is in this case after three weeks of application. In addition to this, there is Treatment 0, since the previous application it did not show any effect.

Table 7. Effects of spray extract every after 30 minutes after three weeks of application

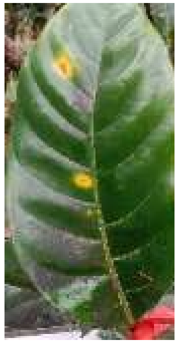
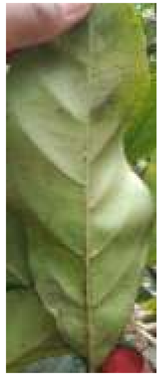
	T0	T1R1	T1R2	T1R3	T2R1	T2R2	T2R3	T3R1	T3R2	T3R3
Before			The leaf died and did not perform any application from day 3		The leaf died and did not perform any application from day 5					
After 30 mins										

Table 7 presents the results obtained after three weeks from observing the before and after-thirty-minute observation of each treatment and their respective replicas. Treatment 1, treatment 2, treatment 3 and their replicas had the total visibility of green coffee scales reduced by more than half, except for T3R2. Treatment 0 showed no changes after 30 minutes of observation. All the replicas of treatment 1 also showed no changes after the observation. All the replicas of treatment 2 showed that there were no changes after the observation. Lastly, all the replicas of treatment 3, just like the other treatments showed no difference after the observation.

Various Treatments in Mitigating Green Coffee Scales

Figure 4-5. Leaf before and after 1 month of application of treatment 0

Figure 4 shows the appearance of the leaf before the application of treatment 0 while figure 5 shows the appearance of the leaf after one month of application and observation. In which distilled water was being used, it showed no evident changes from the application of Treatment 0 until the last application. Also, there was no transition in leaf color or overall appearance. Moreover, there were no diminished or affected green coffee scales.

Table 8. Overall effect of treatment 1

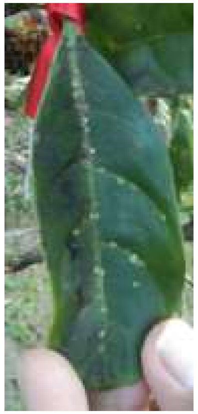
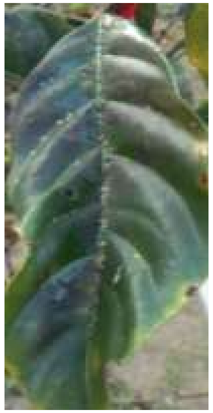
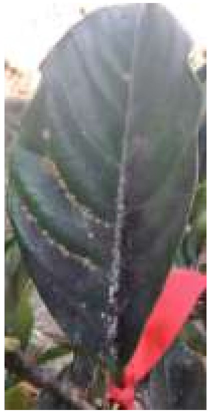
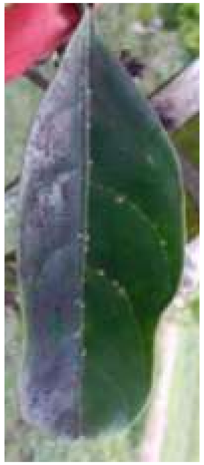
	T1R1	T1R2	T1R3
Before			
After 1 month			

Table 8 shows the results of the effects made by treatment 1 with three replicas after a month of observation. The consistency in both leaf colors of T1R1 and T1R3, which are dark green, was visible. Meanwhile, the leaf of T1R2 turned brown on the third day of application and was found fallen from the tree, resulting in the absence of documentation by the researchers due to the leaf being unfindable. Overall, there were no changes determined for all three replicas of Treatment 1 on the first application. According to Hara et al. (2001), the death of adult green coffee scales can be determined by having a brown color and no visible movements from their spot. In the last application on T1R1 and T1R3, the mortalities were more than a half while on T1R2 all green coffee scales were dead.

Table 9. Overall effect of treatment 2

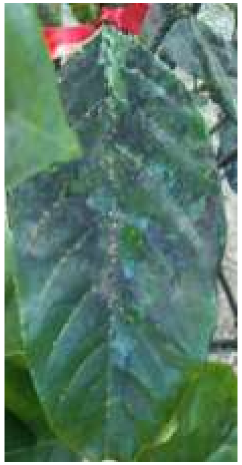
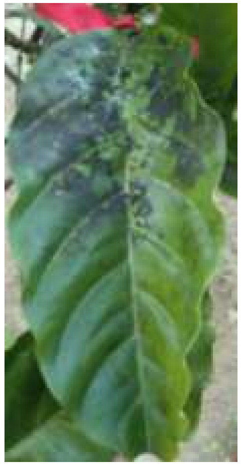
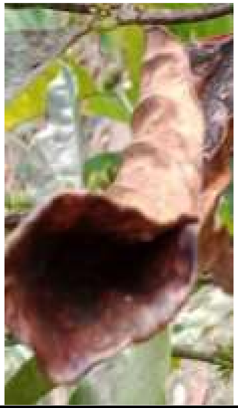
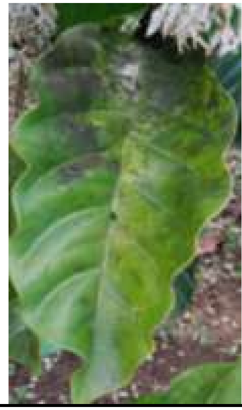
	T2R1	T2R2	T2R3
Before			
After 1 month			

Table 9 presents the results obtained through the observation of treatment 2 with 3 replicas after a month of application. T2R1 ended up being brown in color from being dark green to yellow green and died on the second week of application. T2R2 on the other hand from a light green color turned into yellow green. Then, T2R3 is a consistent dark green.

In terms of the effectiveness of this treatment to the green coffee scales, T2R1 showed some visible changes and T2R2 showed no changes as well as T2R3 on the first day. On the last day, all coffee green scales of replica 1 and 2 leaves turned brown indication that they are already dead. While replica 3, mortalities were more than half of the total number of green coffee scales.

Table 10. Overall treatment of treatment 3

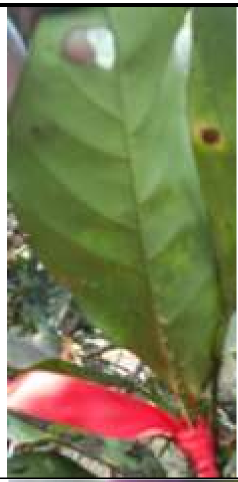
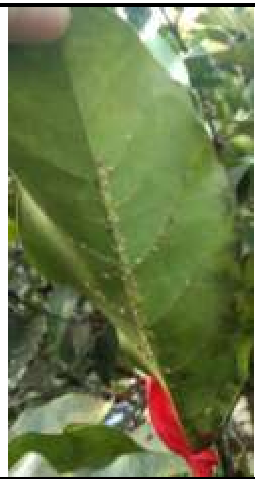
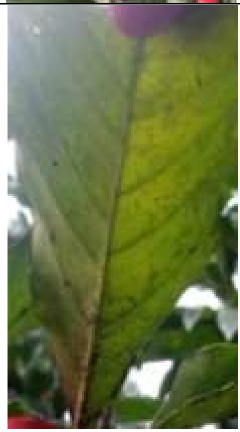
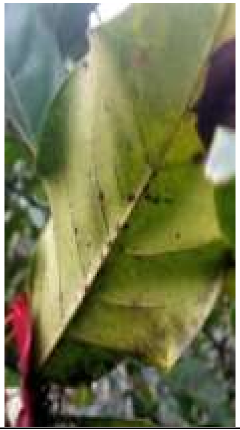
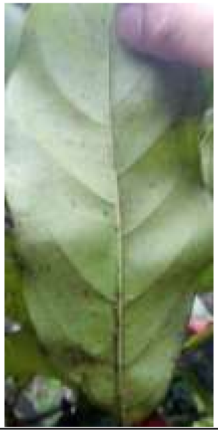
	T3R1	T3R2	T3R3
Before			
After 1 month			

Table 10 provides the results acquired through the observation of treatment 3 with 3 replicas after a month of application. Light green color was unchanged for both leaf of T3R1 and T3R3. T3R2 was a light green also but turned yellow green during the third week of application. Furthermore, all replicas have no visible changes made however at the end of the observation after a month, all green coffee scales were found dead.

Most Effective Treatment Against Coffee Green Scales on Coffee Plants – Leaf Appearance

Table 11. Effects of treatment 0 on the leaf appearance by its color and its mitigating effect

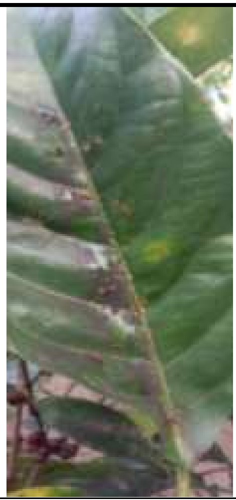
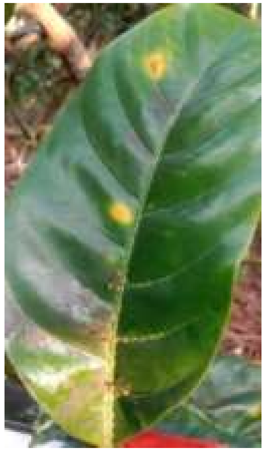
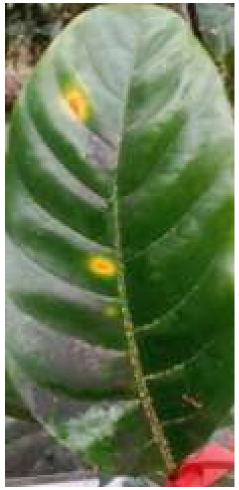
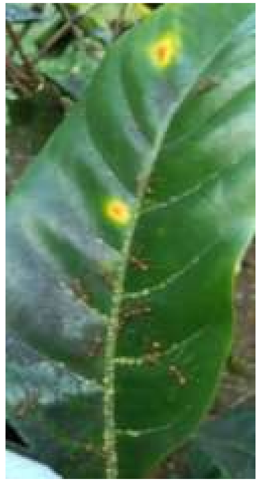
	AFTER 30 MINUTES	AFTER 3 DAYS	AFTER A WEEK	AFTER 2 WEEKS	AFTER 3 WEEKS	AFTER A MONTH
Treatment 0						

Table 11 shows the different effects of treatment 0 based on its color throughout the month that was captured during the observation period. The leaf did not show any changes in its leaf appearance based on its color in the end of the observation. The leaf color of the treatment 0 in the beginning was dark green based on the written checklist. There are some discolorations that appeared on the edge of the leaf during the first week of the application, though, it disappeared on the third week.

Table 12. Effects of treatment 1 on the leaf appearance by its color and its mitigating effect

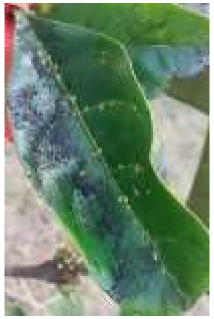
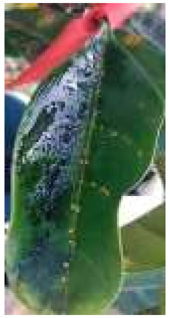
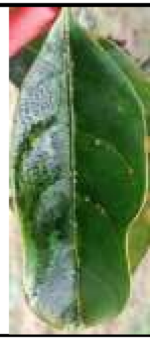
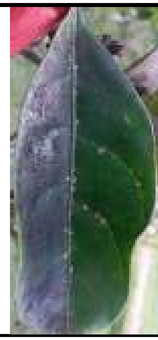
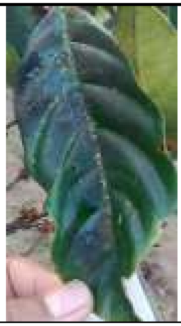
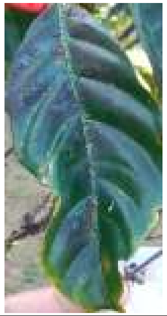
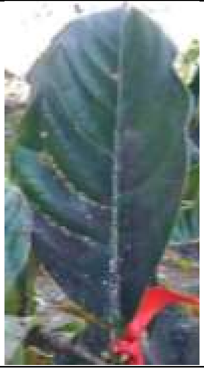
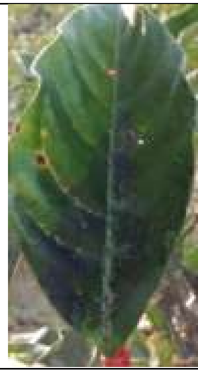
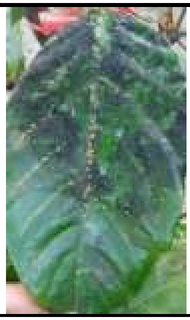
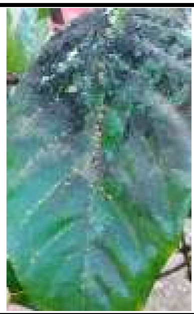
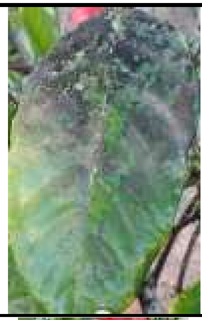
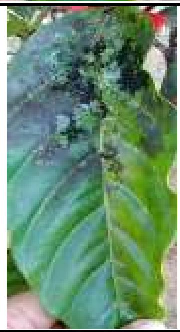
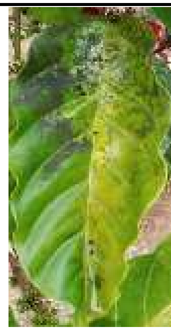
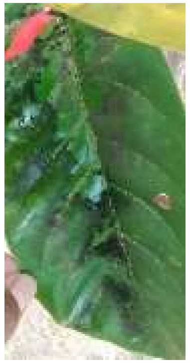
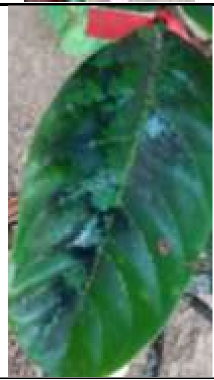
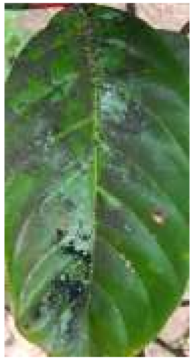
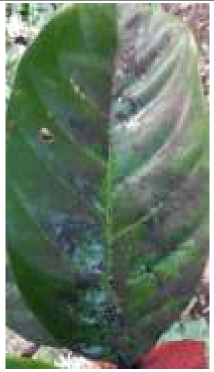
	AFTER 30 MINUTES	AFTER 3 DAYS	AFTER A WEEK	AFTER 2 WEEKS	AFTER 3 WEEKS	AFTER A MONTH
T1R1						
T1R2						
T1R3						

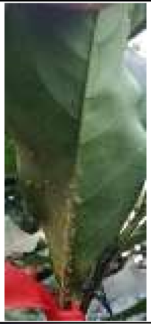
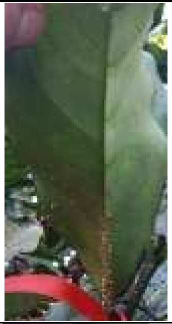
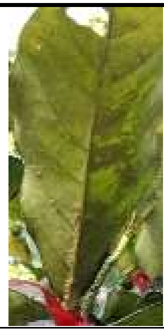
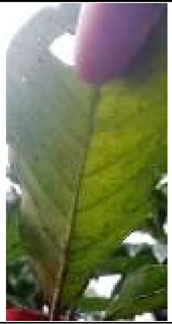
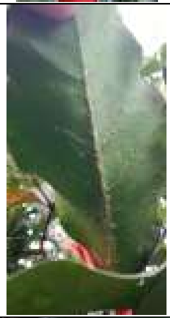
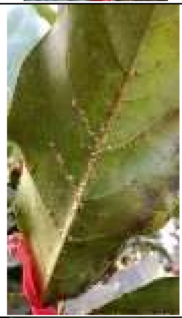
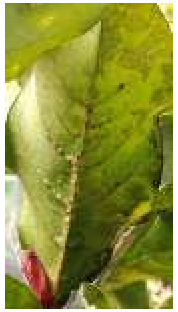
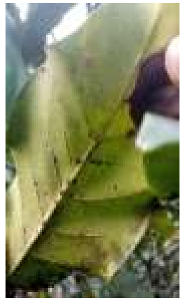
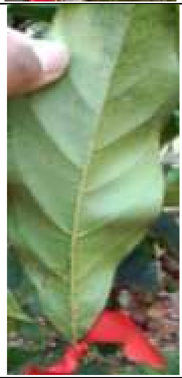
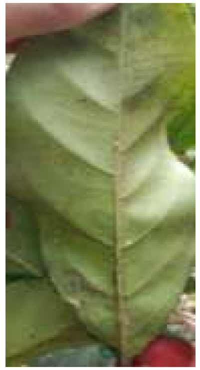
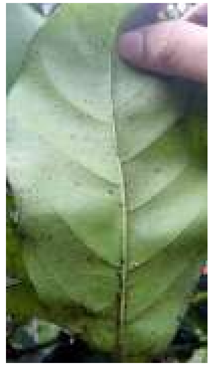
Table 12 represents the changes that occurred during the one-month observation period with the leaves where treatment one was applied. The leaf color of T1R1 was dark green and there were no discolorations that appeared during the observation period. Meanwhile, the other replica, T1R2, had a dark green leaf color, however, the leaf turned brown during the third day of application and was fallen from the tree. In the other hand, T1R3, the third replica, showed no changes in its leaf color which it started as dark green and there were no discolorations that occurred.

Table 13. Effects of treatment 2 on the leaf appearance by its color and its mitigating effect

	AFTER 30 MINUTES	AFTER 3 DAYS	AFTER A WEEK	AFTER 2 WEEKS	AFTER 3 WEEKS	AFTER A MONTH
T2R1						
T2R2						
T2R3						

The effects of the treatment 2 on the leaf appearance based on its color was shown as the table 13. The first replica, T2R1, has a dark green leaf color in the start of the observation. After a week of application, it started to change its color and turned yellow-green based on the checklist given. In the second week of application, it turned brown as it died on the tree. Moreover, T2R2 has its color as light green. It then started to change its color to yellow-green, based on the checklist, on the second week of application and it was its color until the end of the observation. Lastly, T2R3 has its color in the beginning as dark green and there were no any discolorations that was observed during the one-month period.

Table 14. Effects of treatment 3 on the leaf appearance by its color and its mitigating effect

	AFTER 30 MINUTES	AFTER 3 DAYS	AFTER A WEEK	AFTER 2 WEEKS	AFTER 3 WEEKS	AFTER A MONTH
T3R1						
T3R2						
T3R3						

The treatment 14 changes in the leaf appearance based on its color was presented on the table 14. T3R1 has a light-green leaf color based on the provided checklist in the start of the observation period. It did not show any discolorations until the end of the application and observation period. In the other hand, T3R2, also has a light-green color in the beginning of the observation period. However, during the last week, third week of application, it started to shift its color to yellow-green. Also, the third replica, T3R3, has its color as the first replica, light-green, and there were no discolorations seen until the end of the observation.

Most Effective Treatment Against Coffee Green Scales on Coffee Plants – Mitigating Effect

Table 11 shows the photo documentation for every application of Treatment 0. As shown in the table, there were no reactions made by the green coffee scales from the start to the very end of the application, where distilled water was used in every application.

The effects of treatment 1 on mitigating the green coffee scales are seen in Table 12. There were no noticeable changes seen after 30 minutes of the first application. Some visible changes in scales turning brown in T1R1 started after three days, and after three days until after a month, more than half were already dead. Meanwhile, T1R2 had not been observed due to the leaf's falling from the tree after 3 days. T1R3 also acquired visible changes in scales, turning brown after 3 days, until half of its number started to die after one month.

Table 13 presents the overall mitigation impact made by treatment 2 on green coffee scales. T2R1 immediately made visible changes on green coffee scales after 30 minutes of application, while the other two had no visible changes. T2R1 reached more than half of all mortalities in the span of a week and continued until all green coffee scales were dead after a month. T2R2 reached less than half of the mortality rate after 3 days and became more than half of the number after a week, until all died after a month. Lastly, coffee green scales on T2R3 had more than half of their number die after a week until the end of observation.

Table 14 displays the results acquired in effectiveness of treatment 3 by its mitigation period. No changes were seen after 30 minutes of application per replica. T3R1 caused half of the number of green coffee scales to die after 2 weeks and all of them to die after a month. T3R2 only showed visible changes after a week, and half of the number of green scales died after the following week, then all died after a month. Meanwhile, half of the number of scales died in T3R3 after two weeks and all became dead after a month.

Economic Analysis of Leaf Extract

Table 15. Production cost of the leaf extract

MATERIALS	AMOUNT	UNIT
Spray Bottle	30	pesos/bottle
Kakawate Leaves	1	pesos/30grams
Distilled Water	1	pesos/decoction
Labor	2	pesos/bottle
Electricity	2	pesos/bottle
Total	37	pesos/bottle
Daily Production	160	bottles/day
Daily Production Cost	5920.00	pesos/day

Table 15 reflects the list and total amount of expenses in making each bottle of decoction, together with the number of daily productions possible as well as the daily production cost. It contains all the materials that were used to create the most effective decoction, the third treatment, and its corresponding cost per bottle. The daily production was computed by dividing the eight hours of labor per day by three minutes, the amount of time making one decoction bottle while the daily production cost was computed by multiplying the daily production and the total cost of the materials needed per bottle.

Table 16. Production benefits of the leaf extract

	AMOUNT	UNIT
Markup	30%	
Markup Value	11.1	pesos/bottle
Selling Price	48	pesos/bottle
Gross Benefits	7680.00	pesos/day
Net Benefits	1760.00	pesos/day
	7040.00	pesos/week
Monthly Benefits	28,160.00	pesos
Annual Benefits	337,920.00	pesos

Table 16 shows the markup and selling price of each bottle, including the gross and net benefits per day. It also displays the monthly and annual benefits that can be gained. The selling price was computed by adding the markup value to the total cost of the production of one decoction. The gross benefits of the developed extract were computed by multiplying the selling price and the daily production, the number of bottles that can be made in a day. Meanwhile, the net benefits were computed by subtracting the gross benefits to the daily production cost. Then, the net benefits were multiplied to four, number of working days, to get the weekly net benefits. It was then multiplied to four, that corresponds to the four weeks in a month, to get the monthly benefits. Lastly, the annual benefits were gathered by multiplying the net benefits to twelve, corresponds to twelve months per year.

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter contains the summary of this study, as well as the summary of findings that were obtained by the researchers. Also, this chapter discusses the conclusions and recommendations that the researchers came up to where the findings found were the basis.

Summary

Coffee is a popular beverage globally. It is a highly profitable crop where it is the primary source of income to the Filipino farmers especially in upland Cavite. However, it is a crop that has poor management. Due to its poor management, the production of coffee decreases due to the presence of pests and disease on it. One of the causes of this lower production rate of coffee is the coffee green scales, which produces sooty mold, that weakens the plant, wilts the leaves, and lower its yield (Laureles, 2003). On the other hand, Madre de Cacao (*Gliricidia sepium*), also known as *kakawate* locally, is an abundant plant in Indang, Cavite that are usually left behind despite its composition of coumarins, a potent botanopesticide. Therefore, this study aimed to develop a pesticidal control agent made from Madre de Cacao leaf extract to manage the infestation of coffee green scales (*coccus viridis*).

The focus of this study was to determine the potential of Madre de cacao leaf extract as a pesticidal agent against green coffee scales. Scale insects are considered as the most abundant and frequent pests found on coffee plants. This infestation can lead to plant death, which affects the work and income of the coffee farmers in our country. The primary objectives of this study were to: (1) Determine the various treatments with the use of Madre de cacao leaf extract in controlling coffee green scales. (2) Observe the response of the coffee green scale and the effects of the extract on the plant after applying each treatment. (3) Identify the most effective treatment of Madre de cacao leaf extract against coffee green scales in terms of its: (a) leaf appearance and (b) mitigating effect; and lastly, (4) figure out the economic analysis of utilizing the solution.

This study was conducted from November 2023 to July 2023 at Cavite State University particularly in National Coffee Research, Development and Extension Center in Indang, Cavite. The researchers observed the effectiveness of three treatments with different concentrations of Madre de cacao leaf extract with three replicas for each treatment against green coffee scales in an open field area.

The observations of the researchers were presented and discussed in chapter 4 with the use of images of each replica before and after each application of the extract. The observations showed that treatment 3 resulted in the higher death and control rate out of all the three treatments after a month of observation. After 30 minutes, T2R1 showed some visible changes in the amount of coffee green scales. All of the other replicas showed no signs of change after 30 minutes of observation. After 3 days, T1R1, T3R1, T3R2, and T3R3 showed some visible changes in the amount of coffee green scales. T2R2 had less than half of the coffee green scales dead while T1R2 had more than half of the coffee green scales dead. The rest of the replicas showed no signs of change after 3 days of observation. After 1 week, T0 showed no changes. T1R2 turned brown in color while T2R1 turned yellow green in color. The remaining replicas showed visible changes in the amount of green coffee scales. After 2 weeks, T0 showed no changes. T2R1 turned brown in color while T2R2 turned yellow green in color. T1R1 and T3R2 had less than half of the green coffee scales dead and the rest of the replicas had more than half of the green coffee scales dead. After 3 weeks, T0 showed no changes. T3R2 had less than half of the green coffee scales dead while the rest of the replicas had more than half of the green coffee scales dead. After a month, T0 showed no changes. T1R1, T1R3 and T2R3 had more than half of the starting green coffee scales dead while the rest of the replicas had all of the green coffee scales dead and turned black in color.

Conclusion

Following the findings, these conclusions are made:

1. The potential of Madre de Cacao leaf extract as a pesticidal agent against green coffee scales was proven in this study as it shown a high mortality rate amongst the treatments, especially treatment 3.
2. There are different treatments utilizing Madre de cacao leaf extract on mitigating coffee green scales were three, such as treatment 1 containing 10 g of Madre de cacao leaves, treatment 2 with 20 g of Madre de cacao leaves, and treatment 3 with 30g of Madre de cacao leaves, with three replications; each of these treatments boil at 100°C with 100 ml of distilled water.
3. There are no immediate changes or responses, but as the application and observation progress, the responses of coffee green scales are the change of their color into brown and black, an indication that they are already dead, while the effect of each treatment on the plant, particularly the leaves where it was sprayed, is the change in their color as well; some dried, turned yellowish, and some remained green.
4. In terms of mitigating effect, the most successful Madre de Cacao treatment against green coffee scales on coffee plants is treatment three, which has 30g of leaves in 100ml of distilled water, in which each leaf with green coffee scales has full mortality in all three replicas at the outcome of observation, which is a month later.
5. The developed decoction has a daily production cost of 5920.00Php and an annual benefit of 337,920.00Php if there will be a thirty percent markup added on the total cost of materials per bottle that was made.

Recommendations

Based on the findings that were gathered in this study, here are the recommendations that the researchers made:

1. The potential of Madre de Cacao leaf extract as a pesticidal agent against green coffee scales was proven in this study; thus, coffee farmers may use this organic and effective pesticide as an alternative to chemical-based pesticides.
2. The Madre de Cacao leaf extract decoction may be used by coffee farmers to lessen the negative effects of green coffee scales on coffee plants, leaves, and berries.
3. Utilization of the Madre de Cacao leaf extract was encouraged to coffee farmers, especially in the Philippines, to increase coffee production rate that was affected by the green coffee scales.
4. A relevant study can be performed to observe the long-term effects of the Madre de Cacao extract on coffee plants and to determine the shelf life of the decoction itself.
5. Future researchers may conduct another study that is similar to this and consider some variables, such as the weather and temperature, that were not evaluated in this study to see if the data that were obtained will remain the same.
6. Researchers may also conduct a study that focuses on the chemical analysis of Madre de cacao leaves and determine which component of the plant helped to mitigate the coffee green scales.

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APPENDICES

Appendix 1. Leaf appearance observation checklist

POTENTIAL OF MADRE DE CACAO *(Gliricidia sepium)* LEAF EXTRACT AS A PESTICIDAL CONTROL AGENT AGAINST THE COFFEE GREEN SCALES *(Coccus viridis)*

Name (optional): ___________________________________

Date: ______________

Treatment Number: _________ Replica Number: __________

Directions:

Tick the box that corresponds to the color during the observation.

Spraying after…				
Three days				
A week				
Two weeks				
Three weeks				
A month				

Appendix 2. Response of green scales observation checklist

POTENTIAL OF MADRE DE CACAO *(Gliricidia sepium)* LEAF EXTRACT AS A PESTICIDAL CONTROL AGENT AGAINST THE COFFEE GREEN SCALES *(Coccus viridis)*

Name (optional): ________________________________

Date: _____________

Directions:

Fill the chart based on the observation during the application of the spray extract against coffee green scales on coffee plants which will be the infestation of coffee green scales in certain time.

Treatments	After 30 minutes	After 3 days	After a week	After 2 weeks	After 3 weeks	After a month
0						
1						
2						
3						

APPENDIX FIGURES

Appendix Figure 1. Gathering of Madre de cacao leaves

Appendix Figure 2. Preparation of Madre de cacao leaves
and tools and equipment

Appendix Figure 3. Weighing Madre de cacao leaves

Appendix Figure 4. Cleaning the Madre de cacao leaves

Appendix Figure 5. Boiling process

Appendix Figure 6. Transferred Madre de cacao leaf extract to spray bottles

Appendix Figure 7. Application of the extract on the coffee leaves

Appendix Figure 8. Observation of the effectiveness of the spray extract in terms of its leaf appearance and mitigating effect

Appendix Figure 9. Red tag that was attached to the trees that were used for experimentation